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THREE ESSAYS IN IMPACT EVALUATION OF ECONOMIC POLICIES

Dautovic Ernest

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FACULTÉ DES HAUTES ÉTUDES COMMERCIALES

DÉPARTEMENT D'ÉCONOMIE

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THÈSE DE DOCTORAT

présentée à la

Faculté des Hautes Études Commerciales
de l'Université de Lausanne

pour l'obtention du grade de
Docteur ès Sciences Économiques,
mention « Économie politique »

par

Ernest DAUTOVIC

Directeur de thèse
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IMPRIMATUR

Sans se prononcer sur les opinions de l'auteur, la Faculté des Hautes Etudes Commerciales de l'Université de Lausanne autorise l'impression de la thèse de Monsieur Ernest DAUTOVIC, titulaire d'un bachelor en Statistique et Finance de l'Università di Bologna, et d'un master en Statistique et Economie de l'Università di Roma « La Sapienza », en vue de l'obtention du grade de docteur ès Sciences économiques, mention « Economie politique ».

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THREE ESSAYS IN IMPACT EVALUATION OF ECONOMIC POLICIES

Lausanne, le 6 juin 2019

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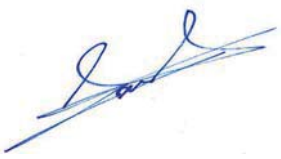
Signature:  Date: 05 June 2019

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ingredients for a successful organization and completion of this adventure. Thanks to their support, advise and their trust the PhD dissertation has taken an unexpected but extremely enjoyable turn.

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UNIVERSITY OF LAUSANNE

Abstract

Faculty of Business and Economics
Department of Economics

PhD in Economics

Three Essays in Impact Evaluation of Economic Policies

by Ernest Dautović

The PhD dissertation consists of three separate chapters. Each chapter is a self-contained academic work and can be read in isolation. The common theme across the three chapters is the desire to master the techniques and methods for a rigorous and causal assessment of economic policies.

The first chapter is a co-authored work with Professor Harald Hau from the University of Geneva, and Professor Yi Huang from the Graduate Institute in Geneva. The paper evaluates the impact of the Chinese minimum wage policy on consumption of low wage household for the period 2002-2009. Using a representative household panel, we find that the consumption response to minimum wage hikes is increasing in the minimum wage share of household income. In particular, we find that poorer households fully consume their additional income. This large marginal propensity to consume is driven by households with at least one child, while childless poor households save two thirds of a minimum wage hike. The expenditure increase is concentrated in health care and education with potentially long-lasting benefits to household welfare

The second chapter is a joint work with Ana Paula Cusolito and David McKenzie both from The World Bank Group. We conduct a five-country randomized experiment in the Western Balkans that works with 346 firms and delivers an investment readiness program to half of these firms, with the control group receiving an inexpensive online program instead. Investment readiness programs attempt to help firms to become ready to attract and accept outside equity funding through a combination of training, mentoring, master classes, and networking. A competition event was held for these firms to pitch their ideas to independent judges. The investment readiness program resulted in a 0.3 standard deviation increase in the investment readiness score, with this increase occurring throughout the distribution. Two follow-up surveys show that these judges' scores predict investment readiness and investment outcomes over the subsequent two years. Treated firms attain significantly more media attention, and are 5 percentage points (p.p.) more likely to have made a deal with an outside investor, although this increase is not statistically significant (95 confidence interval of -4.7 p.p., +14.7p.p.).

The third chapter is a single-authored piece and studies the economic policies in the European banking sector. Specifically, the first chapter describes the methodology and results of an impact evaluation of macroprudential capital regulation on bank capital, risk taking behaviour, and solvency. The identification relies on the policy change in bank-level capital requirements across systemically important banks

in Europe. A one percentage point hike in capital requirements leads to an average CET1 capital increase of 13 percent and no evidence of reduction in assets. The increase in capital comes at a cost. The paper documents robust evidence on the existence of substitution effects toward riskier assets. The risk taking behavior is predominantly driven by large and less profitable banks: large wholesale funded banks show less risk taking, and large banks relying on internal ratings based approach successfully disguise their risk taking. In terms of overall impact on solvency, the higher risk taking crowds-out the positive effect of increased capital.

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List of Abbreviations

2SLS	2 **S**tage **L**east **S**quares
ANOVA	**A**nalysis of **V**ariance
CCoB	**C**apital **C**onservation **B**uffer
CCyB	**C**ountercyclical **C**apital **B**uffer
CCP	**C**learing **C**ounter-**P**arties
CET1	**C**ommon **E**quity **T**ier 1
CRR	**C**apital **R**equirements **R**egulation
CRD	**C**apital **R**equirements **D**irective
EBA	**E**uropean **B**anking **A**uthority
EBAN	**E**uropean **B**usiness **A**ngel **N**etwork
ECB	**E**uropean **C**entral **B**ank
EDIF	**E**nterprise **D**evelopment and **I**nnovation **F**acility
ESRB	**E**uropean **S**ystemic **R**isk **B**oard
EU	**E**uropean **U**nion
GDP	**G**ross **D**omestic **P**roduct
GCG	**G**lobal **C**ommercialization **G**roup
GReaC	**G**etting **R**eady for **C**apital
G-SIB	**G**lobally **S**ystemically **I**mportant **B**ank
IRB	**I**nternal **R**ating **B**ased
ITT	**I**ntention-to-**T**reat
LATE	**L**ocal **A**verage **T**reatment **E**ffect
NBS	**N**ational **B**ureau **S**tatistics
O-SIB	**O**ther-**S**ystemically **I**mportant **B**ank
RICAP	**R**omanian **I**nnovation **C**ommercialization **A**ssistance **P**rogram
RMB	**R**enminbi
RWA	**R**isk **W**eighted **A**ssets
SIB	**S**ystemically **I**mportant **B**ank
SMCR	**S**ystemic **M**acroprudential **C**apital **R**equirement
SRB	**S**ystemic **R**isk **B**uffer
TFEU	**T**reaty of the **F**unctioning of the **E**uropean **U**nion
UHS	**U**rban **H**ousehold **S**urvey
U.S.	**U**nited **S**tates
USD	**U**nited **S**tates **D**ollars

Chapter 1

Consumption Response to Minimum Wages: Evidence from Chinese Households

1.1 Introduction

In China, a minimum wage policy was firstly introduced in 1994 and today operates in a labor market of close to 800 million individuals.[1] By 2012, approximately 18% of urban households had at least one household member with a wage near the minimum wage. Extrapolated to the overall Chinese household population, this proportion means that an estimated 82.5 million households are affected by minimum wage legislation comprising approximately 265 million household members.[2] In this paper we seek to understand how effective China's minimum wage policy is in improving income and consumption of low income households.

As in the Western societies, minimum wage policies are controversial also in emerging countries for fears about unemployment effects, threats to industrial competitiveness, and employment substitution into the informal labour market, Rama, 2001, Comola and De Mello, 2011, Fang and Lin, 2015. These concerns may have negative effects on the transmission of minimum wages into consumption, moreover there are additional concerns why higher minimum wages may fail to translate into higher levels of consumption: first, higher minimum wages may simply substitute for other social transfers so that the effective income increase is considerably attenuated, for the U.S. see for instance Dube, 2017. Second, the disposable income effect of higher minimum wages may be perceived as transitory - particularly in emerging countries with higher price inflation. Consumption smoothing may then result only in a modest consumption increase. Third, higher minimum wages can

[0]This is a joint work with Harald Hau and Yi Huang. We thank Jean-Louis Arcand, Marius Brülhart, David Card, Olivier Cadot, Andrew Clark, Conchita D'Ambrosio, Giacomo De Giorgi, Tony Fang, Eric French, Wei Huang, Gian-Paolo Klinke, Dirk Krueger, Rafael Lalive, Albert Park, Yu Qing, Dominic Rohner, Li Shi, Stephanos Vlachos, Xiaobo Zhang, Shenghao Zhu, Gewei Wang, Shangjin Wei for valuable comments on earlier drafts of the paper. We also thanks seminar and conference participants at the 2017 Asian Meeting of the Econometric Society, 4th Potsdam PhD Workshop in Empirical Economics/EVA-MIN Summer School, 2017 Spring Meeting of Young Economists, Hong Kong University, ILO-Geneva Labor and Development Workshop, Peking University, University of Trier, 2018 China Meeting of the Econometric Society. This research project benefited from a Sinergia Research Grant from the Swiss National Science Foundation (SNSF).

[1]Source: International Labour Organization, ILOSTAT database, using World Bank population estimates. Labor data retrieved in March 2017 https://data.worldbank.org/indicator/SL.TLF.TOTL.IN?locations=CN

[2]See for instance the National Bureau of Statistics NBS, 2013. China Statistical Yearbook 2013. Beijing: China Statistics Press. Available at: http://www.stats.gov.cn/tjsj/ndsj/2013/indexeh.htm

increase household unemployment risk, trigger precautionary savings, and attenuate the consumption effect. Finally, a higher frequency of unemployment can make some households much worse off than in the previous policy regime.

China provides a particularly rich institutional setting for research on the consumption effect of minimum wages. The Chinese minimum wage is set at the county-level and is frequently adjusted in order to keep pace with price inflation and raising standards of living in a high growth environment. For the period 2002-2009, we identify more than 13,874 changes of county-level minimum wages across China's 2,183 counties and 285 cities and match them to the urban household survey (UHS) which covers 73,164 urban household-year observations. No other labour market in the world can rival China's in the frequency, heterogeneity, and magnitude of local minimum wage changes. In this study we use the Chinese urban *household* survey which provides a detailed breakdown of both income and consumption along several categories at the household level. The UHS reports also the amount of income transfers to household stemming from other social policies. This allows us to disentangle the confounding effect of other transfer policies from the impact of the minimum wage policy on income and consumption and study the interactions between minimum wage increases and other social transfers. A caveat is that individual level data for consumption are not available in the UHS, and our modelling choice are therefore restricted to household level consumption. This feature of the data implies that we cannot disentangle the individual marginal propensity to consume of each household earner.

To the best of our knowledge, this paper is the first to estimate the consumption and income response of Chinese households to cross-sectional and intertemporal variation of China's minimum wages.[3] Our main focus is on household consumption since it provides a particularly relevant metric of welfare and is often better measured and less volatile than income, Deaton, 1997, Deaton and Grosh, 2000. Moreover, in the development economics literature, consumption is the standard metric used to assess the relative poverty of households: the World Bank relies on consumption measures to construct the international extreme poverty line, Ravallion, Chen, and Sangraula, 2009.

We perform two-stage least square estimations (2SLS), which use the minimum wage increase as an instrument for household income shock in the consumption

[3]Research on developing countries has examined the role of the minimum wage on the wage distribution and labor income inequality without documenting its effect on consumption. For instance, using labor survey data from Indonesia, Rama, 2001 estimates the impact of a doubling of the minimum wage on the entire wage distribution, and finds that wages above the minimum wage also increased between 5-15%. Bosch and Manacorda, 2010 find that growth inequality of income earnings in Mexico is due to the decline in the real value of the minimum wage. Engbom and Moser, 2016 study the impact of minimum wage changes in Brazil on the reduction of earnings inequality and conclude that minimum wages help reduce earnings inequality in formal sectors of the economy. Previous work on low income households in developing countries has considered alternative income shocks to estimate consumption responses. Wolpin (1982) uses weather induced income shocks in India to estimate an income elasticity of consumption in the range 0.91-1.02 depending on the definition of consumption. Our results for minimum wage changes in China are consistent with these findings. Related work by Paxson (1992) studies weather shocks in Thailand to estimate the saving propensity to income shocks related to weather conditions; the estimated saving propensity to positive and non-transitory weather induced income shocks is found to be greater than zero, but small. However, the persistence of disaster related income shocks is not always easy to assess and might be confounded by associated policies of disaster relief.

function.[4] All our estimates of consumption impact are unconditional on employment status, that is we keep in the sample both workers who retain their jobs and workers who lose their jobs after minimum wage hike. The results indicate that minimum wage increases in China are a very effective policy tool for increasing income and consumption levels of households dependant on the minimum wage. Our estimates show a marginal propensity to consume out of a minimum wage shock of one - implying that low income households spend the entire additional income stemming from a higher minimum wage. For the same type of minimum wage household this compares to the marginal propensity to consume of only RMB 0.35 for RMB 1 increase in labor income. The high marginal propensity to consume due to a minimum wage hike is at odds in comparison to the aggregate low consumption figures in China.

The paper investigates further whether liquidity constraints may be driving the consumption response as in Zeldes, 1989 and Jappelli and Pistaferri, 2010, however the marginal propensity of consumption due to minimum wage does not differ significantly for liquidity constrained households - suggesting that the consumption effect is not driven by liquidity constrained households. The study finds that a large share of more than 30% of the incremental income due to minimum wages is consumed in health and educational expenditure, which is likely to improve the long-run income of the family since these categories of expenditures are closely associated with investment and savings as shown by Attanasio, Battistin, and Ichimura (2007) and Blundell, Pistaferri, and Preston (2008). Only for the 6.5% of households without a child we find an economically large saving effect. These households save two thirds of the income increase due to minimum wages.

The results show a higher consumption responses to minimum wage hikes in China than commonly found in U.S. data.[5] We rationalize the relatively higher effects of minimum wages on consumption in China in three different ways: low levels of minimum wages relative to the median wage, relatively poor living conditions coupled with a weak health and education systems, and a complementarity of minimum wages and other social transfers.

A low level of minimum wages relative to the U.S. implies that the cost of minimum wage labor is substantially lower in China. We do not find that minimum wages have a significant impact on unemployment, this is true also for more vulnerable individuals such as urban migrants.[6] The absence of unemployment effects suggests that the low cost of minimum wage labor in China is not salient with respect to general equilibrium effects in the labor market. At the same time, the absence of

[4] In our setting, consumption changes only due to a shock to household income, however there may be other influences such as peer and network effect which our data does not allow to compute, for network effects on consumption see De Giorgi, Frederiksen, and Pistaferri, 2016.

[5] The impact of minimum wages on income and consumption for U.S. states has been studied by Aaronson, Agarwal, and French, 2012. The authors estimate a positive expenditure effect for minimum wage dependent U.S. households with an elasticity lower than one, and conclude that most of the consumption effect can be traced to durable expenditures such as vehicle purchases. Alonso, 2016 employs aggregate county-level U.S. sales data to find that a 10% increase in minimum wages increases non-durable consumption by 1% in the aggregate, and finds that this aggregate effect is larger in poorer counties. Dube, 2017 examines the relationship of U.S. minimum wages to family income and in particular its distribution among minimum wage households. He concludes that higher minimum wages alleviate poverty by reducing the share of individuals below federal poverty threshold.

[6] For the effects of minimum wages on employment in the U.S. see for example the contributions of Krueger and Card (1995) and Card and Krueger (2000) juxtaposed to Neumark and Wascher (1992) and the recent evidence of Dube, Lester, and Reich (2010), Allegretto, Dube, and Reich (2011), Neumark, Salas, and Wascher (2014a), Neumark, Salas, and Wascher (2014b), Allegretto et al. (2016).

unemployment effects reinforces the results on the marginal propensity of consumption since the potential precautionary savings motive due to negative employment effects cannot be sustained.

In the 1990s the real minimum wage in China was still close to the international poverty line of USD 1 per day and remains comparatively low during our data period 2002-2009. Urgent consumption needs yield a large consumption response and marginal propensities to consumption are in general larger on the lower end of the income distribution. This is further accentuated by a high propensity to consume in health and education expenditures stemming from a minimum wage increase - a consequence of a rather underdeveloped health and costly education systems as suggested Chamon and Prasad, 2010. Health insurance coverage in China was only 29.7% in 2003, see for instance Meng et al., 2012, at the same time in the U.S. an estimated 84.8% percent of the population had health insurance coverage in 2002 according to the U.S. Current Population Survey, Mills and Bhandari, 2003.

We argue that another reason for a higher impact of minimum wages on income and consumption in China is the complementarity of minimum wage increases and other social transfers to poorer households. Minimum wage hikes tend to be associated with higher social transfers in China, while in U.S. higher minimum wages are usually counterbalanced by a reduction of other type of household transfers.[7] We find a positive impact of minimum wages on transfer income, a RMB 1 increase in minimum wages increase transfer income by RMB 0.49 per household member, the impact is doubled if there are two minimum wage workers in a household. These results are consistent with the evidence discussed in Leung, 2006, Hao, 2009, Meng, 2012 and Qu and Zhao, 2017, describing that after 200, the Chinese central and local (province, city or county level) governments implemented several employment protection and social programs for urban households. For instance, in addition to minimum wage policies, China's first Unemployment Insurance Act was issued by the State Council of the Peoples Republic of China in 1999, since then, laid off workers collect their unemployment payment from central offices and this is the period when we observe the UHS survey, see Meng, 2012. Another example is the implementation, in October 1999, of the State Council Regulation on the Minimum Living Allowance System in Urban Areas as described in Leung, 2006 and Hao, 2009.

Minimum wage change captures these complementary social policies at central and local (provincial, city or county wide) governments levels, which together with minimum wages, are the driving forces behind the large increases in consumption. This is particularly more relevant for individuals at the low end of the wage distribution since they are more likely to be affected by the set of these new policies and programs, this is shown in Qu and Zhao, 2017 for the period 2003-2006.

The paper is organized as follows. Section 1.2 presents the China's minimum wage regulation and the urban household survey. Section 1.3 discusses the research design. Section 1.4 presents the main results on the impact of the minimum wage level on total household consumption. Here we also highlight the important role of minimum wages in determining a household's health and education expenditure. The role of household heterogeneity for consumption behavior is discussed in Section 1.5 with a focus on financial constraints and household structure. Employment effects are investigated in Section 1.7, while in Section 3.7 we run a placebo test. Section 1.8 concludes.

[7] For the U.S., Dube, 2017 documents that a reduction in public assistance partly offsets minimum wage income gains. The latter are on average 25% lower when the author includes tax credits and non-cash transfers in the equation.

1.2 Institutional Framework and Data

1.2.1 China's Urban Household Survey

China's Urban Households Survey (UHS) represents a comprehensive and representative survey of urban workers and households managed by the Chinese National Bureau of Statistics (NBS). The UHS is conducted via stratified randomization sampling, it records a wide range of demographic and socioeconomic conditions of Chinese urban households, including detailed information on different income sources, wages and granular consumption items for households on an annual basis. In this paper, we restrict the analysis to eight consecutive years of the UHS from 2002 to 2009. Prior to 2002, the survey does not provide a panel structure and we exclude the earlier years from the econometric analysis. We then merge the urban household survey with the minimum wage data which are observed at an hourly rate and then aggregated at annual frequency, a more detailed presentation of the minimum wage dataset is given in Section 1.2.3. Further, Appendix 1.B provides a detailed description of the merged sample and the data filters applied.

To analyze the impact of minimum wages on household consumption, we distinguish households in terms of their reliance on wage income near the local minimum wage. Let the variable S denote the share of total non-property income earned by the two best-paid household members from wage near the minimum wage.[8] Labor income of any household member is considered to be near the local minimum wage and counted towards the nominator of S if it falls within the range 50%-150% of the county minimum wage.[9]

We calculate the share S for the first year a household enters the survey to limit any endogeneity due to self-selection or composition effects. The fact that S is created based on the first year observations is important since it keeps constant the exposure to the minimum wage in all years. In latter years of the panel, income can decrease because of job loss potentially induced by the minimum wage. To overcome this potential bias all our estimates of consumption are unconditional on employment status, i.e. we keep in the sample both workers who retain their jobs and workers who lose their jobs. By keeping the exposure to minimum wage constant and including unemployed individuals in all our specifications we make sure that the sample is not restricted to workers who keep their job after a MW hike.[10] Nevertheless, a mechanical relationship between S and income is present in the first year which might bias the estimates, for this reason we drop the first year a household is observed.

To maintain the panel structure we include in the sample households that have been surveyed for at least two years and that have at least two household members observed in each survey. Formally, let $E_{m,h,c}$ denote the annual labor income and $w_{m,h,c}$ the wage of the two best paid household members $m = 1, 2$ in household h in

[8] Aaronson, Agarwal, and French (2012) use a similar definition for the minimum wage workers.

[9] The upper bound of 150% is consistent with the findings of spillover/ripple effects of minimum wages on the wage distribution whereby workers earning just above the minimum wage tend to have an upgrade when the minimum wage is increased, Krueger and Card (1995).The lower bound of 50% is applied to reduce measurement errors and to include workers in firms that do not comply fully with the minimum wage policy. The results are robust to other thresholds for minimum wage ripple effect (we experimented with 0.5-1.2 and 0.5-1.3).

[10] The results are robust to other definitions of the treatment, we experimented with treatment status changing every year according to the above thresholds, and with assignment to treatment only if the household earns a minimum wage salary in every year she is observed in the panel. Table 1-VII shows that the proportion of households within different categories of S dose not change significantly across these three different treatment definitions

county c. For a dummy variable $D[.] = 1$ indicating a wage in the range 50%-150% of county minimum wage MW_c, we define minimum wage income share as

$$S_{h,c} = \frac{1}{Total\ Income_{h,c}} \sum_{m=1,2} E_{m,h,c} \times D\left[0.5MW_c \leq w_{m,h,c} \leq 1.5MW_c\right] \quad (1.1)$$

where $Total\ Income_{h,c}$ in the denominator represents the sum of the total disposable income of the two top earners in the household.[11] By definition, the minimum wage income share S_{hc} is between 0 and 1; a higher share implies that the household tends to be poorer and her income more subject to any variation in the minimum wage policy. In the case where both the household head and spouse work at the minimum wage, the share S approaches one.[12] Throughout the analysis, we consider households without any minimum wage income ($S = 0$), the complementary set of households with at least some income related to the minimum wage ($S > 0$), households with at least half of their income from wages near the minimum wage ($S > 0.5$), and households very dependent on the minimum wage for their subsistence ($S > 0.75$). The last two groups are the main focus of interest and we can expect the consumption response to minimum wage changes to be most pronounced for this group.

It is instructive to compare household characteristics across the four different household groups ($S = 0$, $S > 0$, $S > 0.5$ and $S > 0.75$) that increase their dependence on minimum wage income as the share S increases. Table 1-V in Appendix 1.B reports the differences in the structure of household income and spending, Table 1-VI illustrates the differences in demographic structure.

Households with $S > 0.5$ ($S > 0.75$) account for 6% (5%) of all observations, but earn only 2.6% (2.4%) of all labor income, whereas households without minimum wage income represent 72% of the sample and earn 81.9% of all labor income. An advantage of the urban household survey data is that it records also transfer income and sub-components of transfer income such as social assistance income, unemployment benefit, dismissal compensation, indemnity insurance income, subsistence allowance etc. In the sample, and as expected, poorer households (with $S > 0.5$ or $S > 0.75$) feature a lower share of disposable income earned from labor income and rely more on social transfer income from the authorities; almost 20% of their disposable income comes from social transfers. Moreover, minimum wage dependent households tend to consume a higher proportion of their disposable income (82%) compared to households with $S = 0$ (70%).[13]

In terms of demographic characteristics, minimum wage households tend to be only slightly larger with 3.3 members compared to 3.1 for the household $S = 0$. This suggests that the one child policy was implemented consistently across income groups. Unsurprisingly, minimum wage household show lower house ownership rates and their migration to the urban area is typically more recent. We also highlight that minimum wage dependent households are much less likely to work for state-owned enterprise (SOE), in fact these tend to pay higher wages than the private

[11] Disposable income is composed by the sum of labor income, property income, operating income and transfer income. We observe all of these sub-categories of income in the household survey.

[12] If all members of the household are unemployed in the first year the household enters the panel, the sum of the best two earners results in a zero labor income and consequently $S = 0$. We eliminate these households from the data set (i.e. only 166 observations or 0.2% of the overall sample) to avoid any confounding effects with households earning labor income above the minimum wage.

[13] In Table 1-V and throughout the analysis, consumption is defined as expenditure on: food, clothes, household services, medical care, education, transportation and living. This is consumption *net of* purchasing property, transfer expenditures, social contributions and personal social expenditure. It is also *net of* investments, the latter can be confounded with savings.

sector. Finally, the educational level and work experience of the head of household tends to be lower for minimum wage dependent families.

1.2.2 Minimum Wage Regulation

Minimum wage changes in China originate in an administrative and political process that is not subject to an open public debate. The law only stipulates the requirement of regular review of the minimum wage level, not a mandatory change or wage level. When the decision of a higher nominal minimum wage is taken upon proposal by the local government and approval by the provincial authorities, implementation follows swiftly with a delay of only two months after a local government announcement. Following the announcement, the information is spread via local government websites, local radio and TV channels. This decision process implies that little public information is generated that would allow households to anticipate well in advance minimum wage changes and modify their consumption behavior accordingly, Du and Jia (2016).

Chinese minimum wage legislation was first promulgated in 1994 following a wave of economic liberalization policies and the transition from predominantly state-owned production to a mixed economy with a growing private sector. However, the first implementation was ineffective since it lacked provisions and rules for the adjustment to price inflation and local economic conditions. It also suffered from lax enforcement and extensive non-compliance. Rawski (2003), Du and Wang, 2008, Sun and Shu (2011), Ye, Gindling, and Li, 2015.

The access of China to the World Trade Organization and the related boom of the manufacturing sector added pressure for a more efficient minimum wage regulation. In December 2003, the central government opted for a reform of minimum wage regulation, and in March 2004, the Ministry of Labor and Social Security introduced the new Minimum Wage Regulations (MWR) into Chinese Labor Law. The most significant provisions required indexation of the minimum wage to the cost of living and a minimum wage level sufficient to support basic daily needs of employees. Local authorities were required to review the minimum wage at least every two year in light of local economic conditions and propose a revised minimum wage to the provincial authorities. Moreover, implementation of the new MWR was strengthened by increased control at the local administrative level and firm level in pursuit of better compliance. Penalties for non-compliance increased from 20-100% of the statutory minimum wage to 100-500%.

Figure I illustrates the proportion of counties that increase their nominal annual minimum wage between 1996 and 2012. In line with the reformation of the MWR, trade liberalization and the large productivity growth of the booming manufacturing sector, real minimum wage growth in China was higher after the reform. Real minimum wage grew at 5.08% in the period 1996-2003 and accelerated to 8.57% in the period 2004-2012. In monetary terms, the average annual real minimum wage was only RMB 1,259 ($441 under PPP) in 1996, but had increased to RMB 4,610 ($1,309 under PPP) in 2012.[14] In the same period, the annual real growth rate of Chinese labor productivity was 8.9%, while real GDP oscillated around 9.7%.[15] In

[14] Effective annual *nominal* minimum wage increased from RMB 2,628 ($921 under PPP) in 1996 to RMB 13,224 ($3,756 under PPP) in 2012.

[15] Purchasing power parity conversion factors are from the World Bank's International Comparison Program Database, data on growth are from the World Bank World Development Indicators, productivity data are from the OECD.stat Productivity Archives, see http://stats.oecd.org/Index.aspx?DataSetCode=PDB_LV.

other terms, China's average real minimum wage started slightly above the international poverty line set at $1 per day in 1996, and increased to a remarkable $3.55 per day in two decades. In the following section we try to estimate the household use of this increase.

1.2.3 Minimum Wage Data

The data used in this study are collected by Chinese Ministry of Human Resources and report the hourly local minimum wage in 2,183 *counties* and 285 *cities* for the period 1994-2012.[16] The workers are subject to heterogeneous minimum wage changes across counties: in a given year, those working in counties with a minimum wage hike constitute the treatment group and those working in counties with no change in minimum wage policy the control group in a given year.[17]

We aggregate the observed hourly minimum wages to a yearly wage to match the frequency of the annual reporting of the household survey data and for an easier interpretation of our estimates. The UHS reports separately income stemming from bonuses or overtime working hours, this means that a reported worker's labor income is not affected by working extra hours which are classified separately as income arising from bonuses. We exploit this data feature in addition to the the rules of the Chinese Labor Law and assume a 40 hours working week for each full-time worker. Note that this aggregation rule is consistent with Article 36 of the same law establishing that "The State shall practise a working hour system wherein labourers shall work for no more than eight hours a day and no more than 44 hours a week on average".[18]

To check formally whether the assumption of a 40 hour work week (or 160 hours per month) is innocuous for our inference, we compare the reported monthly hours worked of full-time workers (available for a subset of workers in the period 2002-2006) with and without a minimum wage hike and report them in Table 1.1. The reported average monthly working hours tend to be slightly but not significantly above 160 working hours for the sample of full-time workers as shown in Panels A (all households) and B ($S > 0$ households) of Table 1.1. Importantly, in each panel there is no statistically significant difference in hours worked between counties with and without minimum wage hikes.

Only for the year 2002 we find a weak statistical difference of minimum wage workers labor supply between treated and non-treated counties. This is likely due to the mechanical positive correlation between minimum wages and income in the first year the household is observed as described in Section 1.2.1, also for this reason we drop the first year the household enters the panel throughout the later empirical analysis.

Panel C of Table 1.1 reports the evolution of the minimum wage bite (i.e., the ratio of the Chinese minimum wage relative to county median income) in our sample. Chinese minimum wages are generally set at a very low level relative to the median wage. The average ratio of the minimum wage relative to the median wage

[16] The province is the highest administrative division in China, followed by cities and counties. There are 34 provinces in the Chinese administrative subdivision as of April 2015, 333 prefecture-level cities and a total of 2,862 county-level divisions in China.

[17] For their uncertain treatment and control group status, and as described in Appendix 1.B, we also ignore self-employed individuals; retired household members; retired and then re-employed household members, incapacitated persons, homeworkers, soldiers, social volunteers, students and other household members undergoing training.

[18] Details on Chinese Labor Law can be consulted at: http://www.china.org.cn/living_in_china/abc/2009-07/15/content_18140508.htm

fluctuates around 20% in the period 2002-2006 and then declines to 17.6% in 2009. In China, Minimum wage bites never approach the much higher levels observed in some developed countries, where the minimum wage bite ranges from around 30% in the U.S. to 60% in France and Sweden, Dickens (2015). Therefore, the labor income conditions of minimum wage workers in China are much worse in relative terms compared to minimum wage workers in high income economies. In absolute terms, the Chinese *real* minimum wage income of a single worker is close to the international poverty line (see Section 1.2.2). It follows that any policy measure that increases the consumption level of these extremely poor households represents a reduction in poverty by definition. At the same time, the low bite of the minimum wage can suggest that its level is not salient with respect to general equilibrium effects in the labor market. Section 1.7 explores the impact of the minimum wage on employment in more detail.

For the benefit of our inference, minimum wages in China were subject to large and heterogeneous local variation. Our empirical analysis focuses on the years 2002-2009 for which the urban household data is available as a stratified panel and can be matched with county-level minimum wage data. During this period, 79.5% of all county-year events increased their minimum wage in a given year, which translates into a total of 13,874 minimum wage increases. Figure I presents a diagram with the annual *share* of counties and cities that change the *nominal* minimum wage in the range of 0-10% or 10-20% or more than 20%. During the period almost one quarter of China's 2,183 counties (and 285 cities) in the sample raised the nominal minimum wage by more than 20%.[19]

1.3 Research Design

1.3.1 Descriptive Evidence

Various economic channels could potentially generate a spurious relation between both variables and could obscure a causal effect of minimum wages on consumption. Before we explore the causal link from minimum wages to household consumption, it is useful to establish that minimum wages and consumption change together *only* for minimum wage dependent households. To convince the reader that spurious relations for non-minimum wage households do not obstruct the analysis, we apply a simple event analysis based on a two-step procedure.

In a first-stage regression, we regress the county-level real minimum wage MW_{ct} on a set of interacted province fixed effects $D_{Province}$ and year fixed effects D_{Year}. The resulting residuals identify if the minimum wage level in a country (or city) is high relative to the province average in a given year. Formally,

$$MW_{c,t} = \alpha_0 + \alpha_1 \left[D_{Province} \times D_{Year} \right] + u_{c,t}. \tag{1.2}$$

[19] While none of the counties featured a decrease in the nominal wage, local inflation combined with a constant minimum wage can decrease the *real* wage if the nominal wage stays constant. From 2002 to 2009, an average of 20.5% (3590) county-year events show a constant nominal minimum wage — implying a worsening of purchasing power of minimum wage workers. Yet, most local authorities appear attentive to the erosion of the minimum wage by inflation and tend to adjust the minimum wage by more than the rise in consumer prices: of the 13,874 county-year events with a minimum wage increase, only 1,235 had minimum wage increases below the inflation rate in the county. In real terms, approximately half of county-year increases implied a *real* minimum wage change in the range 0-10%, one-third of minimum wage increases was in the range 10-20%, and only a tenth above 20%.

In a second step, we fit household consumption changes ΔC_b to the changes in county-level residuals $\Delta u_{c,t}$. In the absence of other economic channels, a positive regression coefficient between the minimum wage change and consumption changes should appear only for households depending on minimum wages ($S > 0$). To visually inspect this fit, we sort the residual county changes $\Delta u_{c,t}$ into 40 bins of counties with a similar residual and calculate the bin average Δu_b for each bin b. Accordingly, we calculate for all counties in the same bin the corresponding average changes of household consumption ΔC_b. In this aggregation, we distinguish minimum wage dependent households ($S > 0.5$) from those without minimum wage income ($S = 0$). Averaging within the bins yields average consumption changes $\Delta C_b^{S>0.5}$ and $\Delta C_b^{S=0}$. Note that, within a bin, the two groups of households share the common minimum wage change Δu_b relative to the province-level average. Figure II illustrates the binned scatter plots for the two regressions

$$\Delta C_b^{S>0.5} = \beta_0 + \beta_1 \Delta u_b + \epsilon \tag{1.3}$$

$$\Delta C_b^{S=0} = \gamma_0 + \gamma_1 \Delta u_b + \epsilon, \tag{1.4}$$

where we our test requires $\beta_1 > 0$ and $\gamma_1 = 0$. Consumption changes for non-minimum wage households, $\Delta C_b^{S=0}$, show a coefficient estimate of -0.03 with the relative minimum wage change Δu_b, whereas minimum wage dependent households show a positive coefficient of 1.42. A standard t-test for the statistical difference of the two slopes produces a t-statistic of 1.56. Despite the weak statistical significance, it can be inferred from the scatter plot that minimum wage increases are indeed associated with higher household consumption for minimum wage dependent households.

A further refinement of the procedure distinguishes two subsamples: (i) counties in which the nominal minimum wage was constant from one year to another, (ii) those where local authorities implemented nominal minimum wage hikes. In the former case, the county minimum wage decreases with respect to the province-year average, whereas in the latter case, the county minimum wages increase relative to the province average. The implications for household consumption differ in the two subsets: we expect a positive relationship ($\beta_1 > 0$) between consumption changes in minimum wage households and county minimum wage changes only in counties which actively implemented a minimum wage hike. In Figure III, we compare the regression lines for cases (i) and (ii) and confirm the conjectured relationship. Only counties with a local minimum wage increase feature a regression coefficient between consumption changes in minimum wage households and the residual change Δu_b. Minimum wage households show no consumption changes in counties where the nominal minimum wage was constant.

To sum up, the descriptive analysis indicates that a positive change of household consumption happens only in counties where a local minimum wage was increased. Within those counties, the positive change in consumption is linked only with minimum wage dependent households. The two results together suggest that the increase in the minimum wage may be the causal effect behind the increase pattern of consumption. In order to shed more light on this link the next section presents the evidence controlling for county trends and household specific characteristics.

1.3.2 Panel Data Methods

We design a difference-in-difference specification which compares household consumption across counties subject to minimum wage hikes (treatment group) and

not (control group). In light of the heterogeneous household exposure to minimum wages. The household sample is segmented into groups according to their share S of total income received from minimum wage labor. Households without any minimum wage related income ($S = 0$) represent a placebo control group relative to those household with $S > 0.5$ ($S > 0.75$) which earn more than 50% (75%) of their total income from minimum wages.

A more general approach relates household consumption to household income by using the minimum wage change as an instrument to explain variation in household income. In the minimum wage case, the advantage of the 2SLS approach, on top of being robust to measurement error and omitted variable bias, is that it accounts explicitly for the channel through which minimum wages affect consumption. In other terms, the 2SLS uses the minimum wage hike as an instrument for the household income shock and then estimates the induced consumption response to this income shock. Whether the households decision is to consume the income shock or saves it, the minimum wage is a good instrument for the overall increase of disposable income form which increase consumption and saving decision would follow.

In order for the 2SLS to have a clear causal interpretation two assumptions need to be satisfied. Firstly, the instrument should be correlated with the instrumented variable. In China, the large and frequent variation of the real minimum wage guarantees in principle that the explanatory power of the first-stage regression is sufficiently large to satisfy the first assumption. This can be tested, and the next section looks at the power of our first stage and the correlation of the minimum wage hike with labor income, it is expected that the instrument has a stronger effect on labor income the more the household relies on minimum wage earnings. Second, the minimum wage change is uncorrelated with other determinants of the dependent variable, see Angrist and Pischke, 2008a, for instance minimum wage change can rise in areas with good economic progress or in counties with a general increase in wages. It can be shown that minimum wage is not predicted by standard county level macroeconomic determinants, while this is not a formal test, it helps in illustrating that minimum wage changes cannot be easily predicted by household. In other terms, households cannot reasonably predict whether in a particular year the minimum wage would change in their county and consequently smooth their consumption. In Appendix 1.A, we look at county-level determinants of minimum wage change. Tables 1-I, 1-II and 1-III shows for a wide range of regression specifications that the decision to change the minimum wage is not predicted by standard county-level socio-economic or political determinants that may a priori affect and hence predict the minimum wage change.

Formally, the 2SLS first explains household labor income using a first-stage regression:

$$LI_{h,c,t} = \alpha + \beta^{FS}\, MW_{c,t} + \boldsymbol{X}_{m,h,t}\boldsymbol{\Lambda} + \boldsymbol{X}_{h,t}\Theta + \boldsymbol{X}_{city,t}\Xi + \phi_c \cdot t + \eta_h + \delta_{p,t} + \varepsilon_{h,c,t}, \quad (1.5)$$

where $LI_{h,c,t}$ is housheold Labor Income of household h in county c at time t, and in the second stage relates the predicted income variation $\widehat{Income}_{h,c,t}$ induced by minimum wage variation to account for household consumption, therefore

$$C_{h,c,t} = \alpha + \beta^{2SLS}\, \widehat{Income}_{h,c,t} + \boldsymbol{X}_{m,h,t}\boldsymbol{\Lambda} + \boldsymbol{X}_{h,t}\Theta + \boldsymbol{X}_{city,t}\Xi + \phi_c \cdot t + \eta_h + \delta_{p,t} + \varepsilon_{h,c,t}. \quad (1.6)$$

The household survey data provide a rich set of demographic and socio-economic

characteristics ($\boldsymbol{X}_{m,h,t}$) for the two main labor income earners ($m = 1, 2$) in the households. For the purpose of the analysis, we use as controls their age and age squared, gender, years of work experience and work experience squared, years since migration to the city and its squared value. Additional categorical covariates include marital status, level of education, occupation and industry of occupation. The observed household characteristics ($\boldsymbol{X}_{h,t}$) include household size measured by the number of household members, and a house ownership dummy. One of the advantages of the urban household consumption and income survey data is that we observe directly transfer income to households and its sub-components. We exploit this data richness to identify the consumption response to minimum wage changes by controlling for transfer income and studying interrelations between the two. In addition to transfer income, we also observe and control for household net operating income from business, household income from lending activity and income from property.

At the city-level, we dispose of a variety of macroeconomic variables that we use as controls in some specifications ($\boldsymbol{X}_{city,t}$): population size, city real GDP, city real average wage and city unemployment rate. These variables are not available at the more granular county-level. To overcome this we allow for different growth trends at the county-level including the interaction of a county dummy and a time trend ($\phi_c \cdot t$) in the regression.

The inclusion of county-level time trends $\phi_c \cdot t$ is important also to control for diverging county level trends in a difference-in-difference setting. We thus control for county-specific consumption trends as macroeconomic control variables at the local level are not available. If we do not allow for heterogeneous trend growth, the real minimum wage level $MW_{c,t}$ becomes the only county-level regressor, and could subsume county-level heterogeneity and bias the inference. Before proceeding with the exposition of main results of the paper, it is straightforward to illustrate this specification issue by comparing first-stage income regressions with and without county time trends; the results are shown in the Appendix 1.C. In the standard two-way specification with only time fixed effects, without county trends and interacted province-year fixed effects, the regression coefficient of the real minimum wage is highly significant even for the household groups not earning any minimum wage income ($S = 0$), see Column (1) of Table 1-IX. By contrast, after including county trends and province-year fixed effects in Columns (5)-(8), which capture unobserved heterogeneity across counties and provinces, any spurious consumption response of high income households is eliminated. As a consequence of this result, in the following of the paper all specifications include both linear county trends and province-time fixed effects.

The specifications also account for household fixed effects η_h and province-year fixed effects $\delta_{p,t}$ to allow for heterogeneous economic developments across China's main geographic regions. All monetary variables, including the minimum wage, are defined in real terms using the province-level consumer price index.

1.4 Main Results

1.4.1 First-Stage Income Regressions

Table 1.2 presents estimates for the first-stage regression for different definitions of household income. We distinguish among pure labor income in Columns (1)-(3), transfer income in Columns (4)-(6) and the sum of labor and transfer income in Columns (7)-(9) as the dependent variables. We consider three household groups: those that receive at least 25% ($S > 0.25$), at least 50% ($S > 0.5$), or at least 75%

($S > 0.75$) of their total income from minimum wages, respectively. All specifications include county trends and province-year fixed effects to account for unobserved heterogeneity, in all specifications in the paper the standard errors are clustered at the county level, i.e. the level of the policy change.[20]

The first-stage regressions provide information on the strength of our instrument and also on which components of household income (labor and transfer incomes) are affected by the minimum wage change. The results of the first-stage regressions indicate a positive effect of minimum wages on labor income in Columns (1)-(3). This increases in the minimum wage share S of household income, and is significant only for households earning more than half of their disposable income from minimum wages. The coefficient of 1.56 in Column (3) suggests a larger than one marginal propensity to consume for households with a strong minimum wage dependence. This can be explained by the presence of multiple minimum wage earners in the same household. Given the standard error of 0.743, the t-statistic is 2.104 and signals a sufficiently strong instrument.[21]

In the U.S., minimum wage increases can crowd-out transfer income if the latter is subject to eligibility requirements that depend on the labor income, see Dube, 2017. However the Chinese context is rather different, as documented by Leung, 2006, Hao, 2009, Meng, 2012 and Qu and Zhao, 2017, after 2000 minimum wage increases are accompanied with higher social transfer payments (i.e. income relief programs, unemployment benfits, minimum living standard subssidies etc.) as part of a more comprehensive social security benefits policy, these benefits generally target individuals at the low end of the wage distribution as shown by Qu and Zhao, 2017. For instance, in our sample, the level of transfers is RMB 690 (23.5%) higher for $S > 0.5$ households living in minimum wage treated counties with respect to the same category of households living in counties where minimum wage was not increased. This corresponds to 4.3% of overall disposable income of the households in the control group.

The evidence for this is shown in Columns (4)-(6) of Table 1.2.[22] The estimates show a large positive effect of minimum wages on transfer income within the same household group. A positive coefficient of 0.984 in Column (6) for households with more than 75% of their disposable income stemming from minimum wages implies that a RMB 1,000 increase in the annual minimum wage comes with an equally large increase in social transfers at households. It follows that for the combined effect of minimum wages on labor and transfer income we find larger coefficients. The total household income effect of minimum wage is roughly 2.25 times the increase in the annual minimum wage. For a county clustered standard error of 0.823, the t-statistic approaches the value of 3 and the F-statistics is close to 10. This further implies that we dispose of a better instrument if we focus on the sum of labor and transfer incomes as a combined endogenous variable and the related 2SLS estimates will be more precisely estimated as shown later in Section 1.4.3.

[20] All our estimates are robust to two-way clustered standard errors at county and city-year level and two-way clustered standard errors at county and province-year level, results are available from the authors.

[21] Note further that a single instrument 2SLS is median-unbiased and hence less prone to weak instrument critique, Angrist and Pischke (2008a). A more formal test of the validity and relevance of first stage instruments is from Kleibergen and Paap, 2006 and is provided in the 2SLS regressions in Table 1.4

[22] Transfers are intended net of pension or retirement benefits. The measure of net transfers includes social assistance income, dismissal compensation, income insurance, income from donations and other transfer income.

Minimum wages capture the effect on transfers for two reasons: first the simultaneity of the re-evaluation of central and local social policies, second because we are not able to fully capture their simultaneity with our controls despite we include county trends, city-year fixed effects and the set of our household and city-level control variables. As a result, this simultaneous effect on transfers is picked up by the minimum wage policy change in the first stage regression of the minimum wage on transfer income.

The social policy programs increasing transfers particularly relevant for our sample of households with the share of disposable income from the minimum wage above half of the, i.e. the $S > 0.5$ households. For them, the majority of disposable income comes from minimum wages, but this is complemented, since most of the second members of the household are unemployed, by another portion of income coming from several social programs described below. The Annex Table 1-VIII shows that in our sample, when looking only at the best two earners within the household, more than 19% of members from $S > 0.5$ households are unemployed, the corresponding share for $S < 0.5$ households is only 3.2%. This implies that at least 19% of households receive some supplementary income assistance form one of the additional income relief programs.

1.4.2 Reduced Form Regressions

In this section we present the reduced form estimates for the relationship between the real minimum wage and consumption. This helps in reconstructing the 2SLS estimates presented in the next section as the ratio of the reduced form on the first stage. Moreover, it helps also to track the source of the difference in the estimated coefficients of the 2SLS between the specification with and without transfer income.

The reduced form specification of the household consumption equation is the following:

$$C_{h,c,t} = \alpha + \beta^{RF} MW_{c,t} + \boldsymbol{X}_{m,h,t}\boldsymbol{\Lambda} + \boldsymbol{X}_{h,t}\Theta + \boldsymbol{X}_{city,t}\Xi + \phi_c \cdot t + \eta_h + \delta_{p,t} + \varepsilon_{h,c,t}, \quad (1.7)$$

Table 1.3 presents the results with two different specifications. First, Columns (1)-(4) report the standard specification adopted in the minimum wage literature on the impact of minimum wages on some outcome of interest, Aaronson, Agarwal, and French, 2012, Allegretto, Dube, and Reich, 2011 and Neumark, Salas, and Wascher, 2014a. This work controls for *all* non-labor income sources. The second group of estimates in Columns (5)-(8) exclude transfer income as a covariate and therefore allow the effect of transfer income on consumption to be captured by the minimum wage change itself. The resulting coefficient is inflated upwards since the minimum wage estimate captures the additional effect of (correlated) net transfers. Note that in Columns (5)-(8), the point estimates increase noticeably only for households with $S > 0.5$ suggesting that net transfers have a significant contribution in terms of consumption exclusively for households with a higher minimum wage dependence. This is consistent with the descriptive statistics as shown in Table 1-V in Appendix 1.B, for these highly minimum wage dependent households, the relative incidence of net transfers on consumption is substantial given that net transfers (net of pensions) constitute around 20% (8%) of household disposable income

In both specifications of Table 1.3 the point estimate for the annual real minimum wage effect on household consumption increases in the minimum wage share S. For the households most dependent on minimum wage income ($S > 0.75$), the coefficient of interest becomes 1.91 (standard error 0.91) if we control separately for

transfer income in Column (4); the estimate increases to 2.32 (standard error 1.02) in Column (8) where the minimum wage simultaneously captures variations in transfer income and its complementary consumption effect.

1.4.3 Two-Stage Least Square Estimates

In this section we present 2SLS estimates for the effect of minimum wage hikes on consumption. A consequence of the 2SLS estimator is that only the part of the variation in household labor income induced by the minimum wage is used to estimate the marginal propensity to consume. As in the previous sections, we operate with different definitions of household income. Note that in the 2SLS specifications both labor income and consumption are measured at the household level and allow for a more intuitive interpretation of results without the need for scaling for the number of household members on a minimum wage.

Table 1.4 presents the 2SLS estimates of household consumption as a function of real labor income in Columns (1)-(4) and as a function of the sum of labor and transfer income in Columns (5)-(8). We additionally report robust results for different type of clustering of standard errors: two-way clustered at county and city-year level and two-way clustered at county and province-year level in Appendix Table 1-XVII.[23]

We note that the marginal propensity to consume is more precisely estimated as the minimum wage share S increases, this is a consequence of the improved quality of the instrument as S increases. For households earning more than three-quarters of their disposable income from minimum wages a RMB 1000 rise in income increases consumption by RMB 1301. Estimating consumption response as a function of the sum of labor and transfer income yields consumption elasticities closer to unity and considerably smaller standard errors. For minimum wage dependent households with $S > 0.75$ in Column (8), the point estimate is 1.065 with a robust standard error of 0.409. The lower standard errors in Columns (5)-(8) result from higher explanatory power of the minimum wage instrument if we use a more comprehensive definition of the income shock which include transfers.

In both sets of specifications, we reject the null hypothesis of irrelevant or weak instrument using the Kleibergen and Paap, 2006 test only for households earning more than half of their disposable income from minimum wage labor. We note however that p-values of the weak instrument test are generally lower in Columns (5)-(8) when the minimum wage instrument is used to fit labor and transfer income simultaneously. This suggests that the minimum wage is a stronger instrument when both labor and transfer income are fitted in the first stage. Finally, the lack of strength in the minimum wage instrument for households with $S < 0.5$ suggests that the minimum wage as an instrument for labor income shock should be interpreted with caution for this group. This is also expected, since for them, the minimum wages represents a minor proportion of their disposable income.

Overall, we infer from the 2SLS estimates that minimum wage dependent households in China fully spend their labor and transfer income changes induced by the minimum wage increase. Since the minimum wage income increases show unanticipated and persistent behavior (see Table 1-II and Appendix 1.A), we can also interpret these results as consistent with the permanent income hypothesis, Jappelli and Pistaferri (2010).

[23] All our estimates presented in the paper are robust to this type of clustering, results are available from the authors.

In conclusion, it is also instructive to compare the 2SLS estimates of consumption propensity to minimum wage income with similarly specified OLS estimates showing consumption propensity to labor and transfer income changes. The OLS estimates are reported in Table 1-X in Appendix 1.D, they show that the correlations between labor income and consumption are considerably smaller, they fall within a range between 0.33 and 0.44. What can explain this large difference between the 2SLS and OLS estimates? First, expected labor income changes that do not originate from minimum wage variation could generally be more transitory and therefore subject to more consumption smoothing, for instance bonuses, which would imply a lower marginal propensity to consume. Second, reporting and measurement errors with respect to household income itself can attenuate the OLS estimate. At the same time, such measurement errors are likely to be orthogonal to the minimum wage variation, making the 2SLS estimate asymptotically consistent.

1.4.4 Health and Education Expenditure

An extensive economic literature has documented a positive relationship between health and education on the one hand and productivity and long-run income on the other, Mincer ("Investment in human capital and personal income distribution"), Bloom and Canning (2000). Therefore, health and educational expenditure present a particular item of interest indicative of the welfare of a household and its children. The household survey data allow us to examine these consumption items separately and document their relationship to the minimum wage level. From a public policy perspective, higher consumption of both health and educational expenditure of low income households in China is particularly desirable given the relative weakness of China's public health system and often costly access to quality education as documented for instance by Chamon and Prasad, 2010.

As shown by Attanasio, Battistin, and Ichimura (2007) and Blundell, Pistaferri, and Preston (2008), education and health expenditures are characterize by a more durable nature that closely assimilates them to investment and saving activities. Decomposing health and education expenditures in durable and non-durable items is not a straight forward exercise. Some of the health related expenditures are non-durable (i.e. drugs, medicines, treatments) however others have a more durable nature (i.e. medical and health care appliances, health insurances). Similarly, education expenditures may be either non-durable (i.e. stationery, educational activities and other cultural goods), or have an intrinsic durable utility (i.e. tuition fees, textbooks, educational hardware and software, musical instruments).

For all the above reasons we opt not to classify health and education within either durable or non-durable goods, but we provide estimates of the impact of minimum wages on health and education separately from durables and non-durables. We further provide a detailed breakdown between components of health, education, durables and non-durables in Appendix 1.E to describe in more detail the consumption behavior of Chinese households as a reaction to a minimum wage hike. Table 1.5 reports 2SLS estimates of the household consumption equation for annual real health and education expenditure in Columns (1)-(3), for non-durables expenditure in Columns (4)-(6) and for durables expenditure in Columns (7)-(9).

For households with the highest minimum wage dependence ($S > 0.75$), we find that a RMB 1,000 higher annual minimum wage is associated with a higher health and education expenditure of RMB 313, that is more than 30% of any minimum wage increase is spent either on health or education. The standard error is 0.159 and the

estimate is significant at 5% level. Increased health and educational spending represent substantial portion of the overall consumption response to minimum wage increases. The 30% expenditure share for a *marginal* minimum wage income hike is double when compared to the much lower 15% *average* expenditure share of health and educational spending combined, cfr. Table 1-V in Appendix 1.B. Moreover, as shown in a more detailed breakdown in Appendix Table 1-XI for health expenditures, and in Appendix Table 1-XII for education expenditures, the majority of the expenditures in these two categories stems from drugs and medicines, educational goods such as books, textbooks and stationery. Educational courses, CPU and software expenditures have also relatively large coefficients albeit not significant.

In Columns (3)-(6) we report the estimates for the aggregated non-durables category. Households earning more than half of their disposable income from minimum wages spend between RMB 0.34-0.41 for a RMB 1 increase in minimum wages. Results are significant at 5% level. Appendix Table 1-XIII shows a more detailed breakdown for non-durables with a significant coefficient for food in a range of RMB 0.26-0.32 increase for RMB 1 raise in the minimum wage. The point estimate for non-durable services is also significant at 0.09. Coupled with the results on health and education expenditures this suggests that food consumption is a poor proxy for total consumption.

The effect of the minimum wage hike on durable expenditures is not significant. The coefficients of Columns (8)-(9) in Table 1.5 are large (0.32-0.34) and in line with the magnitude of the estimates for health-education and non-durable expenditure, nevertheless, the standard errors are somewhat less precisely estimated not allowing to reject the null of no impact at standard significance levels. The point estimate of the durables component however suggests that the increase in minimum wages is approximately equally split between health and education, non-durable and durable expenditures. Interestingly, Appendix Table 1-XIV shows that approximately 10% of the minimum wage increase can be associated with expenditures on televisions. In comparison to the U.S., where Aaronson, Agarwal, and French, 2012 find that minimum wage households spent their increase in income in vehicles tied to collateralized loans, this finding is illustrative of the relative difference in average living standards across the two countries. In our setting, when a relatively poor household relying on minimum wages for most of their disposable income is faced with a persistent increase in the minimum wage it opts for investing a large share of that windfall in educational and health expenditures.

The result on health and education confirms the findings of Chamon and Prasad (2010) that associate costly education and poor public health provisioning with the high saving rates of Chinese households.[24] We interpret the finding of the large educational expenditure share for additional minimum wage income as a strong intergenerational bequest motive with respect to human capital. Educational spending is regarded as an investment into a higher future household income. In the context of the one-child-policy, parental aspirations typically focus on a single child and educational investment in the child may also serve as a retirement insurance for parents.

[24] In a separate set of regressions we interacted health and education expenditure with the number of children in the household. The estimates show that around 25% of the combined health and education response to minimum wages comes from households with children. However the interaction terms are not significant at standard confidence levels.

1.5 Household Heterogeneity

1.5.1 Liquidity Constraints

Consumption effects of incremental disposable income documented in Section 1.4 could be the result of borrowing constraints, Zeldes, 1989, Jappelli and Pistaferri, 2010. In a high income growth environment like China, households may expect a life-time income which justifies a desired consumption level larger than current disposable income, but borrowing constraints enforce a lower consumption level equal to disposable income. A higher minimum wage alleviates these expenditure constraints and this may explain the high consumption propensity. Indeed, minimum wage households are inherently liquidity constrained due to their low proceeds from labor and generally a lack of collateral to pledge against a loan. It is therefore possible that the findings in the previous section are driven by the inability to smooth consumption over time.

If financial constraints contribute to higher consumption propensities, we expect financially unconstrained households to feature lower consumption propensities of minimum wage income. We identify three variables as proxies for financially unconstrained households, namely those with access to additional liquidity. First, we define a dummy indicating that the household has property income. Property serves as collateral in credit relationships and may be used to guarantee a loan. In the sample, roughly 14% of low income households with $S > 0.5$ dispose of property income and may therefore be less likely to face borrowing constraints.[25] Second, we identify households with interest, dividend or insurance income. The respective dummy variable takes on the value one for 7% of all households with $S > 0.5$. Third, we define outright home ownership households as those who own a house and do not have to make mortgage payments. Contrary to non-owners or owners with mortgage debt, outright home owners can pledge their property as collateral to obtain loans and smooth consumption behavior over the life-cycle. Yet, ownership rates are extremely high at 76% even among relatively poor minimum wage households ($S > 0.5$) and the house value may often be so low that even outright ownership does not necessarily imply access to credit.

Table 1.6 reports how the three proxies for credit access interact with the consumption propensity in the 2SLS setting. Columns (1)-(3) show that, when interacted with the property income dummy, the consumption response to minimum wage induced changes in labor and transfer income differs from the baseline 2SLS coefficient of Table 1.4. Households with property income above the median and with $S > 0.5$ or $S > 075$, consume roughly 30% less of the induced income variation compared to households without property income. Columns (4)-(6) mark minimum wage households with financial assets; but their consumption propensity is not statistically significantly different from other minimum wage dependent households. Finally, outright house ownership reported in Columns (7)-(9) does not appear to matter much for a household's consumption propensity. The coefficient of -0.121 for the interaction term in Column (9) is economically small and again statistically insignificant. These results suggest that variations in liquidity access (identified by our proxies) do not seem to matter for the high propensity to consume addition minimum wage income. Overall, we find little empirical support for the hypothesis that liquidity constraints drive the high consumption propensities found in Section 1.4.

[25] Among households with some income from property, the mean income from property is RMB 2,957 per year, and the median RMB 630. We construct the dummy (=1) if income from property is above the median of RMB 630 per year.

1.5.2 Household Structure

The large household propensity to spend a higher minimum wage income on education suggests that household structure matters for the consumption behavior. The one-child policy implies a predominance of single child households: the majority of households in the UHS sample have one child (77%), households with two children represent 14.5%, childless households are 6.5%, and only 2% of household have more than two children.[26]

The Chinese one-child policy is often blamed for an unbalanced gender ratio between girls and boys because abortions are practiced more frequently if the fetus is female. Some authors claim that this gender imbalance has consequences for the marriage market in which competition for brides requires young unmarried men to demonstrate wealth and real estate ownership. The marriage motive could generate higher savings rates among households with a male child and in particular with a male child of adult age, Wei and Zhang, 2011, Rosenzweig and Zhang, 2014.

Table 1.7 reports the marginal propensity to consume out of the minimum wage change when fitted labor and transfer income is interacted with a dummy for household with children, Columns (1)-(3); with a dummy for a male child, in Columns (4)-(6); and with a dummy identifying households with an adult male child of at least 24 years of age, in Columns (7)-(9). The 2SLS estimates in Column (3) provide evidence that a high consumption propensity of minimum wage income is related to children in the household. In fact, childless families with the highest minimum wage dependency ($S > 0.75$) show a lower point estimate and only households with at least one child show a marginal propensity to consume close to one.[27] We infer from Column (6) that the male gender of a child makes only an economically small and statistically insignificant difference to consumption behavior. Male children of adult age increase rather than reduce consumption on average, but the estimated effects are statistically indistinguishable from zero.

While children in a household boost propensity of consumption of minimum wage income considerably, there is no support for a gender-based saving bias in low income households dependent on minimum wages. Consistently, our identification strategy does not allow us to generalize this finding to wealthier families for which minimum wages do not matter. As aggregate saving rates depend mostly on the saving behavior of middle and high income families, we need to be careful not to extrapolate these findings for low income families to the Chinese aggregate macroeconomic saving behavior as a whole.[28]

[26] Besides simple non-compliance, a series of exceptions to the one-child policy can be highlighted and are documented for China. For instance a time distance of four to six years between two births may provide a justification for two children, rural families can have two children if the first baby is a girl, and further exemptions exist on ethnic and economic considerations, Gu et al., 2007.

[27] In a separate set of regressions we also test for incremental minimum wage effects on consumption in the one-child household group and compare it to households without children. The estimated interaction coefficient of the dummy for one child is larger than the generic dummy for children in Table 1.7. Moreover, we compare one-child households with multiple children households to see if the one-child saving motive holds; yet we do not find significantly different consumption responses across these household groups.

[28] We tried to explore further the heterogeneity of the minimum wage impact on consumption by looking at interactions with urban immigrant households, household with one or both members working for an SOE, households with debt, female headed households and the education of the head of the households. None of these characteristics have significant interactions with the minimum wage.

1.6 Robustness

1.6.1 Parallel Trends

The difference-in-difference estimation requires the parallel (common) trend assumption to hold, whereby the outcome variable in the treatment and control group should exhibit similar trends before treatment occurs, and these trends persist in the absence of treatment. Anticipation effects of policy change or diverging pre-existing trend can bias the inference. We therefore seek to show a high degree of synchronization between consumption changes and minimum wage changes.

To validate our research design, we nest household consumption in a more general specification, which allows for asynchronous effects in a two year window around the implementation of the minimum wage change. Formally, we estimate the augmented reduced form

$$C_{h,c,t} = \alpha + \sum_{k=-2}^{+2} \beta_k^{RF} MW_{c,t+k} + \boldsymbol{X}_{m,h,t}\boldsymbol{\Lambda} + \boldsymbol{X}_{h,t}\Theta + \boldsymbol{X}_{city,t}\Xi + \phi_c \cdot t + \eta_h + \delta_{p,t} + \varepsilon_{h,c,t}, \tag{1.8}$$

where the parameter of interest β_k^{RF} takes on different time subscripts to capture a persistent or anticipated consumption response relative to the date of minimum wage changes. We use time lags of $k = -1, -2$ years or time leads of $k = +1, +2$ years. The lead coefficients are like placebo events for the parallel trend assumption and should exhibit a zero consumption response to rule out confounding parallel trends, hence $\beta_k^{RF} = 0$ for $k > 0$. The lagged coefficients instead provide information on the duration of the impact, i.e. if the minimum wage effect on consumption is persistent over time. By including county linear time trends in the regression, $\phi_c \cdot t$, our specification seeks to identify a sharp contemporaneous relationship between variation of consumption and minimum wage variation even under confounding county-level trends.

Table 1.8 reports the augmented specification. Columns (1)-(4) presents marginal propensities to consume for two periods of lagged response ($k = -1, -2$), and for two periods of lead response ($k = +1, +2$). In both specifications the contemporaneous response is positive, statistically significant, and consistent with the findings in Section 1.4. By contrast, the first lag and lead of the minimum wage have a negative sign and are statistically insignificant; nor the second lag or lead matter from a statistical point of view. Only the first lag for the category $S > 0.5$ shows a marginally significant negative effect. We therefore find no evidence for policy anticipation effects on household consumption. Instead we find that the consumption response occurs contemporaneously to the minimum wage change and is not affected by divergent trends.

1.6.2 Attrition

Attrition of households from the sample can severely bias the results. In this section we construct a dummy for attrition and test whether minimum wages have an effect on the attrition rate.

The UHS is based on a multi-stage probabilistic sample and stratified design. The Chinese national Bureau of Statistics draws a sample of households randomly every three years. After being drawn into the UHS, the households already know for how many years they are expected to be part of the survey. As a general rule, every year one third of the households of the big sample is replaced by other households. This implies that there is a structural attrition in the sample and that is challenging

to disentangle it from the attrition due to voluntarily refusing to take part in the UHS for the predetermined amount of years.[29]

In the following we study attrition by looking at the attrition of household before the minimum three year observation period. We construct a dummy variable for attrition if the worker has stayed in the panel only one or two years. To avoid sample composition bias, some caveats in the construction of the attrition dummy are due: first, our panel starts in 2002 and terminates in 2009. For 2002 we do not observe if the household is part of a the 2002 or an older vintage of the UHS, therefore we drop all households that were already in the UHS in 2002. Second, from 2003 we keep in the sample only new vintages of households. Third, we cannot track for at least three years households entering the panel in 2008 or 2009. We therefore drop form this regression households entering the UHS in 2008 and 2009 since we cannot observe them for three years in a row and cannot define precisely the attrition dummy for them. For new vintages of households for which we can observe at least three years of data, we switch on the attrition dummy when a household is observed only for one or two years and zero if it has at least three years of observations.

The Table 1.9 shows individual level estimates of a proxy for attrition on the natural logarithm of the minimum wage. Results indicate that minimum wage changes do not affect attrition. The results are consistent across all the groups of minimum wage dependency and hold in both the sample of household composed only by best two earners and the full sample of household members.

1.6.3 Minimum wages and Hours Worked

Higher minimum wages may affect labor allocation also on the intensive margin by affecting labor demand and supply. On one hand, employers may demand more hours from their employees after a hike in minimum wages; on the other hand, higher minimum wages may provide incentives for workers to switch from full-time to part-time employment or vice versa. In order to show the impact of the minimum wage on labor supply we regress Equation 1.7 using *monthly* hours worked as the dependent variable and we take the natural logarithm of minimum wages for easier interpretation of estimates. We keep in the sample both employed and unemployed individuals since hours worked may be affected by the loss of employment caused by higher minimum wages. Results are reported in Table 1.10.

They illustrate that there is no significant evidence of either an increase or a decrease in hours worked. At the same time it can be observed that there is a general tendency of decreasing working hours as the share of minimum wage income increases. In Column (4) when the workers belong to households with share $S>0.75$ a one percent increase in minimum wages is associated with a reduction of monthly working time of 4.6 hours. In order to put this estimate into perspective it should be recalled that the average annual increase of real minimum wages is approximately 7.35% (see Table 1.1), on a monthly basis, this translates in a 0.61 percent increase of the real minimum wage.

[29]More specifically, the Chinese national Bureau of Statistics draws a first-stage sample (the "big sample") of households randomly every three years. A small sample is then randomly selected from the big sample for more recurrent interviews and diary-keeping. As a general rule, from 1986 to 2005, every year one third of the households of the big sample is replaced by other households. In addition, as pointed out by Feng, Hu, and Moffitt, 2017 and Ding and He, 2018, this rotation design has not always been strictly enforced resulting in a lower rotation ratio than what was originally planned. For instance, some provinces may have delayed withdrawing and replacing the first-stage sample at the end of the three-year period for funding reasons.

1.7 Minimum Wages and Employment

The UHS collect consumption information only at the level of the household. However, workers' employment status, occupation and industry of employment is available at individual level. In this section we exploit this more granular structure to estimate the impact of minimum wages on employment in both extensive and intensive dimensions.

As shown, higher minimum wages are associated with an increase in the labor income of minimum wage dependent households. All previous regressions include both employed and non employed best two earners in a household implying that the results hold unconditionally from the employment status. It can therefore be inferred that household consumption does not seem negatively affected by potential negative employment effects stemming from higher minimum wages. To corroborate this finding, in this section we disentangle the wage effect from the employment effect and run separate estimates for employment.[30] Evidence of significant negative employment effects would be a relevant objection to an active minimum wage policy and would not be consistent with the finding of previous sections.

Table 1.11 reports individual level regressions where the dependent variable is the employment dummy equal to one for employed household members, a zero dummy identifies workers within the labor force declaring to be unemployed at the time of the survey. The zero group includes all adult household members who do not earn any income, but excludes those in training (for example university students) and homeworkers. The independent variable is the log of the county real minimum wage. Column (1) considers workers/employees from households not depending on minimum wage income as a placebo group, while Columns (2)-(4) focus on workers in households of various degrees of minimum wage dependency. Columns (5)-(8) focus on the migrant population of workers who migrated into the urban area less than 10 years ago. The latter groups can be described as more vulnerable and exposed to minimum wage increases, Orrenius and Zavodny, 2008. All specifications include worker and province-year fixed effects and we add additional county-level trends and city-level macroeconomic controls.

In Column (1) there is a weak positive impact of minimum wages on employment for households not earning a minimum wage. Nevertheless the estimates is rather small, a 10% increase in minimum wages would contribute to a 0.27 percentage points increase in employment. We interpret this result with caution given that S=0 is our placebo group. Columns (2)-(4) show increasingly negative point estimates for the real minimum wage for more minimum wage dependent households. Households with the highest minimum wage dependency in Column (4) feature a coefficient of -0.076: a 10% real minimum wage hike decreases the likelihood of employment by less than 0.8%. The coefficient is economically and statistically insignificant. The standard error on the coefficient is nevertheless precisely estimated at 0.037, which implies that we can exclude large adverse effects of minimum wages on the unemployment risk of a worker.

The employment regressions for migrant workers in Columns (5)-(8) produce a more negative impact of the minimum wage level on employment albeit insignificant. For minimum wage dependent migrant households with $S > 0.75$ in Column

[30] Previous research on China has related higher minimum wages to more instances of lay-off based on firm survey data, Huang, Loungani, and Wang (2014). But unlike our household survey data, firm based surveys do not track individual workers and therefore cannot address questions on worker turnover rates or prolonged unemployment spells. Welfare implications are very different in these two cases.

(8), the point estimate is -0.635, which implies that a 10% larger minimum wage increases the risk of unemployment by 6.35 percentage points. However, also in this case we cannot reject the null hypothesis that the total unemployment effect is zero.[31]

One interpretation of these findings is that the level of minimum wages in China, set at around 20% of the median wage, is low by international standards and has little bite. The low bite of the minimum wage coupled with the evidence on the absence of unemployment effects suggests that the minimum wage level in China is not salient with respect to general equilibrium effects in the labor market. The absence of unemployment effects reinforces the previous results on consumption, since the potential precautionary savings motive due to unemployment effects is not sustained.

Under the circumstances of a relatively low cost of minimum wage labor, minimum wage hikes may contribute to labor reallocation without triggering significant unemployment risk for low wage workers. To test this reallocation effect we can examine the relationship between minimum wage level and occupation switching by defining an occupation switching dummy (=1) if the worker has changed occupation from the previous year and zero otherwise.

Table 1.12 reports employment switching regressions as a function of the minimum wage level. Columns (1)-(4) are based on the sample of all workers in households of different minimum wage dependency S whereas Columns (5)-(8) focus only on migrant workers. We use here the full sample of all migrants and not only the recent flow of immigrants to maximize statistical power through sample size.[32] Workers in the most minimum wage dependent households with $S > 0.75$ have higher rates of switch in occupation for a higher minimum wage. The wage coefficient is positive at 0.407 albeit standard errors are too large to confirm significance at conventional levels of confidence.

Interestingly, for minimum wage dependent migrant workers the wage coefficient is larger: a one percent increase in the real minimum wage is associated with 1.92 percentage points increased probability to switch occupation. The coefficient is statistically significant at 5% confidence level. This evidence suggests that for more vulnerable workers there are some reallocation effects helping to change occupation if faced with unemployment risk due to minimum wages.

1.8 Conclusions

This study provides evidence on the consumption and income response of Chinese households to the large cross-sectional and intertemporal variation of China's minimum wages. For the period 2002-2009, we identify more than 13,874 changes in the local minimum wage across China's 2,183 counties and 285 cities, and match them

[31] All regressions are performed using linear OLS. Non-linear binary dependent variable models are computationally difficult due to the high dimensionality of fixed effects included in the specification. We perform further robustness tests of these finding using county or household level fixed effect: the goodness of fit of these estimates is considerably lower while the point estimates have similar magnitudes. We also experiment with county-level aggregate regressions using a distinct separate county-level dataset on unemployment rate and obtain a point estimate of -0.064 with a standard error of 0.087 for $S > 0.75$. We also test if the minimum wage unemployment effect is present when we restrict the sample to a younger teenager population, we run several estimates for teens with age greater than fifteen but lower than twenty and up to twenty-four. All teen estimates do not show negative employment effect significant at conventional confidence levels.

[32] In a separate set of robustness estimates we drop sequentially the fixed effects and the county trends from the regression and obtain similar results to those in Table 1.12.

to the urban household survey (UHS) which covers 73,164 urban household-year observations.

The main finding of the analysis shows that higher household incomes due to a minimum wage hike are fully spent by minimum wage dependent households. The magnitude of the estimates is consistent with the estimates of the literature on income shocks in developing countries, see Wolpin (1982) and Paxson (1992), suggesting that under similar labor market conditions the results can be reasonably applied to a comparable group of households.

This study finds that the relationship is stronger for households composed of two minimum wage earners and the effect is driven by households with children, whereas households without children feature higher saving rates. The study also finds that roughly 30% of additional minimum wage income is in fact invested in health care and educational spending with potential long-term benefits for household welfare.

We test if the consumption effect of a minimum wage hike is driven by borrowing constraints. In fact, any excess sensitivity of consumption to incremental disposable income could be the result of liquidity constraints and inability to smooth consumption over the life cycle. However, we find that the consumption response do not differ significantly when we compare more or less liquidity-constrained households showing that the impact is not driven by liquidity constraints.

The study finds also evidence of complementarity between minimum wages and other transfers from social policies. Local minimum wage increases are associated with increased (rather the decreased) social transfers for households earning more than 75% of their disposable income from minimum wages. For this group, social transfers therefore magnify the income effect of minimum wage hikes on consumption. This suggests that local minimum wage increases in China are often part of a more comprehensive social policy towards low-income households. In fact, households earning less than 25% of their income from minimum wages do not experience commensurate effects in their transfer income when minimum wages increase.

FIGURE 1.1: Minimum Wage Variation

Proportion of counties increasing their nominal minimum wage in China, 1996-2012. We plot by year the percentage of China's 2,183 counties and 285 cities in our sample with a strictly positive minimum wage change between 0 and 10%, between 10% and 20%, and above 20%, respectively. The column height represents the combined share of counties experiencing an increase of their nominal minimum wage in a given year.

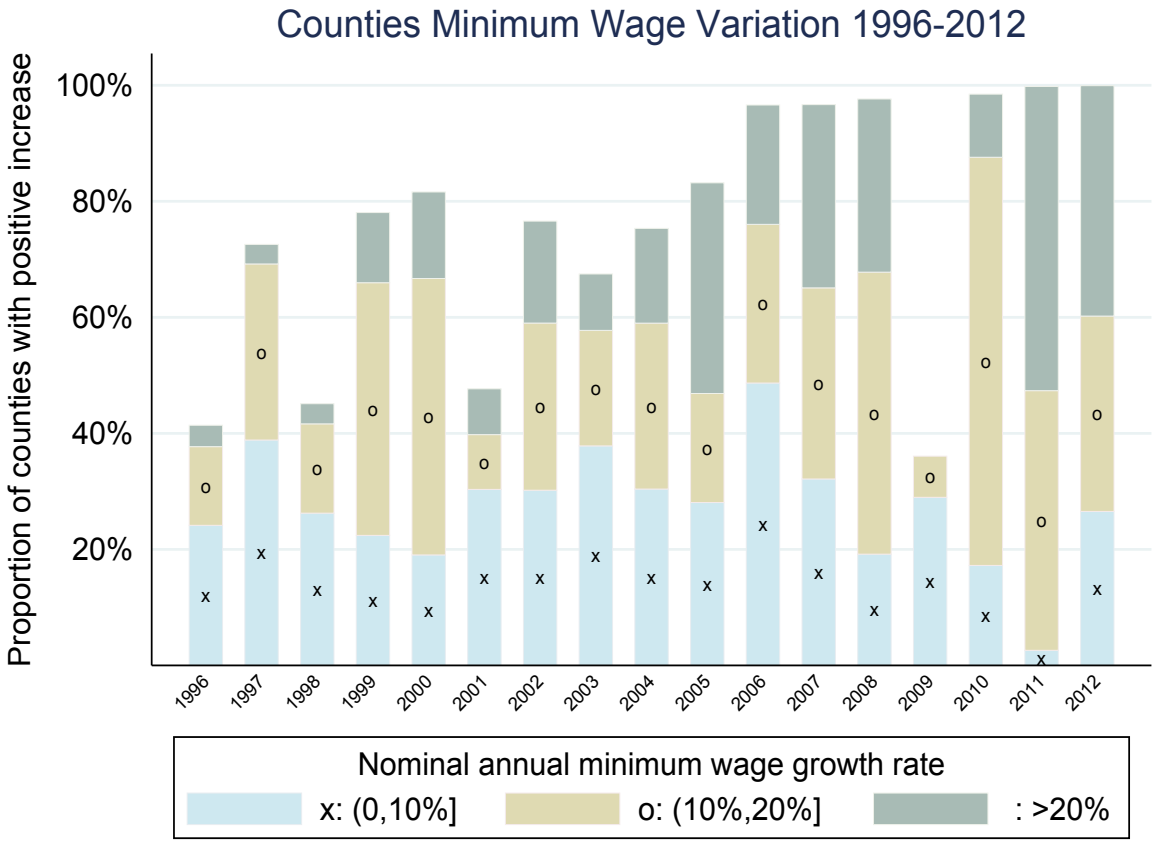


FIGURE 1.2: Household Consumption and County Minimum Wages - I

Average real consumption changes are plotted for minimum wage dependent households ($S > 0.5$, red crosses) and those without minimum wage income ($S = 0$, blue dots). We sort all households into 40 bins according to the magnitude of the local real minimum wage increase relative to province-level average minimum wages. The dashed line represents the fitted linear relationship for minimum wage dependent households and the solid line for households without minimum wage income. N=32,355 household-level observations. A standard t-test for the statistical difference of the two slopes produces a t-statistic of 1.56

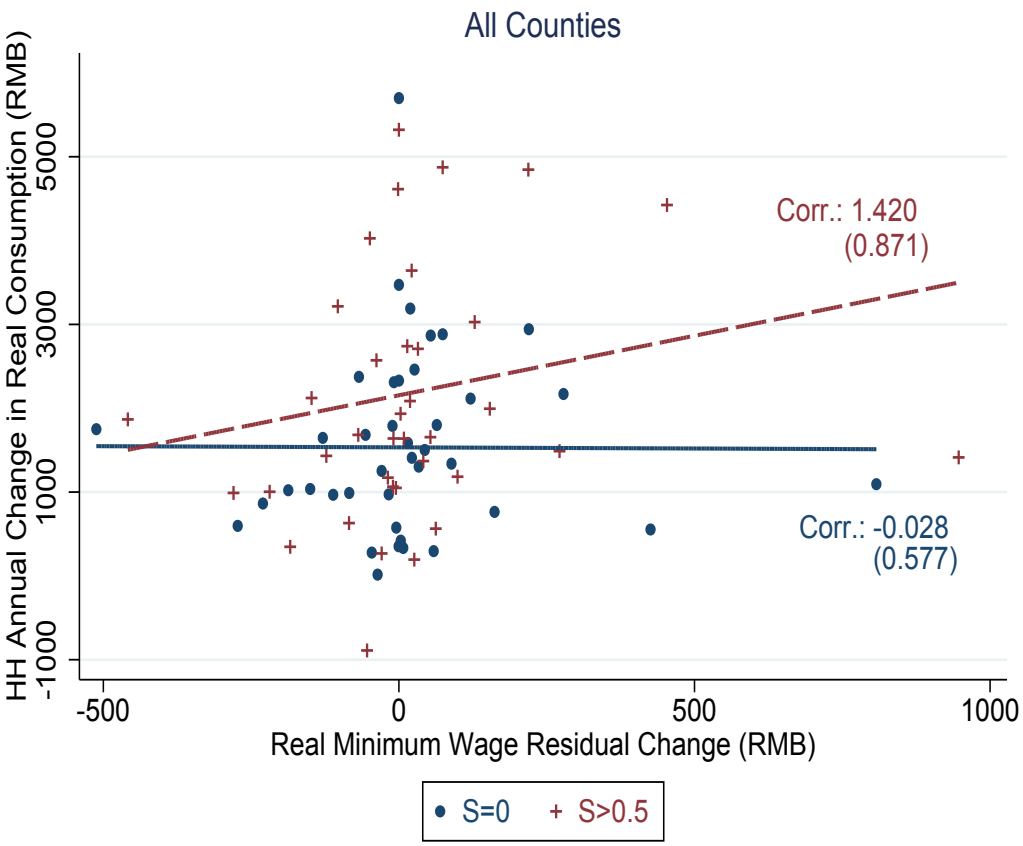


FIGURE 1.3: Household Consumption and County Minimum Wages - II

After sorting counties into those with and without a nominal minimum wage change in a given year, we proceed as in Figure 2: average real consumption changes are plotted for minimum wage dependent households ($S > 0.5$, red crosses) and those without minimum wage income ($S = 0$, blue dots). In each panel households are sorted into 40 bins according to the magnitude of the local real minimum wage increase relative to province-level average minimum wages. The dashed line represents the fitted linear relationship for minimum wage dependent households and the solid line for households without minimum wage income.

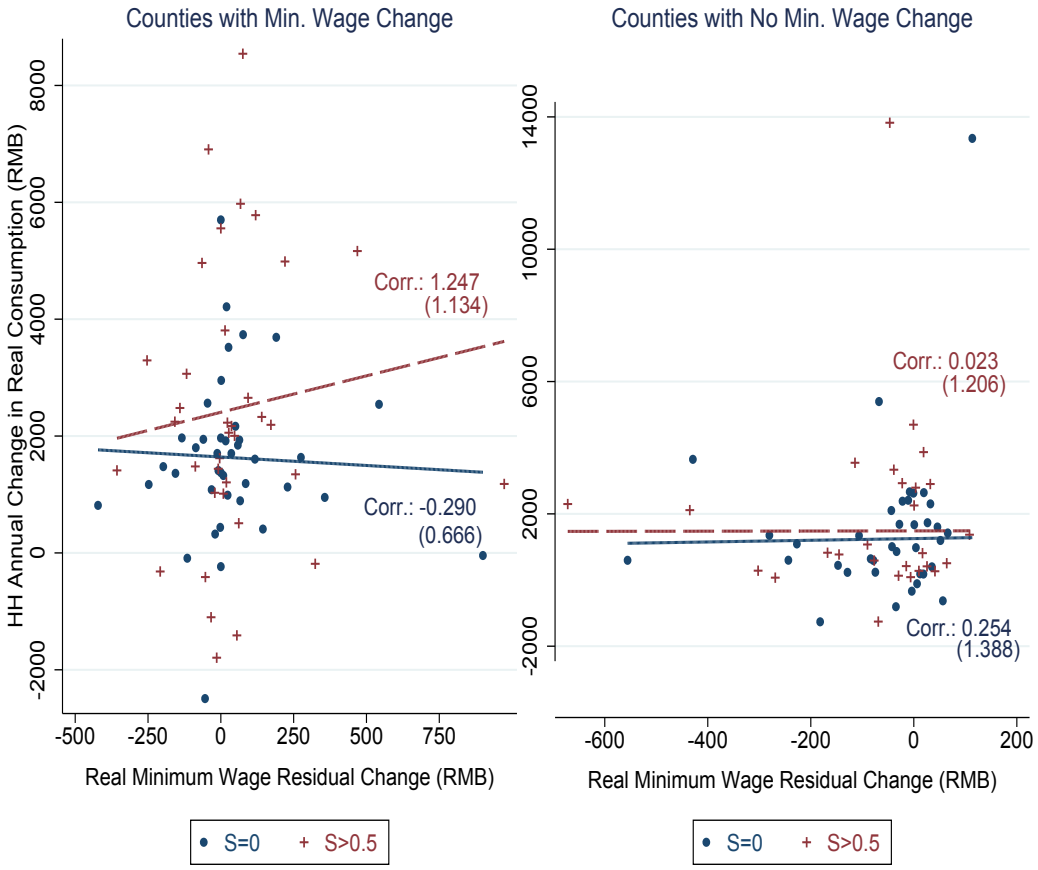


TABLE 1.1: Labor Supply and Minimum Wage Bite

The table reports the monthly supply of working hours for the entire cleaned sample of urban full-time workers (Panel A) and only for the subset of workers in minimum wage households (Panel B). For both groups, the monthly hours worked are reported for counties that have a change in the minimum wage (treated) compared with counties without minimum wage change (control). A t-test for the difference of the means between these two groups is also presented with clustered standard errors at the county-level in parenthesis. Labor supply in terms of monthly hours worked is not available for the years 2007-2009. Panel C reports also average minimum wage bite by year and the annual growth rate of the real minimum wage. The minimum wage bite is computed as the ratio of the minimum wage (MW) to the median wage in each county and then averaged across counties. Standard errors are provided in parentheses.

Year	2002	2003	2004	2005	2006	2007	2008	2009
Panel A: Workers in all households								
Monthly hrs MW treated counties	167.2	166.0	164.3	167.7	168.2	–	–	–
	(54.48)	(58.62)	(58.19)	(57.14)	(56.38)			
Monthly hrs control counties	164.3	163.7	167.8	165.1	177.8	–	–	–
	(58.16)	(56.78)	(56.21)	(60.34)	(69.02)			
T-test	2.99	2.33	−3.48	2.61	−9.59	–	–	–
	(2.35)	(2.04)	(1.99)	(2.40)	(6.12)			
Observations for t-test	31657	41654	43808	44027	38910	–	–	–
Panel B: Workers in MW households (S>0)								
Monthly hrs MW treated counties	162.1	160.7	160.0	163.8	164.1	–	–	–
	(63.11)	(68.41)	(66.04)	(65.41)	(64.94)			
Monthly hrs control counties	156.5	160.3	162.4	159.2	174.5	–	–	–
	(68.33)	(62.72)	(64.27)	(73.56)	(76.96)			
T-test	5.60	0.46	−2.45	4.61	−10.37	–	–	–
	(2.57)*	(2.49)	(2.51)	(4.31)	(7.51)			
Observations for t-test	8065	10406	10705	10828	9240	–	–	–
Panel C: MW bite and Real MW growth								
MW relative to median wage	0.202	0.201	0.197	0.198	0.201	0.185	0.189	0.176
	(0.042)	(0.043)	(0.046)	(0.045)	(0.045)	(0.045)	(0.053)	(0.045)
Real MW growth (p.p.)	10.42	4.65	5.55	10.29	7.51	8.65	8.80	2.93
	(8.55)	(6.71)	(8.96)	(8.08)	(6.86)	(8.11)	(6.20)	(4.09)

TABLE 1.2: Household Labor and Transfer Income and the Minimum Wage

We regress the levels of household real annual labor income in Columns (1)-(3), transfer income in Columns (4)-(6), and their sum in Column (7)-(9), on the local effective real minimum wage level. The samples consist of all households for which the labor income share S from minim wages is zero ($S = 0$), or more than 50% ($S > 0.5$), or more than 75% ($S > 0.75$) of household disposable income. All regressions include household, county and interacted province-year fixed effects, city-level controls and county time-trends as specified in Equation (7). Standard errors clustered at county-level in parentheses.

Dep.var.:	Household Labor Income			Household Transfer Income			HH Labor & Transfer Income		
MW dependency:	$S = 0$	$S > 0.5$	$S > 0.75$	$S = 0$	$S > 0.5$	$S > 0.75$	$S = 0$	$S > 0.5$	$S > 0.75$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Minimum Wage	-0.022	1.378	1.529	-0.071	0.733	0.984	-0.110	1.904	2.247
	(0.574)	(0.632)**	(0.692)**	(0.222)	(0.512)	(0.521)*	(0.623)	(0.811)**	(0.823)***
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	44288	3699	3374	44288	3699	3374	44288	3699	3374
N clusters	625	346	335	625	346	335	625	346	335
N households	20450	1785	1627	20450	1785	1627	20450	1785	1627
Adjusted R^2	0.256	0.700	0.705	0.064	0.244	0.247	0.226	0.672	0.681

TABLE 1.3: Household Consumption and the Minimum Wage

Reduced form specifications regress the annual real household consumption in RMB on the real local minimum wage level where Columns (1)-(4) control for all non-labor income and Columns (5)-(8) for non-labor income without transfer income. The samples consist of all households for which the labor income share S from minimum wages is zero ($S = 0$), more than 25% ($S > 0.25$), more than 50% ($S > 0.5$), or more than 75% ($S > 0.75$) of household disposable income. All regressions include household, county and interacted province-year fixed effects, city-level controls and county time-trends as specified in Equation (6). Standard errors clustered at county-level in parentheses.

Dep.var.:	Household Consumption							
MW dependency:	$S = 0$	$S > 0.25$	$S > 0.5$	$S > 0.75$	$S = 0$	$S > 0.25$	$S > 0.5$	$S > 0.75$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Minimum Wage	-1.039	1.224	1.605	1.914	-1.090	1.325	1.861	2.317
	(0.631)	(0.564)**	(0.798)**	(0.912)**	(0.640)*	(0.575)**	(0.892)**	(1.017)**
Controls:								
All non-labor income	Yes	Yes	Yes	Yes	No	No	No	No
Non-labor income excluding transfers	No	No	No	No	Yes	Yes	Yes	Yes
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	44375	12072	3700	3375	44375	12072	3700	3375
N clusters	626	491	346	335	626	491	346	335
N households	20530	5686	1785	1627	20530	5686	1785	1627
Adjusted R^2	0.229	0.429	0.553	0.583	0.223	0.417	0.567	0.604

TABLE 1.4: Household Consumption under Labor Income Shocks

We report 2SLS level regressions in which real annual household consumption is alternatively regressed on the household's annual real labor income level in Columns (1)-(4), or the annual real labor income plus transfers level in Columns (5)-(8). The samples consist of all households for which the labor income share S from minimum wages is zero ($S = 0$), more than 50% ($S > 0.5$), or more than 75% ($S > 0.75$) of household disposable income. All regressions include city-level controls, household fixed effects, interacted province-year fixed effects, and county time-trends as specified in Equation (8). Standard errors clustered at county-level in parentheses. The p-values in the last line refer to a test under the null hypothesis of weak instruments (Kleibergen and Paap, 2006).

Dep.var.:	Household Consumption							
MW dependency:	$S = 0$ (1)	$S > 0.25$ (2)	$S > 0.5$ (3)	$S > 0.75$ (4)	$S = 0$ (5)	$S > 0.25$ (6)	$S > 0.5$ (7)	$S > 0.75$ (8)
Labor Income	61.461	3.314	1.217	1.301				
	(1986.224)	(4.232)	(0.574)**	(0.648)**				
Labor and Transfer Income					9.258	2.271	1.053	1.065
					(45.461)	(1.990)	(0.405)***	(0.409)***
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	41709	11309	3442	3137	41709	11309	3442	3137
N clusters	597	469	323	314	597	469	323	314
N households	17871	4927	1528	1390	17871	4927	1528	1390
H_0 : Weak instruments (p-value)	0.975	0.529	0.031	0.026	0.845	0.396	0.019	0.009

TABLE 1.5: Household Health & Education, Non-durables and Durables Expenditure

The table reports the same 2SLS level regressions of Table 1.4 using sub-components of household consumption as dependent variable. Expenditure on health and education is shown in Columns (1)-(3), non-durable goods in Columns (4)-(6) and expenditure on durable goods in Columns (7)-(9). All regressions include city-level controls, household fixed effects, interacted province-year fixed effects, and county time-trends as specified in Equation (8). The samples consist of all households for which the labor income share S from minimum wages is zero ($S = 0$), more than 50% ($S > 0.5$), or more than 75% ($S > 0.75$) of household disposable income. Standard errors in parenthesis are clustered at county-level. Weak instrument row shows the p-value of the Kleibergen and Paap (2006) test under the null of weak instrument.

Dep.var.:	Health & Educ. Exp.			Non-durables Exp.			Durables Exp.		
	$S = 0$ (1)	$S > 0.5$ (2)	$S > 0.75$ (3)	$S = 0$ (4)	$S > 0.5$ (5)	$S > 0.75$ (6)	$S = 0$ (7)	$S > 0.5$ (8)	$S > 0.75$ (9)
Labor and Transfer Income	2.110	0.228	0.313	2.034	0.413	0.344	0.164	0.316	0.336
	(4.749)	(0.165)	(0.159)**	(9.677)	(0.189)**	(0.175)**	(1.363)	(0.232)	(0.236)
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	36624	3055	2779	41709	3442	3137	36624	3055	2779
N clusters	290	228	224	597	323	314	290	228	224
N households	15821	1361	1236	17871	1528	1390	15821	1361	1236
H_0 : Weak instruments (p-value)	0.661	0.044	0.022	0.845	0.019	0.009	0.661	0.044	0.022

TABLE 1.6: Household Consumption, Minimum Wage Income Shock and Liquidity Constraints

We report 2SLS level regressions as Table 1.4. Here real annual household consumption is regressed on the household's annual real labor and transfer income and on additional interaction terms identifying liquidity constrained households. The interaction terms are property income dummy in Columns (1)-(3), a capital income dummy for interest, dividends and insurance income in Columns (4)-(6), and a dummy for (debt-free) house ownership in Columns (7)-(9). The samples consist of all households for which the labor income share S from minimum wages is zero ($S = 0$), more than 50% ($S > 0.5$), or more than 75% ($S > 0.75$) of household disposable income. All regressions include city-level controls, household fixed effects, interacted province-year fixed effects, and county time-trends as specified in Equation (8). Standard errors clustered at county-level in parentheses. The p-values in the last line refer to a test under the null of weak instruments (Kleibergen and Paap, 2006).

Dep.var.:	Household Consumption								
MW dependency:	$S = 0$ (1)	$S > 0.5$ (2)	$S > 0.75$ (3)	$S = 0$ (4)	$S > 0.5$ (5)	$S > 0.75$ (6)	$S = 0$ (7)	$S > 0.5$ (8)	$S > 0.75$ (9)
Labor and transfer income	5.989 (17.128)	1.070 (0.380)***	1.068 (0.383)***	6.615 (24.340)	0.907 (0.416)**	0.956 (0.435)**	8.552 (41.467)	1.082 (0.497)**	1.153 (0.506)**
Labor and transfer income × property dum.	-0.480 (1.648)	-0.356 (0.178)**	-0.356 (0.194)*						
Labor and transfer income × capital income dum.				-0.204 (0.902)	-0.101 (0.072)	-0.110 (0.078)			
Labor and transfer income × house ownership dum.							0.825 (3.800)	-0.036 (0.189)	-0.110 (0.195)
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	41709	3442	3137	41709	3442	3137	41709	3442	3137
N clusters	597	323	314	597	323	314	597	323	314
N households	17871	1528	1390	17871	1528	1390	17871	1528	1390
H_0 : Weak instruments (p-value)	0.741	0.022	0.011	0.797	0.024	0.014	0.843	0.018	0.009

TABLE 1.7: Household Consumption and Household Structure

We report 2SLS level regressions as in Table 1.4. Here real annual household consumption is regressed on the household's annual real labor and transfer income and on additional interaction terms identifying household structure. The interaction terms are a dummy for one or more children in the household in Columns (1)-(3), an additional dummy for one or more male children in the household in Columns (4)-(6), or an additional dummy for one or more male children older than 24 years in Columns (7)-(9). The samples consist of all households for which the labor income share S from minimum wages is zero ($S = 0$), more than 50% ($S > 0.5$), or more than 75% ($S > 0.75$) of household disposable income. All regressions include city-level controls, household fixed effects, interacted province-year fixed effects, and county time-trends as specified in Equation (8). Standard errors clustered at county-level in parentheses. The p-values in the last line refer to a test under the null of weak instruments (Kleibergen and Paap, 2006).

Dep.var.:	Household Consumption								
MW dependency:	$S = 0$ (1)	$S > 0.5$ (2)	$S > 0.75$ (3)	$S = 0$ (4)	$S > 0.5$ (5)	$S > 0.75$ (6)	$S = 0$ (7)	$S > 0.5$ (8)	$S > 0.75$ (9)
Labor and transfer income	11.722 (56.254)	0.463 (0.550)	0.349 (0.498)	10.460 (44.459)	0.431 (0.509)	0.309 (0.452)	34.987 (505.309)	0.447 (0.547)	0.325 (0.493)
Labor and transfer income × children dum.	-3.084 (16.180)	0.655 (0.386)*	0.798 (0.315)**	-2.893 (13.583)	0.619 (0.397)	0.743 (0.333)**	-11.590 (171.106)	0.639 (0.374)*	0.784 (0.301)***
Labor and transfer income × male child dum.				0.290 (1.418)	0.064 (0.129)	0.090 (0.147)			
Labor and transfer income × adult male child dum.							9.741 (140.027)	0.048 (0.123)	0.052 (0.148)
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	41709	3442	3137	41709	3442	3137	41709	3442	3137
N clusters	597	323	314	597	323	314	597	323	314
N households	17871	1528	1390	17871	1528	1390	17871	1528	1390
H_0 : Weak instruments (p-value)	0.837	0.021	0.011	0.816	0.018	0.009	0.945	0.020	0.009

TABLE 1.8: Parallel Trends and Anticipation Effects

Reduced form specifications regress the annual real household consumption on the contemporaneous real local minimum wage level including lags and leads for one and two years. The samples consist of all households for which the labor income share S from minimum wages is zero ($S = 0$), more than 25% ($S > 0.25$), more than 50% ($S > 0.5$), or more than 75% ($S > 0.75$) of household disposable income. All regressions include household, county and interacted province-year fixed effects. We control for all other type of income including transfers, we add city-level controls, and county time trends as specified in Equation 1.8. Standard errors clustered at county-level in parentheses.

Dep.var.:	Household Consumption			
	(1)	(2)	(3)	(4)
	$S = 0$	$S > 0.25$	$S > 0.5$	$S > 0.75$
Minimum wage	-0.818	1.412	1.769	2.056
	(0.672)	(0.774)*	(1.044)*	(1.192)*
Minimum Wage$_{t-1}$	0.341	-0.481	-1.865	-1.778
	(0.719)	(0.612)	(1.111)*	(1.131)
Minimum wage$_{t-2}$	0.983	0.860	0.579	0.526
	(0.908)	(0.731)	(1.568)	(1.648)
Minimum Wage$_{t+1}$	-0.815	-0.100	-0.934	-0.941
	(0.504)	(0.490)	(0.892)	(0.989)
Minimum wage$_{t+2}$	-0.192	-0.142	0.017	0.098
	(0.392)	(0.322)	(0.457)	(0.580)
City-level controls	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes
Province $\times$ year FE	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes
Observations	43621	12086	3685	3315
N clusters	626	491	346	335
N households	20530	5686	1785	1627
Adjusted R^2	0.241	0.442	0.563	0.588

TABLE 1.9: Attrition

The table shows individual level estimates of a proxy for attrition on the natural logarithm of the minimum wage. Standard errors clustered at county-level are shown in parentheses. All regressions include province-year fixed effects, and a linear county time trend. We include time varying worker characteristics for family size, outright house ownership, age, age squared, a gender dummy, years of education, years of education squared, years of work experience, work experience squared, years since migrating to urban area, years since migrating to urban are squared, categorical dummies for industry, occupation and marital status. city-level controls are city population, city real GDP, city real average wage and city unemployment rate.

Dep.var.:	Attrition (1/0)							
	HH Best 2 Earners				All HH Members			
	(1) $S = 0$	(2) $S > 0.25$	(3) $S > 0.5$	(4) $S > 0.75$	(5) $S = 0$	(6) $S > 0.25$	(7) $S > 0.5$	(8) $S > 0.75$
Ln(Minimum Wage)	-0.056	0.069	-0.024	-0.102	-0.052	0.040	-0.038	-0.106
	(0.091)	(0.108)	(0.158)	(0.169)	(0.094)	(0.108)	(0.153)	(0.160)
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	89657	17861	6184	5562	93393	19057	6659	6016
N clusters	312	289	240	237	312	290	241	238
Adjusted R^2	0.300	0.311	0.357	0.361	0.296	0.307	0.350	0.354

TABLE 1.10: Minimum Wages and Hours Worked

We report individual level estimates when the dependent variable is monthly hours worked using equation 1.7. We keep in the sample both employed and unemployed individuals since hours worked may be reduced due to loss of employment from higher minimum wages. The exogenous variable is the log of the minimum wage level. Regressions in Columns (1)-(4) include the best two earners in the household and those in Columns (5)-(8) include all workers. Standard errors clustered at county-level are shown in parentheses. All regressions include individual fixed effects, province-year fixed effects and a linear county time trend. We include time varying worker characteristics for family size, outright house ownership, age, age squared, a gender dummy, years of education, years of education squared, years of work experience, work experience squared, years since migrating to urban area, years since migrating to urban are squared, categorical dummies for industry, occupation and marital status. city-level controls are city population, city real GDP, city real average wage and city unemployment rate.

Dep.var.:	Hours Worked per Month							
	HH Best 2 Earners				All HH Members			
	(1) $S = 0$	(2) $S > 0.25$	(3) $S > 0.5$	(4) $S > 0.75$	(5) $S = 0$	(6) $S > 0.25$	(7) $S > 0.5$	(8) $S > 0.75$
Ln(Minimum Wage)	3.308	-2.890	-12.349	-4.622	2.804	-0.476	-12.500	-5.854
	(3.851)	(4.495)	(8.605)	(7.967)	(3.837)	(3.899)	(7.414)	(6.643)
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	112979	23840	7653	6936	116979	25177	8198	7459
N clusters	293	284	248	247	293	284	248	247
N individuals	54028	11598	3820	3477	55389	12040	3999	3648
Adjusted R^2	0.459	0.446	0.568	0.570	0.498	0.508	0.610	0.616

TABLE 1.11: Minimum Wages and Employment

We report individual person level regressions using equation 1.7 where the dependent variable is the dummy of employment status and the log of the minimum wage level is used as the independent variable. Regressions in Columns (1)-(4) include the sample of the best two earners in the household and those in Columns (5)-(8) the sub-set of migrant workers. Standard errors clustered at county-level are shown in parentheses. All regressions include individual fixed effects, province-year fixed effects, and a linear county time trend. We include time varying worker characteristics for family size, outright house ownership, age, age squared, a gender dummy, years of education, years of education squared, years of work experience, work experience squared, years since migrating to urban area, years since migrating to urban are squared, categorical dummies for industry, occupation and marital status. city-level controls are city population, city real GDP, city real average wage and city unemployment rate.

Dep.var.:	Employed (1/0)							
	HH Best 2 Earners				Urban Migrants sub-sample			
MW dependency:	$S = 0$	$S > 0.25$	$S > 0.5$	$S > 0.75$	$S = 0$	$S > 0.25$	$S > 0.5$	$S > 0.75$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln(Minimum Wage)	0.027	-0.011	-0.013	-0.016	0.028	-0.031	0.002	-0.023
	(0.016)*	(0.020)	(0.037)	(0.037)	(0.025)	(0.034)	(0.102)	(0.115)
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	137225	27550	8810	8021	58366	9183	2756	2558
N clusters	671	551	405	398	629	428	277	268
N individuals	64543	13238	4340	3962	28308	4570	1390	1290
Adjusted R^2	0.088	0.112	0.204	0.204	0.084	0.233	0.371	0.407

TABLE 1.12: Minimum Wages and Occupation Change

We report individual level regression using equation 1.7 where the dependent variable is a dummy for occupation switching from the previous year (=1 if switch). The exogenous variable is the log of the minimum wage level. Regressions in Columns (1)-(4) include the sample of the best two earners in the household and those in Columns (5)-(8) the sub-set of migrant workers. Standard errors clustered at county-level are shown in parentheses. All regressions include individual fixed effects, province-year fixed effects and a linear county time trend. We include time varying worker characteristics for family size, outright house ownership, age, age squared, a gender dummy, years of education, years of education squared, years of work experience, work experience squared, years since migrating to urban area, years since migrating to urban are squared, categorical dummies for industry, occupation and marital status. city-level controls are city population, city real GDP, city real average wage and city unemployment rate.

Dep.var.:	Employer Switch (1/0)							
	HH Best 2 Earners				Urban Migrants sub-sample			
	(1) S=0	(2) $S > 0.25$	(3) $S > 0.5$	(4) $S > 0.75$	(5) S=0	(6) $S > 0.25$	(7) $S > 0.5$	(8) $S > 0.75$
Ln(Minimum Wage)	0.096	0.062	0.247	0.407	0.109	-0.242	1.299	1.928
	(0.100)	(0.191)	(0.292)	(0.262)	(0.099)	(0.299)	(0.899)	(0.749)**
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	86228	17514	5396	4919	36820	5887	1699	1582
N clusters	642	524	384	380	598	406	258	253
N individuals	61103	12350	3996	3647	26127	4128	1239	1149
Adjusted R^2	0.333	0.361	0.477	0.507	0.411	0.522	0.760	0.768

1.A Predicting the Minimum Wage

For the correct interpretation of econometric estimates, it is important that minimum wage changes in China are non-predictable and can be considered as a random income shocks from the perspective of households. In this section we show that wage changes are indeed non predictable even when using rich information sets with socio-economic and political data typically beyond the reach of individual households.

First, we use county-level socio-economic data to explore the predictability of minimum wage changes. Second, we aggregate the Urban Household Survey (UHS) data and examine whether these alternative county-level aggregates show any predictability for the minimum wage change. Third, we use biographical data on the two most important political decision makers in Chinese counties, namely the mayor and party secretary, to predict minimum wage changes. Throughout this exercise, we code any nominal minimum wage change in a county as a binary (0/1) decision. Nevertheless, all the results are robust if the (level) change of the minimum wage becomes the dependent variable or if we use the natural logarithm of the new to the old minimum wage. [33]

1.A.1 Predictability Based on County-Level Data

Table 1-I presents OLS regression based on country-level socio-economic data to examine the predictability of minimum wage changes codes as binary outcomes (0/1). The socio-economic data are sourced from the Prefecture Statistical Annual Yearbooks, the Fiscal Statistics for Prefectures, Municipalities and Counties and the National Demographic Yearbook. We note that these county-level data have an imperfect overlap with the sample of counties in our main data and so we do not use them in the analysis on household consumption. Yet they are still a useful data source for a test of predictability of the minimum wage change.

Columns (1)-(3) include the listed covariates as contemporaneous changes and Columns (4)-(6) as lagged changes. All variables are expressed in real terms using a province-level consumer price deflator. We find that none of the county variables robustly predicts (either as contemporaneous or lagged changes) minimum wage across specifications. In Column (3) only the average salary in the county shows weak negative relation with the decision to change the minimum wage. But this marginal significance disappears when we use two-way clustering at the county and province-year levels (not shown). Overall, we conclude that the results indicate no systematic relationship between county-level socio-economic variables and minimum wage changes.

1.A.2 Predictability Based on Aggregates of Household Survey Data

Table 1-II explores the predictability of minimum wage changes based on county-level aggregates of the Urban Household Survey (UHS) used throughout the paper. The set of counties covered differs from Table 1-I and the time span is restricted to the period 2002-2009. The county-level aggregates of the UHS data are complimented by

[33] These results are available from the authors upon request.

TABLE 1-I: County-Level Determinants of Minimum Wage Changes, 1997-2010

The minimum wage change as the dependent variable is coded as a binary decision outcome (1/0) with 1 representing a change and regressed on various county-level socio-economic variables. Columns (1)-(3) use covariates in first differences contemporaneous with the minimum wage change; Columns (4)-(6) use covariates in first differences lagged by one year relative to the minimum wage change.

Dep. variable:	Minimum wage change dummy (1/0)					
	Covariates in Δ_t			Covariates in Δ_{t-1}		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(County Real GDP)	-0.042	-0.191	-0.005	-0.076	-0.097	-0.012
	(0.035)	(0.045)	(0.010)	(0.028)	(0.049)	(0.009)
Ln(County Population)	-0.077	-0.240	0.005	0.165	0.176	0.012
	(0.103)	(0.128)	(0.009)	(0.101)	(0.153)	(0.010)
Ln(County Total Employment)	-0.014	-0.011	-0.001	0.004	0.007	-0.000
	(0.014)	(0.016)	(0.001)	(0.016)	(0.023)	(0.001)
County Government Balance/GDP	-0.001	-0.001	-0.000	-0.000	-0.000	0.000
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)
Ln(County Salary per capita)	0.016	0.002	-0.020	0.021	0.006	0.002
	(0.013)	(0.013)	(0.011)	(0.007)	(0.007)	(0.001)
Ln(County Employment in Agriculture)	-0.021	-0.016	0.000	0.026	0.030	0.001
	(0.009)	(0.010)	(0.001)	(0.009)	(0.012)	(0.001)
Ln(Real County Savings)	-0.002	-0.007	-0.002	0.014	0.005	0.001
	(0.015)	(0.016)	(0.002)	(0.013)	(0.019)	(0.001)
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes			Yes		
County trends		Yes	Yes		Yes	Yes
Province × year FE			Yes			Yes
Observations	8716	8716	8714	7139	7139	7137
N clusters	1651	1651	1651	1647	1647	1647
Adjusted R^2	0.591	0.697	0.990	0.625	0.686	0.992

city-level variables drawn from the China City Statistical Yearbooks in the Chinese Statistical Yearbook Database (CNKI). Again, no statistically significant relationship appears between the various covariates and the minimum wage change. The results also holds if we consider level change in minimum wages as an alternative dependent variable.

1.A.3 Predictability Based on Biographical Data of Local Political Leaders

In democratic societies, important political decisions like minimum wage changes are subject to open political debate and depend on the parliamentary strength of competing political parties. Chinese politics represents an entirely different political setting, important policy issues can be contingent on the preferences of the key local decision makers, Yao and Zhang (2015). Minimum wage changes in China originate in an administrative and political process that is not subject to an open debate that involves the public at large. This implies that little public information is generated that would allow households to anticipate minimum wage changes. Moreover, the law only stipulates the requirement of regular review, not a mandatory change. While individual policy preferences are hard to observe, such preferences and policy outcomes could nevertheless be related to personal political career paths and curricula or to demographic characteristics of local leaders.

The two main political actors in Chinese local politics are the mayor, appointed by the local communist party assembly, and the local party secretary, appointed by personal office of the central party administration. Their biographical data are available in the Chinese Bureaucracies and Leaders Database, which is constructed and maintained by the National Chengchi University.[34] We use biographical information about their respective tenure, their first year in office, the their year of promotion and retirement, as well as their age and experience. Table 1-III presents the regression results with seven biographical variables for the local party secretary and an equal number for the local mayor. Yet none of these biographical variables has any predictive value for minimum wage change. Similar results are obtained if we define the dependent variable as first difference in minimum wage levels.

Overall, we conclude from Tables 1-I, 1-II and 1-III that minimum wage changes in China are not predictable based on county-level socio-economic data or even biographical data on the two most powerful local politicians.

[34] See http://ics.nccu.edu.tw/chinaleaders/. The data are documented in Shih, Shan, and Liu (2010), Yao and Zhang (2015) and Zhou (2016).

TABLE 1-II: Constructed County-Level Determinants of Minimum Wage Changes, 2002-2009

The minimum wage change as the dependent variable is coded as a binary decision outcome (1/0). We construct county-level aggregates from the UHS data and add city-level variables. Columns (1)-(2) present estimates with standard errors clustered at the county-level; Columns (3)-(4) report standard errors clustered two ways at the county and province-year level.

Dep. variable:	Minimum wage change dummy (0/1)			
Standard error clustering:	County		Two-way	
	(1)	(2)	(3)	(4)
County-level variables				
Δ_t Ln(County HH real consumption)	-0.008	0.047	-0.008	0.047
	(0.108)	(0.055)	(0.111)	(0.059)
Δ_t Ln(County HH tot. expend.)	0.001	-0.028	0.001	-0.028
	(0.092)	(0.039)	(0.105)	(0.451)
Δ_t Ln(County HH savings)	-0.002	-0.006	-0.002	-0.006
	(0.019)	(0.008)	(0.018)	(1.265)
Share of county SOE workers	-0.183	0.089	-0.183	0.089
	(0.148)	(0.069)	(0.177)	(2.248)
City-level variables				
Δ_t Ln(City real GDP)	0.484	0.070	0.484	0.070
	(0.211)	(0.111)	(0.450)	(0.753)
Δ_t Ln(City population)	-0.130	0.090	-0.130	0.090
	(0.084)	(0.068)	(0.144)	(1.214)
Δ_t City unemployment rate	0.208	-0.065	0.208	-0.065
	(0.273)	(0.148)	(0.335)	(1.511)
Δ_t Ln(Total city employment)	0.167	-0.130	0.167	-0.130
	(0.199)	(0.133)	(0.330)	(0.507)
Δ_t City employment/population	-0.624	0.357	-0.624	0.357
	(1.121)	(1.166)	(1.578)	(1.486)
County FE	Yes	Yes	Yes	Yes
Year FE	Yes		Yes	
County trends		Yes		Yes
Province $\times$ year FE		Yes		Yes
Observations	1602	1602	1602	1602
N clusters	591	591	99	99
Adjusted R^2	0.353	0.973	0.676	0.973

TABLE 1-III: Political Characteristics and Minimum Wage Changes, 1997-2010

The minimum wage change as the dependent variable is coded as a binary decision outcome (1/0) with 1 representing a change and regressed on the characteristics of the local party secretary and the mayor. Columns (1)-(2) present estimates with standard errors clustered at the county-level; Columns (3)-(4) report standard errors clustered two ways at the county and province-year level.

Dep. variable:	Minimum wage change dummy (1/0)			
Standard error clustering	County		Two–way	
	(1)	(2)	(3)	(4)
Party secretary characteristics:				
First year in office dummy	0.018	0.004	0.018	0.004
	(0.009)	(0.004)	(0.009)	(0.004)
Promotion year dummy	0.049	-0.005	0.049	-0.005
	(0.026)	(0.007)	(0.026)	(0.010)
Retirement year dummy	0.079	0.028	0.079	0.028
	(0.034)	(0.013)	(0.034)	(0.017)
Age	0.047	0.018	0.047	0.018
	(0.057)	(0.016)	(0.055)	(0.028)
Age^2	-0.000	-0.000	-0.000	-0.000
	(0.001)	(0.000)	(0.001)	(0.000)
Province experience dummy	-0.016	0.005	-0.016	0.005
	(0.030)	(0.009)	(0.030)	(0.009)
City tenure length (years)	0.007	0.004	0.007	0.004
	(0.007)	(0.003)	(0.007)	(0.003)
Mayor characteristics:				
First year in office dummy	0.090	-0.008	0.090	-0.008
	(0.091)	(0.026)	(0.085)	(0.026)
Promotion year dummy	0.030	-0.001	0.030	-0.001
	(0.023)	(0.005)	(0.025)	(0.007)
Retirement year dummy	-0.016	-0.001	-0.016	-0.001
	(0.043)	(0.013)	(0.043)	(0.018)
Age	-0.003	0.006	-0.003	0.006
	(0.052)	(0.017)	(0.063)	(0.018)
Age^2	0.000	-0.000	0.000	-0.000
	(0.001)	(0.000)	(0.001)	(0.000)
Province experience dummy	0.024	0.003	0.024	0.003
	(0.023)	(0.006)	(0.026)	(0.008)
City tenure length (years)	0.090	-0.007	0.090	-0.007
	(0.091)	(0.025)	(0.084)	(0.025)
County FE	Yes	Yes	Yes	Yes
Year FE	Yes		Yes	
County trends		Yes		Yes
Province × year FE		Yes		Yes
Observations	14548	14544	14548	14544
N clusters	258	257	232	228
Adjusted R^2	0.383	0.964	0.383	0.964

1.A.4 Persistence of the Minimum Wage Hike

Another issue concerns the intertemporal persistence of *real* minimum wage changes. Even if nominal minimum wage change are not likely to be reversed, price inflation can induce the mean reversion of the real minimum wage. If, on the other hand, *real* minimum wages feature a high degree of persistence, then the increase can be perceived as a non transitory income shock by the households. To explore the intertemporal persistence of real minimum wage increases, we run the regression

$$\Delta MW_{c,t} = \alpha_0 + \rho MW_{c,t-1} + a_1 t + \delta_{p,t} + \gamma_c + \varepsilon_{c,t}, \tag{1.9}$$

where a coefficient $\rho < 0$ captures mean reversion to a time trend t of the real minimum wage MW; δ_{pt} denotes a province-year fixed effect and γ_c a county fixed effect.

Table 1-IV reports the regression results for the period 1992-2012 and for the shorter sample period 2002-2009 corresponding to the time frame of our analysis. We progressively augment the specification with county fixed effects and county trends to mitigate the impact of cross-sectional dependence. The coefficient of interest ρ is negative in most specifications and statistically significant. Yet, the magnitude of the mean reversion is economically weak. For instance, the coefficient in Column (4) implies a half-life of 5.47 years for the real minimum wage.[35]

We also use a unit root test (adapted to panel data) to test for real minimum wage persistence in a narrow statistical sense, Harris and Tzavalis, 1999. Under the null hypothesis of a unit root (i.e. the real minimum wage increase is persistent) such tests provide a critical value for ρ below which the unit root cannot be rejected. The H-T test confirms the persistence of the minimum wage when we do not demean the real minimum wage to take into account cross-county dependence. However, when we compute in each time period the mean of the minimum wage across counties and subtract this mean from the series, the test rejects the null.[36]

[35] Half-life is computed adjusting the standard formula to take into account that we are using the first difference of the minimum wage as dependent variable: $ln(0.5)/ln(-0.119+1) = 5.471$. Using the coefficient in Column (8) implies a half-life of 2.31 years.

[36] To corroborate these findings, we also undertake the Im, Pesaran, and Shin, 2003 test, which relaxes the assumption about the common autoregressive coefficient and runs the test for each cross-section under the null that *all* panels have unit roots, against the alternative that *some* panels are stationary. This test fails to reject the null hypothesis except when we include a time trend and demean the series to reduce the influence of cross-section dependence.

TABLE 1-IV: Persistence of Real Minimum Wage Shock

We regress changes in the real minimum wage (ΔMW_{ct}) on the lagged real minimum wages (MW_{ct-1}) controlling for trend growth. The regressions add county or province-year fixed effects as specified in Equation (1) to limit the influence of cross-county spatial dependence. A significant negative coefficient implies reversion of the minimum wage shocks to trend growth. Standard errors clustered at county-level are shown in parentheses.

Dep. var.:	Real minimum wage change, $\Delta MW_{c,t}$							
	1992-2012				2002-2009			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$MW_{c,t-1}$	-0.005	0.022	-0.118	-0.119	-0.031	0.023	-0.259	-0.260
	(0.003)	(0.003)***	(0.008)***	(0.009)***	(0.005)***	(0.003)***	(0.011)***	(0.012)***
Time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE		Yes	Yes	Yes		Yes	Yes	Yes
County FE			Yes				Yes	
County trends				Yes				Yes
Observations	37320	37320	37320	37320	17464	17464	17464	17464
N clusters	2183	2183	2183	2183	2183	2183	2183	2183
R^2	0.310	0.862	0.871	0.876	0.011	0.810	0.842	0.852

1.B Sample Construction

1.B.1 Household Data Selection

China's Urban Household Survey (UHS) has two components. At the household level, we dispose of data on various consumption items and household income. At the level of household members, additional data captures household member income, income type, employment status, years of education, years of work experience, etc. We merge the household survey data with the minimum wage data at county and city-level from the Chinese Ministry of Human Resources and add additional macroeconomic variables at the county and city-level. All monetary variables are converted in real terms using the province-level urban CPI index with the base year 2002. The raw data constitutes a panel of 201,795 household-year observations and 773,330 household-member-year cells for the period 2002-2009. The following data filters are applied to the household data:

1. We only retain households that are observed at least twice in the panel (i.e. we drop 68,779 household-year observations).

2. We retain only households reporting in their first year of sampling at least two wage earning household members (i.e. we drop 59,624 household-year observations). Wage-earning household members are those who are potentially affected by minimum wage changes.

3. We eliminate households that provide contradictory information about the household head and for which we cannot compute the share S (228 household-year observations).

The final data set comprises 73,164 household-year observations. Descriptive statistics of the main variables and household demographics are shown in Tables 1-V and 1-VI respectively.

1.B.2 Identifying the Two Highest Wage Earners within the Household

For minimum wages changes to matter for household income, a household needs to earn a positive share of its total household income from labor income near or at the minimum wage. Within each household, we identify the two highest wage earners conditioning on the first year the individual is observed in the panel. The selection of wage earners within each household follows these principles:

1. We ignore self-employed individuals (30,971 member-year observations); retired household members (124,901); retired and then re-employed household members (11,396), incapacitated persons (8,396), homeworkers (61,343), soldiers, social volunteers or part-time employed workers (17,879), students (56,737) and other household members undergoing training (251).

2. We ignore household members outside the labor force: below 16 years of age (75,317) and above 59 for males (2,566) and above 54 for females (2,363).

3. We ignore household members with inconsistent records where they are reported as unemployed and nevertheless receive a positive labor income (6363).

4. We ignore members with incomplete reporting on labor income (6,694) and workers with an annual real wage lower than 50% of the annual real minimum wage (12,293).

5. We ignore workers with abnormally high increases in their real wage (above 1000%) between the first and last year of observation in the panel (187).

6. We ignore household members with inconsistent age records that increase by more than one from one year to another or decrease (6,553) and household members who are not relatives (210).

The two highest wage earners within the household are in most cases (80.5%) the head of the household and the spouse. We retain for the household-level regressions their wage income, age, gender, level of education and years of work experience, years since migration to the city, marital status, industry and occupation.

1.B.3 Minimum Wage Dependency of a Household

Finally, we define the share S of household income coming from the wage income (of the two highest wage earners) at or near the minimum wage. We consider a wage earner to earn a minimum wage if her salary ranges between 50% and 150% of the real minimum wage of their county of residence in the first year the individual is observed in the panel. Conditioning on the first year of household observation assures that the treated household group remains unchanged over time.

Among the two highest wage earners of all retained households, we identify 32,580 (18.72%) treated (minimum wage) and 141,442 (81.28 percent) non-treated worker-year observations. We also undertake extensive robustness checks with respect to a narrower salary range from 50% to 120% of the local minimum wage, which results in 18,721 (10.76%) and 155,301 (89.24%) non-treated worker-year observations, respectively.

Table 1-V reports summary statistics on the households income and expenditure components for household groups sorted by their minimum wage income share S. Column (1) includes all households, Column (2) with $S = 0$ all households without wage income at or near the minimum wage, whereas Columns (3)-(5) show household groups of increasing minimum wage dependency.

TABLE 1-V: Incomes and Expenditures Share of Disposable Income

The table summarize the household income and expenditure components as a share of disposable income by different household types sorted by their share S of minimum wage income in total household disposable income. Data are from the Urban Household Survey (UHS) and cover the period from 2002 to 2009. Reported are average values for the entire period and standard errors are in parentheses below.

MW dependency:	All Households	S=0	S>0	S>0.5	S>0.75
INCOME COMPONENTS:					
Labor income	0.902	0.917	0.862	0.779	0.792
	(0.158)	(0.140)	(0.192)	(0.243)	(0.242)
Transfer income	0.083	0.069	0.120	0.195	0.185
	(0.146)	(0.128)	(0.181)	(0.234)	(0.233)
Transfer income net of pension	0.041	0.035	0.055	0.082	0.068
	(0.081)	(0.071)	(0.100)	(0.124)	(0.106)
EXPENDITURE COMPONENTS:					
Consumption	0.724	0.705	0.773	0.820	0.817
	(0.311)	(0.310)	(0.308)	(0.359)	(0.364)
Education expenditure	0.107	0.107	0.107	0.100	0.098
	(0.122)	(0.116)	(0.137)	(0.152)	(0.153)
Health expenditure	0.043	0.041	0.048	0.054	0.053
	(0.084)	(0.075)	(0.105)	(0.116)	(0.117)
Non-durables expenditure	0.383	0.367	0.427	0.465	0.464
	(0.144)	(0.138)	(0.150)	(0.164)	(0.161)
Durables expenditure	0.105	0.109	0.0947	0.0871	0.0874
	(0.144)	(0.151)	(0.123)	(0.179)	
Housing expenditure	0.055	0.060	0.040	0.035	0.031
	(0.491)	(0.502)	(0.458)	(0.441)	(0.420)
Savings	0.240	0.264	0.179	0.143	0.146
	(0.309)	(0.324)	(0.254)	(0.228)	(0.232)
Observations	73164	53054	20110	4365	3990
Share of observations in sample		0.72	0.27	0.06	0.05
Share of total labor income		0.819	0.181	0.026	0.024

TABLE 1-VI: Household Demographics

The table summarize the household demographics by household type sorted on the share S of minimum wage earnings in total household disposable income. Data are from the Urban Household Survey (UHS) and cover the period 2002-2009. Reported are average values for the entire period and standard errors are in parentheses below. Household head refers to the household member with the highest labor income; SOE stands for State Owned Enterprise; education is a categorical variable with a total of nine categories: no schooling, basic literacy classes, primary school, junior high school, senior middle school, secondary, college enrolment, bachelor completed, graduated.

MW dependency:	All Households	S=0	S>0	S>0.5	S>0.75
Household size	3.145	3.118	3.215	3.345	3.355
	(0.724)	(0.703)	(0.773)	(0.862)	(0.869)
House ownership	0.870	0.890	0.818	0.778	0.776
	(0.336)	(0.313)	(0.386)	(0.415)	(0.417)
Years since migrating	8.047	8.429	7.040	6.047	6.149
	(11.10)	(11.15)	(10.91)	(10.63)	(10.69)
SOE employee share	0.735	0.778	0.620	0.436	0.441
	(0.441)	(0.415)	(0.485)	(0.496)	(0.497)
Female Head	0.270	0.292	0.211	0.318	0.316
	(0.444)	(0.455)	(0.408)	(0.466)	(0.465)
Age of the household head	41.38	41.29	41.62	40.58	40.47
	(7.842)	(7.742)	(8.095)	(8.686)	(8.754)
Household head education	5.914	6.127	5.351	4.929	4.941
	(1.441)	(1.419)	(1.345)	(1.172)	(1.174)
Head work experience (years)	20.87	20.84	20.95	19.35	19.23
	(8.703)	(8.590)	(8.995)	(9.804)	(9.859)
Observations	73164	53054	20110	4365	3990

TABLE 1-VII: Different Definitions of Treated Worker

The table summarize the change of the composition of the sample when the households are defined as minimum wage treated using different definitions. The first row defines treated households in the first year of observation and keeps them fixed over the panel. The second row defines treatment status each year the household is observed independently of her treatment status in the first year. The third row shows household are assigned to treatment only if they are treated in all the years they are observed in the panel, i.e. if at least for one year the earn both more than the minimum wage then the household is not treated in this case. Standard errors are reported in parenthesis.

MW dependency:	S=0	S>0	S>0.25	S>0.5	S>0.75
MW treated HH in the first year	0.718	0.282	0.239	0.064	0.058
	(0.450)	(0.450)	(0.426)	(0.245)	(0.234)
MW treated HH by year	0.730	0.270	0.229	0.071	0.066
	(0.444)	(0.444)	(0.420)	(0.257)	(0.249)
MW treated HH in each year	0.836	0.164	0.138	0.037	0.031
	(0.370)	(0.370)	(0.345)	(0.188)	(0.172)

TABLE 1-VIII: Unemployment at worker level

The table summarize the level of unemployment at worker level for the best two earners within the households. The share of unemployed members for different groups of minimum wage income in total disposable income are reported. Standard errors ar ereported in parenthesis.

	All Households	S=0	S>0	S>0.25	S>0.5	S>0.75
Unemployment	0.042	0.036	0.060	0.078	0.189	0.191
	(0.120)	(0.186)	(0.238)	(0.269)	(0.392)	(0.393)
Observations	208607	160635	47972	34869	12764	11861

1.C Specification Issues: county trends and province-year fixed effects

TABLE 1-IX: First-Stage Regressions without county trends and province × year FE

Household annual real labor income is regressed on the annual real minimum wage for households sorted by the share S of household minimum wage income in total disposable income under two alternative specifications. Columns (1)-(4) do not include linear county time trends and province-year fixed effects in the specification, while Columns (5)-(8) control for linear county time trends and province-year fixed effects. All regressions include controls for the two highest labor income earners in the household, namely age and age squared, a gender dummy, years of work experience and work experience squared, years since migration to the city and squared, household size as measured by the number of household members and a house ownership dummy. Additional categorical control variables characterize the level of education, marital status, industry and occupation. City-level variation is accounted for by city population, city real GDP, city real average wage and city unemployment rate.

Dep. variable:	Household Real Labor Income							
	Household FE and year FE				County trends and province × year FE			
MW dependency:	$S = 0$	$S > 0$	$S > 0.5$	$S > 0.75$	$S = 0$	$S > 0$	$S > 0.5$	$S > 0.75$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Minimum Wage	0.972	1.653	1.464	1.296	-0.022	0.364	1.378	1.529
	(0.300)***	(0.443)***	(0.534)***	(0.562)**	(0.574)	(0.561)	(0.632)**	(0.692)**
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes				
County trends					Yes	Yes	Yes	Yes
Province × year FE					Yes	Yes	Yes	Yes
Obs.	44288	12066	3699	3374	44288	12066	3699	3374
N clusters	625	491	346	335	625	491	346	335
N households	20450	5684	1785	1627	20450	5684	1785	1627
Adjusted R^2	0.202	0.395	0.512	0.522	0.256	0.515	0.700	0.705

1.D Marginal Propensity of Consumption from Labor and Transfer Income

TABLE 1-X: Estimates of the Marginal Propensity of Consumption from Labor and Transfer Income

We report OLS regressions, Columns (1)-(4) estimate the change in household real consumption after a change of household real labor income, Columns (5)-(6) use the sum of labor and transfer incomes as the main regressor of interest. All regressions include controls for the two highest labor income earners in the household, namely age and age squared, a gender dummy, years of work experience and work experience squared, years since migration to the city and squared, household size as measured by the number of household members and a house ownership dummy. Additional categorical control variables characterize the level of education, marital status, industry and occupation. City-level variation is accounted for by city population, city real GDP, city real average wage and city unemployment rate.

Dep. variable:	Household Consumption							
MW dependency:	$S = 0$	$S > 0.25$	$S > 0.5$	$S > 0.75$	$S = 0$	$S > 0.25$	$S > 0.5$	$S > 0.75$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Labor Income	0.325	0.432	0.377	0.349				
	(0.030)***	(0.018)***	(0.098)***	(0.093)***				
Labor and Transfer Income					0.329	0.433	0.343	0.305
					(0.026)***	(0.025)***	(0.097)***	(0.097)***
City-Level Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	44288	12066	3699	3374	44288	12066	3699	3374
N clusters	625	491	346	335	625	491	346	335
N households	20450	5684	1785	1627	20450	5684	1785	1627
Adjusted R^2	0.259	0.508	0.607	0.631	0.262	0.514	0.622	0.649

1.E Expenditure Components

TABLE 1-XI: Health Expenditure Components

The table reports the same 2SLS level regressions of Table 1.4 using sub-components of expenditures in health's goods and services. Estimates for expenditure on drugs is shown in Columns (1)-(2), for health related medical treatments are reported in Columns (3)-(4), for appliances (medical equipment) expenditure in Columns (5)-(6) and other health expenditure in Columns (7)-(8). All regressions include city-level controls, household fixed effects, interacted province-year fixed effects, and county time-trends as specified in Equation (8). The samples consist of all households for which the labor income share S stemming from minimum wage is more than 50% ($S > 0.5$), or more than 75% ($S > 0.75$) of household disposable income. Standard errors in parenthesis are clustered at county-level. Weak instrument row shows the p-value of the Kleibergen and Paap (2006) test under the null of weak instrument.

	Drugs and Medicines		Medical Treatment		Appliances		Other	
MW dependency:	$S > 0.5$	$S > 0.75$	$S > 0.5$	$S > 0.75$	$S > 0.5$	$S > 0.75$	$S > 0.5$	$S > 0.75$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Labor and Transfer Income	0.132	0.139	0.023	0.023	0.000	0.002	-0.010	-0.004
	(0.085)	(0.082)*	(0.059)	(0.062)	(0.009)	(0.006)	(0.016)	(0.016)
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3442	3137	3442	3137	3442	3137	3442	3137
N clusters	323	314	323	314	323	314	323	314
N households	1528	1390	1528	1390	1528	1390	1528	1390
H_0 : Weak instruments (p-value)	0.019	0.009	0.019	0.009	0.019	0.009	0.019	0.009

TABLE 1-XII: Education Expenditure Components

The table reports the same 2SLS level regressions of Table 1.4 using sub-components of expenditures in health's goods and services. Estimates for expenditure on CPU and software is shown in Columns (1)-(2), for educational goods (textbooks, books, stationery, magazines, dictionaries) are reported in Columns (3)-(4), for educational courses (tuition fees, tutorials, school accommodation) expenditure in Columns (5)-(6) and educational services (cultural and recreational services) in Columns (7)-(8). All regressions include city-level controls, household fixed effects, interacted province-year fixed effects, and county time-trends as specified in Equation (8). The samples consist of all households for which the labor income share S stemming from minimum wage is more than 50% ($S > 0.5$), or more than 75% ($S > 0.75$) of household disposable income. Standard errors in parenthesis are clustered at county-level. Weak instrument row shows the p-value of the Kleibergen and Paap (2006) test under the null of weak instrument.

	CPU and Software		Educ. Goods		Courses		Educ. Services	
MW dependency:	$S > 0.5$	$S > 0.75$	$S > 0.5$	$S > 0.75$	$S > 0.5$	$S > 0.75$	$S > 0.5$	$S > 0.75$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Labor and Transfer Income	0.048	0.051	0.031	0.028	0.073	0.099	-0.004	0.001
	(0.040)	(0.034)	(0.016)*	(0.014)**	(0.085)	(0.080)	(0.035)	(0.033)
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3442	3137	3442	3137	3442	3137	3442	3137
N clusters	323	314	323	314	323	314	323	314
N households	1528	1390	1528	1390	1528	1390	1528	1390
H_0 : Weak instruments (p-value)	0.019	0.009	0.019	0.009	0.019	0.009	0.019	0.009

TABLE 1-XIII: Non-durables Expenditure Components

The table reports the same 2SLS level regressions of Table 1.4 using sub-components of expenditures in health's goods and services. Estimates for food expenditure is shown in Columns (1)-(2), for household services (vehicle fuel and maintenance, transportation, hair-dresser etc.) are reported in Columns (3)-(4), for clothing expenditure in Columns (5)-(6) and for sundry goods (jewels, watch, cosmetics, beauty appliances etc.) in Columns (7)-(8). All regressions include city-level controls, household fixed effects, interacted province-year fixed effects, and county time-trends as specified in Equation (8). The samples consist of all households for which the labor income share S stemming from minimum wage is more than 50% ($S > 0.5$), or more than 75% ($S > 0.75$) of household disposable income. Standard errors in parenthesis are clustered at county-level. Weak instrument row shows the p-value of the Kleibergen and Paap (2006) test under the null of weak instrument.

	Food		Services		Clothing		Sundry Goods	
MW dependency:	$S > 0.5$ (1)	$S > 0.75$ (2)	$S > 0.5$ (3)	$S > 0.75$ (4)	$S > 0.5$ (5)	$S > 0.75$ (6)	$S > 0.5$ (7)	$S > 0.75$ (8)
Labor and Transfer Income	0.322 (0.148)**	0.257 (0.138)*	0.088 (0.050)*	0.090 (0.047)*	0.032 (0.059)	0.026 (0.043)	0.002 (0.021)	-0.002 (0.019)
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3442	3137	3442	3137	3442	3137	3442	3137
N clusters	323	314	323	314	323	314	323	314
N households	1528	1390	1528	1390	1528	1390	1528	1390
H_0 : Weak instruments (p-value)	0.019	0.009	0.019	0.009	0.019	0.009	0.019	0.009

TABLE 1-XIV: Durables Expenditure Components

The table reports the same 2SLS level regressions of Table 1.4 using sub-components of expenditures in health's goods and services. Estimates for TV expenditure is shown in Columns (1)-(2), for other electronics (cameras and video cameras, DVD players, smartphones, stereo, voice recorder etc.) are reported in Columns (3)-(4), for durable transportation expenditure (cars, motorcycles, electric bicycles, bicycles and other) in Columns (5)-(6), for household equipment (furniture and home appliances, washing machine, refrigerator etc.) in Columns (7)-(8) and for housing expenditure (purchasing or building a house) in Columns (9)-(10). All regressions include city-level controls, household fixed effects, interacted province-year fixed effects, and county time-trends as specified in Equation (8). The samples consist of all households for which the labor income share S stemming from minimum wage is more than 50% ($S > 0.5$), or more than 75% ($S > 0.75$) of household disposable income. Standard errors in parenthesis are clustered at county-level. Weak instrument row shows the p-value of the Kleibergen and Paap (2006) test under the null of weak instrument.

	Television		Other Electronics		Transportation		HH Equipment		Housing	
	$S > 0.5$ (1)	$S > 0.75$ (2)	$S > 0.5$ (3)	$S > 0.75$ (4)	$S > 0.5$ (5)	$S > 0.75$ (6)	$S > 0.5$ (7)	$S > 0.75$ (8)	$S > 0.5$ (9)	$S > 0.75$ (10)
Labor and Transfer Income	0.109	0.102	0.020	0.016	-0.049	-0.005	0.047	0.046	-0.160	-0.171
	(0.066)*	(0.062)*	(0.022)	(0.020)	(0.180)	(0.183)	(0.071)	(0.066)	(0.463)	(0.426)
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3442	3137	3055	2779	3442	3137	3442	3137	3442	3137
N clusters	323	314	228	224	323	314	323	314	323	314
N households	1528	1390	1361	1236	1528	1390	1528	1390	1528	1390
H_0 : Weak instruments (p-value)	0.019	0.009	0.044	0.022	0.019	0.009	0.019	0.009	0.019	0.009

1.F Wage Regression

TABLE 1-XV: Wage Regression at Individual Level

Dep.var.:	Worker Wage							
	HH Best 2 Earners				All HH Members			
	(1) $S=0$	(2) $S>0.25$	(3) $S>0.5$	(4) $S>0.75$	(5) $S=0$	(6) $S>0.25$	(7) $S>0.5$	(8) $S>0.75$
Minimum Wage	-0.070	0.340	0.541	0.580	-0.057	0.387	0.608	0.645
	(0.235)	(0.243)	(0.300)*	(0.327)*	(0.229)	(0.232)*	(0.295)**	(0.318)**
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Worker FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	137227	27550	8810	8021	141647	28985	9392	8581
N clusters	671	551	405	398	671	551	405	398
N individuals	64543	13238	4340	3962	65946	13682	4516	4130
Adjusted R^2	0.172	0.377	0.560	0.565	0.172	0.375	0.557	0.564

1.G Categorizing S

TABLE 1-XVI: Categorizing the Share S: Minimum Wage and Household Consumption

Dep.var.:	Household Consumption					
	(1)	(2)	(3)	(4)	(5)	(6)
Minimum Wage	-0.661	-0.661	-0.651	-0.749	-0.904	-0.910
	(0.475)	(0.476)	(0.476)	(0.544)	(0.602)	(0.605)
× 0<S<0.25	0.796					
	(0.613)					
× 0.25<S<0.75	0.765					
	(0.475)					
× S>0.75	1.732					
	(0.801)**					
× 0<S<0.5		0.824				
		(0.349)**				
× S>0.5		1.451				
		(0.724)**				
× S>0			0.945			
			(0.378)**			
× S>0.25				1.032		
				(0.526)*		
× S>0.5					1.489	
					(0.744)**	
× S>0.75						1.758
						(0.818)**
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes
Observations	61257	61527	61257	56354	47987	47662
N clusters	648	648	648	642	635	633
N households	28422	28422	28422	26134	22235	22077
Adjusted R^2	0.233	0.233	0.233	0.236	0.232	0.233

1.H Two-way clustering

TABLE 1-XVII: Two-way clustering: Household Consumption under Labor Income Shocks

We report 2SLS level regressions as in Table 1.4 in which real annual household consumption is alternatively regressed on the household's fitted annual real labor income level in Columns (1)-(4), or the fitted annual real labor income plus transfers level in Columns (5)-(8). To allow for arbitrary correlation of residuals due to city/province-wide shocks standard errors are now clustered at county and province-year [in squared brackets], and county and city-year levels {in curly brackets}. The samples consist of all households for which the labor income share S from wages is zero ($S = 0$), more than 50% ($S > 0.5$), or more than 75% ($S > 0.75$) of household labor income. All regressions include city-level controls, household fixed effects, interacted province-year fixed effects, and county time-trends as specified in Equation (8). Standard errors clustered at county-level in parentheses. The p-values in the last line refer to a test under the null hypothesis of weak instruments (Kleibergen and Paap, 2006).

Dep.var.:	Household Consumption							
MW dependency:	$S = 0$ (1)	$S > 0.25$ (2)	$S > 0.5$ (3)	$S > 0.75$ (4)	$S = 0$ (5)	$S > 0.25$ (6)	$S > 0.5$ (7)	$S > 0.75$ (8)
Labor Income	61.461 [1938.376] {1900.739}	3.314 [4.368] {4.242}	1.217 [0.518]** {0.568}**	1.301 [0.585]** {0.643}**				
Labor and Transfer Income					9.258 [44.008] {43.206}	2.271 [1.979] {1.986}	1.053 [0.356]*** {0.398}***	1.065 [0.356]*** {0.404}***
City-level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province × year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	41709	11309	3442	3137	41709	11309	3442	3137
N clusters	597	469	323	314	597	469	323	314
N households	17871	4927	1528	1390	17871	4927	1528	1390
H_0 : Weak instruments (p-value)	0.975	0.529	0.031	0.026	0.845	0.396	0.019	0.009

Chapter 2

Can Government Intervention Make Firms More Investment-Ready?

2.1 Introduction

Innovative start-ups and SMEs in developing and transition countries often have good ideas, but may not have these ideas fine-tuned to the stage where they can attract outside funding. This is the case in the Western Balkans, where there is a perceived lack of investment readiness of innovative start-ups to be in a position where they can compete for, and take on, outside equity (Karajkov, 2009). The most common reasons for a lack of investment readiness include a reluctance of entrepreneurs to surrender partial ownership and control of their business, lack of knowledge about the availability of external sources of finance, low investability of business development propositions, a lack of understanding about the key factors investors look for in making investment decisions, and presentational failings such as deficiencies in business pitches (Mason and Kwok, 2010).

Investment Readiness Programs which provide individualized training, mentoring and coaching are designed to overcome these constraints, but the programs can be expensive to provide, and to date there is no rigorous evidence as to their effectiveness. We conduct a five-country randomized experiment in the Croatia, Kosovo, Macedonia, Montenegro and Serbia to test the effectiveness of such a program. A sample of 346 innovative SMEs were randomly divided into two groups: a treatment group that received a high-cost and intensive program that involved help developing their financial plans, product pitch, market strategy, and willingness to take equity financing, along with master classes, mentoring, and other assistance; and a control group which received access to an inexpensive online-only basic investment readiness course. After this program, both groups of firms competed in a pitch event, where they were scored by independent judges (blinded to treatment status) on their investment readiness, with the top 50 firms then going onto a finals stage where they pitched to investors.

The independent judges scored the pitches on six aspects of investment readiness: team, technology, traction, market, progress, and presentation, with each firm

[0]This paper is co-authored with Ana Paula Cusolito and David McKenzie. Funding for this project was received from the European Commission. Funding to support the impact evaluation from the World Bank i2i Trust Fund is gratefully acknowledged. We gratefully acknowledge comments from seminars at Duke, the IGL/Nesta conference, the IPA SME conference, University of Lausanne, Univeristy of Toronto, the European Econometric Society Meeting in Cologne and from: Marius Starke, Janko Milunovic and Peter Trapp. This experiment and a pre-analysis plan were registered in the AEA RCT registry on October 2, 2015: https://www.socialscienceregistry.org/trials/895.

scored by five judges. We find that firms that went through the investment readiness program receive an average of 0.3 standard deviations higher investment readiness scores at this event, and are more likely to get selected to proceed to pitch in front of investors. We then track firm outcomes over the next two years via a six-month and two-year follow-up survey, and through measuring their subsequent media mentions and social media attention. We find that treated firms do get significantly more media mentions and social media buzz over the next two years (our measure excludes any mention related to the competition itself). The judges' scores are found to be statistically significant predictors of investment readiness and investment outcomes over the next two years in the control group, suggesting that improvements in these scores should result in improved firm investment outcomes. Our point estimates show positive, but statistically insignificant, impacts on firm survival, three categories of investment readiness, and on steps towards receiving external financing, with treated firms being 5 percentage points more likely to receive external financing (95% confidence interval of -4.7p.p., +14.7p.p.).

We reconcile the significant impact on judges scores and significant predictive effect of judge scores on firm outcomes with these results through discussion of a funnel of attribution, through which large changes in investment readiness are predicted to result in smaller changes in investment outcomes. The results highlight the difficulty in designing experiments to measure the impacts of such programs.

The remainder of this paper is structured as follows: Section 2.2 discusses what investment readiness programs are, their use around the world, and contrasts them to other types of programs studied in the literature; Section 2.3 outlines the experimental design and provides details of the intervention; Section 2.4 provides the impacts on investment readiness; Section 2.5 examines how investment readiness translates into firm performance; and Section 2.6 concludes.

2.2 What are Investment Readiness Programs and what is the Evidence on Their Effectiveness?

While much policy attention around the world has been given to efforts to expand the supply of equity finance for innovative start-ups and SMEs (through seed and venture capital co-investment funds and other activities to attract capital), the effectiveness of these programs can be hampered by a lack of readiness of these firms to receive equity investment. Mason and Kwok, 2010 highlight three main aspects of this lack of readiness: first, many entrepreneurs are believed to be equity-averse, unwilling to surrender any ownership stake in or even partial control of their firms; second, many businesses that seek external finance are not considered "investible" by external investors due to deficiencies in their team structure, marketing strategy, financial accounts, intellectual property protection, and other business areas; thirdly, even if entrepreneurs are willing to consider equity and have investible projects, presentational failings mean that many firms are unable to pitch their ideas successfully to investors.

2.2.1 What are Investment Readiness Programs?

Investment readiness programs are intended to increase the effective demand for equity financing by helping firms overcome the factors that result in a lack of investment readiness, thereby enlarging the size and quality of the pipeline of potential

funding opportunities for investors and increasing the likelihood of new equity investments being made.

These programs are a relatively new form of intervention, but there are now a number of examples in the U.S. and Western Europe. Appendix 2.A provides details on a number of these programs, and we summarize some of these examples here. In the United States, the Larta Institute uses a combination of personalized mentoring, webinars and learning modules, and market connections to help National Science Foundation grantees in the Small Business Innovation Research program to develop Commercialization Plans. Several universities offer online investment readiness platforms, including the program we offer to our control group. In addition, there are a number of accelerators and incubators that offer investment readiness training as part of their *broader* array of specialized services. Examples in Europe include investment readiness support services provided by Enterprise Ireland, the Invest Academy Programme of the European Business Angel Network, the European program InvestHorizon and several demonstration programs provided by the UK Government's Small Business Service.

Such programs are rarer in less developed countries, but pilot programs have been introduced in a number of recently developed or higher middle income countries. For example, the Romanian Innovation Commercialization Assistance Program (RICAP) worked with 30 firms to help technology innovators address commercialization needs[1], and the Malaysia Bioeconomy Accelerator Programme provides mentoring services to assist the commercialization of innovations developed in Malaysia.[2] The Getting Ready for Capital (GReaC) project funded by the EU aimed to help entrepreneurs in Bulgaria, Poland (and Belgium) understand the private equity market and effectively present their business propositions to investors.[3] The World Bank is preparing an investment readiness component to a program in Morocco.

While there is substantial heterogeneity in the content of these programs, the most comprehensive programs usually cover four dimensions, based on the core reasons that many investment deals do not materialize (Mason and Harrison, 2001; Mason and Kwok, 2010). The first dimension aims at reducing equity aversion, by explaining to entrepreneurs the potential advantages that equity can bring to the firm, both as a source of funding, and also because of the knowledge outside investors can bring to the firm. The second dimension addresses the investability of the business by helping to train the entrepreneur to demonstrate that they have a viable revenue model, can measure market traction, have dealt appropriately with property right issues, have a competitive strategy, etc. The third dimension works on the presentational skills, teaching the entrepreneur how to effectively pitch their business ideas and provide the key information investors are looking for. Finally, some programs also offer a networking dimension, aiming to facilitate the matching process between entrepreneurs and investors through events such as venture forums.

These programs are offered in two modalities: "hard" and "soft" programs. Hard programs usually involve a package of support that combines online tools and training, customized and face-to-face mentoring, group training through masterclasses, and investor demonstration days or pitch events. Soft programs are self-learning online tools structured in modules that entrepreneurs can work through at their own pace.

[1] http://portal.larta.org/ricap# what
[2] https://portal.larta.org/malaysia
[3] http://greac.eu/

Both types of programs tend to be subsidized by governments, even in developed economies like the U.S. and U.K. There are several possible reasons to justify subsidies. The first is that the targeted firms are frequently liquidity constrained, and therefore unable to pay. Some incubator programs like Y-Combinator overcome this constraint by investing seed capital in the firms in exchange for an equity stake in the business. But since equity-aversion is one of the key constraints investment readiness programs are trying to overcome, investment readiness programs have typically not required equity stakes in exchange for participation. Secondly, since many of these programs are new in nature, potential entrepreneurs may find it hard to assess in advance the overall quality of the program, and their payoffs from participation are highly uncertain, making them unwilling to pay the costs of participating. Finally, governments may justify the subsidies in terms of the public benefits (more innovation, higher tax revenues, greater employment) that can come from successful ventures.

2.2.2 Existing Evidence about Their Effectiveness

Currently there is no causal evidence as to the effectiveness of these investment readiness programs. The existing literature consists of several case studies and descriptive evidence. Several studies attempt to argue that a lack of investment readiness hampers equity investment, focusing in particular on presentation skills. Mason and Harrison, 2002 use a case study to argue that poor presentational issues dominate the reactions of potential investors to a business proposal and constrain the likelihood of a deal taking place. Clark, 2008 uses questionnaires submitted to business investors after an investor forum, and shows that presentation skills are significantly correlated with investment decisions.

Mason and Kwok, 2010 provide a descriptive evaluation of the U.K. Government's Small Business Service's Investment Readiness program. Consultants judged the program to have had success in awareness raising, business development, and funding, but acknowledge that they don't have a counterfactual, and that it was difficult for businesses to reflect on what their behavior would have been without the program. They also report that tracking participants in the Finance and Business program of the North East Regional Development authority in England found businesses reported increases in funding, sales, and jobs two years after the program, but do not have a control group against which to compare the before-after comparisons.

More rigorous non-experimental evidence comes from work on related programs.[4] One set of related programs are business accelerators and incubators. These differ from investment readiness programs in typically being more intensive and expensive, often offer some seed capital and workspace in addition to training and mentoring, and work with a much smaller number of firms at any one time. For example, accelerators like Y-combinator take an entry cohort of 10 to 20 firms, who then receive seed capital, move to Silicon Valley for 3 months, and culminate with a demo day in which they present their ideas to selected investors. Several studies have used matching approaches to compare firms going through accelerators to similar firms which did not. Hallen, Bingham, and Cohen, 2014 compare accelerator-backed new ventures to a matched set of non-accelerator ventures and find the former are faster at raising venture capital and gaining customer traction. Smith and Hannigan, 2015

[4] Somewhat, but less closely, related is regression-discontinuity work that shows the impact of financing to innovative firms on subsequent firm outcomes (Kerr, Lerner, and Schoar, 2011; Howell, 2017b); and experimental work on business training and consulting services to firms (reviewed in McKenzie and Woodruff, 2013).

match firms going through Y-Combinator and Tech-Stars to start-ups that instead received financial assistance from angel groups, and find participation in a top accelerator program increases the speed of receiving follow-on funding and the speed of exit. In contrast, Yu, 2016 matches accelerator and non-accelerator companies and find the former raise less funding, and close down earlier. Gonzalez-Uribe and Leatherbee, 2017 use a regression-discontinuity approach to compare start-ups enrolled in the Start-up Chile accelerator program to those just below the qualification threshold, finding a positive relationship between the mentorship and the scale of the start-up and access to seed and venture financing.

Finally, two recent experiments examine effects of short, cheap interventions to potential business ventures.[5] Wagner, 2016 conducts an experiment with 88 Start-up Chile grantees, and finds giving written feedback on their business plans makes firms more likely to survive, as measured by web presence, but is not able to measure other outcomes. Clingingsmith and Shane, 2017 provide 30 minute pitch training to undergraduate students in Ohio, who then deliver 90 second pitches to judges. They find training actually lowers the judges scores on average, by helping judges better distinguish bad from good ideas, and having a more negative impact on low quality ideas than the positive impact on better quality ideas.[6]

Our work differs from this work on accelerators in at least four key aspects. The first is in the type of program being analyzed: investment readiness programs of the type we study here are designed to be able to be scaled up and operate with sizeable numbers of firms at a time, compared to the more intensive focus on a small number of firms at a time in incubator and accelerator programs. Second, ours uses a randomized experiment, overcoming concerns about how well non-experimental methods are able to overcome biases induced by the explicit selection mechanism that aims to choose better firms for the program than the non-participants. Thirdly, the existing literature has largely relied on a small number of outcome measures that can be collected without the use of firm surveys – survival, whether or not they received venture funding, and web traffic measures. We have much more detailed data, including the use of judge scores and intermediate outcome indicators that allow us to focus on investment readiness, and not just investment outcomes. Finally, the majority of studies focus on the U.S. which has a well-developed venture capital market, whereas we focus on an area of the world where firms are only just starting to engage with outside investors, making investment readiness programs potentially more important.

2.2.3 Why an investment readiness program in the Balkans?

Increasing innovation is a key regional priority in the Balkans region as a means to boost firm productivity and sustain economic growth. While it is generally accepted that debt finance is not the optimal source of funding for early-stage SMEs and start-ups, equity finance is only marginally used in the region. A regional report noted that there is a debate as to how much this lack of use of risk capital reflects a lack of supply of equity finance, versus a lack of readiness of entrepreneurs to attract and accept this financing Karajkov, 2009. Based on the viewpoint that action was

[5] Another example of an experiment with early-stage ventures is Bernstein et al. (2017), who randomize the information potential investors on AngelList receive about start-ups, and find that information about the founding team matters for their decision to find out more about the company.

[6] Using a difference-in-differences approach, Howell, 2017a also finds that negative feedback leads to more abandonment of business ventures.

needed on both the supply and demand sides, the Enterprise Development and Innovation Facility (EDIF) initiative financed by the European Commission includes efforts to increase the supply of private equity to the region, improve the legislative frameworks to better encourage venture capital activity, and undertake efforts to increase investment readiness. This paper provides an evaluation of the investment readiness component of this initiative.

2.3 Experimental Design

To implement this intervention, we ran a competitive procurement process where companies specializing in investment readiness programs provided bids. We shortlisted five companies, and together with evaluations of these proposals from Josh Lerner from Harvard University and his team at Bella Research Group, and with advice from experts in the national innovation agencies of the participating countries, chose as the winning firm the company *Pioneers JFDI GmbH* (Pioneers henceforth). Founded in 2009 and based out of Vienna, they are one of Europe's leading platforms for entrepreneurship, organizing an annual "Pioneers Festival" (with 3000 attendees), as well as providing mentoring, pitch training, and opportunities for presentation and networking with European and international founders and investors. They launched a specific investment readiness program called *Pioneers of the Balkans* for this project.

2.3.1 Generating the Sample

Eligibility criteria for the program were developed by the World Bank and Pioneers team, conditional on the rules of the European Commission. To participate in the program, a firm had to be legally registered in at least one of the five countries: Croatia, Kosovo, Macedonia, Montenegro or Serbia. The firm had to be a micro, small, or medium-enterprise, defined as having fewer than 250 employees, and an annual turnover below 50 million euros. It had to be innovative, meaning that "it will in the foreseeable future develop products, services, or processes which are new or substantially improved compared to the state of the art in its industry, and which carry a risk of technological or industrial failure" , and could not be on a sanctions list or operating in a set of negative activities (e.g. gambling or alcohol production).

To launch the program, the brand *Pioneers of the Balkans* was created, and a dedicated website set up.[7] The program was marketed as a competitive program designed especially for innovative entrepreneurs seeking or considering venture financing. The main communications therefore promoted a major pan-regional start-up competition due to take place in two stages, with a Semi-finals in Belgrade and subsequent Finals event in Zagreb. It included a preliminary list of investors who had already confirmed their attendance at the Finals, and noted that selected firms would receive a training and preparation package.

We had set a target of 300 to 350 participating firms. In designing the program, both providers of investment readiness services and experts in the innovation agencies agreed that there was a limit on how many firms potential investors would be willing to listen to pitches from. They also noted a concern that randomly choosing a firm to pitch in front of investors that was not of high quality could have reputational risks to the region, with potential investors observing such firms as a signal

[7] http://www.pioneersofthebalkans.io [accessed May 5, 2018]

more generally that firms in the region aren't of high enough quality to merit investments. A two-stage process was designed to overcome these issues: the Semi-finals would be the main phase of our study, with all firms in the study having a chance to present their ideas in the semi-finals and get scored by independent judges on their investment readiness. Then only the top-50 would progress to the finals, with these firms selected on merit.

Pioneers aimed to create broad awareness of the program among entrepreneurial firms in the region, launching the program at the start of August 2015 (see timeline in Appendix 2.B) and marketing the program rapidly. It used five major instruments to achieve this goal: public sources of information for applicants, direct electronic and physical mailings, social media marketing, a roadshow spanning all five target countries, incentives for early applications (a raffle for a dinner with two leading entrepreneurs from the region), and media relations. A list of more than 1,200 potential contacts was directly emailed using firm names provided by the local innovation funds and government counterparts, and other contacts in the region. LinkedIn and Facebook advertising was used, and "multipliers" were asked to spread the word to their contacts in the region.

Applicants had to apply online, with the data from this application form providing the baseline data for this study. More than 1,200 applications were started online, and a total of 584 full applications were received. These were screened for eligibility, resulting in 346 firms being selected as eligible for the program.

This process succeeded in generating a sample of young firms involved in a wide range of innovative activities. At the time of application, firms had an average of 6 employees, with a 10-90 percentile range of (1, 12). They had been in business for 2.5 years on average, and are involved in high-tech innovative industries such as cloud computing and big data, app development for a wide range of business and personal services, pharmaceutical products, etc. Half of the founders have post-graduate education, and 60 percent have a global rather than regional focus as their key market. To make clear the types of firms involved, it is worth giving some more specific examples of the types of innovation these firms are doing. Some examples are as follows:

- A firm that is developing virtual reality software that can be used in outdoor interactive missions, with the aim of deploying this in military training exercises and theme park adventures (e.g. a team-based maze/obstacle course where dragons and other objects are flying around)
- A firm developing an app that geo-locates users on ski fields in Europe, and provides a way for them to see where all their family members are at any point in time, and to direct them to common meeting places.
- A bio-tech firm that has developed a new coating for common medicines that allows the body to better regulate the dose-intensity, to reduce under- and over-dosages of medicines
- An architecture firm that has developed an innovative luxury "boatel" that runs on an electric motor and can be used on lakes
- A firm that has developed solar-powered benches for public spaces that can charge phones and also monitor air and noise quality.

A number of the firms were developing apps for the Balkan and global markets, covering a wide range of activities such as making it easier to use public transport, a

local version of Uber, an app to connect consumers with producers of organic products, online sports coaching, and an app to manage freight logistics. But there are also firms involved in physical manufacturing of products, such high-end electrical bicycles, smart vending machines, indoor pet houses, and a USB charger that charges while bicycling.

2.3.2 Random Assignment

Applications closed on September 6, 2015 and were then screened to ensure they met the eligibility requirements. All applicants which met the formal eligibility criteria were accepted into the study. Eligible applications were then scored on four criteria to measure their initial level of investment readiness: market attractiveness, product technology, traction, and team. Appendix 2.C describes the scoring methodology. The top 10 proposals overall in terms of score were then randomly assigned to 5 in treatment and 5 in control, in order to ensure that some of the very top proposals were in both groups. Then the remainder of firms were divided into strata based on country (Serbia, Croatia, or the rest), and on whether or not they already have a private investor. Within these six stratum firms were ranked into groups of four on the basis of their investment readiness score. Within these quartets two firms were randomly allocated by computer to treatment and two to control. This was done for an initial batch of 333 firms, allocating 167 to treatment and 166 to control. An additional batch took longer to verify their eligibility requirements and were received after this assignment, these were then also randomly allocated and form a separate strata. This resulted in 346 firms, with 174 treatment and 172 control. A pre-analysis plan was registered with the AEA trial registry on October 2, 2015 to pre-specify the initial outcomes of interest.[8]

This process resulted in treatment and control groups that are evenly balanced and comparable in terms of their initial characteristics. This is seen in Table 2.1. Figure 2.1 shows that the two groups are also similar across the entire distribution in terms of initial investment readiness. As a result, any difference in investment readiness at the conclusion of the program can be reliability assessed as the impact of the program and not due to any pre-existing differences across groups.

2.3.3 Details of the Treatment and Control Offerings

The treatment and control groups were blinded to treatment status, and both were offered a form of investment readiness training – the difference being in the intensity, cost, and medium of the offerings. We summarize both treatment and control programs here. A key issue with understanding the impact of different training programs is that much of the literature does not provide sufficient detail on what was offered, leaving the program as a black box for others seeking to learn or compare. Therefore, in Appendices 4 and 5 we provide much more detailed information on each program.

The treatment group received an investment readiness program provided by Pioneers, but branded under the name *Startup Live Mini-Accelerator*. This was an intensive two-month program that aims to prepare companies to be in a position where they are ready to talk with potential investors. The first phase ("qualification") was structured around an online training platform called *WhatAVenture.* Using this tool,

[8] https://www.socialscienceregistry.org/trials/895

individuals are asked to outline and self-critically assess their businesses by describing the problem or need addressed by their product or service, the commercialization concept and expected revenue streams, conduct a market sizing exercise, and describe their competitive positioning. Each business was assigned a lead mentor who supports them through this process and provides feedback and help.

After completing this first phase, firms were then brought into an "acceleration phase" . In this phase they had individualized mentoring from both their lead mentor, and from a pool of more than one hundred specialized mentors who could help out on specific concrete and sector-specific needs. Mentoring took place both on-site and via video calls. During this phase, there were four masterclass weekends, which took place every week in October from Friday evening through Sunday afternoon. These masterclasses rotated around the different countries, and were recorded so that those who couldn't attend in person could access the contents online. Each workshop followed a similar format, but with the topics varying. On Friday evenings the attending entrepreneurs would have a chance to introduce themselves and their businesses in just 90 seconds with no presentation materials, and also see examples of the same from the mentors, followed by informal discussions. Saturdays would involve five to eight lectures and/or workshops, with themes such as sales and marketing, team building and human resources, and investment and finance. On Sundays, all participants and mentors focused on presentational skills as well as pitch deck structure and design. The final phase was a "pitch preparation phase" and took place in the last two weeks, in the run-up to the semi-finals. This included working on their pitch decks with their mentors, delivering practice pitches, and then on-site training in Belgrade the day before the semi-finals performance as a final practice run.

Both phases of the treatment were geared toward developing a comprehensive set of skills for a successful investment ready start-up. Each of the outcome variables that we are measuring had a specific part of the training dedicated to it. Each start-up was free to choose on which needs and classes to focus on depending also on their current skill set. Our treatment variable being a dummy summarises the impact of all of the different training opportunities in one average estimate on a set of outcomes. With such a set-up it is not clearly possible to identify which particular training was conducive to raising equity funding, or improving sales and revenues, or allowing the firm to survive. All of these outcomes would depend on several components of a start-up, as for instance the team skill set, the quality of the proposed idea, their presentation skills, their networking opportunities, their market traction or their readiness in meeting specific demands from the investors etc. As such the aim of the paper is not to be so granular in identifying which particular component of the training may have brought the positive result since these components may vary across firms depending on their initial competences. The goal is to understand whether a government intervention aimed at reducing the shortcomings of the general investment readiness of a firm, can bridge the gap between supply and demand fro equity in the region.

The total cost of the treatment is estimated to be $ 614,000, or approximately $ 4,000 per active participant.[9] The main component of the cost is the individual

[9]The exact cost per firm differs in terms of services contracted vs services actually delivered, since not all firms used all the mentoring hours they were allocated. Pioneers retrospectively estimates that the actual services delivered to the firms were approximately $ 3,000 based on actual hours mentoring used. Note further that this calculation does not include the costs of advertising the program through roadshows, or of putting on the semi-final and final events which were important in attracting firms

mentoring, which averaged $ 3,072 per beneficiary, with the masterclasses costing $ 793 per beneficiary and pitch training $ 230.

The control group companies were offered an e-learning course developed and distributed by the Global Commercialization Group (GCG) of the University of Texas at Austin. This course is distributed under the label Innovation Readiness Series™ and was launched in 2011. It is targeted to a broad audience of entrepreneurs, scientists, engineers, and students, with the goal in helping transform their innovative and technology-based concepts into a viable commercialization plan and a convincing pitch. The content is delivered online through 10 modules of 45-60 minutes each, with a multiple choice quiz at the end of each module. Appendix 2.E provides descriptions of the content of each module. They cover key issues such as how to articulate the benefits of an innovation to customers and investors, intellectual property protection, market validation, comparing to competition, and how to pitch and present. The cost of the course was a one-time $ 5,000 set-up charge to customize to our program, and then $ 153 per firm.

There were several reasons for offering the control group an online investment readiness program rather than not providing any service at all. The first was that, from a public policy point of view, a key question was whether an expensive and intensive program was needed, or whether identical results could be obtained by cheap and accessible online alternatives. This was considered the more interesting policy counterfactual than offering nothing at all. Second, from an evaluation standpoint, offering both groups an investment readiness program lowers the risk of Hawthorne and John Henry effects, since both groups were told they were being provided with an investment readiness program. Finally, we also believed that offering the control group something would minimize the risk of differential attrition compared to the treatment group.

2.3.4 Take-up

Of the 174 firms randomized into treatment, 157 (90.1%) completed the *WhatAVenture* online training platform, and 79.3% received individual mentoring. Conditional on receiving individual mentoring, entrepreneurs received a median of 8 and mean of 11 hours of individual mentoring from the lead mentor and pool of specialist mentors.[10] 76 out of the 174 (43.7%) attended at least one masterclass in person (videos of the masterclasses were also available online, with typically 10-20 firms watching each). There were approximately 1,150 mentoring hours provided during the masterclasses, of which around 390 hours were individual mentoring, and 760 hours were in the form of lectures and presentations. This represents an average of 15 hours per attendee. In addition, before the semi-finals, 76 firms (43.7%) attended a 3-hour final pitch presentation training.

Table 2.2 examines the correlates of take-up of the *WhatAVenture* tool and of masterclass participation amongst those in the treatment group. We run a probit of take-up on all the baseline characteristics in Table 2.1, and then run a stepwise procedure to progressively drop the largest coefficient with a p-value above 0.2 to end up with the sparser specifications in columns 2 and 4. For the initial stage of using the *WhatAVenture* tool, the only variable that is consistent in the sparse model is the initial investment readiness score: firms with higher initial readiness are more likely

to the program. These overhead costs are estimated at approximately $ 1,500 per firm (in both the treatment and control groups).

[10] Note firms were eligible to receive up to 30 hours of individual mentoring time, so the majority of teams used considerably less hours than allocated to them.

to complete this first phase. However, we then see in columns 3 and 4 that higher initial investment readiness is associated with a lower probability of attending a masterclass. This might reflect that firms who already are more ready feel they have less need to learn from such workshops. We see attendance is lower for firms from Croatia. This perhaps reflects the masterclass weekend in that country being held in Split, rather than the larger city of Zagreb: a one-day workshop was held additionally in Zagreb, and including this reduces the gap slightly. Attendance is higher for firms whose owners have post-graduate education, and for those who have participated in a mentoring or acceleration program before, potentially reflecting a taste or revealed preference for training, or complementarities with existing skills. Finally, companies which use cloud technology were more likely to attend. When asked in our follow-up survey why they didn't attend, the most important reasons given were that they didn't want to take the time away from their businesses (and in some cases second jobs as employees), and that the locations were too far away.

Out of the 172 participants assigned to the control group, 120 (70%) accessed at least once the online Innovation Readiness Series^{TM} platform. However, even conditional on accessing the platform, overall usage was relatively low. Conditional on accessing the online platform, 118 participants viewed at least once the modules' section and 55 viewed it at least 10 times; the mean number of views of the modules section was 21 and the median 9. Each module last approximately half an hour, so we can approximate that the mean time spent on the modules was 10 hours while the median 4.5 hours. Only 63 (37% of the control group) participated in one of the seven quizzes at the end of a module. A total of 51 control group entrepreneurs passed at least 4 quizzes with 45 attaining the threshold of 70% correct answers in all quizzes, necessary to receive a certificate of completion from the IC^2 Institute at the University of Texas at Austin. The main two correlates of taking and passing the quizzes among the control group are having postgraduate education (positively correlated), and having previously participated in a mentoring or accelerator (negatively correlated). The online courses are thus done by those who have more schooling and have not previously had exposure to such content.

2.4 Impacts on Investment Readiness as Scored by Judges

2.4.1 The Semi-finals and Judging Procedure

The semi-finals were held in parallel to, and in cooperation with, the Belgrade Venture Forum, an annual venture capital conference that took place from November 12 to 14, 2015. Participants were invited to present in a pitch event that follows the standard format of such events, with firms giving a 5-minute pitch of their business case, followed by 5 minutes of questions from a jury of judges.

Participation required the founder of the firm or a representative to be physically present in Belgrade. To encourage participation, firms received multiple reminders and calls, were sent an invitation letter with a ticket voucher that allowed them one day of free access to the adjoining Belgrade Venture Forum, and were provided with a transport subsidy that was sufficient to cover the cost of bus travel to the event. The travel time was approximately 4 hours from Croatia, 5 hours from Macedonia, and 6 to 7 hours from Kosovo and Montenegro. In total 211 of the 346 invited firms (61%) attended the semi-finals: 110 firms from the treatment group (63.8%) and 101 firms from the control group (58.1). The attendance rate was similar for Serbia (64%) and Croatia (67%), and lower for the other three countries (51%). Attendance rates were higher amongst those who had participated more in the intervention. Amongst the

treatment group, 81.6% of those who had attended at least one masterclass attended the semi-finals, versus 49.0% of those who had not. Amongst the control group, 88.9% of those who had taken any of the quizzes attended, versus 41.3% of those who had not. We discuss robustness to this attrition in the next section.

A group of 66 independent judges was used to do the scoring. Panels of five judges were assigned to judge a session of six firms at a time, with judges then being rotated so that they are on panels with different judges for their next sessions. Each batch of six firms consisted of three treatment and three control firms, selected to have a similar range of initial investment readiness scores, and grouped according to industry and country of operation. Judges were assigned to batches based on their availability (some were giving talks at the venture forum), industry, and technology used. Appendix 2.F provides details of characteristics of these judges. They were a mix of investors, successful business owners, and experts in mentoring and coaching start-ups. 37 percent lived in one of the five countries taking part in the competition, while two-thirds were based in other countries. Eighty-percent of them regularly mentor start-ups, 64 percent were part of companies that make venture investments, and three-quarters had founded their own companies. They were therefore experienced in what outside investors are looking for in terms of investment readiness.

Judges were blinded to treatment status, and were not provided with any information about the company in advance of scoring. They were briefed and asked to score each firm on six factors:

1. Team: the skills and capabilities of the entrepreneur and his or her team
2. Technology: the degree of innovativeness and technological advancement
3. Traction: indications of measureable market success
4. Market: the commercial market attractiveness and size of the potential market
5. Recent business progress: the amount of progress firms had made during the last three months (the time since initial application)
6. Presentation performance

An aggregate investment readiness score was then formed using the following weights: (team) 28% , (technology) 21% , (traction) 14% , (market) 7% , and (progress) 30% . These weights were not revealed to the judges, but were based on what seed- and early-stage investors would commonly focus on (Kaplan and Strömberg, 2004). They tend to emphasize the quality of the team and their technology (Gompers et al., 2016), and the extent to which the business is continually improving. The presentation score was added to allow judges to independently assess how well the firm presented its ideas, and as "hygiene" factor that could be used if necessary to avoid placing someone unable to present in front of investors at the final. The correlation between this weighted score and an equally-weighted score is 0.995, and we show in Appendix 2.F that our results are robust to this choice of weighting.

There were two ways for firms to be selected for the finals. The main path was through an overall ranking based on the aggregate investment readiness score. Secondly, judges scored each firm after watching its pitch, and then at the end of the batch of six presentations, discussed the set of six. They then were asked to collectively rank the three best they had seen out of the six, and could choose to directly nominate the top-ranked firm to directly be sent to the finals. They were asked to use

this direct nomination selectively, reserving it only for firms they believed should certainly be granted the opportunity to present in the finals. The idea behind direct nomination was to allow for the possibility that through collective discussion, the strength of a firm may be more apparent.

Sixteen firms were directly nominated to the finals, of which only four were not in the top-50 overall based on the individual ranks.[11] Then firms ranked in the top 46 based on the overall score were also chosen to give a total of 50 finalists. We then examined how sensitive these rankings were to allowing for differences in scoring amongst judges, and re-ranked firms on their residual scores after subtracting judge fixed effects. Four additional firms were chosen as finalists based on having judge-fixed-effect-adjusted scores in the top-50 even though their raw scores were not in the top 50. This gave a set of 54 firms that were invited to the finals.

2.4.2 Estimating the Impact on Investment Readiness as Scored by Judges

To estimate the impact of the program on investment readiness as scored by the judges, we use the following (pre-specified) base specification for firm $i$in stratum s:

$$Outcome_i = \alpha + \beta Treat_i + \sum_{s=1}^{S} c_s 1\left(i \epsilon s\right) + \varepsilon_i \tag{2.1}$$

Where $1\left(i \epsilon s\right)$ are strata dummy variables. Note that stratification implicitly controls for baseline investment readiness, country, and whether or not the firm has an outside private investor at baseline. Robust (Eicker-White) standard errors are used. As a robustness check, we also re-estimate equation 2.1 after controlling for judge fixed effects.

It is important to note that the treatment may affect different firms in a different way depending on the personal abilities of each individual member of the team. Recent evidence has shown that the same type of training, for instance online self-learning course may have an heterogeneous benefit on the participants depending on the cognitive skills of the single individual. For instance an individual with above average investment readiness with possibly a previous experience in similar training programs benefits marginally from attending an online course with respect to an individual that is just now beginning to familiarize with the innovation eco-system, for this type of relative gains in technology-aided education see for instance Muralidharan, Singh, and Ganimian, 2019. We test also for such hypothesis in the next Section.

The parameter β is then the intention-to-treat effect (ITT). This measures the impact of being assigned to the treatment group, and being offered the expensive and intensive investment readiness program rather than the online course offered to the control group. We could also attempt to measure the local average treatment effect (LATE) of actually receiving treatment. Recall that 90.1% of the treatment group completed the *WhatAVenture* tool. However, all but one of the treatment group firms that attended the semi-finals (99.1%) had completed this tool, so the non-compliers to treatment status are firms for which we do not have investment readiness scores. As such, the ITT and LATE are almost identical for the firms attending the semi-finals. We therefore just report the ITT results.

The first column of Table 2.3 presents the impact of treatment in our overall measure of investment readiness, as scored by the judges. This is our main outcome in this table, and so our main approach to multiple hypothesis testing for this set

[11] They ranked between 58 and 74.

of outcomes is to rely on this aggregate. The control group has a mean investment readiness score of 2.9 (s.d. 0.9). We find that treatment increases this score by 0.284, which is significant at the 5 percent level. The magnitude is thus equivalent to 0.31 standard deviations. The second row of estimates show that this impact continues to hold after controlling for judge fixed effects, with a larger magnitude of 0.41. Figure 2.3 compares the distributions of investment readiness scores for the treatment and control groups, and shows there is a rightward shift in the distribution, so that these gains appear to be occurring everywhere except at the very top.

The next five rows of Table 2.3 examine which components of the overall score have improved with treatment. We find positive impacts on all five components (team, technology, traction, market, and progress), with the impacts statistically significant for three out of five measures, and significant for all five measures after controlling for judge fixed effects. The seventh row then examines the impact on the team's presentation score. Recall this is not included as part of the overall score, but was scored separately. We find that treatment resulted in a 0.37 unit (0.32 s.d.) increase in the team's presentational score, which is statistically significant at the 5 percent level. Treated firms are therefore more investment ready in terms of both being able to present their idea, and in terms of the quality of the idea presented.

We had hypothesized that the treatment might also reduce the variability among judges in their assessment of how investment-ready firms are. To examine this, in column 8 we consider as an outcome the standard deviation of the individual judge scores for a firm, with a higher standard deviation indicating more divergence amongst judges in their assessment of the firm. However, we see a small and not statistically significant impact of treatment on this measure.

Finally, the last column examines whether treated firms were more likely to be selected as one of the top 54 firms that were invited to pitch to investors in the finals. Only 12 percent of the control group firms were selected for the finals, and treatment has an 11.5 percentage point increase in this likelihood. This is a large effect, doubling the likelihood of making the finals, but it is only significant at the 10 percent level.

The investment readiness scores are only available for firms which participated in the semi-finals. This raises the concern of bias arising from differential participation patterns among treatment and control firms. The last columns of Table 2.1 examines balance on baseline characteristics by treatment status for the firms which participated in the semi-finals. We see that, overall, the sample still looks balanced on most observable characteristics, although the overall joint orthogonality test has a p-value of 0.086. Most importantly, the mean of the baseline overall investment readiness differs only by 0.02 between the two groups, and Appendix Figure 2-II compares the full distribution of the baseline investment readiness score by treatment group and participation status, and shows the distributions also look similar. Our pre-analysis plan specified two approaches to examining the robustness of our results to this attrition: imputing scores for those who did not attend, and using Lee, 2009 bounds. Appendix 2.F shows the results are robust to both approaches, and are also robust to using alternative weighting schemes to aggregate the different components of the overall score. The program therefore succeeded in making firms more investment-ready, as judged by independent experts.

2.4.3 Heterogeneity in Impact by Initial Investment Readiness

In our pre-analysis plan, we hypothesized that the impact of the program is likely to be greater for firms that were less investment-ready to begin with, since firms that

already had very high scores on all components would have had little room to improve. Conversely, this impact could be negative, if training causes less investment-ready firms to present their ideas more clearly to judges, allowing judges to more easily recognize them as low quality as in Clingingsmith and Shane, 2017. To test this hypothesis, we interact treatment with an indicator of whether or not the firm had a baseline investment readiness score below the median of 3 (45.1 percent of firms), and include this interaction, along with the level effect of having a below median readiness score in an expanded version of equation 2.1.

Table 2.4 reports the results of examining this heterogeneity for the same outcomes as were tested in Table 2.3. The point estimate in column 1 is consistent with this hypothesis, with the estimated effect of treatment on investment readiness being twice as large for below median firms as above median firms. However, our power to detect this heterogeneity is low, and we cannot reject the null hypothesis that there is no difference in treatment effects by initial readiness. The next six columns show positive point estimates on four out of five of the interaction effect for the different subcomponents of the overall score, along with a positive point estimate on the interaction with the presentation score. However, the only significant effect is when looking at the technology sub-component as an outcome. Moreover, after correcting for multiple hypothesis testing using Holm, 1979 method this impact is no longer significant. Finally, in the last column we see that the interaction is negative for being selected for the finals. This is consistent with the idea that firms that were far from investment-ready to begin with would not be able to improve enough to get into the top group, although this interaction is not statistically significant and so we cannot reject that the treatment effect on progression to the finals is the same regardless of initial score.

2.5 Longer-term impacts on investment readiness and firm performance

The immediate impacts on investment readiness are seen in the performance in the semi-finals. We then track the firms over time in a variety of ways to see whether this short-term improvement in investment readiness translates into longer-term investment readiness, into the chance of receiving investments, and into firm performance.

2.5.1 Performance in the Finals Event

The Finals event was held in cooperation with the Balkan Venture Forum on December 3 and 4, 2015 in Zagreb. This was the largest venture capital conference in the five target countries to date, with more than 400 attendees. The pitching slots were spread over two days and grouped into batches based on industry segments (business and productivity, lifestyle and entertainment, life science and energy, environment, and mobility and transportation). Jury members consisting of partners at venture capital firms and managers of accelerators/incubators choose a category winner for each batch. Out of eight category winners, 6 came from the treatment group and 2 from the control. These category winners were publicly awarded with a large-format printed award and a bottle of sparkling wine following the slogan "honor, fame, and champagne" . The three lead investors of the conference had each publicly committed to choose at least one firm each to give an "invitation to negotiate" for investment by the end of the conference. They extended these invitations to four finalists in total, of which 3 were from the treatment group and 1 from

the control. The treatment group therefore did better, but because the absolute number of firms winning is so low, these impacts are still small in absolute magnitude (1 to 2 percentage points), and are not statistically significant (the smallest p-value is 0.157 for being a category winner).

Following the finals, a short survey was sent to investors who had attended the finals. Responses were received from 32 investors. Out of these investors, 66 percent said they had talked about a potential investment with at least one firm, 28 percent planned to negotiate with a firm, and 50 percent said they might invest and had added new firms to their watchlists. Only 40 percent had previously invested in the region, and when asked what the main barrier to investing in the region was, the modal answer was in generating deal flow and identifying good investment prospects. Investors were asked whether they planned to increase their investment in the region as a result of attending. 25 percent said they would, 31 percent said they would reallocate their investment from other investments they might make towards firms in the event, and the rest would not change their investment strategies. This provides suggestive evidence that the project may have increased the overall amount of investment towards these types of firms in the region.

2.5.2 Impact on Media Buzz

We examine whether the firm is gaining attention and traction through several measures of media attention and social media buzz. One advantage of these measures is that they are available for the full sample, with no attrition. The media intelligence specialist firm *Meltwater* was contracted to collect online media mentions of the firms in our sample over the six month period March 1 to August 31, 2015 (pre-intervention), and then one year and two years later (March 1 to August 31, 2016; and March 1 to August 31, 2017). Note that these time periods exclude the period of the intervention, semi-finals, and finals, so are independent of any media coverage of the program or pitch events, and correspond to an average of 6 and 18 months post-intervention. Meltwater tracks more than 250,000 global news sources in 190 countries in 25 languages (including Serbo-Croatian and Albanian). Thirteen percent of the firms in our sample had at least one media article about the firm during the six months prior to application, with a median of three articles conditional on having any media.

Column 1 of Table 2.5 show that 9.9 percent of the control sample was mentioned at least once in the media during the six-month intervals in 2016 and 2017, and treatment results in a 4.7 percentage point (2016) and 3.9 percentage point (2017) increase. These increases are large relative to the sample mean, but not statistically significant. Column 2 of Table 2.5 shows that we do see a statistically significant increase in the total number of media mentions in 2017, which are three times as high for the treatment group as the control.

Two-thirds of the firms had some form of social media presence at baseline, with Facebook (which 58% use) and twitter (42% use) being the most common. Column 3 shows a small and statistically insignificant impact of treatment on the number of Facebook followers a firm has, and Column 4 shows that treated firms have 20% more twitter followers after two years, but this is also not statistically significant. We pre-specified an overall index of *media buzz* by taking standardized z-scores of these first four columns.[12] The last column of Table 2.5 shows that treated firms have more

[12]Our pre-analysis plan also noted we would look at the impact on web-traffic, and being included on AngelList, a web platform for fundraising, but that these would not be included in our overall index of media buzz. We find no significant impact on these other outcomes (Appendix 2.G).

media buzz, with this significant at the 5 percent level in 2017.

Tracking Firm Performance Through Follow-up Surveys

We conducted two rounds of follow-up surveys of these firms. The first, intended to measure short-term effects, was taken between April and August 2016, corresponding to a period of approximately six months after the end of the investment readiness program and judging, and enables us to measure short-term effects. The overall survey response rate was 79.2 percent, and does not differ significantly between treatment (79.9%) and control (78.5%). In addition, we collected information on operating status, number of employees, and whether negotiations for an outside investment had occurred for a further 12 percent of firms, resulting in basic data being available for 92.2 percent of firms. The second follow-up survey took place between August 2017 and March 2018, corresponding to an average of two years since the intervention. Catalini, Guzman, and Stern, 2017 show that 75 percent of firms that receive venture capital financing in the U.S. receive their first financing within the first two years after incorporation, so this timing covers a window where we should expect many firms to receive external financing if they will ever do so. The overall survey response rate for this second follow-up was 85.0 percent, and again does not differ significantly between treatment (86.2%) and control (83.7%), with data on firm operating status and receipt of equity available for 94.5% of firms. Appendix 2.H shows no significant difference in response rates by treatment status, and that treatment and control firms remain balanced on baseline observable data for those responding to the survey.

The follow-up surveys focused on measuring changes in the firm in three domains. The first is whether or not the firm is still operating (regardless of whether or not it has been sold to another owner). The second is investment readiness, where we focus on three aspects identified by Mason and Kwok, 2010: (1) willingness and interest in taking on equity investment; (2) general investability, as measured whether there is a viable business of interest to investors in terms of employment, sales, and profits; and (3) whether the firm has put in place specific measures investors want to see before making investments, such as separation of outcomes, revenue projections, knowledge of customer acquisition costs, tracking key metrics of traction, and covering intellectual property. The third and final domain looks at steps towards receiving external funding and then external financing received. Steps towards financing include contacting outside investors, making pitches, working with mentors or experts to help obtain financing, and entering into negotiations. Receipt of external financing considers new debt and equity investments, as well as receipt of incubator and accelerator grants.

We ask several questions under each domain and sub-domain. Our pre-analysis plan then specifies aggregating these measures to form standardized indices. This reduces concerns about multiple hypothesis testing by focusing on one aggregate outcome in each family of questions. Appendix 2.C provides the exact questions used in forming each question, and Appendix 2.I provides treatment impacts on each specific question used in these aggregate measures.

2.5.3 Do Higher Investment Readiness Scores Predict Better Firm Investment Readiness and Investment Outcomes?

The investment readiness program resulted in higher investment readiness scores from judges. To investigate whether these judges' scores are informative about future outcomes for the firm, we use the control group sample to run the regression:

$$Outcome_i = \mu + \theta InvestmentReadiness_i + \gamma_i' X_i + \varepsilon_i \quad (2.2)$$

We carry out this estimation first with no additional controls, and then with controls X for country (dummies for Serbia and for Croatia), whether or not the firm had received funding from an outside investor at baseline, and the business sector (dummies for business and productivity, and lifestyle and entertainment sectors). We estimate this separately by survey, to examine results at different time horizons.

Table 2.6 presents the results. Column 1 shows that 10% of control firms had died by the first follow-up, and 25% by the second follow-up, two years post-intervention. These high death rates are higher than the average rates in developing countries, and likely reflect the firms being young and in relatively developed countries (McKenzie and Paffhausen, 2017). We then see no significant association between higher investment readiness scores and subsequent survival. Columns 2 through 6 then examine the associations between higher investment readiness scores and our different measures of subsequent investment readiness actions and investment steps and outcomes. We see that the judges' scores of investment readiness are statistically significant predictors of the subsequent willingness and interest of the owner in taking on equity investment, whether the firm is meeting specific needs of investors before investment can take place, whether the firm has taken steps towards external financing, and whether they have received external financing. This is true both in the short-run (six-month) survey, and in the two-year survey. The magnitudes range from 0.14 to 0.33, suggesting that a one unit change in the judge scores (which had a mean of 2.9 and standard deviation of 0.9) would predict a 0.14 to 0.33 increase in these indices (corresponding to 0.2 to 0.5 standard deviations). The only measure where we do not find a significant association is in general investability, which is an index of measures of firm employment, profits, and sales.

Finally, in the last column we examine whether the firm had made at least one deal with an outside investor since the start of the program (August 2015). 24.4 percent of the control group have made such a deal after two years. A one-mark higher investment readiness score from the judges significantly predicts a 17 to 18 percentage point increase in the likelihood of making such a deal, which is large relative to this baseline rate.

We therefore have that treatment has a causal impact ($\beta = 0.28$) on the investment readiness score received from judges, and that this investment readiness score in turn is a significant predictor (with coefficient θ) of firm outcomes in the control group sample. Combining these two estimates allows us to obtain an estimate of the *predicted treatment effect* $\beta\theta$. This predicted effect is shown for each outcome in Table 2.6. It assumes that the only impact of the investment readiness program on firm outcomes is captured through the investment readiness score, that the association between score and outcomes observed in the control group is causal, and that the sequential ignorability assumption of Imai et al., 2011 holds.[13] Although these assumptions can be questioned, we believe such an exercise is useful in providing

[13]The sequential ignorability assumption requires that if there are heterogeneous treatment effects, it is not the case that the firms for whom treatment increases investment readiness scores are different from the firms for which an increase in investment readiness scores would increase future outcomes.

a sense of the magnitudes we might expect to see for treatment effects, given how much our program affected investment readiness scores, and how much a change in scores in turn predicts future outcomes. We see that the predicted treatment effects are small in absolute terms: each of our index measures is predicted to increase by only 0.04 to 0.09 over two years, and the predicted increase in the likelihood of receiving outside funding is 4.6 percentage points. We compare our estimated treatment effects to these benchmarks in the next section.

2.5.4 Treatment Effects on Investment Readiness and Investment Outcomes

Table 2.7 presents the treatment effects of the investment readiness program on these survey outcomes after estimating equation (1). Panel A shows the short-run impacts six months after the intervention, and panel B the impacts two years post-intervention. Treatment results in a 7.2 percentage point increase in firm survival over two years, but this is not statistically significant, with a 95 percent confidence interval of (-1.7p.p., +16.1p.p.). We see a reduction in external investment in the very short-run, which comes through less debt financing, but no significant impact on any of our investment readiness or investment outcomes over two years. After two years, the treatment group is 5 percentage points more likely to have made a deal with an outside investor, with a 95 percent confidence interval of (-4.7p.p., +14.7p.p.). The estimated point estimates on all our index measures at two years are all positive, but small, ranging from 0.003 for our external investment index, to 0.089 for general investability. These magnitudes are similar to those of our predicted treatment effects, and in all cases the predicted treatment effect $\beta\theta$ lies within the 95 percent confidence interval for our estimated treatment effects.

Appendix 2.I shows impacts on the individual measures that make up these aggregate indices. The intervention has a large and significant (p=0.013) impact on employment after two years of 4.5 workers, which almost doubles the employment level in the control mean. Employment is often a key policy outcome by itself, and so this program would compare favorably to a number of other programs when judged on employment alone. However, if we correct for testing 25 different outcomes that make up the aggregate indices, this impact is no longer statistically significant (p=0.425).

2.5.5 How should we interpret the lack of treatment effect?

Our results show that the investment readiness program increased investment readiness scores from the judges, that these scores are predictive of future investment readiness and investment outcomes, but that we do not find any significant impacts of the program on these future outcomes. To reconcile these findings, we note that our estimated treatment effects are in line with the predicted treatment effects $\beta\theta$ – while we increased investment readiness scores, we did not increase them by enough to register large enough changes in investment outcomes to be detectable. Our confidence intervals enable us to rule out the program having large absolute impacts on these outcomes, but are wide enough to allow for the program to have moderate sized impacts that are not possible to detect with the sample size we have.

One difficulty in detecting end outcomes comes from the issue of statistical power weakening the more steps one takes along a "funnel of attribution" (McKenzie and Woodruff, 2013). Our experiment starts with a group of firms who apply to a program. To get from this stage to receiving equity investment requires satisfying a

number of steps – they must be interested in receiving investment and become investment ready, take steps towards receiving investment, and then actually receive investment. The effective number of firms drops as we pass from one step to the next, making it harder to detect impacts for end outcomes than initial outcomes. This program is the first randomized experiment of its kind, but like a number of other experiments involving larger firms, the sample size is set by external constraints in terms of the number of firms that the program attracts and caters to, rather than being a choice parameter.

Given the sample size, our funding proposal calculated that we would have 80% power to detect a 0.23 increase in the investment readiness score, based on the mean and standard deviation of the baseline score measure and not accounting for the power gains from stratification. Our estimated treatment effect of 0.28 exceeds this level. In contrast, our funding proposal assumed that it would be very rare for control group firms to receive outside funding, assuming a mean of 3 percent, and then estimated a minimum detectable effect size of 8 percentage points at 80% power, not accounting for the power gains from stratified randomization (since we did not know how strongly our strata would be correlated with the end outcome). Ex post, our randomization strata have an R^2 of 0.29 in a regression of making a deal with an outside investor on strata dummies. Given this, our anticipated power would have been 91 percent to detect an 8 percentage point increase.

In practice, our estimated impact on receiving outside funding is 5 percentage points (similar in magnitude to the predicted impact $\beta\ \theta$= 0.046, which is less than this minimal detectable effect. But the larger reduction in power comes from the control mean being much higher than anticipated. While we expected very few control firms to receive external financing, in practice 24.4 percent of control firms had made a deal within two years. It is much harder to detect an 8 percentage point increase from a control mean of 24.4% than from a control mean of 3% : under our baseline assumptions, power would drop to 33.3% at this mean level. So a key reason for not being able to detect a treatment effect on external investment is that control firms found it easier to get investment than we had anticipated.

We explore the types of investment received in Table 2.8.[14] Firms in the two-year long follow-up survey were asked about whether they had made deals with different types of outside investors, and if so, what type of deal. We see that the most common deals occurred with other business owners (17%), angel investors (10%), and venture capital funds (10%).[15] Most of these deals were for a share of equity in the firm, with royalty deals, convertible notes, and licensing deals not very common. Both the type of investor and type of deal are similar across the treatment and control groups. We have only partial data on the amount of these deals, but know that 16.8% of firms (69% of those receiving an outside investment) received an amount of at least 25,000 euros, with this again not differing significantly by treatment status (Appendix Table 2-XIII).[16]

Finally, firms in the long survey were asked what is the main challenge their business faces in their ability to grow over the next two years. Getting financing is seen as the main challenge by 41% of the control firms and 24% of the treatment

[14]Note that this table was not pre-specified, and is intended to explore the higher than anticipated rate of outside funding received by firms.

[15]Our measure of receiving external financing excludes financing received from family and friends. 10.8% of firms in the long survey received financing from family and friends, but in less than half of cases this was for an equity stake- terms tend to be less formal in such cases.

[16] Using the long follow-up survey only, 43% (42% treatment, 44% control) of those receiving outside funding received at least 100,000 euros in investment. This information is not available for firms doing the short survey.

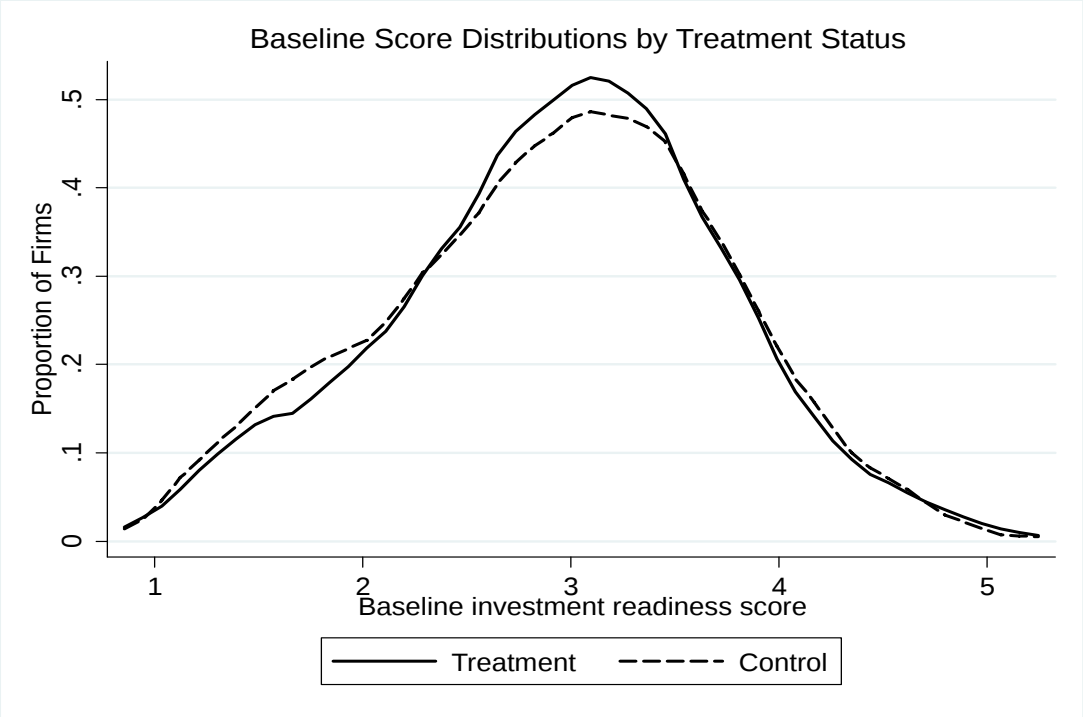
firms, with this difference statistically significant (p=0.002). In addition to the positive point estimate on getting access to external financing, it is possible that the investment readiness program led some treatment firms to realize that they need to improve other areas in their business first.

2.6 Conclusions

Investment readiness programs have been offered in a range of developing and emerging markets, based on the idea of a gap between the quality of ideas entrepreneurs have, and their readiness to attract and receive outside investment in those ideas. Despite their growing use, there has not been any rigorous study of their effectiveness. Our five-country randomized trial enables measurement of the effect of such a program. We do find that investment readiness increases, as measured by scores in a pitch competition, and that these scores are in turn predictive of future investment readiness and outcomes amongst firms. Nevertheless, despite finding positive point estimates, our estimates of the treatment effects of the investment readiness program on these firm investment outcomes over the next two years are not statistically significant. Our analysis suggests that this in part reflects that the change in investment readiness score is not large enough to generate sizeable impacts on subsequent firm outcomes, and also that more of these firms are able to obtain financing without the program than was originally anticipated.

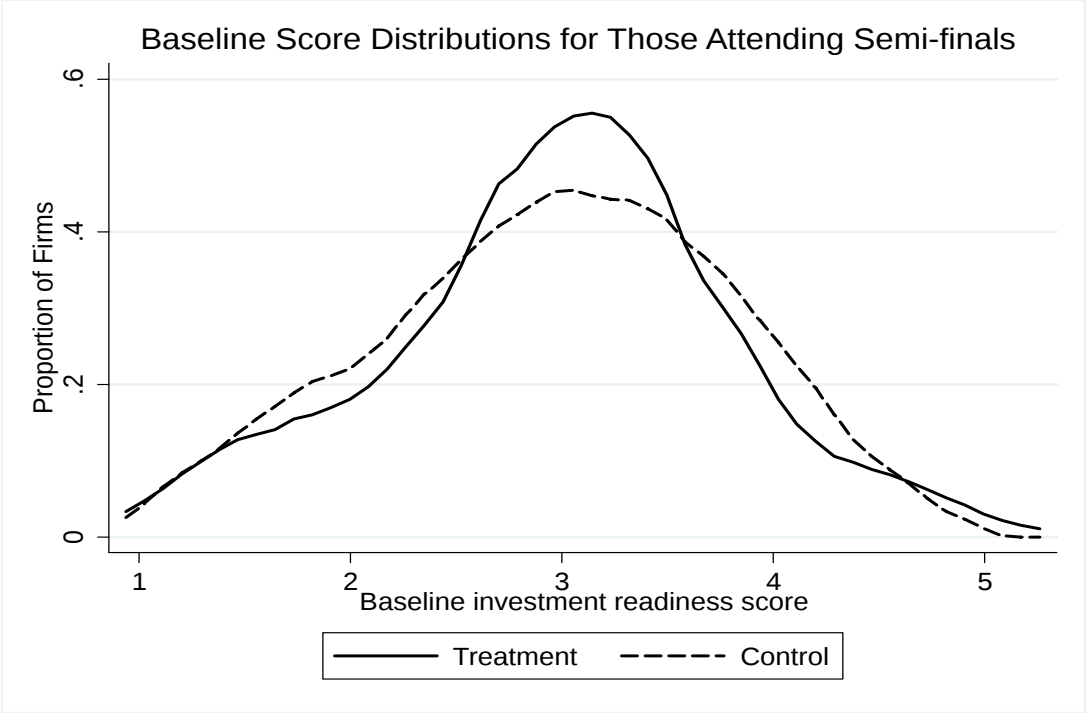
We believe these results offer lessons for governments deciding whether and how to use such policies. Starting with firms that express interest in outside funding, but that require many steps to take place before being in a position to receive funding may end up including many firms for which investment readiness is not the main constraint to receiving outside funding and to firm growth. As a result, investment readiness programs that start from the demand side of outside financing may have stronger impacts on getting firms to take steps towards investment readiness, than on investment outcomes, where other constraints also play a role. A possible alternative to test would be to start from the supply side, starting with investors and asking them for a list of firms that are at the margin of being investible, but for which assistance on specific aspects of investment readiness are needed.

FIGURE 2.1: Baseline Distributions of Investment Readiness for Treatment and Control Groups



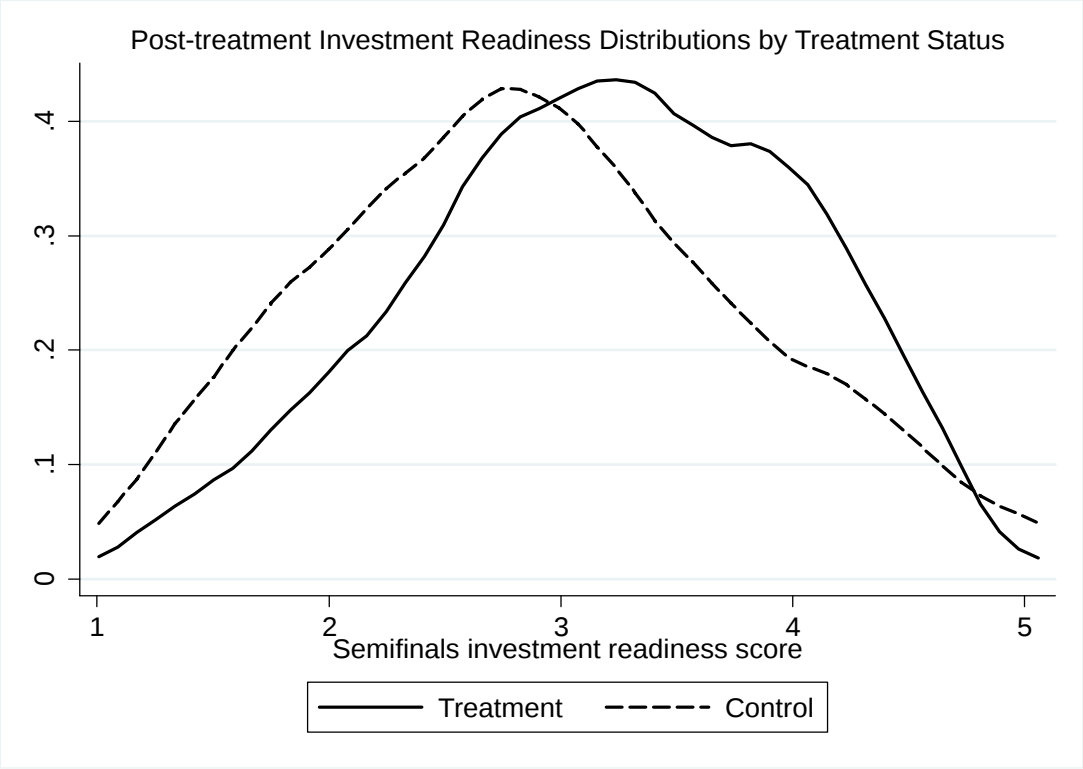
Note: Kolmogorov-Smirnov test of equality of distributions has p-value of 0.988

FIGURE 2.2: Baseline Distributions of Investment Readiness for Those Attending Semi-Finals



Note: Kolmogorov-Smirnov test of equality of distributions has p-value of 0.959

FIGURE 2.3: Distribution of Investment Readiness Scores after Program as Scored by Judges



Note: Kolmogorov-Smirnov test of equality of distributions has p-value of 0.017

TABLE 2.1: Balance Test on Application Data

	Full Sample			Semi-Final Participants		
	Treatment	Control	P-value	Treatment	Control	P-value
Variables stratified on						
Incorporated/Registered in Croatia	0.25	0.24	0.612	0.25	0.30	0.920
Incorporated/Registered in Serbia	0.46	0.46	0.626	0.48	0.48	0.513
Baseline Readiness Score	2.95	2.92	0.150	2.99	2.97	0.476
Has an outside private investor	0.10	0.09	0.178	0.14	0.06	0.170
Other variables						
Market attractiveness score	3.08	3.05	0.851	3.13	3.18	0.579
Product technology score	2.47	2.43	0.835	2.56	2.71	0.085
Traction score	3.34	3.27	0.507	3.28	3.06	0.382
Team score	3.04	3.05	0.878	3.08	3.02	0.207
Sector is business and productivity	0.48	0.39	0.107	0.45	0.36	0.436
Sector is lifestyle and entertainment	0.18	0.23	0.295	0.20	0.27	0.215
Uses Cloud Technology	0.20	0.26	0.231	0.20	0.21	0.984
Uses Big Data	0.18	0.21	0.642	0.17	0.20	0.915
Place in value chain is developer	0.61	0.55	0.171	0.60	0.57	0.677
Place in value chain is service provider	0.59	0.54	0.372	0.60	0.54	0.108
Age of firm (years)	2.61	2.66	0.887	2.24	2.29	0.346
Early stage firm	0.30	0.33	0.475	0.35	0.37	0.554
Revenues in 2014	178073	184760	0.959	37642	144012	0.303
Number of employees	6.47	5.88	0.539	4.65	5.32	0.800
Age of main founder	38.22	36.81	0.204	38.02	36.67	0.362
Main founder has post-graduate education	0.49	0.48	0.816	0.54	0.55	0.740
At least one founder is female	0.16	0.22	0.128	0.16	0.30	0.071
Company has a global focus	0.60	0.58	0.576	0.59	0.63	0.569
Have accepted outside financing	0.34	0.37	0.656	0.42	0.40	0.836
Previouslyin mentoring/accelerator program	0.15	0.16	0.704	0.18	0.22	0.202
Sample Size	**174**	**172**		**110**	**101**	
Joint test of orthogonality of treatment p-value			0.621			0.086

Notes: Full sample denotes the full experimental sample. Semi-final participants are the sample that were scored by judges during the semi-final pitch event. Variables stratified on were the variables used in randomized assignment.

TABLE 2.2: Correlates on the Take-Up Decision among the Treatment Group

	Take-up WhatAventure		Attend Masterclasses	
	Full Model	Stepwise Model	Full Model	Stepwise Model
Baseline Investment Readiness Score	0.494**	0.573***	-0.217	-0.238*
	(0.194)	(0.169)	(0.144)	(0.132)
Incorporated/Registered in Croatia	0.424		-0.757**	-0.771***
	(0.397)		(0.296)	(0.286)
Incorporated/Registered in Serbia	0.409		-0.331	-0.393
	(0.354)		(0.261)	(0.245)
Sector is business and productivity	0.128		0.040	
	(0.254)		(0.262)	
Sector is lifestyle and entertainment	0.191		0.010	
	(0.366)		(0.327)	
Uses Cloud Technology	0.137		0.577**	0.610**
	(0.372)		(0.275)	(0.259)
Uses Big Data	0.740		0.278	
	(0.521)		(0.266)	
Place in value chain is developer	-0.181		-0.360*	-0.309
	(0.292)		(0.215)	(0.207)
Place in value chain is service provider	-0.211		-0.108	
	(0.294)		(0.235)	
Age of firm (years)	-0.005		-0.026	
	(0.056)		(0.044)	
Early stage firm	-0.147		0.024	
	(0.335)		(0.238)	
Number of employees	0.008		-0.005	
	(0.013)		(0.010)	
Age of main founder	-0.020	-0.018	-0.008	
	(0.014)	(0.013)	(0.012)	
Main founder has post-graduate education	-0.141		0.487**	0.485**
	(0.278)		(0.221)	(0.212)
At least one founder is female	-0.674**	-0.455	-0.001	
	(0.302)	(0.337)	(0.270)	
Company has a global focus	0.280		0.073	
	(0.305)		(0.225)	
Have accepted outside financing	0.211		0.210	
	(0.324)		(0.252)	
Has an outside private investor	-0.123		-0.121	
	(0.581)		(0.373)	
Have participated in mentoring/accelerator program before	0.558		0.399	0.488*
	(0.579)		(0.308)	(0.276)
Sample Size	174	174	174	174

Notes: Robust standard errors in parentheses. Coefficients are marginal effects from probit estimation.
*, **, *** indicate significance at the 10, 5, and 1 percent levels respectively
90.1% of firms took up WhatAVenture, and 43.7% attended at least one masterclass.

TABLE 2.3: Impact of Program on Investment readiness as Scored by Judges

	Overall Readiness Score	Team Score	Technology Score	Traction Score	Market Score	Progress Score	Presentation Score	Std Dev of Judge Scores	Selected to go to Finals
Base Specification									
Assigned to Treatment	0.284**	0.167	0.372**	0.206	0.268*	0.373***	0.372**	0.006	0.115*
	(0.126)	(0.150)	(0.152)	(0.130)	(0.137)	(0.137)	(0.164)	(0.049)	(0.068)
Including Judge Fixed Effects									
Assigned to Treatment	0.409***	0.369**	0.476***	0.295**	0.463***	0.440***	0.514***	-0.017	0.090
	(0.135)	(0.158)	(0.174)	(0.142)	(0.139)	(0.143)	(0.191)	(0.051)	(0.076)
Sample Size	211	211	211	211	211	211	211	211	211
Control Mean	2.908	3.042	2.970	2.541	3.406	2.794	3.042	0.723	0.122
Control Std. Dev.	0.903	1.068	1.031	0.947	0.940	0.937	1.145	0.317	0.328

Notes:
Robust standard errors in parentheses. Regressions control for randomization strata. *, **, *** indicate significance at the 10, 5, and 1 percent levels respectively. Judge fixed effects controls for which five of the sixty-five judges judged a particular firm.

TABLE 2.4: Heterogeneity in Impacts on Investment Readiness

	Overall Readiness Score	Team Score	Technology Score	Traction Score	Market Score	Progress Score	Presentation Score	Std Dev of Judge Scores	Selected to go to Finals
Assigned to Treatment	0.203	0.014	0.405**	0.138	0.009	0.314	0.249	0.020	0.177*
	(0.178)	(0.208)	(0.193)	(0.192)	(0.180)	(0.197)	(0.230)	(0.062)	(0.101)
Assigned to Treatment*Baseline Readiness below Median	0.210	0.378	-0.083	0.183	0.646**	0.169	0.310	-0.019	-0.179
	(0.254)	(0.305)	(0.317)	(0.251)	(0.275)	(0.270)	(0.335)	(0.105)	(0.127)
Sample Size	211	211	211	211	211	211	211	211	211
Control Mean	2.908	3.042	2.970	2.541	3.406	2.794	3.042	0.723	0.122
Control Std. Dev	0.903	1.068	1.031	0.947	0.940	0.937	1.145	0.317	0.328

Notes:

Robust standard errors in parentheses. Regressions control for randomization strata. *, **, *** indicate significance at the 10, 5, and 1 percent levels respectively. Regressions also control for level effect of having a baseline investment readiness score below the median of 3.

TABLE 2.5: Impacts on Media mentions and Social Media Buzz

	Any media mention	Number of Media mentions	# Facebook likes	# Twitter Followers	Media Buzz Index
Panel A: Impact at Six Months					
Assigned to Treatment	0.047	0.786	-38.0	15.110	0.085
	(0.031)	(0.483)	(145)	(18.495)	(0.053)
Sample Size	346	346	346	346	346
Control Mean	0.099	0.663	1119	112.471	-0.060
stddev	0.299	3.410	2388	260.201	0.546
Panel B: Impact at Eighteen months					
Assigned to Treatment	0.039	0.736**	0.889	22.106	0.112**
	(0.030)	(0.291)	(218)	(18.974)	(0.047)
Sample Size	346	346	346	346	346
Control Mean	0.099	0.320	1430	106.866	-0.073
Control S.D.	0.299	1.566	3106	249.504	0.528

Notes: robust standard errors in parentheses. *, **, and *** denote significance at the 10, 5, and 1 percent levels. All regressions control for randomization strata fixed effects and for baseline values of outcome of interest.

Any media mention denotes firm was mentioned in news media in 6 month window, **number of media mentions** is the number of times the firm was mentioned, winsorized at the 99th percentile. **# Facebook likes** and **# Twitter Followers** are the number of Facebook likes for the firm's Facebook page, and number of Twitter followers for the firm, both winsorized at the 95th percentile. **Media Buzz Index** is an index of standardized z-scores of these first four columns.

TABLE 2.6: Judges Scores Predict Firm Outcomes 6 months and 2 year after the program

	Firm survival	Interested in equity	General Investability	Specific needs of investors	Investment Steps	External investment	Made a deal with investor
Panel A: Association at Six Months							
without controls	0.024	0.201**	0.076	0.336***	0.222***	0.213**	0.093**
Score assessed by Judges	(0.037)	(0.076)	(0.072)	(0.065)	(0.082)	(0.098)	(0.038)
with controls for country, prior funding, and sector							
Score assessed by Judges	0.017	0.168*	0.052	0.300***	0.179**	0.187*	0.085**
	(0.037)	(0.087)	(0.074)	(0.069)	(0.087)	(0.110)	(0.039)
Sample Size	92	83	83	81	73	82	82
Control Mean	0.898	-0.015	-0.039	-0.059	0.008	0.084	0.083
Control S.D.	0.303	0.764	0.634	0.682	0.720	0.741	0.276
Predicted Treatment Effect	0.007	0.056	0.021	0.094	0.062	0.060	0.026
Panel B: Association at Two Years							
without controls	0.061	0.153*	0.040	0.136*	0.322***	0.322***	0.166***
Score assessed by Judges	(0.041)	(0.088)	(0.073)	(0.082)	(0.100)	(0.072)	(0.048)
with controls for country, prior funding, and sector							
Score assessed by Judges	0.053	0.128	0.027	0.140*	0.324***	0.339***	0.175***
	(0.044)	(0.094)	(0.078)	(0.077)	(0.099)	(0.077)	(0.049)
Sample Size	100	92	86	88	80	99	99
Control Mean	0.753	-0.005	-0.058	-0.059	-0.032	0.018	0.244
Control S.D.	0.433	0.783	0.650	0.692	0.760	0.698	0.431
Predicted Treatment Effect	0.017	0.044	0.011	0.038	0.090	0.090	0.046

Notes: robust standard errors in parentheses. *, **, and *** denote significance at the 10, 5, and 1 percent levels respectively.

Firm survival is a binary variable that takes value one if the firm is operating, and zero otherwise. **Interested in equity** is a standardized index of whether the firm is interested in equity financing, the maximum equity share they are willing to have owned by outside investors, whether they have specific deal terms for investors, and whether they would consider a royalty-based investment. **General investability** is a standardized index of number of employees, whether the founders work full-time in the business, whether the firm had positive sales in the first quarter of the year, whether total sales exceed 10,000 euros in that quarter, whether the firm made a positive profit in the past year, and whether the firm made sales to Western Europe or the United States. **Specific needs of investors** is a standardized index of whether business and personal accounts are separated, whether the firm has made a revenue projection for the next year, whether it knows customer acquisition costs, the number of key metrics tracked, whether it has found out if the product or service can be covered by intellectual property protection, and whether it has at least one form of intellectual property protection received or pending. **Investment steps** is a standardized index of having contacted at outside investor, made a pitch to an outside investor, have a mentor or external expert supporting them to obtain financing, and entered into negotiations with an outside investor. **External investment** is a standardized index of having taken on new debt, having made a deal with an outside investor, have received at least 25,000 euros in outside financing, and have received an incubator or accelerator grant (all since August 2015). **Made a deal with an investor** indicates having made a deal with an outside investor since August 2015 (program start).

v

TABLE 2.7: Impacts on Survey Outcomes 6 months and 2 years after the program

	Firm survival	Interested in equity	General Investability	Specific needs of investors	Investment Steps	External investment	Made a deal with investor
Panel A: Impact at Six Months							
Assigned to Treatment	0.049	0.051	0.026	0.082	-0.017	-0.152*	-0.024
	(0.030)	(0.094)	(0.085)	(0.080)	(0.098)	(0.087)	(0.033)
Sample Size	319	278	277	269	240	279	279
Control Mean	0.898	-0.015	-0.039	-0.059	0.008	0.084	0.083
Control S.D.	0.303	0.764	0.634	0.682	0.720	0.741	0.276
Predicted Treatment effect	0.007	0.056	0.021	0.094	0.062	0.060	0.026
Panel B: Impact at Two Years							
Assigned to Treatment	0.072	0.032	0.089	0.084	0.044	0.003	0.050
	(0.045)	(0.084)	(0.082)	(0.079)	(0.092)	(0.080)	(0.049)
Sample Size	340	309	291	298	282	330	330
Control Mean	0.753	-0.005	-0.058	-0.059	-0.032	0.018	0.244
Control S.D.	0.433	0.783	0.650	0.692	0.760	0.698	0.431
Predicted Treatment effect	0.017	0.044	0.011	0.038	0.090	0.090	0.046

Notes: robust standard errors in parentheses. *, **, and *** denote significance at the 10, 5, and 1 percent levels respectively. All regressions control for randomization strata fixed effects.

Firm survival is a binary variable that takes value one if the firm is operating, and zero otherwise. **Interested in equity** is a standardized index of whether the firm is interested in equity financing, the maximum equity share they are willing to have owned by outside investors, whether they have specific deal terms for investors, and whether they would consider a royalty-based investment. **General investability** is a standardized index of number of employees, whether the founders work full-time in the business, whether the firm had positive sales in the first quarter of the year, whether total sales exceed 10,000 euros in that quarter, whether the firm made a positive profit in the past year, and whether the firm made sales to Western Europe or the United States. **Specific needs of investors** is a standardized index of whether business and personal accounts are separated, whether the firm has made a revenue projection for the next year, whether it knows customer acquisition costs, the number of key metrics tracked, whether it has found out if the product or service can be covered by intellectual property protection, and whether it has at least one form of intellectual property protection received or pending. **Investment steps** is a standardized index of having contacted at outside investor, made a pitch to an outside investor, have a mentor or external expert supporting them to obtain financing, and entered into negotiations with an outside investor. **External investment** is a standardized index of having taken on new debt, having made a deal with an outside investor, have received at least 25,000 euros in outside financing, and have received an incubator or accelerator grant (all since August 2015). **Made a deal with an investor** indicates having made a deal with an outside investor since August 2015 (program start).

Predicted Treatment effect is the treatment effect predicted from association in the control group between the judges score and the outcome, multiplied by the treatment effect of the program on the judges score.

TABLE 2.8: Details on Types of External Funding Deals Made

	Sample Size	Treatment Group	Control Group	P-value
Who was deal made with?				
Sold Firm	221	0.017	0.038	0.547
Deal with Other Business Owner	221	0.165	0.179	0.385
Deal with Angel Investor	221	0.096	0.104	0.804
Deal with Crowdfunding	221	0.043	0.019	0.164
Deal with Accelerator	221	0.087	0.038	0.096
Deal with VC Fund	221	0.096	0.113	0.967
Deal with Government Fund	221	0.070	0.075	0.706
What type of deal was made?				
Equity-Share	221	0.209	0.236	0.765
Licensing Deal	221	0.043	0.009	0.113
Royalty Deal	221	0.035	0.057	0.737
Convertible Note Deal	221	0.026	0.019	0.868
Other Deal	221	0.043	0.057	0.826
Says financing is main challenge	204	0.239	0.411	0.002

Notes: Data are for firms that answered the full survey in the second follow-up, approximately two years post-intervention. Some firms made multiple deals, and so numbers given are proportion of firms which made at least one of this deal type. Says financing is main challenge is an indicator of whether financing is viewed as the main challenge the business faces in its ability to grow.

ONLINE APPENDICES

Appendix 2.A: Examples of Investment Readiness Programs Around the World

Appendix 2.B: Timeline

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Appendix 2.G: Impact on web traffic and being included on AngelList

Appendix 2.H: Follow-up survey completion rates and balance

Appendix 2.I: Treatment effects on individual survey outcomes

2.A Appendix: Examples of Investment Readiness Programs Around the World

The text provides some examples of investment readiness programs offered in other countries. We provide more discussion of these examples here, with Mason and Harrison, 2001 and Mason and Kwok, 2010 also providing reviews of some programs.

2.A.1 Australia

The "Impact Investment Readiness Fund" offers grants of up to $ 100,000 for enterprises to purchase specialized capacity building support from providers such as advisory, financial, intermediary or legal services. The program aims to bridge the gap in the Australian market that exists between mission-driven organizations in need of funding and investors actively seeking impact investment opportunities.[17]

2.A.2 United Kingdom

In the UK, there are different types of investment readiness programs. Some of them discriminate in favor of entrepreneurs that have a social mission, while others focus on all types of firms. Within the first group, the "Investment and Contract Readiness Fund" [18], supported by the Office for Civil Society, assists social ventures to build their capacity to be able to raise capital. The "Impact HUB Westminster" also offers an investment readiness program, the "Impact Investment Readiness" , which aims to accelerate investment into social and environmental businesses based in London. It helps entrepreneurs to learn which type of investment is right for them, discover how to write investable business plans, and articulate their business mission as an attractive impact investment. They usually offer two days of free in-depth content on relevant topics, led by experts and supported by peer-to-peer learning.[19]

Within the second group, the "Growth Accelerator" [20] provides investment readiness services that help the entrepreneur understand which type of finance is right for her/him, build strong business plan and investment pitch, ensure the financial information provided to potential investors is credible and robust, pitch to the right type of investor for the entrepreneur's business, connect with a wide range of finance institutions and investors across the country and secure finance. Another example in the UK is the investment readiness program provided by the "Angel Capital Group" , which focuses specifically around three key dimensions: (i) positioning in the market, (ii) developing attractiveness to the investor, and (iii) pitching the message and opportunity correctly. From its headquarters in central London, the Angel Capital Group works both nationally and internationally, providing access to leading-edge services designed to improve investment readiness, facilitate access to early stage investment, and create opportunities for the development of new early stage co-investment funds, with a key focus on the angel investment market.[21] The "Greater London Enterprise" [22] is also another provider of investment readiness services, usually through a combination of an e-learning model and legal and financial

[17] http://impactinvestingaustralia.com/iirf/.

[18] http://www.sibgroup.org.uk/investment-readiness/.

[19] https://westminster.impacthub.net/impact-investment-ready/

[20] http://www.ga.businessgrowthservice.greatbusiness.gov.uk/what-we-offer/access-to-finance/

[21] http://www.angelcapital.co.uk/.

[22] https://www.gle.co.uk/gle-business-support.html

advisors, who are also investors. Mason and Kwok, 2010 also provide details on several other programs in the U.K. These include the different variants of investment readiness programs tried by the U.K. Small Business Service's Investment Readiness Demonstration Project, the University of Warwick's Science Park's Investment Readiness program; and the Finance and Business program delivered in the North East of England by the North East Regional Development Agency.

2.A.3 Europe

In Ireland, "Enterprise Ireland" offers investment readiness support to entrepreneurs by giving them access to the network "Enterprise Ireland Advisers" , and allowing them to get specialist support in a range of key strategic business development functions, including equity raising, technology development, market research, and export sales. The "Invest Academy Programme" , is an investment readiness program sponsored by the European Business Angel Network (EBAN), Sun& Sup, and Eurada geared to train entrepreneurs to understand sources of financing for their company by building their knowledge of financial sources, and helping them to refine their business propositions and business plans to make them attractive to potential investors and/or lenders. "InvestHorizon" is a program designed to increase investments made in Innovative European SMEs through Investment Readiness development and investor sensitization. The program assists companies getting started, raising awareness amongst SMEs about investment sources, options and requirements, providing coaching services to get funded, and matching entrepreneurs with specialized and active investors through investment forum events.

A European Union financed project led to the Ready for Equity[23] program which now offers training programs for fund-seeking entrepreneurs throughout Europe, with an 8-module course that includes an introduction to equity, discussion of the investment process, team building, how to do the perfect presentation, and how to value the enterprise and manage exit.

2.A.4 United States

In the U.S, there are also several initiatives to foster investment readiness. For example, the "Lean Startup" methodology developed by Steve Blank[24] offers entrepreneurs a framework to focus on what's important to be ready. Teams use the Lean Startup toolkit: the Business Model Canvas + Customer Development process + Agile Engineering to prepare themselves and be ready to present their business propositions to potential investors. These three tools allow start-ups to focus on the parts of an early-stage venture that matter the most for investors: the product, market fit, customer acquisition/base, revenue and cost models, channels and partners. The "Larta Institute" also offers investment readiness services.[25] By working side-by-side with entrepreneurs to identify and address their unique challenges and opportunities, they help them to be ready to raise equity finance. The Larta Institute gives entrepreneurs access to top-notch specialists in financial planning and mentors that support the entrepreneur in building a credible and attractive business plan. They have also worked with NSF grantees to help them commercialize their ideas.

[23] http://www.readyforequity.eu/article/2010/start_page/

[24] http://steveblank.com/about/.

[25] http://www.larta.org/services/entrepreneurs

2.B Appendix: Timeline

- Aug 14, 2015: applications launched
- August 2015: roadshows, advertising
- Sept 6, 2015: Applications closed
- Sept 10, 2015: Random assignment done by computer
- Oct 2, 2015: Registration in AEA RCT registry
- Sept 10-Nov 13, 2015: Investment Readiness program implemented, master classes, mentoring, etc.
- November 12-14, 2015: Semi-finals and pitch event in Belgrade
- December 2-4, 2015: Finals with the top 54 firms from the semi-finals pitching in front of the investors VC fund managers and Business Angels.
- April-August 2016: First follow-up survey (approximately 6 months post-program)
- August 2017-March 2018: Second follow-up survey (approximately 2 years post-program).

2.C Appendix: Scoring Methodology and Variable Definitions

The key variables are measured and defined as follows:

2.C.1 *Baseline Investment Readiness*

The applications were scored by a team from Pioneers Ventures, a seed-stage venture capital investment unit. Two professional investment managers reviewed each eligible application independently and assigned a score, based on for sub-scores using an agreed scoring metric as detailed below in Appendix Table 2-I. Where the independent scores differed by more than one unit, they discussed the cases to arrive at a consensus score, otherwise the scores were averaged. Each business was scored on four sub-components as follows:

TABLE 2-I: Description of the Investment Readiness Scoring Scale

Category	*Weight*	*Points*	*Threshold description*
Market attractiveness	**10**%	1	Market does not exist/ no market need
		2	Small market well served by competitors or equally good substitutes
		3	Large market well served by competitors or equally good substitutes
		4	Attractive niche in small market with unique solution/ positioning
		5	Attractive niche in large market with unique solution/ positioning
		6	Very large and mostly untapped/ underserved market with right offering
Co-founder(s) and team	**20**%	1	Single founder, no team
		2	Team of 2+ people
		3	Complimentary team with little experience
		4	Complimentary team with significant experience
		5	Serial entrepreneur(s)
		6	Serial entrepreneur(s) with exit
Product/ technology	**30**%	1	No/ low innovation - Imitation of existing products or services
		2	Low innovation - Localization of proven business models from abroad

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		3	Some innovation - Incremental improvements of existing products or services
		4	Innovative new solutions or business models that address customer needs
		5	Competitive technological innovation/ advantage
		6	Patented/ patent-pending technological innovation or otherwise protected IP
Traction	**40**%	1	No traction
		2	Soft traction (press coverage, facebook likes etc.)
		3	Test users/ prototype testing
		4	Non-financial KPIs (e.g. downloads, pre-orders)
		5	Generating revenues
		6	Sustainable business (generated revenues in 2014 > GPD/capita for each founder)

The *baseline investment readiness score* was then calculated as a weighted average of these four sub-components, using the weights detailed above.

2.C.2 Semi-finals scores provided by Judges

Judges scored each of the following on a six-point scale, with the score being the simple average of the scores of each of the five judges scoring the pitch:

1. *Team:* a score for the skills and capabilities of the entrepreneur and team
2. *Technology:* a score for the degree of innovativeness and technological advancement
3. *Traction:* a score for indications of measureable market success
4. *Market:* a score for commercial market attractiveness
5. *Progress:* a score for recent business development progress (in the last 3 months)
6. *Presentation:* a score for the presentation performance.

The following two variables were then calculated:

1. *Overall readiness score:* this is calculated as a weighted average of the team (28% weight), technology (21% weight), traction (14% weight), market (7% weight), and progress (30% weight) scores.

2. *Std dev of judge scores:* the overall readiness score is calculated for each judge. We then calculate the standard deviation of the five judge scores for a firm to get this measure of how much disagreement amongst judges there was in the scoring.

Finally, we also construct a dummy variable *Selected to go to Finals* to denote whether or not the firm was selected by virtue of having a top overall score or by direct nomination to go through to the Finals event.

2.C.3 Media mentions and social media buzz

1. *Any media mention* is a dummy variable that takes value one if the firm is mentioned in any of the over 250,000 global news sources covered by Meltwater during the six month period March 1 to August 31. This is measured for 2016 in panel A of Table 2.5, and for 2017 in panel B.

2. *Number of media mentions:* the number of times the firm is mentioned in any of the global news sources covered by Meltwater during the six month period March 1 to August 31. This is winsorized at the 99^{th} percentile to reduce the influence of outliers.

3. # *Facebook likes:* the number of likes for the firm's Facebook page, measured approximately 6 months and 18 months post intervention. This is recorded as zero for firms without Facebook pages (including firms that have closed down), and is winsorized at the 99^{th} percentile.

4. # *Twitter followers:* the number of followers the firm's twitter account has, measured approximately 6 months and 18 months post intervention. This is recorded as zero for firms without twitter profiles (including firms that have closed down), and is winsorized at the 99^{th} percentile.

5. *Media buzz index:* Standardized z-scores of each of the above four variables are obtained by subtracting their mean and dividing by their standard deviation (separately by time period). The media buzz index is then the mean of the standardized z-scores for any media mention, number of media mentions, # facebook likes, and # twitter followers.

2.C.4 Survey outcomes

1. *Firm survival*: this is a dummy variable coded as one if the firm is still operating (regardless of whether or not it has the original owners), and 0 otherwise.

2. *Interested in equity:* this is an average of standardized z-scores from the following variables:

    - *Interested in equity financing for the business:* a dummy variable which takes value one if the owners says they are interested in receiving new equity financing for the business.
    - *Maximum equity share willing to have held by outside investors:* this variable ranges from 0 to 100, and is the percent of equity the firm owner reports being willing to have held by an outside investor. It is coded as 100 for individuals who have sold their whole firm, and as the share of equity currently held by investors for those who are not interested in receiving new equity.

- *Have specific deal terms of offer outside investors:* this is a dummy variable, coded as one if the firm owner reports having specific deal terms (e.g. a draft term sheet) to offer outside investors, and zero otherwise. It is coded as zero for firms that have closed.
- *Would consider a royalty-based investment:* a dummy variable, coded as one if the firm owner reports willingness to consider a royalty-based investment, and zero otherwise. It is coded as zero for firms that have closed.

3. General investability: this is an average of standardized z-scores of the following variables:

   - *Number of employees in the company:* the number of employees in the company, coded as zero for firms that are closed, and winsorized at the 99^{th} percentile.
   - *Founder/co-founders work full-time in the company:* a dummy variable that takes value one if at least one of the founders works full-time in the company, and zero otherwise.
   - *Positive total sales for first quarter:* this is a dummy variable which takes value one if the firm made positive sales in the first quarter of 2016 (first follow-up survey), or in the first quarter of 2017 (second follow-up survey), and zero otherwise. It is coded as zero for firms that have closed.
   - *Total sales for first quarter of at least 10,000 euros:* a dummy variable which takes value one if the firm made sales of at least 10,000 euros in the first quarter of 2016 (first follow-up survey), or in the first quarter of 2017 (second follow-up survey), and zero otherwise. It is coded as zero for firms that have closed.
   - *Business made positive profit in last year:* a dummy variable which takes value one if the firm made a positive profit in 2015 (first follow-up survey) or in 2016 (second follow-up survey), and zero otherwise. It is coded as zero for firms that are closed.
   - *Sales made in Western Europe or U.S.:* a dummy variable which takes value one if the firm makes sales in European Union countries (excluding Croatia and Slovenia) or in the United States, and zero otherwise. It is coded as zero for firms that are closed.

4. *Meeting the specific needs of investors:* this is an average of standardized z-scores of the following variables:

   - *Accounts of the business are separated from those of the owners:* a dummy variable that takes value one if the business accounts are kept separately from those of the owner, and zero otherwise. It is coded as zero for closed firms.
   - *Revenue projection made for the next 12 months:* a dummy variable that takes value one if the firm has in place a revenue projection for the next 12 months, and zero otherwise. It is coded as zero for closed firms.
   - *Business knows customer acquisition costs:* a dummy variable that takes value one if the firm knows the cost of acquiring a customer, and zero otherwise. It is coded as zero for closed firms.

- *Number of key metrics (out of 11) being tracked:* the number of key metrics being tracked such as newsletter sign-ups, pre-orders, free user downloads, requests for samples or free trials, free pilot projects with customers, current active users, new sales leads per month, sales meetings per month, paid pilot projects with customers, paid customer sign-ups or paid downloads, and customer life-time value. This is coded as zero for closed firms.
- *Found out whether product or service can be covered by intellectual property protection:* a dummy variable that takes value one if the firm has found out whether their product or service can be covered by some form of intellectual property protection, and zero otherwise. This is coded as zero for closed firms.
- *Has at least one form of intellectual property protection or application pending:* A dummy variable that takes value one if the firm has, or has pending, a copyright, trademark, industrial design right, patent, or other form of IP protection, and zero otherwise. This is coded as zero for closed firms.

5. *Investment Steps:* this is an average of standardized z-scores of the following variables:

   - *Has contacted an outside investor to see if they are interested in making an investment:* A dummy variable taking the value one if, in the last year, the firm has contacted an outside investor to see if they are interested in making an investment, and zero otherwise. Firms that say they are not interested in investment and that do not answer this question are assumed to have not contacted an investor. Coded as zero for closed firms.
   - *Has made a pitch to outside investors outside of our program:* A dummy variable taking the value one if, in the past year, the firm made a pitch to outside investors at an event. Firms were explicitly asked to exclude pitches made during the semi-finals and finals of the Pioneers program. Firms that say they are not interested in outside investment are assumed not to have made a pitch. It is coded as zero otherwise, including if the firm is closed.
   - *Have a mentor or external export supporting them to obtain external financing:* a dummy variable that takes the value one if the firm has a mentor or external expert helping them to raise funding, and is zero otherwise, including if the firm is closed.
   - *Entered into negotiations with outside investor since August 2015:* a dummy variable which takes the value one if the firm has entered into negotiations with any outside investor since August 2015, and zero otherwise. It is coded as zero if the firm is closed. Firms which have been sold, or which have received outside equity investments, and which did not answer this question, are assumed to have entered into negotiations.

6. *External investment:* this is an average of standardized z-scores of the following variables[26]:

[26] Our pre-analysis plan also originally added a fifth variable to this index: total amount of outside investment received. However, after our first follow-up survey found firms were very reluctant to specify the exact amount of funding received, this question was dropped from the second follow-up survey, and so is not included in the overall index.

- *Taken on new debt since August 2015:* a dummy variable which takes value one if the firm has taken on new debt since August 2015, and zero otherwise. It is assumed to be zero for firms closed.
- *Have made a deal with an outside investor since August 2015:* a dummy variable which takes value one if the firm has made a deal with an outside investor (who is not family or friends) since August 2015, and zero otherwise. This takes value one if the firm has been sold, and zero if the firm has closed before being sold.
- *Received at least 25,000 euros in new outside investment since August 2015:* a dummy variable that takes value one if the firm has received at least 25,000 euros in outside investment since August 2015, and zero otherwise. It is set at zero for firms that have closed and not been sold for more than 25,000 euros.
- *Received incubator/accelerator grant since August 2015:* a dummy variable that takes the value one if the firm has received a grant from an incubator or accelerator since August 2015, and zero otherwise.

7. *Have made a deal with an outside investor since August 2015:* a dummy variable which takes value one if the firm has made a deal with an outside investor (who is not family or friends) since August 2015, and zero otherwise. This takes value one if the firm has been sold, and zero if the firm has closed before being sold. Note that this is also considered as part of the external investment index, but given its role as a summary statistic of whether investment readiness leads to new investment, is also considered as an outcome by itself.

2.D Appendix: Additional Details on Treatment Intervention

2.D.1 Selection of Content

The treatment group intervention was designed to reflect best international standards for investment readiness programs and guarantee quality of training and mentoring. One of the main concerns for us was to find an implementer having the capacity to train more than one hundred firms across five countries in the Western Balkans in a limited amount of time. This required the availability of a considerable quantity of mentors, both local and international, willing to travel to the region and with a wide-ranging background of skills in business development. We also needed to find a partner with demonstrated capacity on organizing internationally renowned pitch events, where small and nascent enterprises have the opportunity to pitch in front of international investors and opportunity to network their product and ideas, witness successful stories from established young entrepreneurs and the investors' community.

The selection procedure consisted in three phases: a call for an Expression of Interest (EOI), followed by submissions of Technical Proposals (TP) and a final phase where we made a comprehensive assessment of the technical proposals and their compatibility with the Terms of Reference (TOR). The first phase saw eight companies submitting their EOI. We selected five out of the nine companies that expressed their interest for the second phase: all of them shared a few characteristics like an international focus, and a team with experiences in the region and familiarity with the SMEs and VC eco-systems of the Western Balkans.

The World Bank team reviewed these technical proposals, and also sought an outside evaluation from Professor Josh Lerner and his team at the Bella Research Group. They have worldwide experience in assessing venture capital eco-systems and business accelerator programs. In addition, we referred to the expert opinion of country officials in the Western Balkan region, experts in the local national innovation agencies, familiar with the regional eco-systems and hence able to detect incongruences of the technical proposals with local conditions. The final overall assessments merged the feedbacks of these three main sources: it listed the positives and negatives of each proposal and identified specific questions to be submitted to the applicants in case there were aspects to investigate further. The final ranking that emerged from the series of consultations and assessments identified the Austrian company Pioneers JFDI GmbH as the best suitable candidate for the planned intervention.

Pioneers JFDI GmbH was the best candidate because of the experience of their team in the region and in providing small businesses personalized training and advice, the competences and logistical as well as human capital capacity to deliver a widespread training program across five countries. Prior to 2011, the Pioneers team was involved with STARTeurope, which offered the Startup Live events, a series of training workshops and pitch events. Pioneers' mentors have deep experience as venture-funded startups entrepreneurs and represent the countries of interest in the Western Balkan region and in addition Austria, Germany, Greece, Israel, Lithuania, Poland, Slovakia, Turkey, United Kingdom and the United States. Many of their mentors come through the Pioneers JFDI GmbH program already, so they already know the curriculum and thus do not need to be trained.

2.D.2 Treatment website

The treatment was operated under a separate brand to ensure separation and clearly communicate the difference between the "Pioneers of the Balkans" competition and the investment readiness program for the treated group. The "Startup Live Mini-Accelerator" provided a dedicated website that also provides a central point of access to all of the treatment resources. It was password-protected to ensure that only invitees (i.e., Treatment Group participants, mentors, the program management team and World Bank Group team members) could access it.

At the beginning of the program each beneficiary of the treated group was provided with a starter kit including a detailed booklet with instructions and description of all the four parts of the investment readiness program: qualification phase, mentoring phase, masterclasses, and pitch training; and details of the Pioneers team and their contact details.

2.D.3 WhatAVenture

WhatAVenture asks a simple set of question about the business in order to i) match the entrepreneur with the appropriate mentor ii) understand the phase of development and the preparation of the entrepreneur in order to tailor to each firm the subsequent individual mentoring phase, iii) bring the treatment group firms to a similar level of qualification before proceeding with individual mentoring in the second stage of the training period.

The application WhatAVenture and the methodology therein was developed and tested in the context of post-graduate studies at the University of Economics and Business in Vienna, in close collaboration with leading academics and practitioners

from the innovation and entrepreneurship field. It is an online interactive course for start-ups to put in words the details of their business idea, from the development of the business plan to marketing strategy and their financing needs.[27] The application is designed for self-paced progress along its steps. Once registered, startups assigned to the treatment group were granted access to the tool until 31 December 2015 independent of their progress or advancement. After completing each step, they had the opportunity to discuss their progress, findings and potential questions or difficulties in short online mentoring sessions (typically 30-45 minutes). The main questions addressed with the WhatAVenture application are:

1. Customer Exploration: the first step requires the team to answer questions on the targeted customers, to identify the customer segment and to customer needs related to their product
2. Solution: develop a solution to the problem and match it to the customers' needs
3. Business model – frame a sound business model around the value proposition of the company
4. Competitor analysis – Elaborate on the competitive advantage of the firm, organize an idea of marketing, sizing and competitive positioning
5. Market size: define the target size of the customer segment
6. Financials: quantify the costs and revenue structures, expected profitability and financing needs until break-even

In the first meetings of the WhatAVenture the mentor takes some time to ask questions and understand in detail the product the company plans to market and the possible value generation. This is important for providing a better mentorship in the successive acceleration phase.

2.D.4 Assignment to Mentors

In the qualification phase each company was assigned a lead mentor from the beginning who takes the role of a direct contact person for getting started in the mentoring program. The lead mentors support their mentees not only as their personal sparring partner during the qualification phase but also as primary contact person and advisor during the acceleration and pitch preparation phases. Match-making is conducted based either on relevant professional experience (e.g., an entrepreneur in the dairy industry might be assigned a lead mentor with an academic background in dairy product management), personal interests (e.g., a participating business active in the area of design might be assigned a lead mentor with a passion for sailing), technical expertise (e.g., a team that lacks even a basic online presence might be assigned a web-/graphics designer as a lead mentor) or proximity.

[27] Since the beginning of its external commercialization in 2014, the WhatAVenture has already been rolled out at several academic institutions as well as leading European corporates like Deutsche Telekom that use it for standardizing and professionalizing their intrapreneurship processes. Furthermore, several (corporate) accelerator programs like Bayer's Grants4Apps and two Austrian governmental equity financing and R& funding institutions (Austrian Federal Promotional Bank; Vienna Business Agency) have chosen the tool as their central application for tracking startups progress and coordinating mentoring sessions throughout their programs.

In addition, a "Mentors Catalogue" was distributed to each firm. It contains relevant biographical and professional information of the 100+ mentors forming the pool of regional and international experts from where the participants can draw in addition to the assigned lead mentors. The catalogue was sent to the treated group beneficiaries in the welcoming package just before the beginning of the program and they were provided with an internet interface where they have access to the network of dedicated mentors, and where they have the possibility to screen the qualifications and the field of expertise of the mentors through a short CV and contact them directly to book a mentoring session.

In total the treatment group could benefit from 141 mentors, who came from 26 different countries. Most of them live in Austria (43.3%) followed by Serbia (10.6%) and Germany (9.2%). They can be divided in four main groups: standard teachers and mentors (i.e. business consultants, university and business school professors), successful entrepreneurs (i.e. CEOs of their companies), successful young enterprise investors (e.g. business angel investors, venture capitalists etc), leading public speakers and pitch trainers. All of them cover a wide range of expertise and have at least three years of mentoring experience, while more about half of mentors have, individually, more than 10 years of experience in business mentoring. The majority having experience in business development and management in the IC& T industry; there are more technical mentors with a science background as software or hardware experts, payment systems and financial industry experts. Other industries were also covered, as for instance health care and pharmaceuticals, automotive and transportation, shipping and apparel sectors. All mentors have a good knowledge of business development, but a dedicated group of mentors was highly specialized in sales, marketing and e-commerce as well as intellectual property, competitive strategy and marketing. A smaller subset has experience in human resources, relationships and team building.

2.D.5 Acceleration phase

Upon successfully completing the qualification phase all beneficiaries are inducted into the acceleration phase. The individual mentoring sessions were scheduled on the online dedicated website to the program and were carried out either remotely via phone, video call[28] or on-site mentoring depending on the availability of mentors in the cities where the entrepreneur is located. It is important to note that among the pool of 100+ mentors many of them are internationals living and residing in the Western Balkan region, hence there was still the possibility to get international mentoring in English within the city of residence of the entrepreneurs. We ensured that every startup in the program gets some on-site mentoring exposure, partly also as an instrument to ensure their continued personal commitment to the program and to allow for the development of personal relationships beyond voice and video calls.

Average mentoring sessions typically lasted approximately 90 minutes and required additional work between sessions from the entrepreneur to improve the business proposal before the next session. In total we had more than 1800 hours of individual mentoring. Once a mentor submits his feedback to the central database, the information entered into the first part of the form is be forwarded via e-mail to

[28] Remote session were arranged between both parties to take place either via Skype or, especially for remote group mentoring hosted on our software solutions to provide video calls (e.g. WebEx).

the mentored entrepreneur, along with the request to likewise provide feedback to the mentor in question. This bidirectional feedback process not only serves the purpose of assessing mentees' satisfaction with the mentor and the benefit gained from a particular session, but also to validate the mentor's feedback and data entered by means of a counterparty review process.

Examples of the discussion in the acceleration phase were:

- Some companies were developing more products so needed advice on what would be best to focus on or whether to spin-off part of their business.
- Explore value proposition for different customer segments and how to structure it (i.e. B2B or B2C), how to implement it and what channels of communication to use. When necessary narrow down customer segment.
- Some firms needed a market validation - to take a prototype or mockup to target customers and test the outcomes.
- Formulating and analyzing the competitor's matrix, set up a market research plan to investigate competition in target markets.
- Identifying local partners for collaboration and regional expansion.
- Defining a clear pricing strategy for different markets (e.g Western Balkans, Europe, U.S. etc)
- For companies in a more advanced stage discussions on possible financing options for current expansions plans, the amount to be asked and the form of partnership.
- Discuss legal ways to achieve monetization: early-stage selling, licensing to interested parties worldwide for franchising etc.
- Making sure the startup product abides to and will operate according to existing regulations and the differences in regulations between the EU and the Western Balkans for limited liability partnerships and equity financing.
- Practice to present the company in 5 minutes and in an elevator pitch of 90 seconds; preparation for the questions time to understand what investors want, and working on telling a clear story.

2.D.6 Masterclass weekends

Additional training during the acceleration phase is delivered in from of classes and lectures, these take place during 2.5 days "masterclass weekends" organized in the participating countries. At the masterclass weekends general business education is taught, courses such as marketing, finances, team building, sales, competition as well as rhetoric, body language and design.

A dedicated website for masterclasses and the material was set up, the portal also offers information about and access to a dedicated community communication channel "ChatGrape" . This is an instant communication tool available as a browser-based application as well as native application for most mobile devices and allows for private as well as group communication in a structured way by allowing all users to set up and join subject-specific groups and to tag information and questions posted with key word expressions.

Masterclasses took place in the following four locations and dates:

- 9 to 11 October - Split, Croatia
- 16 to 18 October - Novi Sad, Serbia
- 23 to 25 October - Pristina, Kosovo
- 30 October to 1 November - Skopje, Macedonia

Each weekend had a main theme but were not exclusively dedicated to it with lectures, panels and presentations covering other topics as well. For example, the weekend in Split dealt with the business model, while the masterclass in Novi Sad with sales and marketing. The Pristina masterclass had the main lectures on team building and human resources while the Skopje weekend dealt with investment and finance. The final program of each masterclass weekend was set up at the end of September and published on the information portal so that beneficiaries can gather information and decide which masterclass weekends they want to attend. Before each masterclass the mentors and the beneficiaries are provided with a guide that helps them to understand the organizational structure of the weekend and the benefits of participating in the weekend. Some examples of the content of the masterclasses are described below.

The lecture on "Research and networking" introduced the importance of research and networking for the best business model. It explained the difference between a business model and a business plan, how to prepare an action plan and structure a business model canvas step by step. It urged entrepreneurs to think about the weakest points of their plans and possible solutions. It then touched upon the importance of customers, competition, sales, marketing, traction, business development and finances.

The class "Rapid Prototyping" described how to move from an idea to a market validated product. It explained the concept of rapid prototyping, the importance and the methods of prototyping and using examples from the cinema, cars and smartphone applications sectors. It then covered the concept of minimum viable product (MVP) and the need to frame business hypotheses on the market reaction to their product, the customers and financial hypotheses too. All of them should be tested in the market to get feedback and fine tune product development.

The team building panel addressed questions on how to create a team and what are the most important features a new company must develop in order to have the investors' attention. Two main things emerged: the first is that a successful enterprise has to form an eclectic and competent team encompassing all possible functions that a nascent company must have. The spectrum of functions proposed ranges from not only having a developer and an idea but also in having a good lawyer, a technician, a person familiar with the financing. But the most important of all seem to be having a very good member acting as a sales person. This figure should end up being most of the time the CTO of the company if not a co-founder because dedicated persons are really difficult to find, in those cases is the founder itself that must acquire sales skills and complement them with partners acting as supporters in this role. The importance of having a team with a wide-ranging expertise that complement each other turned out to be one of the best ways sending a positive message of confidence and investment readiness to the investors, a message saying that if you put the money in my company you are minimize the risk of wasting your money.

The traction presentation emphasized the importance of the three Ts: team, technology and traction. Traction because it is strictly linked with the term growth, with the importance of scaling up and having sustainable growth and having a "product-market fit" which is another way of saying that the product should be in line with the

demand coming from the market. However it was stated that one size does not fit all and there are no general rules, what works for one company is not always good for others, as well as a channel to gain traction today is not guaranteed that will work for the same company some time down the road. The focus shifted then to the need to update the targets, reset the objectives forward every time a target is reached. The channels to increase traction were also covered, 19 of those channels were mentioned and briefly explained (social and display ads, offline ads, email marketing, targeting blogs, direct sales, trade shows etc).

The presentation "The quantified startup" delved into trying to use data driven decision frameworks into strategic decision making of a startup. The presentation is directed mostly, but not exclusively, to web service providers, that is companies that can track their users online. What kind of metric are important to identify which stage your startup belongs at the moment, what metrics are important to scale up or increase traction? The presentation provided references of papers and books the presenter recommends to identify the metrics needed for every stage in the startup development. Measures such as churn, acceptance rate, viral coefficient, cost per user and similar were overviewed.

The presentation "How to sell to corporations" covered the topic of how to get access to established corporates for nascent startups. How to ally with them and exploit the market potential and value they have. One of the main point is that corporations, despite investing money in in-house accelerators and alliance partnership programs for startups, they do not really understand fully the value the startups that approach them have. So it is up to the startups to get ready for this kind of partnership, it is they that have to explain and convince the corporations of the value of their idea. The presenter described a process toward strategically thinking about approaching a corporation. How to convince corporations? Set the targets, find the best match, do your research, be well prepared, set our sales steps. An important aspect touched upon was that, once arranged a meeting you need to frame the meeting in order to get the idea convened, speak about concrete and clear things.

The lecture on B2B marketing saw a short introduction on the history of marketing. Some general information was given and the difference between the B2B and B2C marketing was explained. Introductions to new paradigms like the C2B and C2C was also described. The speaker explained processes of customer decision making and affiliation with a brand, with few examples from the most established companies and their marketing strategies. The importance of tradeshows for marketing was emphasized despite being an expensive option. But is one of the best way to get in touch with professional buyers informally.

The lecture on "EU funding" delved into the landscape of funding opportunities for startups and SMEs at the institutional EU level through EU structural funds for development. Information on different type of funding, the application process and the best way to approach these funding minimizing the load of work for the application. The need of a consultant for the application was also pushed forward as a good idea to develop these proposals and how much consultancy is needed.

The presentation "How to craft a pitch" as delivered in all four masterclasses and described how to structure the pitch and what to emphasize in it. The second part of the talk dealt with the 90 second elevator pitch. The emphasis for the 5 minute pitch was on seven main points to take into account: i) product/service what it is and explained it in detail to make the audience understand it, ii) market opportunity, what are the prospects, the vision and the demand for the product, iii) team, who are the main components of the team, what's their expertise and role, iv) competition, v) finances and cost structure, vi) development stage: where you are, at what stage,

what you need, vii) future, where you will be, or expect to be, in 6 months to a year.

2.D.7 Pitch preparation

The mentoring program transitions into the Pitch Preparation Phase after the last masterclass weekend. This phase is intended to ensure that all beneficiaries focus their attention entirely on their pitch performance in the remaining two weeks before their appearance on stage in front of jury members in the semi-finals pitch event.

In the course of this phase, a standard pitch training approach was implemented, this was developed and tested in the context of the annual Pioneers Festivals and consists of the following steps:

1. The entrepreneurs were asked to upload the pitch decks (tailored to a 5-minute on-stage presentation followed by another 5 minutes of questions and answers with the jury). This pitch deck is then made available to the lead mentor for initial review.
2. The entrepreneurs schedule a video call with their lead mentor to begin practicing the pitch together.
3. During the sessions, the entrepreneur delivers his/her pitch and receive feedback on both the oral pitch performance as well as the pitch deck.
4. Lead mentor and entrepreneur may schedule additional sessions bilaterally to review progress as the entrepreneur implements recommendations.
5. In parallel, the program management team assigns each entrepreneur two additional mentors, one it has worked with already and one new mentor.
6. Also these mentors are asked to schedule pitch training sessions with the entrepreneur and request the latest version of the pitch deck.
7. The program management team collects and reviews feedback protocols to assess the entrepreneurs' preparedness for their Semi-finals appearance.

The entrepreneurs were encouraged to use the time between sessions to work on their pitch decks and practice their oral delivery of the pitch further. Additionally, to this standard pitch training cycle and the live "dress rehearsal" on the day prior to their pitch in the Semi-finals, entrepreneurs can request further support from specialists on rhetoric, body language or slide deck design by approaching relevant mentors from the mentors' catalogue if needed, or upon recommendation by one of their pitch preparation mentors.

2.D.8 Detailed cost breakdown

The cost of offering the program is provided in Appendix Table 2-II

TABLE 2-II: Detailed Program Cost Breakdown

Investment readiness programs - Calculatory program cost

A. Individual mentoring	**Unit**	**Quantity**	**Rate [USD]**
1. Direct cost of individual mentoring	hours per beneficiary	30	1'917
2. Overhead cost per mentor	per beneficiary	1	326
3. Overhead cost of mentoring program	per beneficiary	1	492
4. Online mentoring tool	per beneficiary	1	338
Subtotal per beneficiary			***3'072***
B. Masterclasses			
1. Organization	per beneficiary	1	321
2. Venue & catering	per beneficiary	1	107
3. Lectures	per beneficiary	4	175
4. Travel and accomodation cost	per beneficiary	1	191
Subtotal per beneficiary			***793***
C. Pitch training			
1. Organization	per finalist	1	170
2. Venue & catering	per finalist	1	73
3. Pitch training	per finalist	1	279
4. Travel and accomodation cost	per finalist	1	168
Subtotal per finalist			***690***
Grand total per beneficiary			
A. Individual mentoring	per beneficiary	1	3'072
B. Masterclasses	per beneficiary	1	793
C. Pitch training	per beneficiary	0.33	230
			4'095
Grand total per investment readiness program			
A. Individual mentoring	Number of beneficiaries	150	460'865
B. Masterclasses	Number of masterclasses	4	118'932
C. Pitch training	Number of finalists	50	34'513
			614'310

2.E Additional Details on Control Intervention

2.E.1 Selection of Content

We organized the control group intervention design around a few simple guidelines: i) an online course, ii) relatively cheap or free to use, iii) offering general knowledge of simple investment readiness concepts and iv) providing e-guidance toward a start-up pitching competition. The World Bank team conducted market research together with Innovative Ventures Incorporated, a specialized investment advisor to international financial institutions and governments in private equity and venture capital funds. After this initial screening of available alternatives the decision was made to use a paid online course since the alternatives without fee did not offer the necessary quality standards. For the paid alternatives we carefully evaluated the contents and undertook the full demo versions to understand the specific differences among the candidate courses.

The program chosen is an e-learning course developed and distributed by the Global Commercialization Group (GCG) of the IC^2 Institute at the University of Texas at Austin. The group is an internationally active facilitator for growth of innovative and technology based businesses and it offers a wider range of technology commercialization training programs for managers around the world. The Innovation Readiness Series™ was created to bring the work of the Global Commercialization Group to a global customer base at a cheaper price vis-à-vis delivering training and international business development programs in-country. Since its launch in 2011, the Innovation Readiness Series™ has trained more than two thousand entrepreneurs and students from 20 countries worldwide. The content can be offered in three different languages: English, Spanish or Russian. For the Pioneers of the Balkans cohort we opted for the English based course.

2.E.2 Course details and content

The program introduces students to common terminology used in the start-up ecosystem, and the requirements to commercialize innovations, including protecting intellectual property, describing an innovation and the benefits it provides (vs. features), navigating development, understanding competition (substitutes and direct competitive products), market validation, creating a 'pitch' and presenting to investors, customers and others.

This content is delivered online through 10 modules of 45-60 minutes each. The modules have a set of slides that are read and explained via a recorded voice. Each module has detailed steps to work through for creating a business proposition and includes assignments in two formats: quizzes with multiple-choice answers beneficiaries can take to test their understanding of the material, and in the case of some of the ten modules (i.e. technology brief and description, benefits, competition and presentation skills) written exercises to be voluntarily handed in. Finally, in the last module there is the possibility to record and upload a video sample of the planned pitch. Nevertheless, for the Pioneers of the Balkans cohort the program was customized to allow feedback only after the multiple choice quizzes in form of number of correct answers. Written exercise and the video of the pitch were voluntarily uploaded on the platform but were not commented or discussed with the participant.

While this program is not a substitute to one-on-one mentoring, it gives a basic introduction to business planning and pitching, is well-structured and cheap alternative to a mentorship based investment readiness program, it is comprehensive and

allows beneficiaries to create a sketch of business model which can be presented to investors, customers and other interested parties. Moreover, it is a self-learning tool, beneficiaries can work at their own pace, the ten module series introduces the key concepts of innovation, and explores each of the primary issues that impact bringing a technology to the market allowing for a self-paced learning environment.

In terms of curricular incentives, at the completion of all the modules, beneficiaries who answer correctly at least 70% of quiz questions and take active part in all of them, receive a certification of Investment Readiness from IC2 Institute at the Texas University through the World Bank Group program "Pioneers of the Balkans" .

The list of the ten modules and short description of the content is provided.

Module 1 – Introduction: the introduction module explains how the Innovation Readiness Series works, and the objectives for the course. It explains what commercialization is, and helps distinguish between innovation and invention.

- Module 1 – Introduction: the introduction module explains how the Innovation Readiness Series works, and the objectives for the course. It explains what commercialization is, and helps distinguish between innovation and invention.
- Module 2 - Technical Description: the technology description module helps participants describe their innovation using technical jargon and key words.
- Module 3 – Benefits: the benefits module teaches how to articulate the benefits of an innovation in a way that conveys value to customers and users.
- Module 4 - Development Status: the development status module delivers an overview of the product development cycle with an eye to the market.
- Module 5 - Intellectual Property, Part 1: explains what IP is, the different types of ownership, and what can be protected. It also explains Trademarks and Copyrights.
- Module 6 - Intellectual Property, Part 2: the focus is on Patents and Trade Secrets, and provides a foundation to designing an individual IP strategy.
- Module 7 – Competition: the competition module will help the participant discover and compare key benefits to those of the competition.
- Module 8 - Market Validation: the market validation module explains the validation process and how to discover exactly what the market expects from an innovation.
- Module 9 - Pitching Your Innovation: the planning and pitching module helps prepare a technology brief of the innovation and can be used in the next steps to commercialization.
- Module 10 - Presentation Skills: the presentation module is taught by an internationally established and experienced public speaker, demonstrates how to deliver presentations in an effective and captivating way.

Depending on the previous experience of the participant and their commitment to hand in a written set of answers, a minimum of four weeks is recommended to deliver a basic course and the total envisioned time to complete the course lectures, answer the quizzes and compile the written exercises is 15-30 hours. However, recall

that among the set of assignments only the quizzes after each session were graded and participants receive feedback on the number of correct answers. In case of written exercises and uploaded pitch video no feedback was offered so that the only incentive in that case was self-motivation. Moreover only quizzes counted toward the receipt of the final completion certificate, given this incentive structure we expect a lower usage of the written exercises and video pitch uploads than multiple-choice quizzes.

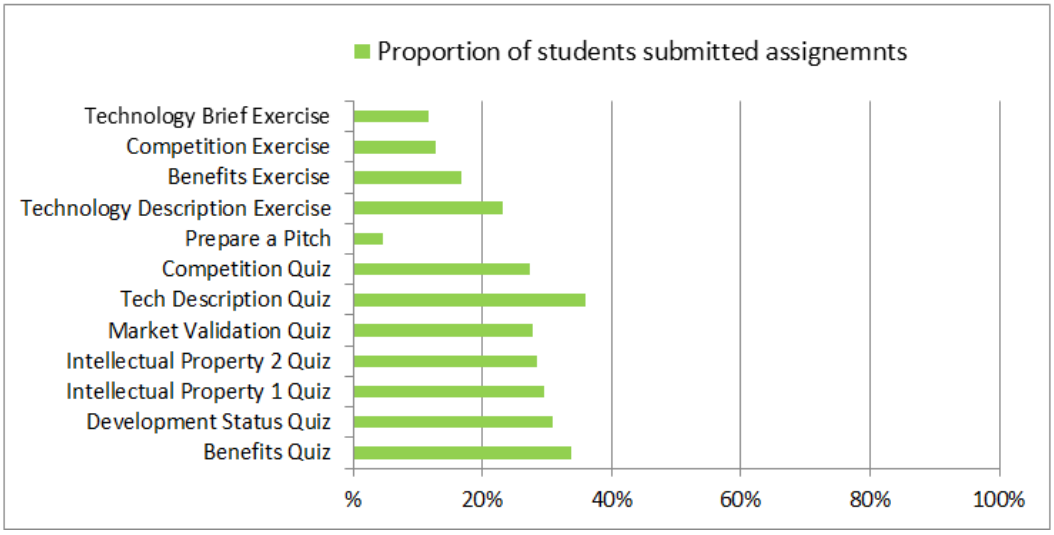
2.E.3 Communication and Reminders

During the deployment of the intervention our team sent weekly motivational announcements to the students on the platform and on their email address, the aim of the announcements was to promote learning and active participation. They were structured as progress reports where we showed the top ten performing firms in the last week in terms of correct answers in submitted quizzes, and explained the reasons why it is important to take part in the course. Firms were told that going through the modules would both help provide matching of their businesses with judges who had sectoral expertise in their business, and that going through the contents of the modules would likely increase their chances of getting a higher score in the semi-finals and getting selected for the finals.

2.E.4 Usage

Appendix Figure 2-I summarizes the proportion of students that submitted assignments (either quizzes or written exercises), each bar corresponds to an assignment. Out of the 120 participants that connected at least once to the online platform, 63 (36.6% of the total) actively participated in one of the quizzes, with 45 of them completing the threshold of 70% correct answers. For the non-graded written exercises, the technology description was completed by 40 participants, the technology brief by 20, benefits exercise by 29 and the competition exercise by 22 participants. Lastly, only 8 students uploaded a video of their pitch.

FIGURE 2-I: Participation of the Control Group in Online Course Content



2.E.5 Satisfaction

A short survey was administered after the semi-finals to assess their satisfaction with different elements of the program. Respondents are therefore only the entrepreneurs that participated in the semi-finals. The survey was answered by 102 treated group firms (92.7% of the treated semifinalists) and 87 control group (86.1% of control semi-finalists). Appendix Table 2-III compares the overall satisfaction of the treated and control group semifinalists over few dimensions on a scale from 1 to 6. The treated group values more the communication, the structure and design and the training materials provided, the difference is statistically significant. However, the mean grade given by the control group to those dimension is well above 4. Recall that firms were blind to treatment assignment. Where there is no significant satisfaction difference between the treated and control group is in the feedback received from the jury at the semifinals and the organization of the semifinals. These features were common to both groups. As such, the satisfaction survey indicates the value added of the treatment also in the subjective assessment of the program by participants.

TABLE 2-III: Treated vs. Control Satisfaction survey – How satisfied are you with each of the following?

Dimension	Treatment Obs.	Mean	Std. dev.	Control Obs.	Mean	Std. dev.	p-value
Communication overall	**102**	5.17	.95	**87**	4.55	1.44	0.014
Structure and Design of PotB	**101**	5.00	1.14	**86**	4.43	1.26	0.005
Training Resources	**102**	5.31	1.02	**84**	4.36	1.25	0.000
Jury Feedback	**101**	4.45	1.43	**86**	4.11	1.68	0.486
Semi-Finals (Belgrade Venture Forum)	**101**	4.45	1.42	**83**	4.34	1.36	0.861

Note: PotB denotes Pioneers of the Balkans program

2.F Appendix: Additional Details on Semi-Finals and Finals

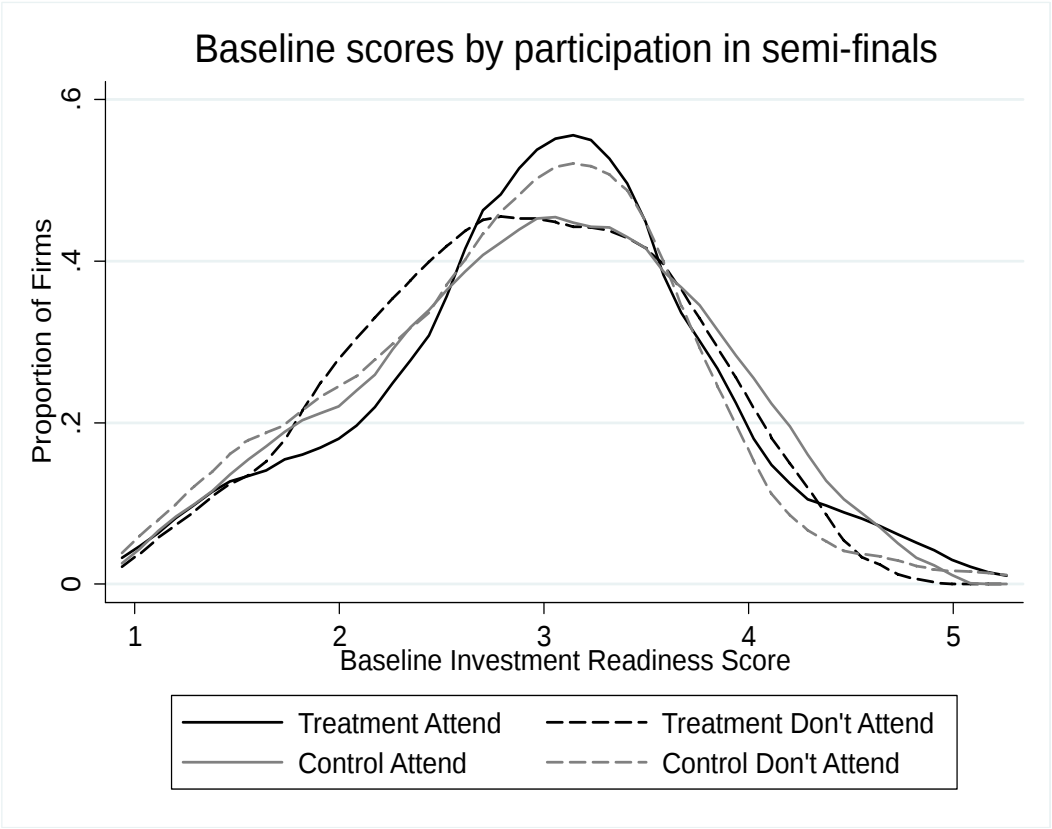
Appendix Table 2-IV summarizes the characteristics of judges used for the scoring

TABLE 2-IV: Semi-Final Judges Characteristics

	Mean	Std. Dev.
Lives in the Western Balkans	0.37	0.49
Lives in European Union (except Croatia)	0.48	0.50
Male	0.88	0.33
Age	39.1	10.4
Has Founded a Company	0.75	0.43
Years of Experience in their industry	11.5	8.5
Company makes venture investments	0.64	0.48
Is an Angel Investor	0.37	0.49
Regularly Mentors Start-ups	0.80	0.40
Sample Size	**65**	

Note: data unavailable for one judge.

FIGURE 2-II: Baseline Investment Readiness Scores by Participation in the Semi-finals and Treatment Status



Appendix Figure 2-II shows that the baseline distribution of investment readiness scores is similar for those that participated in the semi-finals (and therefore received judges' scores) and those that did not.

2.F.1 Robustness to Non-participation

Our pre-analysis plan specified two approaches to examining the robustness of our results to the attrition that results from not all participants attending the semi-finals, and therefore not having judges' scores for all firms.

The first approach is to impute investment scores for firms which did not participate in the finals. We pre-specified that we would do this by estimating the following equation on the control group sample who participated in the semi-finals:

$$\begin{aligned} OverallScore_i = a &+ bBaselineTeamScore_i + cBaselineMarketScore_i \\ &+ dBaselineProductScore_i + eBaselineTractionScore_i \\ &+ fCroatia_i + gSerbia_i + hBaselineOutsidePrivateInvestor_i + \varepsilon_i \end{aligned} \tag{2.3}$$

This yields a prediction of the semi-finals investment readiness score as a function of the baseline scores on the different components, the country of operation, and whether or not they had an outside private investor at baseline. We replace missing scores for both treatment and control with these predicted values and re-estimate equation (1). The first column of Appendix Table 2-V repeats our estimated impact on the overall score from Table 2.3, which assumes scores are missing-at-random. Column 2 then shows the impact on the score after imputing missing values. The impact is still positive and statistically significant, with an estimated effect of 0.19 points.

The second approach is to compare the participation rates of treatment and control and use Lee, 2009 bounds to adjust for differential attrition. The participation rate in the semi-finals was 63.2 percent for the treatment group, and 58.7 percent for the control group. The difference of 4.5 percent is not statistically significant (p=0.39, or 0.37 after controlling for strata fixed effects). Nevertheless, we test sensitivity to this difference in attrition rates by dropping the top or bottom eight (4.5% of 174) scores from the treatment group. The next two columns of Appendix Table 2-V then show the Lee upper and lower bounds respectively are 0.41 and 0.18. Since Table 2.3 and Appendix Figure 2-II shows that the differential attrition is not coming from the tails of the baseline investment readiness score distribution, we think it highly unlikely that it would be coming from either tail of the follow-up distribution either.

As a final robustness check, we show in the last two columns of Appendix Table 2-V that our results are not sensitive to how we aggregate the different sub-scores. Column 5 aggregates the five sub-scores using equal weights instead of the different weights in our main specification, while Column 6 also includes the presentation score. We see the estimated effects of 0.277 and 0.293 are very similar in sign, significance, and magnitude to those using the unequal weights.

Taken together, these results show that the impact of treatment on the investment readiness score is unlikely to be driven by differential participation patterns in the semi-finals between the treatment and control groups, nor by the weighting, and so our finding that the investment readiness program has improved investment readiness is robust.

TABLE 2-V: Robustness of Impact on Investment Readiness to Attrition and to how Scores are Weighted

		Imputed	Lee	Lee	Equally weighted	
	Score	Score	Upper	Lower	5 components	6 components
Assigned to Treatment	0.284**	0.193***	0.408***	0.176	0.277**	0.293**
	(0.126)	(0.065)	(0.119)	(0.130)	(0.123)	(0.124)
Sample Size	211	343	203	203	211	211
Control Mean	2.908	2.865	2.908	2.908	2.950	2.966
Control Std. Dev	0.903	0.750	0.903	0.903	0.884	0.894

Notes:
Robust standard errors in parentheses. Regressions control for randomization strata.
*, **, *** indicate significance at the 10,5, and 1 percent levels respectively
Score is the investment readiness score in the semi-finals. Imputed score imputes missing scores based on regressing the score for the control group on baseline team, traction, market readiness, product technology, country, and having an outside investor and using predicted score for missing observations. Lee upper and Lee lower bounds trim the bottom 8 and top 8 scores respectively from the treatment group to adjust for higher attrition in the control group. Equally weighted scores weight the five (team, technology, traction, market and progress) or six (also presentation) sub-scores equally.

2.G Appendix: Impact on Web Traffic and on being included in AngelList

Our pre-analysis plan also noted that we would consider several measures of web traffic and web presence that have been used by other researchers (e.g. Kerr, Lerner, and Schoar, 2011, Gonzalez-Uribe and Leatherbee, 2017, but which may be less appropriate for firms in a less developed market: whether or not the firm is included in AngelList, a popular web platform for fundraising, startup jobs and investing allowing startups to raise capital from angel investors; and the global web-traffic rankings of the company's webpage as collected by Alexa and SimilarWeb. We see no significant impacts on any of these measures.

TABLE 2-VI: Impacts on Web Traffic and AngelList

	Appears on Angel List	Has Alexa Rank	Alexa Global Ranking	Has Similar Rank	Similar Web Ranking
Panel A: Impact at Six Months					
Assigned to Treatment	-0.022	-0.042	-304.7	0.013	447.5
	(0.035)	(0.043)	(1412)	(0.047)	(2068)
Sample Size	346	346	188	346	160
Control Mean	0.308	0.535	11161	0.442	12364
Control S.D.	0.463	0.500	8383	0.498	9434
Panel B: Impact at Eighteen months					
Assigned to Treatment	-0.034	0.032	120.6	-0.008	1952.4
	(0.041)	(0.048)	(1438)	(0.048)	(1945)
Sample Size	346	346	132	346	156
Control Mean	0.372	0.343	7407	0.442	12614
Control S.D.	0.485	0.476	5431	0.498	9949

Notes:
Robust standard errors in parentheses. *, **, and *** denote significance at the 10, 5, and 1 percent levels respectively.
All regressions include controls for baseline level of outcome, and for strata used in randomization.
Alexa Global ranking and Similar Web ranking are expressed in 1000s, and are conditional on having a ranking at all.

2.H Appendix: Follow-up Survey Response Rates and balance on responders

Appendix Table 2-VII reports the completion rates by treatment status for three definitions of completion. Initially we began with a longer follow-up survey, which in addition to asking about our key outcomes, also asked a series of process questions about the Pioneers of the Balkans program and their reasons for participating or not participating. In order to encourage responses from more reluctant firms, we removed these questions to shorten the questionnaire for a second interviewing phase, with the short survey containing all the key outcomes in our pre-analysis plan. Finally, for firms that we could not interview after multiple attempts, we attempted to collect basic information in a few minutes from them, asking for their current operating status, their number of employees, whether they had entered into negotiations with an outside investor to make an investment in their firm since August 2015, and how much new investment they had received since August 2015. In the second follow-up, this basic information was restricted to whether the firm was still operating, and whether it has received external financing, and also used web searches and secondary contacts.

We see that the treatment group was more likely to respond to the full survey than the control group in the first follow-up survey (p=0.066), but there is no significant difference in response rates for having at least the short survey, or at least basic information, and no significant treatment differences for the second follow-up.

TABLE 2-VII: Follow-up Survey Completion Rates

	Overall	Treatment	Control	p-value
First Follow-up Survey				
Completed Full Survey	0.65	0.70	0.60	0.066
Completed at least Short Survey	0.79	0.80	0.78	0.781
At least basic information	0.92	0.93	0.91	0.520
Second Follow-up Survey				
Completed Full Survey	0.64	0.66	0.62	0.282
Completed at least Short Survey	0.85	0.86	0.84	0.504
At least basic information	0.95	0.95	0.94	0.873
Sample Size	346	174	172	

Note: p-value is for test of equality of treatment and control completion rates after controlling for randomization strata.
At least basic information denotes that information on whether the firm is operating and whether it has received external financing is available.

Appendix Table 2-VII compares baseline observables for the treatment and control groups, conditional on completing at least the short survey. We cannot reject that these observables are orthogonal to treatment status for either definition of survey completion. Given the lack of significant difference in response rates by treatment status, and that the sample responding to at least the short survey is balanced on observables, we treat attrition as missing at random in our analysis of the survey data.

TABLE 2-VIII: Balance test on Sample Interviewed at Folow-up

	Answered First Follow-up			Answered Second Follow-up		
	Treatment	Control	P-value	Treatment	Control	P-value
Variables stratified on						
Incorporated/Registered in Croatia	0.230	0.237	0.869	0.27	0.24	0.623
Incorporated/Registered in Serbia	0.446	0.481	0.619	0.48	0.50	0.637
Baseline Readiness Score	2.997	2.899	0.183	2.93	2.94	0.163
Has an outside private investor	0.122	0.067	0.145	0.10	0.10	0.227
Other variables						
Market attractiveness score	3.112	3.062	0.885	3.06	3.09	0.657
Product technology score	2.485	2.419	0.649	2.44	2.48	0.872
Traction score	3.433	3.233	0.818	3.32	3.17	0.135
Team score	3.090	3.008	0.971	3.00	3.11	0.630
Sector is business and productivity	0.460	0.393	0.435	0.47	0.38	0.172
Sector is lifestyle and entertainment	0.187	0.230	0.516	0.19	0.23	0.428
Uses Cloud Technology	0.201	0.252	0.617	0.19	0.26	0.187
Uses Big Data	0.187	0.222	0.959	0.19	0.24	0.186
Place in value chain is developer	0.647	0.533	0.056	0.63	0.57	0.270
Place in value chain is service provider	0.568	0.533	0.479	0.59	0.56	0.482
Age of firm (years)	2.712	2.622	0.445	2.55	2.50	0.951
Early stage firm	0.331	0.304	0.475	0.32	0.37	0.464
Revenues in 2014	197649	157401	0.955	181796	127478	0.630
Number of employees	6.856	5.467	0.341	6.08	5.35	0.218
Age of main founder	38.216	36.563	0.222	38.02	37.19	0.433
Main founder has post-graduate education	0.525	0.496	0.934	0.50	0.50	0.770
At least one founder is female	0.137	0.222	0.066	0.15	0.22	0.063
Company has a global focus	0.583	0.578	0.850	0.59	0.60	0.815
Have accepted outside financing	0.374	0.348	0.559	0.35	0.39	0.614
Previously in mentoring/accelerator program	0.173	0.178	0.535	0.16	0.17	0.905
Sample Size	139	135		150	144	
Joint test of orthogonality of treatment p-value			0.417			0.167

Note: interviewed at follow-up denote that firm completed at least the short survey

2.I Appendix: Treatment Effects on Individual Survey Outcomes

Appendix Tables 2-IX, 2-X, 2-XI, 2-XII and 2-XIII report the treatment impacts estimated on each of the individual outcomes that make up the aggregate indices presented in Table 2.7. Our main approach to multiple testing is to use the standardized indices of z-scores, which are contained in Table 2.7, and are presented again at the end of each table. Alternatively, since there are 25 outcomes presented in these appendix tables for each time period, using Holm's (1979) step-down method gives an adjusted p-value for the most significant of the individual outcomes (the employment effect in round 2) of 0.425. Thus none of the coefficients shown in these tables are individually significant after adjustments for multiple testing.

TABLE 2-IX: Treatment Impacts on Willingness and Interest in Taking on Equity investment

	Interested in equity investment	Maximum equity share	Has specific deal terms	Would consider Royalties	Aggregate Index
Panel A: Impact at Six Months					
Assigned to Treatment	-0.019	3.920	0.001	0.025	0.051
	(0.066)	(3.169)	(0.061)	(0.065)	(0.094)
Sample Size	278	264	271	268	278
Control Mean	0.603	23.155	0.331	0.508	-0.015
Control S.D.	0.491	23.439	0.472	0.502	0.764
Panel B: Impact at Two Years					
Assigned to Treatment	-0.034	-2.175	0.050	0.105*	0.032
	(0.055)	(2.972)	(0.051)	(0.056)	(0.084)
Sample Size	309	285	309	303	309
Control Mean	0.575	25.066	0.242	0.487	-0.005
Control S.D.	0.496	26.591	0.430	0.501	0.783

TABLE 2-X: Impacts on General Investability

	Number Employees	Founder full-time	Positive Revenue	Revenue >10,000 euros	Positive Profit	Sales US/Europe	Aggregate Index
Panel A: Impact at Six Months							
Assigned to Treatment	1.100	0.061	0.008	0.035	-0.061	-0.019	0.026
	(1.215)	(0.052)	(0.061)	(0.068)	(0.059)	(0.060)	(0.085)
Sample Size	318	269	277	277	272	265	277
Control Mean	6.111	0.750	0.699	0.353	0.289	0.386	-0.039
Control S.D.	10.596	0.435	0.461	0.480	0.455	0.489	0.634
Panel B: Impact at Two Years							
Assigned to Treatment	4.554**	0.018	0.032	-0.017	0.085	0.051	0.089
	(1.814)	(0.061)	(0.071)	(0.068)	(0.061)	(0.055)	(0.082)
Sample Size	291	291	232	242	276	310	291
Control Mean	4.683	0.620	0.526	0.361	0.482	0.340	-0.058
Control S.D.	6.381	0.487	0.502	0.482	0.502	0.475	0.650

TABLE 2-XI: Impacts on Meeting the Specific needs of Investors

	Separates Accounts	Has revenue projection	Knows customer acquisition cost	Number key metrics tracked	Found out if can protect IP	Has IP or pending	Aggregate Index
Panel A: Impact at Six Months							
Assigned to Treatment	0.060	0.066	0.009	-0.168	0.033	0.054	0.082
	(0.053)	(0.066)	(0.064)	(0.299)	(0.065)	(0.061)	(0.080)
Sample Size	268	268	268	268	269	269	269
Control Mean	0.742	0.561	0.409	2.106	0.439	0.364	-0.059
Control S.D.	0.439	0.498	0.494	2.598	0.498	0.483	0.682
Panel B: Impact at Two Years							
Assigned to Treatment	0.086	0.018	0.061	-0.092	0.059	0.049	0.084
	(0.060)	(0.061)	(0.059)	(0.361)	(0.063)	(0.057)	(0.079)
Sample Size	291	291	291	269	271	275	298
Control Mean	0.577	0.486	0.352	1.667	0.444	0.244	-0.059
Control S.D.	0.496	0.502	0.479	2.854	0.499	0.431	0.692

TABLE 2-XII: Impacts on Steps Towards Investment

	Contacted outside investor	Made a pitch	Has mentor helping raise finance	Entered into negotiations	Aggregate Index
Panel A: Impact at Six Months					
Assigned to Treatment	-0.082	0.016	0.078	-0.008	-0.017
	(0.074)	(0.068)	(0.063)	(0.057)	(0.098)
Sample Size	239	240	232	279	240
Control Mean	0.509	0.549	0.236	0.323	0.008
Control S.D.	0.502	0.500	0.427	0.470	0.720
Panel B: Impact at Two Years					
Assigned to Treatment	-0.019	0.006	0.050	0.068	0.044
	(0.057)	(0.047)	(0.040)	(0.059)	(0.092)
Sample Size	282	282	279	279	282
Control Mean	0.324	0.184	0.097	0.328	-0.032
Control S.D.	0.470	0.389	0.297	0.471	0.760

TABLE 2-XIII: Impact on External Investment

	Taken on new debt	Made deal with investor	Received at least 25,000	Amount of new investment received	Received incubator grant	Aggregate index
Panel A: Impact at Six Months						
Assigned to Treatment	-0.118**	-0.024	-0.032	-11232*	-0.036	-0.152*
	(0.057)	(0.033)	(0.028)	(6425.486)	(0.037)	(0.087)
Sample Size	276	279	277	277	269	279
Control Mean	0.419	0.083	0.068	13452.273	0.090	0.084
Control S.D.	0.495	0.276	0.253	62358.927	0.288	0.741
Panel B: Impact at Two Years						
Assigned to Treatment	-0.059	0.050	-0.024	n.m.	-0.005	0.003
	(0.048)	(0.049)	(0.041)		(0.036)	(0.080)
Sample Size	278	330	317		268	330
Control Mean	0.182	0.244	0.168		0.076	0.018
Control S.D.	0.388	0.431	0.375		0.267	0.698

Note: n.m. denotes not measured in this survey round.

Chapter 3

Has Regulatory Capital Made Banks Safer?

3.1 Introduction

One of the primary objectives of central banks is to foster the stability of the banking system. Capital requirements are in general used to increase banks' resilience by requiring them to hold more capital, thereby improving loss absorption capacity during financial downturns. The policymakers' rationale for demanding more capital is to increase the skin in the game of bank equity holders, limiting risk taking behaviour while at the same time reducing the probability of insolvency and the cost of bank failure for taxpayers.

Theoretical contributions on the skin in the game argument postulate that for banks with higher capital ratios, there is an incentive by bank managers to avoid excessive risk-taking. This is because more risk increases the variance of returns which in turn can amplify the probability of significant losses on banks' equity, (Hellmann, Murdock, and Stiglitz, 2000; Repullo and Suarez, 2004; Repullo, 2004).

At the same time, banks might increase their asset risk in response to higher capital requirements, possibly overcompensating the positive effect of the higher capital buffer. A strand of academic research argues that better capitalized banks are not necessarily taking on less risks.[1] For instance, the principal-agent theory shows how the presence of imperfect information, which is endemic in complex organizations such as banks, can manifest itself in moral hazard associated with the existence of distorted incentives between the principal and the agent.[2] Similarly, empirical banking literature shows how more regulated banks can have risk-taking incentives due to the negative effect of higher capital requirements on bank profits, (Koehn and

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[1]In this paper, risk-taking behaviour is intended as exposure risk of the portfolio of banks' assets, measured as the ratio of risk-weighted assets over total assets.

[2]Several strands of literature have shown the consequences of the principal-agent asymmetric information problem. Academic contributions range from the fields of economics Stiglitz and Weiss, 1981, finance Acharya and Naqvi, 2012, managerial Wiseman and Gomez-Mejia, 1998, corporate finance (Ross, 1973; Bolton, Mehran, and Shapiro, 2015) to law and banking regulation Alexander, 2006. This literature illustrates how within a principal-agent relationship the presence of incomplete information and misaligned incentives can induce managers to take on excessive risk and how regulation can help to limit this inefficiency.

Santomero, 1980; Kim and Santomero, 1988; Blum, 1999). This divergence of views raises the question as to whether and how banks' risk taking behaviour is affected by increases in regulatory capital requirements.

This paper sheds light on this question by exploiting a policy change whereby systemically important European banks were subject to variations in macroprudential capital requirements imposed by the regulator. In spirit, the study is closely related to the earlier empirical studies on risk-taking and risk sensitive capital requirements such as Shrieves and Dahl, 1992 or Jacques and Nigro, 1997. The present study contributes to this literature by using an exogenous policy shock as a source of variation to bank capital requirements for the identification of the causal response.

The econometric specification relies on a panel of bank-level balance sheet data and a regression difference-in-difference design. A cross-country bank-level panel controls for time varying macroeconomic variation absorbed by country-time dummies, and, in contrast to single country bank-level studies, can increase the external validity of the results. At the same time, in comparison to country-level panels, it improves on the granularity of available data fostering the study of heterogeneous effects. More specifically, the use of the granular bank-level database allows to measure banks' interconnectedness with the financial system through interbank lending and OTC derivatives. This is an essential feature for delivering unbiased estimates since the calibration of capital requirements is a function of banks' interconnectedness and complexity. In addition, a bank-level panel allows to control for the quantitative-easing channel of non-conventional monetary policy which may influence banks ability to raise capital and hence solvency by providing a more stable source of funding. This is controlled for by including cash held at Central Banks. Finally, this study provides a detailed account for heterogeneity in terms of size, profitability, and funding sources.

Starting in 2014, the newly introduced macroprudential capital requirements have been gradually phased-in across the 28 European Union (EU) countries. They apply to parents and subsidiaries of systemically important banks.[3] The focus on systemic banks is important due to financial stability concerns. EU macroprudential regulation empowers national authorities to set *individual* bank-level capital requirements for systemic risk, these are introduced at different times across EU countries. The staggered policy implementation across borders and time fosters the opportunity for a research design based on a quasi-experiment. Nevertheless, threats to the identification of causal effects may arise from several sources, in particular the following assumptions must hold: i) banks do not anticipate the change, i.e. the common trend assumption is not violated, ii) the policy change is exogenous, ii) there are no spillovers across borders.

The failure of the common trend assumption due to anticipating behavior by control group banks is a standard threat for the identification. Section 3.7 discusses those threats and presents several robustness tests.[4] The first test of the common trend assumption controls for bank-level trends in the regression as in Wolfers (2006), the second inspects the existence of anticipatory behaviour which would invalidate the

[3] As of 2017Q3, Global and Other Systemically Important Banks (G-SIBs and O-SIBs) in the EU are 204 financial credit institutions. They represent 86% of total consolidated assets of EU banks in 2016 according to consolidated balance sheet statistics, see ECB source. The sample composition of SIBs may vary from year to year due to new banks being designated as O-SIB, or old banks not satisfying any more the requirements to be designated as O-SIBs. See European Banking Authority Guidelines on O-SIB.

[4] Two standard tests of the common trend assumption and an additional test of the anticipation behavior stemming from announcement effects.

common trend assumption. The third test investigates the presence of announcement effects of the policy and is akin to Alpert, 2016. All of them present robust evidence on the absence of diverging pre-treatment effects across the treated and the control group.

The exogeneity of the policy change may not be warranted because capital requirements are introduced for each bank individually by its own macroprudential authority and are not centralised at EU level. This leaves discretion to national regulators and could cause the introduction of these requirements to be endogenous if the Member State behaves strategically and wants to protect (weaker) domestic banks. The paper investigates this possibility in Section 3.8 without finding evidence supporting endogenous behavior. In fact, several provisions enshrined in EU banking regulation are specifically aimed at eliminating national biases with respect to macroprudential risks.

The first provision establishes that four different EU institutions are overseeing the implementation of macroprudential buffers across the EU, namely the European Systemic Risk Board (ESRB), the EU Commission, the EBA and the ECB.[5] Second, the ESRB ha the mandate to identify and monitor systemic risk in the EU. To preserve financial stability, the ESRB can issue public *warnings* and *recommendations* to Member States where identified systemic risks are deemed to be significant and not addressed. Moreover, the ESRB can issue confidential warnings to the Heads of States in the EU Council and must monitor their follow-up.[6] Third, the ECB has top-up power for Euro Area banks, this guarantees that there is no inaction bias toward strategically important domestic banks since the ECB can apply higher macroprudential capital requirement than the one established at national level.[7] With a further aim of fostering consistency, the ECB has also developed a framework to provide a minimum common floor when calibrating systemic capital requirements applied at the national level.[8] Fourth, any measure requires the approval of the ECB Governing Council, and acting on a proposal by the EU Commission, the EU Council of ministries has the power to reject the proposed national macroprudential measure. This provision guarantees that foreign subsidiaries are treated fairly and equally without being affected by protectionist measures.[9]

The validity of the research method could be further questioned if large banks shift their assets across borders to branches or subsidiaries in order to conduct regulatory arbitrage. In this case, the existence of spillover effects may produce biased estimates. However, also this concern is addressed within the regulatory framework which envisages the possibility of reciprocation. This grants the power to a Member State to request a countervailing capital increase to foreign branches, or directly across borders when risks of spillover are deemed significant. Reciprocation should ultimately ensure the reduction of the incentive to search for regulatory

[5]See fot instance, Article 131(7) of the Capital requirements Directive IV (CRDIV) which states that before setting or resetting an O-SIB buffer, the competent authority shall notify the Commission, the ESRB, EBA, and the competent microprudential supervisors of the Member States concerned one month before the publication of the decision.

[6]For more information on ESRB's tasks and powers see the related ESRB regulation.

[7]For the ECB top-up power and the scrutiny of the ECB on national macroprudential measures see Articles 5(1) and 5(2) of the Single Supervisory Mechanism Regulation.

[8]See ECB floor methodology for setting the capital buffer for an identified Other Systemically Important Institution (O-SII). By providing a minimum floor, the ECB reduces national discretion in calibration of the capital instrument and provides the basis of a discussion between the ECB and national authorities on the overall assessment of the appropriateness of a macroprudential stance.

[9]This is in accordance with Article 291 of the Treaty on the Functioning of the European Union (TFEU).

arbitrage and the enforcement of a level playing field among parents, subsidiaries, and branches within and across the borders.[10] This study addresses the concerns of spillovers by using consolidated financial accounts of EU banks which eliminate the possibility of arbitrage. The use of consolidated data is also warranted because macroprudential capital requirements are levied at a group consolidated level.

The reciprocation framework, in conjunction with other provisions established in the EU banking regulation, alleviate to a great extent the concerns on the validity of the research method due to endogeneity stemming from national considerations.

The paper finds that the EU-wide regulatory effort to increase the resilience of the banking sector has contributed to a better capitalized European financial system. In the baseline specification, a one percentage point increase in capital requirements increases CET1 capital by an average of 13 percent. The impact is higher (17.7 percent) for banks with a buffer lower than two percentage points from the minimum capital requirement and for which the policy tightening is more binding. When requirements are relaxed in a downturn, the increase in highest quality CET1 capital can help the banks in supplying credit acting counter-cyclically to sustain economic growth in bad times.

However, the significant increase in capital is accompanied with a cost: banks react to a one percentage point hike in capital requirements by increasing the average risk weights of their portfolio by 6.1 percentage points. The impact is attenuated for small banks (4.3 p.p.), but medium (7.3 p.p.) and large (9.6 p.p.) systemically important banks have a significantly higher risk taking behavior after a hike in capital requirements. These linearly increasing in size findings for medium and large banks indicate that costs such as those potentially arising from an intensification of agency problems may lie behind our results. As shown by Ang, Cole, and Lin, 2000, a diluted ownership structure typical of large publicly traded firms is proportionally associated with increasing agency costs.

In order to estimate the overall impact on banks' solvency of the two opposing effects - i.e. higher resilience achieved with a capital increase versus lower resilience arising from more risk-taking - the study estimates the impact of the policy change on probabilities of default extrapolated from credit ratings. Results indicate that the positive effect of accumulating more equity capital is counterbalanced by the negative substitution effect toward more riskier assets. The overall net effect on solvency as measured by probabilities of default is thus null. At the same time, results indicate that rating agencies evaluate the capital increase as the prevailing effect on the probability of default of medium and large banks *relative* to the smaller banks.

In terms of heterogenous effects of capital requirements, the study documents that banks adopting the internal rating based (IRB) approach manage to show a lower propensity to risk taking on their financial accounts, this evidence suggests the existence of a competitive advantage for IRB banks since lower risk weights imply a lower cost of compliance to higher capital requirements. In addition, results indicate most of the increase in risk taking is due to less profitable institutions as measured by net interest income, suggesting that they try to achieve higher returns by substituting toward more riskier assets to compensate for the low profitability as

[10]The reciprocity framework is codified in two main documents: (i)Recommendation of the ESRB/2015/2; (ii) Article 5 of Decision ESRB/2015/4. For a detailed account of the reciprocation framework in the EU consult the dedicated ESRB web page on reciprocation, and Chapter 11 of the ESRB Handbook on operationalising macroprudential policy. In this context, the ESRB has an important coordination role in assessing measures, discussing cross-border effects, and recommending mitigating measures, including reciprocity.

a symptom of gambling for resurrection. Further, the study documents that wholesale funded banks have a lower tendency to increase their risk profile with respect to retail funded banks. This result can be interpreted as a strategic need to control excessive risk taking to compensate for the riskier funding model inherent in wholesale funded banks. It may also be a consequence of competitive advantage arising from the capacity to exploit cross-border funding in regions where monetary policy conditions are more expansionary improving thus profitability, see Bruno and Shin, 2015.

The paper is organised as follows: Section 3.2 reviews the theoretical and empirical literature, the EU macroprudential regulation is presented in Section 3.3 while the empirical methodology is illustrated in Section 3.4. Section 3.5 presents the evidence while the robustness to common trend assumption is presented in Section 3.7, and a formal test of endogeneity is presented in Section 3.8. Finally, the overall impact on the probabilities of default is described in Section 3.9, and conclusions are drawn in Section 3.10.

3.2 Literature

3.2.1 Related Theoretical Literature

The theoretical literature approached the question of the relationship between higher capital and risk taking from different angles. Since the pioneering contribution of Modigliani and Miller, 1958, the literature expanded and relied on a variety of modelling techniques. Despite the richness of existing contributions a consensus has not been reached. According to theoretical literature, the effect of capital requirements on risk taking behavior is ambiguous and hence the relationship is still an open empirical question.[11]

In the basic version of their model, Modigliani and Miller, 1958 assume that financial markets are efficient and perfect, while taxes, agency and bankruptcy costs are absent. As a result, the Modigliani and Miller, 1958 two famous propositions state: i) the capital structure does not affect the value of the firm and, ii) more levered firms have higher expected returns on equity than non-levered firms. The literature has shown that failure of the M&M assumptions may lead to departures from the theorems' propositions. For instance, in their later correction paper, Modigliani and Miller, 1963 show how tax advantages for debt instruments lead to non-proportional after tax returns across firms. Keeping constant the balance sheet size, stricter capital requirements imply that banks are less able to exploit favourable tax treatment of debt. For banks, Miller, 1995 argues that the deposit insurance can be regarded as a net tax subsidy, enabling banks to obtain funds at less than an appropriately risk-adjusted cost, promoting in the limit the minimization of the desired equity ratio.

One of the implications of the second M&M proposition is that a higher capital requirement would reduce the expected return of the bank's earning assets and thus curb the incentive for risk taking ensuring that banks always choose socially optimal risk levels. At the same time, higher capital requirement add another layer of protection for the taxpayer, and Miller, 1995 points out that capital requirements are

[11] Theoretical contributions range from portfolio models maximizing a mean-variance utility function (Kahane, 1977; Koehn and Santomero, 1980; Kim and Santomero, 1988; Rochet, 1992), models using option pricing methods to value the deposit insurance subsidy (Merton, 1977; Galai and Masulis, 1976; Furlong and Keeley, 1989), dynamic models of charter value and competition (Keeley, 1990; Blum, 1999; Hellmann, Murdock, and Stiglitz, 2000), or the principal-agent framework, (Saunders, Strock, and Travlos, 1990; Dewatripont and Tirole, 1994)

no panacea in this regard because the banks cannot be trusted from offsetting the added taxpayer protection resulting from higher capital requirements by increasing the risk of their assets further. Furthermore, the presence of significant agency costs, which are generally higher in large firms due to the diluted ownership structure, see Ang, Cole, and Lin, 2000, can also lead to the failure of the M&M propositions. Bankruptcy costs also play a role, as pointed out by the Basel Committee in their study on the costs and benefits of stronger capital regulation, the main benefits of a stronger financial system reflect a lower probability of banking crises and their associated bankruptcy costs, BCBS, 2010. As such the predictions of the M&M theorem on the risk taking behavior of banks after a hike in capital requirements remain uncertain.

Limited liability and deposit insurance models claim that depositors do not have any incentive to monitor banks' behaviour, it follows that managers would have more opportunity to increase asset riskiness and exploit moral hazard arising from the *deposit insurance subsidy*, Green, 1984. In these models, the moral hazard problem may be further exacerbated by the presence of informational advantage for bank managers, Jensen and Meckling, 1976. Similarly, Kareken and Wallace, 1978 find that in a monopoly model of banking with complete contingent claims and under an FDIC-type deposit insurance scheme, the banking industry maintains a risky portfolio and capital requirements do not forestall bankruptcy.[12]

Portfolio choice models support both views, on one side Kahane, 1977, Koehn and Santomero, 1980, Flannery, 1989 conclude that capital requirements are inefficient in constraining the risk shifting in the bank portfolio insulating them from market discipline. Nevertheless, Furlong and Keeley, 1989 show that for a value-maximizing bank and the presence of option-value of deposit insurance, the incentives to increase asset risk decline as bank capital increases. More recently, Kim and Santomero, 1988 show that the the use of simple capital ratios is ineffective to bound the insolvency risk of banks, and propose theoretically corrected risk-weights as a solution to the risk taking behaviour. Similarly, Rochet, 1992 argues that utility, as opposed to value, maximizing banks can reduce risk taking if capital ratios take into account their asset risk. Blum, 1999 models a dynamic decision problem of a bank to conclude that capital adequacy rules may increase bank riskiness.

Merton, 1977 fostered the use of option-pricing models which consider deposit insurance as an option-value, to reach the conclusion that more skin in the game, i.e. higher capital requirements, can reduce incentives for increasing portfolio riskiness. Galai and Masulis, 1976 use a capital asset pricing model and an option pricing model to show how unanticipated changes in firm capital can induce investments in portfolios with higher variance. Similarly, Gennotte and Pyle, 1991 show how deposit guarantees in combination with higher capital requirements lead banks to increase asset risk.

A further strand of models uses the charter value of the bank, i.e. the difference between going concern and liquidation value, to support the skin in the game argument, Marcus, 1984. By the same token, Benston, 1986 argues that bank shareholders have more incentives to operate conservatively when the amount of their own funds is at risk. The prospect of loosing charter value on managers' career can remind managers of the consequences of excessive risk-taking. Saunders, Strock, and Travlos, 1990 show how managers may have incentives to reduce the default risk below the shareholders desired level in order to protect their own human capital.

[12]Notice that, as convincingly showed by Diamond and Dybvig, 1983 deposit insurance is at the same time a fundamental policy tool to avoid bank runs, hence notwithstanding the moral hazard incentive, deposit insurance is widely used to limit bank panics and bank runs in time of distress.

The question is if the bank-managers have the same incentives of the shareholders. Dewatripont and Tirole, 1994 model the classic moral hazard problem with unobservable managers' effort to conclude that banks with low leverage may have an incentive to increase risk since interference from principal is lower, and viceversa. We test for this hypothesis in section 3.6.2. More recently, the theoretical literature using the charter value argument was augmented by including competition in the banking industry to conclude how the presence of more competitors may reduce the charter value and increase default risk through asset risk, Keeley, 1990, Hellmann, Murdock, and Stiglitz, 2000.

3.2.2 Related Empirical Literature

Previous empirical research on the impact of higher capital requirements on bank risk-taking is scant. Pioneering empirical contributions focused on the introduction of risk-weighted regulatory standards in the late 1980s and was rather fervent in the 1990s. It used descriptive regression analysis and simultaneous equation models relying thus on endogenous components of capital increase by bank managers, (Shrieves and Dahl, 1992; Jacques and Nigro, 1997).

One of the earliest empirical contributions is provided by Shrieves and Dahl, 1992. The authors adopt a two-stage simultaneous equation estimation to analyze the relationship between risk and capital. They estimate discretionary changes in asset portfolio risk induced by a variation of capital taken endogenously by the bank. The authors find a positive relationship between increased capital levels and risk taking as measured by average risk-weights. The positive relation holds also for banks with capital in excess of the minimum requirements, leading the authors to conclude that risk-taking behaviour is influenced by bank owners' and/or managers' private incentives.

Haubrich and Wachtel, 1993 apply an analysis of variance (ANOVA) to study whether the 1998 risk-based capital accord (Basel I) led to the risk shifting of commercial banks' portfolio toward government securities and hence a lower average risk-weight. The authors conclude that the implementation of Basel I fostered risk reduction, with poorly-capitalized banks shifting their portfolios away from high-risk assets and towards low-risk assets.

Using a three-stage least squares simultaneous equation model, Jacques and Nigro, 1997 examine the impact of the risk-based capital standards on bank capital and portfolio risk in the first year the Basel risk-based standards were in effect. As in Shrieves and Dahl, 1992, they use discretionary bank management adjustments to capital, and measure risk as the ratio of risk-weighted assets to total assets. The paper concludes that risk-based capital standards were effective in increasing capital ratios and reducing portfolio risk for banks which already met the new risk-based standards. Interestingly, Jacques and Nigro, 1997 define also a *supervisory pressure* variable assuming that banks may respond differently depending on whether they are in excess or in shortage of required capital. For capital-constrained banks the responses showed little connection to the degree to which they fell short of the standards. Applying a similar simultaneous equation framework to a sample of Swiss banks, Rime, 2001 finds that supervisory pressure induces banks to increase their capital, but does not affect the level of risk.

After the turn of the century, academic focus on the impact of bank capital requirement on risk-taking has subdued. More recently, Gropp et al., 2016 exploit

the 2011 European Banking Authority (EBA) capital exercise[13] and a difference-indifference matching estimator to find that treated banks increase capital ratios by reducing their credit supply. On the margin of their study, the authors show that the EBA capital exercise did not have significant effects on risk reduction as measured by the risk-weighted asset to total asset ratio. Similarly, Calomiris and Jaremski, 2016 exploit a staggered implementation of deposit insurance laws in the U.S. and the fact that those laws were applied only to some depository institutions within the states to corroborate the theoretical literature on the moral-hazard consequences of deposit insurance.

3.3 The EU macroprudential capital based regulation

One of the criticisms of earlier Basel standards for capital requirements, is the lack of emphasis on risks stemming from correlated exposures that may accumulate over time and increase systemic risk, (Hellwig, 1995; Acharya, 2009; Haldane and May, 2011). Basel I and II capital standards are focused exclusively on individual portfolios without acknowledging the importance of how much these portfolios are diversified, the pattern of co-variances among individual assets, systemic correlation of risks and interconnectedness, and/or the cost of failure of big and more complex banks.[14]

Basel III standards include additional capital requirements aimed at tackling some of these issues and add three main new buffers: the Capital Conservation Buffer (CCoB) for build-up of adequate buffers above the minimum that can be drawn down in periods of stress, the Countercyclical Capital Buffer (CCyB) aimed at limiting the procyclicality of credit growth, and additional capital buffers for Global Systemically Important Banks (G-SIB) aimed at addressing the liquidation cost of too-big-to fail banks.[15] These efforts notwithstanding, critics have questioned both the lack of ambition and the design of some of the Basel III buffers Repullo and Saurina, 2011.

In Europe, the Capital Requirements Regulation (CRR) and the Capital Requirements Directive (CRD IV) introduced a new macroprudential framework transposing the Basel III agreement.[16] The CRDIV has been officially transposed in law on 17th July 2013 and the full reform package entered into force on the 1st January 2014. The overarching goal of the new EU regulation is to limit systemic risk in the banking sector through the introduction of a set of Systemic macroprudential Capital Requirements (SMCR) available to national authorities to address systemic risks. The set of SMCR include three main capital based instruments: the Systemic

[13]The EBA capital exercise required 61 banks to build-up additional capital buffers to reach a level of 9% core tier 1 ratio in 8 months, from 26 October 2011 until June 2012

[14]On one hand Basel I introduced risk-weighted exposures in order to force banks with more risk in their portfolios to maintain a higher capital level, while Basel II main innovation was the introduction of the Internal Rating Based (IRB) and the Standardized Approach (SA) models for the computation of risk-weights. For a more detailed history of Basel capital standards and their deficiencies see for instance Brealey, 2006 and Hellwig, 2010.

[15]In addition, Basel III introduces favourable risk-weights for OTC derivatives cleared through central counterparties (CCPs), and is raising the risk-weights on exposures to financial institutions relative to the non-financial corporate sector, as financial exposures are more highly correlated than non-financial ones.

[16]Detailed information on the Capital Requirements Regulation and Directive can be found on the European Commission website. Norway and Iceland, despite not being formally EU Member States opted for participating in the new EU macroprudential framework for banks as established in the CRR and the CRDIV.

Risk Buffer (SRB), the Other Systemically Important Banks (O-SIB) buffer and the Globally Systemically Important banks (G-SIB) buffer.[17] The SRB aims to address systemic risks of a long-term structural and non-cyclical nature as for instance the accumulation of systemic risk and the degree of interconnectedness. The O-SIB and G-SIB buffers are predominantly concerned with increasing loss absorption capacity and reducing public costs of default of bigger and complex banks.

While the economic rationale behind the diverse types of buffers may differ in scope and objective, all of them have to be met with an additional highest quality Common Equity Tier1 (CET1) capital as a share of risk-weighted assets (RWA). All SMCRs are applied at individual bank-level and levied in addition to the minimum requirements, and they are specifically addressed to a set of both globally and nationally systemically important banks (SIBs).[18] The list of systemically important banks is updated each year by national authorities following EBA guidelines. The main criteria for systemic importance are: a) size; b) importance for the economy of the relevant Member State or the Union, capturing substitutability/financial institution infrastructure; c) complexity, including the additional complexities from cross-border activity; d) interconnectedness of the institution or (sub-)group with the financial system.[19]

It is important to notice that not all G-SIBs or O-SIBs are subject to the SMCR as of 2017Q3. In fact, despite the introduction of the capital based macroprudential framework in 2014 in the EU, some national macroprudential authorities have not yet activated any of the structural SMCRs. Under the oversight of the ESRB and the ECB, the EU regulation allows for discretion to activate and to set the level for each O-SIB and SRB buffer. On the one hand, these country divergences and the staggered implementation across countries facilitate the empirical identification problem. On the other hand, they may lead to concerns regarding the potential endogeneity of the policy change with respect to the health of the country banking system. These concerns are, however, alleviated by four main elements enshrined in the regulation: i) four EU institutions coordinated oversight contribute to refraining from inaction bias and national favoritism,[20] ii) the ECB has the power to top-up the requirement if considers it insufficient to cope with the relevant risk, or may object the decision in case considered excessive or punitive toward foreign subsidiaries, and iii) the ESRB can issue public warning and recommendations where an identified systemic risk has materialised and has not yet been addressed and iv) the reciprocation framework

[17] The new macroprudential regulation in the EU includes also the Basel III capital conservation buffer (CCoB) as well as the dynamic countercyclical capital buffer (CCyB). Nevertheless, the CCoB and the CCyB are buffers set at the country-level and hence at the same level for systemic and non-systemic banks in the country. Since these two buffers are absorbed by country-quarter fixed effects in our empirical design they are not contributing to additional variation and to the identification of the effects.

[18] Under the CRD IV/CRR capital framework, EU banks are required to hold a minimum amount of total capital equal to at least 8% of RWA. The new regulation raises the minimum share of capital that has to be of the highest quality CET1 capital from 2% to 4.5%. Additional capital until the minimum threshold of 8% can be fulfilled with Tier 1 minimum capital or Tier 2 minimum capital (max. 2%). As such, the new EU-wide CRD IV/CRR minimum capital regulation places greater emphasis on the quality of capital.

[19] For more details cfr. the EBA Guidelines on the criteria to assess systemically important banks in the EU. The EBA provides and maintains also an updated G-SIBs list and O-SIBs list in Europe over time on its website.

[20] It is important to notice that in order to ensure consistent macroprudential oversight across the Union, the ESRB develops principles tailored to the Union economy and is responsible for monitoring their application.

allows a Member State to request a reciprocation of a macroprudential measure.[21]

The calibration of the G-SIB buffer is set internationally according to the Basel G-SIB score range for each G-SIB, BCBS, 2013. The calibration of the SRB and the O-SIB buffers depend on the systemic importance of the bank for the country in question and is not subject to centralized guidelines from EBA. As mentioned earlier, the ECB has developed a framework to provide a minimum common floor when calibrating O-SIB buffers at the national level to foster a level playing field. Above this floor, each country calibrates the buffers using own methodologies.[22]

In sum, and contrary to the Basel III capital standards, the EU package is more ambitious since instructs Member States to designate own systemically important banks to which then a *wider* battery of bank-specific systemic capital buffers may be applied. Table 3-1 provides an overview of the newly introduced capital requirements in the EU.

3.4 Empirical Methodology

3.4.1 Data

This study uses two main data sources to construct an integrated dataset combining bank-level financial accounts data and systemic macroprudential capital requirements. The source of bank-level financial accounts data is the commercial provider SNL Financials which collects financial accounts from financial institutions around the World. More specifically, financial accounts for all G-SIB and O-SIB in the EU and Norway from 2006Q1 until 2017Q3, leading to a total number of 205 banks in the sample, with 14 G-SIBs and 191 O-SIBs.[23] The list of banks sorted by total assets is presented in Appendix 3.A.[24]

The bank specific SMCRs are obtained from the ESRB database on macroprudential policies based on the notifications from the national authorities.[25] Table 3-3 illustrates the evolution of capital requirements for the sample of EU G-SIBs and O-SIBs from 2010Q1 until 2017Q3. In Panel A of Table 3-3 the simple mean of the capital requirements for both treated and non-treated banks is shown. The first row shows

[21] See respectively, Article 131(7) of the Capital requirements Directive IV (CRDIV), Articles 5(1) and 5(2) of the Single Supervisory Mechanism Regulation, Article 3 of the ESRB regulation and the Recommendation of the ESRB/2015/2 in conjunction with Article 5 of Decision ESRB/2015/4

[22] For instance, the Commission de Surveillance du Secteur Financier (CSSF), the macroprudential authority in Luxembourg adopts *"a statistical approach involving linear regression and a scaling framework with the goal to ensure consistency between O-SIBs buffers and the buffers applied to G-SIBs."* See CSSF notification to the ESRB. Additional notifications may be found on the ESRB website.

[23] For the list of G-SIB with cut-off date 2016Q4 consult the Financial Stability Board page available on this link.

[24] One caveat to keep in mind when constructing a bank-level database over a long time period is the churning rate of financial institutions from the sample. In particular the merger of two or more financial institutions may bias the results. To limit this possibility, When a merger happens, the study sample is adjusted in order to reflect this change: old entities are discontinued in the sample and a new entity is added with a separate identifier as a result of the merger. To grasp the idea of sample construction in case of mergers, one examples of recent merger episodes over the period is shortly summarised in this footnote. On 2nd Jan 2017 Nordea Bank Denmark merged with Nordea Bank AB, see link. As a consequence of the merger, a Danish entity Nordea Real Kredit has been identified as O-SIB by the Danish macroprudential authority. It follows also that Nordea Bank Denmark has been removed from the O-SIB list in DK, and also from the list of O-SIBs in the study sample.

[25] The ESRB macroprudential database covers all changes in macroprudential regulation notified by the 28 EU countries and Norway. Notifications are published on the ESRB website or disseminated through ESRB publications. For detailed information on the national macroprudential policies in the EU cfr.: ESRB National Policies

the phasing-in of the SMCR after 2014. From 2014 onward the SMCR CET1 capital requirements for EU G-SIBs and O-SIBs increase by an average of 0.21 percentage points yearly.[26]

The average capital requirement is higher if we compute the average conditional on effectively treated banks. This conditional mean is shown in Panel B of Table 3-3 and implies an average increase of the SMCR by 1.18 percentage points in 2017Q3. This is a substantial increase in capital requirement, in particular for banks that are closer to the minimum requirement. An inspection of the standard deviation of SMCR shows the ample variation in capital requirement setting. This is a welcome feature of the data since it contributes to lower the variance of the estimated coefficient of interest and provide more precise estimation of the relationship between risk-taking and capital requirements.

As explained in Section 3.3, an O-SIB may not have any SMCR if the regulator decides not to implement any on it, see Table 3-1 for a summary of the macroprudential capital requirements in the EU. In our sample 26.34% of bank-quarter observations are not treated. In other terms, for those banks the regulator opted not to increase the SMCR, while this is a discretionary decision, as explained in the introduction there are substantial institutional arrangements to guarantee that the decisions are taken objectively without favoring any national champion.

The second row of each panel of Table 3-3 shows the overall capital requirement for CET1 capital (OCR), i.e. the sum of the Pillar I capital requirements and the combined macroprudential capital requirement. The average banks' supply levels of CET1 capital are shown in the third row of each panel. The difference between the OCR and the supply of capital by banks is then computed in order to derive a proxy for the stringency of the binding of the capital requirement at bank-level (row four). In fact, banks' response to higher capital requirement are expected to be a function of the distance to the regulatory minimum, or in other words an inverse function of their excess capital above the minimum requirement. In particular, banks are expected to increase their capital supply if they are close to the regulatory minimum as shown already by Jacques and Nigro (1997) and Rime, 2001.

Table 3-4 illustrates descriptive statistics of banks' financial accounts as extracted from the SNL Financials database. Descriptive statistics are shown for all variables used in the later empirical analysis, when absolute values are shown these are expressed in EUR throughout the paper. The asset side of the balance sheet is composed by three major components: loans gross of provisions for impairment (58.29%), securities (25.13%) and cash (15.29%).[27] It is worth noting the average level of RWA over total assets, i.e. the risk-ratio, which is 50.91%, as this measure will be a useful benchmark for the following analysis. Securities can be further broken down by Held for Trading (HFT), Available for Sale (AFS) and Held to Maturity (HTM). On the liabilities side the table shows the means of the main funding sources for banks:

[26]Note that over the sample period, other type of *country level* macroprudential buffers were also levied on EU banks, as for instance the CCoB and the CCyB. The total combined yearly average of macroprudential buffer averaged 0.65% from 2014 until 2017Q3. However, in this paper, the focus is exclusively on bank-level macroprudential buffers since they allow for more precise estimates and allow to control for time varying country-level variation by including country-time fixed effects. In other terms, the country-time fixed effects absorb the variation generated by the country-level capital requirements. Note also that there is a small average increase (i.e. 0.01%) of the SMCR across the sample already in 2013 since in Norway the macroprudential capital requirements where the Systemic Risk Buffer (SRB) was introduced in 2013Q3.

[27]Cash includes reserves and balances at the Central Bank, operating cash, cash and cash equivalents according to the relevant accounting standard, i.e. "short-term, highly liquid investments that are readily convertible to known amounts of cash and which are subject to an insignificant risk of changes in value".

deposits (48.5% of total assets), short and long-term wholesale funding (33.3%) and debt (17.9%).[28]

Importantly, the SNL Financials database also allows to capture the extent to which systemically important financial institutions are interconnected with each other and the wider financial system. In fact, excluding measures of bank interconnectedness and complexity would bias the results due to their direct correlation with the level of the SMCR, see Section 3.3 above and EBA Guidelines on the criteria to assess systemically important banks in the EU. Table 3-4 presents four indicators used in the paper as proxies for interconnectedness and complexity, namely: i) interbank lending as a direct measure of interconnectedness; ii) assets held for trade as measure of complexity and interconnection with financial markets' developments through mark-to-market trading book accounting which directly impacts banks' profit and loss statements; iii) over the counter (OTC) derivatives securities held on the balance sheet as a measure of both complexity and interrelation with the counterparty risk in he financial system; iv) cash held at the Central Bank for interbank payments' settlements.[29]

3.4.2 Empirical Design

The introduction of the CRD IV/CRR regulatory framework and of the new macroprudential capital requirement offers an opportunity to employ an identification strategy based on a controlled comparison by studying the effect of a policy change on differently affected banks. As noted in previous sections, the SMCRs are set at individual bank-level for systemically important banks in the EU. This implies that within a country banks are subject to different level of requirements depending on their systemic importance. This ensures cross-country and within-country variation at bank level, which in turn is suited for using a multi-treatment group difference-in-difference identification strategy. [30] The baseline estimated equation is:

$$lnY_{ict} = \alpha_i + \beta \Delta SMCR_{ict} + \ln X_{ic,t-1}\gamma + \delta_{ct} + + u_{ict} \tag{3.1}$$

Where i, c and t are indicators for bank, country and time respectively. The specification includes bank fixed effects, α_i, to control for time-invariant bank heterogeneity. Importantly, the parameters δ_{ct} are dummy variables for capturing within state endogenous variation, for instance time varying macroeconomic effects such as: general economic growth, supply and demand shocks or fiscal and monetary policy changes within a country. The country-quarter fixed effects control thus for time varying country level factors that might simultaneously affect the SMCR and Y are controlled for and help to isolate the impact of an increment of capital requirements on the outcome of interest. It is important to note that the identifying source of variation therefore comes from time variant bank level SMCR Finally, u_{ict} is the residual unexplained term.

[28] The total sum of funding sources and equity is not 100% of total assets due to few missing observations across these variables.

[29] Cash held at the central bank is also an important bank-level control variable for unconventional monetary policy operations of quantitative easing whereby bank's accounts at the ECB were credited with cash after monetary policy operations.

[30] In this setting each bank is a group of treatment and is compared with other treated banks in terms of intensity of treatment (i.e. different levels of capital requirement increases) and with the group of banks that had not have any increase in the SMCR over the sample period. For details on the multi-treatment group difference-in-difference estimation technique see Chapter 5.2. in Angrist and Pischke (2008).

The outcome variables of interest are grouped in the vector Y_{ict}, they are: the capital ratio (CET1/RWA), the level of CET1 and the level of total capital for capital specifications; RWA, and its decomposition in RWA/Assets and total assets for risk specifications. The policy variable of interest is the change in the systemic macroprudential capital requirement $\Delta SMCR_{ict}$. Both the outcome and the policy variables are used at time t. The main coefficient of interest in the equation is β, which can be interpreted as the average treatment effect of a one percentage point increase in capital requirement on the outcome variable of interest.

The matrix X_{ict-1} includes bank-specific, time varying control variables lagged by one quarter to limit simultaneity bias.[31] The set of control variables is motivated by the nature of the setting and calibration of capital requirements as per the EBA guidelines, which both depend on the size of the bank (total assets), the value of domestic payments (central bank reserves used for settlement of payments), the importance of the bank in the financial system (deposits and loans). As mentioned in section 3.4.1, the capital requirements are a function of the complexity and the interconnectedness of a bank with the financial system, hence the model controls for interbank lending, held for trading securities, OTC derivatives and cash at the Central Bank. Finally, in order to improve the precision of the estimates the specification controls for total debt, other accounting classifications of securities holding (i.e. available for sale and held to maturity), return on assets and the cost to income ratio as further controls.

Bank Risk Measure

In terms of measurement, one of the most important elements of the analysis presented in this paper is the measurement of risk-taking behaviour which must be able to identify individual bank specific risk-taking behaviour. One way to approach this problem is to look directly at the intrinsic risk stemming from the combination and composition of the portfolios on the assets side of banks' balance sheet. This is the approach followed by the Basel Committee on Banking Supervision (BCBS) under the Basel II rules on risk sensitive capital requirements.

But how can banks adjust their CET1 ratio after an increase in the regulatory capital requirement? A look at the CET1 ratio can help discerning the effects:

$$CET1Ratio = \frac{CET1}{RW_a Asset_a} \tag{3.2}$$

where CET1 is the amount of Common Equity Tier 1 capital held by the bank, RW represents the non-negative risk weight specific to asset a, and Asset is the amount of nominal exposure in asset a. As Equation 3.2 shows, banks can increase their regulatory capital ratio in three mutually non-exclusive ways: by increasing capital, reducing the risk-weights or reducing their assets. A bank can raise capital by either

[31] More specifically, the full set of control variables includes the lags of: the natural logarithm of total assets to control for size and a series of variables all divided by total assets: loans and total deposits as controls for business model, total debt to control for leverage, total cash and like cash instruments to control for unconventional monetary policy liquidity effects and securities held for trading (HFT), securities classified as available for sale (AFS) and securities held to maturity (HTM) to control for the unconventional monetary policy effects of central banks' securities purchase programs. A series of controls are included for market and financial institutions interconnectedness: OTC derivatives securities, interbank loans; finally return on assets ratio and the cost to income ratio control for cyclical and structural profitability.

issuing new shares and/or not paying dividends to its shareholders to retain earnings. The newly issued shares and retained earnings increase the CET1 ratio, provided that the bank does not increase its risk-weighted assets. Alternatively, holding equity constant, the management of the bank can reduce risk-weighted assets, either through shifting assets composition towards exposures with lower risk-weights such as government securities, or reducing assets, that is by reducing lending, selling securities, impaired loans or other assets.

From Equation 3.2 a logical approach for the measurement of bank specific risk taking behaviour lies in the Basel II rules on risk-sensitiveness of assets. The ratio of RWA over total assets, for simplicity the *risk ratio* or *risk density*, is a natural measure of bank risk taking behaviour if we keep fixed the risk weights measurement approach. The risk ratio provides the average risk the bank's portfolio according to the risk-weight associated with each asset. It has the advantage of being a simple and very intuitive measure of bank risk taking, Berger, 1995, even if the appropriateness of risk-weights has been questioned in the literature, see Hellwig, 2010. A further benefit of using the risk ratio is that it takes into account the deterioration of the *quality* of a credit portfolio, as already noted by Shrieves and Dahl (1992) and Jacques and Nigro (1997). In fact, regulatory provisions foresee higher risk-weights for non performing exposures and impaired assets.[32]

In addition, the risk ratio indicator is a *decision* variable within the reaction function of banks' risk-management and its decision making process to changes in capital requirements determined by the regulator. The response of the risk management is exclusively determined by strategic decision and thus more apt to measure risk-taking behaviour than market based risk measures such as CDS spreads which are usually measures of solvency. In addition, the latter are of minor interest since they are external to the decision making of the banks' management, and are a mere reflection on how the financial markets judge the probability of the bank being solvent when payments are due.[33]

A further advantage of the use of internal risk-weights is that they provide for a not delayed response when an increase in capital requirements occurs. this is primarily driven by supervisory interference and sanctions due to late compliance.

Some notes of caution in using the risk ratio are due. Banks using internal rating based approach (IRB) to set risk-weights on their portfolio have a competitive advantage with respect to banks using standardized approach (SA), see for instance **praet2004**; **tschemernjak2004assessing**; **haselmann2016banks** The competitive advantage arises because IRB banks use their own empirical models to estimate market and credit risk, while SA banks use the risk weights defined in the regulation which are on average more stringent. Internal rating models are fine-tuned to minimize the risk weights for each risk exposure resulting in a lower risk ratio even if the bank has effectively the same portfolio of a competing SA bank. It follows that IRB banks are able to 'artificially' increase the supply of capital since the denominator of the capital ratio decreases. This study controls for this heterogeneity using bank-level fixed effects in all specifications (note that risk weights measurement approach is sticky in

[32]Some authors suggest to use directly non-performing loans (NPLs) as proxies for risk-taking since granting high-return, but high-risk, loans underlines a risk-taking propensity. However, NPLs would not be entirely apt to our task due to lags in their accounting rules, they are recognized as non-performing starting on the 90th day past due (depending on the type of asset and the accounting classification) implying a difficult identification problem for the econometrician regarding the timing of the impact.

[33]It is also important to notice that the scope of application of CDS pricing is very limited in our sample since CDS prices are generally available only for some of the large systemic banks. In our sample, this translates to only 49 banks with available CDS prices.

time), in addition it explores the extent of the competitive advantage of IRB banks by interacting the macroprudential capital requirement with an IRB dummy in Section 3.5.

A final note of caution is due since, by construction, the risk ratio identifies risk stemming predominantly from on-balance sheet exposures, while the risk associated with *unobserved* off-balance sheet exposures is not entirely captured in this metric. In the transposition of Basel standards in the EU, the CRR asserts that off-balance sheet items are treated like on-balance sheet exposures and shall be risk-weighted, however the calculation method implies a lower risk weight for off-balance sheet exposures.[34] Since off-balance sheet items are unobserved in the dataset, we can only try to form an educated guess on the bias arising from omitted variable. Table 3-2 shows the direction of omitted variable bias given the correlation patterns between the omitted variable, the treatment variable and the dependent variable. Due to the preferential regulatory treatment for off-balance sheet assets, it is very likely that banks react to higher capital requirement by shifting some of their risky assets to unobserved off-balance sheet positions implying a *positive correlation* between regulatory capital hike and off-balance sheet activity. In addition, due to lower risk weights of off-balance sheet exposures, the β_2 coefficient in Table 3-2 should be lower than zero. It follows that the estimates on the impact of capital requirements on risk taking behaviour may result downward biased if the incidence stemming from off-balance sheet items is large enough. This downward bias may underestimate the real risk-taking behaviour in our estimates, probably even more for more complex institutions which have a higher capacity to transfer assets off-balance sheet.

3.5 Results

By presenting the first set of results, the paper acknowledges that banks tend to maintain a capital buffer on top of the regulatory minima as a signal of financial health to the markets, to attract funding and to minimize supervisory interference Shrieves and Dahl (1992) and Jacques and Nigro (1997). Moreover, microprudential supervisors encourage banks to maintain an additional voluntary buffer on top of the requirements, this indicates the adequate level of capital to be maintained in order to withstand stressed situations.[35] This study sorts banks by how binding is the new capital requirement. To this end, an indicator of the distance from the OCR is interacted with the change in the systemic macroprudential capital requirement.[36]

[34]Not all activities of the banks can be moved off-balance sheet, off-balance sheet items are typically exclusively those not owned by or not a direct obligation of the bank, for instance securitised activities and operating leases are the most common off-balance items. The key difference between off-balance and on-balance exposures relates to the calculation method of the *exposure value* that should be risk-weighted. The definition and calculation of the exposure value of off-balance sheet items is detailed in CRR Article 166 for the IRB approach and CRR Article 111 for the SA.

[35]In the Banking Union framework, this is regulated via an additional Pillar 2 Guidance which is calibrated on the basis of the adverse scenario in the supervisory stress tests. see ECB description of the Pillar 2 Guidance

[36]In turn, levels of desired capital may depend on external factors such as the macroeconomic environment, the market interest rate, the degree of tax differentials between debt and equity financing Schepens, 2016, as well as the degree of regulatory pressure. In a bank-level empirical setting, the country-level features can be controlled for in specification 3.1 via country-time fixed-effects, these help to absorb the bias in the estimates arising from country-level specific influences.

3.5.1 Capital: Baseline and binding distance interaction

Before investigating the relative importance of the moral hazard versus the skin in the game channels, it is instructive to understand how effective the capital requirement is at increasing the banks' capital. This section provides evidence on whether banks increase the numerator of the capital ratio and, as a consequence, whether their solvency is strengthened. Table 3-5 illustrates the results of the impact of an increase in the Systemic macroprudential Capital Requirements (SMCR) on three measures of capital: the risk-weighted CET1 ratio, the volume of available CET1 capital and the volume of supplied total capital. All regressions follow the specification in Equation 3.1, and include quarterly varying country-time fixed effects. The first columns (1)-(3) present the baseline estimates, while Columns (4)-(6) differentiate the impact by the cushion banks maintain from the OCR.

Column (1) shows how the resulting average impact on the risk-weighted capital ratio is not statistically significant. For the average bank, and without categorizing banks by distance from the minimum requirement, the impact of the SMCR is not strictly binding. This result is however not distinguishing by the buffer banks maintain on top of regulatory minima.[37] Column (4) indicates that once we include in the regressions dummies for distance, and their interaction with the SMCR, a one percentage point increase in the capital requirement induces an increase of the CET1 ratio by 0.83 percentage points, providing evidence that significant European banks are effectively constrained by the regulatory change. The interaction effect is not statistically different for the group of banks with a more than two percentage points excess capital with respect to the minimum requirement. The absence of negative sign for non capital constrained banks, provides evidence that the reaction to the hike in capital requirement is widespread. This finding is in line with the notion that banks have a preference to maintain a desired, or target level of capital, above the minimum to assuage market pressure and reduce supervisory interference, Shrieves and Dahl (1992) and Jacques and Nigro (1997).

But how this increase in the ratio occurs? In Column (2), the focus shifts to the amount of CET1 capital, i.e. the numerator of the CET1 ratio. On average, a one percentage point higher SMCR yields CET1 to increase by 8.9 percent. In Column (5), we differentiate the impact by distance to OCR: the result highlights again that banks with a relative shortage of capital have almost a double effect (17.7 percent) with respect to the average impact in Column (2). The coefficient for the reference group of banks with less than 2 p.p. of CET1 buffer above the minimum, translates in a 17.7 percent increase of CET1 ratio for a 1 p.p. rise in capital requirements. This positive impact provides evidence of the direct benefits of capital based macroprudential regulation in the EU. The reforms promoted widespread increase in capital levels across the sample of systemically important banks, and in particular for banks with lower loss absorption capacity, increasing capital for banks with lower buffers and therefore improving the overall resilience of the system. Significant banks with capital in excess of the minimum regulatory threshold show somewhat weaker but still strong effects in terms of the magnitude of CET1 capital increase.[38]

[37] In the following note that the estimation sample is composed by 137 significant banks, the distribution of the OCR distance variable in the estimation sample has mean 8.7 percentage points and median at 7.8 percentage points. Similar results are obtained with different break-down of the distance from OCR, the results are available from the author.

[38] Note that the number of observations in each bucket of the distance from the OCR are: 71 for the bucket of banks below 2pp of the OCR, 385 for the bucket with 2pp<OCR<5pp, 1836 for the bucket with 5pp<OCR<10pp and 903 for the bucket with the OCR>10pp

Column (3) and Column (6) corroborate the results on CET1 capital when including additional Tier1 capital and Tier2 instruments in the numerator. The net impact is attenuated since the bulk of the increase is borne by CET1 capital, a natural consequence of the SMCR requirement. The induced higher levels of capital ratios mean a greater loss absorption capacity for European banks when the next financial crisis hits, Jiménez et al. (2016).

3.5.2 Risk: Baseline and binding distance interaction

This section presents the first results on the skin in the game versus moral hazard channels. It shows how the banks react to their strengthened capital position which was documented in the previous section.

As summarized in Section 3.2, a branch of the banking literature shows how more regulated banks can have risk-taking incentives due to the negative effect of higher capital requirements on bank profits.[39] On the other hand, the skin in the game argument postulates that for banks with higher capital ratios there is an incentive by bank managers to avoid excessive risk-taking since more risk increases the variance of returns with higher probability of significant losses on banks' equity.[40] This section shed lights on the capital requirements and risk-incentive relationship using the risk ratio as a measure for riskier assets, and interacting the SMCR with the distance from the OCR in order to study the interaction of risk-taking with the supply of regulatory capital.

Table 3-6 presents the estimates. Columns (1)-(3) investigate the effect without distinguishing banks by their distance from the overall capital requirement. Column (1) shows the estimates on the impact on the combined risk weighted assets, columns (2) and (3) presents the impact on the decomposition of RWA in risk ratio (or density) and total assets. The results suggest that, on average, banks show a significant tendency to increase their RWA after a tightening of the capital requirements. In particular, as shown in Column (2), the impact stems from higher risk taking, as the composition of the asset side of banks' balance sheets tilts toward more riskier assets. The risk taking behaviour manifests in considerably higher risk ratios (RWA/Assets), with a one percentage point hike in capital requirements being associated with 6.9 percentage points increase of the risk ratio. The estimates are significant at 1 percent confidence level and are indicative of the existence of a risk taking channel of capital adequacy requirements, raising concerns on the non-intended consequences and perverse effects of capital based regulation.

To understand better the magnitude of this impact, recall that the average risk ratio level in the sample is 50.9 percent (see Table 3-4). In other words, a one percentage point increase in the SMCR could shift the average risk ratio to 57.8 percent. This is an economically significant amount and, as noted in Section 3.2, the qualitative impact is consistent with previous theoretical and empirical work. Moreover, we can try to extrapolate this impact to the average EU systemically important bank, we can compare how much this risk taking relates to the effective increase in capital requirement occurred during the observation period. Table 3-3 shows that over the four years between 2014 and 2017, the SMCR increase on average in the sample of systemically important EU banks by 0.87 percentage points. A simple linear approximation would thus entail an average increase of risk weights by 6 percentage points, i.e. 0.87 multiplied by 6.9 the coefficient of Column (2).

[39] See for instance Koehn and Santomero (1980), Kim and Santomero (1988), and Blum (1999).

[40] See for instance Hellmann, Murdock, and Stiglitz (2000), Repullo and Suarez (2004), and Repullo (2004)

The second part of Table 3-6 tests the hypothesis of a non-linear relationship between capital requirement and risk taking, Hellmann, Murdock, and Stiglitz (2000), Repullo and Suarez (2004), and Repullo (2004). Contrary to the predictions of this strand of the literature, the evidence in Columns (4)-(6) does not show signs of a decreasing risk taking behaviour by banks with a greater supply of capital. In fact, all the interaction terms in the specification are not significant at standard confidence levels. All groups of banks, irrespective of their level of capital supply, show similar propensities to take on more risk after a hike in capital requirements.

The results of this section show a clear tendency to react to more capital by shifting the portfolio toward riskier assets. The predisposition to take on more risk can be interpreted as evidence that the moral hazard channel is stronger than the skin in the game channel of capital regulation. Potential losses to equity holders arising from greater risk taking are not the main driver of risk management decisions in the adjustment process. The positive aspect of the new regulation is that banks react by increasing the amount for capital even if this does not restrain them from taking on more risk.

3.6 Heterogeneity

3.6.1 Heterogeneity by Size and IRB

This section investigates how size and internal rating based approach affect the relationship between capital requirements and risk taking behaviour. Bank size is measured using total assets, with small banks classified as those having less than EUR 20 billions in total assets, medium banks defined as banks with assets between EUR 20 to EUR 100 billions and large banks have more than EUR 100 billions in total assets.[41]

Further, banks are distinguished by their risk weights measurement approach in order to gauge whether more sophisticated financial institutions can successfully circumvent the risk-weighting system and present lower risk-weights on their books. The indicator variable for the IRB approach is constructed from SNL Financials where the risk weights measurement framework is provided and the dummy takes value one if the bank is using either the advanced or the foundation IRB.[42] A priori, we expect a positive correlation between size and IRB, due to resource constraints smaller banks may not have the required human capital to design and deploy the IRB approach which is more demanding in terms of modelling skills. In our sample, size and IRB have a positive pairwise Paerson correlation coefficient of 0.31, this correlation is significant at one percent significance level. Table 3-7 presents the evidence on the impact of a hike in capital requirements for capital indicators,

[41] The classification of banks follows a division of the sample in three approximately equal parts in order not to lose observations and hence statistical power when performing heterogeneity effects, see Table 3-I. For the smaller banks, this subdivision is also in line with the EU Banking Union criteria to distinguish Least Significant Institutions (i.e. total assets $<$ EUR 30 billions) and Significant Institutions (total assets $>$ EUR 30 billions). Other thresholds for size have been tested and results do not alter the conclusions presented in this section. Regressions by other categorizations are available from the author.

[42] There are two versions of the IRB approaches. The Advanced (A-IRB) is the most sophisticated of two credit risk modelling approaches agreed by regulators in 2004. It allows banks to calculate the probability of default (PD) for a loan, as well as the exposure at the point of default and the resulting losses. Its simpler cousin, the foundation IRB, only allows PD to be modelled. In the following we consider a dummy one for banks using either the A-IRB or the foundation IRB approaches, or a mixture of the two. The dummy is set to zero for purely standardized approaches (SA).

while Table 3-8 shows the estimates for measures of risk. All regressions include bank-level controls, bank fixed effects and country-quarter fixed effects, the latter control for time varying macroeconomic heterogeneity.

Impact on Capital by Size and IRB

Following the results in Section 3.5.1, Table 3-7 adopts the specification with a dummy variable for distance which is 1 if the distance from the OCR is greater than two percentage points, for the sake of space and according to the results of Table 3-5 the dummy for distance takes on only two values.[43] The estimates on the impact of capital do not present strong evidence of hetereogeneous impact by size or risk weights measurement framework. The interaction with the distance from the overall capital requirement is likewise not significant. The evidence on capital raising from Table 3-7 leads to conclude that there is no significant heterogeneous behaviour between small and big banks or between banks adopting the IRB or the SA.

The results related to the risk taking behaviour are more informative. Table 3-8 illustrates the outcome of the regression, this time without differentiating by distance from the OCR since risk taking behaviour does not appear to be related to the buffer of capital the bank maintains on top of the minimum requirement, this was shown in Table 3-6. Columns (1)-(3) show the results by bank size while Columns (4)-(6) present evidence for banks with IRB and for the interaction of size and IRB.

Impact on Risk by Size and IRB

The results related to the risk taking behaviour are more informative. Table 3-8 illustrates the outcome of the regression without differentiating by distance from the OCR since risk taking behaviour does not appear to be related to the buffer of capital the bank maintains on top of the minimum requirement, this was shown in Table 3-6. Columns (1)-(3) show the results by bank size while Columns (4)-(6) present evidence for banks with IRB and for the interaction of size and IRB.

Column (1) of Table 3-8 indicates that RWA are increasing by approximately seven percent for a one percentage point increase of capital requirements. The impact on RWA does not appear significantly different between smaller and bigger banks. In Column (2), RWA are divided by total assets to obtain the risk ratio.[44] The evidence indicates a clear increase of the impact on the risk ratio as the size of the banks increases. Banks with total assets above EUR 20 billions tend to take on more risk compared to small banks, approximately a two percentage point more for every percentage point increase in capital requirements. Column (3) confirms further that banks do not decrease their assets size significantly following an increase in capital requirements.

In Column (4)-(6) we augment the specification with the risk weight measurement framework represented by the indicator variable for IRB, which takes the value one if the bank is using the internal rating based approach. Column (4) reveals that the increase in RWA is driven exclusively by banks with assets greater than EUR 100 billions. The coefficient for large banks increased to eighteen percent following a one percentage point hike in capital requirements. The impact for smaller banks is

[43] Same categories for the breakdown of distance from OCR as in the previous section, as well as other categories of size of the bank have been experimented, the results are similar in terms of both magnitude and statistical significance, they are available from the author.

[44] Notice that netting out total assets from RWA eliminates also concerns on endogeneity due to reverse causality.

no longer significant. Even more telling is the impact for banks with more than EUR 100 billions in assets using the IRB approach, they appear able to exploit their modelling techniques for risk-weights and decrease the impact on RWA by fifteen percent less than large banks relying on the SA for risk-weights. The marginal impact of one percentage point increase of the SMCR on large IRB banks is a two percent increase in RWA.

Column (5) of Table 3-8 takes a closer look by netting out the confounding effect of the RWA ratio denominator. The first and the forth row of Column (5) confirm that even smaller banks take more risks following a rise in capital requirements while the IRB approach for small banks does not bring significant benefit in curtailing their risk ratio. For smaller banks, a one percentage point increase in capital requirements induces an increase of the risk ratio by 4.3 percentage points. More interestingly, the second and the third row of Column (5) suggests that there is a positive relation between risk taking behaviour and bank size. As the size of the bank increases, and with it its systemic importance, the risk taking behaviour is more accentuated. A one percentage point increase in capital requirements is associated with a 7.3 percentage points increase of the risk ratio for medium banks, and with a 9.6 percentage points increase for large banks, both at 5% significance level. These results are consistent with the presence and intensification of agency costs as the financial institutions becomes larger with a more fragmented shareholders base. In fact, as pointed out by Ang, Cole, and Lin, 2000, agency problems are directly proportional with the dilution of the ownership structure, and it can be inferred that in large publicly traded banks these are substantial.

Can IRB banks reduce the *observed* risk taking behaviour by exploiting the more advanced approach to measure risk weights? The last row of Table 3-8 presents the results. For medium banks, the interaction coefficient between size and IRB is negative even if it is not statistically significant. Large IRB banks with total assets above EUR 100 billions show a decrease of their risk ratio by 3.6 percentage points with respect SA banks of similar size. They show a significantly lower propensity to augment their risk ratio when capital requirements are incremented despite the marginal effect is still greater than the baseline banks with assets lower than EUR 20 billions. This implies that large IRB banks are successful in presenting a reduced risk exposure to their supervisors, suggesting overall lower levels of risk taking, even if their balance sheet could have a similar risk profile to the one of their competitors using the standardized approach. To what extent this risk reduction is real and effective, or is just the result of manipulating the risk weights in their own favor, it is impossible to discern with the data used in this paper. Nevertheless, the evidence establishes the presence of a competitive advantage for IRB banks since lower risk weights imply a lower cost of compliance to a hike of regulatory capital requirements.[45]

[45]These result raise the question whether very big and sophisticated banks, the G-SIBs and their subsidiaries across Europe, are driving this behaviour. Unfortunately, all 14 G-SIB in our sample are sophisticated enough to adopt the IRB approach for risk weights measurement, this lack of variation does not permit to test this hypothesis. A solution is to use a higher threshold for the size of the very large banks and as a proxy rule we defined the threshold of EUR 300 billions for the very big banks in the EU, but even in this case the required variation in the IRB variable was not sufficient to obtain the estimates, see Table 3-I. Only three banks with assets greater than EUR 300 billions adopt the SA and 29 use the IRB.

3.6.2 Heterogeneity on Risk by Profitability, Funding and Leverage

This section explores further the heterogenous impacts of a change in capital requirements on bank risk taking behaviour by looking at three measures of bank performance: net interest income as a proxy for profitability, wholesale funding as a proxy for inherent liquidity risk, and the leverage ratio as a measure of bank capitalization.

Profitability and risk taking

The low interest rate environment which characterised the past decade shrinks the interest income margin of banks and increases pressure on their profitability. The literature has shown convincingly this link in both theoretical and empirical contributions, Samuelson (1945), Hancock (1985), and Borio, Gambacorta, and Hofmann (2017). Therefore, less profitable banks may take more risk in order to compensate for the reduced profitability. This argument is strictly intertwined with the proponents of the charter value theory of the bank, as summarized in Section 3.2, which support the skin in the game argument whereby banks have more incentives to operate conservatively when the amount of equity is at risk, Marcus (1984) and Benston (1986).

If the above arguments are true, more profitable banks should show a less aggressive risk taking behaviour when faced with a capital increase. To test this proposition, the specification is augmented including an interaction of the SMCR and an indicator dummy of net interest income (NII) as a proxy for profitability. NII is defined as interest income less interest expense before provisions for loan losses, and hence is a direct measure of return stemming from interest rate. Table 3-9 presents the results for profitability in Columns (1)-(2). The dummy for profitability is switched on if net interest income is above median (NII $= 1$), reporting the estimates for more profitable banks.

The evidence suggest that there is a greater tendency to take on more risk by the cluster of less profitable banks. This finding is shown when the dummy for profitable banks is turned on (NII $= 1$). The interaction coefficient of small banks with a net interest income above the median has a positive albeit insignificant magnitude. More interestingly, profitable medium and large banks show a significantly lower propensity to increase risk with respect to similarly sized less profitable banks. Medium banks with above median net interest income decrease their risk ratio by 1.6 percentage points (s.d. 0.741) less than same sized banks with below median NII. The same compensatory pattern in risk taking is observed for large profitable banks, they decrease the risk ratio by 2.01 percentage points (s.d. 0.925) with respect large banks with below median NII. For both median and large banks, a test of the sum of the coefficients for above and below median NII banks, fails to reject the null.[46]

These results confirm the fact that more profitable banks show a less aggressive risk taking behaviour when faced with a capital increase, and indicate that most of the increase in risk taking associated with size is related to less profitable institutions. This leads to the conclusion that the increase in risk taking associated with bank size is due to less profitable banks and the tendency to gamble for resurrection.

[46]For median banks the null hypothesis of the linear combination 2.158-1.634=0 has a p-value=0.63 and fails to reject the null. For large banks the tested linear combination is 2.842-2.067=0 with a resulting p-value=0.48

Wholesale funding and risk taking

This section introduces a link between liquidity risk and the risk taking behaviour. In general, banks with a greater reliance on market funding are more prone to liquidity runs in times of crisis, see Rajan, 2006; Brunnermeier, 2009.[47] Wholesale funded banks have to frequently rollover large amounts of funds which makes them particularly vulnerable when market or interbank liquidity dries up. In addition, Huang and Ratnovski, 2011 show how on the supply side of wholesale funding the financiers do not have incentives to conduct costly monitoring of banks since they may withdraw on short notice based on negative news signals, exacerbating further the risk of a potential bunk run. This inherent liquidity risk residing in wholesale funded banks poses a threat to their stability.

Based on the evidence provided in previous sections the question arises as to whether wholesale funded banks recognize the inherent liquidity risk of their funding model when reacting to a hike in regulatory capital or not. If not, the consequences of an increase in capital requirement from a systemic standpoint may be even more worrisome since higher risk taking is more likely to lead to negative news signals and subsequent bunk runs.

The evidence on the interaction between wholesale funding model and risk taking behaviour following an increment of the SMCR is provided in Column (3)-(4) of Table 3-9. Wholesale funded banks are coded with a dummy being one when the ratio of wholesale funding, short and long term, over total assets is greater than the median. The first three rows corroborate the results observed in previous specifications. Medium and large banks show more than 2 percentage points higher reaction of the risk ratio than smaller banks suggesting once more that agency costs may be a driver of this difference. The results change significantly when the SMCR increase is interacted with size and a dummy representing wholesale funded banks (WHS=1). Smaller wholesale funded banks show a further increase in the risk ratio by 1.34 percentage points with respect to similar size non wholesale funded banks. On the contrary, medium and large wholesale funded banks decrease their risk ratio by the same amount of their risk increase after the hike in capital requirements.

This reduction compensates the propensity to rise the risk ratio associated with medium and large banks and indicates that the increase of the risk ratio is largely driven by medium and large retail funded banks. The results suggest that wholesale funded banks have a lower incentive to increase the riskiness of their portfolio when faced with a capital requirement hike.

This may be due to several factors, in particular can be interpreted as a strategic need to reduce the publicly observed risk ratio in view of the already riskier funding model. A further interpretation may be related to profitability and the results in Column (3)-(4) on wholesale funding can be reconciled with the evidence provided in the previous section on profitability and risk taking in Columns (1)-(2). In fact, recent literature has shown that wholesale funded banks have a competitive advantage in a low interest rate environment since they can shift their funding globally towards regions where monetary policy conditions are looser and exploit thus cross-border funding to limit the negative pressure on profitability due to low interest rates, see Bruno and Shin, 2015. It follows that wholesale banks are on average more profitable than banks relying on standard deposit funding, this is described in Figure 3-1 for our sample of G-SIBs and O-SIBs in the EU, and therefore have lower incentives to increase their riskiness to compensate for lower interest income.

[47] For instance, Shin, 2009 notes that in the Northern Rock bank run case, wholesale funding plummeted by more than 50%, from 26.7 billion pounds in June to 11.5 billion pounds in December 2007.

Leverage and risk taking

This section investigates the link between the leverage ratio and risk taking. The relationship is expected to be positive according to the previous contributions by Furlong and Keeley, 1989 and Dewatripont and Tirole, 1994. Leverage is measured following the Bank of International Settlements definition by dividing Tier 1 capital by the bank's average total consolidated assets (i.e. the sum of the exposures of all assets and non-balance sheet items).[48] In addition, a dummy variable is defined for above (LR=1) or below (LR=0) the median leverage ratio in the sample. The evidence for the interlinkages between leverage and risk taking subject to a regulatory capital increase is presented in Columns (5)-(6) of Table 3-9.

While the first three rows confirm again the incremental impact of regulatory capital on the risk taking behaviour by bank size, the heterogeneous impact by above median leverage ratio is not statistically significant. The sign of the interaction coefficients for medium and large banks hints at a negative relationships, however the estimates are rather noisy suggesting an absence of relationship between risk taking and leverage ratio following an increase in regulatory capital requirement. This result is consistent with the evidence shown in the baseline regression for risk taking presented in Table 3-6 where the impact was broken down by the distance from the minimum overall capital requirement. Despite the distance from OCR being a risk-sensitive measure of capital due to the use of risk-weighted assets at the denominator, it is positively correlated (correlation coeff. = 0.35) with the non-risk-based leverage ratio measure and has a similar economic interpretation.

3.7 Robustness: Common Trends

The failure of the common trend assumption due to diverging behavior between treated and control banks is a standard threat for the identification of Difference-in-Difference (DiD) empirical strategies, Angrist and Pischke, 2008b. In the current setting the common trend assumption implies that the risk taking behaviour of banks would be same in the absence of treatment. This section presents the evidence of three alternative tests of the common trend assumption for DiD regressions. The first test controls for bank specific trends in the specification, the second test augments the model with bank specific leads of the policy variable to detect anticipation effects across banks, the third method distinguishes between treated and control banks pre-treatment trends during the announcement period and investigates for diverging behavior[49]

3.7.1 Bank specific trends and a longer T

The first test studies the influence of confounding pre-existing trends at the level of the policy variable by including a bank specific trend in the model as in Wolfers

[48] For more detailed information on the Basel III leverage ratio consult the documentation provided on the BIS website

[49] It is useful to note the difference between the standard two-way DiD setting and the multi-group setting. In the two groups setting, uniformly treated and non-treated groups are compared and the uniform treatment variables is a dummy (1/0). In the multi-group DiD setting the intensity of treatment varies across the treated group: in this paper these are represented by heterogeneous capital requirements across banks, i.e. the treatment variable is not a simple dummy but varies across banks. In addition, in this study the time dimension is not constituted by only two periods (after/before) as in the standard two-way DiD approach, instead, each quarter can have progressively stricter treatment intensity per bank introducing thus a more dynamic multi-period treatment.

(2006). If banks' trends are not controlled for, and treated and control banks have diverging trend, then the estimates of the impact of capital requirements may suffer of bias due to the confounding effect on them induced by the diverging trends across the two groups.[50]

It is important to note another reason why including bank specific trends in the regression is necessary for unbiased identification. When pre-existing bank trends are correlated with both the change in capital requirements (i.e. main regressor of interest) and the risk taking behaviour of banks (i.e. the dependent variable), the inclusion of bank specific trends in the model ensures that the estimated coefficient on the variable of interest is not affected by omitted trend bias, see Wolfers, 2006.

Formally, to test for the robustness of the inclusion of bank trends the baseline model is augmented with bank specific trends represented by the product $\phi_i \cdot t$ where i is the indicator for banks and t stands for the time dimension (i.e. quarters):

$$lnY_{ict} = \alpha_i + \beta \Delta SMCR_{ict} + \ln X_{ic,t-1}\gamma + \phi_i \cdot t + \delta_{ct} + u_{ict} \tag{3.3}$$

If the impact of the increment in capital requirements on the risk ratio is not statistically significant after including bank-level trends then the evidence presented should be interpreted with caution. In that case, it is very likely that divergent trends would affect the findings, i.e. the increment in capital requirements would have happened predominantly in banks where already a rising risk ratio was being implemented by bank management.

The first evidence for the first test on common trends is illustrated in Table 3-10. The Table is split in two parts, Columns (1)-(3) present the results for capital to be compared with baseline regression without bank specific trend as in Table 3-5; Columns (4)-(6) presents the results for risk taking behaviour to be compared with baseline Table 3-6. After including bank specific trends the statistical significance of the coefficients remains unchanged for both capital and risk taking. The magnitude of the coefficients for the *level* of CET1 and total capital are slightly smaller than in the baseline regressions. Similarly, the coefficient on the risk ratio decreases after including bank trends, the impact of higher capital requirement on risk taking results halved to 3.1 percentage point increase for a one percentage point increase of the SMCR. While this is a considerable reduction of risk taking, it is a symptom that bank specific trends play a significant role in the estimates driving down the overall results.[51]

For the second part of the evidence on the bank specific trends, it is important to notice that the estimated trends may depend on the length of the time series. In fact, as shown in Wolfers, 2006, controlling for bank specific trends only works well when there is a sufficient sample period available before the treatment period commences. As such, the estimated trends in Equation 3.3 may require more observations to be properly fitted to the data.[52] The test is therefore repeated extending the estimation sample to begin in 2006 rather than in 2010. This allows to estimate bank specific

[50]Note that trends in risk taking behaviour may diverge because of several reasons: for instance structural changes in bank business models or because of the formation of expectations on future regulation as for example the introduction of new provision within Basel IV that may affect strategic portfolio allocation of banks.

[51]Note that the coefficient of determination R-squared is considerably higher since data now explain a greater portion of the variation of dependent variables. As common when trends at the policy variable are included standard errors are bigger implying a higher p-value.

[52]The problem is exacerbated when there is a structural break in the pre-existing trend of the outcome variable as it is likely to have happened after the 2007-8 financial crisis as shown for capital in Figure 3-2.

trends on a full financial cycle starting in 2006 before the financial crisis and ending with the introduction in 2014 of macroprudential capital buffers.

The second part of the evidence is shown in Figure 3-3. From left to right in each plot, the dots represent different βs estimated when increasing progressively the starting period of the sample by one year and shrinking thus the available observations for the estimation of the trend. The first column of Figure 3-3 presents the evidence for capital variables with one plot each for CET1 ratio, CET1 capital and total capital. The second column illustrates the evidence for risk with one plot for RWA, the risk ratio and total assets. Vertical bars show confidence intervals for every estimated β.

By looking at the results, it is confirmed that the assumption of common trends is robust also to different lengths and starting years of the sample which allow for a better fit of pre-existing trends to the data. Consistently with the previous results, the risk ratio and the RWA show similar estimated coefficients as in Table 3-10. The level of CET1 is however not always significant when the trend is allowed to be computed prior to 2010, even if the failure to accept is due to few decimals of a percentage points, indicating that the results for the level of CET1 may suffer marginally from the non holding of the common trend assumption.

3.7.2 Anticipation effects

An additional method to test for the common trends assumption is to use leads of the policy variable. If leads of SMCR turn out to be significant, the common trend assumption may be questioned due to differential pre-treatment trends across the banks. In other terms, some banks may anticipate the incoming change in capital requirements and front load their compliance while others not. To grasp the idea, Figure 3-2 shows the dynamics of the supply of capital for systemically important banks in the EU. It is shown that CET1 capital ratio of SIBs increased by more than 6 percentage points since 2010 with strongest increase occurring in 2013 when the EU CRDIV/CRR regulation was officially transposed into law. This may suggest that EU banks could have foreseen a tighter macroprudential policy stance by raising capital ratios in anticipation of the stricter capital requirements. To test the presence of anticipation effects the baseline specification is enriched with two year leads of the policy variable. Formally:

$$lnY_{ict} = \alpha_i + \sum_{q=0}^{2} \beta \Delta SMCR_{ic,t+q} + \ln X_{ic,t-1}\gamma + \delta_{ct} + u_{ict} \tag{3.4}$$

Table 3-11 summarises the evidence for capital in Columns (1)-(3) and risk in Columns (4)-(6). The one and two years leads are computed summing the coefficients of the four quarters prior to policy change, and standard errors are adjusted accordingly.

The results in Table 3-11 present some novelties: Column (1) reveals that banks adjust their capital *ratio* already one year prior to the policy change, probably as a signalling effect to the markets. This adjustment seems to be driven by a deleveraging policy via a reduction of total assets, see Column (6).

Importantly, none of the main results of previous section is affected by the introduction of leads in the specification. The level of CET1 is statistically significant only at the time of the policy change. The same holds for RWA and the risk ratio in Columns (4)-(5). Overall, the findings indicate that banks in the sample had comparable pre-intervention trends for the level of CET1 capital and the risk ratio.

3.7.3 Announcement effects

A further method to test for the presence of diverging trends prior to the implementation of the policy is to look at announcement effects. This section implements a different method in modelling bank anticipatory behavior, it does so by defining a specific exogenous treatment status and models separate trends for a treatment and control groups instead of modelling a bank specific trend as in Section 3.7.1, or bank specific lead effects of the policy variable as in Section 3.7.2.

The announcement of a change in the capital requirements policy may itself lead to strategic reactions by banks invalidating the common trend assumption. The European Commission anticipated publicly the intention to strengthen its capital framework for systemically important banks in September 2009, when it introduced the possibility to increase macroprudential capital buffers in good times to be released in a downturn.[53] This change of paradigm may have induced banks to anticipate their reaction to the capital increase before the implementation in 2014 and may confound the previous findings.

In order to test formally for the impact during the announcement period this section relies on an event analysis framework akin to Alpert, 2016. In the following set-up, the announcement period dummy is defined as the period from 2009Q4 until 2013Q4. At time of the announcement, and during the announcement period, large European banks may expect to be levied with higher capital requirement and react to the paradigm shift. However, being effectively levied a capital requirement and hence assigned a treatment status after 2014 is a discretionary choice of the regulator, and this choice is exogenous to banks' expectations which are predetermined. In other terms, in 2009 banks are not aware of what would be the regulators' revealed preferences in 2014. This framework ensures that banks cannot self-select in the treatment group since the decision to levy a capital requirement on a specific bank is exogenous to their expectations. As such, to define the treatment group, a dummy takes the value of one if the bank has been subject to a positive SMCR in any quarter after 2014q1.

Formally, variants of the following DiD equation are estimated:

$$\begin{aligned} lnY_{ict} = \alpha_i + \beta \Delta SMCR_{ict} + \omega D(Announcement) * D(Treated) + \ln X_{ict-1}\gamma + \\ + \eta D(Announcement) + \theta D(Treated) + \delta_{ct} + u_{ict} \end{aligned} \tag{3.5}$$

This basic strategy compares deviations from trends of capital and risk taking between a treatment and a control group of banks during the announcement period, the coefficient of interest is the ω of the interaction term $D(Announcement) * D(Treated)$. If the coefficient is statistically significant then the trend deviations across the treated and control groups are diverging and the common trend assumption across the two groups would not hold.

The results are presented in Figure 3-4 for the level of CET1 capital and in Figure 3-5 when the dependent variable is the risk ratio. The left panels of each figure show the ω coefficient of the interaction term $D(Announcement) * D(Treated)$ for different starting periods of the estimation sample similar to the reasoning of Table 3-3. The right panels of each figure plot the β coefficient for $\Delta SMCR_{ict}$ as specified in Equation 3.5.

[53] The proposed changes were introduced under the Commission Directive 2009/111/EC of the European Parliament and of the Council of 16 September 2009 amending Directives 2006/48/EC, 2006/49/EC and 2007/64/EC as regards banks affiliated to central institutions, certain own funds items, large exposures, supervisory arrangements and crisis management. A copy of this directive may be found at this link.

For either capital or risk indicators, the evidence indicates that there is generally no statistically significant difference in the reaction of treatment banks during the announcement period and in comparison to the non-treated group. For the risk ratio, and only when the sample begins in 2006, the impact is significant at the ten percent confidence level. The impact of the SMCR in the implementation period, i.e. after 2014, remains in line with the coefficient found in the baseline Tables 3-5 and 3-6. In other words, the impact of the SMCRs is not absorbed or curtailed by the introduction of a dummy that captures the announcement period and we can conclude that the estimated positive relationship between higher capital requirements and higher capital and risk taking is robust to the inclusion of announcement periods.[54]

3.8 Robustness: Endogeneity

The exogeneity of the policy change may not be warranted even if the change in the SMCR is external to the bank decision making process. A variable of interest that is external, but not exogeneous, will not yield consistent estimates of the parameter of interest, see Deaton, 2010.

Macroprudential capital requirements are set for each bank individually at national level by its own macroprudential authority. This leaves discretion to national regulators and could cause the introduction of macroprudential capital requirements to be endogenous if the Member State behaves strategically and wants to protect (weaker) domestic banks. If it does, then undercapitalised banks may have a favorable treatment and the level of capital will be determining the SMCR introducing reverse causality. As described earlier, significant regulatory provisions are aimed at ensuring that this does not happen, nevertheless a test for this possibility is warranted.

This section presents a simple procedure to test for the possibility of endogeneity by looking if the outcome variables of interest are correlated with the SMCR exploiting the within variation of the fixed effect estimator. The following equation is estimated:

$$\begin{aligned} SMCR_{ict} = \alpha_i + \psi Y_{ict} * D_{2010Q1-2013Q4} + \ln X_{ict-1}\gamma + [\phi_i \cdot t] \\ + \chi D_{2010Q1-2013Q4} + \zeta Y_{ict} + \delta_{ct} + u_{ict} \end{aligned} \tag{3.6}$$

In Equation 3.6, the systemic macroprudential capital requirement is regressed separately on the series of outcomes of interest Y_{ict} representing in turn the capital and risk variables used as dependent variables throughout the paper. The dummy variable $D_{2010Q1-2013Q4}$ is turned on in the period prior to the commencement of the phasing-in of the SMCR in the EU, that is prior to 2014. The specification controls for bank level characteristics $\ln X_{ict-1}$ and a bank trend $\phi_i \cdot t$ is included to control for diverging trends across treated and control groups, as before, α_i are bank fixed effects and δ_{ct} are country-time fixed effects.

The main coefficient of interest in the equation is the coefficient of the interaction term $Y_{ict} * D_{2010Q1-2013Q4}$ estimating the relationship between pre-determined outcome variables prior to the treatment period and the realised capital requirement after 2014. If the coefficient ψ is significant then bank capital situation prior to the

[54] Alternative later periods may be considered as the beginning of the new macroprudential framework in the EU as for instance since the EU Commission public consultation on the new CRD-IV in 2010Q2. Nevertheless, similar results to those presented in Figures 3-4 and 3-5 are obtained when the announcement period is set in 2010Q2. Results are available from the author. The document of the consultation is available at this link.

phasing-in may have influenced the setting of the SMCR questioning the exogeneity assumption. If this is not the case, then results will substantiate the assumption on the absence of strategic targeting by policy makers. For simultaneity bias then it is useful to observe the ζ coefficient of Y_{ict}.

Results are presented in Table 3-12 for capital and in Table 3-13 for risk. In both tables any sign of correlation between outcome variables and the SMCR vanishes as bank specific trends are included in the regression. For capital, in Table 3-12 Columns (1)-(2) the CET1 ratio is not related with the SMCR even without bank trends. The level of CET1 in Columns (3) however shows some negative relation prior to 2014, as a potential sign of favouritism towards weaker banks, however this disappears once bank trends are controlled for in Column (4). For risk, in Table 3-13 Columns (1), (3) and (5) may suggest endogeneity, this however is not robust to inclusion of bank specific trends in Columns (2), (4) and (6). Importantly, for the risk ratio which is the main variable of interest, the simultaneous bias does not appear to be a problem even when bank trend are not controlled for in Column (3). Overall, the results indicate once more the importance of bank specific trend in the estimation and the relevance of the tests presented and discussed in Section 3.7.1.

A similar result is shown also in Table 3-14. The table presents a simple regression of the average of the SMCR by bank after 2014 on the average prior to 2014 of the bank level outcome variables. The aim is to investigate whether the average of the outcome variables before 2014 correlates with the regulation after 2014. If there is positive correlation then is likely that the SMCR is endogenous since bank capital and risk taking prior to the implementation of the macroprudential capital requirements would have affected the discretionary decision of national competent authorities in setting the capital requirement. Note that by taking bank level averages prior and post the start of the implementation phase the bank level trend is controlled for by construction.

Results in Table 3-14 confirm that there is no statistical relationship between the capital and risk position of the bank prior to 2014 and the subsequently levied capital requirements. Column (1) indicates that there is some positive relation between the average CET1 ratio before 2014 and the later SMCR, however this relation is positive suggesting that stronger (and not weaker) capitalised banks may have been subject to harsher capital requirements. Nevertheless this relationship is not robust to the inclusion of country dummies. Similarly, from Column (3) to (8) there is no systematically strong evidence of capital and risk prior to 2014 influencing the setting of the SMCR post policy implementation. The absence of significant correlation is an encouraging sign since it shows that SMCR were not systematically levied on less capitalised banks or banks with higher risk ratios.

3.9 Solvency: Probability of Default

This section explores the impact of a hike in capital requirements on the solvency of financial institutions. As shown previously, the tightening of the capital requirements has two opposing effects: i) results of Section 3.5.1 would suggest that higher capital requirements would make banks more solvent and, consequently, reduce their probability of default; ii) at the same time, the findings in Section 3.5.2 show that higher capital requirements may lead to moral hazard and increased risk-taking, thus weakening banks' solvency. Hence, the net impact of the two opposing effects on banks' probability of default is ambiguous.

In order to shed light on which of the two opposing effects on solvency is stronger, this section uses credit ratings as a gauge of banks' probabilities of default. The default probabilities are extrapolated from bank issuer ratings provided by three major rating agencies.[55] The probabilities of default are obtained by mapping and converting of alphanumeric ratings using publicly available conversion tables on rating agencies websites. The constructed distance to default variable informs about the solvency of a bank by estimating the default probability over the next, two, three, four and five years. It provides timely information reflecting current market perception, and summarises market-wide information on the drivers of default probability.

Similarly to Section 3.4.2, the phasing-in of SMCR in the EU is used as a tool for a controlled comparison whereby different institutions across Europe are subject to heterogeneous intensity of capital requirements. However, this section departs fundamentally from the previous estimates since the dependent variable is now part of the reaction function of *market agents* to higher capital requirements and not a reaction of the bank itself. Results are presented in Table 3-15. The table presents in each column the evidence for a different probability of default horizon. Estimates are broken down by the size of the bank. The first thing to notice is that the sample size decreased due to the limited availability of ratings for some banks with respect to the capital and risk ratio regressions, the consequence is that results should be interpreted with an additional ounce of caution for external consistency.[56]

The evidence shows that the market reaction to higher capital requirements is bringing some benefits to medium and large banks in terms of reduced probability of default but only with respect to smaller banks. The relative impact is slightly greater for banks with total assets above EUR 100 millions, and increasing in the probability of default horizon for both medium and large banks. Depending on the maturity horizon of the probability of default, medium and large banks have a lower probability of default with respect to small banks, i.e. 1.3-2.0 percentage points lower for a one percentage point increase in capital requirements. This result suggests that, *relative* to small banks, for medium and large banks the effect of the increase in CET1 capital is stronger than the risk taking channel.

Nevertheless, the *marginal* effects for medium and large banks, while having a negative sign, is not statistically significant as shown in the second panel of Table 3-15. For instance for the one year horizon, the marginal effect of a one percentage point increase in capital requirements for large banks is -0.938 (st.dev. 0.900). While this indicates that the rating agencies may tend to assess the capital increase channel to be stronger, this assessment cannot be statistically corroborated. Similar results are obtained for the marginal effects at different time horizons and for medium sized banks.[57]

The evidence on leads to conclude that the increase of capital requirements does not improve banks' probability of default in absolute terms. In other words, the positive effect of accumulating more equity capital is counterbalanced by the negative substitution effect toward more riskier assets, so that the overall net effect on

[55] The rating agencies are Fitch, Moody's and S&Ps

[56] An alternative market based measure of banks' solvency are CDS prices. Nevertheless, contrary to the ratings, the scope of application of CDS pricing is very limited in our sample since CDS prices are generally available only for some of the large systemic banks. In our sample, this translates to 49 banks with available CDS prices which is much less than the number of clusters in previous regressions. The use of CDS prices would thus create a sample composition bias relative to previous estimates.

[57] This is further confirmed by a baseline regression of the probability of default without the dummy for size, and those broken down by the distance from the OCR, the net interest income and wholesale funding dummies. All of them do not have statistically significant results at standard confidence levels, these specifications are available from the author.

solvency is zero. This raises a concern for the policy maker since the improved resilience achieved by demanding higher capital requirements can be crowded-out by an increase in risk taking.

3.10 Conclusions

The paper presents empirical evidence on the reaction of systemically important EU banks to a hike in capital requirements. Endogeneity concerns related to the change in capital requirement may arise since these are set at a country level. These are, however, alleviated by several provisions within the EU banking regulation mitigating considerably the influence of national interest.

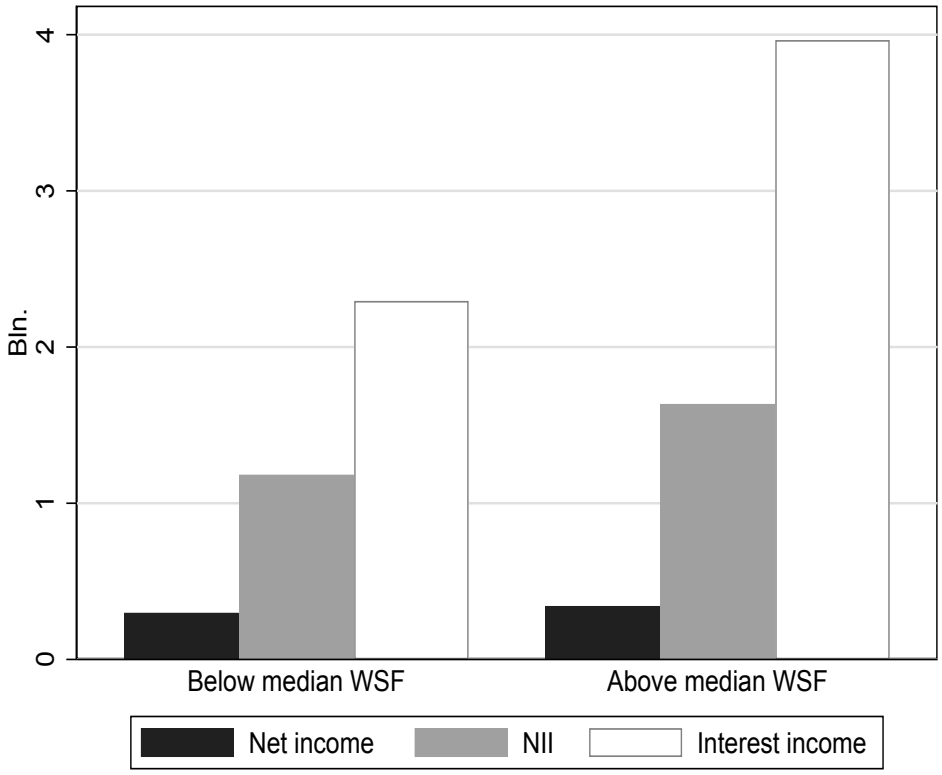
The evidence shows that the impact for O-SIBs and G-SIBs contributed to a substantial increase of CET1 capital levels in the EU banking sector. In response to the implementation of the new legislative package, the overall capital levels, and hence the solvency and the loss absorption capacity, of European systemically important banks increased. This would likely translate in a strengthened resilience of the EU banking sector and would presumably sustain credit growth in a downturn of the financial cycle. The building of capital buffers would limit also the cost to the taxpayer when next bank bankruptcies occur.

At the same time, the paper documents some unintended consequences of bank regulation, which promoted a pronounced risk-taking behaviour by banks suggesting that banks tend to exploit moral hazard when faced with higher capital requirements. This result indicates that there is a risk-capital trade-off: if banks consider that higher regulatory requirements can hinder further their profitability prospects, they will invest in potentially more profitable but riskier assets. This finding is particularly true for less profitable and large banks, suggesting that gambling for resurrection and agency costs may be associated the increased risk taking. The paper documents that banks adopting the IRB approach mitigate substantially the increase in risk taking and exploit their competitive advantage in the calibration of the risk weights. At the same time, after a capital requirement hike, wholesale funded banks show lower risk taking possibly due to a strategic need to reduce the observable risk in view of the already fragile funding position.

The paper shows that the net impact of the two opposing effects on banks solvency is not statistically different from zero. In other words, the increased risk taking is compensating the positive results on solvency arising from higher shareholders' capital so that the net effect on banks' probabilities of default is insignificant.

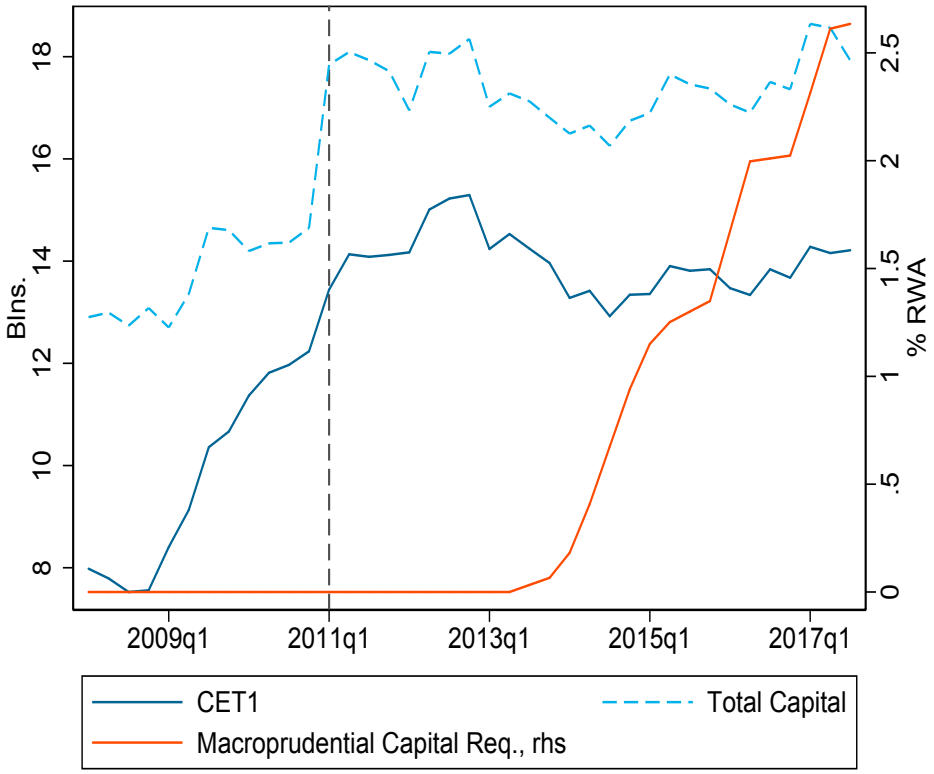
This raises the question as to how policy intervention should aim at constraining bank's risk-taking behaviour. While several suggestions are being currently discussed in the regulatory and policy fora, it is important to keep in mind that introducing policies to lower risk-taking may create further perverse incentives for banks. For instance, it can promote a more systematic use of internal rating based models, or it can induce banks to shift risks to off-balance sheet exposures. The regulatory task is not a simple one, any policy change requires a comprehensive assessment of hidden incentives behind regulatory action.

FIGURE 3-1: Profitability and Wholesale Funding



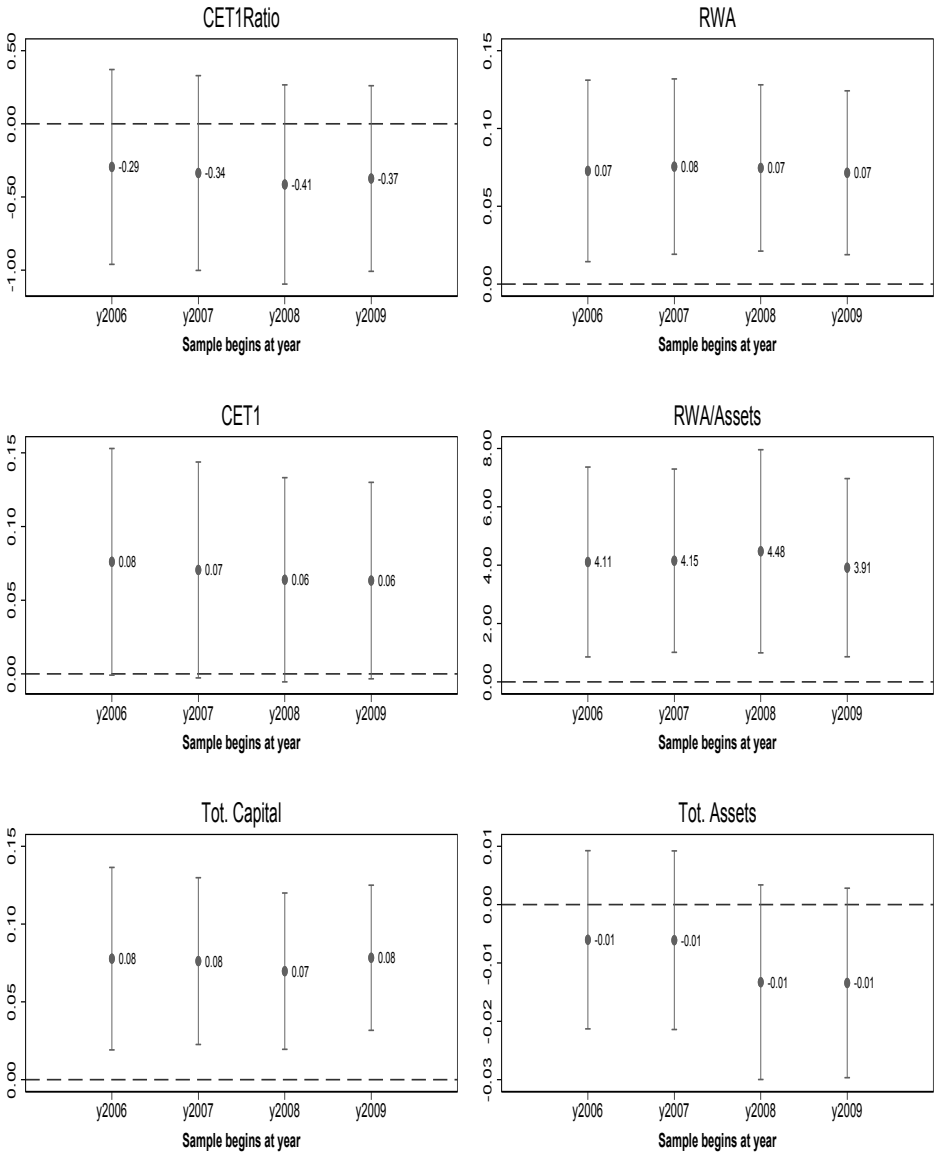
Note: the bar chart show some profitability measures broken down by above and below median wholesale funding reliance. For profitability it is used net overall income, net interest income (NII) and total interest income. A standard test of mean difference is run separately for the three income variables in a pooled panel. They are regressed on a dummy for wholesale funding above median. For net interest income and interest income the estimated β coefficients are both significant and respectively 0.45 (s.d. 0.091) and 1.67 (s.d. 0.182) where standard errors are robust to heteroschedasticity and serial correlation. The coefficient on mean difference for net income is 0.04 (s.e. 0.035) and thus not statistically significant.

FIGURE 3-2: The longer term trend of Capital



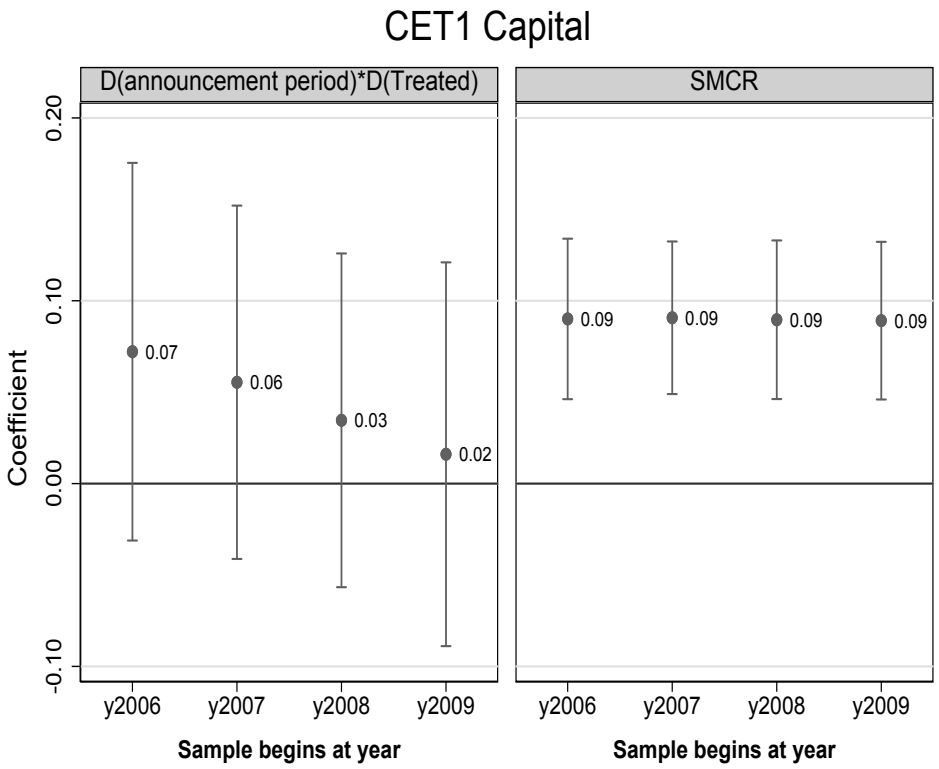
Note: The plot illustrates the evolution of the average CET1 and Total capital across the systemically important banks in the EU. The dashed line shows the moment of a break in the upward trend until 2011Q1.

FIGURE 3-3: Robustness: the impact on Capital and Risk after controlling for bank specific trends



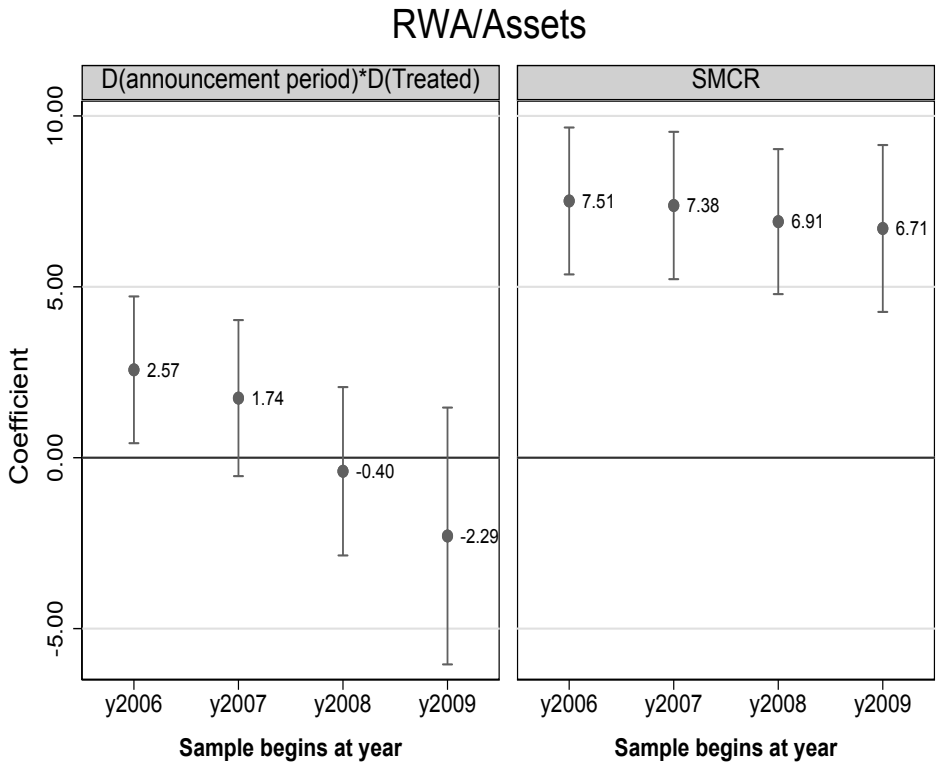
Note: The figure shows the evolution of the β coefficient of equation 3.3 when the estimation sample is progressively reduced by one year. All models have bank trends included in the specification. On the horizontal axis every point represents the staring year of the respective estimation sample, for each sample the last quarter is 2017Q3. Moving to the right of each plot the sample period shrinks by one year each time and hence there are less observations available to compute bank-level trends. On the y-axis, the coefficients represent the impact of a hike in the macroprudential capital requirement. Vertical bars represent confidence interval at 10% significance level. Standard errors are clustered at bank-level and robust for serial correlation and heteroschedasticity.

FIGURE 3-4: Robustness: Announcement effect of EU macroprudential policy on CET1 Capital



Note: The graph shows the evolution of ω and β coefficients of equation 3.5 when the dependent variable is the level of CET1 Capital. The estimation sample is progressively reduced by one year, notice that for each sample the last quarter used in all regressions is 2017Q3. The announcement period is represented by a dummy for the period between 2009Q4-2013Q4, that is since the publication of the EU Commission Directive 2009/111/EC of the European Parliament and of the Council of 16 September pre-announcing a change in macroprudential regulation in the EU. Vertical bars represent confidence interval at 10% significance level. Standard errors are clustered at bank-level and robust for serial correlation and heteroschedasticity. Similar results are obtained when the regressions control for bank specific trends, these results are available from the author.

FIGURE 3-5: Robustness: Announcement effect of EU macroprudential policy on the Risk Ratio



Note: The graph shows the evolution of ω and β coefficients of equation 3.5 when the dependent variable is the risk ratio (i.e. RWA/Assets). The estimation sample is progressively reduced by one year, notice that for each sample the last quarter used in all regressions is 2017Q3. The announcement period is represented by a dummy for the period between 2009Q4-2013Q4, that is since the publication of the EU Commission Directive 2009/111/EC of the European Parliament and of the Council of 16 September pre-announcing a change in macroprudential regulation in the EU. Vertical bars represent confidence interval at 10% significance level. Standard errors are clustered at bank-level and robust for serial correlation and heteroschedasticity. Similar results are obtained when the regressions control for bank specific trends, these results are available from the author.

TABLE 3-1: Macroprudential Capital Requirements in Europe

Buffer	CRD Article	Level	Scope
Capital conservation buffer (CCoB)	Art. 129	The objective is to conserve the bank's capital. Mandatory capital buffer equal to 2.5% of RWAs, this implies a minimum CET1 ratio requirement is 7%	**Country-level (i.e. same for all banks within MS)**
Counter-cyclical Capital buffer (CCyB)	Art. 130, 135-140	The purpose of this buffer is to counteract the effects of the economic cycle. Buffer rate calibrated on MS credit-to-GDP gap.	
G-SIB and O-SIB Systemically Important Banks buffer (SIB)	Art. 131	For banks that are identified by the relevant authority as systemically important: $1 \leq x \leq 3.5\%$ of RWAs for G-SII $0 \leq x \leq 2.0\%$ of RWAs for O-SII	**Bank-level (i.e. set at bank level within MS)**
Systemic risk buffer (SRB)	Art. 133 and 134	To prevent and mitigate long term non-cyclical systemic or macro-prudential risks: $0 \leq x \leq 5.0\%$ of RWA Above 5% the MS must be authorized by Commission	

Note: The table summarises the four macroprudential capital requirements introduced in EU in 2014. The CCoB and the CCyB are country-level capital requirements levied on all banks within a country. The capital requirement for systemically important banks and the SRB buffer are applied at bank-level. MS stands for EU Member States, Norway, despite not being an EU Member State implemented the EU capital based macroprudential regulation.

TABLE 3-2: Direction of Omitted Variable Bias

The table illustrates the sign of the bias due to omitted variable in a simple bivariate model where x_1 is the treatment variable and x_2 is the omitted variable:

$$y = \beta_1 x_1 + \beta_2 x_2 + u$$

	$Corr(x_1, x_2 > 0)$	$Corr(x_1, x_2 < 0)$
$\beta_2 > 0$	Bias > 0	Bias < 0
$\beta_2 < 0$	Bias < 0	Bias > 0

TABLE 3-3: Descriptive statistics by year: Capital, Requirements and Distance

The table summarize the evolution over time of simple means (Panel A) and means conditional on treatment (Panel B) and for non-treated banks (Panel C) of the systemic macroprudential capital requirement (SMCR). Note that the OCR for the control group increases after 2014 due to phasing in of the CCoB and CCyB buffers, see Section 3.3. Standard deviations in parenthesis.

	2010	2011	2012	2013	2014	2015	2016	2017
Panel A: Simple Means:								
SMCR (%)	0	0	0	0.014	0.149	0.442	0.656	0.870
	(0)	(0)	(0)	(0.170)	(0.618)	(1.032)	(1.070)	(1.100)
Overall CET1 Req. (OCR) (%)	4.500	4.500	4.500	4.533	5.174	5.800	6.510	7.124
	(0)	(0)	(0)	(0.384)	(1.414)	(2.014)	(1.824)	(1.705)
CET1 Ratio (%)	10.70	11.51	12.58	13.90	14.90	16.16	17.09	17.58
	(2.872)	(3.314)	(3.848)	(4.752)	(5.372)	(6.895)	(6.998)	(7.415)
Distance from OCR (%)	7.190	8.043	8.523	9.806	9.993	10.33	10.50	10.47
	(6.295)	(6.536)	(6.432)	(6.935)	(6.192)	(6.622)	(6.620)	(7.270)
Tot. Capital Ratio (%)	15.26	15.92	16.12	17.44	17.83	19.08	20.17	20.83
	(7.175)	(8.050)	(7.288)	(8.015)	(6.800)	(7.584)	(8.692)	(10.59)
Observations	820	820	820	820	820	820	820	615
Panel B: Means Conditional on Treatment								
SMCR (%)	0	0	0	0.020	0.203	0.600	0.892	1.184
	(0)	(0)	(0)	(0.199)	(0.712)	(1.163)	(1.160)	(1.130)
Overall CET1 Cap. Req. (OCR) (%)	4.500	4.500	4.500	4.545	5.349	6.067	6.849	7.509
	(0)	(0)	(0)	(0.447)	(1.564)	(2.203)	(1.967)	(1.809)
CET1 Ratio (%)	11.36	11.93	12.81	14.16	15.07	16.39	17.15	17.63
	(2.858)	(2.921)	(3.278)	(4.179)	(5.327)	(7.264)	(7.301)	(7.029)
Distance from OCR (%)	7.416	8.052	8.676	9.803	9.938	10.27	10.24	10.24
	(4.408)	(4.612)	(4.352)	(4.726)	(5.556)	(6.904)	(6.766)	(6.847)
Tot. Capital Ratio (%)	15.50	15.96	16.21	17.26	17.80	19.15	20.08	20.76
	(5.077)	(5.508)	(4.972)	(5.149)	(5.761)	(7.609)	(8.090)	(7.988)
Observations	604	604	604	604	604	604	604	453
Panel C: Means Controls								
SMCR (%)	0	0	0	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Overall CET1 Cap. Req. (OCR) (%)	4.500	4.500	4.500	4.500	4.685	5.056	5.565	6.046
	(0)	(0)	(0)	(0)	(0.656)	(1.042)	(0.778)	(0.563)
CET1 Ratio (%)	8.668	10.26	11.88	13.20	14.46	15.54	16.96	17.47
	(1.752)	(4.026)	(5.175)	(5.996)	(5.482)	(5.795)	(6.205)	(8.244)
Distance from OCR (%)	6.505	8.020	8.084	9.812	10.14	10.48	11.17	11.02
	(10.05)	(10.20)	(10.29)	(10.85)	(7.657)	(5.828)	(6.192)	(8.196)
Tot. Capital Ratio (%)	14.52	15.82	15.85	17.95	17.94	18.90	20.42	21.01
	(11.44)	(12.93)	(11.61)	(13.03)	(9.143)	(7.529)	(10.13)	(15.51)
Observations	216	216	216	216	216	216	216	162

TABLE 3-4: Descriptive statistics: EU G-SIB and O-SIB Financial Accounts

The table summarizes descriptive statistics of the balance sheet variables used in the paper. The sample is the sample of designated Systemically Important Banks (SIB) in the EU as described in section 3.4.1. For each variable the simple mean, standard deviation, the median, the 25th and 75th quintiles and the maximum are shown. Time period: 2006Q1-2017Q3. The data source is SNL Financials.

	Mean	Std.dev.	p25	p50	p75	Max.
Capital Position:						
CET1 Ratio(%)	13.64	6.06	10.20	12.60	15.70	74.93
Distance from OCR (%)	8.34	6.56	4.84	7.29	10.14	82.36
Tot. Capital Ratio(%)	16.58	7.87	12.28	15.00	18.30	111.64
Leverage Ratio (%)	7.60	4.07	4.66	6.86	9.80	32.98
Risk:						
RWA (bln.)	70.37	139.15	5.54	19.26	60.89	1129.63
RWA/Assets(%)	50.06	21.41	33.14	50.29	64.91	261.02
Assets:						
Tot. Assets (bln.)	196.15	379.97	8.58	39.19	198.37	2506.28
Gross Loans/Assets(%)	58.29	19.62	48.08	62.57	71.59	121.83
Net Loans/Assets (%)	54.71	19.06	44.77	59.03	67.53	105.21
Securities Holdings/Assets (%)	25.13	16.92	13.86	22.15	32.22	99.56
Total Cash/Assets(%)	15.29	11.86	6.94	12.23	20.58	93.64
Securities Holdings:						
Securities Held for trading/Assets (%)	7.55	9.50	1.17	4.15	10.08	65.40
Securities Available for Sale/Assets (%)	9.34	8.29	2.59	8.13	13.88	57.99
Securities Held to Maturity/Assets (%)	2.68	5.63	0.00	0.24	2.51	89.18
Funding Structure:						
Deposits/Assets (%)	48.45	22.96	31.46	51.25	66.51	98.31
Total Wholesale Funding/Assets(%)	33.23	21.95	16.69	29.29	45.48	95.82
Debt/Assets (%)	17.92	18.13	4.62	13.08	24.69	95.82
Interconnectedness:						
Loans to Banks/Assets (%)	10.01	11.23	3.07	6.21	12.95	92.65
Tot. HFT Assets/Assets (%)	8.34	10.63	1.23	4.22	11.40	67.32
Securities OTC derivatives/Assets (%)	5.56	10.01	0.37	1.84	6.12	74.30
Total cash balance at C.B./Assets (%)	5.34	6.08	1.13	3.09	7.19	43.88
Profitability:						
ROA (%)	0.32	1.14	0.10	0.31	0.71	6.56
Cost/Income(%)	58.64	21.87	47.83	56.14	65.60	390.50

TABLE 3-5: The Impact on Capital

The table summarises the baseline reduced form specification of the change in systemic macroprudential capital requirements (SMCR) on bank capital in Columns (1)-(3). Columns (4)-(6) present the heterogenous impact by bank distance from the overall CET1 capital requirements (OCR). All dependent variables that are measured in levels, i.e. CET1 capital in columns (2) and (5) and total capital in columns (3) and (6), are transformed using natural logarithms. Bank-level control variables are as specified in equation 3.1. Time period: 2010Q1-2017Q3. Standard errors are shown in parenthesis clustered at bank-level, robust to heteroscedasticity and serial correlation. FE stands for fixed-effects. Stars indicate statistical significance levels: *** p<0.01, ** p<0.05, * p<0.10.

	Non-Binding			Binding		
	(1) CET1 Ratio (p.p.)	(2) CET1 (ln)	(3) Tot. Capital (ln)	(4) CET1 Ratio (p.p.)	(5) CET1 (ln)	(6) Tot. Capital (ln)
SMCR	-0.054	0.089	0.081	0.834	0.177	0.116
	(0.359)	(0.027)***	(0.027)***	(0.402)**	(0.036)***	(0.042)***
SMCR ×				-0.143	-0.042	-0.003
2pp< OCR distance <5pp				(0.215)	(0.022)*	(0.026)
SMCR ×				0.003	-0.047	-0.012
5pp< OCR distance <10pp				(0.214)	(0.024)*	(0.031)
SMCR ×				0.087	-0.053	-0.013
OCR distance >10pp				(0.232)	(0.024)**	(0.031)
Bank Controls	yes	yes	yes	yes	yes	yes
Bank FE	yes	yes	yes	yes	yes	yes
Country-quarter FE	yes	yes	yes	yes	yes	yes
Obs.	3174	3174	3174	3173	3173	3173
N. clusters	137	137	137	137	137	137
R2	0.688	0.672	0.663	0.800	0.763	0.695

TABLE 3-6: The Impact on Risk

The table illustrates the baseline reduced form specification of the change in systemic macroprudential capital requirements (SMCR) on banks' risk-taking and assets in Columns (1)-(3). Columns (4)-(6) show the heterogenous impact by bank distance from the overall CET1 capital requirements (OCR). All dependent variables that are measured in levels, i.e. CET1 capital in column (2) and Risk-weighted Assets in column (3), are transformed using natural logarithms. Bank-level control variables are as specified in equation 3.1. Time period: 2010Q1-2017Q3. Standard errors are shown in parenthesis clustered at bank-level, robust to heteroscedasticity and serial correlation. FE stands for fixed-effects. Stars indicate statistical significance levels: *** p<0.01, ** p<0.05, * p<0.10.

	Non-Binding			Binding		
	(1) RWA (ln)	(2) RWA/Assets (p.p.)	(3) Tot. Assets (ln)	(4) RWA (ln)	(5) RWA/Assets (p.p.)	(6) Tot. Assets (ln)
SMCR	0.101	6.873	-0.007	0.065	6.073	-0.016
	(0.023)***	(1.388)***	(0.008)	(0.026)**	(1.455)***	(0.012)
SMCR ×				0.002	-0.139	-0.002
2pp< OCR distance <5pp				(0.009)	(0.419)	(0.006)
SMCR ×				0.011	-0.219	0.005
5pp< OCR distance <10pp				(0.011)	(0.533)	(0.005)
SMCR ×				0.013	0.242	0.004
OCR distance >10pp				(0.011)	(0.523)	(0.005)
Bank Controls	yes	yes	yes	yes	yes	yes
Bank FE	yes	yes	yes	yes	yes	yes
Country-quarter FE	yes	yes	yes	yes	yes	yes
Obs.	3277	3277	3277	3195	3195	3195
N. clusters	137	137	137	137	137	137
R2	0.749	0.646	0.875	0.768	0.677	0.875

TABLE 3-7: The Impact on Capital: the role of bank size and internal rating approach (IRB)

The table summarises the reduced form specification of the change in systemic macroprudential capital requirements (SMCR) on bank capital. Columns (1)-(3) present the heterogenous impact by bank size and distance from the overall CET1 capital requirements (OCR). Columns (4)-(6) show the heterogeneous impact by IRB and distance from the OCR. Bank-level control variables are as specified in equation 3.1. Time period: 2010Q1-2017Q3. Standard errors are shown in parenthesis clustered at bank-level, robust to heteroscedasticity and serial correlation. FE stands for fixed-effects. Stars indicate statistical significance levels: *** p<0.01, ** p<0.05, * p<0.10.

	Size			IRB		
	(1) CET1 Ratio (p.p.)	(2) CET1 (ln)	(3) Tot. Capital (ln)	(4) CET1 Ratio (p.p.)	(5) CET1 (ln)	(6) Tot. Capital (ln)
SMCR	0.214	0.133	0.057	-0.006	0.149	0.099
	(0.680)	(0.049)***	(0.056)	(0.543)	(0.046)***	(0.049)**
SMCR × OCR distance >2pp	0.131	-0.027	-0.006	0.164	-0.049	-0.025
	(0.463)	(0.024)	(0.031)	(0.503)	(0.035)	(0.038)
SMCR × 20bln.< Tot.Ass <100bln	0.701	0.458	0.013			
	(3.232)	(0.503)	(0.420)			
SMCR × Tot.Ass>100bln.	-0.506	-0.043	-0.055			
	(0.655)	(0.062)	(0.070)			
SMCR × OCR distance >2pp × 20bln.< Tot.Ass <100bln	-0.683	-0.455	0.006			
	(3.213)	(0.504)	(0.421)			
SMCR × OCR distance >2pp × Tot.Ass>100bln.	-0.300	0.011	0.065			
	(0.622)	(0.056)	(0.068)			
SMCR × IRB				-0.229	-0.075	-0.100
				(0.495)	(0.056)	(0.069)
SMCR × OCR distance >2pp × IRB				0.051	0.065	0.097
				(0.555)	(0.056)	(0.070)
Bank Controls	yes	yes	yes	yes	yes	yes
Bank FE	yes	yes	yes	yes	yes	yes
Country-quarter FE	yes	yes	yes	yes	yes	yes
Obs.	3312	3312	3312	3298	3298	3298
N. clusters	144	144	144	143	143	143
R2	0.692	0.711	0.662	0.696	0.706	0.656

TABLE 3-8: The Impact on Risk: the role of bank size and internal rating approach (IRB)

The table illustrates the estimates of a reduced form specification for the impact of the change in systemic macroprudential capital requirements (SMCR) on banks' risk-taking and assets. Columns (1)-(3) show the heterogenous impact by bank size. Columns (4)-(6) show the heterogenous impact by bank size and IRB. Variables measured in levels, i.e. risk-weighted Assets and total assets, are transformed using natural logarithms. Bank-level control variables are as specified in equation 3.1. Time period: 2010Q1-2017Q3. Standard errors are shown in parenthesis clustered at bank-level, robust to heteroscedasticity and serial correlation. FE stands for fixed-effects. Stars indicate statistical significance levels: *** p<0.01, ** p<0.05, * p<0.10.

	Size			Size and IRB Banks		
	(1) RWA (ln)	(2) RWA/Assets (p.p.)	(3) Tot.Assets (ln)	(4) RWA (ln)	(5) RWA/Assets (p.p)	(6) Tot.Assets (ln)
SMCR	0.071	3.944	-0.004	0.066	4.345	-0.020
	(0.036)*	(1.731)**	(0.018)	(0.043)	(1.904)**	(0.019)
SMCR × 20bln.< Tot.Ass <100bln.	0.020	1.864	-0.002	0.030	2.963	-0.006
	(0.019)	(1.073)*	(0.010)	(0.024)	(1.224)**	(0.010)
SMCR × Tot.Ass>100bln.	0.022	2.079	-0.001	0.181	5.324	0.004
	(0.024)	(1.149)*	(0.011)	(0.049)***	(2.149)**	(0.018)
SMCR × IRB				0.001	-0.034	0.008
				(0.014)	(0.901)	(0.004)*
SMCR × IRB × 20bln.< Tot.Ass <100bln.				-0.009	-1.498	0.008
				(0.031)	(1.469)	(0.010)
SMCR × IRB × Tot.Ass >100bln.				-0.157	-3.595	-0.002
				(0.042)***	(1.802)**	(0.016)
Bank Controls	yes	yes	yes	yes	yes	yes
Bank FE	yes	yes	yes	yes	yes	yes
Country-quarter FE	yes	yes	yes	yes	yes	yes
Obs.	3277	3277	3277	3277	3277	3277
N. clusters	137	137	137	137	137	137
R2	0.750	0.648	0.878	0.756	0.655	0.878

TABLE 3-9: Profitability, Funding and Leverage

The table illustrates the reduced form specification for the impact of the change in systemic macroprudential capital requirements (SMCR) on banks' risk-taking. Columns (1)-(2) show the heterogenous impact by bank profitability as measured with a dummy equal to one if the bank has above the sample median net interest income (NII). Columns (3)-(4) show the heterogenous impact by wholesale funding (WSF) as captured by a dummy equal to one for above median WSF. Columns (5)-(6) illustrate the impact by bank leverage as measured by a dummy above median for the ratio of Tier1 capital on total assets (LR). Bank-level control variables are as specified in equation 3.1. Time period: 2010Q1-2017Q3. Standard errors are shown in parenthesis clustered at bank-level, robust to heteroscedasticity and serial correlation. FE stands for fixed-effects. Stars indicate statistical significance levels: *** p<0.01, ** p<0.05, * p<0.10.

	NII		Wholesale Funding		Leverage Ratio	
	(1) RWA (ln)	(2) RWA/Assets (p.p.)	(3) RWA (ln)	(4) RWA/Assets (p.p.)	(5) RWA (ln)	(6) RWA/Assets (p.p.)
SMCR	0.070	4.296	0.066	3.699	0.052	3.943
	(0.029)**	(1.262)***	(0.032)**	(1.341)***	(0.032)	(1.389)***
SMCR ×	0.026	2.158	0.022	2.101	0.030	2.199
>20bln.< Tot.Ass <100bln.	(0.017)	(0.815)***	(0.018)	(0.897)**	(0.024)	(1.226)*
SMCR ×	0.055	2.842	0.027	2.310	0.033	2.605
Tot.Ass>100bln.	(0.025)**	(0.993)***	(0.027)	(1.104)**	(0.026)	(1.141)**
SMCR × NII	0.018	1.142				
	(0.013)	(0.741)				
SMCR × NII ×	-0.029	-1.634				
>20bln.< Tot.Ass <100bln.	(0.013)**	(0.761)**				
SMCR × NII ×	-0.055	-2.067				
Tot.Ass >100bln.	(0.020)***	(0.925)**				
SMCR × WSF			0.011	1.339		
			(0.011)	(0.633)**		
SMCR × WSF ×			-0.059	-2.124		
>20bln.< Tot.Ass <100bln.			(0.025)**	(1.132)*		
SMCR × WSF ×			-0.060	-2.110		
Tot.Ass >100bln.			(0.025)**	(0.994)**		
SMCR × LR					0.026	0.456
					(0.027)	(1.328)
SMCR × LR ×					-0.014	-0.451
>20bln.< Tot.Ass <100bln.					(0.027)	(1.355)
SMCR × LR ×					-0.021	-1.010
>20bln.< Tot.Ass <100bln.					(0.027)	(1.396)
Bank Controls	yes	yes	yes	yes	yes	yes
Bank FE	yes	yes	yes	yes	yes	yes
Country-quarter FE	yes	yes	yes	yes	yes	yes
Obs.	2794	2794	2713	2713	2794	2794
N. clusters	142	142	142	142	142	142
R2	0.747	0.644	0.747	0.649	0.748	0.644

TABLE 3-10: Bank Trends

The table presents the reduced form specification augmented with bank specific trends to control for the presence of diverging trend across banks. SMCR stands for systemic macroprudential capital requirement. Columns (1)-(3) present the estimates for the impact on capital differentiated by the distance from the OCR. Columns (4)-(5) show the evidence for risk and assets without differentiating by distance from OCR since risk and capital are not sensitive to distance from OCR, see 3-6. Bank-level control variables are as specified in equation 3.1. Time period: 2010Q1-2017Q3. Standard errors are shown in parenthesis clustered at bank-level, robust to heteroscedasticity and serial correlation. FE stands for fixed-effects. Stars indicate statistical significance levels: *** p<0.01, ** p<0.05, * p<0.10.

	Capital			Risk		
	(1) CET1 Ratio (p.p.)	(2) CET1 (ln)	(3) Tot. Capital (ln)	(4) RWA (ln)	(5) RWA/Assets (p.p.)	(6) Tot. Assets (ln)
SMCR	-0.265	0.064	0.074	0.061	3.115	-0.008
	(0.371)	(0.037)*	(0.028)***	(0.029)**	(1.555)**	(0.012)
Bank Controls	yes	yes	yes	yes	yes	yes
Bank FE	yes	yes	yes	yes	yes	yes
Country-quarter FE	yes	yes	yes	yes	yes	yes
Bank Trends	yes	yes	yes	yes	yes	yes
Obs.	3312	3312	3312	3312	3312	3312
N. clusters	144	144	144	144	144	144
R2	0.804	0.778	0.791	0.845	0.824	0.898

TABLE 3-11: Anticipation Effects

The table shows the impact of the change in systemic macroprudential capital requirements (SMCR) on bank capital, it includes two years leads of the impact to assess the presence of anticipation effects. Columns (1)-(3) present the impact on capital variables while Columns (4)-(6) present the estimates for the RWA and its components. Bank-level control variables are as specified in equation 3.4. Time period: 2010Q1-2017Q3. Standard errors are shown in parenthesis clustered at bank-level, and robust to heteroscedasticity and serial correlation. FE stands for fixed-effects. Stars indicate statistical significance levels: *** p<0.01, ** p<0.05, * p<0.10.

	Capital			Risk		
	(1) CET1 Ratio (p.p.)	(2) CET1 (ln)	(3) Tot. Capital (ln)	(4) RWA (ln)	(5) RWA/Assets (p.p.)	(6) Tot. Assets (ln)
SMCR	0.132	0.107	0.072	0.107	7.009	0.014
	(0.168)	(0.028)***	(0.017)***	(0.028)***	(2.608)***	(0.017)
$SMCR_{t+1\ year}$	1.084	0.067	0.060	-0.002	1.630	-0.050
	(0.302)***	(0.042)	(0.026)**	(0.036)	(2.198)	(0.026)*
$SMCR_{t+2\ years}$	-0.288	-0.057	-0.047	-0.013	-0.265	0.025
	(0.411)	(0.054)	(0.041)	(0.043)	(1.502)	(0.006)***
Bank Controls	yes	yes	yes	yes	yes	yes
Bank FE	yes	yes	yes	yes	yes	yes
Country-quarter FE	yes	yes	yes	yes	yes	yes
Obs.	3126	3126	3126	3126	3126	3126
N. clusters	137	137	137	137	137	137
R2	0.750	0.768	0.740	0.772	0.655	0.911

TABLE 3-12: Endogeneity: Capital

The table shows the relation between SMCR and the main dependent variables for capital. A dummy representing the period prior to the commencement of the phasing-in of the SMCR is interacted with the main outcomes of interest for capital. The table presents the estimates with bank specific trends. Bank-level control variables are as specified in equation 3.1. Time period: 2010Q1-2017Q3. Standard errors are shown in parenthesis clustered at bank-level, robust to heteroscedasticity and serial correlation. FE stands for fixed-effects. Stars indicate statistical significance levels: *** p<0.01, ** p<0.05, * p<0.10.

	SMCR					
	(1)	(2)	(3)	(4)	(5)	(6)
$D_{2010Q1-2013Q4}$	-1.420	-2.612	-0.484	-2.859	-0.576	-2.302
	(0.161)***	(1.561)*	(0.480)	(1.621)*	(0.488)	(1.749)
CET1 Ratio	0.002	-0.000				
	(0.004)	(0.002)				
$D_{2010Q1-2013Q4} \times$ CET1 Ratio	-0.005	-0.002				
	(0.006)	(0.002)				
ln(CET1)			0.145	0.028		
			(0.075)*	(0.039)		
$D_{2010Q1-2013Q4} \times$ ln(CET1)			-0.059	0.014		
			(0.027)**	(0.016)		
ln(Tot. Capital)					0.126	0.045
					(0.076)	(0.036)
$D_{2010Q1-2013Q4} \times$ ln(Tot. Capital)					-0.056	0.014
					(0.027)**	(0.015)
Bank FE	yes	yes	yes	yes	yes	yes
Country-quarter FE	yes	yes	yes	yes	yes	yes
Bank Trends		yes		yes		yes
Obs.	3334	3334	3330	3330	3405	3405
N. clusters	144	144	144	144	144	144
R2	0.991	0.996	0.991	0.996	0.991	0.996

TABLE 3-13: Endogeneity: Risk

The table presents the reduced form specification augmented with bank specific trends to control for the presence of diverging trend across banks. SMCR stands for systemic macroprudential capital requirement. Columns (1)-(3) present the estimates for the impact on capital differentiated by the distance from the OCR. Columns (4)-(5) show the evidence for risk. Bank-level control variables are as specified in equation 3.1. Time period: 2010Q1-2017Q3. Standard errors are shown in parenthesis clustered at bank-level, robust to heteroscedasticity and serial correlation. FE stands for fixed-effects. Stars indicate statistical significance levels: *** p<0.01, ** p<0.05, * p<0.10.

	SMCR					
	(1)	(2)	(3)	(4)	(5)	(6)
$D_{2010Q1-2013Q4}$	-0.560	-2.940	-1.640	-2.606	0.074	-3.019
	(0.441)	(1.646)*	(0.163)***	(1.598)	(0.608)	(1.624)*
ln(RWA)	0.214	0.065				
	(0.118)*	(0.057)				
$D_{2010Q1-2013Q4} \times$ ln(RWA)	-0.051	0.018				
	(0.023)**	(0.015)				
RWA/Assets			0.005	0.003		
			(0.003)	(0.002)		
$D_{2010Q1-2013Q4} \times$ RWA/Assets			0.003	-0.000		
			(0.002)**	(0.001)		
ln(Tot.Assets)					-0.006	-0.050
					(0.041)	(0.036)
$D_{2010Q1-2013Q4} \times$ ln(Tot.Assets)					-0.079	0.021
					(0.030)***	(0.018)
Bank FE	yes	yes	yes	yes	yes	yes
Country-quarter FE	yes	yes	yes	yes	yes	yes
Bank Trends		yes		yes		yes
Obs.	3423	3423	3423	3423	3573	3573
N. clusters	144	144	144	144	144	144
R2	0.991	0.996	0.991	0.996	0.990	0.996

TABLE 3-14: Endogeneity: Averaging pre and post treatment periods

The table presents a simple OLS regression of the macroprudential capital requirement (SMCR) at bank level averaged for the period 2014-2017Q. this is rtegressed on the bank-level averages of outcome variables for the period prior to the implementation of the macro-prudential policy 2010-2014. The aim is to investigate whether the average of the outcome variables before 2014 correlates with the regulation after 2014 which may hint that weaker banks were protected by national authorities. Bank-level control variables are also averaged prior to 2014 and are the ones as specified in equation 3.1. Standard errors are shown in parenthesis robust to heteroscedasticity and serial correlation. FE stands for fixed-effects. Stars indicate statistical significance levels: *** p<0.01, ** p<0.05, * p<0.10.

	SMCR							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CET1 Ratio	0.049	0.011						
	(0.021)**	(0.007)						
ln(CET1)			0.274	-0.024				
			(0.231)	(0.057)				
ln(RWA)					-0.278	-0.169		
					(0.229)	(0.106)		
RWA/Ass.							-0.007	-0.005
							(0.006)	(0.003)*
Bank-level controls	yes	yes	yes	yes	yes	yes	yes	yes
Country FE		yes		yes		yes		yes
Obs.	138	138	138	138	138	138	138	138
R2	0.292	0.968	0.264	0.967	0.263	0.968	0.265	0.969

TABLE 3-15: Impact on the Probability of Default

The table presents the baseline reduced form specification for the impact of the change in the SMCR on the probability of default as inferred from banks' ratings. Bank-level control variables are as specified in equation 3.1. Time period: 2010Q1-2017Q3. Standard errors are shown in parenthesis and are clustered at bank-level, robust to heteroscedasticity and serial correlation. FE stands for fixed-effects. Stars indicate statistical significance levels: *** p<0.01, ** p<0.05, * p<0.10.

	Probability of Default Horizon				
	5yrs (p.p.)	4yrs (p.p.)	3yrs (p.p.)	2yrs (p.p.)	1yr (p.p.)
SMCR	1.346	1.293	1.161	0.930	0.533
	(1.044)	(1.042)	(1.028)	(0.981)	(0.776)
SMCR ×					
>20bln.< Tot.Ass <100bln.	-1.843	-1.840	-1.811	-1.717	-1.345
	(0.833)**	(0.835)**	(0.831)**	(0.803)**	(0.654)**
SMCR ×					
Tot.Ass>100bln.	-2.011	-1.999	-1.960	-1.868	-1.471
	(0.893)**	(0.895)**	(0.888)**	(0.858)**	(0.699)**
Bank Controls	yes	yes	yes	yes	yes
Bank FE	yes	yes	yes	yes	yes
Country-quarter FE	yes	yes	yes	yes	yes
Obs.	1969	1969	1969	1969	1969
N. clusters	87	87	87	87	87
R2	0.451	0.451	0.446	0.433	0.396
	Marginal Effects				
SMCR ×					
>20bln.< Tot.Ass <100bln.	-0.497	-0.548	-0.650	-0.787	-0.811
	(1.100)	(1.101)	(1.094)	(1.052)	(0.840)
SMCR ×					
Tot.Ass>100bln.	-0.665	-0.706	-0.799	-0.938	-0.938
	(1.183)	(1.182)	(1.172)	(1.126)	(0.900)

3.A List of Banks

TABLE 3-I: List of GSIBs and O-SIBs with more than EUR 300 billions in total assets as of 2016Q4

Number	Country	GSI-OSI	Bank Name	Euro Area	Total Assets	IRB
1	UK	GSI	HSBC Holdings Plc	No	2251961725	1
2	FR	GSI	BNP Paribas SA	Yes	2076959000	1
3	DE	GSI	Deutsche Bank AG	Yes	1590546000	1
4	FR	GSI	Credit Agricole SA	Yes	1524232000	1
5	UK	GSI	Barclays Bank Plc	No	1421778818	1
6	FR	GSI	Societe Generale SA	Yes	1382241000	1
7	ES	GSI	Banco Santander, SA	Yes	1339124751	1
8	UK	OSI	Lloyds Banking Group Plc	No	957795606	1
9	UK	GSI	Royal Bank of Scotland Group Plc	No	935382435	1
10	UK	OSI	Goldman Sachs International	No	885924120	1
11	IT	GSI	UniCredit SpA	Yes	859532774	1
12	NL	GSI	ING Groep N.V.	Yes	845081000	1
13	FR	OSI	Credit Mutuel Group	Yes	793522000	1
14	FR	GSI	BPCE SA	Yes	765069000	1
15	ES	GSI	Banco Bilbao Vizcaya Argentaria, SA	Yes	731855527	1
16	IT	OSI	Intesa Sanpaolo SpA	Yes	725100000	1
17	SE	GSI	Nordea Bank AB (publ)	No	615659000	1
18	UK	GSI	Standard Chartered Plc	No	613193354	1
19	UK	OSI	J.P. Morgan Capital Holdings Ltd.	No	555986552	0
20	UK	OSI	Nomura Europe Holdings plc	No	548007616	1
21	DE	OSI	DZ BANK AG Deutsche Zentral-Genossenschaftsbank	Yes	509447000	1
22	NL	OSI	Rabobank	Yes	498468992	1
23	DE	OSI	Commerzbank AG	Yes	480450000	n/a
24	DK	OSI	Danske Bank A/S	No	468501389	0
25	UK	OSI	Morgan Stanley & Co. International Plc	No	401416677	1
26	UK	OSI	Merrill Lynch International	No	395201226	1
27	NL	OSI	ABN AMRO Group NV	Yes	394482000	1
28	UK	OSI	Santander UK Plc	No	355038592	0
29	ES	OSI	CaixaBank, SA	Yes	347927262	1
30	UK	OSI	Citigroup Global Markets Ltd.	No	327705506	1
31	UK	OSI	Credit Suisse International	No	315163664	1
32	DE	OSI	UniCredit Bank AG	Yes	302090000	1

TABLE 3-II: Banks with total assets between EUR 100 and EUR 300 billions in total assets as of 2016Q4

Number	Country	GSI-OSI	Bank Name	Euro Area	Total Assets	IRB
33	BE	OSI	BNP Paribas Fortis SA	Yes	297790000	1
34	BE	OSI	KBC Group NV	Yes	275200000	1
35	SE	OSI	Svenska Handelsbanken AB (publ)	No	274321632	1
36	SE	OSI	Skandinaviska Enskilda Banken AB (publ.)	No	273597716	1
37	UK	OSI	Nationwide Building Society	No	263401902	1
38	NO	OSI	DNB Bank ASA	No	258682038	1
39	DE	OSI	Landesbank Baden-Wurttemberg	Yes	243620000	0
40	FI	OSI	Nordea Pankki Suomi Oyj	Yes	238775000	1
41	FR	OSI	La Banque Postale, SA	Yes	229577420	1
42	SE	OSI	Swedbank AB (publ)	No	224900662	1
43	ES	OSI	Banco de Sabadell, SA	Yes	212507719	1
44	DE	OSI	Bayerische Landesbank	Yes	212150000	1
45	AT	OSI	Erste Group Bank AG	Yes	208227070	1
46	ES	OSI	Bankia, SA	Yes	190167459	1
47	DK	OSI	Nykredit Realkredit A/S	No	188360510	1
48	BE	OSI	Belfius Banque SA	Yes	176720926	1
49	DE	OSI	NORD/LB Norddeutsche Landesbank Girozentrale	Yes	174797000	1
50	DE	OSI	Landesbank Hessen-Thuringen Girozentrale	Yes	165164000	0
51	DE	OSI	ING-DiBa AG	Yes	157553000	1
52	NL	OSI	NV Bank Nederlandse Gemeenten	Yes	154000000	1
53	IT	OSI	Banca Monte dei Paschi di Siena SpA	Yes	153178466	1
54	BE	OSI	ING Belgie NV	Yes	150418720	0
55	ES	OSI	Banco Popular Espanol, SA	Yes	147925728	1
56	DE	OSI	NRW.BANK	Yes	142065678	1
57	AT	OSI	Raiffeisen Zentralbank osterreich AG	Yes	134846575	0
58	FI	OSI	OP Financial Group	Yes	133747000	1
59	DE	OSI	Volkswagen Financial Services AG	Yes	130148000	1
60	NL	OSI	SNS REAAL NV	Yes	124806000	1
61	IE	OSI	Governor and Company of the Bank of Ireland	Yes	123129000	1
62	UK	OSI	Credit Suisse Securities (Europe) Ltd.	No	112791235	1
63	AT	OSI	Raiffeisen Bank International AG	Yes	111863845	0
64	DK	OSI	Nordea Bank Danmark A/S	No	108970440	1
65	AT	OSI	UniCredit Bank Austria AG	Yes	105785411	1
66	DE	OSI	Landesbank Berlin Holding AG	Yes	102437000	1

TABLE 3-III: Banks with total assets between EUR 20 and EUR 100 billions in total assets as of 2016Q4

Number	Country	GSI-OSI	Bank Name	Euro Area	Total Assets	IRB
67	IE	OSI	Allied Irish Banks, Plc	Yes	95622000	0
68	DE	OSI	Landwirtschaftliche Rentenbank	Yes	95045800	1
69	PT	OSI	Caixa Geral de Depositos, SA	Yes	93547313	1
70	DE	OSI	Westdeutsche Genossenschafts-Zentralbank AG	Yes	89794496	1
71	DE	OSI	DekaBank Deutsche Girozentrale	Yes	85954700	1
72	DE	OSI	HSH Nordbank AG	Yes	84365000	1
73	GR	OSI	Piraeus Bank SA	Yes	81500534	1
74	DK	OSI	Jyske Bank A/S	No	78902758	1
75	GR	OSI	National Bank of Greece SA	Yes	78531000	1
76	NO	OSI	Nordea Bank Norge ASA	No	73744593	1
77	PT	OSI	Banco Comercial Português, SA	Yes	71264811	0
78	GR	OSI	Eurobank Ergasias SA	Yes	66393000	n/a
79	GR	OSI	Alpha Bank AE	Yes	64872266	n/a
80	PL	OSI	Powszechna Kasa Oszczednosci Bank Polski SA	No	64851280	1
81	PT	OSI	Novo Banco, SA	Yes	52332672	1
82	LU	OSI	Deutsche Bank Luxembourg SA	Yes	51787398	1
83	UK	OSI	UBS Ltd.	No	47624329	1
84	IE	OSI	Citibank Europe Plc	Yes	46729176	1
85	NO	OSI	Kommunalbanken AS	No	46082260	1
86	LU	OSI	CACEIS Bank Luxembourg SA	Yes	46081972	0
87	PT	OSI	Santander Totta, SGPS SA	Yes	44991681	1
88	LU	OSI	BGL BNP Paribas SA	Yes	44980200	0
89	LU	OSI	Banque et Caisse d'Epargne de l'Etat, Luxembourg	Yes	43468625	0
90	LU	OSI	Societe Generale Bank & Trust SA	Yes	42187856	0
91	CZ	OSI	ceskoslovenska obchodní banka, a.s.	No	40177083	0
92	AT	OSI	Bank fur Arbeit und Wirtschaft und Osterreichische Postsparkasse AG	Yes	39743000	1
93	PL	OSI	Bank Polska Kasa Opieki SA	No	39562822	1
94	CZ	OSI	ceska spořitelna, a.s.	No	39473826	0
95	AT	OSI	Raiffeisenlandesbank Oberosterreich AG	Yes	39385129	0
96	PT	OSI	Banco BPI, SA	Yes	38284652	1
97	BE	OSI	Bank of New York Mellon SA/NV	Yes	36427299	1
98	HU	OSI	OTP Bank Nyrt.	No	36291787	1
99	BE	OSI	Argenta Spaarbank NV	Yes	36156329	1
100	CZ	OSI	Komercní banka, a.s.	No	34151966	0
101	PL	OSI	Bank Zachodni WBK SA	No	34086447	1
102	FI	OSI	Kuntarahoitus Oyj	Yes	34052186	0
103	IE	OSI	Ulster Bank Ireland DAC	Yes	30694000	1
104	PL	OSI	mBank SA	No	30372081	1
105	FI	OSI	Danske Bank Oyj	Yes	28962100	1
106	BE	OSI	AXA Bank Belgium SA	Yes	27994508	0
107	IE	OSI	DEPFA BANK Plc	Yes	27596000	0
108	PL	OSI	ING Bank slaski SA	No	26678248	1
109	AT	OSI	Raiffeisenlandesbank Niederosterreich-Wien AG	Yes	25404784	1
110	IE	OSI	Permanent TSB Group Holdings Plc	Yes	23601000	1
111	CZ	OSI	UniCredit Bank Czech Republic and Slovakia, a.s.	No	23503916	0
112	LU	OSI	Banque Internationale a Luxembourg SA	Yes	23148659	0
113	CY	OSI	Bank of Cyprus Public Company Ltd.	Yes	22171935	1
114	PT	OSI	Caixa Economica Montepio Geral, caixa economica bancaria, SA	Yes	21345909	0
115	DK	OSI	DLR Kredit A/S	No	20944292	0

TABLE 3-IV: Banks with total assets lower than EUR 20 billions in total assets as of 2016Q4

Number	Country	GSI-OSI	Bank Name	Euro Area	Total Assets	IRB
116	IE	OSI	UniCredit Bank Ireland Plc	Yes	19987653	1
117	DK	OSI	Sydbank A/S	No	19727068	1
118	HR	OSI	Zagrebacka banka d.d.	No	16980269	0
119	PL	OSI	Bank BGŻ BNP Paribas SA	No	16419888	1
120	PL	OSI	Bank Millennium SA	No	15622293	0
121	AT	OSI	HYPO NOE Landesbank fur Niederosterreich und Wien AG	Yes	15392051	0
122	PL	OSI	Getin Noble Bank SA	No	15105513	0
123	BE	OSI	Euroclear Bank SA/NV	Yes	14885444	1
124	RO	OSI	Banca Comerciala Romana SA	No	14873912	0
125	SK	OSI	Slovenska Sporitelna, a.s.	Yes	14825374	0
126	CY	OSI	Cyprus Cooperative Bank Ltd.	Yes	14100791	1
127	SK	OSI	Vseobecna uverova banka, a.s.	Yes	14037154	0
128	AT	OSI	Sberbank Europe AG	Yes	12709542	0
129	PL	OSI	Raiffeisen Bank Polska SA	No	12094460	1
130	SI	OSI	Nova Ljubljanska banka d.d., Ljubljana	Yes	12039011	0
131	CZ	OSI	Raiffeisenbank a.s.	No	11984202	1
132	RO	OSI	Banca Transilvania SA	No	11443660	1
133	RO	OSI	BRD-Groupe Societe Generale SA	No	11429840	1
134	SK	OSI	Tatra banka, a.s.	Yes	11373028	0
135	MT	OSI	Bank of Valletta Plc	Yes	11014330	0
136	HR	OSI	Privredna Banka Zagreb d.d.	No	10867118	1
137	BG	OSI	UniCredit Bulbank AD	No	10424208	1
138	PL	OSI	Bank Handlowy w Warszawie SA	No	10266811	1
139	EE	OSI	Swedbank AS	Yes	10233000	1
140	HU	OSI	K&H Bank Zrt.	No	9148828	1
141	HU	OSI	UniCredit Bank Hungary Zrt.	No	8861671	1
142	AT	OSI	Oberosterreichische Landesbank AG	Yes	8756780	1
143	CY	OSI	RCB Bank Ltd.	Yes	8699021	0
144	HR	OSI	Erste&Steiermarkische Bank d.d.	No	8680694	0
145	SK	OSI	Ceskoslovenska obchodna banka, a.s.	Yes	8543773	0
146	RO	OSI	UniCredit Bank SA	No	8284788	0
147	AT	OSI	Hypo Tirol Bank AG	Yes	7632172	1
148	LT	OSI	AB SEB bankas	Yes	7517939	1
149	RO	OSI	Raiffeisen Bank SA	No	7371604	0
150	LT	OSI	Swedbank, AB	Yes	7324953	0
151	MT	OSI	HSBC Bank Malta Plc	Yes	7305964	1
152	CY	OSI	Hellenic Bank Public Company Ltd.	Yes	7037604	0
153	HU	OSI	MKB Bank Zrt.	No	6804454	1
154	HU	OSI	Magyar Takarekszovetkezeti Bank Zrt.	No	6776778	0
155	HU	OSI	Erste Bank Hungary Zrt.	No	6627237	1
156	HU	OSI	Raiffeisen Bank Zrt.	No	6457088	n/a
157	RO	OSI	CEC Bank SA	No	6204473	0
158	BG	OSI	DSK Bank EAD	No	6050100	0
159	EE	OSI	AS SEB Pank	Yes	5775400	0

TABLE 3-IV: Ctd. Banks with total assets lower than EUR 20 billions in total assets as of 2016Q4

Number	Country	GSI-OSI	Bank Name	Euro Area	Total Assets	IRB
160	HU	OSI	CIB Bank Zrt.	No	5277329	0
161	LV	OSI	Swedbank AS	Yes	5242209	0
162	CZ	OSI	PPF banka a.s.	No	5063556	0
163	CZ	OSI	J&T Banka, a.s.	No	4926761	0
164	CY	OSI	Eurobank Cyprus Ltd.	Yes	4879262	n/a
165	SI	OSI	Nova Kreditna banka Maribor d.d.	Yes	4823450	0
166	HR	OSI	Raiffeisenbank Austria d.d.	No	4679339	0
167	BG	OSI	First Investment Bank AD	No	4647865	1
168	PL	OSI	Bank Polskiej Spoldzielczosci SA	No	4578087	0
169	SK	OSI	Postova banka, a.s.	Yes	4261460	0
170	LT	OSI	Luminor Bank AB	Yes	3988565	n/a
171	LV	OSI	ABLV Bank, AS	Yes	3973323	0
172	PL	OSI	SGB-Bank SA	No	3947797	1
173	SI	OSI	Abanka d.d.	Yes	3614833	0
174	HR	OSI	Splitska banka d.d.	No	3577384	0
175	LV	OSI	AS SEB banka	Yes	3523911	0
176	BG	OSI	United Bulgarian Bank AD	No	3495997	0
177	BG	OSI	Eurobank Bulgaria AD	No	3486344	0
178	LV	OSI	JSC "Rietumu Banka"	Yes	3473590	1
179	LV	OSI	AS Citadele banka	Yes	3349515	0
180	BG	OSI	Raiffeisenbank (Bulgaria) EAD	No	3329009	0
181	BG	OSI	Societe Generale Expressbank AD	No	3246381	0
182	RO	OSI	Alpha Bank Romania SA	No	3245660	1
183	SI	OSI	SKB banka d.d., Ljubljana	Yes	2955262	0
184	HR	OSI	Addiko Bank d.d.	No	2777215	0
185	BG	OSI	Central Cooperative Bank AD	No	2651696	0
186	SI	OSI	UniCredit Banka Slovenija d.d.	Yes	2642950	0
187	HR	OSI	Hrvatska postanska banka, d.d.	No	2611695	1
188	CY	OSI	Alpha Bank Cyprus Ltd.	Yes	2596415	0
189	SI	OSI	SID - Slovenska izvozna in razvojna banka, d.d., Ljubljana	Yes	2596076	0
190	RO	OSI	SC Bancpost SA	No	2564081	n/a
191	MT	OSI	MeDirect Group Ltd.	Yes	2489506	0
192	SI	OSI	Banka Intesa Sanpaolo d.d.	Yes	2325663	0
193	LV	OSI	Luminor Bank AS	Yes	2259247	0
194	RO	OSI	Garanti Bank SA	No	1973878	0
195	HU	OSI	FHB Jelzalogbank Nyrt.	No	1921279	0
196	LT	OSI	siauliu bankas AB	Yes	1861278	0
197	SI	OSI	Sberbank banka d. d.	Yes	1846119	n/a
198	RO	OSI	OTP Bank Romania SA	No	1808437	1
199	CY	OSI	Alfa Capital Holdings (Cyprus) Ltd.	Yes	1803745	1
200	HR	OSI	OTP banka Hrvatska d.d.	No	1694090	n/a
201	BG	OSI	CIBANK EAD	No	1584441	1
202	BG	OSI	Piraeus Bank Bulgaria AD	No	1508035	1
203	RO	OSI	Piraeus Bank Romania SA	No	1446053	1
204	RO	OSI	Banca Romaneasca SA	No	1418917	n/a
205	HR	OSI	Sberbank d.d.	No	1225733	n/a

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