Subsidising car purchases in the euro area: Any spill-over on production?

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Abstract

Due to input-output linkages, an industry level shock can widely transmit to the rest of the economy. We identify government policies on the automobile industry, which change final prices and estimate their effect on sales and production. An example could be the scrappage schemes that many European governments introduced at the start of the Great Recession. In line with previous studies, we confirm that the effect on car sales is positive. More interestingly, we extend the literature that explores the effects of these policies on domestic and foreign production to disentangle the potential spill-overs.

JEL codes: C32, C54, E23, E62, H25

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1 Non-technical Summary

This paper identifies the reaction of domestic and foreign car producers after experiencing country specific shocks, which affect the final car consumer price. The identification of the effect in a specific industry has gained importance lately. Until recently, it was understood that by the law of large numbers idiosyncratic shocks to individual firms should cancel each other out when considering the economy in the aggregate. This view has been challenged by recent research, which considers that microeconomic shocks can be at the root of macroeconomic fluctuations when the input-output structure of an economy exhibits sufficient asymetry in the role of some disaggregated industries as supplier to others. According to this view, then stabilisation policies directed to specific sectors could have sizeable effects, which would call for a systematic identification of those sectors in each economy. For the US, the automobile industry is considered to have one of the greatest impact on aggregate output among all sectors.

In fact, at the onset of the Great Recession, we have seen examples of those kind of policy shocks. Governments implemented car sector specific fiscal policies, which were aimed at containing the effects of the financial market crisis on the real economy. Across the euro area, eleven countries introduced Vehicle Scrapping Schemes to support demand and production in the automotive industry. The idea was to provide monetary incentives to potential buyers (so affecting the final price of the car), who would hand-in an old vehicle in exchange for a price reduction on a new car. We ask ourselves, considering that it is likely that the importance of the car sector in the euro area mimics the one in the US, if those kind of shocks indeed have any impact on car production in the euro area.

In particular, we want to determine empirically two things.
First, the impact of government policies on domestic car production. From a theoretical point of view, the effect on domestic car production is unclear. Does a higher demand for cars in a single country create an increase in its own local car production? Technical necessity, political sensitivities and market variation could keep final vehicle assembly, and by extension much part of production, close to end markets. But does this depend on the internal market size? Small countries with a small internal market might have less of an influence on domestic production than otherwise. On the contrary, if domestic car production would only depend on prospective global demand for cars or domestic plant competitiveness, then there should not be any effect due to government intervention and those policies would be ineffective with respect to production. In other words, no government consumer price shock would affect car production. In that case, there should not be any effect on companies decisions about hiring or about plants' location and the only effects of those subsidies would be to smoothen inventory cycles. The case for supporting that industry would then be low and most probably influenced by the lobbying capacity of the sector among different governments.

Second, the impact of those policies on foreign car production. If the demand for cars increases in one country and these vehicles are not produced locally, there could be a theoretical trade channel from where positive effects would appear. Therefore, we do not restrict ourselves to a unique country, but to several within the euro area, aiming at exploring possible spill-over effects to other countries. Could an increase in demand in a country foster production in other countries? Imagine that Austrian producers have strong links to the German car market, then an increase in German car registrations should probably affect the Austrian producers' market. The opposite should be less expected. If this would be true, there could be a case for introducing policy measures in countries with fiscal space, which not only foster internal demand but at the same time support peer countries in the euro area.

We follow a Structural Bayesian VAR with exogenous variables, which will be transformed into a Structural Bayesian Global VAR. The identification of a net tax shock, i.e. an increase/decrease of taxes and/or a decrease/increase of subsidies, which affects only car consumer prices, not car producer prices, is done by combining sign and exclusion restrictions for selected euro area countries. We control each time for the influence of the rest of countries demand and their common business cycle. Although the Global VAR is an increasingly popular method in the literature to account for spill-overs, as far as we are aware, we are the first to use this methodology for an specific industry.

Results suggest that government policies, which could qualify as net tax shocks, are in general effective in increasing car registrations and when affecting local production, they do it in a positive way. We also find spill-overs to other countries in terms of production, specific effects depending on the country origin of the shock (for example, Austria always reacts positively to Germans shocks) and the very same nature of the shock (net tax vs demand).

2 Introduction

This paper is about identifying the effects of fiscal policy shocks on domestic and foreign production in the car industry. According to Lucas (1977), by the law of large numbers idiosyncratic shocks to individual firms should cancel each other out when considering the economy in the aggregate. This view has been challenged by recent research, which considers that microeconomic shocks can be at the root of macroeconomic fluctuations when the input-output structure of an economy exhibits sufficient asymetry in the role of some disaggregated industries as supplier to others.[1] According to this view, then stabilisation policies directed to specific sectors could have sizeable effects, which would call for a systematic identification of those sectors in each economy. For the US, Bigio and La'O (2016) find that the automobile industry has the greatest impact on aggregate output among all sectors.

In fact, at the onset of the Great Recession, governments implemented expansionary car sector specific fiscal policies, which were aimed at containing the effects of the financial market crisis on the real economy. Across the euro area, eleven countries introduced Vehicle Scrapping Schemes (VSS) to support demand and consequently production in the automotive industry. The idea was to provide monetary incentives to potential buyers, who would hand-in an old vehicle in exchange for a price reduction on a new car.[2] In the case of Spain, they were still in place in 2016. VSS effectiveness on car sales have been researched by several studies,[3] such as Mian and Sufi (2012) for the US, Adda and Cooper (2000) for France, Licandro and Sampayo (2006) for Spain and Böckers *et al.* (2012) for Germany.[4] The first three conclude that the effect is short-lived and null in the medium term. The only effect is a short-run stimulation in car demand, with a subsequent decrease in sales after the policy is terminated. On the contrary, the last one finds a genuine increase in sales.[5]

Therefore, we ask ourselves, considering that it is likely that the importance of the car sector in the euro area mimics the one in the US, if government policies have any impact this time on car production in the euro area.[6] Furthermore, we will not restrict ourselves to VSS,

[1] Acemoglu *et al.* (2012)

[2] At the time, detailed information information could be found in ACEA(European Automobile Manufacturers' Association)'s website, "Fleet Renewal Schemes in the European Union 2010" and "Fleet Renewal Schemes in the European Union 2009" or IHS Global Insight.

[3] For a literature review on VSS see e.g. Böckers *et al.* (2012) or Heimeshoff and Müller (2013) and the references quoted therein.

[4] These studies focus in specific programmes as CARS (Cars Allowance Rebate System) in 2009 in the US, the Balladur and Juppé scrappage schemes in 1995-96 in France, the Plan Prever in 1997 in Spain and the Umweltprämie in 2009 in Germany.

[5] Heimeshoff and Müller (2013) and Leheyda and Verboven (2013) analyze the overall performance of the 2009-2010 programs worldwide and in Europe, respectively. Their results also suggest positive sales with small pull-forward effects in most countries.

[6] Our analysis restricts to eight countries: Belgium, Germany, Spain, France, Italy, Netherlands, Austria and Portugal. Therefore, we avoid the need to consider the impact of exchange rates.

but will include all policies, which directly affect car consumers final price. For instance, a VAT tax rate change.

In particular, we want to determine empirically two things:

1. **The impact of government policies on domestic car production.**
   According to manufacturers' associations domestic car production is intimately linked to keeping jobs and avoiding plant dislocations - ANFAC(2010).[7] Is this true? From a theoretical point of view, the effect on domestic car production is unclear. Does a higher demand for cars in a single country create an increase in its own local car production? According to Sturgeon *et al.* (2009), technical necessity, political sensitivities and market variation have kept final vehicle assembly, and by extension much part of production, close to end markets. But does this depend on the internal market size? Small countries with a small internal market might have less of an influence on domestic production than otherwise. On the contrary, if domestic car production only depends on prospective global demand for cars or domestic plant competitiveness, then there should not be any effect due to government intervention and those policies would be ineffective with respect to production. In other words, no government consumer price shock would affect car production. In that case, there should not be any effect on companies decisions about hiring or about plants' location and the only effects of those subsidies would be to smoothen inventory cycles. The case for supporting that industry would then be low and most probably influenced by the lobbying capacity of the sector among different governments.[8]

2. **The impact of those policies on foreign car production.**
   If the demand for cars increases in one country and these vehicles are not produced locally, there could be a theoretical trade channel from where positive effects would appear. Therefore, we do not restrict ourselves to a unique country, but to several within the euro area, aiming at exploring possible spill-over effects to other countries. Could an increase in demand in a country foster production in other countries? Imagine that Austrian producers have strong links to the German car market, then an increase in German car registrations should probably affect the Austrian producers' market. The opposite should be less expected. If this would be true, there could be a case for introducing policy measures in countries with fiscal space, which not only foster internal demand but at the same time support peer countries in the euro area.

[7] http://www.lavanguardia.com/mobi/noticia/54063606540/El-hundimiento-de-la-venta-de-coches-amenaza-al-sector.html

[8] Copeland and Kahn (2013) find that the 2009 US program had only a modest and fleeting impact on production, as inventories buffered the movement in sales. Leheyda and Verboven (2013) touches slighlty upon the issue of producers, but more based on firm's nationality than country of production

We follow a Structural Bayesian VAR with exogenous variables (S-BVARX), which will be transformed into a Structural Bayesian Global VAR (S-BGVAR). The identification of fiscal shocks is done by combining sign and zero restrictions for selected euro area countries, where we control each time for the influence of the rest of countries demand and their common business cycle. As far as we are aware, we are the first to use this methodology in this strand of the literature.[9] The GVAR[10] is an increasingly popular method in the literature to account for spill-overs, stemming from different kind of shocks: risk, Gray *et al.* (2013), housing demand, Cesa-Bianchi (2013), external, Mauro *et al.* (2007), credit supply, Eickmeier and Ng (2011), liquidity, Chudik and Fratzscher (2011) and oil, Cashin *et al.* (2014), just to mention some.

The identification scheme we choose, sign and exclusion restrictions, is aimed at identifying a **net tax**[11] government shock, which affects only car consumer prices (*CCP*), not car producer prices (*CPP*), and the particular market structure of the car industry.
A simple visual exercise helps us putting these policies into perspective in the euro area. In Appendix A.1, we plot *car registration*[12] series and we colored periods in yellow where VSS were on-going from 1996 to 2014. We also depict other possible measures like VAT/registration tax changes, which we would also expect to have a direct effect on CCP. The Graphs would seem to be in line with some of the conclusions of the above-mentioned studies. Graphically, in general VSS seem to have a positive short-run effect supporting demand while in place. Another piece of evidence is that in the previous quarter before a VAT hike there is always a higher demand for cars (Germany, Spain, France, Italy, Netherlands and Portugal), surely due to the expectations of price increases in the following quarter (Appendix A.2). On the contrary, when we visually analyze the evolution of CCP during that period, it is not clear-cut that the increase in demand was indeed the effect of a reduction in the final price. This could suggest that sellers may use consumer expectations of declining prices to maintain or even increase those prices.[13] The lack of pricing transparency for consumers, i.e. the difficulty to compare prices before and after the policy would provoke this phenomenon.[14] Indeed, the expectation of a price decline, shifts demand up, even if finally prices do not decrease.

[9] Böckers *et al.* (2012) also use a time series approach, counter-factual analysis but with traditional estimation techniques in their case. Unrelated to the car industry, Feldkircher and Huber (2016) use a Bayesian GVAR to analyze the international transmission of US shocks based on sign restrictions.

[10] The original contribution developed by Pesaran *et al.* (2004) shows how to use VAR estimates and stack them according to their respective trade weights (in our case, specific to the car industry) and upon a country specific shock how to obtain not only within country responses but also spill-overs to the trading partners.

[11] In the literarure a net tax shock includes an increase/decrease of taxes and/or a decrease/increase of subsidies.

[12] Car registration is the proxy we use in the paper for car sales. We will refer to the two irrespectively in the paper as car demand indicators, because we assume that supply (production) will always meet demand within one quarter.

[13] See Jiménez *et al.* (2011) for an example of this issue.

[14] According to Moreno and Terwiesch (2012) in the car industry, final or transaction prices are very much influenced by incentives that result in discounts from the list prices, which is the manufacturer suggested retail price. For a nice overview of price setting in general, see Bitran and Caldentey (2003).

This would be equal to a traditional demand shock, for example due to a change in people's preference, not induced by the government. Our identification will take care of these two possibilities that we have intuitively presented. We will call **net tax** shock, the supply shock that does have a depressing effect on CCP (after government intervention, for example). We will call **demand** shock, the traditional demand shock where CCP increase.

Results suggest that government policies, which could qualify as net tax shocks, are in general effective in increasing car registrations and when affecting local production, they do it in a positive way. We also find spill-overs to other countries in terms of production, specific effects depending on the country origin of the shock (for example, Austria always reacts positively to Germans shocks) and the very same nature of the shock (net tax vs demand).

The paper is structured as follows. The third section lays out the benchmark model and the data we use for our empirical exercise. A more detailed description of the empirical model, including both methodology and identification strategy, is described in section four. All results are shown and explained in section five. Section six concludes.

3 Benchmark model and data

Our benchmark model is a VARX with a 4-dimensional X =(CPP, CCP, reg, prod) for the car industry, with series that proxy producer prices, domestic prices, domestic demand and domestic supply. Our main series are car producer prices (CPP), car consumer prices (CCP), car registration (reg) and car production (prod). We estimate a VARX (later on a global VAR based on this VARX) quarterly model over the period 1996Q1- 2014Q4 for a "reduced euro area": Austria, Belgium, Germany, Spain, France, Italy, the Netherlands and Portugal. All used data are available or derived from public sources, either from the Statistical Data Warehouse of the European Central Bank or Eurostat. Car producer prices (CPP) are taken from Eurostat's short term statistics - Producer Price Index, domestic sales ; NACE 29-30; Manufacture of motor vehicles, trailers and semi-trailers; Manufacture of other transport equipment - NACE Rev2. Car consumer prices (CCP) correspond to Eurostat's HICP - Motor cars. CPP differs from CCP because it reflects basic prices, which exclude VAT and similar deductible taxes directly linked to turnover. By contrast, any subsidies on products received by producer should be added. CPP includes the margins of the producer but not the margin of the retailer selling the product. Car registration (reg) is used as a proxy for car demand. Data on new commercial vehicles and new passenger cars in units are added up. Car Production (prod) is used as a proxy for car supply. In this case, we use industrial production indices on manufacture of motor vehicles, trailers and semi-trailers - NACE Rev2 (NACE29). All series are working day and seasonally adjusted and measured in natural logarithms. They enter the estimation in levels.[15] In our framework, two exogenous control variables are used: a synthetic real GDP for our "reduced euro area" to control for the cycle and real extra euro-area car export trade based on SITC classification to control for the cycle in the rest of the world, which could potentially drive demand. In the case of exports, we seasonally adjust the data using Tramo Seats. We complete the model including four extra exogenous variables, which will be the same that will form part of the GVAR framework later on, i.e. rest of euro area CPP, CCP, reg and prod. All these variables help controlling for increases in domestic production that are due to external demand increases in other euro area countries. The exogenous foreign country specific variables from the domestic variables are constructed following Pesaran *et al.* (2004). For the trade weights with which those foreign factors are constructed, we rely on trade statistics as published by Eurostat based on SITC classification (Motor vehicles for the transport of persons). The 8x8 matrix is computed as average export shares between 1999-2014 and is presented in table 1 of the appendix B.[16] The car industry trade shares for each country are presented in rows. This matrix plays a key role in showing the degree of linkages between countries for this specific industry. Table 1 shows that most of the countries could potentially react strongly to an increase in demand in Germany, as their exports share varies from around 33% in Spain to 60% in Austria. It also shows the importance of the German car sector as an important industry not only for the country itself but also for the rest of Europe. In our GVAR framework, when checking spill-overs, we will mainly focus in shocks stemming from the big-4, as according to the matrix, they show quantitatively the highest degree of connectedness to the rest of countries.

4 Estimation

4.1 Model

This section explains the empirical model we use to infer how big is the effect of a net tax shock stemming from government decisions towards the car industry in the various countries. The methodology we pursue is the same as in any Global Vector Autoregressive (GVAR) Model.[17] The basis of the GVAR is a VARX model, where the weakly exogenous part is a weighted average of all other countries' variables. For the reactions within any country i the **VARX** looks like this:

$$x_{i,t} = a_{i,0} + \sum_{j=1}^{j=p} \Phi_j x_{i,t-j} + \sum_{l=0}^{l=p} \Lambda_l x^*_{i,t-j} + \sum_{m=0}^{m=r} \Upsilon_m D_{t-m} + \epsilon_{i,t} \tag{1}$$

[15] Results are in general robust to prices entering in the model as first differences.

[16] We have taken different samples to construct the weight matrix and shares do not change much.

[17] For a thorough description of the methodology confer the original paper on the GVAR by Pesaran *et al.* (2004)

where the shock $\epsilon_{i,t}$ is normally distributed with mean zero and the covariance matrix Σ_i ($\epsilon_{i,t} \sim N(0, \Sigma_i)$). The subscript i stands for country i[18] that the vector of endogenous variables $x_{i,t}$ comprises for every country. The ordering of variables within the vector is as follows:

$$x_{i,t} = (CarProductionPrices_{i,t}, CarConsumerPrices_{i,t}, CarRegistration_{i,t}, CarProduction_{i,t})'$$

This vector is regressed on its own lags (until p=5), on the contemporaneous foreign variables $x^*_{i,t}$ and their lags. Those foreign variables represent a trade weighted average of the same endogenous variables abroad (from the point of view of country i). It is important to note again (compare the data section) that the trade weights do not refer to overall trade of country i with country j but just car related trades. All in all the foreign variable can be represented by

$$x^*_{i,t} = \sum_{j \neq i}^{N} \omega_{ij} x_{j,t}. \tag{2}$$

Finally, each country is regressed on two common variables and their lags D_t which are the same for all countries and comprise a car export extra-trade variable for our euro aggregate and the common euro aggregate output, both in real terms. These common variables should act as controls for each country to "factor out" internal and external business cycle fluctuations.

As we are interested in spillovers between countries, we need to follow Pesaran *et al.* (2004) or Mauro *et al.* (2007) thoroughly and stack the countries and their respective coefficient matrices below each other to arrive at the **GVAR**. For country i this would then look as follows:

$$A_i W_i x_t = B_i W_i x_{t-1} + u_{it} \tag{3}$$

with W_i being the trade matrix for country i which relates its own coefficient matrix with the overall vector of all endogenous variables stacked x_t. This is done for every country i with the final global solution then given by:

$$\begin{pmatrix} A_1 W_1 \\ ... \\ A_N W_N \end{pmatrix} x_t = \begin{pmatrix} B_1 W_1 \\ ... \\ B_N W_N \end{pmatrix} x_{t-1} + \begin{pmatrix} u_{1t} \\ ... \\ u_{Nt} \end{pmatrix} \tag{4}$$

or equivalently:

$$G x_t = H x_{t-1} + u_t \tag{5}$$

[18] Altogether there are eight countries in our analysis: Austria, Belgium, Germany, France, Italy, Spain, Netherlands, Portugal

Upon inverting the reduced form global solution is at the end:

$$x_t = Fx_{t-1} + \epsilon_t \tag{6}$$

with: $F = G^{-1}H$ and $\epsilon_t = G^{-1}u_t$ This form is then ready for dynamic analysis, i.e. impulse responses and forecast error variance decomposition. Due to this last step, inverting the global contemporaneous matrix G, both F (the coefficient matrix on the lagged variables) and u_t (the reduced form shocks) define the new contemporaneous relationships between countries.

4.2 Methodology

Because of the large number of coefficients in our model,[19] we use a Bayesian approach for estimation and inference. Cuaresma *et al.* (2014) show that to use a Bayesian variant of a GVAR is better in terms of forecasting performance than a global model without shinkage in the parameters. We use a Minnesota prior where coefficients are drawn from a Normal-inverse-Wishart posterior distribution. We impose the same prior variance structure for the exogenous variables as for the endogenous variables, i.e. the most recent lags of a variable are expected to contain more information than ealier lags. We draw the true candidates from the posterior and a random possible decomposition of the covariance-variance matrix to construct impulse response functions. We keep only draws satisfying the imposed restrictions to all shocks simultaneously. Figures are produced after 10000 successful draws from the posterior. The inference is based on the median response and 68% posterior distribution.

4.3 Identification Strategy

Taking a look at the graphs in Appendix A, it could be tempting to follow a narrative approach as introduced by Romer and Romer (2010), as we have detected some policies during those years which affected the car industry. However, there are at least two pitfalls. First, we have only assessed VAT rate changes and VSS because we wanted to give some intuition to the idea behind our research question. A proper narrative approach would need a more thorough analysis of each country's budget in order to identify the cost of each policy related to the car industry. Second, we would need to take into consideration only the legislated changes that are passed for philosophical reasons or to reduce an inherited budget deficit to deal with the problem of endogeneity (pervasive omitted variable bias). Otherwise, if we were to use the legislative changes that are introduced because the economy is weak, we would not deal

[19] As we are using quarterly data, we consider five lags for each variable.

with the above mentioned bias. Unfortunately, one of the main policies we are interested in would not qualify for that. VSS are introduced very often when there is a downturn in the economy to help supporting demand in that sector. Therefore, if we were to take into account only tax changes motivated by factors unrelated to the current or prospective state of the economy, we would probably end up only with the VAT changes and these would be too few to properly identify their effects.

The OECD[20] states: "In typical OECD car market conditions, **with no supply constraint and some excess production capacity** VSS usually provoke a considerable fall in the prices of new models and of second-hand cars that are more recent than the age requirement imposed". Following the expertise of the OECD, we consider that short-term car supply is elastic, as any car demand is covered by production within 1 quarter. Therefore, in a market as described previously, we consider as plausible a short-term flat AS curve. The car industry either has enough car inventories to cover a possible increase in demand in one country or production is simply tailor-made, i.e. vehicles are only produced after the sale is completed, because they are "à la carte". Another point reinforcing the AS flat curve is that the in the car market one can find many products, which could be considered as almost perfect substitutes.

We summarize then government intervention as follows. A simple graph helps to visualize the idea.

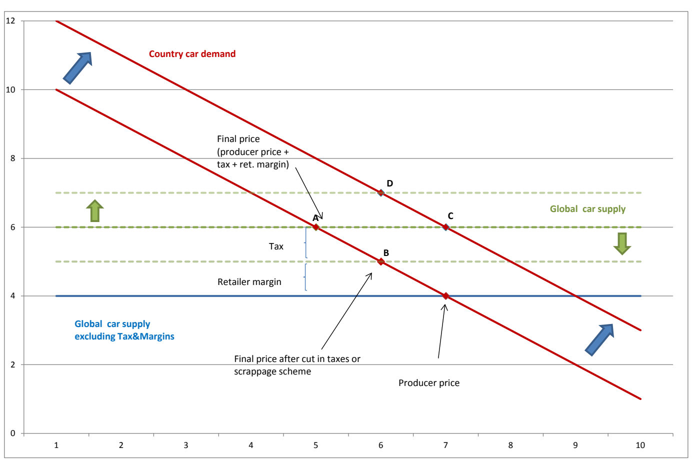

Figure 1: AS-AD Curve with taxation

A VSS or decrease in VAT[21] are shocks (net tax shocks) that directly affect CCP, but this

[20] Cleaner Cars Fleet Renewal and Scrappage Schemes (1999) OECD

[21] A retailer mark-up shock can also be thought as having those same effects

is not due to a downward shift in the AS curve (technological shock). On the contrary, the reduction in CCP thanks to the government intervention with the aim of increasing demand (car registration) in its country would correspond to moving along the demand curve from an initial point A to B in Figure 1. Neither CPP nor retailer margins have changed. If retailers try to capture the reduction in net taxes offered by the government by augmenting margins, this would be akin to moving back in the direction of A or even beyond. On the contrary, a "traditional" demand shock (without government intervention) would shift the AD curve to the right. Moving the new equilibrium to point C, CCP would not move or move slightly upwards, if the AS curve would not be completely flat. Again, CCP could further increase if retailers would react increasing their margins. We would then move from point C to D, as the green line would shift upwards.

We identify shocks having in mind all this information, where short-term aggregate supply is elastic, horizontal AS curve, and the AD curve is as expected downward-sloping. Our aim is to properly identify the effects of a net tax innovation, and differentiate it from a technological shock, which would decrease CPP, and a pure demand shock as explained in Figure1. In order to do so, we follow a simple identification strategy based on sign and zero restrictions[22] on the contemporaneous impact matrix is:

Identification of different sources of innovations				
	CPP_t	CCP_t	reg_t	$prod_t$
Technological shock	$\downarrow$	?	?	?
Net tax shock	0	$\downarrow$	$\uparrow$ (?)	?
Demand shock	0	$\uparrow$	$\uparrow$	?
Inventory shock	0	0	0	$\uparrow$

Table 1: Identification scheme

After a positive demand or negative net tax shock, registrations are expected to increase.[23] But we expect a different reaction on CCP depending on the shock origin. A demand shock should provoke, if anything, a positive reaction from domestic CCP. A negative "net tax" shock decreases CCP. In order to pin down properly those previous shocks, we do not allow CPP to contemporaneously react. Finally, we assume that an inventory shock, increase in production in one country, could only have a lagged effect on domestic prices and domestic registration. This would be fully justifiable from the previous description of excess capacity in the industry and the fact that the global production is what matters when assessing formation of prices from the supply side. Only a global supply disruption would be expected to have an immediate effect if any, taking into account that inventories could not provide any relief in that

[22]Sign restrictions are implemented as $\geq$ or $\leq$, which implies that a zero impact is also possible. For details, on the algorithm used, we refer to Reppa (2009) and Arias *et al.* (2014).

[23]We test it empirically in the results section for the case of the net tax shock.

case.[24] Finally, we define a technological shock as any shock that reduces CPP. Example of those could be any shock that reduces the production costs (labour/capital/productivity/oil) or producer margins.

With respect to the identification at a GVAR level, we keep the 10000 successful draws (in line with our identification at a country level). We construct 10000 GVAR models, as explained in the model section, combining the 10000 VARX models of the country where the shock is originated (whose IRF are in line with our identification scheme), with the median model for the rest of the countries.[25] We will only keep the draws where our sign restrictions within-the-origin-country are respected. We believe that this assumption is plausible, because it boils down to saying that the spill-over cannot be large enough to change the sign of a specific country policy.[26] Exact zero restrictions are by construction not respected anymore by the median response at the GVAR level, but this does not invalidate our country-specific identification.[27] In any case, the zero falls always inside the IRFS uncertainty bands.

5 Results

We can see that empirically our results are in line with what we would expect from theory, i.e. a negative **net tax shock** (Annex C 1a. Figure 18 and 19), which produces a decrease in CCP, does have a median positive effect on *local car registration* with a high probability (defined as higher than 84%)[28] in all countries, where the 16th quantiles of IRFs distributions are above 0. Effects on car registration seem to be of a short-lived nature, in general though. Data then confirm a downward-sloping demand curve for all our countries. On impact, a decrease in the CCP between 0.1-0.5 percentage points (pp) increases registrations between 2-10 pp depending on the country. Therefore, we can conclude that car registrations are very sensitive to changes in CCP.

The median effect of a **net tax shock** on *local car production* tends to be significantly positive only in Spain, France and the Netherlands.[29] In Germany and Italy we do not find any significant positive effect (median around 0). The effect on production is much smaller

[24] We are in any case not interested in this paper in investigating effects of inventory shocks and therefore results are not presented.

[25] It is possible to construct 10000^8 models as each draw is independent, but we think that the median model is the most representative.

[26] In fact, this is the case for 90% of our draws on average. We have to disregard only 10% of the draws, so that the new IRFs still have the defined signs.

[27] For a thorough discussion on the technical details of the implementation of the identification in the GVAR, please see Cesa-Bianchi (2013) or Cashin *et al.* (2014). In his case, the identification is achieved with a Cholesky decomposition of the covariance matrix of the reduced form residuals. You can also see there that zero restrictions are not respected anymore once at the GVAR model.

[28] We will only comment when this is the case.

[29] We do not consider as very likely that an increase in demand in small markets like Austria, Belgium, Netherlands and Portugal, can move their local car production.

than the one in car registration. We find that an initial shock between 0.1-0.5 pp increases local production with a peak around 1 pp.
In contrast, if we focus on the **demand shock** (Annex C 1b. Figure 20 and 21), it provokes a median positive response on *local car production* with high probability in Austria, Germany, Spain, France and the Netherlands.
For those countries, the effect of a demand shock in production is greater than the effect of the previous net tax shock.

Our aim was to unveil **spill-overs** to other countries from those policies. Results logically depend on the country origin of the shock. The specific reasons for the closer link among some countries are so far beyond the scope of this paper. However, one could hypothesize about specific characteristics of this industry, where the demand for a specific car model could drive the production response of the factory responsible for its production, whose location does not need to coincide with the country shock origin.[30]
A **net tax shock** (Annex C 2 Figure 22) in Germany has a median positive impact on *production* in Austria, Belgium, Spain, Italy and the Netherlands. A net tax shock in Spain has a median positive peak on production in all countries but Belgium, the Netherlands and Portugal. A net tax shock in France has positive effects in all countries but Portugal. Finally, a net tax shock in Italy seems to have only a positive effect in Spain. In terms of size, the maximum peak reaches around a 0.8 pp change in car production levels.
A **demand shock** (Annex C 2 Figure 22) in Germany seems to have a median positive peak effect on *production* all countries. The sames as when the shock origin is in Spain. As hinted before, this could indicate that a genuine increase in demand has positive effects in general, while when focusing on some car models, net tax shocks might produce substitution effects and therefore favor some country producers. A demand shock in France shows a median positive peak on production in all countries but Austria and Italy. Finally, a demand shock in Italy generates a median positive peak on production in Belgium, Spain, France and Portugal.
In general, a demand shock seems to have a stronger effect than a net tax shock.

As we can see, it is important to disentangle net tax from demand shocks, because their production effects in terms of size seem to be different. Government interventions, which could qualify as net tax shocks, are in general effective in increasing car registrations and when affecting local production, they do it in a positive way (Spain, France and the Netherlands). A demand shock is generally able to increase production even more that the net tax shock. We find spill-overs to other countries in terms of production, being in general greater when we talk about a demand shock. Our results clearly point to spill-over effects depending on the country origin of the shock and the very same nature of the shock (net taxes vs demand).

[30] In this case, we would need to map the demand for specific models with countries where they are produced in order to clearly identify, if this is the reason.

So far, we are not able to identify a clearer pattern, although we believe that this might be very much related to the specific model preferences of each country buyers and where those models are produced.

6 Conclusion

The present study examines the dynamics of car markets in the major economies in the euro area. Specifically, we look at net tax and demand shocks and analyze how those transmit to registration and production both within and across countries. Using Bayesian techniques, the empirical methodology we follow is a structural VAR with exogenous variables (S-BVARX), which will be transformed into a structural Global VAR (S-BGVAR). *Firstly*, we can confirm some simple economic points from basic micro applied to this particular market. A shock that decreases CCP has the same effect that a demand shock, both increase car registrations. In terms of supply, when significant, production reacts positively to both net tax and demand shocks. *Secondly*, we find the existence of spill-overs with respect to production. The effect of a negative net tax or a positive demand shock very much depends on the country shock origin and the nature of the shock (net tax vs demand). In order to pin down more exactly the reason of the differences of responses, a more micro-level study should be conducted, so to match these results with micro-level evidence on the type of car demand at each country and where those models are being produced.

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Appendix

A.1 Car Registration and Idiosyncratic Fiscal policy changes

Blue lines, registration levels. Yellow shaded areas depict times of scrapping schemes.

Figure 2: Austria

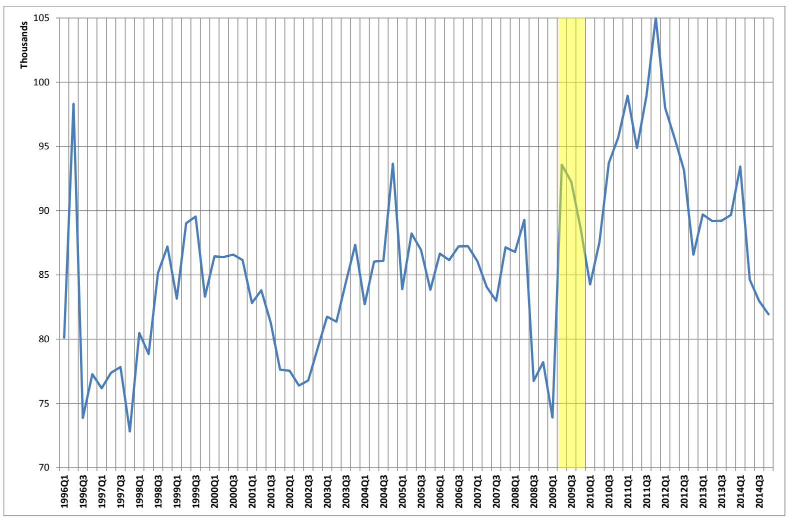


Figure 3: Belgium

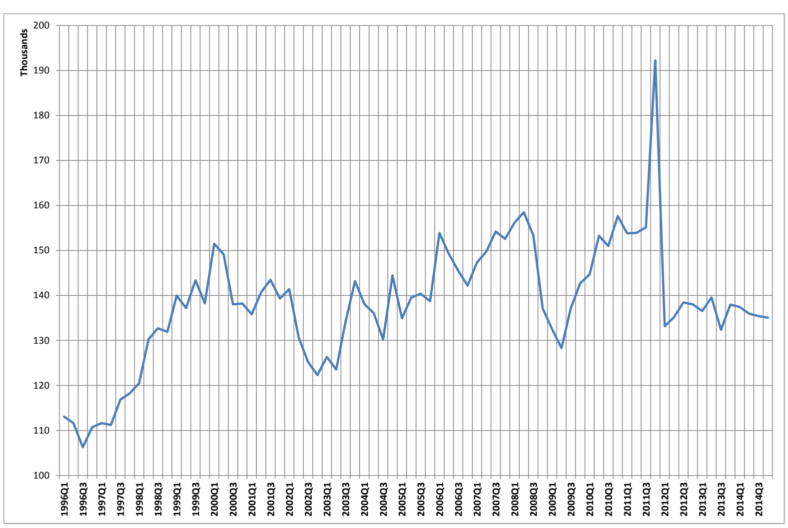


Figure 4: Germany

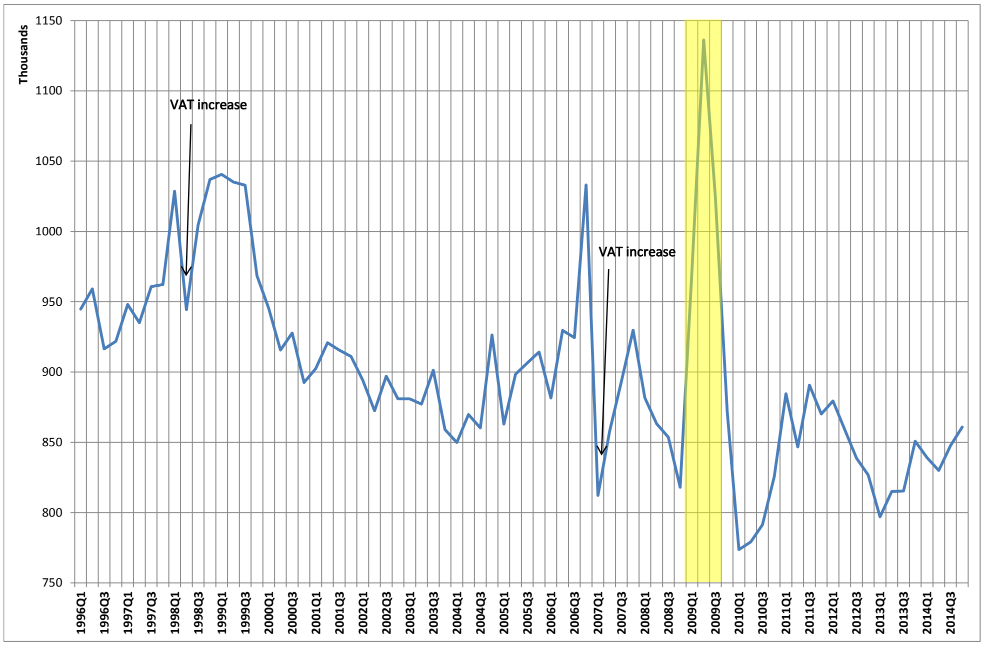


Figure 5: Spain

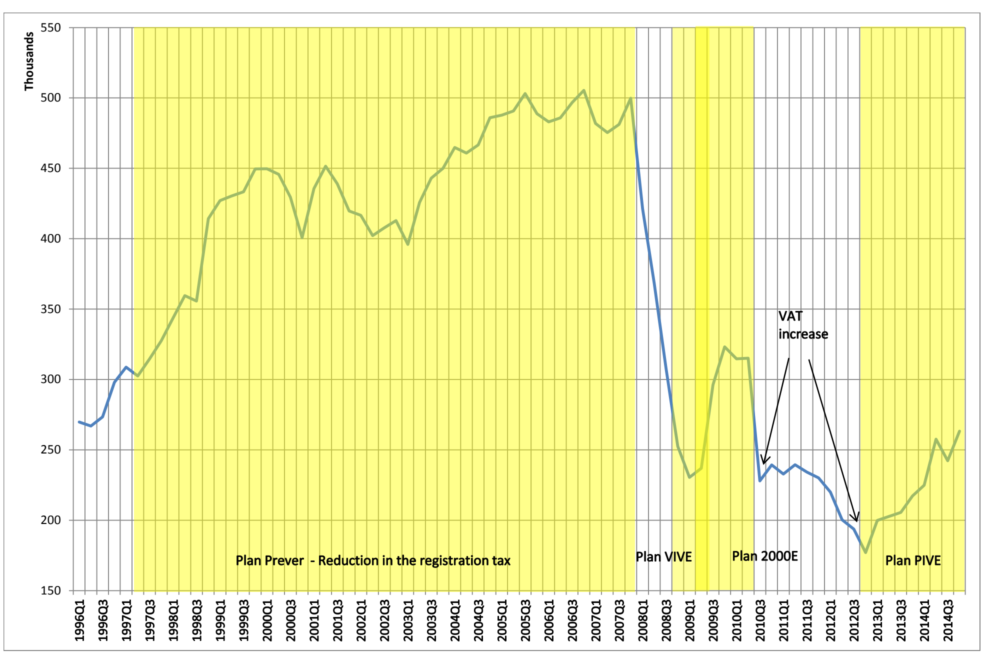


Figure 6: France

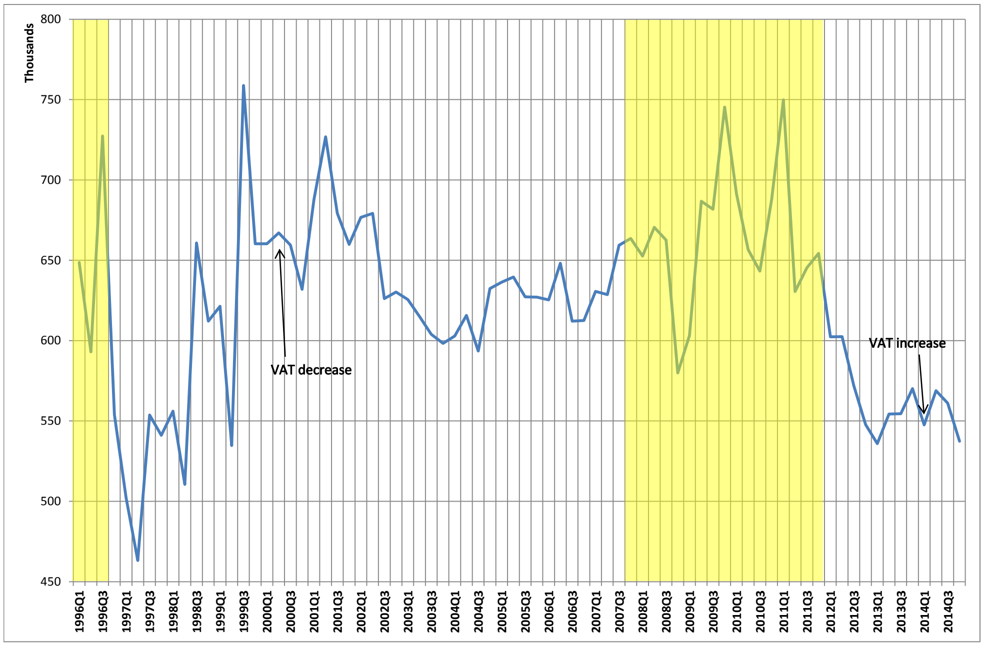


Figure 7: Italy

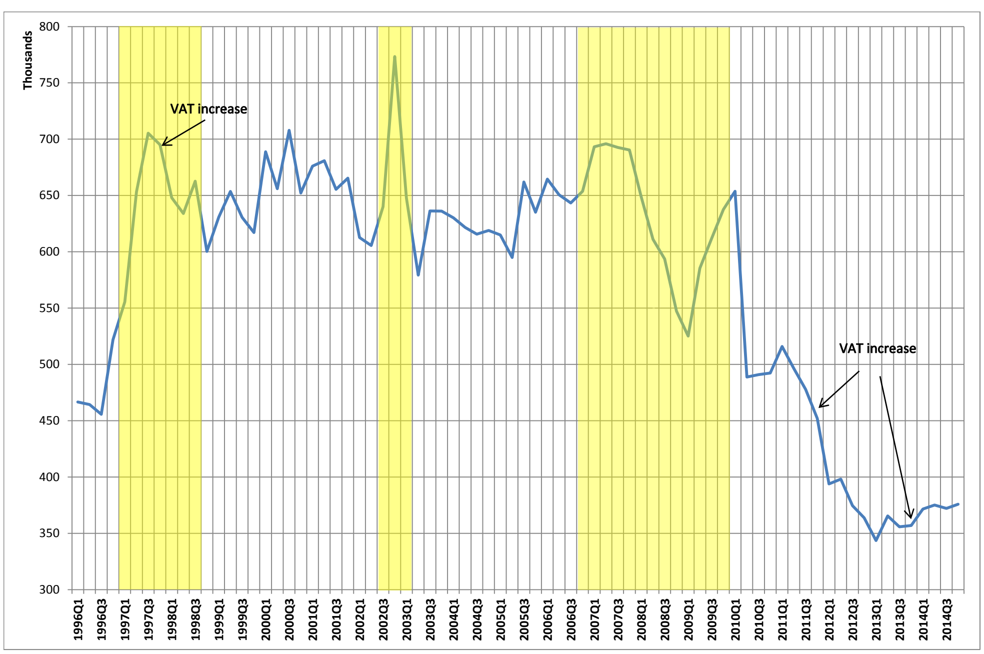


Figure 8: Netherlands

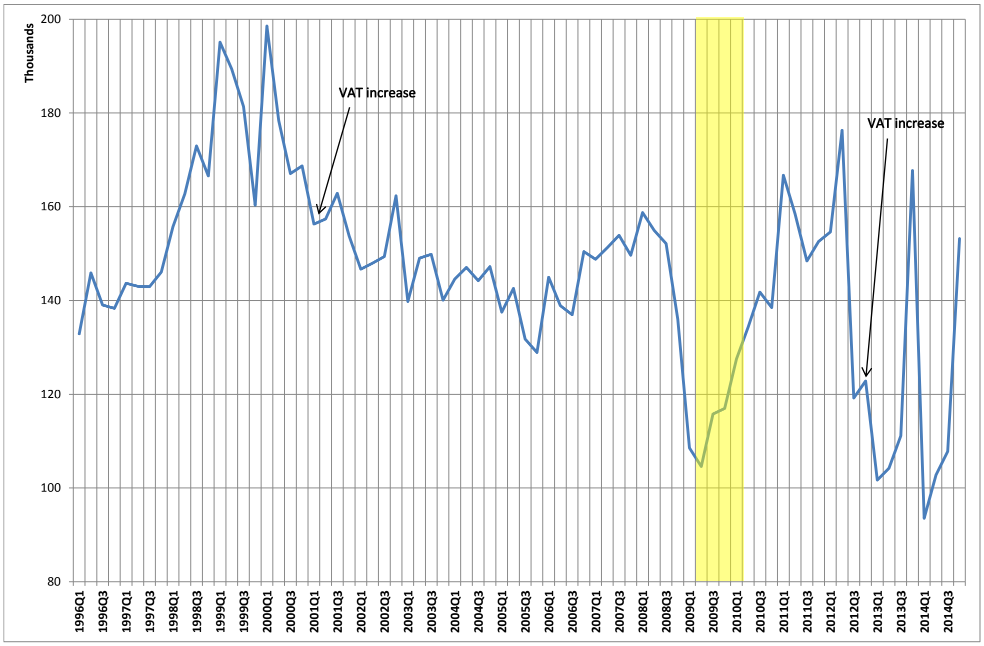
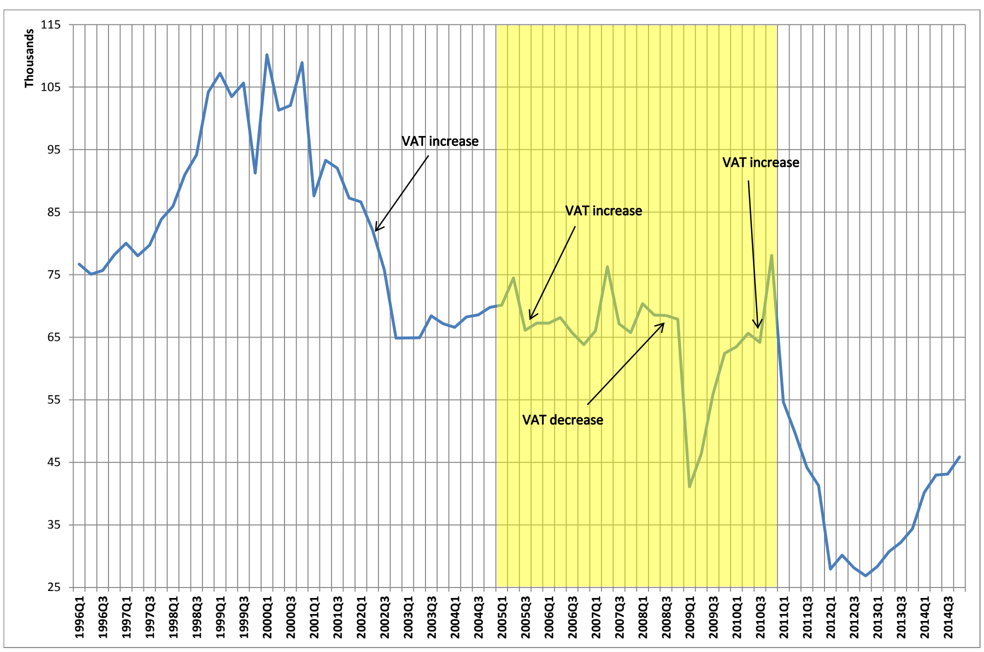


Figure 9: Portugal



A.2 Car Prices and Idiosyncratic Fiscal policy changes

Red lines are q-o-q growths; blue lines, levels. Yellow shaded areas depict times of scrapping schemes

Figure 10: Austria

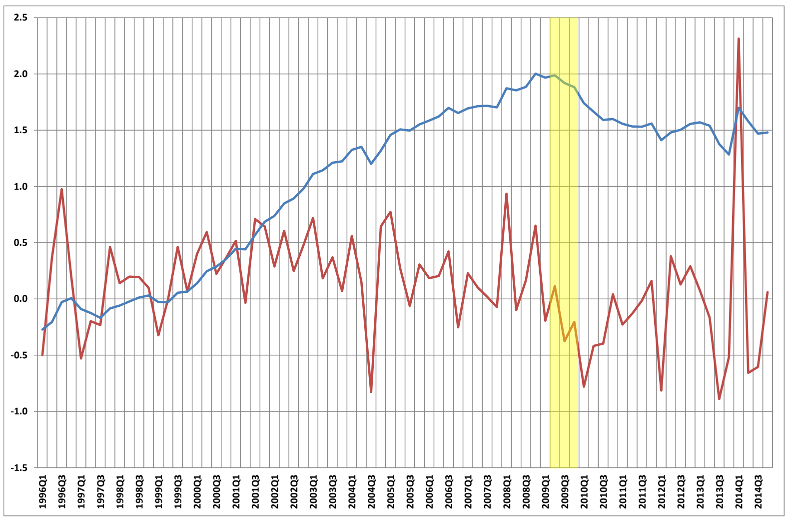


Figure 11: Belgium

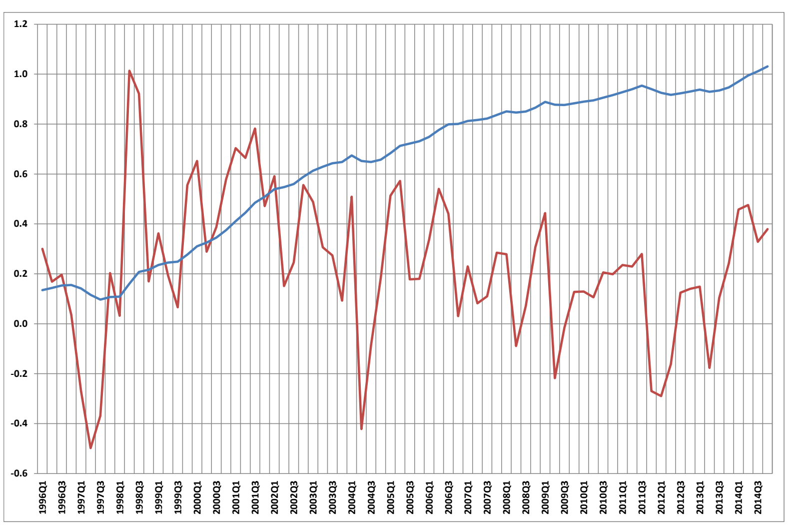


Figure 12: Germany

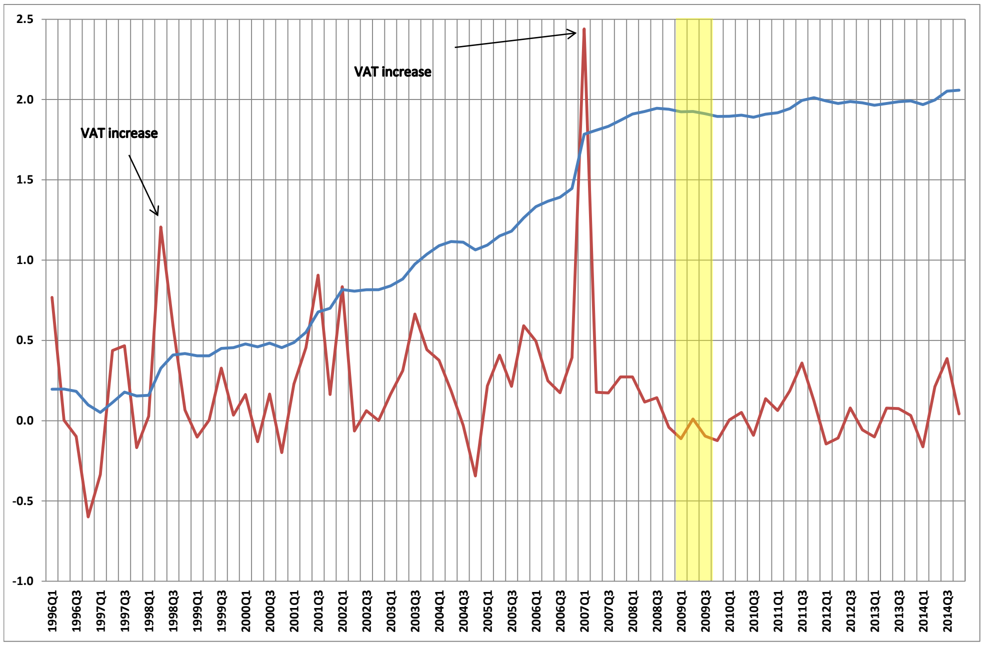


Figure 13: Spain

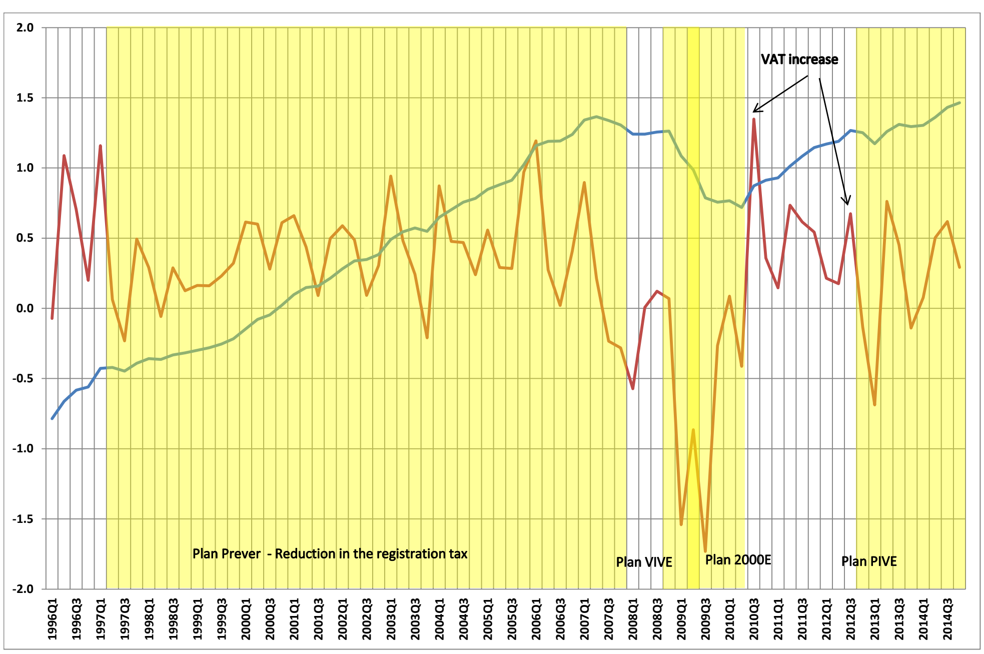


Figure 14: France

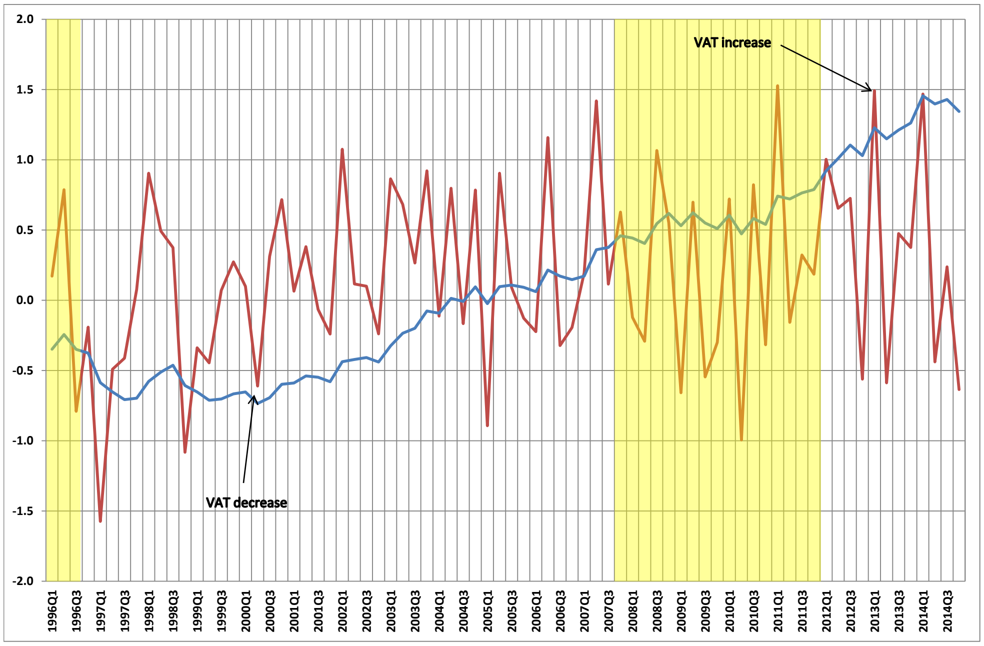


Figure 15: Italy

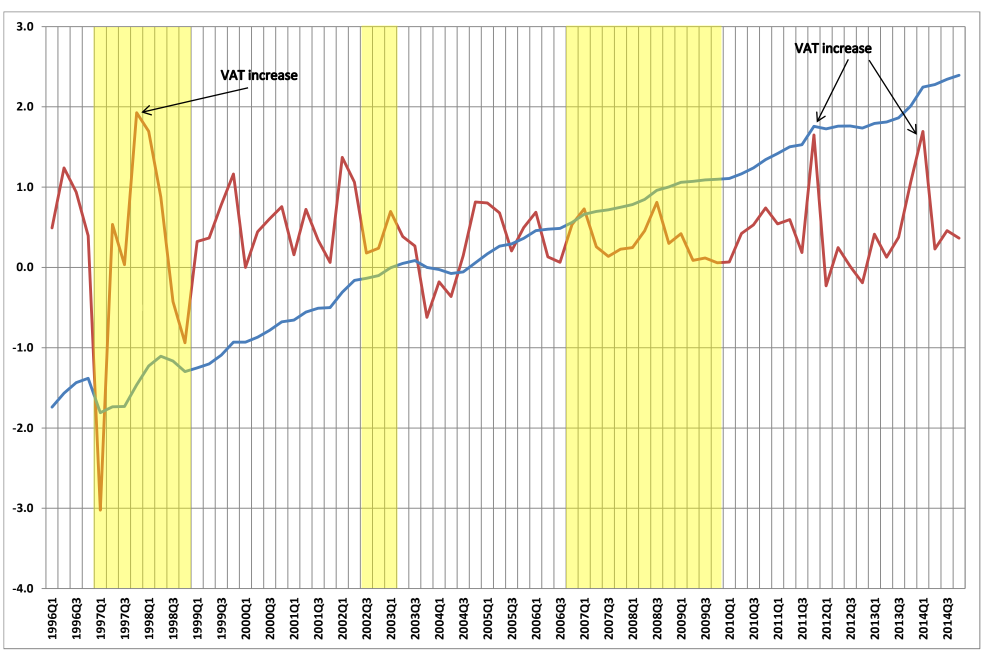


Figure 16: Netherlands

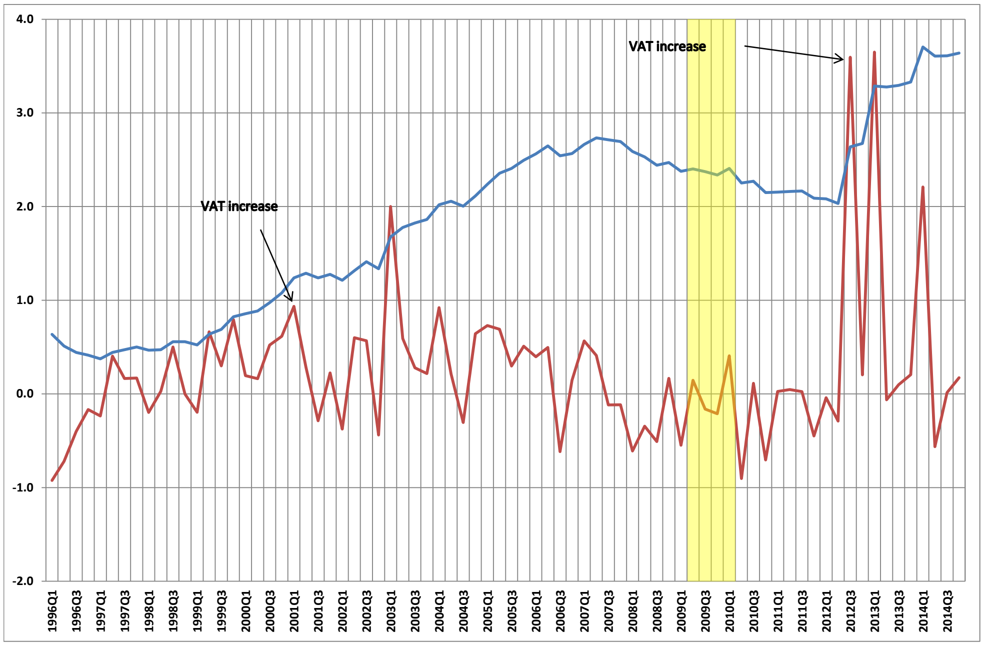
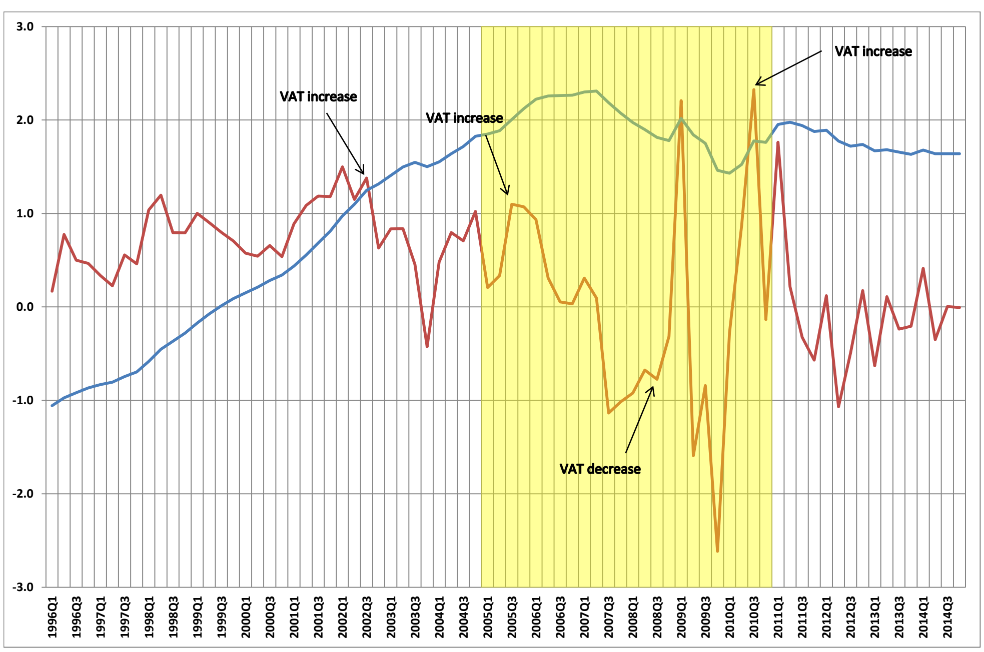


Figure 17: Portugal



B Estimation Results

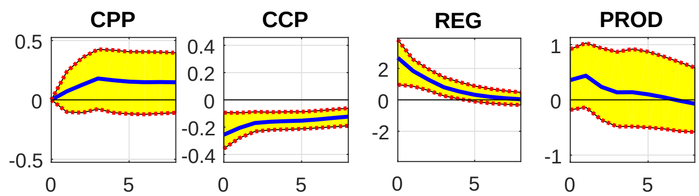
6.1 Calibrated Trade Weights

	Austria	Belgium	Germany	Spain	France	Italy	Netherlands	Portugal
Austria	0	0.07	0.60	0.09	0.11	0.11	0.02	0.01
Belgium	0.02	0	0.47	0.09	0.21	0.06	0.14	0.02
Germany	0.08	0.21	0	0.17	0.22	0.21	0.08	0.04
Spain	0.02	0.07	0.33	0	0.40	0.11	0.02	0.04
France	0.02	0.14	0.34	0.32	0	0.13	0.03	0.02
Italy	0.03	0.06	0.52	0.15	0.21	0	0.02	0.01
Netherlands	0.02	0.33	0.44	0.07	0.09	0.04	0	0.01
Portugal	0.01	0.08	0.47	0.21	0.15	0.06	0.01	0

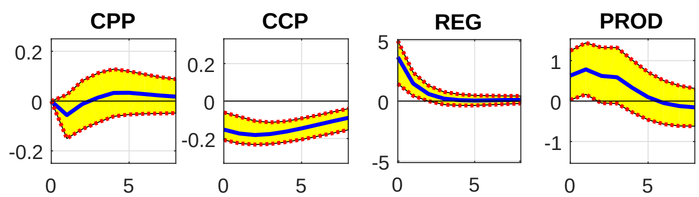
Table 2: Trade Weights of car exports across countries under consideration: These trade weights are used to calculate the foreign variables in the VARX and for the stacking in the GVAR

C Figures

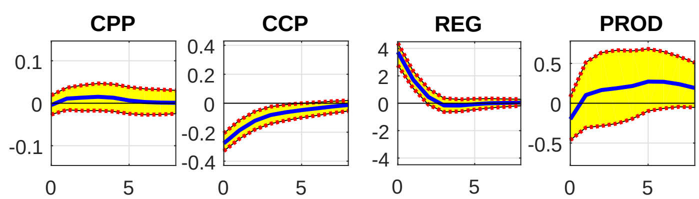
1a. Exclusion and sign restriction. GVAR results. Impact of a country specific tax shock on its own country



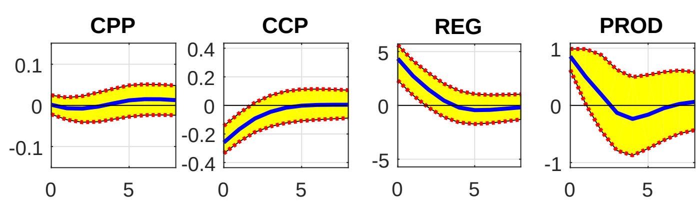
Austria



Belgium



Germany



Spain

Figure 18: *Figures are median (blue solid) impulses responses to a one standard deviation decrease in the car CCP level (second column), together with the 16th and 84th quantiles of the distribution of the impulse response functions. Unit on the vertical axis: percentage points. Unit on the horizontal axis: quarters.*

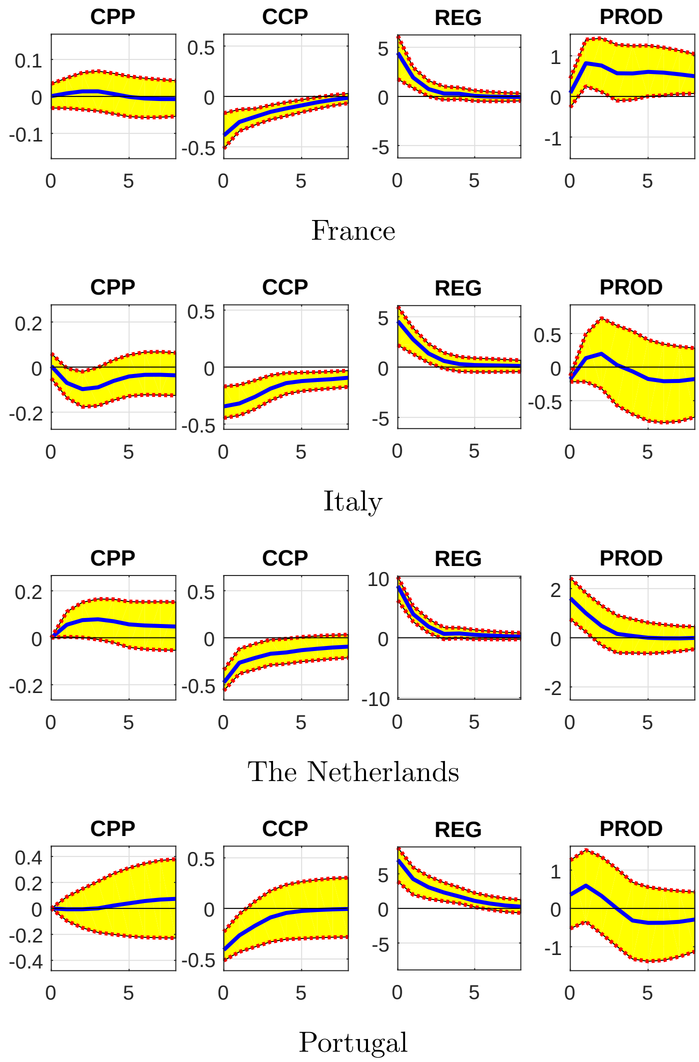


Figure 19: *Figures are median (blue solid) impulses responses to a one standard deviation decrease in the car CCP level (second column), together with the 16th and 84th quantiles of the distribution of the impulse response functions. Unit on the vertical axis: percentage points. Unit on the horizontal axis: quarters.*

1b. Exclusion and sign restriction. GVAR results. Impact of a country specific demand shock on its own country

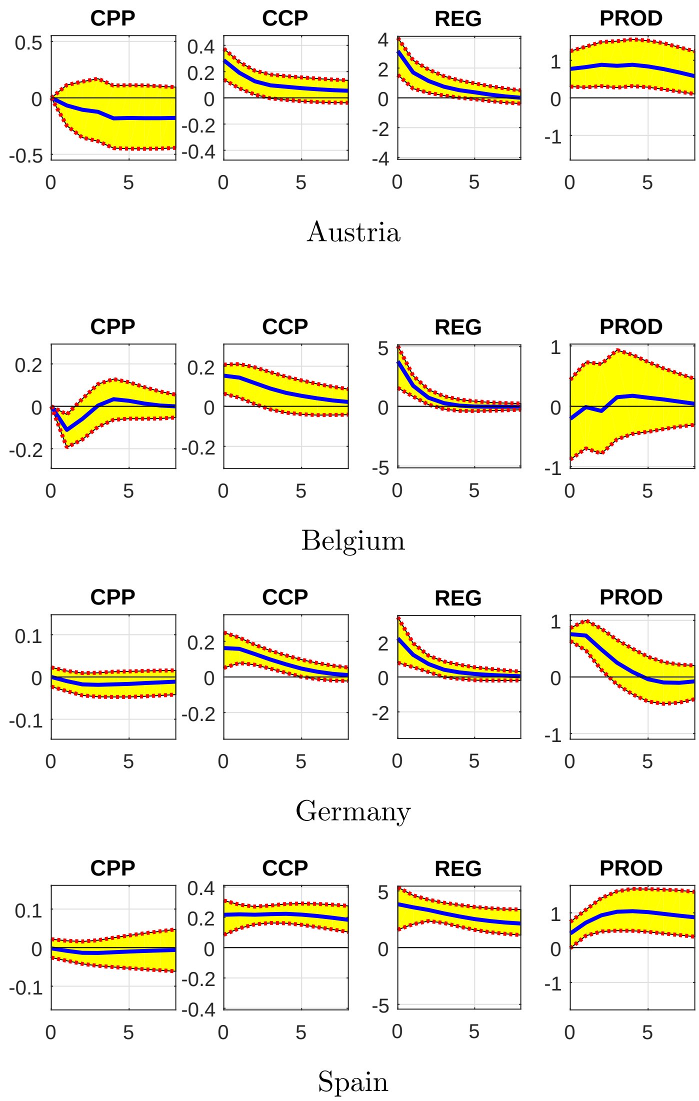


Figure 20: *Figures are median (blue solid) impulses responses to a one standard deviation increase in car registrations (third column), together with the 16th and 84th quantiles of the distribution of the impulse response functions. Unit on the vertical axis: percentage points. Unit on the horizontal axis: quarters.*

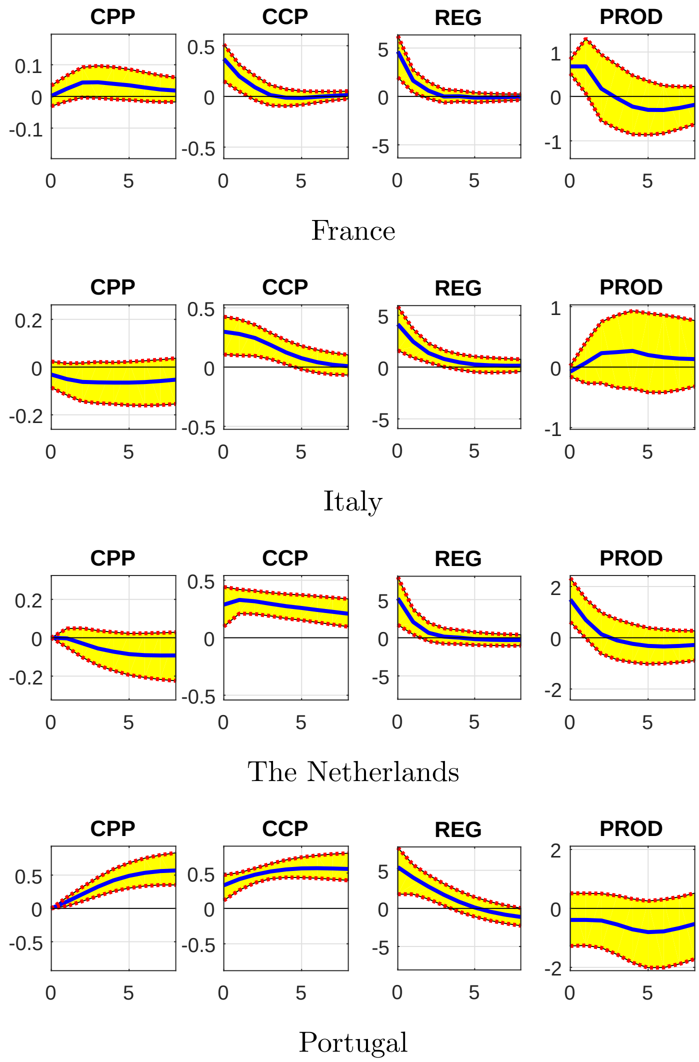


Figure 21: *Figures are median (blue solid) impulses responses to a one standard deviation increase in car registrations (third column), together with the 16th and 84th quantiles of the distribution of the impulse response functions. Unit on the vertical axis: percentage points. Unit on the horizontal axis: quarters.*

2. GVAR results. Impact of a tax (blue) and a demand (red) shock on car production on euro area countries

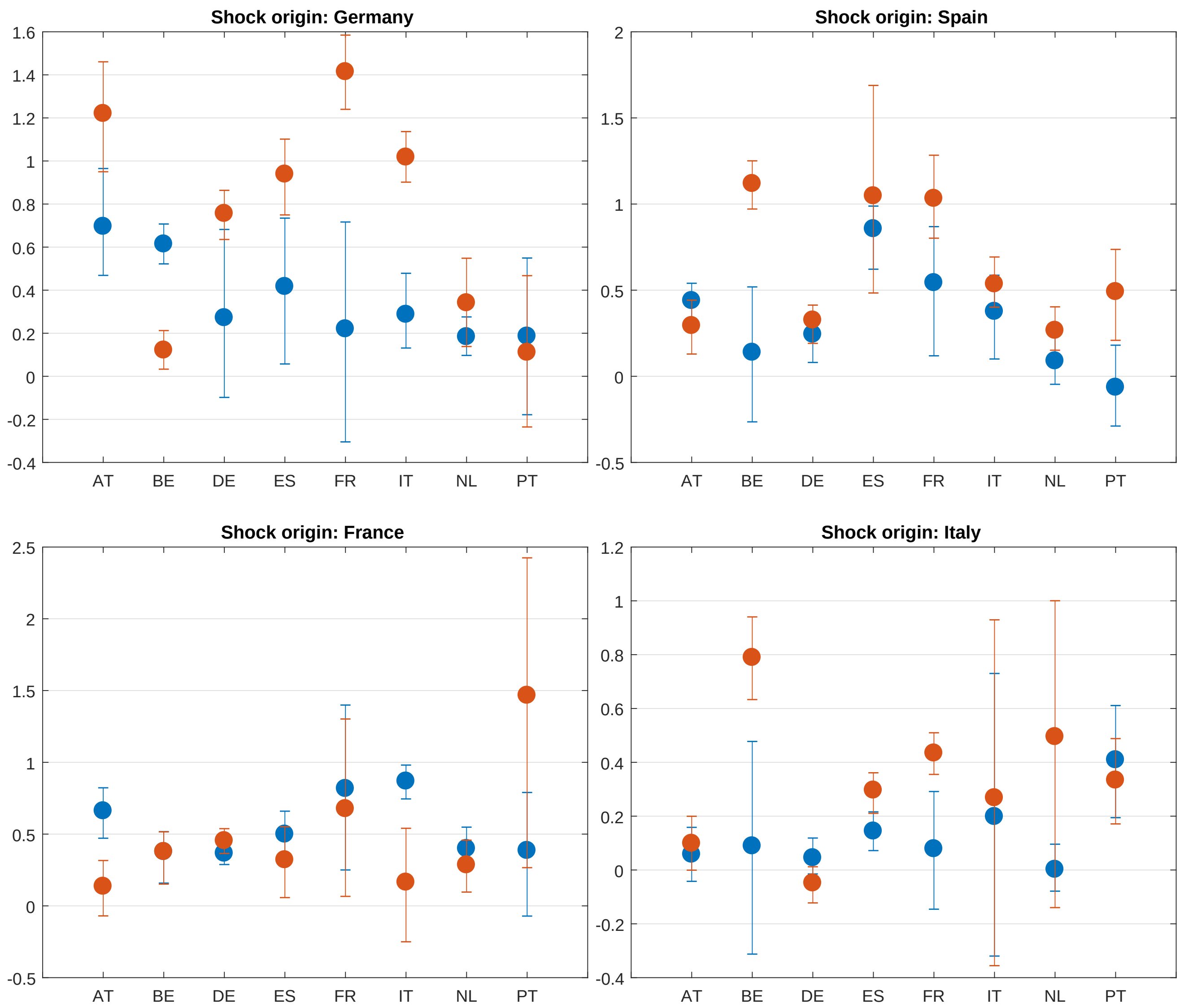


Figure 22: Shock origins: Germany and Spain (first row). France and Italy (second row)

Note: Figures are the production peaks (dots) of the median impulse responses to a one standard deviation increase in car registrations together with their 16th and 84th quantiles of the distribution at that point. Unit on the vertical axis: percentage points.