

CROSS-BORDER EFFECTS OF CAR SCRAPPING SCHEMES: THE CASE OF THE GERMAN CAR SCRAPPING PROGRAMME AND ITS EFFECTS ON THE CZECH ECONOMY

Prague Economic Papers
DOI: 10.18267/j.pep.567
Accepted: 8 April 2015
Published: 19 November 2015

Petr Maleček, Ota Melcher*

Abstract:

Many countries decided to launch car scrapping schemes during the 2009 crisis in order to support their car industries and to boost domestic demand. Owing to the existence of significant international trade links in the automotive sector, there is also a strong theoretical foundation for cross-border effects of such scrappage programmes. This paper explores spillovers of the German scheme to the Czech economy on the basis of a close mutual trade link between these two countries and the size of the Czech automotive sector. It is demonstrated that the German programme provided for a significant boost for Czech personal car exports, which were also coupled with increased imports due to large import requirements of the Czech automotive segment. Overall, the contribution of first-round effects of the German car scrapping scheme to the Czech real GDP growth in 2009 is estimated to have reached between 0.4 and 0.5 percentage points.

Keywords: car scrapping scheme, international trade in personal cars, vector error correction model, input-output tables

JEL Classification: C32, C67, F47, H20

1. Introduction

In the second half of 2008, repercussions of the financial crisis reached the European economy and economic performance in many European countries had begun to slow down markedly. In most cases, this unfavourable development led to a severe recession in 2009. The promptly falling domestic demand in most countries accentuated the difficulties of excess production capacity already faced before the crisis (OECD, p. 88). The automotive industry was particularly hit by the collapse of consumer and business confidence: car sales around the world suffered a sharp drop with figures at the level of synchronisation that was unprecedented (IHS, p. 9). This resulted in a free fall of motor vehicles production (by 25% y-o-y in the EU countries in the fourth quarter of 2008).

Faced by a rapid deterioration of economic conditions together with worsening and highly uncertain outlook in the second half of 2008, many countries sought ways to boost their economic output, having relied on traditional Keynesian channels to tackle the adverse economic conditions. One of such policy measures were the car scrapping schemes, adopted in many core world economies, most notably in Germany, the U.S. and Japan. Two main goals of these schemes can be identified. First, to provide a support to the car industry

* Petr Maleček, Faculty of Economics, University of Economics, Prague, Czech Republic (petrxmalecek@gmail.com);

Ota Melcher, Faculty of International Relations, University of Economics, Prague, Czech Republic (ota.melcher@vse.cz).

by shifting future consumption to the present, which is particularly valuable in a recession, when there is an abundance of unemployed resources that can be put to work at low net economic cost (CEA, p. 1). Secondly, replacing old cars with high emissions by new ones should have brought about a positive ecological outcome (BAFA, p. 2).

Owing to strong international trade linkages especially in the car segment, the incidence of such measures may not be limited to domestic economy only but can also result in spillover effects to other countries. In this paper, we decided to elaborate on one such link by quantifying the effects of the German scrapping scheme on Czech macroeconomic aggregates, namely real exports, imports and GDP. Furthermore, these two countries may serve as an ideal “laboratory” sample principally due to three reasons. First, resources designated for the German scrapping scheme were by far the most extensive among all the implementing countries. Secondly, there exists a very tight trade linkage, whereas the Czech Republic has had traditionally the highest share of automotive industry in total gross value added compared to EU countries (3.7% *versus* the EU average of 1.2% in 2008). Finally, the Czech Republic did not opt for its own car scrapping programme, as such its export figures were not distorted by increased domestic demand for cars.

The paper will proceed as follows. Section 2 provides a review of literature related to car scrapping programmes. Next, a short description of selected scrappage schemes is presented with a particular focus on the German scheme and its effects on the Czech car industry. Section 4 examines international trade links to Germany and portrays time series of personal vehicles exports to Germany in four sample countries. Sections 5 and Section 6 present the model for Czech personal cars exports and imports, respectively; the results are then the basis for the quantification of effects of the German scheme on Czech macroeconomic aggregates in Section 7. Section 8 concludes the paper.

2. Literature Review

This paper is closely linked to the growing body of literature evaluating the incidence of the car industry subsidies on the domestic economy and car sales.

In general, the academia began to engage with the issue of vehicle retirement programmes in the 1990s, focusing predominantly on determining the optimal setup of such schemes. More recent studies within the scrappage programmes context shifted the focus either on environmental impacts or sales volumes. Attention is given to estimation of cost effective emission reduction rates and studies generally show that car scrappage programmes may not be the optimal ways to achieve the environmental goal. Van Wee *et al.* (2000) find rather modest emission reduction effect in the Netherlands and a poor cost effectiveness of the scheme. OECD (2009) also concludes that in general, scrappage schemes do not seem to be cost-effective tools to reduce greenhouse gas emission. Environmental aspect are also studied by Li *et al.* (2010) who find rather poor contribution of the U.S. scrappage programme to emission reductions; moreover, it comes at a very high cost.

Recent studies find that car scrapping schemes may have important effects on the domestic economy, notably by means of a short-term surge in car sales. In the global context, OECD (2009) points to a generally significant increase of car sales in 2009; IHS (2010) estimates that the car 2009 scrapping schemes contributed on aggregate to the EU-wide GDP in 2009 by 0.16–0.2%. At the level of individual countries, CEA (2009) considers induced sales development by assessing the Car Allowance Rebate System programme in the U.S. with a conclusion that the programme is likely to have substantial incidence

on the GDP growth. Mian and Sufi (2010) found that the U.S. scheme provided for a significant boost to car sales, which were, however, almost completely reversed by the following year. Similarly, Copeland and Kahn (2013) analysed the U.S. case with a particular emphasis on inventories and found in some scenarios no significant longer-term effects on car production.

Policy of subsidizing replacement of old cars with new ones in France was studied by Adda and Cooper (2000), stating that these policies stimulate the automobile sector in the short run, furthermore pointing to long-term negative impact on government revenue compared with no intervention scenario. Romano and Scandurra (2012) evaluated the five past Italian schemes and found statistically significant increase in car sales in two instances, including the last one in 2009. The 2009 German scheme is examined by Kaul *et al.* (2012) who examine the influence of car subsidies on car prices. It is shown that the average price of subsidised buyers decreased so that subsidised customers benefited more than the subsidy amount. Böckers *et al.* (2012) demonstrate that the German programme was successful in creating additional demand during the policy period and the overall effect is positive even in the long run.

This paper contributes to the literature on scrapping programmes effects by examining crossborder effects of a particular scheme pointing out to policy's spillovers beyond the domestic economy. To best of our knowledge, this is the first detailed analysis of the incidence of the German scrapping programme on macroeconomic aggregates of the Czech Republic and in general, the first detailed elaboration on the theme of cross-border effects of scrapping programmes. For the calculation of Czech car exports triggered by the German scheme, we exercise the vector-error correction model, and the incremental imports to the Czech Republic are calculated using input-output tables.

3. A short Description of the 2009 Car Scrapping Programmes

As hinted in the introduction, car scrapping schemes enjoyed a particular resurgence during the 2009 crisis, both in terms of the number of countries involved and the total amount of funds allocated by governments. In the EU alone, 12 out of 27 countries introduced scrapping programmes (IHS, p. 42). The German car scrapping scheme dominated in the global context by its size with public support amounting to EUR 5 billion. A particularly strong incentive was also provided by the United States and Japan, each reaching approximately half of the German support. The rest of the countries designated relatively less resources in nominal terms, but not necessarily in terms of a share of their GDP.

The fundamental principle of car scrapping schemes was in most countries; the schemes were also designed as temporary programmes. In most cases, they were limited to the year 2009, although several countries decided to prolong their duration well into 2010, see Table 1. On the other hand, conditionality and generosity of the programmes varied markedly across countries. In the EU context, the German scheme, exceeding all other programmes by its size, was also one of the most generous in terms of the size of an individual subsidy (EUR 2,500).

German government implemented two stimulus packages called *Konjunkturpaket 1* in 2008 and *Konjunkturpaket 2* in 2009. The scrapping scheme (officially called *Umweltprämie*) was a part of the second package, which was adopted by the German government on 14 January 2009. The act stated an option to apply for a premium starting from 27 January

(BAFA, p. 13). Buyers could claim a scrapping premium in case they owned a car 9 years old or older for at least one year, in order to purchase a new or up to 14 months old vehicle. Required emission class Euro 4 was demanded for any new vehicle purchase on the EU level since 2006. Last but not least, only private car owners could benefit from the scheme.

Table 1 | Government Subsidy and Duration of Selected Scrapping Schemes during the 2009 Crisis

Country	Funds allocated (mil. EUR)	Subsidy per vehicle (EUR)	Duration
Germany	5,000	2,500	14 Jan 09 – 31 Dec 09
Japan	2,839 (370,000 JPY)	959–1,918 (125,000–250,000 JPY)	10 Apr 09 – 31 Mar 10 ¹
USA	2,151 (3,000 USD)	2,509–3,226 (3,500–4,500 USD)	24 Jul 09 – Nov 09
Italy	1,074	1,500–6,000	Feb 09 – Dec 09 ²
France	600	1,000	4 Dec 08 – 31 Dec 09 ³
UK	449 (400 GBP)	1,122 (1,000 GBP)	18 May 09 – 31 Mar 10
Spain	140	500	18 May 09 – Jul 10 ⁴
Slovakia	55.3	1,000–1,500	9 Mar 09 – 14 Apr 09 ⁵

Source: OECD (pp. 99–101), IHS (2010), Eurostat, see also footnotes.

Having met a particularly high demand, allocated funds were depleted already on 2 September with subsidy provided to 2 million buyers. After this date, there was an opportunity to register on a waiting list for 15,000 additional participants (all places were filled up on 14 October 2009), while it was still possible to claim the scrapping subsidy until 31 July 2010 (BAFA, p. 5). Therefore, it cannot be stated at what precise moment effects of this scheme faded away. For purpose of this paper, we set the end of the German scheme to December 2009 also in line with Böckers *et al.* (2012) and Kaul *et al.* (2012). The choice of the final month of the policy has nevertheless an insignificant impact on the overall outcome of this study.

3.1 The first glimpse at the effects of the German scheme on the Czech car industry

While designed with no intended preferences, the scrapping programme triggered demand namely for smaller and lower priced cars: 84% of subsidies were granted for purchases in following categories: mini, small and compact. This was a greater share than the 75% of scrapped clunkers in these categories (BAFA, p. 18). Yet such outcome is far from striking

- 1 Further extended to September 2010 (Canis *et al.*, p. 12).
- 2 Romano and Scandurra (2012, p. 180); the budget estimate is taken from IHS, (p. 48).
- 3 Followed by a second round in the course of 2010, with additional EUR 240 mil. allocated for the programme (OECD, p. 99, IMF, p. 4).
- 4 These figures comprise only the central government sector, on the top of that, there were Autonomous Communities' and manufacturers' contributions (Jiménez *et al.*, pp. 4–5).

as the scrappage premium was constant and buying a small and lower priced car resulted in a higher subsidy to price ratio. Additionally, owners of cars older than nine years are not likely to be a target group for costly vehicles, even with a subsidy: according to IFEU (2009), the average age of a clunker in Germany was 14.4 years. Furthermore, adverse economic conditions and low consumer confidence at that time were generally not conducive to major purchases. Lastly, given that the subsidy was aimed at private consumers and was not available for commercial entities, utility cars and large vans represented only 5% of subsidized vehicles (BAFA, p. 19).

It is somewhat obvious from above stated facts that the scheme accordingly pulled in exports largely from countries where car industry focuses its production on smaller cars, such as the Czech Republic. The Czech car industry has been dominated by three companies: Škoda Auto with flagship models in small category (Fabia - the second most subsidised model during the German scheme) and compact category (Octavia), TPCA⁵ - focusing on mini city cars (Toyota Aygo, Peugeot 107 and Citroën C1) and Hyundai (the compact i30). It is also to be noted that the start-up of the Hyundai processing plant in late 2008 and its gradual production increases coincided with the timing of the German programme. Hyundai share on German subsidies was nevertheless just 6.7% of models produced in the Czech Republic, according to the BAFA (2010) data. Furthermore, as it will be shown later on, the model for Czech car exports rests on observed long-term increases in car sector production capacity so that the launch of Hyundai production would fit in well, similarly as a (gradual) start-up of the TPCA plant in 2005.

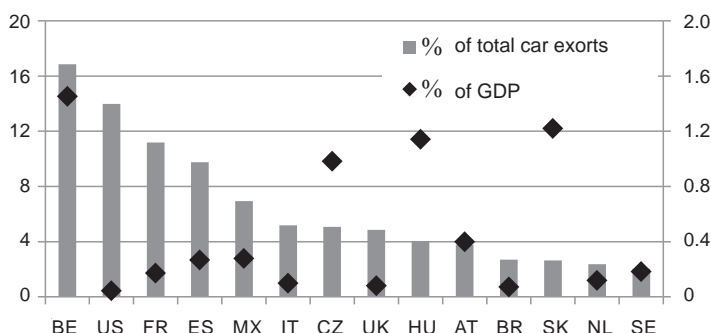
4. Personal Cars Trade Linkages to Germany

Besides providing a large stimulus for car manufacturers located in Germany, the programme also resulted in significant imports from other countries, as hinted in the previous section in the case of Czech cars. Figure 1 shows that in 2008, the German car market was penetrated especially by imports from Belgium, the U.S., France and Spain, which made up for a half of total German car imports. When estimating impacts of the German scrapping scheme on foreign economies, it is important to take into account their respective size. As seen also on Figure 1, despite the programme triggered large nominal imports from several countries, the outcome of such an impulse may not be necessarily significant with respect to their GDP.

We can identify four countries with relatively high ratios of car exports to Germany, exceeding 1% of GDP, where cross-border effects of the German scheme might have been particularly tangible: Belgium, Slovakia, Hungary and the Czech Republic.

5 A joint venture of Toyota, Peugeot and Citroën.

Figure 1 | Personal Cars Exports to Germany (2008)



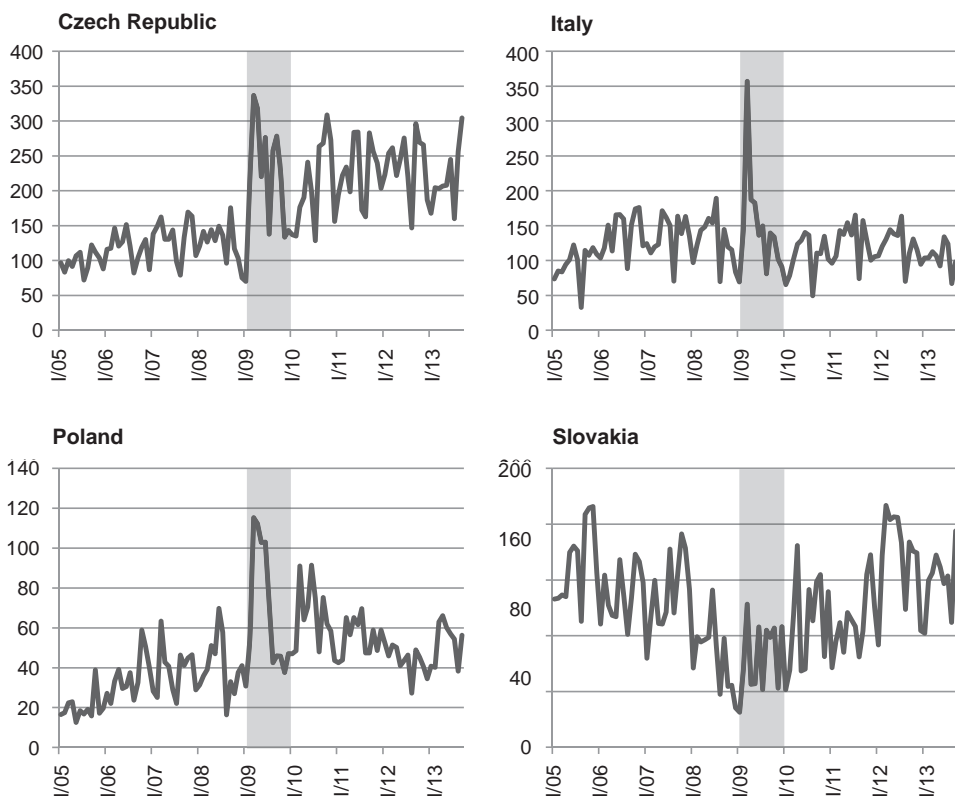
Note: % of total car exports to Germany (left axis), % of a country's GDP (right axis)

Source: Comext, Eurostat, WEO October 2012 database, own calculations

To commence with the actual time series analysis, Figure 2 depicts the development of nominal car exports to Germany in four sample countries. We can spot a remarkable surge in exports throughout the duration of the programme (the shaded area). Particularly, in March 2009, car exports reached more than 2.5 times the level than in the previous year in Italy, Poland and the Czech Republic. On the other hand, domestic car scrapping schemes restructured the domestic production in the way that capacities were more utilized to cover domestic consumption spurred by the subsidies which could have also contributed to dampen exports; this might be the case for Italy and Slovakia, the latter's economy being particularly dependent on exports to Germany, so that an effect similar to the Czech one may have been expected *ex-ante*. Furthermore, there was no such obvious pattern in countries' exports of parts and accessories for motor vehicles to Germany that might have also risen to nurture the increasing German demand. In several cases, exports of motor vehicles' parts even slightly dropped (this is also the case of the Czech Republic), which is the result of shifting the capacities to domestic production. These effects will be studied in Section 6.

There is also a stream of literature discussing the so called "payback effect", *i.e.* shifting sales from future to the present. Yet, the evidence is rather mixed. While Mian and Sufi (2010) show that this effect may have been almost complete in case of the US scheme, OECD (2009) suggests that there is no clear evidence on its timing and magnitude. Furthermore, IHS (2010) together with CEA (2009) point to computational and estimation difficulties around such effects. Böckers *et al.* (2012) find varying payback effects in different car segments for the German programme. Theoretically, such as these could be also carried over to exports; yet the visual inspection of the figure below does not seem to support such assumption in the selected cases, we therefore argue, along with other studies, that it remains practically immeasurable in the examined Czech case.

Figure 2 | Personal Cars Exports to Germany (mil. EUR)



Source: Comext, Eurostat

5. Exports Model Description

In Sections 5 and Section 6, we present a way to estimate the incremental Czech exports and imports, respectively, triggered by the German scrappage scheme. In order to quantify incremental exports, we have to first render the baseline scenario, *i.e.* a situation where the German car scrapping scheme is non-existent. This may be attained by many different techniques, ranging from rough “arithmetic” estimates presented in CEA (2009), difference-in-difference estimation in Jiménez *et al.* (2011) or autoregressive methods in Böckers *et al.* (2012), who elaborate specifically upon the univariate autoregressive model (AR) and the vector autoregression (VAR). For the purposes of this paper, however, neither of the approaches is feasible due to the nature of the time series we examine. As shown in Figure 2, Czech car exports to Germany seem to follow non-stationary path which, without any adjustments, cannot be processed by either of these methods without taking the cost of the existence of spurious regressions (for further discussion see *e.g.* Hamilton, p. 557).

For determining the baseline exports that would have occurred without the existence of the German programme, we rather use the vector error correction model (VECM), which is also applied by OECD (2009) to determine the effects of car scrapping schemes on car sales.

Hereafter, we base our calculations upon Czech exports of personal cars to Germany (SITC Group 781), which are depicted in Figure 2.⁶ We then have to find plausible explanatory variables for Czech car exports to Germany that would be likewise available on monthly basis. We chose two variables that seem to meet these requirements, as will be clarified later on in this section. First, exports of Czech durable manufactured goods to Germany, consisting of consumer durable goods, processed industrial supplies and capital goods except transport equipment, all defined by the Broad Economic Categories nomenclature. This variable is chosen to capture long-term increases in Czech export capacities of durable goods. The second variable is the German consumer confidence index, as surveyed by European Commission's DG ECFIN, which in turn captures changes in German domestic demand.⁷ For all variables, we examine the timespan of January 1999 to September 2013.

Being interested in tracing the impact of German scrappage scheme on real Czech macroeconomic aggregates, we have to adjust the nominal trade data. Due to the lack of available trade deflators at this level of detail, we approximate them by German price index for personal cars and non-energy durable industrial goods, respectively. With this approach we thus inherently treat all other influences, such as profit margins of exporters, as stationary. The two time series are then presented in CZK using monthly exchange rates and also seasonally adjusted by Tramo/Seats; for the consumer confidence indicator seasonally adjusted data are taken directly from Eurostat using its own methodology. Finally, for further purposes, we use trade data in natural logarithms, while the confidence indicator is taken in levels.

Having specified the three endogenous variables, we can now move on to describe the model in further detail. In its general form, the VECM of lag order n can be written as follows (Juselius, p. 80):

$$\Delta \mathbf{x}_t = \alpha \beta' \mathbf{x}_{t-1} + \Gamma_1 \Delta \mathbf{x}_{t-1} + \dots + \Gamma_{n-1} \Delta \mathbf{x}_{t-n+1} + \boldsymbol{\mu} + \Lambda_1 \mathbf{y}_{1,t} + \dots + \Lambda_m \mathbf{y}_{m,t} + \boldsymbol{\varepsilon}_t \quad (1)$$

In our setup, \mathbf{x}_t represents the vector of the three previously described endogenous variables, $\Gamma_1, \dots, \Gamma_{n-1}$ being the 3×3 coefficient matrices and $\boldsymbol{\mu}$ the vector of constant terms. So far, this part of the model can be referred to as a “VAR section”, as the endogenous variables, being cointegrated of order one (as will be explained further on), are expressed in their first differences, resulting in a stationary process.

The error-correction part is then defined by the term $\alpha \beta' \mathbf{x}_{t-1}$. It consists of a vector lagged endogenous variables \mathbf{x}_{t-1} and the element α , that can be interpreted as the speed of adjustment of the model to the long-run equilibrium (Juselius, p. 88). The long-term equilibrium itself is then defined by the vector β (Juselius, p. 80). Finally, $\mathbf{y}_{1,t}, \dots, \mathbf{y}_{m,t}$ denote vectors of m exogenous variables, and $\Lambda_1, \dots, \Lambda_m$ their corresponding coefficient vectors; finally, $\boldsymbol{\varepsilon}_t$ is the vector of error terms.

The only exogenous variables we employ are several dummy variables. The first two need to be applied to accommodate the change in the way international trade data was collected, due to the Czech Republic's joining the European Union in May 2004. Next, each

6 We do not take into account utility vehicles (SITC Group 782), because Czech exports in this category to Germany are insignificant (amounted to less than 1% of personal cars exports in 2008). Moreover, as argued in Section 3.1, they represented only a minor share of German subsidies.

7 All raw data in this study are taken from Eurostat, trade data specifically from Eurostat's Comext database, in EUR.

month in the course of the German car scrapping scheme (Feb09 to Dec09) is marked with its own dummy variable, see also Table 10 for further information.⁸ As noted in Section 3, no precise end-point of the effects of the German scheme can be stipulated, we rather observe a gradual phase-out. These dummy variables are used solely to accurately estimate the model coefficients (*i.e.* to disregard any inferences from the scrapping scheme in the baseline scenario) and are thus not directly involved in the export forecasting exercise.

The first step in the modelling exercise is to determine the order of integration of all endogenous variables. Table 4 in the Appendix shows that according to the augmented Dickey-Fuller test, all three variables are non-stationary, whereas their first differences are stationary; therefore, all are integrated to the order of one, in other words, they are $I(1)$ processes. This result is not surprising in case of Czech exports to Germany, since the Czech economy went through significant transformation during the selected time span (January 1999–September 2013) while becoming ever more export oriented. Also, a confidence index could be theoretically stationary over a sufficient time period. The time span we apply, however, was not sufficient for the German consumer confidence index to portray this proposition in practice. Although the mainstream methodological VECM approach allows only dealing with $I(1)$ processes – in line with the original idea of Engle and Granger, having stationary variables in the system should nevertheless not present an issue, as discussed by Lütkepohl (p. 246) or Hjalmarsson and Österholm (p. 5).

We have found that the all three variables are non-stationary, yet we can use the VECM model only in case they are also cointegrated. In other words, we have to find out whether there exists a linear combination of all three variables which would be stationary (Lütkepohl, p. 245). To confirm this, we apply the Johansen cointegration tests that can tell us the number of cointegration relationships. As seen in Table 5 in the Appendix, we can firmly reject the hypothesis of an absence of cointegration, there is also a particularly strong evidence of one cointegration relationship. Although it is not possible to reject the hypothesis of two cointegrating vectors, due to more convincing test values and keeping parsimony at the same time, we choose the model setup with one cointegrating vector.

Finally, we need to determine the number of lags in the VAR section. To this purpose, we follow the traditional approach by choosing a setup with minimum relative information loss. Table 6 in the Appendix tells us that the Akaike information criterion favours the setup with one lag, whereas the Schwarz criterion is virtually indifferent between one lag and the absence of the VAR section. We decided to keep one lag in our model, which is further supported by the fact that we firmly cannot reject this one lag by the Wald exclusion test.

Having fully specified the model, we can then turn to estimating its parameters;⁹ table below shows the long-run relationships. We can see that the parameters have expected signs, *i.e.* that there exists a positive long-term dependence between exports of personal cars, durable goods and the German consumer confidence index. Furthermore, the parameters are highly statistically significant, as previously implied by the particularly strong cointegration.

8 We thus consider each month during the course of the scrapping scheme as a separate one-off event; nevertheless, including just one global dummy variable for the duration of the scheme yields almost the same overall results.

9 The standard tests show that the residuals are homoscedastic and not serially correlated (see the Appendix). However, the large car exports in three months at the beginning of the last decade cause the residuals to be not normally distributed.

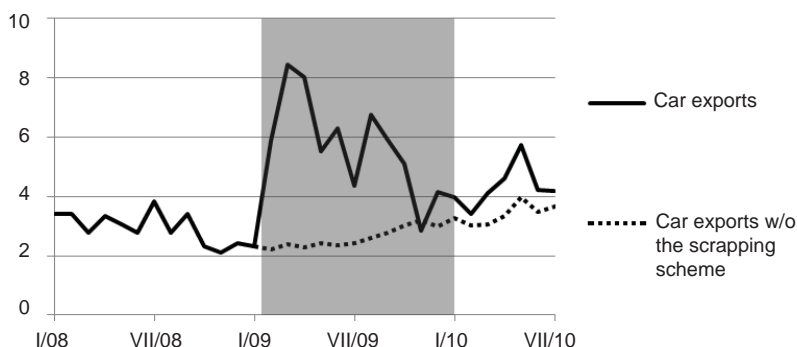
Table 2 | Estimates of the Cointegrating Vector

	Cars	Durables	CCI
value	1.0000	-0.5440	-0.0160
t-stat.	-	-3.7922	-4.1209
prob.	-	0.0002	0.0000

Source: Eurostat, own calculations

Finally, Figure 3 shows the actual development of Czech car exports to Germany (solid line) compared with baseline car exports in case of the absence of the German scrapping scheme (dashed line). This baseline scenario is calculated as a forecast of car exports using estimated parameters of the described VECM model and known values for durable goods exports and the consumer confidence index, while having switched off the monthly dummy variables for 2009. One remarkable feature is that the model does not predict any dramatic decrease of Czech car exports to Germany in the course of 2009. Although the German consumer confidence index had been deteriorating until April 2009, the main drop in durable goods exports occurred already in the last quarter of 2008 and these exports started to pick up somewhat thereafter. During the second half of 2009, baseline car exports started to increase, then also on the back of improved consumer confidence, and reached roughly the average level of the year 2008. Finally, the post-2009 values are to illustrate the behaviour of the model, which is shown over a longer-term period in Figure 6 in the Appendix. It seems that the development of car exports is captured reasonably well, even after a long one-off period in 2009 and 4½ years of forecast.

Figure 3 | Exports of Personal Cars from the Czech Republic to Germany (bil. CZK at 2005 prices, seasonally adjusted)



Source: Eurostat, own calculations

The incremental car exports to Germany triggered by the car scrapping scheme are then obtained simply by summing the difference between the two scenarios over the time period February 09 to December 09. Using this value, we then estimate that the impact of the German car scrapping scheme on annual growth of (total) real exports of goods and ser-

vices in 2009 in the Czech Republic reached 1.29 pp. A more detailed analysis is presented in Section 7.

6. Import Content of Car Exports

Clearly, the increased car exports to Germany necessarily resulted in additional imports, as an automotive industry employs a broad range of intermediate goods in the production chain that cannot be manufactured in the domestic economy “from the scratch”. Estimating a model similar to the one presented in the previous section, now for imports, would not be feasible precisely due to the mere number of intermediate products. Rather, we estimate the import content of car exports by means of input-output tables which allow us to unravel interdependencies among all sectors of an economy.

For quantification of the Czech car exports import content, we draw upon the official OECD methodology described in Loschky and Ritter (2006), using input-output tables for products for 2009 as published by the Czech Statistical Office. Whereas the level of detail of data is quite high (the Czech economy is divided into 82 product groups), the group “motor vehicles” still comprises lorries and parts and accessories for motor vehicles. The final figure for import content of personal cars exports would then necessarily be an approximation, resting on an assumption of similarity of particular import contents. However, we assume the results would still be plausible, also because personal cars represent a large share of the Czech motor vehicles industry.

We start the actual calculation of import content of Czech cars by expressing intermediate consumption of imported products as a ratio to production, obtaining the row vector of coefficients A_m . Indirect effects are then captured by the Leontief inverse matrix $(I - A_d)^{-1}$, allowing the imported good to be embodied in a domestic output at the second, third, *etc.* stage before it becomes incorporated in the exported good. This item is then the matrix analogue of an infinite geometric sum (Hummels *et al.*, p. 7). Here, A_d represents a 82×82 matrix containing values of intermediate production used reciprocally in each product, as a ratio to production; and I is an identity matrix of size 82. Import content of exports of each product p is then calculated using the formula below, *i.e.* as the p -th component of the vector IC . It should be noted that there is an intrinsic assumption that the import content is the same for domestic final use and for exports (Loschky and Ritter, p. 15), which seems reasonable for the car industry.

$$IC_p = A_m(I - A_d)^{-1} \quad (2)$$

Using the described methodology, we estimate that the import content of Czech personal cars exports stood at 54.2% in 2009. This figure is an evidence of a particularly large dependence on international supply chains – the car segment had the 6th largest import content out of the 82 product groups in the Czech economy in 2009, after *e.g.* coke and refined oil products and electronics.

7. Programme Impact on Czech Macroeconomic Aggregates

Having quantified incremental exports that occurred due to the launch of the German scrapping scheme and incremental imports implicit from international supply linkages of the Czech car industry, we estimate that the overall first-round impact of the German scrapping programme amounts to 0.44 pp. of real GDP growth in 2009 (as seen in Table 3). In case the

scheme would not be in place, the decline in (total) real exports of goods and services in the Czech Republic would be larger by 1.29 pp., and the decline in (total) real imports of goods and services larger by 0.75 pp. The calculations underlying Table 3 are straightforward, using solely the GDP identity and comparing scenarios with volumes of real exports and imports on the basis of the (non)existence of the scrapping scheme as calculated in previous sections. Since we estimate only first-round effects of the scrapping scheme through the trade channel, we do not track down effects on other GDP items.

Another particularly important aspect is that the real export impulse materialized in its greatest intensity in the first quarter of 2009, *i.e.* at the time the Czech Republic recorded its greatest GDP decline (3.3% q-o-q). As can be seen in Figures 4 and 5: in absence of the scheme, real exports would have fallen by 8.9% in q-o-q terms in Q1/2009, instead of the actual drop of 7.2%.

Table 3 | Impact of the German Car Scrapping Scheme on the Czech Real Macroeconomic Aggregates (2009, CZK, annual growth in %, in ESA95 methodology)

	Actual figures	Without the car scrapping scheme	Difference (pp.)
GDP	−4.51	−4.94	0.44
Exports	−10.87	−12.17	1.29
Imports	−12.02	−12.77	0.75

Source: Czech Statistical Office, own calculations

Although we cannot precisely determine the quarterly real GDP contributions of the car scrapping scheme – we do not have knowledge of the exact distribution of incremental imports in time, this timely response of the Czech car industry may have nevertheless helped to moderate the trough in real GDP growth. It is worth mentioning that due to the base effect and gradually receding effects of the programme as a whole, q-o-q export growth in the second half of 2009 would be (perhaps somewhat counter-intuitively) higher in case of the absence of the scrapping scheme, even when the level of exports would be still lower.

Figure 4 | Real Exports (bil. CZK at 2005 prices, seasonally adjusted)

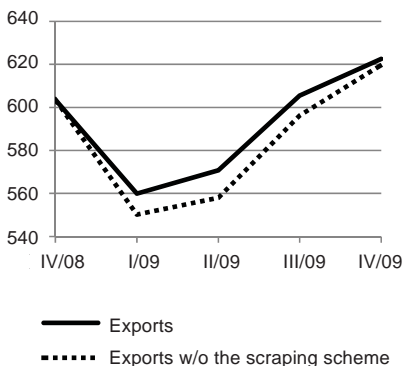
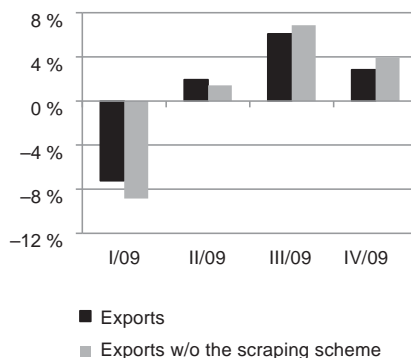


Figure 5 | Real Exports Growth (q-o-q, CZK, seasonally adjusted)



Source: Czech Statistical Office, own calculations

An additional uncertainty regarding the precise time distribution of the impulse of the scheme on GDP during the year 2009 stems from the development in inventories. As discussed in IHS (p. 77), the initial surge of car sales was primarily fed by reducing inventories, whereas there was a lag of several months before production lines started to respond to higher sales. Copeland and Kahn (p. 293) show this lag to hover at around 2.5 months in the U.S. case. Similar developments might have occurred in the Czech case, *i.e.* exports during the first months of 2009 may have been to certain extent offset by virtue of decreasing inventories, as hinted in the Škoda Auto 2009 Annual Report (p. 43). The increased demand for smaller cars then resulted in inventory of those cars generally being quickly exhausted (IHS, p. 77). Replenishment of car inventories to the pre-crisis levels would then cause the GDP impulse to be more evenly spread throughout the year 2009 than implied solely by the development of real exports.

The aim of this paper was the quantification of the first-round impacts of the German car scrapping scheme. Obviously, secondary effects of such impulse to GDP growth would not be negligible, yet a more detailed elaboration would require further research. Specifically, there were likely spillover effects to other branches of the economy owing to a higher demand for parts of personal cars (a portion of those would be certainly still imported, as discussed in the previous section). Furthermore, the German scheme could have resulted in some positive employment gains, as discussed in Cooper *et al.* (2010) in the case of the U.S.; the channels for such employment creation are arguably quite similar in case of the “triggering” economy (Germany) and its trade partner (the Czech Republic). Consequently, the domestic demand may have been somewhat stronger. There are also effects that could have played a role in the opposite direction, namely it is likely that the Czech koruna would have depreciated more in absence of the German scheme, thus increasing the cost competitiveness of Czech exports.

8. Conclusion

The existing literature suggests that car scrapping schemes may have important impacts on domestic economies in terms of increased car sales or GDP growth at least in the short term. We found out that there is also a basis for cross-border effects of these programmes in case a country is strongly linked to the one implementing its own scrappage programme. We studied the case of the Czech Republic, where car exports to Germany accounted for 1% of the Czech GDP in 2008.

Due to the nature of the subsidy, the German scheme was targeted almost predominantly on smaller cars that represented 84% of purchased cars within the German scheme. This was particularly important for the Czech car industry that almost entirely produces cars in these categories. Using the vector error correction model, we found out that the German programme provided for a significant boost to Czech exports; in case of the absence of the scheme, the decline in Czech real export growth in 2009 would have been deeper by 1.29 pp. Due to large import demands in the automotive segment, these incremental exports resulted also in major surge in imports. In sum, we found out that the first-round effects of the German scheme – *i.e.* accounting only for the trade channel – contributed to the Czech real GDP growth in 2009 by 0.44 pp. Secondary effects of the programme, encompassing positive impacts on employment and domestic demand, may not be negligible, however, that remains a subject for a further research.

APPENDIX

Table 4 | Augmented Dickey-Fuller Tests¹⁰

null hypothesis: existence of a unit root

	Levels		First differences	
	test stat.	prob.	test stat.	prob.
Cars	−3.1042	0.1087	−19.9751	0.0000
Durables	−2.2211	0.4745	−4.5763	0.0015
CCI	−1.4687	0.1324	−4.7299	0.0000

Table 5 | Johansen Cointegration Tests

null hypothesis: the number of cointegration equations is $\leq r$

	Trace test		Maximum eigenvalue	
	test stat.	prob.	test stat.	prob.
$r = 0$	51.8850	0.0000	41.6536	0.0000
$r = 1$	10.2314	0.2633	6.7057	0.5245
$r = 2$	3.5257	0.0604	3.5257	0.0604

Table 6 | Values of Information Criteria

VAR lag length	Akaike	Schwarz
0	0.2427	0.5129
1	0.1898	0.5154
2	0.2201	0.6014
3	0.2489	0.6864
4	0.2729	0.7670

¹⁰ “Cars” and “durables” are tested with a constant and linear trend, whereas the consumer confidence indicator is tested without these items, which were found to be not statistically significant in this case. The tested lag length was chosen according to the modified Schwarz criterion, following Ng and Perron (2001).

Table 7 | White Heteroscedasticity Test

null hypothesis: absence of heteroscedasticity

Test stat.	Prob.
142.4611	0.9924

Table 8 | Autocorrelation Lagrange Multiplier Test

null hypothesis: no serial correlation at a given lag

Lag	Test stat.	Prob.
1	14.2843	0.1126
2	5.75749	0.7639
3	13.1019	0.1580
4	11.6748	0.2323
5	12.4381	0.1897
6	19.0635	0.0247
7	11.8612	0.2212
8	14.6190	0.1019
9	9.70813	0.3746
10	4.49955	0.8756
11	8.58142	0.4768
12	6.14716	0.7251

Table 9 | Jarque-Bera Normality Test

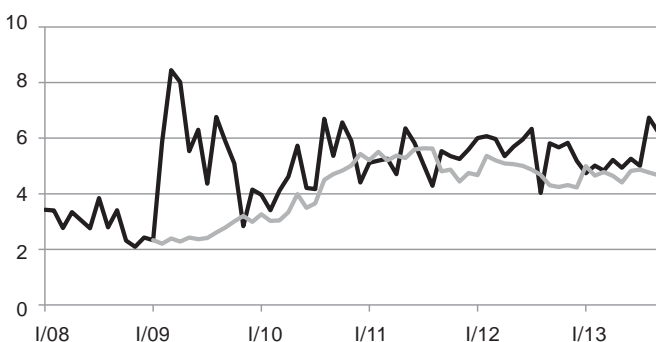
null hypothesis: residuals are normally distributed

	Test stat.	Prob.
Cars	26.9063	0.0000
Durables	22.9618	0.0000
CCI	6.81782	0.0331
Joint test	56.6860	0.0000

Table 10 | Properties of Dummy Variables¹¹

Month	Coeff.	t-stat.	Month	Coeff.	t-stat.	Month	Coeff.	t-stat.
01/99-04/04	-0.610	-18.291	05/09	0.242	0.864	10/09	0.154	0.584
05/04	-0.122	-2.662	06/09	0.541	1.994	11/09	-0.394	-1.511
02/09	0.920	3.583	07/09	0.162	0.609	12/09	0.299	1.161
03/09	0.934	3.506	08/09	0.629	2.394			
04/09	0.712	2.584	09/09	0.355	1.349			

Figure 6 | Exports of Personal Cars from the Czech Republic to Germany (bil. CZK at 2005 prices, seasonally adjusted).



Note: Modelled car exports demonstrate the behaviour of the model using the last data for car exports only up to January 2009 and calculated using estimated parameters and information for durable goods exports and consumer confidence index.

References

- Adda, J., Cooper, R.** (2000), "Balladurette and Juppette: A Discrete Analysis Of Scrapping Subsidies." *Journal of Political Economy*, Vol. 108, No. 4, pp. 778–806, <http://dx.doi.org/10.1086/316096>
- Böckers, V., Heimeshoff, U., Müller, A.** (2012), "Vorsprung durch Technik: Empirical Evidence of the German Scrappage Program." Paper presented at Jahrestagung des Vereins für Socialpolitik 2012: Neue Wege und Herausforderungen für den Arbeitsmarkt des 21. Jahrhunderts.
- Cooper, A., Chen, Y., McAliden, S.** (2010), "The Economic and Fiscal Contributions of the Cash for Clunkers Program – National and State Effects." Center for Automotive Research Memorandum.

¹¹ The here listed coefficients and t-statistics apply to VEC equations describing car exports, with the exception of the first dummy variable, which describes the part of the VEC describing durable goods exports.

- Copeland, A., Kahn, J.** (2013), "The production impact of "Cash-for-Clunkers": implications for stabilization policy" *Economic Inquiry*, Vol. 51, No. 1, pp. 288–303, <http://dx.doi.org/10.1111/j.1465-7295.2011.00443.x>
- Council of Economic Advisors** (2009), *Economic Analysis of the Car Allowance Rebate System ("Cash for Clunkers")*, Executive Office of the President Report.
- Bundesamt für Wirtschaft und Ausfuhrkontrolle (BAFA)** (2010), *Abschlussbericht - Umweltpremie*, November 2010.
- Canis, B., Grimmert, J. J., Platzer, M. D., Yacobucci, B. D.** (2010), "Accelerated Vehicle Retirement Programs in Japan and South Korea: Background for Congress." Congressional Research Service Report, October 2010.
- Hamilton, J. D.** (1994), *Time Series Analysis*. Princeton, New Jersey: Princeton University Press.
- Haugh, D., Mourougane, A., Chatal, O.** (2010), "The Automobile Industry in and Beyond the Crisis." OECD Economics Department Working Paper No. 74.
- Hjalmarsson, E., Österholm, P.** (2007), "Testing for Cointegration Using the Johansen Methodology when Variables Are Near-Integrated." IMF Working Paper No. 07/141.
- Hummels, D., Yi, K.-M.** (1999), "The Nature and Growth of Vertical Specialization in World Trade." Federal Reserve Bank of New York Staff Reports, No. 72, <http://dx.doi.org/10.2139/ssrn.163193>
- IFEU** (2009), *Abwrackprämie und Umwelt – eine erste Bilanz*. IFEU Heidelberg ad hoc study.
- IHS Global Insight** (2010), *Assessment of the Effectiveness of Scrapping Schemes for Vehicles: Economic, Environmental, and Safety Impacts*. March 2010, Final Report.
- IMF** (2010), *France: 2010 Article IV Consultation-Staff Report*. International Monetary Fund Country Report No. 10/240.
- Jiménez, J. L., Perdiguerro, J., García, C.** (2011), "Evaluation of Subsidies Programs to Sell Green Cars: Impact on Prices, Quantities and Efficiency." Sèrie de documents de treball de la XREAP, No. 14/2011, <http://dx.doi.org/10.2139/ssrn.1948755>
- Juselius, K.** (2006), *The Cointegrated VAR Model*. Oxford, New York: Oxford University Press.
- Kaul, A., Pfeifer, G., Witte, S.** (2012), "The Incidence of Cash for Clunkers: An Analysis of the 2009 Car Scrappage Scheme in Germany." University of Zurich, ECON - Working Papers, Working Paper No. 68, <http://dx.doi.org/10.2139/ssrn.2034394>
- Li, S., Linn, J., Spiller, E.** (2010), "Evaluating "Cash-for-Clunkers": Program Effects on Auto Sales and the Environment." Resources for the Future Discussion Paper No. 39.
- Loschky, A., Ritter, L.** (2006), "Import Content of Exports." Paper presented at the 7th OECD International Trade Statistics Expert Meeting.
- Lütkepohl, H.** (2005), *New Introduction to Multiple Time Series Analysis*. Berlin: Springer.
- Mian, A., Sufi, A.** (2012), "The Effects of Fiscal Stimulus: Evidence from the 2009 Cash for Clunkers Program." *The Quarterly Journal of Economics*, Vol. 127, No. 3, pp. 1107–1142, <http://dx.doi.org/10.1093/qje/qjs024>
- Ng, S., Perron, P.** (2001), "Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power." *Econometrica*, Vol. 69, No. 6, pp. 1519–1554, <http://dx.doi.org/10.1111/1468-0262.00256>
- OECD** (2009), *OECD Economic Outlook*. Organization for Economic Cooperation and Development, November 2009, Vol. 86.
- Romano, A. A., Scandurra, G.** (2012), "The Effectiveness of Car Scrapping Schemes in the Italian Market." *Metodološki zvezki*, Vol. 9, No. 2, pp. 175–190.
- Škoda Auto** (2010), *Škoda Auto Annual Report 2009*.
- Van Wee, B., Moll, H. C., Dirks, J.** (2000), "Environmental Impact of Scrapping Old Cars." *Transportation Research Part D: Transport and Environment*, Vol. 5, No. 2, pp. 137–143, [http://dx.doi.org/10.1016/S1361-9209\(99\)00030-9](http://dx.doi.org/10.1016/S1361-9209(99)00030-9)