RESEARCH PAPER

On Portfolios of Preventive Decisions for Multiple Health Risks – Evidence from US-Based Data

Portefeuilles de décisions de prévention face aux risques de santé – une analyse sur données américaine

CHRISTOPHE COURBAGE, PhD
Associate Professor
Geneva School of Business Administration
University of Applied Sciences Western Switzerland (HES-SO)
Geneva, Switzerland

VERONIKA KALOUGUINA, MSc, PhD (c)
Department of Actuarial Science
Faculty of Business and Economics (HEC)
University of Lausanne
Lausanne, Switzerland

Abstract
Individuals face multiple health risks and therefore can undertake many preventive activities simultaneously, thus creating a portfolio of preventive activities. In this article, we first investigate the determinants likely to influence the composition of portfolios of preventive activities. Second, we look at the interactions between preventive activities. We use the US Behavioral Risk Factor Surveillance System survey data set conducted in 2016, comprising 22,510 observations from 50 states and US territories. Our results show that information-related variables, in particular, being aware of illness, having access to information and having a personal doctor, increase the portfolio size of preventive activities. We also show that vaccinations tend to be performed together with screening activities and to a lower extent with exercising.

Résumé
Les personnes font face à de nombreux risques en matière de santé et, par conséquent, peuvent prendre plusieurs mesures préventives simultanément, créant ainsi un portefeuille

d'activités de prévention. Dans cet article, nous nous intéressons d'abord aux déterminants susceptibles d'influencer la composition de tels portefeuilles. Ensuite, nous étudions les interactions entre les diverses activités de prévention. Nous avons recours aux données de l'enquête du Système de surveillance des facteurs de risques comportementaux réalisée aux États-Unis en 2016, laquelle comprend 22 510 observations provenant de 50 états et territoires des États-Unis. Nos résultats montrent que les variables liées à l'information – en particulier, être au fait de la maladie, avoir accès à l'information et avoir un médecin de famille – font croître le contenu du portefeuille d'activités de prévention. Nous démontrons également que la vaccination tend à accompagner les activités de dépistage et, dans une moindre mesure, l'activité physique.

Introduction

Given that individuals face multiple risks, for example, risks of cancers, influenza and heart attacks, they are most likely to undertake different preventive activities simultaneously, for example, cancer screenings, vaccination, health checkup and regular physical activity (Spring et al. 2012). Hence, they create a portfolio of preventive activities. Understanding the drivers of such portfolios of preventive activities is crucial to design efficient health policies. Indeed, public authorities must be able to foresee the potential outcome of a policy and to predict the spillover effects of a prevention-oriented policy before implementing it, especially when another program is already targeting a different prevention type. The importance of information in driving specific preventive activities has already been highlighted in existing literature, including awareness of health issues (Slark and Sharma 2014), health literacy (DeWalt et al. 2004; Fernandez et al. 2016), health knowledge (Vanslyke et al. 2008) and the role of the general practitioner as a means and source of health information (McIlfatrick et al. 2013; Qi et al. 2006). Along with information, other determinants of specific preventive activities include socio-economic factors, such as age, marital status, the level of income and self-reported health (Dorner et al. 2013; Welch et al. 2008), as well as risk attitudes (Hoebel et al. 2014) and health insurance (Simon et al. 2017). However, most of this literature addresses the determinants of one specific preventive activity instead of a whole portfolio of individual preventive decisions. We thus aim to fill this gap in the literature by specifically considering, in this article, the drivers of the number of preventive activities, that is, of the size of portfolios of preventive activities. We especially focus on health-related information drivers, including experience with health risks as related to being a caregiver, having easy access to health information and having a general practitioner. The determinants of one preventive activity can also affect the realization of another, giving rise to the issue of complementarity between preventive activities (Beydoun and Beydoun 2007). For instance, Carlos et al. (2005) showed that prostate-specific antigen (PSA) screenings are more likely to be performed with a colorectal cancer screening. Welch et al. (2008) documented that regular physical exercise and being a nonsmoker are determinants of feminine cancer screening. However, considering

statin use and health behaviours as preventive activities, Kaestner et al. (2014) found conflicting evidence for the hypothesis that investments in disease prevention are complementary. The question of complementarity, hence, remains open. We hypothesize that the relationship between preventive activities might depend on their nature, for example, being behavioural or medicalized. In this article, using the US Behavioral Risk Factor Surveillance System (BRFSS) survey data set, which encompasses many types of preventive activities, we aim at (1) investigating the determinants likely to alter the composition of portfolios of preventive activities, with a focus on the role played by health-related information, and (2) identifying preventive activities that are complementary to each other and encourage each other's uptake.

Methodology

Data

For the purpose of our study, we used the BRFSS survey data set. BRFSS is a health-related phone survey, which is carried out yearly in all the 50 states of the US with the District of Columbia and three US territories. The BRFSS collects state data about US residents regarding their health-related risk behaviours, chronic health conditions and use of preventive services. The BRFSS data set was particularly well suited for our analysis, as it contains information on several types of preventive activities, including both medical and nonmedical preventive activities, namely mammography, Papanicolaou (Pap) test, human papilloma virus (HPV) test, blood stool test for colorectal cancer, colonoscopy, PSA test, checkup, tetanus and flu vaccinations and exercising. We used the 33rd wave conducted in 2016, which is composed of 22,510 complete observations.

Variables

DEPENDENT VARIABLES

We used two types of dependent variables for preventive activities classified by gender. We subdivided the population into two groups, individuals below and above 50 years, following the U.S. Preventive Services Task Force recommendations regarding cancer screenings (U.S. Preventive Services Task Force 2008). This allows for a better tailored portfolio, as several cancer screenings are not available or are very rarely administered below the age of 50. The first dependent variable was the sum of preventive activities per individual performed during the past 12 months. These preventive activities are presented in Table 1. The number of performed preventive activities summed up to a maximum of six for women below 50 years and up to a maximum of nine for women above 50 years. As for men, this number went up to four for men below 50 years and seven for those above 50 years.

TABLE 1. Portfolios of preventive activities

	Prevention before the age of 50			Prevention after the age of 50		
	Behavioural	**Screenings**	**Vaccination**	**Behavioural**	**Screenings**	**Vaccination**
Men	Exercise	Checkup	Flu Tetanus	Exercise	Checkup Blood stool Colonoscopy PSA test	Flu Tetanus
Women	Exercise	Checkup Pap test HPV test	Flu Tetanus	Exercise	Checkup Blood stool Colonoscopy HPV test Pap test Mammography	Flu Tetanus

The second type of dependent variable was a selection of preventive activities, which were segregated in three types according to their nature, that is, behavioural preventive activity, screenings and vaccinations, as presented in Table 1. The classification of preventive activities by types allowed us to investigate the interactions between preventive activities of different natures. The underlying hypothesis was that relationships between preventive activities may depend on the type of prevention, and the former may change depending on the individual's age.

INFORMATION-RELATED VARIABLES

We defined three variables to account for the role of health-related information on preventive activities. The first variable was a caregiver dummy variable. The underlying assumption justifying the use of this variable was that caregivers have a greater experience with health risks and their consequences, which may in turn incentivize them to pay more attention to their own health (Banford et al. 2001; Broughton et al. 2011). This variable, hence, proxied the effect of awareness about potential health issues and their consequences. The second variable was a dummy variable assessing the ease with which the respondent gets advice or information about health or medical topics if needed. This variable allowed to control for the accessibility of information to the individual, which in turn may influence preventive decisions. The third variable was a personal doctor (PD) dummy depending on whether the individual reported having one person he/she thinks of as a PD or healthcare provider or not. Having a PD is a well-recognized source of health information, and individuals reporting having a PD should be more likely to have better and more personalized information about the benefits of preventive activities (Noar et al. 2007).

OTHER VARIABLES

Following the literature, we included a set of control variables that have been shown to affect preventive decisions. We first included a series of socio-economic factors, namely, age, marital status, number of children below 18 years, education higher than high school, preferred race, employment and income. Concerning health-related control variables, we included health

coverage, which is a dummy variable assessing whether the respondent has any kind of health coverage, including health insurance, prepaid plans such as health maintenance organizations (HMOs) or government plans such as Medicare or Indian Health Service. We also included the subjective health, which was a count variable ranging from 1 (*poor*) to 5 (*excellent*). Finally, we added a health-risk tolerance variable to capture the idiosyncratic relationship of the respondent to health risks. This variable was a dummy controlling for whether the respondent smoked in his/her entire life at least 100 cigarettes, has driven drunk at least once in the past 30 days or has had a red or painful sunburn that lasted a day or more during the past 12 months.

DESCRIPTIVE STATISTICS

Table 2 (available online at www.longwoods.com/content/26222) provides a concise description of the set of variables used in the next section's econometric specifications.

Econometric methodology

Following Carlos et al. (2005) and Welch et al. (2008), who used the same BRFSS data set, our first regression was a linear model with White standard errors to correct for heteroskedasticity. The dependent variable was the number of individual preventive activities. The explanatory variables were the set of informational factors and all the individual control variables. This first model aimed at investigating the determinants of the size of preventive activities' portfolios. We also considered a submodel for which the sum of preventive activities corresponded only to either screening activities or vaccination activities to address the determinants of more specific portfolios of preventive activities, that is, a portfolio of screening activities and a portfolio of vaccination activities. The second linear regression, also corrected for heteroskedasticity with White standard errors, was run on the three groups of preventive activities described in Table 1. In addition to the information-related variables and our control variables, we included in the set of explanatory variables the other preventive activities' groups. This second model aimed at investigating the interactions between different types of preventive activities.

Results

Tables 3 through 6 are available online at www.longwoods.com/content/26222.

Information-related determinants

Starting with the caregiver variable, its effect on the size of the total portfolios of preventive activities is overall positive for individuals below the age of 50. For these individuals, having provided regular care or assistance to a person with health problems or disability during the past 30 days increases the size of the portfolio by 0.3 units for women and 0.24 for men. As for the role of ease of access to medical information, it correlates positively and significantly with the size of the overall portfolio of preventive activities indifferent of age and

gender. However, the impact of the access to health information seems to be much higher for respondents of age 50 years and above. When it comes to the portfolio of screening activities, only women of age 50 years and above seem to be affected by the ease of access to information. Regarding the variable PD, it positively and very significantly impacts the size of the overall portfolio of preventive activities disregarding age and gender. This variable is the most important driver of the size of the overall portfolio (β between 0.50 and 0.78). The presence of a PD is more valued by individuals of age 50 and above, as it represents for both men and women, one third to one half of the standard deviation of the size of the portfolio. The same results apply for portfolios of screenings and vaccinations.

Socio-economic determinants

Looking at the effect of some of our control variables, as shown in Table 4, being married has a positive impact on the overall portfolio of men above 50 years old. This is especially the case when it comes to the portfolio of screening activities. Looking at education, a level higher than a high school diploma leads to a larger overall portfolio in younger women and men of all ages. Healthcare coverage is also significant, mostly for portfolios of cancer screenings and vaccinations. It is also worth noting that an increase in subjective health is positively correlated with the number of overall preventive activities performed for both men and women above 50 years old. However, when it comes to portfolios of specific preventive behaviours, a decrease in subjective health leads to an increase in the number of vaccinations.

Interaction between preventive activities

For women, health screenings and vaccinations are complementary. A woman of age 50 years or older, who underwent at least one preventive activity in the "vaccination" portfolio during the past 12 months, has a "screenings" portfolio larger, on average, by 0.36 units than a woman who did not, *ceteris paribus*. Similarly, a woman who is exercising has a larger portfolio of screening activities. This relationship applies the other way round; for example, a woman above 50 years old who underwent a screening is more likely to undergo a vaccination or to exercise. The complementary relationship between health screenings and vaccinations holds for men as well, whereas the complementary relation between exercising and health screenings holds only for men below 50 years old. Exercising and vaccinations, however, present statistically weak results, and no pattern is decipherable.

Discussion

Our results can be related to previous studies. When it comes to the positive association between being a caregiver and the size of the portfolio of preventive activities, our results go along with those of Brown and Brown (2014), who showed that caregiving may yield beneficial health and well-being outcomes. One explanation could be that caregiving is associated with more preventive activities. Indeed, caring after dependent individuals seems to raise awareness about potential health problems and the benefit of preventive activities

for individuals below 50 years old. Interestingly, this variable stops being relevant for those older than 50. This could occur because individuals of age 50 and above may have already experienced health problems or may have relatives with health problems, hence rendering this feature meaningless. Therefore, raising awareness about health problems among young men tends to increase the number of screenings they perform. Our results also highlight the dominant role of the PD in driving the number of performed preventive activities. These results confirm earlier works on the topic, for instance, those of Qi et al. (2006) showing that, in Canada, the presence of a regular medical doctor was associated with increased rates of a specific preventive screening. When it comes to sociodemographic drivers, being married increases the portfolio size of preventive activities for men above 50 years old. These results are in line with the observation of Jaffe et al. (2007) and Manzoli et al. (2007), who found that mortality rates were lower for married men. Married women seem to have a positive influence on their spouse in terms of taking care of themselves, and hence, the married men perform more preventive activities. Our findings present a channel through which we observe more longevity for married men, as they perform a higher number of preventive activities. Health coverage increases the number of cancer screenings and vaccinations, which could be explained by the fact that these preventive activities are medicalized, and, hence can potentially be reimbursed by insurance. As for the role of subjective health, it seems that younger individuals are less driven by their health when deciding to perform preventive activities. However, subjective health is shown to be negatively associated with the number of vaccinations. This is in accordance with the study by Wu (2003), who showed that respondents with poorer health are more likely to be vaccinated. Finally, vaccination is shown to be positively associated with screening activities and to a lower extent with exercising. These results confirm that the complementary relationship between preventive activities depends on the nature of the preventive activities considered. Although we believe that our results provide the right correlations between the variables of interest, one important limitation of our study comes from the cross-sectional nature of our data. Therefore, causation has to be inferred with caution. In addition, our data are based on a survey that contains only self-reported answers, which can entail biases attributed to social desirability and could distort the results (Bauhoff 2011; van de Mortel 2008). Finally, the measurement or nonresponse biases cannot be entirely excluded from any survey (Schneider et al. 2012).

Conclusion

Our results offer some valuable insights in terms of prevention-oriented policies. In particular, they highlight the role and quality of health information in driving the overall portfolio of preventive activities. Not only does awareness of health issues play an important role in influencing the number of preventive activities, but, more importantly, the role of health professionals, and in particular the PD, is paramount in that respect. Hence, with the aim of developing preventive activities, PD and other health professionals should communicate further with their patients on the benefits of such behaviours. Furthermore, communication

should target single and young individuals on priority, as they are less likely to perform multiple preventive activities than married and older individuals, especially when it comes to screening activities. Another insight from our results is related to the complementarity between some preventive activities. This complementarity suggests that having performed one specific preventive activity is a cue to action to perform another. Hence, policies promoting vaccinations should also influence the uptake of screenings activities (and vice versa). Although our results apply to the US, a comparison between countries is necessary to understand whether our observations are related to a country's healthcare system or deeply rooted in human behaviour. In that respect, generalizing our study to Canada, for example, which has a universal single-payer healthcare system very different from the US system but a rather similar culture, would offer a relevant test of our results.

Acknowledgement

Christophe Courbage acknowledges the financial support of RCSO E&M.

Correspondence may be directed to: Christophe Courbage, Geneva School of Business Administration, University of Applied Sciences Western Switzerland (HES-SO), Geneva 1127, Switzerland. He can be reached by e-mail at christophe.courbage@hesge.ch.

References

Banford, M., M. Kratz, R. Brown, K. Emick, J. Ranck, R. Wilkins and M. Holm. 2001. Stroke Survivor Caregiver Education. *Physical Occupational Therapy in Geriatrics* 19(1): 37–51. doi:10.1080/J148v19n0103.

Bauhoff, S. 2011. Systematic Self-Report Bias in Health Data: Impact on Estimating Cross-Sectional and Treatment Effects. *Health Services and Outcomes Research Methodology* 11: 44–53. doi:10.1007/s10742-011-0069-3.

Beydoun, H.A. and M.A. Beydoun. 2007. Predictors of Colorectal Cancer Screening Behaviors among Average-Risk Older Adults in the United States. *Cancer Causes Control* 19(4): 339–59. doi:10.1007/s10552-007-9100-y.

Broughton, M., E.R. Smith, R. Baker, A.J. Angwin, N.A. Pachana, D.A. Copland et al. 2011. Evaluation of a Caregiver Education Program to Support Memory and Communication in Dementia: A Controlled Pretest-Posttest Study with Nursing Home Staff. *International Journal of Nursing Studies* 48(11): 1436–44. doi:10.1016/j.ijnurstu.2011.05.007.

Brown, R.M. and S.L. Brown. 2014. Informal Caregiving: A Reappraisal of Effects on Caregivers. *Social Issues and Policy Review* 8(1): 74–102. doi:10.1111/sipr.12002.

Carlos, R.C., W.R. Underwood, A.M. Fendrick and S.J. Bernstein. 2005. Behavioral Associations between Prostate and Colon Cancer Screening. *Journal of the American College of Surgeons* 200(2): 216–23. doi:10.1016/j.jamcollsurg.2004.10.015.

DeWalt, D.A., N.D. Berkman, S. Sheridan, K.N. Lohr and M.P. Pignone. 2004. Literacy and Health Outcomes. *Journal of General Internal Medicine* 19(12): 1228–39. doi:10.1111/j.1525-1497.2004.40153.x.

Dorner, T., W. Stronegger, K. Hoffmann, K.V. Stein and T. Niederkrotenthaler. 2013. Socio-Economic Determinants of Health Behaviours across Age Groups: Results of a Cross-Sectional Survey. *Wien Klin Wochenschr* 125(9-10): 261–69. doi:10.1007/s00508-013-0360-0.

Fernandez, D.M., J.L. Larson and B.J. Zikmund-Fisher. 2016. Associations between Health Literacy and Preventive Health Behaviors among Older Adults: Findings from the Health and Retirement Study. *BMC Public Health* 16: 596. doi:10.1186/s12889-016-3267-7.

Hoebel, J., A. Starker, S. Jordan, M. Richter and T. Lampert. 2014. Determinants of Health Check Attendance in Adults: Findings from the Cross-Sectional German Health Update (GEDA) Study. *BMC Public Health* 14(1): 913. doi:10.1186/1471-2458-14-913.

Jaffe, D.H., O. Manor, Z. Eisenbach and Y.D. Neumark. 2007. The Protective Effect of Marriage on Mortality in a Dynamic Society. *Annals of Epidemiology* 17(7): 540–47. doi:10.1016/j.annepidem.2006.12.006.

Kaestner, R., M. Dardenb and D. Lakdawalla. 2014. Are Investments in Disease Prevention Complements? The Case of Statins and Health Behaviors. *Journal of Health Economics* 36: 151–63. doi:10.1016/j.jhealeco.2014.04.006.

Manzoli, L., P. Villari, G.M. Pirone and A. Boccia. 2007. Marital Status and Mortality in the Elderly: A Systematic Review and Meta-Analysis. *Social Science & Medicine* 64(1): 77–94. doi:10.1016/j.socscimed.2006.08.031.

McIlfatrick, S., S. Keeney, H. McKenna, N. McCarley and G. McElwee. 2013. Investigating the Role of the General Practitioner in Cancer Prevention: A Mixed Methods Study. *BMC Family Practice* 14: 58. doi:10.1186/1471-2296-14-58.

Noar, S.M., C.N. Benac and M.S. Harris. 2007. Does Tailoring Matter? Meta-Analytic Review of Tailored Print Health Behavior Change Interventions. *Psychological Bulletin* 133(4): 673–93. doi:10.1037/0033-2909.133.4.673.

Qi, V., S.P. Phillips and W.M. Hopman. 2006. Determinants of a Healthy Lifestyle and Use of Preventive Screening in Canada. *BMC Public Health* 6(1): 275. doi:10.1186/1471-2458-6-275.

Schneider, K.L., M.A. Clark, W. Rakowski and K.L. Lapane. 2012. Evaluating the Impact of Non-Response Bias in the Behavioral Risk Factor Surveillance System (BRFSS). *Journal of Epidemiology and Community Health* 66(4): 290–95. doi:10.1136/jech.2009.103861.

Simon, K., A. Soni and J. Cawley. 2017. The Impact of Health Insurance on Preventive Care and Health Behaviors: Evidence from the First Two Years of the ACA Medicaid Expansions. *Journal of Policy Analysis and Management* 36(2): 390–417. doi:10.1002/pam.21972.

Slark, J. and P. Sharma. 2014. Risk Awareness in Secondary Stroke Prevention: A Review of the Literature. *JRSM Cardiovascular Disease* 3: 2048004013514737. doi:10.1177/2048004013514737.

Spring, B., A. Moller and M. Coons. 2012. Multiple Health Behaviours: Overview and Implications. *Journal of Public Health* 34: i3–i10. doi:10.1093/pubmed/fdr111.

U.S. Preventive Services Task Force. 2008. Screening for Prostate Cancer: U.S. Preventive Services Task Force Recommendation Statement. *Annals of Internal Medicine* 149(3): 185–91. doi:10.7326/0003-4819-149-3-200808050-00008.

Van de Mortel, T.F. 2008. Faking It: Social Desirability Response Bias in Self-Report Research. *Australian Journal of Advanced Nursing* 25(4): 40–48.

Vanslyke, J.G., J. Baum, V. Plaza, M. Otero, C. Wheeler and D.L. Helitzer. 2008. HPV and Cervical Cancer Testing and Prevention: Knowledge, Beliefs, and Attitudes among Hispanic Women. *Qualitative Health Research* 18(5): 584–96. doi:10.1177/1049732308315734.

Welch, C., C.W. Miller and N.T. James. 2008. Sociodemographic and Health-Related Determinants of Breast and Cervical Cancer Screening Behavior. *Journal of Obstetric, Gynecologic Neonatal Nursing* 37(1): 51–57. doi:10.1111/j.1552-6909.2007.00190.x.

Wu, S. 2003. Sickness and Preventive Medical Behavior. *Journal of Health Economics* 22(4): 675–89. doi:10.1016/S0167-6296(03)00042-0.