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Cargo bikes and their modal shift effects: from substitution to car renunciation

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Abstract
In the context of a modal shift towards alternative transport modes such as cycling, walking and public transport, cargo bikes for personal transport could fill a void in the transport market by providing an alternative to car trips, especially among families. Yet, few studies have considered their modal shift effects on the use of other transport modes. We conduct a nationwide survey of 696 cargo bike owners in Switzerland, one of the largest samples to date. Cargo bikes' modal shift effects are considered through three dimensions (1) their owners' characteristics, motivations and uses; (2) the substitution of trips by other transport modes; and (3) the renunciation of ownership of other transport modes – especially the car. Our results provide a typology of five types of households depending on how the cargo bike induces a modal shift from the car.

Keywords Cycling · Cargo bike · Modal shift · Substitution · Renunciation · Car ownership

Introduction

Due to its negative externalities, from environmental degradation to health and social inequality, overcoming car dependence has become a policy goal. The transition from a system of automobility to a post-car system (Dennis and Urry 2009) implies a modal shift from the car to a combination of other transport modes which can fulfil people's travel needs. Reducing car dependance can be especially difficult for families, who make complex non-work trips related to children's activities (e.g. school run, sports classes) or "mobilities

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of care" (McCarthy et al. 2017; Ravensbergen et al. 2020). Families value the car because it represents a way to organize the complexity of daily life, and because of its reliability, comfort, safety, and ability to carry people and heavy goods (e.g. groceries, strollers, toys) (Kent 2022). A single mode of transport is unlikely to substitute the car, but a combination of alternatives including walking, public transport, and, the focus of this paper, cargo bikes, could be a suitable solution.

Cargo bikes are a family of bicycles (including two or three-wheelers) which allow a combination of passenger and freight transport. For freight, cargo bikes can help to replace trucks for last-mile delivery in dense urban contexts (Verlinghieri et al. 2021). For individuals, cargo bikes represent an alternative to the family car (Thomas 2021), by combining the advantages of cycling (physical activity, sustainability, autonomy) with additional space for the transport of children or objects. Although bicycles with a transport function exist since the early 20th century, they were progressively replaced by the car (Narayanan and Antoniou 2022).[1] The recent revival of cargo bikes follows the success of electrically assisted bicycles (e-bikes), which have made cycling easier and more accessible (Marincek and Rérat 2022).

To date, most research has focused on commercial cargo bikes (see reviews by Carracedo and Mostofi 2022; Narayanan and Antoniou 2022). Literature on the private use of cargo bikes remains scarce, although it has been increasing (Marincek et al. 2024). Studies have mostly considered cargo bike sharing (CBS) services, (Becker and Rudolf 2018b; Hess and Schubert 2019; Bissel and Becker 2024). The few studies on owned cargo bikes have come from a North American context, focusing on the use of cargo bikes by families in car-dominated contexts (Riggs and Schwartz 2018; Thomas 2021). Thus far, the effects of owned cargo bikes on other transport modes remain relatively unknown. Current studies have hitherto only considered the short-term substitution of trips by cargo bikes (Riggs 2016). There remains a substantial research gap regarding the long-term modal shift effects of cargo bikes, especially in more multimodal contexts such as Europe. Understanding these effects is important to assess their potential for transport.

This paper aims to address the modal shift effects of cargo bikes on other mobility practices in an urban transport market. Traditionally, a modal shift is thought of as the replacement or substitution of trips made by a transport mode through another mode. However, focusing only on trip substitution oversimplifies the complexity of this phenomenon, the difficulty of making such a switch, and its potential for changing mobility habits in the long term (Rérat et al. 2024). Indeed, a modal shift can also imply a lifestyle change (giving up ownership of a car or a purchase) or continuing to live car-free. Enlarging the scope of modal shift effects to include renunciation of car ownership can thus help to better understand cargo bikes' potential.

In this paper, we approach the modal shifts related to cargo bikes in several ways. Firstly, we contextualize the cargo bikes' role through the profile of users, their motivations, and uses. Secondly, we consider their substitution effects, by assessing which modes were previously used, and how their use changed after cargo bike adoption. Thirdly, we consider renunciation, or the long-term effects of cargo bikes on giving up the ownership of other vehicles or transport passes. This approach can be summarized by our three research questions:

[1] Cargo bikes remained popular as a form of personal transport in high-cycling countries such as the Netherlands, or in cities such as Copenhagen, where an estimated 25% of households with children own cargo bikes (City of Copenhagen 2017).

1. Who adopts a cargo bike, why, and for which trips?
2. Which effects does owning a cargo bike have on substituting trips made by other transport modes?
3. How does cargo bike adoption affect the renunciation to the ownership of other transport modes, especially the car?

Our study is based on a nationwide survey among cargo bike owners in Switzerland, one of the largest samples to date ($n=696$). Our results offer a novel approach of modal shift effects of cargo bikes through three lenses: (1) adoption and use, (2) substitution of trips, (3) renunciation of ownership.

The remainder of our paper is structured as follows. Section "Background" provides a background on the concept of modal shift, before reviewing findings regarding cargo bikes. Section "Method" presents our methodological approach. Section "Results" presents our results on cargo bike adoption and use, substitution, renunciation, and a typology of modal shifts from cars to cargo bikes. Section "Discussion" discusses these results within the literature. Finally, Sect. "Conclusions" concludes and opens on further research and policy recommendations.

Background

Widening the perspective on modal shifts: from substitution to renunciation

A classic definition of a modal shift refers to the substitution (or replacement) of a trip conducted with one mode, such as the car, by another transport mode, such as the bicycle. However, this definition does not consider the relationships between transport modes, and only considers short-term effects on mobility practices.

Considering only trip substitution limits our understanding of the relationships of competition and synergies among modes within systems of mobility. Reducing the need for a car is difficult because of the hegemonic position automobility occupies among mobility practices (Urry 2004). Meanwhile, vélomobility, or the system of mobility around cycling, remains incomplete, both in terms of material conditions (urban form, infrastructure) and social representations (too dangerous, too tiring) (Koglin and Rye 2014; Rérat 2021b).[2] Replacing car ownership requires more than one mode, such as a combination of walking, cycling, and public transport (Baehler and Rérat 2022). Having access to a portfolio of transport modes within the urban transport market enables travellers to opt for suitable solutions in terms of speeds, spatial ranges, and provides synergies in terms of inter- and multi-modality (Guidon et al. 2019). As a complement to public transport, walking or cycling, cargo bikes can play an important role in a mobility portfolio by providing a larger capacity for trips which would have required a car, like transporting goods or children.

To go beyond short-term substitution and consider modal shift effects in the long-term, a longitudinal approach of mobility practices over time is needed. Mobility biographies research views car driving and cycling as mobility trajectories stretching over an individual's life course, which can change under the influence of "key events" in other spheres of life

[2] This the result of decades of marginalization of cycling in transport planning policies (Koglin and Rye 2014).

(e.g. work, family) (Lanzendorf 2003; Müggenburg et al. 2015). Changes in car ownership often represent an adaptation to changes in life circumstances such as household composition, employment status, income, or childbirth (Clark et al. 2016). At the same time, such events can also provide an opportunity to get back into cycling (Chatterjee et al. 2013; Janke and Handy 2019). Depending on a person's mobility trajectory, modal shifts take on different forms. For instance, not owning a car may be linked to two pathways. Either giving up car ownership or "demotorization" (Aguilera and Cacciari 2020), or avoiding entering car ownership at all (Rau and Manton 2016). While adopting an e-bike or a cargo bike may represent a switch from car driving or public transport to start or resume cycling, it could also represent an upgrade from a conventional bicycle to avoid giving up cycling despite physical limitations or contextual changes (Marincek and Rérat 2021).

Cargo bike adoption, use, and effects on other modes

Existing research on cargo bikes stems mostly from the domain of freight or commercial transport of goods (Schliwa et al. 2015; Anderluh et al. 2017; Arnold et al. 2018; Blazejewski et al. 2020; Llorca and Moeckel 2021; Verlinghieri et al. 2021; for a review, see Narayanan and Antoniou 2022). Due to the novelty of cargo bikes, there has been very little research on the use of proprietary cargo bikes for personal transport (see review by Carracedo and Mostofi 2022). Exceptions to this include studies in North America on the role of cargo bikes for women and young parents (Masterson 2017; Riggs and Schwartz 2018; Thomas 2021), and for substituting automobile trips (Riggs 2016). A few cargo bike trials have been conducted in Norway (Bjørnarå et al. 2019), and Sweden (Börjesson Rivera and Henriksson 2014). However, these studies have small sample sizes, limiting possible comparisons.

Adoption and use of cargo bikes

The profile of cargo bike owners, their motivations and patterns of use provide a first indication of the opportunities and constraints of a modal shift to the cargo bike. Cargo bike owners are mostly people in the active phases of life aged between 30 and 50 years (Carracedo and Mostofi 2022; Narayanan and Antoniou 2022). While some studies report a majority of men (e.g. 62% for Riggs 2016), cargo bikes are often shared among partners within the household[3]. North American studies found cargo bikes appealed mainly to families (95%) and represented a parenting tool (Riggs 2016; Thomas 2021). Their owners have a high socioeconomic status and can afford a relatively high purchase price (several thousand euros). In the United States, 67% held bachelors' degrees and 50% had a household income over 100,000 USD (Riggs 2016).

A major motivation for buying cargo bikes is reducing dependence on the car (Riggs 2016; Thomas 2021). In congested urban areas, cargo bikes provide the ability to bypass traffic and avoid searching for parking (Masterson 2017; Thomas 2021). In car-free neighbourhoods, they represent an alternative to the car for heavy-load trips (Börjesson Rivera and Henriksson 2014; Baehler and Rérat 2022). Cargo bikes may also be adopted as a way to be more coherent with ones' environmental values (Baehler and Rérat 2022; Becker

[3] Cargo bikes are adjustable to different body types and heights.

and Rudolf 2018b) or as "an extension of (one's) environmental, social, and health values" (Masterson 2017, p. 54).

In contrast to cargo bike sharing which requires advance planning and is used infrequently (Carracedo and Mostofi 2022; Hess and Schubert 2019), owned cargo bikes are often a person's primary daily vehicle (Riggs and Schwartz 2018). Reported distances travelled by cargo bike owners in the United States range from 4.8 to 16 km per day (average of 10.4 km) (Riggs 2016). In Norway, an average weekly distance of 22.4 km, or 4.5 km per day was measured over a 9-month trial (Bjørnarå et al. 2019). Cargo bikes are used for a broad range of purposes including work, dropping children off at school, and non-work trips like running errands, going to appointments, or having fun with children (Riggs and Schwartz 2018; Schwartz 2016). Child-related purposes such as transporting children to and from school, often trip-chained with other activities, represent over half of all trips (57%) among North American users, and especially women (Riggs and Schwartz 2018; Schwartz 2016). Running errands such as buying food or groceries are also an important trip purpose which would otherwise have been made by car (Schwartz 2016; Riggs and Schwartz 2018; Bjørnarå et al. 2019). Recreational rides can also be made by cargo bike either as a specific trip, when trip-chaining, or as part of an "exploratory phase" after adoption (Börjesson Rivera and Henriksson 2014; Hess and Schubert 2019; Thomas 2021). Meanwhile, "cargo" purposes like transporting cumbersome items such as furniture, or goods from a hardware store, are less frequent, unlike for shared cargo bikes where they are one of the main draws (Becker and Rudolf 2018a; Börjesson Rivera and Henriksson 2014).

Effects of cargo bikes on other transport modes

Cargo bikes potentially compete with a wide spectrum of transportation modes, but only a handful of studies have considered their substitution effects. In countries with high car use like the United States, cargo bikes mainly substitute car trips (Riggs and Schwartz 2018; Thomas 2021). Before adopting a cargo bike, 60% of owners drove a car (either alone or carpooling) as their main mode, while only 19% did afterwards (Riggs and Schwartz 2018). Cargo bikes reduced 1 to 2 car trips per day (3–4 trips instead of 5–6) (Riggs 2016). In the European context, where cargo bike sharing (CBS) users have been surveyed, car ownership was already quite low, accounting for 27% of users in Basel, Switzerland (Hess and Schubert 2019) while only 6% considered the car as their main mode in Germany (Becker and Rudolf 2018a). However, many CBS users (46% in Germany and 31% in Switzerland) would otherwise have used the car or car sharing, suggesting a substitution potential (Becker and Rudolf 2018a; Hess and Schubert 2019). Cargo bikes may better substitute certain trip purposes, such as work or child-related trips, rather than suburban shopping trips (Bjørnarå et al. 2019).

Beyond substitution, no studies have considered the effect of cargo bikes on giving up ownership of a car in the household, which could potentially be high. According to Riggs (2016) 62% of cargo owners considered giving up a vehicle after adopting a cargo bike, although such a decision is constrained by other practical factors like work location (Riggs and Schwartz 2018). In Germany, CBS reduces car ownership between 7.4% and 18.1% when accounting for giving up ownership, but also for delaying or avoiding car purchase (Bissel and Becker 2024).

Conventional cycling and cargo biking share many similarities in terms of materials (vehicle and infrastructure), meanings (e.g. sustainability, efficiency), and competences (e.g. pedalling), making it easier for users to switch between the two (Hess and Schubert 2019). Unsurprisingly, many cargo bike users have cycling experience. In the United States, 29% of cargo bike owners previously considered the bicycle as their main mode of transport, and 11% still did after adopting the cargo bike, suggesting it does not entirely substitute the bicycle (Riggs 2016). In Germany, 71% of CBS users cycled as their main mode of transport (69% conventional, 2% e-bike), while 27% stated they would have otherwise used the bicycle for their cargo trips (Becker and Rudolf 2018a). Cargo biking also has a cumulative effect on cycling. In Norway, using cargo bikes increased overall cycling frequency and the share of parents cycling to work after 9 months, although not to other destinations (kindergarten or grocery store) (Bjørnarå et al. 2019).

Compared to the car, very little is known about the modal shift effect of cargo bikes on public transport and walking. In the American context where public transport is less developed, only 5.2% of cargo bike owners previously used public transport and 4.1% walking as their primary travel mode, with both being almost entirely replaced by cargo biking (Riggs 2016). However, in Switzerland, where public transport occupies an important place, CBS substituted a much larger share of 20% of public transport and 3% of walking trips (Hess and Schubert 2019). Meanwhile, in Germany, 13% of users previously considered public transport their main mode, and in the absence of a cargo bike, 9.6% would have used public transport and 3.3% walking (as well as 12.8% who would not have travelled) (Becker and Rudolf 2018a).

Summary and research gaps

Research on cargo bike owners is still very recent. It originates mostly from a North American context, which is very different from the European context. We identify several research gaps. Firstly, much remains to be known about why, how, and in which circumstances owners adopted cargo bikes, and to which extent they had access to other transport modes in the household. Secondly, there is a lack of information on the uses of cargo bikes, in terms of trip purposes, frequency, duration, and distance. Thirdly, the modal shift effects of cargo bikes on the substitution of trips by other transport modes, especially for public transport and walking, remain relatively unknown. Lastly, the effects of cargo bike ownership on reductions in motorization (i.e. giving up the second car in the household, or going car-free), have not been considered yet. To fill these gaps, we now present our methodology and data.

Method

Data collection

We conducted a nationwide online survey of cargo bike owners in Switzerland. This country of 8 million inhabitants has four national languages: German (70.6% of the population), French (24.8%) and Italian (4.3%), as well as lesser-spoken Romanche (0.3%) (FSO 2022b). In 2021, 8% of journeys were made by bicycle, with large differences between German-speaking (9.6%) and French-/Italian-speaking cantons (4.2%/2.7%), due notably to

differing cycling infrastructure and policies (Rérat 2021a). About 4200 electrically assisted cargo bikes have been sold in the country in 2023 (+184% since 2019), and about 18,000 since 2016 (Velosuisse 2024).

Cargo bike users were contacted through social network posts (Twitter, Facebook and LinkedIn). National and regional associations in the field of cycling and sustainable mobility diffused the survey among their members and through their social networks. Flyers containing a QR code linking to the survey were distributed onto cargo bikes in several regions and two shops in Basel and Lausanne diffused the survey to their clients. The survey was launched on June 13th, 2022, and ran until September 20th. A total of 696 cargo bike owners responded to the survey. The final sample does not aim to be geographically representative of the Swiss population. French-speaking respondents are over-represented compared to German-speakers due to the researchers' location and close contacts with cycling associations. Any linguistic and geographic differences in responses were accounted for in the results.

Variables

The survey consisted of 42 questions inspired by the literature on cargo bikes and modal shift. The first part focused on the adoption of the cargo bike, the profile of users, and patterns of use. To begin, we asked participants information about their cargo bike (model, price, subsidy, date of purchase). We assessed their socio-demographic profile (age, gender, household composition), socioeconomic status (income, education) and place of residence (recoded into 5 categories: urban municipalities in large urban regions, medium-sized urban regions, smaller urban regions, peri-urban municipalities, rural municipalities). Participants were asked about which vehicles were available in their household, as well as individually held travel passes (public transport and car sharing). Later, we evaluated the motivations for using a cargo bike, through a list of nine statements derived from the literature which could be answered on a five-point Likert scale (strongly disagree; rather disagree; neutral; rather agree; strongly agree). To measure the use of the cargo bike, we asked participants their overall frequency of use (every day or almost; several times per week; a few times a month; a few times a year; I don't use it anymore) and their frequency for specific trip purposes (work, school, recreation, groceries, carrying objects, social outings) with the same scale. Cumulated use was measured by asking the yearly distance of cargo bike use (recoded into 6 categories) and seasonal variation of use in winter (yes, like other seasons; yes, but less often; no; did not use this winter yet).

The second dimension of a modal shift, or the effects of cargo bike on trips by other travel modes, was evaluated through three questions. Firstly, we asked participants the substitution effect of the cargo bike, or how using a cargo bike had affected trips by car, motor two-wheelers, cycling, e-bikes, public transport, and walking (I do more; no change; I do less; does not apply). Secondly, we asked how they would have travelled before for the trips they now conducted by cargo bike (I did not do these trips; public transport; rental car/car sharing; car; motor two-wheeler; e-bike; mechanical bike; walking).

Lastly, the third dimension of a modal shift, the renunciation of the ownership of travel modes, was assessed by asking participants whether the cargo bike had led them to give up owning a car, buying a new car, owning a bicycle, an e-bike, or a public transport pass (yes; no; not concerned).

In a further step, we segmented participants into five groups based on the different modal shift effects of cargo bikes on car substitution (reducing car trips), car renunciation (giving up ownership), and current car ownership. Based on the modal choice literature (De Witte et al. 2013), we tested the effects of four categories of independent variables on these five groups: socio-demographic characteristics (employment status, income), household structure, spatial indicators (place of residence), vehicle ownership, transport passes, journey characteristics (frequency of use, winter use), and habits (previously used modes). To this end, we conducted descriptive statistics (Crosstabs), as well as Pearson's Chi Square tests to identify significant differences between these groups.

Sample characteristics

As represented in Table 1, the majority of respondents are aged between 30 and 49 years (81%), suggesting adults over 60 and under 30 may either have less need for transporting goods or children, or be deterred by high price. Due to this age structure, cargo bike users are mainly employed full-time (43.5%) or part-time (52.2%), with very few respondents not working, retired or studying. Most respondents are male (64.9%). However, they are usually not the only users given that 79.3% share the cargo with their partner. Cargo bike owners mostly live in familial households (77.4%), of which 93.9% carry children by cargo bike. Their educational background is very high (80.7% university degree or equivalent), and they have a higher net household income than the national average (51.7% over 9000 Swiss Francs [CHF] compared to an average of 6600 CHF[4]). Most cargo bike owners reside in an urban or suburban municipality (87.5%), either located in a large (69.3%), medium-sized (14.6%), or small (3.6%) urban region. The remaining 12.4% live in peri-urban (8.3%) or rural municipalities (4.2%). Four out of ten respondents are German-speaking (40.3), compared to 59.7% of French speakers. The latter are overrepresented compared to their actual weight in the population due to the researchers' location and word-of-mouth recruitment process.

Table 2 indicates that the most owned cargo bike model is the front-loader with box in the front (66.9%), followed by the longtail with an extended rear rack (23%). Three-wheelers are less common (10.1%). A majority of cargo-bikes have electrical assistance (87.9%). Two thirds (65%) were bought in the last 3 years, with longtails increasing strongly in popularity in the last two years, presumably due to their smaller size and greater ease of use compared to larger models. Most cargo bikes (84.4%) were new purchases, but not all (15.6%), suggesting a used market exists. Purchase subsidies, either through the municipality or region, were obtained by 34.5% of owners. Most cargo bikes (48.7%) cost between 3000 and 6000 CHF (roughly equivalent to Euros), although one third were over 6000 CHF.

Results

Mobility portfolio: access to vehicles and transport passes

Cargo bike owners have access to a mobility portfolio which includes vehicles in their household and individual transport passes (Table 3). Overall, they show a low reliance on

[4] Household budget survey: results 2019 (FSO 2022a).

Table 1 Profile of cargo bike owners

Variables	Categories	*N*	%
Age	20–29	15	2.5
	30–39	222	36.9
	40–49	265	44.1
	50–59	83	13.8
	60 and over	16	2.7
Gender	Male	396	64.9
	Female	214	35.1
Household composition	Non-family household	138	22.6
	Family household	473	77.4
Employment situation	Student	3	0.5
	Part-time work (80% or less)	314	52.2
	Full-time work (90–100%)	262	43.5
	Unemployed or homemaker	15	2.5
	Retired	8	1.3
Educational background	University or equivalent[a]	489	80.7
	Other (apprenticeship, vocational school)	117	19.3
Monthly net household income	>3000 CHF	22	4.3
	3000 to 6000 CHF	68	13.4
	6000 to 9000 CHF	155	30.6
	9000 to 12,000 CHF	162	32
	12,000 CHF and more	100	19.7
Number of children transported by cargo bike (only families)	None	31	6.1
	1	163	32.3
	2 or more	311	61.6
Cargo bike used by other members of household	No	120	20.7
	Yes	461	79.3
Language of the survey	French	413	59.3
	German	283	40.7
Place of residence[b]	Urban municipality in large urban region	400	69.3
	Urban municipality in medium urban region	84	14.6
	Urban municipality in small urban region	21	3.6
	Peri-urban municipality or rural centre	48	8.3
	Rural municipality	24	4.2

[a]University, Polytechnic University of Applied Sciences or Pedagogy

[b]Based on the 2012 typology of municipalities by the Federal Statistical Office (FSO 2017)

motorized modes compared to the national population in the 2021 Mobility and Transport Micro-census. Despite 92% owning a drivers' licence, almost half live car-free (45.5%), while 54.5% own at least one car, compared to 22% car-free at the national level (FSO & FOSD 2023). Even if cargo bike users are mainly city dwellers, the proportion of car-free households is very high, considering that only 7% of family households live without a car in Switzerland (FSO & FOSD 2023). In addition to, or as a replacement for a private car, four in ten users own carsharing passes (39.6%), much higher than the 4% in the population

Table 2 Cargo bike purchase information

Variables	Categories	*N*	%
Type of cargo bike	Front-loading 2-wheeler	424	66.9
	Longtail	146	23
	3-wheeler	64	10.1
Type of purchase	New	570	84.4
	Used	105	15.6
Date of purchase	2016 and before	100	16.2
	2017–2018	113	18.3
	2019–2020	210	34
	2021-summer 2022	194	31.4
Electrical assistance	None (unassisted)	82	12.1
	25 km/h	526	77.6
	45 km/h	70	10.3
Purchase subsidy	Yes	229	34.5
	No	434	65.5
Price	0–3000 CHF	110	17.8
	3001–6000 CHF	301	48.7
	6001 CHF and over	207	33.5

Table 3 Vehicle ownership (in the household) and transport passes

Variables	Categories	%	% Swiss micro-census
Drivers' licence	Yes	92	83
	No	8	17
Cars in the household	0	45.5	22
	1	48.8	49
	2	4.1	23
	3 or more	1.6	6
Motor two-wheeler	0	92	88
	1 or more	8	12
Bicycle (unassisted)	0	10.2	39
	1	14.5	22
	2	23.4	18
	3 or more	51.9	21
E-bike (25 km/h) without cargo-bike	0	66.8	82.1
	1 or more	33.2	17.9
Speed-pedelec (45 km/h) without cargo-bike	0	88.3	97.1
	1 or more	11.7	2.9
Carsharing pass	No	60.4	96
	Yes	39.6	4
Public transport pass (excluding half-fare)	None	74.8	80.4
	National general pass	13.6	8.6
	Other pass (e.g. local zone pass)	11.6	11

(FSO & FOSD 2023). Less than one in ten own a motor two-wheeler (8%), compared to 12% nationally.

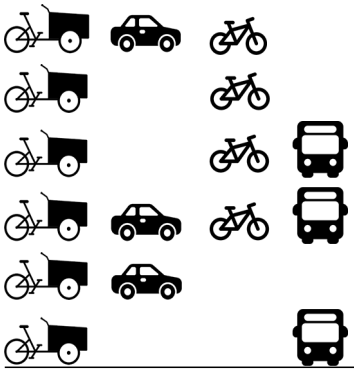
Cargo bike owners are a population of experienced cyclists. Almost all households own at least one conventional bicycle (89.7%), one third an e-bike (pedelec) (33.2%), and one in ten a speed-pedelec (11.7%). By comparison, in 2021, only 61% of Swiss households owned one or several bicycles, 17.9% e-bike[5] and 2.9% a speed-pedelec[6] (FSO & FOSD 2023). Public transport passes are only held by one in four users (25.2%), a rather low rate for urban residents, but similar to the national average (19.6%). This figure excludes half-fare passes (50% discount on all public transport). Holders of a general pass giving access to all public transport in the country (trains, buses, trams, boats) account for 13.6%, compared to 8.6% nationally (FSO & FOSD 2023). Meanwhile, the remaining 11.6% have another type of public transport pass (e.g. a local zone pass).

Table 4 classifies cargo bike owners based on their access to vehicles within the household and their public transport passes. In addition to a cargo bike, 41.7% own bicycles (or e-bikes) and cars, while 30.5% are exclusive cyclists without a car nor public transport pass. Less frequent are cyclists who own public transport passes (14.2%), and multimodal users who have access to bicycles, public transport passes and cars (10.8%). Meanwhile, those who only own cars account for 2.3% of cargo bike users, and those with only public transport passes for 0.5%. However, many car-free users (75.7% of cyclists with public transport and 61.4% of exclusive cyclists) compensate for a lack of private car ownership by owning a car-sharing pass.

Motivations for adopting cargo bikes

The motivations for adopting cargo bikes provide insights into whether modal shift is a reason to buy a cargo bike (Table 5). A principal component analysis (Table 6) indicates that these motivations can be summarized into 3 dimensions: (1) physical activity; (2) sustain-

Table 4 Typology of household vehicle ownership and individual public transport passes

	Group	%
	Car and bike	41.7
	Exclusive cyclist (no public transport, car)	30.5
	Cyclist with public transport (no car)	14.2
	Multimodal with bike (car, public transport)	10.8
	Car driver (no public transport, no cycling)	2.3
	Public transport only (no car, bike)	0.5

[5] This value includes e-cargo bikes, which are not a separate category in the Swiss Micro-Census.

[6] E-bikes come in two categories. Pedelecs, the most common (85% of sales) have a pedaling assistance until 25 km/h, while speed-pedelecs (15%) have an assistance until 45 km/h (Velosuisse 2024).

Table 5 Motivations for cargo bike purchase (%)

	Strongly disagree	Rather disagree	Neither agree nor disagree	Rather agree	Strongly agree
To reduce or do without the car	2.1	2.3	5.1	11.3	79.2
Adopting sustainable mobility	0.6	1.2	4.4	14.7	79.1
Transporting children to activities	7.9	2.6	4.7	6.4	78.4
Move independently and efficiently	0.9	0.9	3.8	16.5	77.8
To have an alternative to public transport	4	4.7	10.3	23.4	57.6
Carrying heavy loads	1.5	4.2	9.2	33.5	51.5
Going for family rides	6.8	5.8	14.9	28.4	44.1
Cycling more	10.4	9.3	23.6	24.3	32.3
Exercise while travelling	12.2	14.4	22.2	26.7	24.5

Table 6 Principal component analysis (PCA) for motivations for cargo bike purchase

Rotated component matrix[a]	Components and loadings		
	Physical activity	Sustainable travel	Carrying children
Cycling more	**0.85**	0.11	0.10
Exercise while travelling	**0.87**	0.11	0.10
To have an alternative to public transport	0.38	0.34	0.33
Move independently and efficiently	0.16	**0.61**	0.24
Carrying heavy loads	-0.15	**0.66**	-0.08
To reduce or do without the car	0.30	**0.53**	0.01
Adopting sustainable mobility	0.19	**0.73**	0.00
Transporting children to activities	0.01	0.04	**0.88**
Going for family rides	0.18	0.00	**0.82**

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization

Bold values are over 0.4

[a]Rotation converged in 4 iterations

able travel; (3) and carrying children. Contrary to other motivations, having an alternative to public transport does not clearly load onto any of the 3 components.

The strongest motivations are related to cargo bikes' benefits for mobility and sustainability: adopting a sustainable form of mobility (93.8% (strongly) agree), moving independently and efficiently (94.3%), reducing the use of the car (or doing without it) (90.5%), and

having an alternative to the car or public transport (81%). This suggests that substituting car trips or giving up the car is a clear objective. A second set of motivations are related to cargo bikes' transport capacity, namely the ability to carry heavy or bulky items (85%). A third set of motivations are child-related, including the ability to transport children to school or activities (84.8%) and to go on rides with or without the family (72.5%). Again, these motivations suggest the wish to prioritize cycling, rather than driving, for these activities. Meanwhile, the physical activity benefits of cargo bikes are slightly less important, including the wish to cycle more (56.6%), and the ability to exercise during trips (51.2%). This indicates that many users are already cycling and do not need additional exercise.

Uses of the cargo bike

Understanding how cargo bikes are used is a way to measure their modal shift potential. As Table 7 shows, frequency of use is very high, with almost all (91.3%) owners using their vehicle daily or several times per week. This suggests that cargo bikes play a central role in their users' daily mobility, rather than just being used for specific trips. The median cumulated yearly distance is 1600 km per year, which represents 31 km per week. This distance varies between models, with three-wheelers travelling less (median: 1000 km) than longtails and other 2-wheelers (median: 2000 km and 1700 km), likely due to a larger size ill-suited for daily trips. Similarly, faster s-pedelec models travel much longer distances (median: 3000 km) than regular e-bikes (1500 km) and non-assisted models (1350 km). Cargo bikes are not only used in warmer seasons but year-round, with 74.9% continuing to use them at the same rate in winter, 20.2% less often (maybe due to fewer cycling tours), and only 2.1% interrupting cycling.

The trip purposes give an indication of the activity space covered by cargo bikes. As shown in Table 8, cargo bike users cycle regularly for a variety of trip purposes. The most frequent trips are taking children to school (68.5% weekly) and shopping or groceries (65.6% weekly). However, cargo bikes are also used frequently for commuting (57.1% weekly). Less frequent purposes include recreational rides (33.4% weekly) and going to social activi-

Table 7 Patterns of cargo bike uses

Variables	Categories	%
Frequency of use	Every day or almost every day	54.8
	Several times a week	36.5
	A few times a month	7.5
	A few times a year	1
	I don't use it any more	0.1
Yearly distance	0–1000 km	32.1
	1001–2000 km	35.9
	2001–3000 km	17
	3001–4000 km	6.3
	4001–5000 km	4.2
	5001 km and over	4.4
Winter use	Yes, as in other seasons	74.9
	Yes, but less often	20.2
	No	1.9
	Not yet used in winter	3

Table 8 Cargo bike trip purpose and frequency (%)

	Every day or almost every day	Several times a week	A few times a month	A few times a year	Never	Not concerned
Transporting bulky items (e.g. furniture, recycling)	4.9	11.3	41.1	32.2	8.1	2.4
Social activities (e.g. restaurant)	6.2	19	39.5	20.4	9.9	5
Recreational rides (with or without children)	7.2	26.2	42.3	14.7	5.4	4.2
Shopping or groceries	15.9	49.6	29	4.3	0.6	0.5
Commuting to work or school	35.2	21.9	12	10.2	13	7.6
Taking children to school or activities	38.1	30.4	10.4	2.1	6.1	12.8

Table 9 Previously used mode for trips now conducted by cargo bike (how would you have travelled before for the journeys you now make by cargo bike?)

	% selected	% not selected
Public transport	58.6	41.4
Car	46.1	53.9
Mechanical bicycle	46	54
Walking	37.9	62.1
Car sharing	15.4	84.6
E-bike (excluding cargo bikes)	10.5	89.5
Motorbike/scooter/moped	3.1	96.9
Did not do these trips/my situation has changed	6.7	93.3

ties (25% weekly). Lastly, carrying heavy or bulky goods is less common (16.2% weekly), but mostly done a few times per month or year.

Effects on other mobility practices

Substitution effect

To understand the substitution effect of cargo bikes, we first consider the transport modes previously used for these trips, a multiple-choice question (Table 9). These modes are firstly public transport (58.6%), followed by the car, either privately owned (46.1%) or shared (15.4%), the bicycle, either mechanical (46%) or e-bike (10.5%), and walking (37.9%). Given that less than half previously drove a car, many respondents already had multimodal travel patterns and relied heavily on alternatives to the car such as public transport, cycling and walking.

The substitution effect of cargo bikes, or the variation in the use of other transport modes, is shown in Table 10. Despite low car ownership, the most substituted modes are cars, which 59.7% of owners use less since adopting cargo bikes. Public transport trips were also strongly reduced (58.9%). Mechanical cycling decreased for 41.4% of users and e-biking for 11.3%, but also increased (10.8% for bikes and 6.5% for e-bikes), suggesting that cargo bikes increase overall cycling. Lastly, walking trips were reduced by 30.6% of users. These results suggest that cargo bikes substitute urban transport modes over both short and medium ranges.

Table 10 Substitution effects (what are the effects of using a cargo bike on your travel?) (%)

	The car	Public transport	The mechanical bicycle	Walking	The e-bike (excluding cargo bikes)	Motorbike/scooter/moped
I do less	59.7	58.9	41.4	30.6	11.3	7.3
No change	11.8	29.8	38	64.8	24.9	11.5
I do more	2.3	2.9	10.8	2	6.5	1.7
Does not apply	26.2	8.3	9.8	2.6	57.3	79.5

Table 11 Renunciation effects (thanks to the cargo bike, have you given up …)

	Owning a car	Buying a new car	Owning a public transport pass	Owning an e-bike	Owning a motorbike/scooter	Owning a mechanical bicycle
Yes	31.2	30.9	26	24	18.9	8.3
No	47	27.3	45.9	37.8	17.6	73.6
Does not apply	21.8	41.8	28.1	38.3	63.5	18.1

Renunciation effect

The most radical modal shift effect is renunciation, which refers to giving up ownership of a vehicle/season ticket following cargo bike adoption. As shown in Table 11, the strongest renunciation effect is observed for owning a car, which 1 out of 3 cargo bike users (31.2%) have given up. This is an important result given that renouncing car ownership is a serious decision to make for a family, as it requires selling a car and reorganising household mobility habits. Additionally, 30.9% of users have given up buying a new car, which can be interpreted as renouncing a future car purchase, or not replacing an old car. Beyond the car, one in four owners (26%) gave up owning a public transport pass, an individual decision which is less difficult than for car ownership. One in four (24%) gave up owning an e-bike and 18.9% a motorbike/scooter, two modes with similar performances to cargo bikes in an urban context but offering less capacity. However, only 8% gave up owning a conventional bicycle, suggesting that most users intend to keep other forms of cycling which fulfil a different purpose than cargo bikes (e.g. sport or recreation).

A classification of modal shifts to the cargo bike

From giving up the car to already living car-free

To categorize the various modal shifts from cars to cargo bikes, we create a typology based on current car ownership, renunciation to the car, and substitution effects. As depicted in Fig. 1, cargo bike users can be segmented into five groups.

The first group are those who ***gave up the car*** ($N=154$, 25.3%). They used the cargo bike to fully renounce car ownership and live car-free. Few in this group were previously using the car (31%), but many were using public transport (72%), cycling (51%), as well as car sharing (30%). It might have been easier to give up their car because they were not so

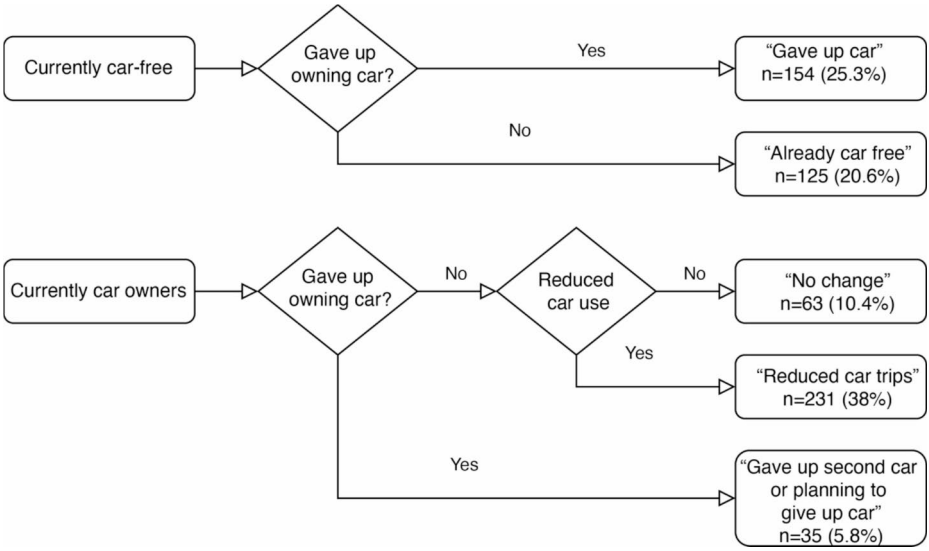


Fig. 1 Typology of modal shifts from car to cargo bike

dependent on it for their daily trips. Indeed, they have several non-car options beside cargo bikes including public transport passes (30%), car-sharing passes (64%), and e-bikes (31%).

The second group are those who ***gave up a second car or are planning to give up their car*** ($N=35$, 5.8%). Since adopting the cargo bike, they stated their intention to give up owning a car, but currently still own one in their household, suggesting it was either a second car, or they were not able to give it up yet. However, almost all reduced their car trips (94%) and 62% gave up buying a new car, indicating the cargo bike substituted car trips. They may have trouble giving up car ownership entirely because most previously relied on driving (74%), whereas fewer cycled (40%), used public transport (34%) or walked (26%). Currently, in addition to cars, they own the most e-bikes (43%) and speed-pedelecs (17%), but the fewest public transport passes (9%). This reliance on individual transport modes could be explained by a higher share of rural or peri-urban dwellers compared to other groups (30%).

The third group are those who ***reduced car trips*** ($N=231$, 38%). Adopting a cargo bike enabled them to reduce their car use, but not to give up car ownership. Still, 26% gave up buying a new car. Like the previous group, they may find it difficult to abandon the car because they previously relied heavily on driving (81%) rather than public transport (53%), cycling (34%) or walking (32%). Currently, their mobility portfolio is composed of cars and a high share of e-bikes (36%) and motor two-wheelers (12%), but few public transport passes (22%). Like the previous group, their residential location may influence their reluctance to give up the car, with 18% living in a peri-urban or rural context.

The fourth group are those who did ***not change*** (i.e., reduce) their car habits after adopting cargo bikes ($N=63$, 10.4%). Initially, these car owners appear to be the most reluctant to change, showing no substitution of car trips and no renunciation to car ownership. However, although they own cars, only 16% were previously driving them, while most were using public transport (56%), cycling (52%), walking (46%) and e-biking (19%). Although

they did not reduce car use, only 5% increased it, but 54% saw no change and 41% found the question non-applicable. Thus, this group did not need to reduce car trips because they already drove rarely before adopting a cargo bike. Their reluctance to give up cars (despite not using them) may be related to a higher income, with 65% of monthly household incomes over 9000 CHF, or a high share of familial households (92%) compared to other groups. In addition to cars, this group also includes a high share of conventional bicycles (92%) and e-bikes (40%) but few public transport passes (18%).

The fifth group are those who were ***already car-free*** ($N=125$, 21%). Since adopting a cargo bike, people in this group did not renounce cars (most responded "does not apply"), because they already did not own one. Instead, they previously used public transport (67%) and had the highest share of cycling (66%) and walking (44%), and the lowest share of car driving (10%), likely through shared or borrowed cars. Having several alternatives to the car and previous experience of cycling likely made their switch to the cargo bike easier. Indeed, they currently own the most car-sharing passes (66%) and public transport passes (34%). Another possible factor is that almost all live in an urban context (98%) where a car is less needed.

Factors associated with membership of a cargo bike user group

To understand the differences between each group, we conduct a multinomial logistic regression (Table 12) which tests the odds of being a member of one of the groups in the typology - "reduced car trips"; "gave up car or planning to give it up"; "already car free" - compared to a reference group ("no change"). Because of its small sample size, we combined the group "gave up second car" with "gave up car" into a single group named "gave up car or second car". The model considers the following independent variables: sociodemographic

Table 12 Multinomial logistic regression models for typology of cargo bike modal shifts from the car ($n=430$)

	Reduced car trips			Gave up car or second car			Already car free		
	Exp(B)	Sig.	Std. Error	Exp(B)	Sig.	Std. Error	Exp(B)	Sig.	Std. Error
Income > CHF 9'000	0.92	ns	0.41	**0.44**	**p < .1**	**0.43**	**0.17**	**p < .001**	**0.46**
Urban place of residence	0.49	ns	0.61	0.82	ns	0.65	**5.26**	**p < .1**	**0.94**
Public transport pass	2.13	ns	0.59	2.17	ns	0.60	**3.79**	**p < .05**	**0.60**
Car sharing pass	1.69	ns	0.55	**9.93**	**p < .001**	**0.55**	**10.84**	**p < .001**	**0.57**
Daily CB* use	0.78	ns	0.42	0.53	ns	0.44	**0.38**	**p < .05**	**0.47**
Previously cycling for trips by CB*	**0.33**	**p < .01**	**0.42**	0.51	ns	0.44	1.10	ns	0.48
Previously using PT for trips by CB*	1.41	ns	0.40	**2.61**	**p < .05**	**0.43**	**2.61**	**p < .05**	**0.45**
Motivation: Physical activity (factor score)	1.32	ns	0.19	1.14	ns	0.20	0.96	ns	0.21
Motivation: Sustainable travel (factor score)	**1.59**	**p < .01**	**0.15**	**3.09**	**p < .001**	**0.21**	**1.93**	**p < .001**	**0.19**
Motivation: Carrying children (factor score)	**0.55**	**p < .05**	**0.25**	**0.58**	**p < .05**	**0.27**	**0.56**	**p < .05**	**0.27**

Reference category: « no change »; ns = non-significant; Significant values are shown in bold; Model fit indicator (Nagelkerke R Square) : 0.416

*Cargo bike

characteristics (income, life course position, family/household situation, geographical location), mobility equipment (other alternatives to the car), travel habits (intensity/frequency of cargo bike use; previously used modes), and motivations for cargo bike use (factor scores presented in Sect. "Motivations for adopting cargo bikes").

Compared to the reference group ("no change"), cargo bike users who ***reduced car trips*** are more motivated to travel sustainably, but less motivated by the ability to carry children. They are less likely to have previously cycled for the trips now undertaken by cargo bike. They show no significant difference in terms of sociodemographic characteristics or mobility equipment.

Cargo bike users who ***gave up the car or a second car*** are – as expected - very motivated by traveling sustainably, and less motivated by carrying children. In terms of mobility equipment, they are much more likely to own a car sharing pass which still gives them access to a car when needed. They are also likely to have previously traveled by public transport for the trips now taken by cargo bike, suggesting a low reliance on the car for daily trips.

Cargo bike users who are ***already car free*** are also more motivated than the reference group to travel sustainably. Interestingly, they are unlikely to have a high income, suggesting a link between a car free lifestyle and financial situation. Having access to alternative mobility options to the car strongly increases the likelihood of living car free, especially owning a car sharing pass, but also a public transport pass. Having previously used public transport also increases the likelihood of living car free. In terms of travel habits, members of this group are less likely to use the cargo bike every day. This could suggest a lower frequency of trips due to a less tight schedule, or the use of other bicycles alongside the cargo bike. Lastly, people in this group are also more likely to live in an urban municipality which provides many transport options and makes living car-free easier.

Determinants of car renunciation and substitution by the cargo bike

We now ask ourselves which factors are associated with renouncing car ownership, or with substituting car trips following cargo bike adoption. To answer this question, we use two binary logistic regressions (Table 13), with car substitution and car renunciation as dependent variables. For our independent variables, we again consider sociodemographic characteristics (life course position, family/household situation, geographical location), mobility equipment (other alternatives to the car), travel habits (intensity/frequency of cargo bike use; previously used modes), motivations for cargo bike use (factor scores presented in Sect. "Motivations for adopting cargo bikes").

The first model for renunciation compares those who gave up car ownership (yes) and those who did not (no), while those "not concerned" are purposely left out. All else being equal, we observe that the likelihood of renouncing the car after purchasing a cargo bike is heavily influenced by owning a car sharing pass which offers the possibility to live car free but still use a car when needed. Being motivated to travel sustainably is – as expected - positively associated with giving up car ownership. Travel habits also have a significant effect on giving up car ownership. Continuing to use the cargo bike in winter increases the likelihood of renouncing the car. However, using the cargo bike on a daily basis has a negative effect, which may be related to having stronger time constraints which make it more difficult to give up owning a car. Previously using public transport for trips now made by cargo bike also increases the likelihood of car renunciation, suggesting those with a lower reliance on

Table 13 Binary logistic regression models for car renunciation ($n=431$) and substitution ($n=399$)

	Renunciation			Substitution		
	Exp(B)	Sig.	Std. Error	Exp(B)	Sig.	Std. Error
Age over 50 years	**0.45**	**p<.05**	**0.35**	2.06	ns	0.46
Family with children	**0.54**	**p<.1**	**0.32**	1.67	ns	0.39
Car sharing pass	**4.01**	**p<.001**	**0.24**	1.31	ns	0.29
Winter cycling with CB*	**1.97**	**p<.05**	**0.29**	**0.36**	**p<.01**	**0.39**
Daily frequency of CB* use	**0.58**	**p<.05**	**0.25**	**1.75**	**p<.1**	**0.29**
Previously cycling for trips by CB*	1.24	ns	0.24	**0.43**	**p<.01**	**0.29**
Previously using PT for trips by CB*	**1.60**	**p<.05**	**0.24**	0.69	ns	0.28
Motivation: Physical activity (factor score)	0.99	ns	0.12	**1.35**	**p<.05**	**0.14**
Motivation: Sustainable travel (factor score)	**1.83**	**p<.001**	**0.15**	**1.34**	**p<.05**	**0.12**
Motivation: Carrying children (factor score)	1.13	ns	0.14	0.84	ns	0.16

Significant values are shown in bold

ns=non-significant; Model fit indicator (Nagelkerke R Square): 0.274; 0.146

*Cargo bike

the car are better prepared to live without one. For sociodemographic variables, being aged over 50 years has a negative effect on renunciation, indicating a generational reluctance to give up car ownership which may be related to health concerns, or a higher number of leisure trips for which the car is preferred. Living in a familial household also reduces the likelihood of giving up car ownership, although only with a low level of significance ($p<.1$) in the final model once motivations are included. Conversely, previously cycling and the motivation to stay active or carry children had no significant effect on renunciation.

The second model for substitution compares those who substituted car trips (i.e. use the car less) since adopting a cargo bike to those who did not, again without considering those "not concerned". Compared to renunciation, we find that some effects are reversed. Using the cargo bike daily increases the likelihood of reducing car use, as one mode of transport replaces the other. Both continuing to use the cargo bike in winter and having previously cycled for the trips now undertaken by cargo bike is negatively related to substituting car trips. This suggests that users who substituted car trips were not previously cycling and are not year-round cyclists. In terms of motivation, the wish to reduce car trips is – as expected - positively associated with car substitution, as well as the motivation to stay physically active. Other variables including demographic characteristics (age, familial situation), mobility equipment (carsharing pass) and previous use of public transport do not show a significant effect on reducing car trips.

Discussion

The diffusion of cargo bikes has rapidly increased in the last two years. Cargo bikes mainly attract parents aged 30–49 years, with high education and income, who rely less on cars (45.5% are car-free) and own many bicycles. They fill an important travel need for families, confirming previous findings in America (Thomas 2021), but also 22.6% of other non-family households.

The motivations for buying a cargo bike are related to the ability to reduce car use, move independently, use a sustainable form of mobility, and carry children or bulky goods. Cargo bikes are used intensively – daily or several times a week – and for a wide range of trip purposes. The most common are taking kids to school/activities and shopping/grocery trips, but cargo bikes are also used for going to work, recreational rides, and social activities, in line with American findings (Riggs and Schwartz 2018), whereas heavy-load "cargo" trips are quite rare. The yearly volume of use confirms this intensity, with average distances of over 1600 km per person, amounting to 31 km per week, comparable to existing studies (Carracedo and Mostofi 2022). Practically all owners continue to ride them in winter, even if slightly less often. These results show that cargo bikes have become their owners' central daily vehicles, rather than a back-up mode for trips requiring cargo capacity.

The intensive use of cargo bikes suggests that their substitution effect on other transport modes is also high. Our results show that, prior to using a cargo bike, the most previously used modes were public transport, the car (owned or shared) and cycling (mechanical or e-biking). Following cargo bike adoption, the most important decrease in use is for driving and public transport, while cycling is effectively "transferred" to cargo biking, and even increases in some cases. This result confirms that cargo bikes substitute car trips in Europe as well, and not just the north American context (Riggs 2016; Riggs and Schwartz 2018; Thomas 2021). It also suggests that within the urban transport market, the cargo bike competes with public transport, an interesting new finding.

Beyond substituting trips, cargo bikes also have a deeper modal shift effect on giving up ownership of other transport modes in the household. After adopting the cargo bike, one third of respondents gave up owning or purchasing a future car. This finding is particularly impressive given the difficulty of giving up a car, the short period of cargo bike ownership and the fact that many households are already car free. It suggests that cargo bikes might have an important modal shift potential in the future, not just for people giving up car ownership, but also those already car-free and wishing to stay so. Compared to findings for cargo-bike sharing (Bissel and Becker 2024), the effect of owned cargo bikes on car reducing ownership is greater still.

To categorize these modal shifts from car ownership to cargo bike, owners were segmented into five groups based on their substitution of car trips, renunciation to car ownership, and current car ownership: (1) Those who gave up the car since adopting the cargo bike; (2) those planning to give up the car, or a second car; (3) those who reduced car trips; (4) those who did not change; and (5) those who were already car-free.

The factors associated with giving up car ownership among cargo bike users include a previous experience using other transport modes (public transport), access to alternative travel options (car sharing), being motivated to travel sustainably, and using the cargo bike year-round. Being aged more than 50 years, and to a smaller extent, living in a family with children, reduces the likelihood of giving up car ownership. This suggests a need for better understanding the needs and barriers affecting older demographic categories. It also confirms that families with cargo bikes remain constrained to own a car by a range of practical factors (Riggs and Schwartz 2018).

Meanwhile, reducing car trips is associated with daily cargo bike use and being motivated to travel sustainably and stay physically active, but not with previous cycling experience nor year-round cycling. This result suggests that contrary to those who give up the car, those who merely reduce its use tend to have less experience in cycling before adopting a

cargo bike. This result highlights the difference between car substitution and renunciation of car ownership, which are two different processes which concern different types of cargo bike users.

Conclusions

Cargo bikes have the potential to fill a void in the urban sustainable transport market, where the focus is on seamless individual transport (i.e. micromobility, bike-sharing, public transport) but few transport modes cater to the familial sphere. They fill a practical need for many families, but also other households, to order the "messy" organization of daily lives (Kent 2022). Cargo bikes attract people wishing to reduce or avoid car use, and who cycle frequently and for a wide range of purposes. Adopting this new daily vehicle has a strong substitution effect on car trips, but also, on public transport trips.

As we have shown, properly understanding the effects of cargo bike adoption requires considering different levels of modal shifts. Widening our definition of modal shifts to include not just trip substitution, but also renunciation to vehicle ownership, is increasingly necessary to reduce car dependancy. Owning cargo bikes within a portfolio of other alternatives to the car (public transport, walking, car sharing), makes it possible to give up car ownership, but also to avoid needing a car for households who already live car-free and wish to remain so.

The findings of this study offer a first glimpse of the role which cargo bikes could play in the urban transport market. Yet, there remain gaps in our knowledge. Future research could enhance our understanding of the modal shift effects of cargo bikes by adopting longitudinal designs or employing mobility calendars or mobile tracking apps to enable users to keep track of their behaviour over longer periods of time. Focusing on the use of cargo bikes at different life stages, beyond parenting, could help to better understand their role within individual's cycling trajectories. Qualitative approaches may shed light on individual and household strategies, motivations and barriers related to demotorization and car-free living, and the role of the cargo bike. Lastly, more research is needed to understand the experiences of cargo bike users in a variety of territorial contexts and mobility cultures. One of the limitations of this study is its specific context in Switzerland, with a high purchasing power and an efficient public transport network, which may facilitate giving up the car compared to other contexts. However, our results could apply to metropolitan or urban regions which also share similar characteristics in terms of high density and public transport.

To accompany the development of cargo bikes and remove barriers to their adoption and use, public policies could play a role. To increase access to cargo bikes by lower-income groups, purchase subsidies could complement the second-hand market. Developing infrastructure like bike parking or wider bike paths, and offering bike training, could encourage the use of larger two- and three-wheeler cargo bike models. Better year-round maintenance of cycle tracks would expand cargo bike use in winter. Finally, moving to urban planning policies which value local proximity and short trips, for instance by adopting the model of a fifteen-minute city (Moreno 2020), would facilitate the choice to live car-free and encourage the switch to cargo bikes.

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Declarations

Competing interests The authors declare no competing interests.

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