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***Rault: Ensae,

Achats transfrontaliers de carburant à la frontière franco-allemande

Cet article exploite l'introduction de la taxe carbone allemande en 2021 ainsi que les réductions de taxes d'accise sur les carburants en France et en Allemagne, consécutives à la crise pétrolière de 2022, pour déduire comment les recettes des taxes sur les carburants réagissent aux changements des prix relatifs. Sur la base des données françaises à haute fréquence issues des comptes bancaires individuels, nous constatons un déplacement substantiel entre la consommation étrangère et la consommation nationale. Lorsque les prix relatifs augmentent de 1 %, la demande transfrontalière relative diminue de 7,8 %. En outre, il n'y a pas de différence substantielle dans la réponse de la demande aux taxes sur le carbone ou aux taxes d'accise.

Mots-clés : Taxation des produits ; coordination fiscale ; tarification du carbone ; expérience quasi-naturelle ; tourisme à la pompe ; données au niveau des transactions.

Classification JEL : H20, H23, H77, R48.

Cross-border shopping for fuel at the France-Germany border

This paper exploits the introduction of the German carbon tax in 2021 as well as excise tax rebates on fuel in France and in Germany, consecutive to the 2022 oil crisis, to infer how fuel tax revenue responds to changes in relative prices. Based on French high-frequency transaction-level data issued from individual banking accounts, we find substantial displacement between foreign and domestic consumption. When relative prices increase by 1%, the relative cross-border demand decreases by 7.8%. Moreover, there is no substantial difference in demand response to either carbon or excise taxes.

Keywords: Commodity taxation; Tax coordination; Carbon pricing; Quasi-natural experiment; Fuel tourism; Transaction-level data.

JEL Classification: H20, H23, H77, R48.

1 Introduction

Fuel is typically a good for which commodity taxes account for a substantial fraction of the price (about 60% in France in 2021, including the 20% VAT and excise taxes). On the one hand, tax changes across neighboring countries modify price differentials and impact cross-border shopping. On the other hand, the importance of fuel tourism is an empirical issue. In the context of reducing greenhouse gas (GHG) emissions being a primary and worldwide objective due to global warming, carbon taxation is a natural instrument at the disposal of policy-makers (Andersson, 2019), despite redistributive concerns (Douenne, 2020) that can only be partly mitigated (Sallee, 2019).

Our empirical analysis leverages a most appropriate research design, composed of policy-driven price changes consecutive to the introduction of a carbon tax in Germany in 2021, as well as of tax rebates effective both in France and Germany, consecutive to the 2022 oil crisis. We view these events as quasi-natural experiments which provide us with a clear source of identifying variability for relative fuel prices between these countries. To take the best advantage of such exogenous variations, we resort to high-frequency transaction-level data issued from individual bank accounts of a major French bank. We estimate that cross-border shopping in the three French *départements*[1] (Moselle, Bas-Rhin, and Haut-Rhin) that are located at the border with Germany is very responsive to relative prices. Based on a log-log estimating equation combined with an instrumental variable (IV) strategy that relies on sharp policy-induced price variations as instruments, we find that fuel tourism is quite sensitive to a change in the foreign-to-domestic price ratio (relative prices, hereafter). Assuming that the total fuel consumption is not affected by a change in relative prices, a 1% increase in relative prices turns out to diminish the relative demand by 7.8%. Comparing the reactions that followed the introduction of the sole carbon tax to those consecutive to excise tax rebates indicates that those responses look quite similar: from that viewpoint, those results do not point out to carbon taxation being more salient. We then perform counterfactual simulations in order to evaluate the causal impact of the introduction of carbon taxation in Germany on French fuel tourism. According to our simulations, it resulted in a 3pp relative drop of the German market share with respect to the French market share: from 11% to 8% in Moselle and Bas-Rhin, from 10% to 7% in Haut-Rhin.

[1] An administrative division of France, somehow intermediate between a state and a county in the US.

Literature This paper intersects two strands of the literature: a first one devoted to (carbon) tax salience, and a second one dedicated to both tax coordination (theoretically) and cross-border shopping (empirically).

First, in a seminal contribution based on both experimental and non-experimental price variation, Chetty et al. (2009) showed that salience issues can be at the source of substantially heterogeneous demand responses. Focusing on actual beer consumption, they found that a 10% increase in the non-salient sales tax induced the same demand reaction as a 0.6% increase in the salient excise tax. In that vein, a recent literature has thus wondered whether green taxes are more salient. Rivers and Schaufele (2015) show that in the Canadian province of British Columbia, carbon taxation caused a decline in short-run gasoline demand that is significantly greater than would be expected from an equivalent increase in the market price of gasoline. According to Andersson (2019) who examines the case of the Swedish carbon taxation based on aggregated data, individuals would be three times more averse to a carbon tax than to a corresponding price increase. However, there is no consensus on that topic: when studying the gasoline taxation that prevails in the US, including both state and federal taxes, Li et al. (2014) provide evidence that consumers respond more strongly to gasoline price changes driven by the tax component than to those driven by the pre-tax component, but Kilian and Zhou (2023) find that they are equally responsive to both. In our case, fuel tourists located near the France-Germany border respond quite similarly to both carbon tax and excise tax changes.

Second, our paper contributes to the theoretical literature on tax coordination and to the empirical one on cross-border shopping. From the theoretical side, Kanbur and Keen (1993) develop a stylized two-country, single good model of spatial competition, and show that tax competition between countries of similar sizes is inefficient under revenue maximization. Their results suggest that some tax coordination on fuel between France and Germany, two countries comparable in size, is desirable to prevent any wedge between commodity taxes. According to their model, though, coordination would rather imply imposing minimum tax rates (i.e., lower bounds) than a common tax rate. Extensions of their approach include Nielsen (2001) who considers an even simpler conceptual framework, though reaching similar conclusions; Wang (1999) who allows one country to be a leader in the sense of Stackelberg; and Agrawal (2015) who considers both multiple jurisdictions and levels of government. From the empirical side, cross-border shopping has been the object of researchers' attention.[2] Asplund et al. (2007), for instance, estimated that the elasticity of (overall) Swedish demand for alcohol with respect to the foreign price was about 0.3. We build upon their paper by relying on exogenous price shocks: our analysis relies on a IV strategy that exploits quasi-experimental, policy-driven price variation. Following this paper, several studies including Banfi et al. (2005), Manuszak and Moul (2009), Gopinath et al. (2011), Friberg et al. (2022) and Hillion (2024) have focused on the role played by the distance to the border. More recently, Burstein et al. (2023) exploit both the border closure in Switzerland, consecutive to the COVID-19 pandemics, and the appreciation of the CHF franc, viewed as quasi-experimental sources of variation in relative prices. Our approach is complementary to the previous papers since we rely on a tax differential between two major members of EU, Germany and France, based on the introduction of a green tax; on top of that, our high-frequency dataset provides a very granular picture of variations in cross-border shopping. Interestingly, Jansen and Jonker (2018) find limited fuel tourism in Netherlands for people living close to either German or Belgian border, which they relate to the low level of cross-border commuting by Dutch workers. By contrast, a substantial share of French residents located near the German border buy fuel in Germany: the German market share is slightly lower than 10% of the French market share in those border *départements*, and the relative demand turns out to be quite responsive to changes in relative prices.

The rest of the paper is organized as follows. Section 2 presents our data and the institutional background. Our empirical analysis is exposed in Section 3. Section 4 concludes.

2 Data and context

Our empirical analysis relies on de-identified bank account data. Our database is issued from the *Crédit Mutuel Alliance Fédérale*, a French group of banks with about 30 million customers. The construction of key variables follows a recent strand of literature exploiting such data including, e.g., Baker (2018), Ganong and Noel (2019) and Andersen et al. (2023). We dispose of transaction-level data on credit and debit card payments,[3] paper checks, cash withdrawals, cash deposits, bank transfers, and direct debits. We observe the amount of each transaction, in euros; such information is timestamped, hence available

[2] See Leal et al. (2010) for a survey and Huynh et al. (2022) for a meta-analysis.

[3] In France, the use of credit cards is scarce: it accounts for less than 10% of bank cards.

at a high frequency. We nevertheless base our analysis on a daily aggregation. On top of that, balance sheets are available each month. The statistical unit of observation is a household; the data contains various socio-demographics on households' members like age, sex, *département*,[4] family status, occupation, and the type of location (in 3 categories: urban, rural, and semiurban areas).

Working sample Our estimation period runs from September 2021 to February 2023. Our initial raw data is a sample of about 300,000 households who primarily bank at *Crédit Mutuel-Alliance Fédérale*, this sample being stratified by *départements* of metropolitan France and by 5-year age dummies. To alleviate concerns about representativeness, we proceed to calibration weighting using the method proposed by Deville and Särndal (1992) (see Appendix C for details), and weight our estimating equations using calibration weights. We further restrict our attention to households with the same number of adults (aged at least 18) over the period. We focus on customers who spend at least €150 during three rolling months, either by card or in cash. Moreover, we impose that customers be present and meet previous criteria all over the period, which leaves us with about 194,000 active customers primarily banking at *Crédit Mutuel-Alliance Fédérale*. Figure 2a shows that fuel purchases abroad can represent more than 20% of fuel expenditures in some border *départements*. We last restrict our attention to 11,865 individuals living in 3 *départements* (57: Moselle, 67: Bas-Rhin, 68: Haut-Rhin) that are located on the France-Germany border; these *départements* are the only ones in which purchases in Germany exceed 3% of fuel expenditures (Figure 2b). Together, these *départements* account for 3.8% of fuel purchases nationwide.

Fuel spending Our bank account data provide the Merchant Category Code (MCC) classification as well as the country of purchase. For the French households in our sample, fuel purchases in Germany represent 0.4% of total fuel expenditures but 6.2% in border *départements* (Table 1). Based on that taxonomy, we consider that spending categorized with codes 5541 and 5542 corresponds to fuel spending as Andersen et al. (2023) and Gelman et al. (2023) do. Last, we obtain fuel quantity, in liters, as the ratio of that adjusted

[4]an administrative division like, e.g., the county in the U.S. Mainland France, i.e. France at the exclusion of Corsica and overseas, is divided into 94 *départements*. Metropolitan France includes the two Corsican *départements*.

fuel spending over the fuel price index; we now explain how we compute the latter.

Prices Timestamped and geolocated fuel prices in France and Germany are disclosed online at the gas station level.[5] Such data has already been used by researchers: see, e.g., Montag et al. (2021) or Gautier et al. (2023). It contains information on each and any price change for different kinds of fuel (diesel and different types of gasoline: super unleaded petrol (SP95), super unleaded petrol (SP95-E10), super unleaded petrol (SP98), etc.). In the subsequent analysis, we focus on two types of fuel: diesel and standard gasoline, which we confound with SP95-E10, given that the latter exhibits similar variations over time as both SP95 and SP98. On top of that, the data provides with an identifier and the location of each retailer.

As detailed in Appendix A of Gautier et al. (2023), the first step consists in mapping raw data to a daily panel dataset at the (retailer, type of gasoline) level. Since different price changes may occur within the same day, we consider the price that prevails at 5pm as Montag et al. (2021) do. In a second step, we remove inactive stations, which we define as stations that have not experienced any price change since at least 30 days, following Gautier et al. (2023); note that a station may be active for, say, diesel, but inactive for gasoline. We then trim outliers by deleting top and bottom 1% of price observations for each (*département*, type of fuel, day).[6] Admittedly, transaction prices are measured with error: we ignore the exact location of purchase: we only know the country of purchase and the *département* of residence of the customers. Hence we approximate prices of fuel bought in France with the daily average in the *département* where lives the customer and we approximate prices of fuel bought in Germany with the daily average in the *Länder* located on the France-Germany border.

As another limitation of our data, we lack information about the type of fuel actually purchased, diesel or gasoline, which is yet unimportant provided that those prices similarly covary. Empirically, those prices are very correlated: the corresponding Pearson coefficient is above 0.95 over the whole period of observation in the *département* and *Länder* located on the French- German border, even though diesel and gasoline prices sometimes experience

[5] https://www.prix-carburants.gouv.fr/rubrique/opendata/ for French prices and https://dev.azure.com/tankerkoenig/_git/tankerkoenig-data for German prices.

[6] As regards German prices, they are equal to their daily averages over the whole set of German gas stations.

different short-run variations due to specific conditions affecting the oil market, for instance. We therefore build a fuel price index that weighs diesel and gasoline prices with respect to their share for French Residents using the French survey *Enquête Mobilité*.

Context: Carbon tax in Germany, Russo-Ukrainian war, 2022 oil crisis, and policy responses (temporary excise tax rebates on fuel) In cross-border *départements*, the ratio of German over both French and German fuel purchases exceeds 6%, while it is almost always lower than 1% in the rest of France. The importance of fuel tourism seems to go beyond the sole share of cross-border workers, about 1% in the Grand-Est region (about 48,000 individuals among 5,5 million inhabitants in 2019).[7]

In December 2020, namely before the introduction of the German carbon tax, the French diesel was 14% more expensive than the German one which amounted to €1.15 per liter; the corresponding differential was 7% as regards gasoline. Figure 1 depicts the evolution of relative prices, namely the ratio of foreign (German) over domestic (French) fuel prices, from July 2020 to February 2023. This ratio rose sharply at the beginning of year 2021 due to two distinct reasons: the introduction of a carbon tax in Germany and the end of a temporary VAT cut in that very same country. Indeed, Germany has introduced a €25 per ton of CO_2 carbon tax for each firm that was not already subject to the European Union Emissions Trading System (EU ETS). This public policy results from an agreement between the Bundesrat and the German government on the Fuel Emissions Trading Act (BEHG) that dates back to December 2019; the corresponding bill was passed on October 2020. The application of that tax scheme to the road transportation consisted in further taxing the price of the diesel (gasoline) by €0.067 (€0.06) per liter from January 1st, 2021 onwards (before VAT, hence about €0.08 after VAT, or 7% of the after-tax price). As a result, the price of diesel increased from €1.15 (end of December 2020) to €1.23 (beginning of January 2021) per liter in Germany, while the price of gasoline rose from €1.26 to €1.33. Overall, the observed evolution of prices is consistent with almost full pass-through, as confirmed by Appendix E. At the same time, the standard VAT rate was reduced from 19% to 16% during six months from July to December 2020 as part of a fiscal stimulus package designed to mitigate the impact of the Covid-19 pandemics.

Fuel prices have then experienced substantial variations in 2022, partly due to the oil

[7] Fuel tourism may also be observed with respect to Belgium, yet corresponding price differentials are lower: diesel is slightly cheaper while gasoline is slightly more expensive.

price surge consecutive to the Russo-Ukrainian war starting on 02-24-2022. The world then faced a pervasive oil crisis: for the first time since 2014, the price of a barrel exceeded the symbolic $120 threshold, in nominal terms. In France, the government decided to intervene by directly subsidizing prices at the pump. On April 1st, 2022, the before-tax gasoline price is reduced by €0.15 per liter from April 1st onwards (about €0.18 per liter including VAT, with some minor geographic variations due to *département*-specific VAT rates). While this first public intervention was bound to last until the end of Summer 2022, the Parliament decided to extend it to the beginning of October, consecutive to the energy crisis. A rebate of €0.3 per liter (i.e. an extra €0.12 rebate for each liter purchased) has then been effective on the after-tax price from 09-01-2022 to 11-15-2022 and reduced to €0.1 before being completely removed by the end of the year. Meanwhile, in Germany, a similar temporary excise tax cut on fuel was adopted from June 1st to September 1st, 2022: - €0.34 per liter on gasoline, and - €0.17 per liter on diesel.

3 Empirical analysis

3.1 Identification

We rely on previous policy-driven fuel price changes in both France and Germany, viewed as quasi-natural experiments, which provide us with convincing sources of identifying variability for the sensitivity of cross-border demand to relative prices. More precisely, the inference of the price sensitivity rests on four shocks: (i) the German carbon tax in January 2021, (ii) the French rebate in April 2022, (iii) the German rebate in June 2022, and (iv) the combination of the removal of that temporary rebate with the second rebate in France in September 2022. Germany has nearly the same amount of tax as France (per unit excise taxes represent roughly 40% of fuel prices and *ad valorem* VAT about 20%), but the German before-tax price was slightly lower at the end of 2020; lower markups there could be related to less concentrated markets in that country. As regards diesel for instance, that price amounted to €1.15 per liter as opposed to €1.3 in France, and the introduction of the German carbon tax reduced that gap to 7 cents only after that tax has been almost entirely passed through to consumers (Appendix E). In any case, when announcing discounts at the pump, governments *de facto* offer tax rebates. These policies were publicly disclosed, hence salient to consumers. Note that the September 2022 shock is the strongest in nominal terms and that it resulted in a price differential of about €0.42 per liter as the combination of two shocks pointing in the same direction: French prices falling by €0.12 per liter at the onset of the month, consecutive to the second fuel price rebate, and German prices concomitantly increasing by roughly €0.30, due to the end of the temporary excise tax rebate there. Figure 1 suggests that cross-border demand is quite responsive to those sharp variations in relative prices. We thus adopt an IV strategy based on previous tax changes as instruments for relative prices. Such an approach also addresses any concern about measurement error, simultaneity, and imperfect pass-through (see Montag et al. (2021) as well as Appendix E for more details on that topic).

3.2 Econometric specification

Our goal is to quantify by how much fuel cross-border shopping depends on relative prices, i.e. on the foreign-to-domestic price ratio. A tractable method to address that issue consists in estimating log-log demand equations. To nonetheless be able to perform counterfactual simulations, we provide a stylized micro-foundation for such equations at the *département* d level.

We therefore assume that consumer i living in *département* d receives the utility:

$$U_{iFdt} = \alpha_{Fd} + \beta \log(p_{Ft}) + \xi_{Fdt} + \varepsilon_{iFdt} \equiv \delta_{Fdt} + \varepsilon_{iFdt} \tag{1}$$

when purchasing foreign (F) on day t, and the utility:

$$U_{iDdt} = \alpha_{Dd} + \beta \log(p_{Dt}) + \xi_{Ddt} + \varepsilon_{iDdt} \equiv \delta_{Ddt} + \varepsilon_{iDdt} \tag{2}$$

when purchasing domestic (D).

Assuming further that the idiosyncratic terms ε_{idt} are i.i.d. according to some EV(1) distribution, the domestic market shares writes:

$$s_{Ddt} = \frac{e^{\delta_{Ddt}}}{e^{\delta_{Ddt}} + e^{\delta_{Fdt}}} \tag{3}$$

One can normalize $\alpha_{Dd} = 0$ without loss of generality since $(\alpha_{Dd}, \alpha_{Fd})$ and $(0, \alpha_{Fd} - \alpha_{Dd})$ are observationally equivalent. A similar reasoning prevails when normalizing $\xi_{Ddt} = 0$.

Following Berry (1994), an estimating equation is:

$$\log \frac{s_{Fdt}}{s_{Ddt}} = \alpha_{Fd} + \beta \log \frac{p_{Ft}}{p_{Dt}} + \xi_{Fdt}. \tag{4}$$

In our econometric specification, we posit that $\xi_{Fdt} = \nu_{Fds(t)} + \eta_{Fdt}$ where $\nu_{Fds(t)}$ captures seasonal effects (day-in-the-year, day-of-the-week, and bank holidays) while η_{Fdt} corresponds to unexplained error terms.

In practice, we replace the left-hand side of equation (4) with the ratio of foreign-to-domestic purchases since the market size plays no role here. It is worth pointing out that this model does not contain any outside option: in other words, it is conditional on purchasing, and empirically our estimation will be performed on car drivers who do purchase fuel (either in France or in Germany), abstracting from any other consideration (that might include foreign purchases in Belgium, Luxembourg, or Switzerland, not to omit adjustments at the extensive margin, namely reducing fuel purchases, or intertemporal substitution, i.e., postponing fuel consumption[8]). As a result, the parameter β governs the sole allocation between foreign and domestic consumption, keeping total consumption -the sum of foreign and domestic consumption- unchanged. By contrast, a price-elasticity coefficient would indicate by how much total consumption would respond to price changes, taking thus the possibility of no purchase into account. In Adam et al. (2023), we estimate that this price elasticity amounts to -0.3, on average. Here we assume instead that it is equal to 0, and hence neglect the response of total demand to price variations when focusing on the sole allocation between foreign and domestic purchases. The specification we adopt emphasizes the trade-off between price and distance, whereby the distance of each and any consumer to the border is approximated by the *département* where she lives -the actual distance between consumer residence and the gas station where the transaction occurred being not available in the data.

To alleviate endogeneity issues due to, e.g., measurement error, simultaneity or imperfect pass-through, we instrument for relative prices, based on the German carbon tax and on rebates in both countries as instruments. Standard errors are clustered by block bootstrap at the individual level.

To investigate whether carbon tax is more salient than excise taxes, we may perform

[8] If intertemporal substitution was important, we would see some spikes of demand around price shocks, which is not the case (Figure 1).

separate estimations where we rely either on the sole price shock from January 2021 consecutive to the introduction of a German carbon tax, or on subsequent excise tax rebates. To gain statistical power, we rather consider a unique estimating equation while allowing for the price coefficient β to correspondingly vary over time. To ease interpretation, any variation of that relative price-sensitivity over time would suggest that consumers differently value relative price increases of similar magnitude, depending on whether they result from a carbon tax or an excise tax, consistently with behavioral effects induced by tax salience.

3.3 Estimation results

In practice, we estimate the previous model with Germany (resp. France) being the foreign (resp. domestic) country. Table 2 displays our results issued from both OLS and IV estimations. Column IV contains our favorite point estimate corresponding to the IV specification with seasonal controls. A +1 log-point relative price increase causes relative fuel purchases to fall by $\hat{\beta} \approx -8.1$ log-point. Put differently, when relative prices increase by +1%, the relative demand falls by about 7.8%[9]. In the three border *départements* (Moselle, Bas-Rhin, Haut-Rhin), the conditional German share amounts to 7-8%, on average. At such levels, both marginal own- and cross-price effects are given, in absolute, by: $\frac{\partial s_c}{\partial p_c} = \hat{\beta}\frac{s_c(1-s_c)}{p_c}, \forall c = D, F$, omitting unnecessary indices here. The effect of German prices increasing by nearly $\Delta p_F = 7.5$ cents from January 1st, 2021, on German share is thus roughly $\Delta s_F \approx \Delta p_F \frac{\partial s_F}{\partial p_F} \approx 0.075 \times (-8.1) \times \frac{0.075(1-0.075)}{1.2} \approx -3.5$pp -slightly less than one half of that share (see also section 3.4 below for the corresponding counterfactual simulation, and for an estimation of the corresponding change in French tax revenue).

We address salience issues in Table 5 where we allow for the coefficient β to vary over time, separating what happened consecutive to the introduction of the carbon tax in Germany from what is related to tax rebates. As a robustness check, we also split our sample and provide separate estimations before and after September 1st, 2021 (see Appendix D). From a purely statistical point of view, one cannot reject the null hypothesis of homogeneity of that coefficient over the whole period once the German lockdown from December 16th, 2020 to 6th, May, 2021 has been excluded from the sample (Table 11). That specification aside, we obtain that the relative demand responds more to the carbon

[9] Namely $1 - e^{-0.081}$

tax than to excise tax rebates, as would be the case if the carbon tax were more salient than excise taxes. From an economic point of view, there is yet no substantial difference: the point estimate obtained is -8.6 for the carbon tax, as opposed to -7.6 for excise taxes.

3.4 Counterfactuals

The main advantage of the previous approach is to predict the effect of any change in relative prices on country-specific shares. Denoting by $q_{dy} = q_{Ddy} + q_{Fdy}$ fuel purchases in *département* d on year y,[10] the nationwide German share in France aggregates local foreign shares:[11]

$$\tilde{s}_y = \sum_d \hat{w}_{dy} \tilde{s}_{dy}, \tag{5}$$

based on *département*-specific weights $\hat{w}_{dy} = \frac{q_{dy}}{\sum_d q_{dy}}$ that account for the importance of *département* d in nationwide fuel consumption. Local foreign shares on that year $\tilde{s}_{dy}$ are given by:

$$\tilde{s}_{dy} = \sum_{t \in y} \hat{w}_{dt} \tilde{s}_{dt}, \tag{6}$$

i.e., summing up over all days on year y with respect to daily weights $\hat{w}_{dt} = \frac{q_{dt}}{q_{dy}} = \frac{q_{dt}}{\sum_{t \in y} q_{dt}}$ that account for the importance of day t in annual fuel consumption. By construction, our counterfactuals rule out any correlation in the choice of the country of fuel purchase and intertemporal substitution; the same holds as regards substitution between *départements*. In practice, both assumptions sound quite fair approximations of actual consumer trade-offs. Relying on previous behavioral assumptions enables us to compute the local market shares that would prevail[12] at any counterfactual German price $\tilde{p}_{Ft}$, replacing observed price p_{Ft} with the latter in equation (3), based on previous estimates $(\hat{\alpha}, \hat{\beta}, \hat{\xi})$ obtained under our favorite, homogeneous specification where $\hat{\beta} = -8.1$. In what follows, we focus on a counterfactual scenario in the absence of any German carbon tax at the onset of 2021, and thus consider the German fuel share in year $y = 2021$ only.

[10] Once again, we abstract here from any change in fuel consumption in other countries than France or Germany. We therefore focus on market shares that are conditional on buying either in France or in Germany.

[11] In what follows, we omit the subscript F in s_{Fdt} since the discrete-choice model considered here is binary.

[12] For the sake of that thought experiment, we also assume that the share of fuel purchases in Germany in non border *départements* remains unchanged.

The results are displayed by Table 6, which decomposes behavioural responses in each of the three border *départements*. We first evaluate that the German carbon tax has decreased the German (conditional) share of fuel purchases by 28-29% in Bas-Rhin, in Moselle, and in Haut-Rhin. Overall, it has reduced that (conditional) share by 23% nationwide. Remembering that the carbon tax was about 6 cents per liter (before VAT) only, namely 5% of the German price at the time, that counterfactual simulation is helpful to get a sense of the magnitude of the relative price sensitivity of fuel purchases to foreign taxes. From these estimations, and still assuming that the national French fuel consumption is not affected by the introduction of the German tax, we can deduce that the German carbon tax increased domestic consumption, hence French fuel tax revenue, by 3.3% in the three *départements* considered (and 0.13% on the national level[13]). In nominal value, the France would thus have benefited from a supplementary household tax revenue of 31m (from an estimated value of 24,7bn in 2021)[14]. Adopting now the German viewpoint, this figure illustrates the fact that a fraction of fuel consumption avoids taxation through cross-border shopping, and that such an avoidance mechanism should be taken into consideration when performing an evaluation of the tax policy.

4 Conclusion

This paper has exploited exogenous, policy-driven price changes (the introduction of German carbon tax in 2021 and excise tax rebates in 2022) to infer the sensitivity of French fuel tourism to relative prices at the German border. Based on both a convincing research design and high-frequency transaction-level data, we have established that cross-border demand is quite elastic: that relative demand decreases by 7.8% when relative prices increase by 1%. Moreover, we find similar demand responses to the carbon tax, on the one hand, and to excise tax rebates, on the other hand: though the difference in corresponding estimated price-sensitivities is statistically significant at usual levels, the gap in point estimates is small from an economical viewpoint, and the null hypothesis of equality cannot

[13]Bas-Rhin, Haut-Rhin and Moselle account for 3.8% of French fuel consumption. We further assume that the French fuel consumption in the other *départements* is not affected by the introduction of the German tax.

[14]17,8bn excise tax and 6,9bn VAT, according to https://www.statistiques.developpement-durable.gouv.fr/bilan-energetique-de-la-france-en-2022-synthese?rubrique=19&dossier=170 and authors' calculations.

be rejected in some specifications. We interpret this result as evidence against the carbon tax being more salient than other fuel taxes. To the best of our knowledge, this is the first empirical evidence based on clean, large-scale quasi-experimental research design and on high-frequency transaction-level data that does not support the idea that carbon taxation is more salient than other taxes. Our results thus illustrate the need for coordinating tax policies, be the tax considered a green tax or not. To the extent of external validity, they also give a flavor of what could result from imposing a carbon tax at the border. Investigating whether our results extend to other institutional settings, and therefore assessing that external validity sounds like a promising area of further research.

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A Figures

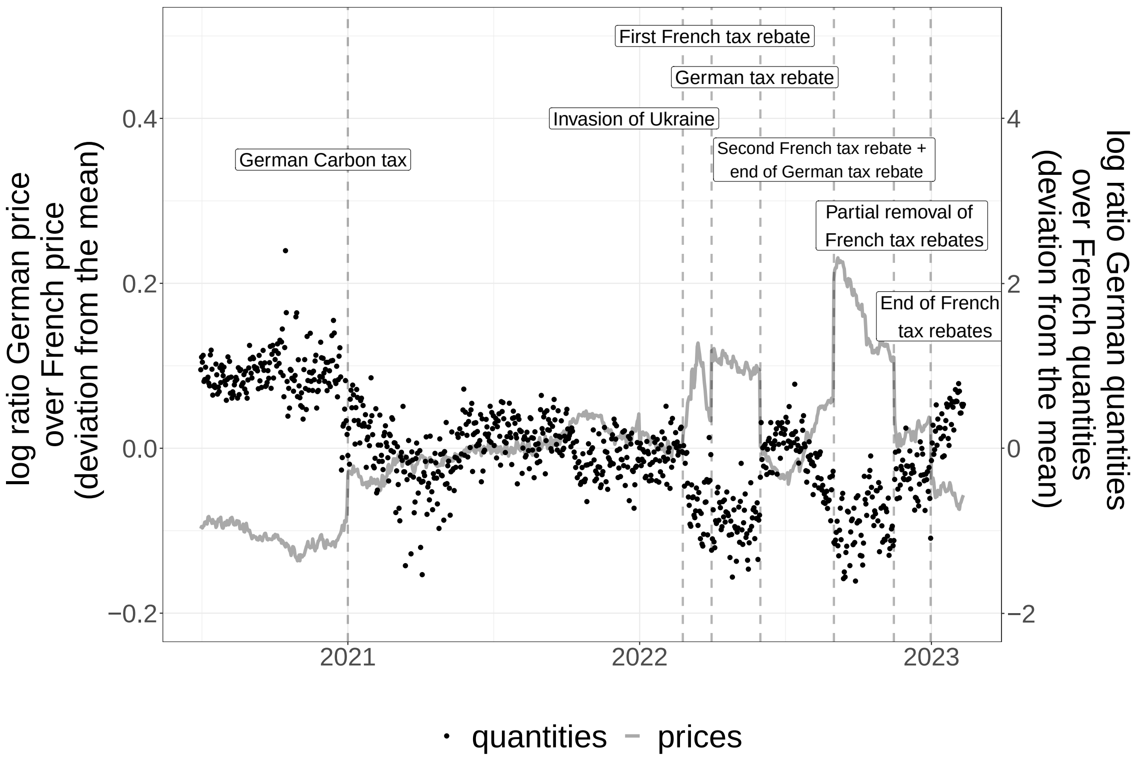


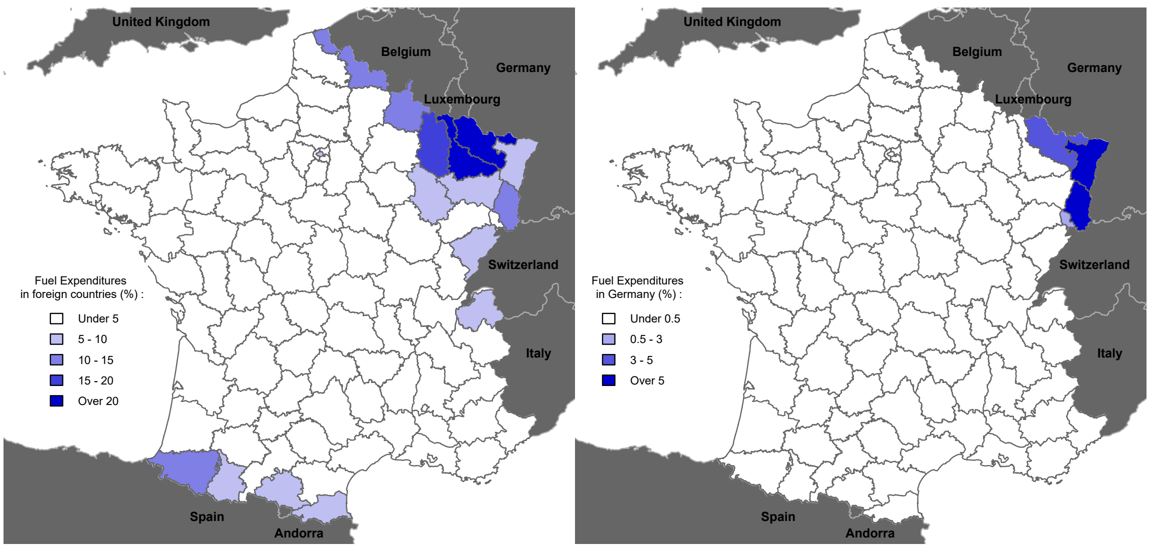
Figure 1: Relative German/French fuel prices and purchases (normalized log ratio)

Notes. Dashed lines correspond to the different shocks on prices : the invasion of Ukraine and policy interventions (introduction of a carbon tax in Germany on January 1st 2021, tax rebate in France on April 1st 2022, tax rebate in Germany on June 1st, the combination of the removal of the rebate in Germany with an additional rebate in France on September 1st, partial removal of the rebate in France on November 15th and finally the complete removal of rebates in France on December 31th).

Sources. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale*.

Figure 2: Share of fuel expenditures

(a) in foreign countries (b) in Germany



Lecture. In 2021, fuel purchases in foreign countries account for more than 20% of fuel expenditures of French households living in Moselle.
Source. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale*.

B Tables

Table 1: Cross-border fuel expenditures

Country of purchase	Share in fuel expenditures (%)	
	All départements	German border
France	95.6	77.3
Luxembourg	1.3	14.5
Spain	0.9	0.2
Belgium	0.7	0.1
Germany	0.4	6.2
Swiss	0.3	0.8
Italy	0.2	0.3
Other countries	0.6	0.4

Note. German border: 3 *départements* (Moselle, Bas-Rhin and Haut-Rhin).
Lecture. In 2021, fuel purchases in Germany account for 6.2% of fuel expenditures of French households living in a German border *département*.
Source. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale*.

Table 2: Main estimates

	I	II	III	IV
β	-7.73 (0.20)	-7.57 (0.20)	-8.15 (0.21)	-7.97 (0.22)
Instrumental variables			✓	✓
Seasonal controls		✓		✓
Départment FE	✓	✓	✓	✓
# of customers	11,870	11,870	11,870	11,870
# of *départements*	3	3	3	3
# of *days*	955	955	955	955
Adjusted R^2	0.49	0.55	0.48	0.54
Wu-Hausman stat.			41	31
F-test (first stage)			5,050	4,886

Note. This table provides the results of the regression of the log ratio of fuel purchases on the log ratio of prices. Estimation sample: 11,870 customers in 3 *départements* located on the France-Germany border (Moselle, Bas-Rhin and Haut-Rhin). Estimation period: from July 1st, 2020, to February 10th, 2023. Standard errors computed from block bootstrap at the individual level. Columns I and II: OLS estimations. Columns III and IV: IV estimations. All regressions are weighted by age, sex and population in the *département*.
Source. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale.*

Table 3: Robustness: 1st decile of prices by department (nuts 3)

	I	II	III	IV
β	-7.19 (0.19)	-7.07 (0.20)	-7.74 (0.21)	-7.58 (0.22)
Instrumental variables			✓	✓
Seasonal controls		✓		✓
Départment FE	✓	✓	✓	✓
# of customers	11,870	11,870	11,870	11,870
# of *départements*	3	3	3	3
# of *days*	955	955	955	955
Adjusted R2	0.46	0.54	0.46	0.54
Wu-Hausman stat.			67	48
F test first stage			4,415	4,283

Note. This table provides the results of the regression of the log ratio of the quantities of fuel purchased on the log ratio of prices (using 1st deciles of prices by *département* (nuts 3). Estimation sample: 11,870 customers in 3 *départements* located on the French-German border (Moselle, Bas-Rhin and Haut-Rhin) observed from July 1st, 2020, to February 10th, 2023. Standard errors computed from block bootstrap at the individual level. Column I and II correspond to OLS estimations (with and without controls). Column III and IV correspond to IV estimations (with and without controls). All regressions are weighted to reproduce known population totals for three auxiliary variables: age, sex and population in the *département*.
Source. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale.*

Table 4: Robustness: log ratio of the number of transactions

	I	II	III	IV
β	-5.15 (0.15)	-5.04 (0.16)	-5.58 (0.17)	-5.46 (0.17)
Instrumental variables			✓	✓
Seasonal controls		✓		✓
Départment FE	✓	✓	✓	✓
# of customers	11,870	11,870	11,870	11,870
# of *départements*	3	3	3	3
# of *days*	955	955	955	955
Adjusted R2	0.41	0.53	0.41	0.52
Wu-Hausman stat.			61	54
F test first stage			5,050	4,886

Note. This table provides the results of the regression of the log ratio of the number of transactions on the log ratio of prices. Estimation sample: 11,870 customers in 3 *départements* located on the French-German border (Moselle, Bas-Rhin and Haut-Rhin) observed from July 1st, 2020, to February 10th, 2023. Standard errors computed from block bootstrap at the individual level. Column I and II correspond to OLS estimations (with and without controls). Column III and IV correspond to IV estimations (with and without controls). All regressions are weighted to reproduce known population totals for three auxiliary variables: age, sex and population in the *département.*
Source. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale.*

Table 5: Heterogeneity (by tax salience)

	I	II	III	IV
β	-8.33 (0.19)	-8.02 (0.22)	-9.06 (0.20)	-8.26 (0.21)
$\beta \times$ (Post Carbon Tax)	1.25 (0.24)	0.94 (0.27)	2.13 (0.30)	0.68 (0.37)
Instrumental variables			✓	✓
Seasonal controls		✓		✓
Départment FE	✓	✓	✓	✓
# of customers	11,870	11,870	11,870	11,870
# of *départements*	3	3	3	3
# of *days*	955	955	955	955
Adjusted R2	0.49	0.55	0.49	0.55
Wu-Hausman stat.			37	14
F stat first stage (log price ratio)			5,050	4,886
F stat first stage (log price ratio)x(Post)			1,998	1,659

Note. Estimation sample: 11,870 customers in 3 *départements* located on the France-Germany border (Moselle, Bas-Rhin and Haut-Rhin). Estimation period: from July 1st, 2020, to February 10th, 2023. The post-carbon tax period begins from September 1st, 2021. Standard errors computed from block bootstrap at the individual level. Columns I and II: OLS estimations. Columns III and IV: IV estimations. All regressions are weighted by age, sex and population in the *département.*
Source. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale.*

Table 6: Counterfactual market shares

	I Observed prices	II No carbon tax in Germany
German share in Moselle	7.95 (0.37)	11.05 (0.51)
German share in Bas-Rhin	6.90 (0.32)	9.63 (0.42)
German share in Haut-Rhin	7.98 (0.31)	11.06 (0.42)
German share in the rest of France	0.11 (0.01)	0.11 (0.01)
German share in France	0.42 (0.01)	0.54 (0.01)
Seasonal controls	✓	✓
Départment FE	✓	✓

Lecture note. In 2021, the conditional market share of fuel purchases in Germany (i.e., conditional on buying either in France or in Germany) amounted to 8.44%. In the absence of any German carbon tax, that share would have reached 11.45%. All regressions are weighted by age, sex and population in the *département*.
Note. Standard errors computed from block bootstrap at the individual level.
Source. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale.*

Appendix

C Data: details

Two concerns have been raised by the literature as regards the external validity of bank account data (Baker, 2018): representativeness and completeness. We therefore resort to several external sources to assess both representativeness and completeness of our databases.

C.1 Representativeness

To alleviate concerns about representativeness, and to build upon previous works afore mentioned, we proceed to calibration weighting using the method proposed by Deville and Särndal (1992). We compute weights that exactly reproduce some targets for auxiliary variables, related to the whole population, while ensuring that these calibrated weights are as close as possible to original sampling weights. By construction, the weighted sample has the same distribution as regards the corresponding variables as the whole population. We consider the following dimensions, called margins: age, sex and *département*, for that auxiliary information.

The distribution of household expenditures with respect to their position in the standard of living distribution obtained in transaction data matches closely the one issued from the representative consumption survey *Budget des Familles* (Figure 5). In particular, putting aside both ends of the income distribution, spending-to-income ratios look remarkably similar, decreasing from 1 to 0.75, which mitigates previous concerns related to measurement error on income. If anything, our data overestimate spending, probably because Crédit Mutuel customers tend to be richer. This is confirmed by Table 7 which suggests that Crédit Mutuel customers are wealthier: they dispose of higher income (Figure 3), detain more assets (Figure 4), and spend more than the average (Figure 5). The pregnancy of liquidity constraints can be assessed by looking at the liquid wealth-to-income ratio, about 10, meaning that, on average, households dispose of liquidity equivalent to 10 months of income. It decomposes into a 3.5 ratio of liquid assets over end-of-month balances on deposit accounts (this number compares well with the one documented in the U.S. by Baker (2018)), and another 3.5 ratio of end-of-month balances on deposit accounts over monthly income. Finally, these customers are younger, on average, and tend to live in more peripheral areas. Figure 6 focuses on the sole fuel category: it can be verified that our sample spends systematically a bit more, probably because it is composed of richer customers. Reassuringly, the evolution of fuel spending looks yet quite identical (Figure 8) to the one issued from the comprehensive *Groupement des Cartes Bancaires* (GIE-CB) dataset, with a 0.99 correlation. On top of supporting external validity, this empirical evidence provides some grounds for a seasonal adjustment based on the data issued from that French interbank network. More generally, we believe that it alleviates legitimate concerns about selection bias.

C.2 Completeness

First, our measure of spending exhibits quite the same evolution as the one issued from the *Groupement des Cartes Bancaires CB*, the French national interbank network (Figure 7).

Second, our measure of income is more volatile (Figure 9) than the one measured by Insee.[15] This higher dispersion is rather expected: it is intrinsically related to the fact that we do not observe income directly, but rather all incoming transfers. Yet it is reassuring to see that the magnitude of possible measurement error is limited.

Third, our measure of liquid assets is slightly more dynamic than the one reported by *Banque de France* that centralizes information from all other bank networks (Figure 10). If anything, Crédit Mutuel customers likely enjoy higher capital gains (Fagereng et al., 2019) but that composition effect looks again rather limited.

On the whole, these comparisons with external sources suggest (i) that representativeness is not too much of a concern, (ii) that the calibration weighting contributes to alleviate this problem, and (iii) that the remaining differences on earnings and assets are mostly due to differences in concepts, rather than to incompleteness.

[15] namely, the gross standard of living as the ratio of gross disposable income over the number of consumption units.

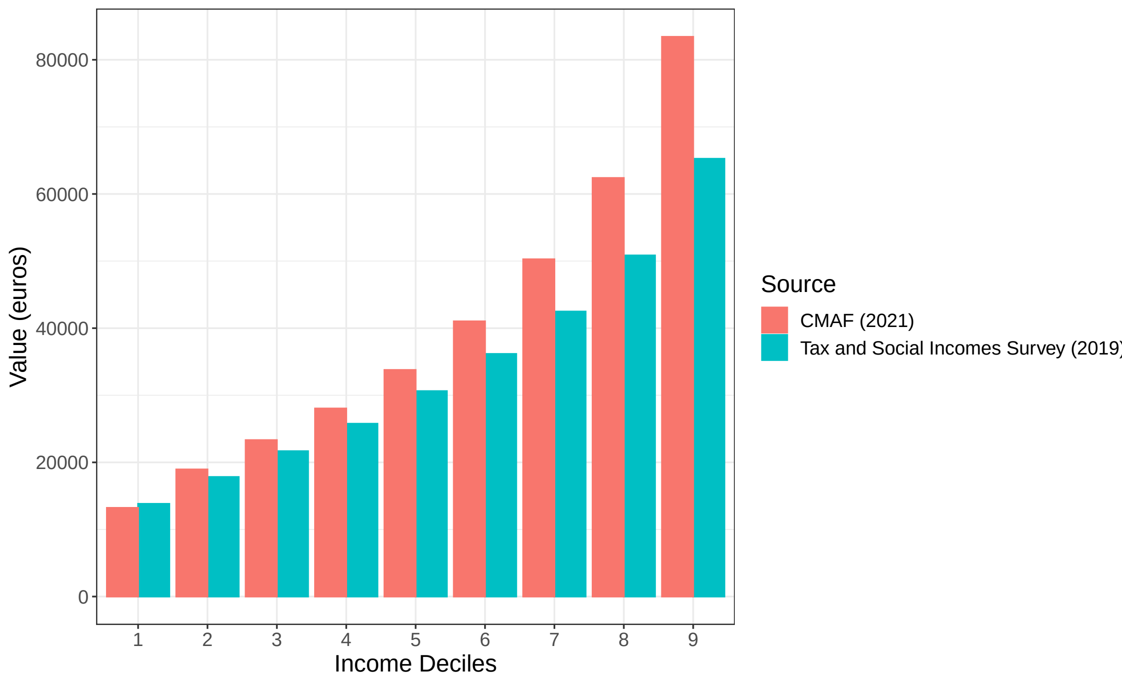
C.3 Data: External validity

Table 7: Summary statistics

	Weighted sample
# of observations	193,780
	Banking variables (sample means)
Monthly Spending	2,721
Fuel (cards)	94
Income	3,702
Financial Assets	
Liquid financial Assets	38,486
Illiquid financial Assets	23,399
Ratio liquid assets/deposit account	3.1
	Household head characteristics (sample means)
Age	53
Female	0.41
Craftsmen, merchants and business owners	0.08
Managerial and professional occupations	0.13
Technicians and associate professionals	0.12
Employees	0.17
Workers	0.11
Periphery areas	0.42
Rural areas	0.19
Urban areas	0.37

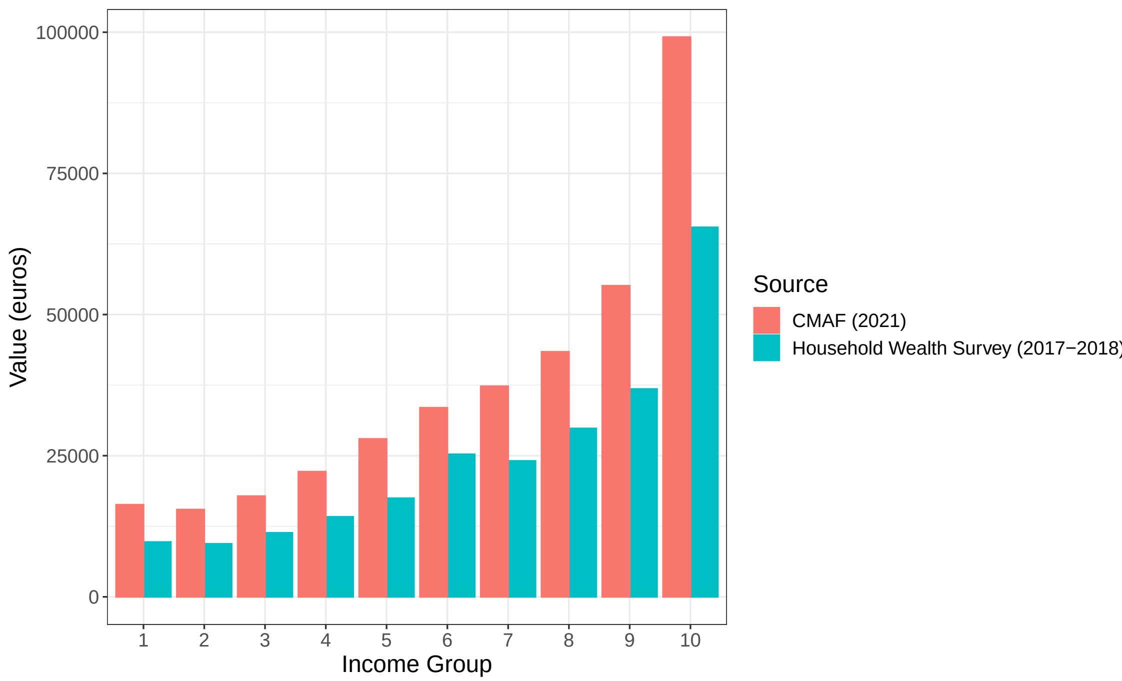
Note. Estimation period: 2021 for transactions (spending, income), January 2021 for assets and socio-demographics. Pecuniary amounts in €. The oldest member of the household is the head of the household.
Source. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale.*

Figure 3: Distribution of income (transaction data vs. survey data from *ERFS*, Insee)



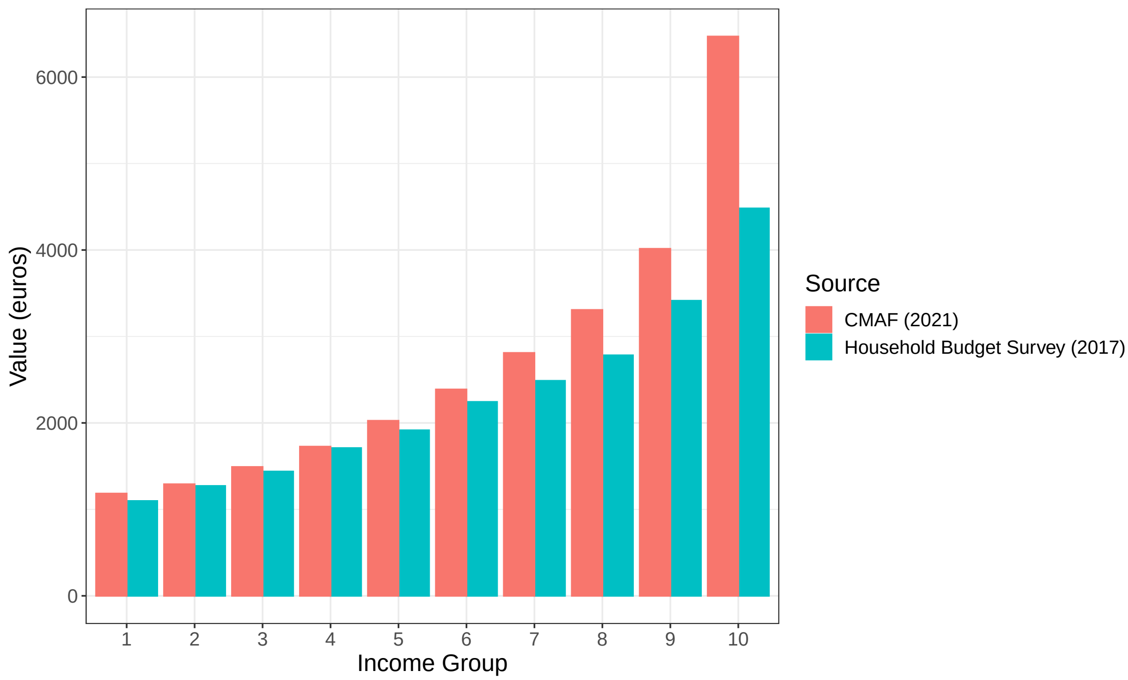
Sources. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale*; *Enquête sur les Revenus Fiscaux et Sociaux* (ERFS) survey.

Figure 4: Household financial wealth by income (transaction data vs. survey data from *Histoire de Vie et Patrimoine*, Insee)



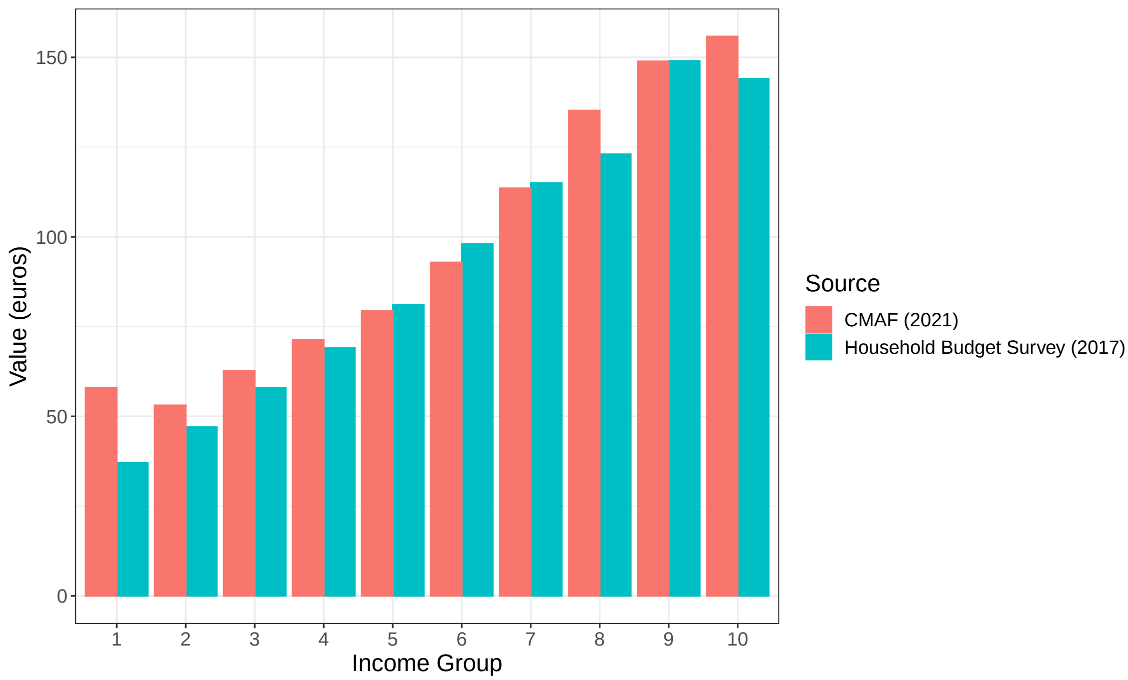
Sources. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale*; *Patrimoine* survey.

Figure 5: Household monthly expenditures by income (transaction data vs. survey data from *Budget des Familles*, Insee)



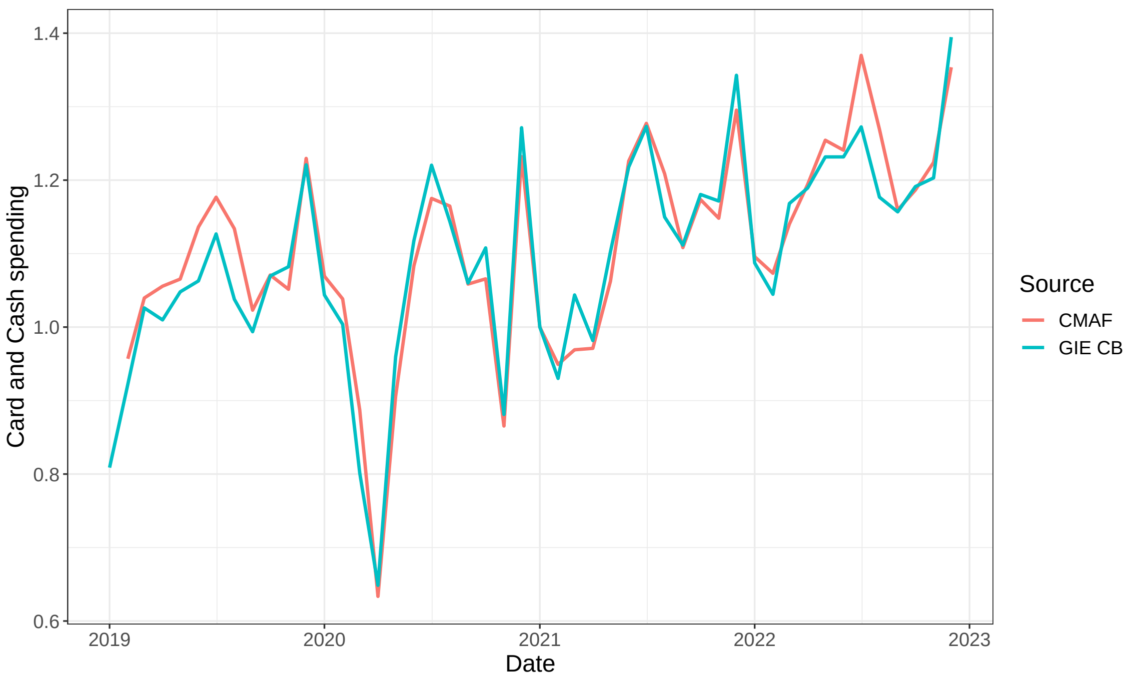
Sources. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale*; *Budget des Familles* survey.

Figure 6: Distribution of monthly fuel spending, by income (transaction data vs. survey data from *Budget des Familles*, Insee)



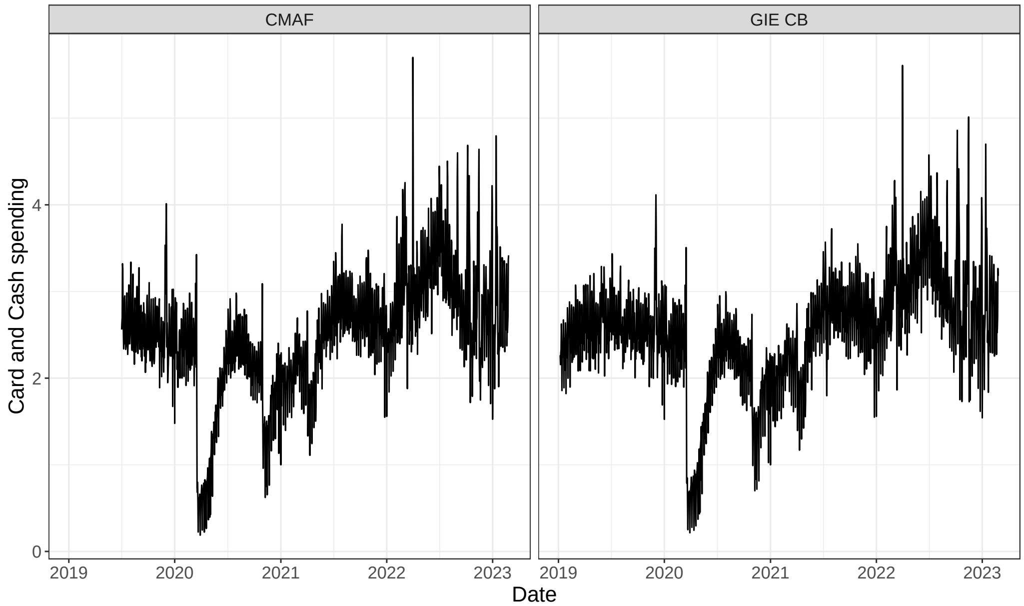
Sources. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale*; *Budget des Familles* survey.

Figure 7: Evolution of spending (transaction data vs. aggregate data from the French interbank network)



Sources. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale*; *GIE-CB* data.

Figure 8: Evolution of fuel spending (transaction data vs. aggregate data from the French interbank network)

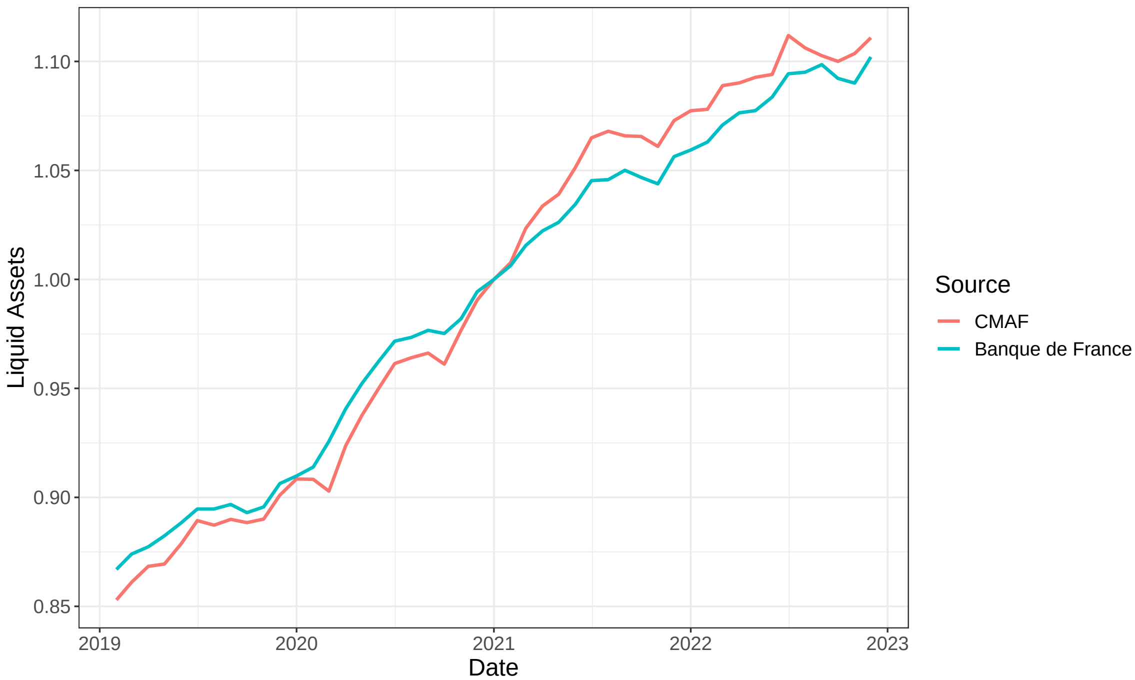


Sources. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale*; *GIE-CB* data.

Figure 9: Income (transaction data vs. aggregate data from national accounts, Insee)

Sources. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale*; French National Accounts.

Figure 10: Liquid Assets (transaction data vs. aggregate data from Banque de France)



Sources. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale*; *Banque de France.*

D Robustness checks

Table 8: Estimates based on the sole German carbon tax introduction (from 07-01-2020 to 08-31-2021)

	I	II	III	IV
β	-9.29 (0.27)	-4.94 (0.94)	-10.21 (0.32)	-8.35 (0.89)
Instrumental variables			✓	✓
Seasonal controls		✓		✓
Départment FE	✓	✓	✓	✓
# of customers	11,870	11,870	11,870	11,870
# of *départements*	3	3	3	3
# of *days*	425	425	425	425
Adjusted R2	0.36	0.53	0.35	0.53
Wu-Hausman stat.			69	7
F test first stage			1,275	1,818

Note. Estimation sample: 11,865 customers in 3 *départements* located on the French-German border (Moselle, Bas-Rhin and Haut-Rhin) observed from July 1st, 2020, to September 1st, 2021. Standard errors computed from block bootstrap at the individual level. Column I and II correspond to OLS estimations (with and without controls). Column III and IV correspond to IV estimations (with and without controls). All regressions are weighted to reproduce known population totals for three auxiliary variables: age, sex and population in the *département*.
Source. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale.*

Table 9: Estimates based on excise tax rebates (from 09-01-2021 to 02-10-2023)

	I	II	III	IV
β	-7.14 (0.27)	-7.59 (0.33)	-7.42 (0.31)	-8.24 (0.42)
Instrumental variables			✓	✓
Seasonal controls		✓		✓
Départment FE	✓	✓	✓	✓
# of customers	11,870	11,870	11,870	11,870
# of *départements*	3	3	3	3
# of *days*	316	316	316	316
Adjusted R2	0.41	0.45	0.41	0.45
Wu-Hausman stat.			4	9
F test first stage			1,579	1,657

Note. Estimation sample: 11,865 customers in 3 *départements* located on the French-German border (Moselle, Bas-Rhin and Haut-Rhin) observed from September 1st, 2021 to February 10th, 2023. Standard errors computed from block bootstrap at the individual level. Column I and II correspond to OLS estimations (with and without controls). Column III and IV correspond to IV estimations (with and without controls). All regressions are weighted to reproduce known population totals for three auxiliary variables: age, sex and population in the *département*.
Source. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale.*

Table 10: Estimates based on the sole German carbon tax introduction (from 07-01-2020 to 08-31-2021, excluding German lockdown from 12-16-2020 to 05-06-2021)

	I	II	III	IV
β	-7.62 (0.20)	-6.24 (0.84)	-8.00 (0.22)	-8.35 (0.89)
Instrumental variables			✓	✓
Seasonal controls		✓		✓
Département FE	✓	✓	✓	✓
# of customers	11,870	11,870	11,870	11,870
# of *départements*	3	3	3	3
# of *days*	283	283	283	283
Adjusted R2	0.44	0.56	0.44	0.56
Wu-Hausman stat.			32	5
F test first stage			15,612	1,462

Note. Estimation sample: 11,865 customers in 3 *départements* located on the French-German border (Moselle, Bas-Rhin and Haut-Rhin) observed from July 1st, 2020, to September 1st, 2021. The German lockdown period which could affect the results is excluded (from December 16th, 2020 to 6th, May, 2021). Standard errors computed from block bootstrap at the individual level. Column I and II correspond to OLS estimations (with and without controls). Column III and IV correspond to IV estimations (with and without controls). All regressions are weighted to reproduce known population totals for three auxiliary variables: age, sex and population in the *département*.
Source. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale.*

Table 11: Estimates based on both German carbon tax introduction and excise tax rebates (excluding German lockdown from 12-16-2020 to 05-06-2021)

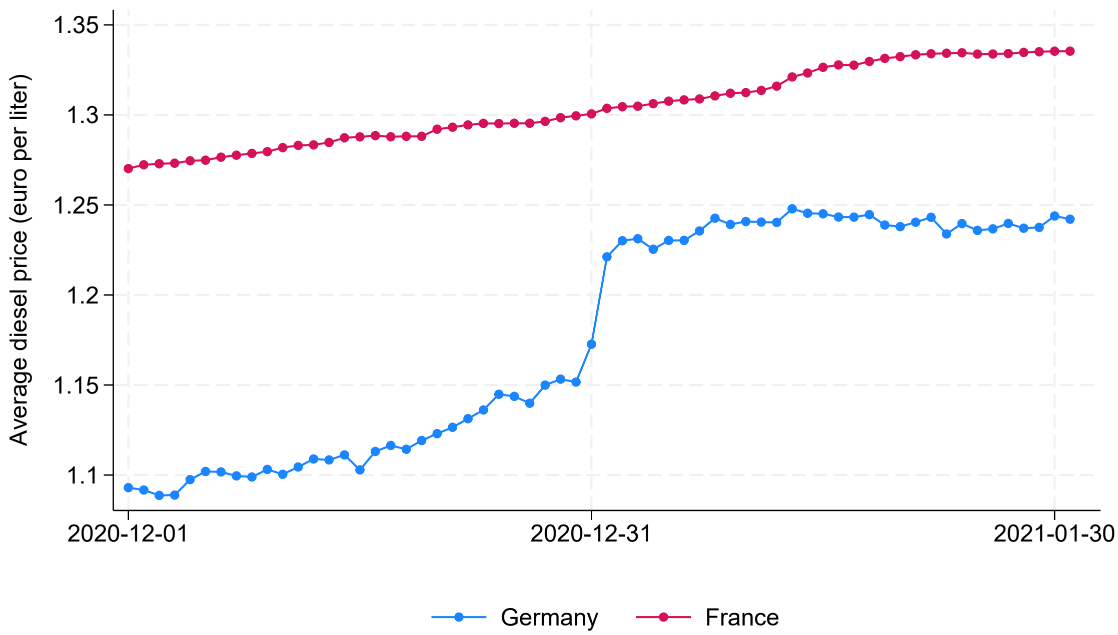
	I	II	III	IV
β	-8.71 (0.19)	-8.26 (0.21)	-8.78 (0.19)	-8.23 (0.20)
β(Post 01/09/2021)	1.49 (0.23)	1.11 (0.29)	1.18 (0.29)	0.52 (0.36)
Instrumental variables			✓	✓
Seasonal controls		✓		✓
Département FE	✓	✓	✓	✓
# of customers	11,870	11,870	11,870	11,870
# of *départements*	3	3	3	3
# of *days*	812	812	812	812
Adjusted R2	0.57	0.61	0.57	0.61
Wu-Hausman stat.			8	9
F stat first stage (log price ratio)			4,741	5,701
F stat first stage (log price ratio)x(Post)			1,755	1,935

Note. Estimation sample: 11,865 customers in 3 *départements* located on the French-German border (Moselle, Bas-Rhin and Haut-Rhin) observed from July 1st, 2020, to February 10th, 2023. The German lockdown period which could affect the results is excluded (from December 16th, 2020 to 6th, May, 2021). Standard errors computed from block bootstrap at the individual level. Column I and II correspond to OLS estimations (with and without controls). Column III and IV correspond to IV estimations (with and without controls). All regressions are weighted to reproduce known population totals for three auxiliary variables: age, sex and population in the *département*.
Source. Sample of households who primarily bank at *Crédit Mutuel Alliance Fédérale*.

E Pass-through

In this section we estimate the price pass-through of the German carbon tax. The price increase due to the German carbon tax on diesel was +6.7 cents per liter before VAT, hence a +8 cents per liter increase of the after-price tax (remembering that the VAT rate decreased from 19% to 16% from July to December 2020). Figure 11 shows the average evolution of diesel prices in both French and German gas stations located near the border.[16]

Figure 11: Mean diesel price in France and Germany around January 1st, 2021



Given prices p^{pre} before the introduction of the carbon tax, and under full pass-through, prices p^{post} after that introduction should verify:

$$p^{\text{post}} = \frac{1.19}{1.16} p^b + 0.067 \times 1.19 \approx 1.02586 p^{\text{pre}} + 0.08, \tag{7}$$

where p^b accounts for the before-tax price that prevailed at the end of 2020. Given that

[16] In France this refers to the previous *départements* (57, 67 and 68) while in Germany we consider four first-two postcode areas (66, 76, 77 and 79). All subsequent results are not sensitive to this sample restriction and the estimated pass-through is very homogeneous regardless of the "distance" to the border.

average diesel prices in December 2020 were roughly €1.11 per liter, prices at the beginning of 2021 should then be around €1.21 per liter, hence a price gap of about 10 cents per liter.

We then resort to an event study around January 1st, 2021 (day 0 in what follows). More specifically, we estimate the following equation:

$$p_{cst} = \beta_t \times \text{Germany}_s + \lambda_t + \alpha_c + \eta_s + \epsilon_{cst}, \tag{8}$$

where countries are indexed by c, gas stations by s and days by t, and *Germany* is a dummy equal to 1 for stations located in Germany.

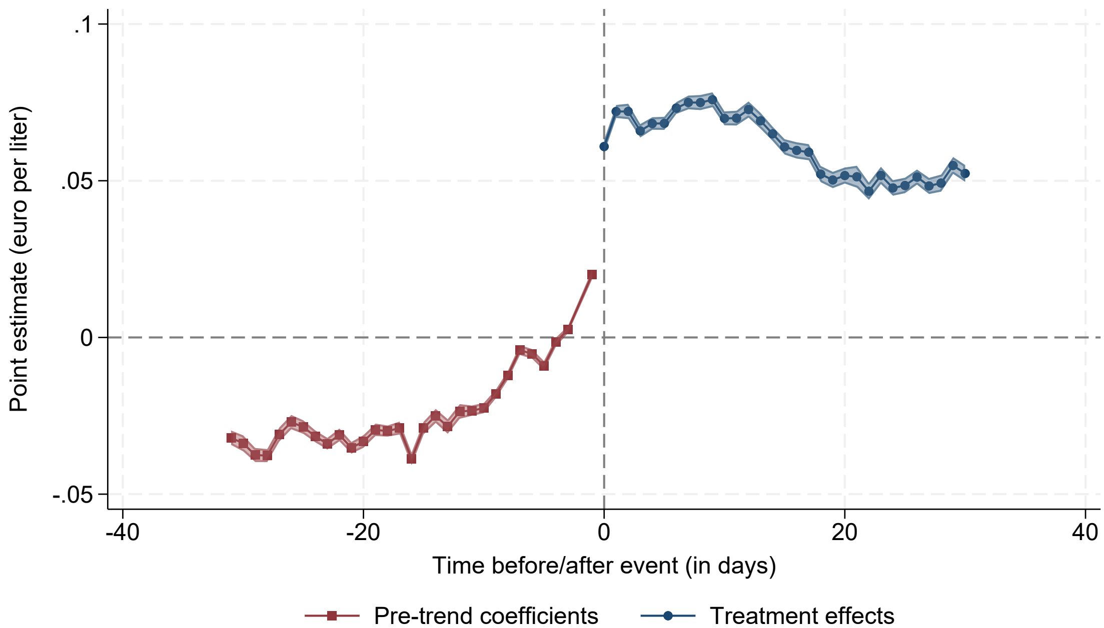


Figure 12: Event study on diesel prices (1 month around 01-01-2021)

The figure provides empirical evidence of immediate and almost full pass-through in the short run.

In order to get a point estimate of that pass-through, we now adopt a DinD viewpoint based on a 1-month time window before/after the introduction of the carbon tax. More precisely, we define *Post* as a dummy equal to 1 after January 1st, and we estimate the following:

$$p_{cst} = \text{Post}_t(\lambda + \beta \text{Germany}_s) + \alpha_c + \eta_s + \epsilon_{cst} \tag{9}$$

Table 12: Pass-through (diesel only, 1 month around 01-01-2021)

	(1)	(2)	(3)	(4)	(5)
	Daily diesel price				
Constant	1.286***	1.186***	1.205***	1.205***	1.205***
	(0.000540)	(0.000195)	(0.000199)	(0.000293)	(0.000961)
German gas station	-0.169***				
	(0.000700)				
Post-January 1st	0.0367***	0.0367***			
	(0.000761)	(0.000434)			
German gas station after Jan-1st (β)	0.0844***	0.0838***	0.0836***	0.0836***	0.0836***
	(0.000989)	(0.000563)	(0.000520)	(0.000995)	(0.00327)
FE		Gas station	Gas station + Day	Gas station + Day	Gas station + Day
Clustering level				Gas station	Gas station + Day
Observations	63,120	63,120	63,120	63,120	63,120

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Our estimate of the pass-through is thus close to 84% (namely 8.4 cents per liter, which should be compared with the expected increase of about 10 cents per liter), which can be interpreted as imperfect (but close to full) pass-through. In any case, instrumenting the foreign-to-domestic price ratio in equation (4) should mitigate any concern about imperfect pass-through: from that viewpoint, equation (9) may be interpreted as a first-stage, previous point estimates providing comforting evidence about the strength of the instrument.

F Data-related acknowledgements (in French)

Data from *Crédit Mutuel Alliance Fédérale*:

Première banque à adopter la qualité d'entreprise à mission, Crédit Mutuel Alliance Fédérale a contribué à cette étude par la fourniture de données de comptes bancaires sur la base de deux échantillons : un échantillon d'entreprises et un échantillon de ménages par tirage aléatoire et construit de telle sorte qu'on ne puisse pas identifier les entreprises (exclusion de sous populations de petite taille) ou les ménages. Toutes les analyses réalisées dans le cadre de cette étude ont été effectuées sur des données strictement anonymisées sur les seuls systèmes d'information sécurisés du Crédit Mutuel en France. Pour Crédit Mutuel Alliance Fédérale, cette démarche s'inscrit dans le cadre des missions qu'il s'est fixées :

- contribuer au bien commun en oeuvrant pour une société plus juste et plus durable : en participant à l'information économique, Crédit Mutuel Alliance Fédérale réaffirme sa volonté de contribuer au débat démocratique ;
- protéger l'intimité numérique et la vie privée de chacun : Crédit Mutuel Alliance Fédérale veille à la protection absolue des données de ses clients.

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