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Effectiveness of car scrappage schemes: Comparative analysis of European countries

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EFFECTIVENESS OF CAR SCRAPPAGE SCHEMES: COMPARATIVE ANALYSIS OF EUROPEAN COUNTRIES

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IES Working Paper 28/2023

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Effectiveness of Car Scrappage Schemes: Comparative Analysis of European Countries

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Abstract:

This study aims to investigate the effectiveness of car scrappage schemes implemented in the European Union (EU) during the economic crisis of 2009. The study uses a synthetic control variable and a difference-in-differences method to evaluate these policies. Using monthly data on new passenger car registrations in European countries, the study examines the impact of the schemes. The results show that the impact of scrappage schemes varies across countries, with statistically significant effects observed in Germany and Slovakia, followed by Greece and Italy, albeit limited in some aspects. The results of the study underline the need for careful policy design and show that the effectiveness of car scrappage schemes goes beyond the level of premiums or budget allocations. It is also influenced by other elements such as the duration of the scheme, the overarching policy environment and the novelty of the implementation strategies.

JEL: H23, C21, R48

Keywords: car scrappage schemes, synthetic control method, difference-in-differences

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1. Introduction

Car scrappage schemes have been implemented in the past in several countries, including the largest economies such as Germany, France, Italy, the United Kingdom, the United States or Japan, as a means of stimulating new car sales, supporting socio-economic development and promoting environmental sustainability. The basic premise of a scrappage scheme is that individuals are given a financial incentive to scrap their old, less fuel-efficient vehicles and buy new, more fuel-efficient and environmentally friendly ones. The government often contributes to this incentive with some form of fiscal subsidy.

In times of economic recession, scrappage schemes have been used as a means of stimulating demand in the automotive industry, which is an important industrial sector in many economies. During the economic depression of 2008–2009, 14 European countries implemented scrappage schemes and there may be a growing expectation that the current situation could lead to similar government support. The combination of the effects of the COVID-19 pandemic, the energy crisis, the need to meet strategic European environmental targets (in particular the Green Deal and Fit for 55) and the shortage of components in the automotive industry make the prospect of new government subsidies or incentives in the coming years even more likely.

While scrappage schemes have been successful in stimulating new car sales and promoting environmental sustainability, they have also been the subject of criticism. Some argue that they simply encourage people to buy new cars when their old ones are still perfectly serviceable, leading to unnecessary waste. Others argue that the government subsidy could be better spent on other environmental initiatives.

The implementation and effectiveness of car scrappage schemes continues to provide a unique opportunity for in-depth economic research. Despite existing studies on this topic, most of them have focused on individual countries or a selected group of them, limiting the overall understanding of the impact of these schemes across the EU. Against this background, this study fills a significant gap in the literature by providing a comprehensive analysis of all EU countries that have implemented car scrappage schemes. A distinguishing feature of our study is the careful identification of the periods during which these schemes were active, the different forms they took and the budgets allocated to them.

In addition, this research introduces an extended approach to analysis in this area by combining the synthetic control variable with the difference-in-differences method. This combination of analytical methods, rarely used together in previous studies, adds robustness to our findings and enhances the nuanced understanding of the effects of the schemes.

2. Rationale behind scrappage schemes

The objectives of scrappage schemes can be multifaceted, with governments seeking to achieve a range of economic and environmental objectives through their implementation. However, the success of these schemes can depend on a number of factors, including their

design, implementation and the wider economic and political context in which they are implemented. Similarly, communication by national institutions to the public about the primary objectives and presumed benefits of these schemes has varied (Aldred & Tepe, 2011).

Stimulation of demand for new vehicles

Previous research suggests that the impact of car scrappage schemes on the automotive industry varies, depending on the specific scheme and the country. Cantos-Sánchez et al. (2018) found that Spain's 2009 car scrappage scheme increased the likelihood of purchasing a new car, but reduced the average expenditure on the new vehicle. Moreover, the scheme had a neutral effect on household welfare. Marin & Zoboli (2020) and Romano & Scandurra (2012) found that the Italian car scrappage scheme of 2009 was very successful in promoting the replacement of older cars. Böckers, Heimeshoff & Müller (2012) also confirmed that the German scheme was successful in creating additional demand for new cars during the policy period (especially for two specific market segments).

Grigolon et al. (2016), who analysed eight European countries, found that scrappage schemes played a significant role in stabilising total car sales in 2009. These schemes helped to prevent a 30.5% decline in total car sales in countries with schemes specifically targeting low emission vehicles, and a 29.0% decline in countries with non-targeted schemes. The results of Lüth (2021) show that while the removal of subsidies led to a shift in consumer behaviour over time, the overall impact on car registrations remained positive in all OECD countries studied, except for the UK, where any increase in sales was completely offset by a subsequent decline in consumer enthusiasm.

However, this fiscal stimulus also affected the pricing mechanisms in the car market. Kaul, Pfeifer & Witte (2016), who evaluated the scrappage scheme in Germany, found that the average prices of vehicles actually fell for buyers who received subsidies compared to those who did not, suggesting that subsidised customers ended up benefiting by more than the amount of the subsidy. But for more expensive cars, subsidised buyers received large additional discounts on top of the government premium. On the other hand, Jiménez, Perdiguero & García (2016) found that manufacturers increased vehicle prices by an average of €600 in Spain.

Environmental impacts

Similarly, there is considerable disagreement as to whether scrappage schemes have made a significant contribution to reducing emissions. A comprehensive literature review by Van Wee, De Jong & Nijland (2011) concludes that the indirect impact on the used car market, the impact on car use and emissions from use, and life cycle emissions have not been sufficiently taken into account. The impact on emissions is small and temporary. The cost-effectiveness of scrappage schemes is often unsatisfactory, while the most favourable cost-effectiveness results are observed in densely populated urban areas and only when cars without emission control technologies are scrapped.

A similar conclusion was reached by Lelli et al. (2010), who mentioned that the evolution of CO2 emissions over the whole vehicle life cycle is neutral with respect to the acceleration of car replacement stimulated by scrappage schemes, as well as Brand (2013), who found that scrappage schemes save little CO2 and may even increase emissions on a life-cycle basis.

On the other hand, scrappage schemes had notable environmental benefits in terms of increased fuel economy, as eligible cars generally had better fuel efficiency (Grigolon et al., 2016). A study on the environmental and safety impacts of scrappage schemes in France, Germany and the United States found that fleet renewal initiatives can reduce CO2 emissions and air pollution and improve road safety. However, the benefits are not sufficient to compensate for the value of the scrapped vehicles (given that these vehicles could still be used reliably for some time). In some cases, net losses have been substantial (Fraga, 2011).

Thus, in the light of the above, the relative incremental environmental benefit of the car scrappage scheme is relatively small compared to the total cost of the fiscal intervention. The potential reduction in CO2 emissions achieved by the schemes could be much higher if the replacement of old vehicles were restricted to hybrid cars in particular (Kagawa et al., 2023).

Table 1: Summary of key potential benefits and negatives of car scrappage schemes

KEY POTENTIAL BENEFITS	KEY POTENTIAL NEGATIVES
Stimulating demand: Scrappage schemes can support demand for new cars, which can be particularly valuable during periods of economic uncertainty or recession when the level of consumer spending is lower.	High fiscal cost: Scrappage schemes can be expensive to implement, especially if they involve significant subsidies or incentives to consumers.
Supporting the automotive industry and its supply chain: By supporting the automotive industry and its supply chain, scrappage schemes can help to protect jobs and maintain employment levels during an economic downturn.	Distorting the market: Scrappage schemes can distort the market for new cars by encouraging consumers to buy certain models or brands, which may not be the most efficient or cost-effective options. Scrappage schemes may also favour certain manufacturers over others.
Reducing emissions: Scrappage schemes can help remove old, polluting cars from the road, reducing emissions of pollutants that can harm human health and contribute to climate change. Newly purchased cars are also more fuel efficient.	Limited environmental benefits: While scrappage schemes can help reduce pollutant emissions, the overall environmental benefits may be limited. There is a need to focus on promoting and stimulating demand, especially for very low emission vehicles (hybrid or electric cars).
Promoting technological innovation: Scrappage schemes can encourage the uptake of newer, cleaner technologies, such as electric and hybrid vehicles, which can support wider environmental objectives and stimulate technological innovation.	Short-term effects: Scrappage schemes may provide a short-term boost to the automotive industry and the economy as a whole, but their effects may not be sustainable in the long run or may be offset by the strategic behaviour of participants.

Source: Own creation.

3. Descriptive analysis of European scrappage schemes

In the European Union, a total of 14 countries introduced some form of scrappage scheme during the economic crisis around 2009: Austria, Cyprus, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Romania, Slovakia, Spain, and the United Kingdom.

Already at the beginning of 2010, European scrappage schemes were described by Buttigieg et al. (2010b). However, their report only covered developments up to the beginning of 2010; it did not cover subsequent developments in the countries that continued the scrappage scheme (France, Luxembourg, Portugal, Romania and Spain), nor could it cover the development of the scrappage scheme in Ireland, which only introduced it in 2010. Their report also often had to rely on preliminary data or did not yet have it available (this often refers to the number of cars scrapped under the scheme). Since then, no one has described and analysed all European scrappage schemes; only partial studies focusing on selected countries have been produced.

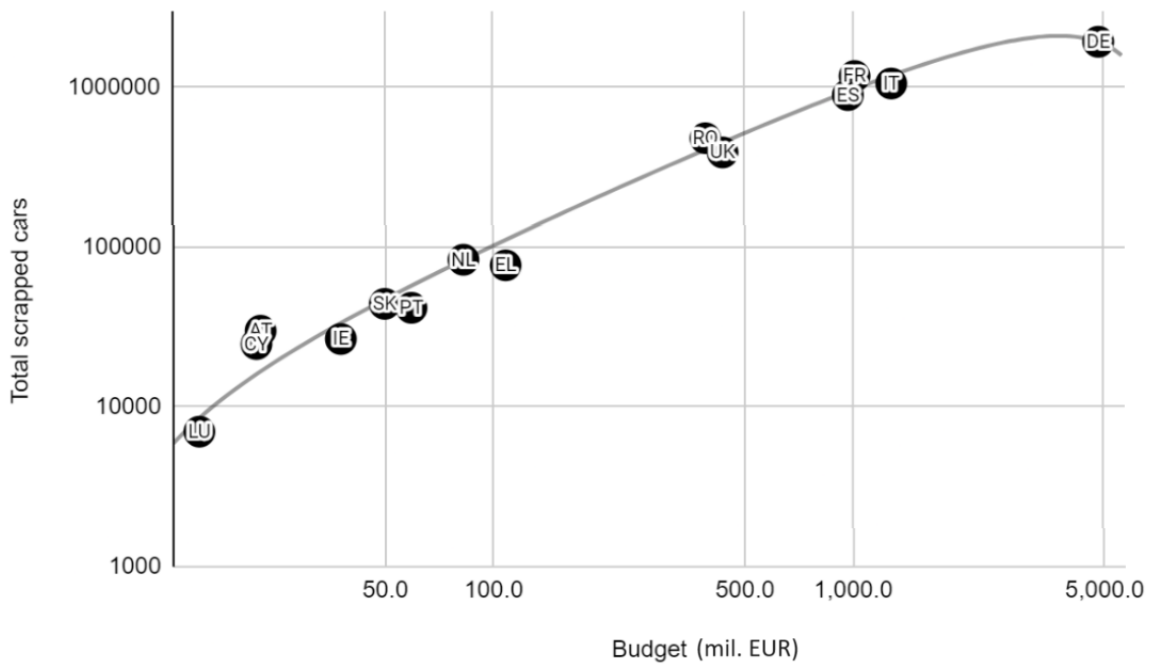
For the purpose of our research, we have chosen the 2005-2013. However, even drawing comparison for this extended period is not without complications, as different countries' scrappage schemes differ significantly in length, eligibility requirements and magnitude of financial incentives and their accessibility. Annex 1 and Tables 4-6 outline in greater detail the data sources for each of our observed countries, and the specifics of their respective scrappage schemes in terms of:

- Length of their scrappage schemes
- Their focus on support for scrapping old cars or support for buying new cars
- Their requirements for scrapped and purchased cars
- Financial incentives for their scrappage schemes

Despite the diversity of the scrappage schemes across the observed countries, it is possible to compare at least what they all had in common, namely the scrapping of old cars and the corresponding costs for public budgets. To our knowledge, no one has yet made such a comparison. The likely reason is that information on the final uptake of the scrappage scheme and the final number of vehicles supported is not a common part of statistical outputs. This section includes a brief visual representation of selected aspects and their interpretation.

First of all, the number of scrapped cars can be expected to be related to the size of the budget. This is illustrated in the following graph. Given the large variance of budgets, it is appropriate to use a logarithmic transformation of the two axes to make the relationship between the two variables more visible.

Figure 1: Comparison of the total number of scrapped cars and the total budget of the scheme



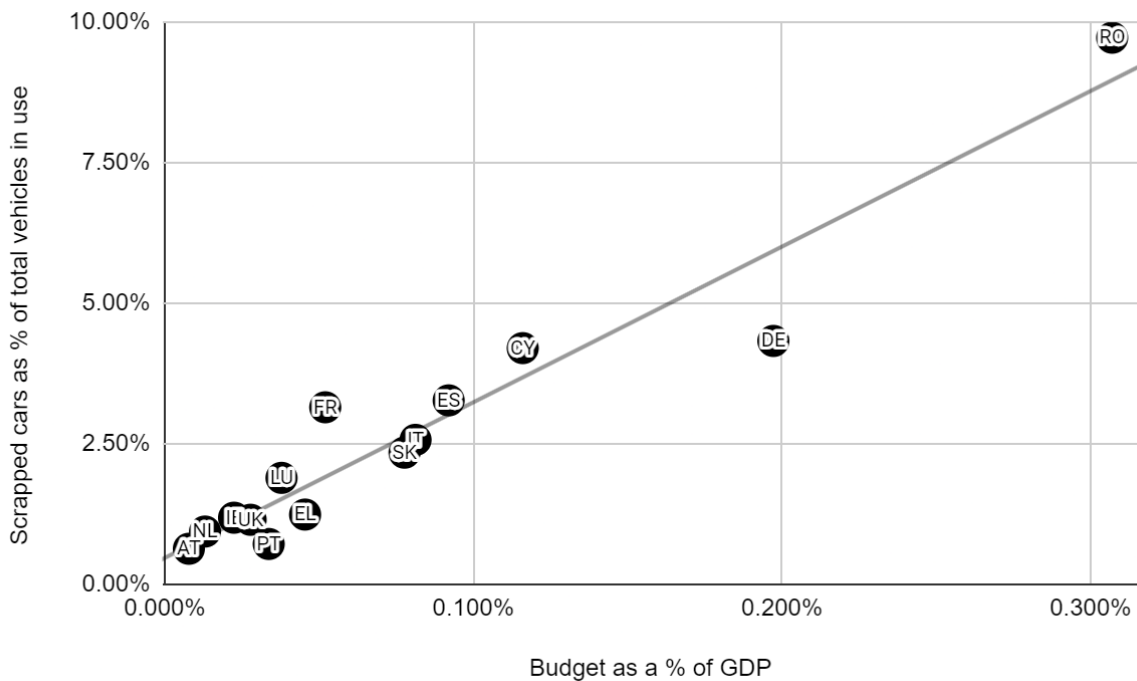
Source: Own creation.

Attention is immediately drawn to the remote observation that Germany represents. It spent four times (!) more on the scrapping scheme than Italy, the country with the second largest scheme, while its scheme lasted a third less time. In fact, Germany spent more on the scrapping scheme than all other countries combined.

Unsurprisingly, there seems to be a correlation between the amount of funds spent and the number of cars scrapped under the scrapping scheme. The distribution of countries in the graph is probably best described by a polynomial trend. This suggests that less budget-intensive schemes tend to be more efficient.

The size of the budget of a scrapping scheme, however, may be related to the size of the market. It is therefore useful to put the budget of the scheme in the context of the GDP of the country, and similarly the number of scrapped cars in the context of the total fleet of the country. A comparison between countries can be seen in the following chart.

Figure 2: Comparison of the share of end-of-life vehicles in the total fleet and the share of the scheme budget in GDP



Source: Own creation.

The outlying position on the top right of this chart no longer belongs to Germany. It is Romania, which ran a scrappage scheme throughout the whole period 2005–2013 and no sub-periods significantly related to the crisis years. (This is different from France, Italy, Portugal and Spain, which had a longer scrappage scheme, but we only include the period related to the economic crisis in our analysis.)

This chart can serve as a rough comparison of the effectiveness of the scrappage scheme. For example, Germany’s fleet renewal rate was only slightly higher than Cyprus (4.33% compared to 4.19%), but the budget spent as a proportion of GDP was 1.7 higher. Spain and France are a similar case: the fleet renewal rate in Spain is higher by 4%, but the budget spent as a share of GDP is higher by 77%.

The trend line shown will also help interpretation. Simply put, countries above the trend line have been able to renew their fleets at a lower than average cost.

4. Quantitative analysis

4.1 Research objectives

By conducting a comprehensive analysis across all EU countries that implemented car scrappage schemes, this study is extending previous research, which primarily focused on

individual or select countries. The following aspects are considered to be the main contributions of this research:

- Authors specifically delved into the periods these policies were enacted and their variations. At the same time, authors distinguish between the anticipation, treatment and pull-forward periods in deep detail for each country.
- Furthermore, authors innovatively combined the synthetic control method and the difference-in-differences method, providing robust analytical frameworks that enhance the accuracy of attained findings.

In the context of the above mentioned, our main research question was the following: did scrappage schemes affect the number of new registrations in individual European countries?

We assume that there have been certain changes in the number of registered vehicles as a result of the introduction of the scrappage scheme. To identify the size of this effect in each country, we simulate the synthetic control variable (including a specific combination of countries where scrappage schemes have not been implemented) and compare the development of the number of passenger car registrations through difference-in-differences method (these methods are explained in more detail in the following section).

In addition, we extend previous research by carefully identifying periods when subsidy support was active (specific years and months) and also identify periods prior to implementation when, for example, governments sent out messages to society that scrappage would be introduced. Even these announcements may have influenced the evolution of demand for new vehicles. Similarly, we expect that during the post-scrappage period demand may have changed.

4.2 Data overview

European countries

Due to insufficient frequency of data on newly registered cars from national statistical offices and other relevant institutions, and therefore problematic comparability, as the most suitable dataset for the analysis of the scrappage scheme in a whole European context were chosen the data on the number of newly registered cars on a monthly basis provided by the European Automobile Manufacturers' Association (ACEA). While these data do not offer a more detailed insight into the brands and types of vehicles, they do, on the other hand, offer the possibility of comparing the development of new car registrations in all European countries. Moreover, this time series is available for the period of 1990–2021.

Input data for the synthetic control variable

As an input to the basic difference-in-difference model for the different European countries, we use a synthetic control variable. For this purpose, we use the same data as Lüth (2021), but for an extended number of countries. The advantage of this approach is a more direct comparability with previous research and with the OECD countries analysed by Lüth.

In order to obtain a more robust control for the countries in our dataset, a set of covariates is obtained that includes GDP per capita (PPP, quarterly, seasonally adjusted), unemployment rate (monthly), 3-month short-term interest rate (monthly), industrial production index (monthly, seasonally adjusted, with 2015 as base year), consumer price index (monthly, base year 2015), all obtained from the OECD Main Economic Indicators database. In addition, following Lüth (2021), we also include the World Bank's CO2 per capita measure (annual) from the World Development Indicators database. Data with a frequency lower than monthly are linearly imputed for our purposes.

These six indicators are intended to broadly capture each country's current economic situation and prospects, as well as the level of commitment to environmental protection, all of which are expected to influence the volume of car registrations and scrapping rates.

4.3 Data processing

Method used

The two most commonly used methods for policy impact analysis are the difference-in-differences method and the more recent synthetic control method developed by Abadie, Diamond and Hainmueller (2010). The basic idea behind the latter is to construct a synthetic control variable that is as close as possible to the treated variable of interest outside the treatment period by assigning weights to observations from a pool of untreated units (in our case, countries without a scrapping scheme), and then to observe whether or not the treated and constructed synthetic variables continue to converge during the treatment.

In analysing the impact of scrapping schemes across European countries, we combine both methods, resulting in a model that benefits from both the analytical simplicity and clarity of the difference-in-differences approach and the data-driven approach of the synthetic control method. Thus, we obtain the inferential result of a difference-in-differences model with multiple treatment periods, while avoiding one of the major methodological weaknesses of the common trend assumption by using the constructed synthetic controls for each treated country as input.

In practice, this means that we do not select a specific control group for each country (e.g. the Czech Republic as a control for Slovakia), but rather a statistically rigorous weighted average of countries without scrapping policies, obtained using the synthetic control method, whose development prior to the treatment period is closer to the treated country than any other individual country. It also allows us to take into account various socio-economic factors in the construction of the synthetic variable itself.

The synthetic control method used here works as follows. Take a sample of $J + 1$ countries. For simplicity, only the first country ($j=1$) introduces a scrapping policy, while the remaining countries remain as controls. The synthetic control variable for the country in question is calculated as a weighted average of all units $j=2, \dots, J+1$. T indicates the number of time periods.

If we denote the registrations of country j without a scrapping policy in period t as Y_{jt}^N and Y_{jt}^I as the outcome affected by the introduction of the scrapping policy in country j in period t , the impact of the treatment intervention in the period after the introduction of the scrapping policy can be expressed as (since these two outcomes should be the same in the period before the intervention):

$$v_{jt} = Y_{jt}^I - Y_{jt}^N$$

Our main goal is to identify the most fitting weighted average of countries without the scrapping policy to create the synthetic control variables. Following Abadie and Gardeazabal (2003), we defined the required weights as $w = \{w_2, w_3, \dots, w_{j+1}\}$, while:

$$\sum_{j=2}^{J+1} w_j = 1$$

where $j = 2, \dots, J + 1$. Therefore, the estimators of v_{jt} and Y_{jt}^N can be denoted as:

$$\hat{v}_{jt} = Y_{jt}^I - \hat{Y}_{jt}^N$$

$$\hat{Y}_{jt}^N = w_2 Y_{2t} + \dots + w_{j+1} Y_{j+1,t}$$

The weights w_2, \dots, w_{j+1} , we choose so that to minimise:

$$v_1(X_{11} - w_2 X_{12} - \dots - w_{j+1} X_{1,j+1})^2 + \dots + v_k(X_{k1} - w_2 X_{k2} - \dots - w_{j+1} X_{k,j+1})^2$$

We opt for the cross-validation technique as in Opatrný (2021), leading us to find weights that would minimise the prediction error. These are obtained by the minimization of the root mean square predicted error (RMSPE):

$$RMSPE = \left(\frac{1}{T_0} \sum_{t=1}^{T_0} \left(Y_{1t} - \sum_{j=2}^{J+1} w_j * Y_{jt} \right)^2 \right)^{\frac{1}{2}}$$

In order to obtain good results, this method requires several conditions to be met. Apart from the need for a balanced panel, countries with similar treatment should not be included in the data to avoid biased results. Similarly, the countries that serve as the control pool should have some similarity in performance with the treatment unit to obtain a good fit. It should also be taken into account that the control countries could also be affected by the scrapping policy in a neighbouring country, if many people buy or sell cars across borders and the policy allows this.

In the table in Annex 2, we therefore test the robustness of the synthetic variables for each country by looking at the weights assigned to each control country within the pool of controls. If a country is overwhelmingly represented by only one country, the results will be less robust.

We then construct a difference-in-differences model with multiple treatment periods, using the synthetic controls as inputs, to assess the effect of the scrapping policy, taking into account the anticipation period and the pull-forward period.

Using the OLS method for each of the countries $i \in \{1, \dots, N\}$ with a scrappage scheme, we run the following model:

$$Y_{it} = \beta_0 + \beta_1 * country_i + \beta_2 * P1_{it} + \beta_3 * P2_{it} + \beta_4 * P3_{it} + \delta_1 * DID1_{it} + \delta_2 * DID2_{it} + \delta_3 * DID3_{it} + \varepsilon_{it},$$

with a set of dummy variables, where $country_i = 1$ for the treated country i , and is zero otherwise, $P1_{it}$ is the indication that the current period t is the anticipation period for country i , $P2_{it}$ similarly denotes the treatment period and $P3_{it}$ the pull-forward period. $DID1_{it}$, $DID2_{it}$ and $DID3_{it}$ are the difference-in-differences covariates of interest between $country_i$ and $P1_{it}$, $P2_{it}$ and $P3_{it}$ respectively. Y_{it} are the new registrations in country i in period t .

Treatment periods

As mentioned above, one of the original benefits of this paper is the inclusion of both anticipation and pull-forward periods in the model, and their identification for each country separately.

Therefore, for the purpose of statistical analysis, the time-series data were divided into five periods:

- A. The period during which the public did not yet expect the introduction of a scrappage scheme and therefore their investment and consumption behaviour was not influenced by this policy.
- B. The anticipation period, during which the public expected the imminent introduction of a scrappage scheme and could adjust their behaviour accordingly, in particular by delaying the scrapping of old vehicles and buying new ones.
- C. The treatment period, during which the scrappage premium was applied and citizens registered new vehicles purchased under this policy.
- D. The pull-forward period during which some citizens would have purchased a new car under otherwise identical circumstances, but the scrapping premium actually accelerated the purchase.
- E. The period in which the effect of the scrapping premium was exhausted and no longer influenced behaviour.

The duration of each period was not evident beforehand and required interpretation of the available data. We proceeded as follows:

Anticipation period: It can be assumed that this period started at the latest when the local government announced the introduction of the scrappage scheme (or in the month following the announcement) and lasted until the start of the treatment period. However, it can also be assumed that the public expected the scrappage scheme to be introduced earlier, given the public debate that preceded the approval and implementation of the scrappage scheme. This public discussion was in some cases very short (such as in Slovakia, where it lasted less than a month), but in others lasted several months (especially in countries that were among the first to introduce a scrappage scheme). To do this, we used Google Trends to analyse the intensity of searches for the scrappage topics and for the term “scrappage” in the local language. In the end, we determined the start of the anticipation period based on the first method (the date of the policy announcement) and adjusted it only if Google Trends showed significant activity earlier.

Treatment period: In most cases, of course, the start of this period was determined by the official start of the scrappage scheme in the country concerned. However, in some cases it is reasonable to assume that the treatment effect will not be seen until the following month (typically when the initiative started in the middle of the month, as in Germany; it took some time to fulfil all the conditions and register a new car). Setting the end of the period was even less obvious. Governments usually decided that the scrappage scheme would end either on a specific date or when the funds were exhausted. (For example, in Austria, the scrappage scheme was potentially valid from April 2009 until December 2009, but the funds were exhausted in July 2009). The allocation of funds was linked to the date of purchase of a new car, not to its delivery. In some countries (e.g. Slovakia), a delay of several months was reported in the delivery of the most popular brands and models under the scrappage scheme. As our data are linked to the date of registration of a new car and not to the date of sale, it was necessary to determine the end of the treatment period accordingly. We did this by first setting the end of the period at the official planned end of the period and then shortening this end if there was a decline in new registrations before then (i.e. it was clear that the scrappage effect had already worn off).

Pull-forward period: Unlike the previous periods, this period cannot be determined on the basis of official announcements. One option would have been to determine the length of this period individually for each country, based on how long a decline in new registrations (compared to the synthetic reference variable) was observed. However, this method would not be correct as it would not lead to an unbiased measurement of the effect; rather it would mean selecting data to maximise the effect. We therefore decided, on the one hand, to base the length of this period on what the data indicated, but, on the other hand, to fix this length for all countries. We reasoned that the time horizon over which consumers are willing to consider accelerating the purchase of a new car is not significantly related to cultural differences or a country’s GDP. In the end, we decided to set this period at two months.

Table 6 gives an overview of the length of the anticipation, treatment and pull-forward periods for each country, together with an explanation.

4.4 Results

In this section we present the results of the statistical analysis using the above defined data and methods. These results are further elaborated also in the Discussion section below.

The following table shows the results of the difference-in-differences analysis, where we compared the evolution of new car registrations in a given country with the synthetic variable, using indexed values for new registrations with January 2005 as the base month for easier comparability. The abbreviation DID1 refers to the difference-in-differences calculations for the anticipation period (pre-policy), DID2 for the treatment period (policy) and DID3 for the pull-forward period (post-policy) defined for each country in the previous section.⁴

No statistical significance was found for the anticipation period (pre-policy) and for the pull-forward period (post-policy) in any of the countries analysed. However, the treatment period (policy) proved to be statistically significant for several countries, including Austria, Germany, Greece, Italy, Luxembourg, Slovakia, while on the borderline of acceptable significance are Portugal and Spain. In other words, in all these countries the introduction of the scrapping premium had a positive effect on the number of new car registrations compared to countries where the scrapping premium was not introduced. On the other hand, in France, Ireland, the Netherlands and the United Kingdom, no statistical significance was found during the treatment period.

It is also notable that in many cases the coefficients for the anticipation period (pre-policy) and the pull-forward period (post-policy) are negative, implying that in these periods the number of new car registrations was on the contrary negatively influenced by the scrappage scheme. However, the differences did not prove to be statistically significant.

⁴ Notice: Unfortunately, for Cyprus and Romania it has not yet been possible to obtain all the data needed to construct the synthetic variable (or standardised data of the same scope and quality as for the other countries). For this reason, these two countries have not been included in the model. The following analysis and conclusions are therefore limited to the other twelve countries.

Table 2: Comparison of the number of new car registrations across selected European countries (country comparison with the synthetic variable, difference-in-differences)

	Intercept (SD) (t-value)	Pre-Policy (SD) (t-value)	Policy (SD) (t-value)	Post-Policy (SD) (t-value)	Country Variable (SD) (t-value)	DID1 Pre-Policy (SD) (t-value)	DID2 Policy (SD) (t-value)	DID3 Post-Policy (SD) (t-value)	R2	Adj-R2
Austria	114.19 1.76 64.91***	-15.83 12.32 -1.29	-16.178 6.34 -2.55*	-10.94 12.31 -0.89	-1.76 2.49 -0.70	0.10 17.40 0.01	28.73 8.97 3.20**	-15.46 17.40 -0.89	0.08	0.0532
France	109.71 1.86 58.83***	0.02 16.89 0.00	4.77 3.90 1.22*	0.86 12.01 0.07	-7.91 2.64 -2.99**	-8.18 23.88 -0.34	9.05 5.52 1.64	16.13 16.99 -0.95	0.10	0.0653
Germany	131.68 2.02 65.17***	-19.48 13.99 -1.39	-18.56 6.52 -2.84**	-22.62 14 -1.62	-0.19 2.87 -0.10	2.679 19.80 0.14	49.98 9.03 5.54***	-9.90 19.80 -0.50	0.19	0.1623
Greece	66.95 2.31 28.98***	-12.52 13.40 -0.93	-21.72 10.49 -2.07*	-26.81 16.34 -1.64	-19.48 3.27 -5.96***	6.50 19.00 0.34	51.61 14.80 3.48***	13.44 23.10 0.58	0.18	0.1514
Ireland	75.89 2.80 27.15***	-45.42 26.23 -1.73*	-14.24 6.75 -2.11*	-25.48 18.65 -1.37	-48.76 3.95 -12.33***	19.09 37.09 0.52	11.10 9.55 1.16	7.90 26.37 0.30	0.47	0.4501
Italy	89.28 1.94 46.07***	-17.21 18.59 -0.93	-15.52 5.31 -2.93**	5.07 13.22 0.38	-14.24 2.74 -5.19***	16.06 26.30 0.61	29.39 7.51 3.92***	-4.19 18.70 -0.22	0.14	0.1091
Lux.	119.39 2.26 52.88***	-35.58 21.06 -1.69*	-17.76 5.31 -3.35*	0.07 14.98 0.01	-9.96 3.19 -3.12**	-1.06 29.80 -0.00	21.25 7.51 2.83**	-32.58 21.20 -1.54	0.12	0.0881
Netherlands	77.09 1.74 44.32***	-13.27 11.99 -1.11	-14.34 5.35 -2.68	8.10 11.99 0.67	-19.99 2.46 -8.13***	-0.74 17.00 -0.00	6.46 7.56 0.85	-3.46 17.00 -0.20	0.29	0.2656
Portugal	101.45 2.37 42.75***	-20.21 22.51 -0.90	1.37 5.93 0.23	-0.54 22.51 -0.02	-17.75 3.36 -5.29***	40.30 31.80 1.27	19.68 8.38 2.36*	-3.15 31.80 -0.10	0.15	0.1196
Slovakia	129.99 2.28 57.09***	-6.51 22.67 -0.29	3.53 8.82 0.40	3.77 16.10 0.23	7.75 3.22 2.41*	-45.65 32.00 -1.40	66.68 12.50 5.35***	-36.49 22.80 -1.60	0.3	0.2737
Spain	87.52 5.50 15.90***	5.26 21.67 0.24	6.55 6.51 1.01	11.56 15.81 0.73	-18.62 7.79 -2.39*	5.22 30.65 0.17	22.52 9.20 2.45*	2.99 22.36 0.13	0.10	0.0661
UK	109.74 4.297 25.54***	-24.52 41.88 -0.56	-21.39 13.28 -1.61	-3.24 29.77 -0.11	-9.09 6.08 -1.50	-3.58 59.23 -0.06	20.56 18.78 1.10	-14.23 42.10 -0.34	0.02	0.008

Significance codes: 0 ***; 0.001 **; 0.01 *

We further verified the results through f-tests for joint significance of the difference-in-differences variables for all analysed periods in each country. In this case, France, Ireland, Netherlands and the United Kingdom appeared to be statistically insignificant. The strongest statistically significant differences were again found especially in Germany and Slovakia, followed by Greece and Italy.

This means that in the case of the former countries, the overall effect of the scrapping policy was not found significant – even if the treatment period itself was, it was offset by the

opposite effect of the anticipation and pull-forward periods. On the other hand, in the latter countries, we find evidence that the overall effect of the policy was non-zero, meaning that for example in Slovakia, even accounting for the anticipation and pull-forward periods, we observe a positive total impact of the policy on new registrations.

Table 3: F-test for joint significance of DID1, DID2, DID3

	F-statistic	P-value
Austria	3.7652	0.0116*
France	1.1908	0.3143
Germany	10.4150	0.0001***
Greece	4.1262	0.0072**
Ireland	0.5381	0.6567
Italy	5.2451	0.0017**
Lux.	3.6685	0.0132*
Netherlands	0.4265	0.8503
Portugal	2.3065	0.0777*
Slovakia	11.3970	0.0001***
Spain	2.1624	0.0936*
UK	0.4533	0.7152

Significance codes: 0 ***; 0.001 **; 0.01 *

Figure 3 in Annex 3 is a graphical representation of our analysed data. The curve in each of the graphs expresses the relative difference in the number of new passenger car registrations in a given country on the one hand, and within the synthetic variable (the simulation of comparable country) on the other hand. Dashed vertical lines are indicating the treatment (policy) periods (in the case of Greece and Spain, there are more than one treatment periods involved in the analysis).

5. Discussion

The number of passenger cars in the EU has increased from 203 million in 2006 to over 253 million in 2021, but the composition of the fleet has changed considerably due to slower renewal rates of passenger cars. This might have negative implications for the environment and public health as older vehicles tend to be less fuel-efficient and emit more pollutants than newer ones. However, the increasing share of electric and hybrid vehicles in the fleet, as well as the declining share of diesel vehicles, may offset these negative effects. The average CO2 emissions of new passenger cars fell by almost 33% between 2006 and 2021, but achieving the proposed goal of zero emissions for all new cars in the future will require sustained reductions in emissions in the years to come.

Moreover, the number of end-of-life vehicles in the EU has fluctuated over the period of 2006–2020, with a peak of 7.7 million vehicles reported in 2009 due to the governments' scrapping incentives during the financial crisis. It is therefore appropriate to ask whether these facts, together with European green initiatives, will lead again to re-consideration of the scrappage schemes or similar schemes.

To add new contributions to the debate, we focused on two key aspects within this research – a thorough descriptive analysis of all available information relating to scrappage in all European countries combined with the statistical analysis. While previous analyses by other authors have focused on the number of new registrations, this paper also examines the effect on monthly scrappage rates. This is a complementary approach to confirm the extent to which the scrappage scheme has had an impact on fleet renewal.

One reason for the difficulty to isolate the effect of the scrappage scheme with sufficient reliability seems to be the effect of seasonality. When constructing a synthetic variable, the effect of seasonality should be attenuated if the countries being compared are subject to similar seasonal fluctuations. For this reason, we did not seasonally adjust the data. However, it turned out that this did not completely remove the effect of seasonality. For example, in the case of Ireland or the United Kingdom, Figure 3 in Annex 3 clearly shows recurrent fluctuations in the number of new registrations (or fluctuations in the difference from the number of new registrations for the synthetic variable). Their magnitude is much larger than the possible effect of the scrappage scheme and therefore does not allow its reliable identification.

Another reason why it is difficult to identify the impact of scrappage schemes is the way in which they were introduced. Only a few countries have introduced scrappage schemes on a one-off basis and for a short period of time. Measuring the impact of the scheme is then methodologically relatively straightforward. This is the case in Germany and Slovakia, where the results were significant. The challenge comes from countries that have implemented a series of scrappage schemes with different durations, different eligibility conditions and different levels of financial incentives. An example is France, where a scrappage scheme (under a different name) was in operation both before and after the period considered, differing essentially only in the level of the scrappage premium; moreover, even during the official scrappage scheme, the level of the scrappage premium changed several times. In the current model, we have only used a dummy variable for the whole period of the scrappage scheme in France, but other model settings are worth testing in the future. Other countries where it might be helpful to consider other scrappage schemes are Italy, Portugal, Romania and Spain.

We also paid particular attention to determining the length of the anticipation period and pull-forward period for each country. However, the significance of these periods could not be demonstrated as the respective dummy variables were not significant enough for any of the countries. At least for some countries, the coefficients have the expected (negative) sign. However, this is not the case for all countries. It turns out that the impact of scrappage schemes can only be statistically proven for some countries – significant for Germany and

Slovakia, then Greece and Italy, and not significant for Austria, Luxembourg, Spain and Portugal. For the other countries, the impact of scrappage schemes could not be demonstrated. This was either because the treatment itself did not have a large effect, or because the anticipation and pull-forward periods offset any positive effects of the treatment.

The results of the quantitative analysis of the effectiveness of the car scrappage schemes can be related to the design of the schemes in each country and also to the respective budgets, as discussed in the descriptive analysis. From this point of view, the success of the Slovak car scrappage scheme can be considered to be above average. On the one hand, a net positive effect of the scrapping premium on the number of new registrations has been demonstrated and, on the other hand, the Slovak scheme was very fast (1.17% fleet renewal per month). In addition, the Slovak budget for the car scrappage scheme was not too high (in monthly terms it was in the middle of all countries). However, it should be noted that the monthly budget per GDP was the second highest – higher than in Germany.

Germany is the second country where the impact of the car scrappage scheme was found to be most significant. The descriptive analysis shows that this was achieved at a relatively high cost. The scrappage premium was the highest of all countries (and significantly higher than in most countries), but the rate at which it succeeded in scrapping vehicles was half that of Slovakia. Cyprus, for example, managed to scrap a similar percentage of its fleet as Germany, but in Germany the scrapping premium per GDP per capita was more than twice as high. The efficiency of the resources spent on the German scrappage scheme was therefore lower than in some other countries.

Another question is whether a similar effect can be demonstrated in countries where there was no price cap on new car purchases. Indeed, there is reason to believe that even then consumers tended to prefer cheaper cars. One reason is the proportion of the car scrappage premium in the price of the car – if consumers were concerned with the percentage discount rather than the absolute amount of the discount, the scrappage premium would make cheaper models more attractive. The second reason may be the price elasticity of demand for cars, which is likely to be higher for poorer consumers. This presents a question for further research in this area.

6. Conclusions and future research directions

In assessing the effectiveness of different car scrappage schemes across the EU, this research found no clear correlation between the level of the scrappage premium and the number of cars scrapped. Even after adjusting for factors such as the size of the country, the length of the scheme and the wealth of the country, no clear patterns emerged. However, the data indicate a negative relationship between the duration of the scheme and the scrapping rate, with shorter schemes scrapping cars at a faster rate. It also shows that the size of the budget has an impact on the number of cars scrapped, although schemes with larger budgets may be less efficient.

Country-specific variations were observed within the descriptive analysis, particularly in Greece, Slovakia, Germany, Austria and Portugal. Despite possible data inconsistencies, the Greek scheme appeared to be highly effective in a certain way, probably due to the uncertain duration of the scheme related to impending changes in government. Slovakia achieved impressive results in a relatively short period of time, although its scheme was comparatively average in terms of budget allocation and fleet replacement. Germany, with the highest average scrappage premium and a scheme cost exceeding all other countries combined, was below average in terms of fleet replacement in relation to GDP expenditure. Comparisons with Cyprus, which achieved similar fleet renewal at a much lower cost, suggest that the German scheme may have been more generous than necessary. Austria outperformed Portugal in fleet renewal despite having a lower budget and a shorter duration of the scheme. This discrepancy may be attributed to Austria's time-limited innovative approach, as well as to Portugal's more conventional scheme adaptation.

Given that any scrappage scheme is a burden on public budgets and always has costs in terms of other unrealised projects (whether public or private), our analysis finds no justification for long-lasting and expensive schemes. Comparisons have shown that the effectiveness of scrappage schemes declines over time and that the level of the scrappage premium is not as important as other factors. If the political representation decides to introduce a scrappage scheme, it should be limited to a few months, with a clearly defined target in terms of eligibility for scrappage and eligibility for new cars. The money saved could be used for other projects or to reduce the tax burden.

In any case, our statistical analysis confirms that the existence of scrappage schemes appears to have a significant impact on new passenger car registrations in many countries, such as Germany and Slovakia, then Greece and Italy, and was somewhat significant for Austria, Luxembourg, Spain and Portugal. In other words, the introduction of the scrappage scheme in these countries had a positive effect on the number of new car registrations compared to countries that did not introduce the scheme.

On the other hand, in France, Ireland, the Netherlands and the United Kingdom, the impact of the scrappage scheme could not be demonstrated. The impact of the scrappage scheme was either too small or was cancelled out in the anticipation and pull-forward periods. In some cases, the specific design of the scheme may be to blame – for example, in the Netherlands it was possible to buy used cars more than eight years old. Elsewhere, however, there is no such explanation – in the UK, for example, the design of the scrappage scheme and its budget (as a percentage of GDP per capita) were similar to those in Italy. It is therefore not possible to make a general claim that a scrappage scheme will actually boost new car sales, and caution should be exercised when considering its introduction. It should also not be forgotten that the scrappage scheme may encourage people to buy cheaper cars. This further undermines the potential increase in car sales and therefore reduces the effectiveness of the scrappage scheme in this direction.

Overall, our findings point to the need for careful policy design and suggest that the effectiveness of scrappage schemes is not simply a function of premium levels or budget

allocations, but may be influenced by factors such as scheme duration, policy environment and innovative approaches to implementation. Scrappage is not a policy that can be clearly recommended. On the contrary, its effects have only been partially demonstrated, and if further research were to include other effects (e.g. a fall in the average price of cars, a shift in expenditure from other sectors), the effectiveness of scrapping schemes in terms of social welfare would be even lower. It should be noted that the effects were found to be particularly significant in countries that spent a high percentage of GDP per capita on car scrapping schemes. This raises serious additional doubts not only about the effectiveness but also the efficiency of such a policy measure (compared to other available policies to support economic activity).

The analysis could also extend to issues other than economic efficiency. The emission savings from scrapped cars and newly sold fuel-efficient cars have been examined in other studies. However, monthly data and our chosen methodology would allow a more precise measurement of the environmental effects. It would also be possible to ask questions about the overall environmental impact, i.e. not only focusing on emission savings, but taking into account the whole life cycle of the vehicles (the newly sold vehicles must have been produced and will have to be scrapped one day).

In the future, it would be useful to add other dimensions to the analysis. First, in this analysis we have only examined one type of compensatory behaviour, namely intertemporal substitution. However, the scrapping premium may also crowd out other types of purchases: for example, consumers may have started buying new cars at the expense of used cars or reduced purchases of other goods (presumably durables). The question is therefore whether the scrapping scheme has increased total household spending. Moreover, the average age of deregistered cars in Slovakia fell by almost two years during the two months of the scrapping scheme. This raises the question of whether these cars could have been in good working order for some time, but were taken off the road for the coveted premium.

Yet another question is how the total value of cars sold has changed – it is possible that the net increase in the number of cars sold has been offset by a lower average price. This hypothesis would also be supported by the development of average motor car prices in Slovakia in 2009, which, according to data from the European Central Bank, declined slightly in 2008 (around 1% per month) and then fell by more than 6% month-on-month in March 2009 (the first month of the scrapping scheme). All these questions could become the subject of further research in this area.

Annex 1: Brief description of the scrappage schemes in each country and comparison summary

Austria⁵

Total cost: €22.5 million (0.008 % of GDP)

Time period and eligibility:

- The scheme was designed to run from 1 April 2009 to 31 December 2009 or until the funds were exhausted, which occurred on 8 July 2009. New cars could be registered until 31 December 2009.
- Eligible old cars were passenger cars at least 13 years old. Eligible new cars had to meet the Euro 4 standard.

Incentive value:

- Under the scrappage scheme, each car was given an incentive worth €1,500. The government only contributed €750 towards the incentive, with the remaining €750 (or more) being covered by the automotive industry, including car manufacturers, national sales companies, importers, and dealers.

Cyprus⁶

Total cost:

- €11.4 million in 2008 (0.060 % of GDP)
- €8.5 million in 2009 (0.046 % of GDP)
- €2 million in 2010 (0.010 % of GDP)

Time period and eligibility:

- Several waves of the scrappage scheme have been implemented in Cyprus.
- The first scheme was designed to run from January 2008 to July 2008 in two stages (January–March, May–July). In the first stage, eligible old cars were passenger cars at least 20 years old; in the second stage, they had to be at least 15 years old.
- The second scheme ran from February 2009 until September 2009 when the funds were exhausted. Eligible old cars were passenger cars at least 15 years old.
- The third scheme ran from July 2010 until the end of 2010. Eligible old cars were passenger cars at least 15 years old, including the last 10 years in Cyprus. Eligible new cars had to emit less than 165 g CO₂ per km.

Incentive value:

- The 2008 scheme included four levels of financial support: If the registered old car had paid road tax in the 12 months before scrapping and the owner bought a car with a fuel consumption of up to five litres per 100 km, the allowance was €1,708. If the

⁵ Source: Ökoprämiengesetz (2009), Lampert (2014).

⁶ Source: Leonidou (2008a), Leonidou (2008b), *Ετήσια Έκθεση* (2009), Cyprus Mail (2010), Buttigieg et al. (2010a), *Σχέδιο* (2010).

new car had a consumption of up to seven litres per 100 km, the contribution was €1,281. Those who did not buy a new car had a contribution of €683. Finally, those who did not buy a new car and their registered old car did not have a valid road tax received €256.

- The 2009 scheme had the same conditions.
- In 2010, the allowance was €1,800 and was only for those who bought an eligible new car.

France⁷

Total cost:

- €14 million in 2008 (0.0007 % of GDP)
- €514 million in 2009 (0.026 % of GDP)
- €501 million in 2010 (0.025 % of GDP)

Time period and eligibility:

- Several waves of the scrappage scheme have been implemented in France.
- The first scheme ran from 5 December 2007 to 3 December 2008. Eligible old cars were passenger cars older than 15 years.
- The second scheme ran from 4 December 2008 and was prolonged until 31 December 2010. Eligible old cars were passenger cars older than 10 years. Eligible new cars had to emit less than 160 g CO₂ per km (reduced to 155 g CO₂ per km from 1 January 2010). Light commercial vehicles were also eligible; they were not subject to the emission limit.
- In 2011, France returned to the original scheme (cars older than 15 years), and the emission limit was lowered to 150 g CO₂ per km.

Incentive value:

- At the end of 2007, environmental purchase incentives were introduced, positive for cars emitting less than 131 g CO₂ per km and negative for cars emitting more than 160 g CO₂ per km. The positive incentive started at €200 (below 131 g CO₂ per km) and ended at €5,000 (below 60 g CO₂ per km). Buyers could get an additional bonus of €300 (called a super bonus) if they scrapped an old car older than 15 years.
- A new scheme aimed specifically at scrapping old cars (prime à la casse) was in place from 4 December 2008 until the end of 2010. The amount of the allowance varied over time: €1 000 in 2009, €750 by the end of June 2010, €500 by the end of 2010.
- In 2011, France returned to the original system (super bonus of €300, decreased to €200 in 2012). The eco-bonus-malus system has been in place since then and is still evolving.

⁷ Sources: *La prime à la casse* (2010), *PLR2009* (2010), *PLR2010* (2011), *PLR2011* (2012), *Évaluation* (2013), *Les Comptes* (2009), *PLR2012* (2013), Michel (2014), Buttigieg et al. (2010a).

Germany⁸

Total cost: €4,832 million (0.197 % of GDP)

Time period and eligibility:

- The scheme was designed to run from 14 January 2009 to 31 December 2009 or until the funds were exhausted, which occurred on 2 September 2009.
- Eligible old cars were passenger cars at least 9 years old. Eligible new cars had to meet the Euro 4 standard. Used vehicles less than one year old were also eligible.

Incentive value:

- The scrappage scheme delivered a fixed premium incentive of €2,500 per vehicle.

Greece⁹

Total cost: €108 million¹⁰ (0.045 % of GDP)

Time period and eligibility:

- In 2009, Greece implemented two schemes aimed at promoting new car sales.
- The first scheme ran from early April 2009 to early August 2009. It consisted of halving the registration fee for new or imported cars.
- The second scheme, a scrappage scheme, was introduced on 28 September 2009 and was to last until the end of 2012. However, the newly elected government cancelled it on 2 November 2009 with immediate effect.
- Eligible cars for scrapping were those meeting at most the Euro 3 standard. Eligible new cars were cars meeting the Euro 4 standard.

Incentive value:

- The registration fee reduction scheme applied to the first registration of all new and used cars meeting the latest Euro 4 standard. It should be noted that in Greece, the first registration fee was significantly higher than in the rest of the European Union, ranging from 5% to 50% of the factory price of the car, depending on the engine cubic capacity.
- The scrappage scheme included a triple incentive:
 - 1) The scheme provided financial support for scrapping old cars. The amount of support was graduated according to the cubic capacity (from €500 for an engine up to 900 cc, up to €2,200 for an engine over 2,400 cc).
 - 2) When buying a new car meeting the Euro 4 or 5 standard, aid of €1,000 was granted (€1,500 in case of a light commercial vehicle).
 - 3) Road tolls were to vary according to the Euro standard of the car (from a bonus of €18 for Euro 4 or 5 cars, to a malus of €150 for Euro 0 or 1 cars).

⁸ Source: VDA (2013), *Abschlussbericht* (2010), Buttigieg et al. (2010a).

⁹ Source: TO BHMA (2009b), *Μειώνεται* (2009), ΣΕΑΑ (2009), TO BHMA (2009c), TO BHMA (2009a), Buttigieg et al. (2010a)

¹⁰ Rough estimate based on Buttigieg et al. (2010a).

Ireland¹¹

Total cost: €37.6 million (0.022 % of GDP)

Time period and eligibility:

- The scheme was designed to run from 1 January 2010 to 31 December 2010. In late 2010, it was decided to extend the scheme until 30 June 2011.
- Eligible old cars were passenger cars at least 10 years old, with valid insurance in the last year. Eligible new cars had to emit less than 140 g CO₂ per km.

Incentive value:

- The scheme provided a vehicle registration tax rebate of €1,500. In the extended period (2011), this was lowered to €1,250 but made available to a spouse or a civil partner.

Italy¹²

Total cost: €1,284 million (0.081 % of GDP)

Time period and eligibility:

- There have been several waves of scrappage schemes in Italy, starting as early as 1997.
- Shortly before the economic crisis, a scrappage scheme was in place throughout 2007. Eligible cars for scrapping were those meeting at most the Euro 1 standard; eligible new cars were those meeting the Euro 4 standard and the emission limit of 140 g CO₂ per km.
- The next scheme was in place throughout 2008. Eligible cars for scrapping were those meeting at most the Euro 2 standard and more than 11 years old; eligible new cars were those meeting the Euro 4 standard and the emission limit of 140 g CO₂ per km (petrol), or 130 g CO₂ per km (diesel).
- The third scheme ran from 7 February 2009 to 31 December 2009, with new cars able to be registered until 31 March 2010. Eligible cars for scrapping were those meeting at most the Euro 2 standard and more than 9 years old. The rules for new cars remained the same as the year before.
- All waves of the scrappage scheme targeted not only passenger cars but also light commercial vehicles.

Incentive value:

- The 2007 scheme provided a scrapping premium of €800 and a two-year remission of road tax (three years if the new car had an engine up to 1,300 cc, or if it was a family of at least six and they had no other car). A bonus of €1,500 was added if the new car was gas-powered, and €2,000 for electric cars. (There was no need to scrap the old car

¹¹ Source: 'Car Scrappage' (2009), 'Scrappage Scheme' (2010), 'End of the Road' (2011).

¹² Source: 'Auto' (2009), Sabelli (2007), Sabelli (2008), Sabelli (2009), Marin & Zoboli (2020), Buttigieg et al. (2010a), *Fleet Renewal* (2010), *Bilancio* (2010).

to get this bonus.) If a person did not buy a new car after scrapping an old one and committed not to buy new vehicles for three years, the state reimbursed them for a one-year season ticket to local public transport within their municipality of residence or workplace.

- The 2008 scheme reduced the aid to €700 and the road tax remission for one year (three years if the scrapped vehicle only complied with Euro 0). The original level of support (€800) was only for cars with emissions below 120 g CO₂ per km. The level of support for gas and electric cars remained as in 2007.
- The 2009 scheme increased the basic support to €1,500 but abolished the remission of road tax (which was around €100–200 per year). The age of eligible old cars was reduced to 9 years.
- The basic bonus for gas cars was €1,500, rising to €2,000 if the car emitted less than 120g of CO₂ per km. The basic bonus for electric cars was €1,500, increased to €3,000 if the car emitted 120 g CO₂ per km, and €3,500 if the car emitted less than 120 g CO₂ per km.
- In the case of light commercial vehicles, the scrapping premium was €2,500. The basic bonus for new gas light commercial vehicles was €1,500, increased to €2,000 if the car emitted less than 120 g CO₂ per km. The bonus for CNG-powered cars was €4,000.

Luxembourg¹³

Total cost: €15.2 million (0.038 % of GDP)

Time period and eligibility:

- In Luxembourg, the scrapping scheme (called PRIME CAR-e plus) was introduced as an extension of an existing scheme to promote the sale of environmentally friendly cars.
- The scrapping scheme was to run from 22 January 2009 to 31 December 2009. At the end of 2009, it was decided to extend the scrapping scheme until 31 July 2010.
- Eligible old cars were passenger cars older than 10 years; associated eligible new cars had to emit less than 150 g CO₂ per km.
- Independently, the PRIME CAR-e scheme promoted the sale of more environmentally friendly cars. It was introduced on 5 December 2007 and designed to run until 31 December 2009. It was repeatedly extended until the end of 2012. After that, only the electric and hybrid variant was valid until 31 December 2014.
- Eligible new cars had to emit less than 120 g CO₂ per km which was lowered to 110 g from 1 August 2010, to 100 g from 1 August 2011. (In case of households with at least six members and their large car, or in case of cars for disabled people, electric, gas or hybrid cars, the threshold was 160 g CO₂ per km throughout the validity of the scheme.)

Incentive value:

¹³ Source: *Ministère* (2010), *Prime* (2013).

- The scrappage premium for eligible new cars was €1,500, rising to €2,500 if the car emitted up to 120g of CO₂ per km (160g for large households and their large cars, cars for disabled people, electric, gas or hybrid cars), and to €3,250 if the car emitted less up to 100g of CO₂ per km.
- The premium that was available to those who bought a new car without scrapping the old one, was €750 for eligible new cars. From 1 August 2010, it was raised to €1500 for cars with emissions up to 100 g CO₂ per km (90 g CO₂ per km from 1 August 2011).
- From 1 August 2011, a €3,000 bonus was introduced for electric cars and cars with emissions of up to 60 g CO₂ per km which was raised to €5,000 from 1 January 2012.

Netherlands¹⁴

Total cost: €82.4 million (0,013 % of GDP)

Time period and eligibility:

- The scheme was designed to run from 29 May 2009 to 31 December 2010 or until the funds were exhausted, which occurred on 21 April 2010.
- Eligible old cars were passenger cars and light commercial vehicles more than 9 years old (13 years in case of a petrol engine). The cars had to have a valid period motor vehicle test at least three months old. Eligible cars purchased were petrol-engined cars built from 2001 or diesel-engined cars with a diesel particulate filter; the car had to comply with Euro 4 or have particulate emissions of up to 5 mg per kilometre.

Incentive value:

- The amount of financial support depended on the age and type of scrapped car. For cars and vans with a petrol engine that were registered for the first time up to 1989, the premium was €750; for the first registration between 1990 and 1995, the premium was €1,000. For diesel cars and vans registered up to 1999, the premium was €1,000; only for vans weighing over 1,800 kg (but under 3,500 kg) the premium was €1,750.
- Beyond the national scheme, two cities came up with their own scheme. The Hague gave car owners an additional bonus of €500. If someone did not buy a new car after scrapping an old car (which disqualified them from the national scheme), they received a bonus of €1 000. Amsterdam has had a similar system since 1 October 2009, where, depending on the characteristics of the old car, people received between €250 and €1,000 on top of the national scrapping premium, or between €500 and €1,000 if they did not buy a new car.

¹⁴ Source: *Evaluatie* (2010), *De Nationale Sloopregeling* (2011).

Portugal¹⁵

Total cost: €59 million¹⁶ (0,034 % of GDP)

Time period and eligibility:

- Portugal introduced a scrappage scheme as early as 1 December 2000. Eligible vehicles for scrapping were those at least 10 years old, both passenger cars and light commercial vehicles. No restrictions were initially placed on new cars. It was not until 2009 that an emission limit for new cars was introduced (140 g CO₂ per km, followed by 130 g CO₂ per km in 2010).
- Following the economic crisis, the scheme was temporarily extended from 7 August 2009 to 31 December 2009. The required age of the old vehicle was reduced to 8 years and the financial incentive was increased. The scheme was to continue in a reduced form in 2010, but due to the delayed approval of the state budget, it did not apply until 29 April 2010. It finally ended on 31 December 2010.
- However, Portugal continued to support scrapping under a different scheme. Since July 2010, a €5,000 premium has been introduced for the purchase of an electric car, increased by €1,500 in the case of scrapping an internal combustion engine vehicle that is at least 10 years old.

Incentive value:

- Since 2000, the financial incentive has taken the form of a car tax rebate for the purchase of a new car, amounting to 150,000 escudos (€750) for cars at least 10 years old and 200,000 escudos (€1,000) for cars at least 15 years old. In 2004, the premium was consolidated at a higher amount (€1,000). In 2006, the premium for older cars was raised to €1,250.
- A temporary extension of the scheme in 2009 meant a premium of €1,250 if the old vehicle was at least 8 years old, or €1,500 if it was at least 13 years old. When it ended, the age limits in 2010 reverted to the original values of 10 years and 15 years, respectively, and the premiums were reduced to €750 and €1,000, respectively. At the same time, the emission limit for new cars was lowered to 130 g of CO₂ per km.

¹⁵ Source: Decreto-Lei (2000), Lei (2003), Decreto-Lei (2006), Lei (2008), Lei (2009), Portaria (2010), *Valorcar* (2010), *Valorcar* (2011).

¹⁶ Own estimate based on the number of vehicles scrapped under the scrappage scheme Programa de Incentivo Fiscal ao Abate de VFV (PIFAVFV) and the likely age distribution of scrapped vehicles. Data for the estimation obtained from *Valorcar* (2010). Official figures are not available.

Romania¹⁷

Total cost:

- €12.0 million in 2005 (0.015 % of GDP)
- €13.3 million in 2006 (0.013 % of GDP)
- €14.0 million in 2007 (0.012 % of GDP)
- €23.3 million in 2008 (0.017 % of GDP)
- €29.1 million in 2009 (0.023 % of GDP)
- €141.5 million in 2010 (0.112 % of GDP)
- €101.9 million in 2011 (0.075 % of GDP)
- €34.3 million in 2012 (0.025 % of GDP)
- €21.2 million in 2013 (0.015 % of GDP)

Time period and eligibility:

- In Romania, the scrappage scheme has been in force in various forms since 2005. The scrappage scheme was approved on 26 November 2004, initiated on 1 May 2005 and has been extended every year. Initially, cars at least 12 years old were eligible for scrapping. There was no emission restriction on new cars. Since 2009, the required age of a scrapped car has been reduced to 10 years. Since June 2009, light commercial vehicles have also been eligible. From 2010, legal entities could also benefit from the scrappage scheme (under the *de minimis* regime). In 2010–2011, the scheme also applied to tractors. During 2011, hybrid and electric vehicles were included in the scheme. In 2012, the required age of an old vehicle for legal entities was reduced to five years.
- In subsequent years, the scheme has been further modified. Currently (2023), cars that are at least 6 years old are eligible for scrapping.

Incentive value:

- From 2005 to 2008 the scrapping premium was RON 3,000 (about €850). In 2009 it was increased to RON 3,800 (about €900). Since 2010, the same person who scrapped the old car did not have to buy a new car. The buyer of a new car (if an individual) could use up to three scrapping vouchers (the vouchers were valid for 30 days), which made the system much more flexible.
- In 2013, the conditions of the financial incentive were changed again: the amount of the scrapping voucher was RON 6,500 (about €1,460), plus an ecobonus of RON 500 (about €110) for each of the following characteristics of a new vehicle (maximum two

¹⁷ Source: Ordonanță (2004), Ordonanță (2006), Ordonanță (2007), Ordonanță (2008a), Ordonanță (2008b), *Ghid de Finanțare* (2009), *Ghid de Finanțare* (2013), *Ghid de Finanțare* (2020), Răceanu (2014), *Raportul* (2006), *Raportul* (2007), *Comunicat de Presă* (2007a), *Comunicat de Presă* (2007b), *Raportul* (2008), *Comunicat de Presă* (2008a), *Comunicat de Presă* (2008b), *Raportul* (2009), *Comunicat de Presă* (2009a), *Comunicat de Presă* (2009b), *Raportul* (2010), *Direcția de Comunicare* (2010), *Raportul* (2011), *Comunicat de Presă* (2011a), *Comunicat de Presă* (2011b), *Raportul* (2012), *Comunicat de Presă* (2012), *Raportul* (2013), *Comunicat de Presă* (2013a), *Comunicat de Presă* (2013b), *Raportul* (2014), *Evoluția* (2022).

ecobonuses together): meeting the Euro 6 standard, emissions of less than 100 g CO₂ per km, hybrid drive. The scrapping voucher ceased to be transferable; its validity for set to 45 days.

- In subsequent years, the incentives were further modified. At present (2023), the scrapping bonus (the so-called Rabla Classic Programme) for the purchase of a new vehicle (or motorcycle) is RON 7,000 (€1,400) for the scrapping of one vehicle, or RON 10,000 (€2,000) for the scrapping of two vehicles. In addition, an ecobonus of RON 1,500 (€300) can be obtained if the new vehicle has emissions of no more than 120 g CO₂ per km or burns LPG/CNG or an ecobonus of RON 3,000 (€600) if the new vehicle is equipped with a hybrid engine. If the scrapped vehicle was at least 15 years old and complied with the Euro 3 standard at most, an ecobonus of RON 1,500 (€300) is granted. In addition, there is the so-called Rabla Plus programme, where the scrapping bonus is RON 51,000 (€10,200) for the purchase of a new pure electric vehicle or a new vehicle with a hydrogen fuel cell, excluding motorcycles (RON 54,000 (€10,800) if two cars are scrapped); RON 26,000 (€11,200) for the purchase of a new hybrid electric vehicle, excluding motorcycles, which produces no more than 80 g CO₂ per km (RON 29,000 (€5,800) if two cars are scrapped); RON 26,000 (€5,200) for the purchase of an electric motorcycle. If the scrapped vehicle was at least 15 years old and complies with Euro 3 at most, an ecobonus of RON 1,500 (€300) is granted.

Slovakia¹⁸

Total cost: €49.8 million (0.078 % of GDP)

Time period and eligibility:

- The scrapping scheme was to run from 9 March 2009 to 31 December 2009 or until the number of scrapped vehicles reached 22,100. This occurred on 25 March 2009. A new scheme was therefore launched on 9 April 2009 with the same limit on the number of scrapped vehicles. The scheme was already exhausted on 14 April 2009. Eligible vehicles for scrapping were those older than 10 years. Eligible new cars were cars registered for a maximum of 6 months or with a maximum mileage of 6,000 km, and with the price not exceeding €25,000. The scheme was open both to individuals and legal entities.

Incentive value:

- In the first wave of the scrapping scheme, the scrapping premium was €1,000. If the dealer gave a €500 discount, the premium increased to €1,500. In the second wave of the scrapping scheme, one premium of €1,000 was granted, but only if the dealer provided a discount of the same amount.

¹⁸ Source: Výnos (2009a), Výnos (2009b), *Informácia o Priebehu Čerpania* (2009), *Informácia o Priebehu Čerpania* (2010).

Spain¹⁹

Total cost:

- Plan VIVE: €145.6 million²⁰ (0.014 % of GDP)
- Plan 2000e: €461.8 million²¹ (0.043 % of GDP)
- Plan PIVE1–4: €365 million (0.036 % of GDP)

Time period and eligibility:

- Spain has a long history of various scrappage schemes. Between 1994 and 1997, the *Renove Plan* ran, providing a discount on registration tax if a vehicle at least seven years old was scrapped. Between 1997 and 2007, the *Prever Plan* ran. This provided a registration tax rebate for scrapping a vehicle that was at least 10 years old. In 2001–2003, the scheme was extended to provide a higher incentive if the scrapped vehicle was a leaded petrol vehicle and the newly purchased vehicle was an unleaded petrol vehicle. It was also possible to buy a used car up to five years old or a light commercial vehicle. Between 2004 and 2006, the *Nuevo Prever Plan* ran, combining the previous plans into one. This plan was eventually extended until the end of 2007; in the last year, however, the scheme was limited to new passenger cars.
- On 27 June 2008, the Council of Ministers approved the so-called *VIVE Plan* (*Vehículo Innovador-Vehículo Ecológico*), which was to run from August 2008 to July 2010. Cars older than 15 years were eligible for scrapping. To be eligible, a new vehicle had to either have emissions of up to 120 g CO₂ per km or have emissions of up to 140 g CO₂ per km while being equipped with an electronic stabilisation system and occupancy detectors in the front seats. However, the setting of financial incentives attracted little interest (after 100 days of validity, only 50 incentives had been used) and the government therefore modified the conditions in November 2008. Cars that were at least 10 years old or with at least 250,000 km on the clock became eligible; used cars up to five years old could also be purchased, as well as light commercial vehicles. The financial incentives have also changed significantly (see on the right). This accelerated the uptake of the scheme and the 2008–2009 budget was exhausted at the end of May 2009.
- For this reason, a new scheme, *Plan 2000e*, was introduced on 23 May 2009, which was to run from 18 May 2009 (retrospectively) until 18 May 2010 or until the budget (200,000 vehicles) was exhausted. By November 2009, the budget was almost

¹⁹ Source: *El Plan Prever termina* (2007), *Referencia* (2008), *Seijo* (2008), *Costas* (2008a), *Costas* (2008b), *Real Decreto* (2009a), *Costas* (2009), *Real Decreto* (2009b), *Resolución* (2010), *Últimos Coletazos Del Plan 2000E* (2010), *El Confidencial* (2010), *Remo* (2012), *Delco* (2012), *Resolución* (2012), *Costas* (2012), *Costas* (2013a), *Resolución* (2013b), *Costas* (2013b), *Resolución* (2013a), *Real Decreto* (2013), *Consejo de Ministros* (2013), *Real Decreto* (2014a), *Autocasión* (2014), *Real Decreto* (2014b), *Real Decreto* (2014c), *Instituto para la Diversificación y el Ahorro de la Energía* (2015), *Real Decreto* (2015a), *Real Decreto* (2015b), *Estos son los ocho planes* (2020).

²⁰ The total budget was €700 million, but the disbursement was not in the form of a premium but in the form of an interest-free loan. The Council of Ministers estimated the value of the savings to the consumer at around 21% of the loan granted. To ensure comparability, we present the recalculated budget.

²¹ Half was provided by the Spanish State, half by regional governments.

exhausted and was therefore increased by a further 80,000 vehicles. The 2010 budget was 200,000 vehicles and was exhausted in June 2010. Eligible old cars were cars that were at least 10 years old or with at least 250,000 km on the clock, or cars that were at least 12 years old (if bought second-hand and up to 5 years old at the time of purchase). Eligible new cars were cars costing up to €30,000, even if used, and up to 5 years old. The vehicle had to either have emissions of up to 120 g CO₂ per km, or have emissions of up to 149 g CO₂ per km while being equipped with an electronic stabilisation system and front seat occupancy detectors, or have emissions of up to 149 g CO₂ per km while being equipped with a three-way catalytic converter for petrol vehicles or an exhaust gas recirculation (EGR) device for diesel vehicles. Light commercial vehicles were also eligible; they had to meet an emission limit of 160 g CO₂ per km.

- The next plan came in 2012 (Plan PIVE – Programa de Incentivos al Vehículo Eficiente) and the first phase was to last from 1 October 2012 to 31 March 2013; the budget was exhausted on 11 January 2013. Eligible vehicles for scrapping were passenger cars at least 10 years old or light commercial vehicles at least 12 years old. The new vehicle had to fall into category A or B according to the Spanish Institute for Diversification and Energy Saving (Instituto para la Diversificación y Ahorro Energético). The government has gradually decided to extend the scheme as the budget has been exhausted each time: in addition, PIVE 2 (February–July 2013) introduced support for multi-family families that purchased a car with more than five seats. This could be in category C and with a price of up to €30,000. The scrapping age for light commercial vehicles was reduced to 7 years. PIVE 3 (July–October 2013) had the same conditions. PIVE 4 (October–December 2013) extended the scheme to support disabled drivers. This was followed by PIVE 5 (February–June 2014), PIVE 6 (June–October 2014, extended November–December 2014), PIVE 7 (March–April 2015, tightened the conditions where the applicant had to own the scrapped vehicle for at least one year and have a valid roadworthiness test), and PIVE 8 (May 2015–July 2016).
- The Renove plan offered a financial incentive of €480; if the vehicle was at least 10 years old, the incentive increased to €601. The Prever plan offered a financial incentive of €480 for scrapped vehicles that were at least 10 years old; if they were leaded petrol vehicles, the incentive was €721. The incentive was €480 for used cars purchased and for light commercial vehicles. In the last year of operation (2007), the incentive was limited to new passenger cars and amounted to only €480.
- Under the VIVE plan, a financial incentive was provided in the form of a low-interest loan for the purchase of a new car. The first €5,000 was granted interest-free and the rest of the purchase price (up to €20,000) at EURIBOR plus 250 basis points. The savings from the interest-free loan were estimated by the Government at €1,040. After the unsuccessful start of the scheme, the interest-free loan limit was increased to €10,000 and the maximum price of the car to €30,000 in November 2008. It was also no longer necessary to finance the entire purchase price with a loan, but only a part of it at the buyer's discretion.

- The financial support under the 2000e Plan from the State was €500; local authorities could add to this (typically €500). The seller (in the case of a new car) had to provide a €1,000 discount. In total, therefore, the support could amount to up to €2,000.
- In the PIVE plan, the state support was €1,000, to which the manufacturer had to add another €1,000. The price of a new car had to be up to €25,000. In the second phase, support for large families was added; the state incentive was €1,500. The third phase contained identical incentives. The fourth phase added support for the purchase of vehicles for the disabled (€1,500). The last, eighth phase, reduced the support to €750.

United Kingdom²²

Total cost: €436 million (0.028 % of GDP)

Time period and eligibility:

- The scrappage scheme was due to run from 18 May 2009 until the end of February 2010; it was subsequently extended until the end of March 2010. Vehicles eligible for scrapping were those older than 10 years, both passenger cars and light commercial vehicles. There was no restriction on new cars (the scheme applied to both passenger cars and light commercial vehicles).

Incentive value:

- The amount of the incentive was £1,000 (about €1,110); however, it had to be matched by a dealer discount of the same amount.

Summary statistics

Table 4: Financial settings for scrappage schemes

	Amount of financial incentive	Actual average scrapping premium per scrapped car	Required vendor contribution (discount)	Average scrapping premium per scrapped car as a share of GDP per capita
Austria	€750	€750	€750	2.17%
Cyprus	€256–1800	€885	---	3.75%
France	€300–1000	€861	---	2.84%
Germany	€2500	€2500	---	8.37%
Greece	€500–2200	€1400	---	6.55%
Ireland	€1250–1500	€1412	---	3.85%

²² Source: HM Treasury (2009), *Car Scrappage* (2010), *Car Scrappage* (2014).

Italy	€1500–3000	€1212	---	4.54%
Luxembourg	€1500–3250	€2171	---	2.71%
Netherlands	€750–1750	€987	---	2.59%
Portugal	€1250–1500	€1416	---	8.53%
Romania	€850–1460	€811	---	3.26%
Slovakia	€1000–1500	€1127	Wave 1: Voluntary €500 to increase the state premium Wave 2: €1000	9.47%
Spain	€480–2080	€1085	From 2009: €1000–1500 (depending on the amount of the scrapping premium)	4.61%
United Kingdom	€1110	€1110	€1110	4.42%

Source: Own creation based on national sources and World Bank data. See the sources listed in Annex 1 for each country.

Table 5: Scrappage scheme budgets and scrappage numbers

	Sources of information	Budget drawn	Budget drawn as a share of GDP	Total cars scrapped	Total cars scrapped as a share of the total fleet in 2009
Austria	News in the media	€22.5 million	0.008%	30,000	0.63%
Cyprus	Ministry annual reports	€21.9 million	0.116%	24,755	4.20%
France	Ministry annual reports Annual reports of the relevant Commission	€1015 million (2009–2010)	0.052%	1,179,417	3.15%
Germany	Final report of the Authority	€4,832 million	0.197%	1,932,929	4.33%
Greece	Estimate by Buttigieg et al. (2010a)	€108 million	0.045%	77,000	1.24%
Ireland	News in the media	€37.6 million	0.022%	26,632	1.19%
Italy	Car club report Buttigieg et al. (2010a)	€1,284 million (2009)	0.081%	1,059,504	2.57%

Luxembourg	Chamber of Commerce report	€15.2 million.	0.038%	7,000	1.90%
Netherlands	Analytical Agency Report	€82.4 million.	0.013%	83,444	0.94%
Portugal	Annual reports of the relevant authority	€59.1 million (2009)	0.034%	41,735	0.72%
Romania	Annual reports of the relevant authority	€390.4 million (2005–2013)	0.307%	481,543	9.73%
Slovakia	Ministry reports	€49.8 million	0.078%	44,200	2.34%
Spain	Royal Decrees News in the media Presentation of the relevant institute	€972.4 million (2008–2014)	0.092%	896,519	3.27%
United Kingdom	Scheme website	€436 million	0.028%	392,227	1.15%

Source: Own creation based on national sources, World Bank data, European Motor (2012), and CEIC (2023). See the sources listed in Annex 1 for each country.

Table 6: Temporal structure of the periods included in the model

Country	Local Name	Anticipation period	Treatment period	Pull-forward period
Austria	Ökoprämie	02–03/2009	04/2009–11/2009	12/2009–01/2010
	<p>Note on the anticipation period: The initiative was officially announced in 01/2009. Google Trends results show an increase in searches for scrappage in the second half of January 2009, which we do not expect to be reflected in new registrations until February.</p> <p>Note on treatment period: The initiative was valid from 1 April to 31 December 2009. However, the funds were exhausted on 8 July 2009. The data show that although most new cars were registered by July, the effect lasted until November 2009.</p>			
Cyprus	απόσυρση παλαιών οχημάτων	12/2007 01/2009 06/2010	01/2008–07/2008 02/2009–09/2009 07/2010–08/2010	08–09/2008 10–11/2009 09–10/2010
	<p>Note on the anticipation period: Due to lack of data, we expect only a one-month anticipation for all three waves of the scheme.</p> <p>Notice: Due to the lack of data for the construction of the synthetic variable, Cyprus was eventually excluded from the model and no statistical analysis was performed for it.</p>			
France	Prime à la Casse	12/2008	01/2009–12/2010	01–02/2011

	<p>Introductory note: In France, the scrappage scheme has been in force in one form or another since December 2007 to date. However, in 2008–2010, the scrappage scheme was temporarily adjusted and financial incentives were increased in the context of the automotive sales crisis. Our analysis therefore focuses on assessing the impact of this period only.</p> <p>Note on the anticipation period: The scrappage scheme was announced on 4 December 2008. It seems that the details of the stimulus package, including the scrappage scheme, were not known to the public in advance. We found the first mentions in the media on 2 December 2008 (which is consistent with the Google Trends results). This is not only why we do not expect the anticipation period to start in 11/2008, but also why we consider 12/2008 to be part of the anticipation period.</p> <p>Note on the treatment period: The increased scrapping incentive was introduced on December 4, 2008. Initially, it was planned to last until December 31, 2009. In late 2009, it was extended until December 31, 2010 with a gradually decreasing premium (initial €1,000 decreased to €700 in 1/2010, and €500 in 7/2010).</p>			
Germany	Umweltprämie, Abwrackprämie	11/2008–01/2009	02–11/2009	12/2009–01/2010
	<p>Note on the anticipation period: The idea was born in 10/2008. It was publicly discussed in 11–12/2008 and launched in mid-January 2009.</p> <p>Note on the treatment period: The initiative was valid from 14 January 2009 until 31 December 2009. However, the funds were exhausted on 2 September 2009. The data show an increase in registrations until November 2009.</p>			
Greece	1) τέλους ταξινόμησης 2) διάλυσης	03–04/2009 10/2009	05–08/2009 11/2009	09/2009 12/2009
	<p>Introductory note: In Greece, two different schemes were implemented in 2009 to promote the sale of new cars, but only the second involved the scrapping of old cars. Nevertheless, we have decided to include both in our model. The reason is that they both took place in the same year and had a similar purpose. So it makes sense to track their effectiveness together.</p> <p>Note on the anticipation period: A plan to reduce car registration fees for four months was introduced and discussed in 03/2009. The initiative started at the beginning of 04/2009 (reflected in registration numbers in 05/2009). Then, seeing the decline in sales in 09/2009, the government introduced a car scrappage scheme at the end of 09/2009. However, the results in terms of car registrations were not visible until 11/2009 (similar to the lag in data observed in spring).</p> <p>Note on the treatment period: The temporary reduction of registration fees applied from the beginning of April until 7 August 2009. The scrappage scheme was announced on 22 July and was valid from 28 September 2009 to 2 November 2009.</p> <p>Note on the pull-forward period: In the case of Greece, it did not make sense to consider a two-month pull-forward period. Firstly, October 2009 (which would otherwise be included in a pull-forward period) should already be considered as an anticipation of the scrappage scheme. Second, the scrappage scheme lasted only one month, so it would not be appropriate to consider a two-month pull-forward period at the end of 2009.</p>			
Ireland	Scrappage	12/2009	01/2010–06/2011	07–08/2011
	<p>Note on anticipation period: The scrappage scheme was announced in 12/2009. Google Trends also shows an increase in searches for the scrappage topic only in December.</p> <p>Note on the treatment period: The scrappage scheme ran from 1 January 2010 to 31 December 2010 and has been extended until 30 June 2011.</p>			

	Rottamazione	01/2009	02/2009–03/2010	04–05/2010
Italy	<p>Introductory note: Italy introduced its first scrappage scheme in 1997 and has run various schemes on and off since then. However, in 2009 there was a scrappage scheme linked to the economic crisis, which significantly increased the scrappage premium. Our analysis therefore focuses only on the impact of this increased premium.</p> <p>Note on anticipation period: The initiative was announced in 01/2009. Google Trends only shows an increase in searches for scrappage in January 2009.</p> <p>Note on the treatment period: While the initiative ran from 7 February 2009 to 31 December 2009, new vehicles could be registered until the end of 03/2010.</p>			
Luxembourg	Verschrottungsprämie / Prime à la casse / Abwrackprämie	12/2008	01/2009–07/2010	08–09/2010
	<p>Note on the anticipation period: Google Trends shows an increase in search intensity between 11/2008 and 12/2008.</p>			
Netherlands	Slooppremie, sloopregeling	04–05/2009	06/2009–04/2010	05–06/2010
	<p>Note on anticipation period: The scheme was announced by the government on 25 March 2009. Google Trends shows a significant increase in search intensity in 04/2009.</p> <p>Note on the treatment period: The scrappage scheme came into effect on 29 May 2009 and lasted until 21 April 2010.</p>			
Portugal	Abate de Veículos	07/2009	08/2009–12/2009	01–02/2010
	<p>Introductory note: In Portugal, the scrappage scheme was in force from December 2000 until the end of 2010 (except for the first four months of 2010). Since then, other versions of the financial incentives have been in place until today. In our analysis, therefore, we only examine the effect of the temporary increase in the incentive in 2009.</p> <p>Note on the anticipation period: The increased value of the scrappage scheme was announced to be effective from 08/2009. Google Trends shows an increase in searches since July 2009.</p>			
Romania	Prima de casare, Rabla	04/2005 05-06/2006 03-04/2008 03-05/2008 03/2009 03/2012 03-05/2013	05-12/2005 07-12/2006 05-12/2007 06-12/2008 04-12/2009 03/2010-01/2011 04-12/2011 04-12/2012 06-12/2013	01-02/2006 01-02/2007 01-02/2008 01-02/2009 01-02/2010 02-03/2011 01-02/2013
	<p>Introductory note: In Romania, the car scrappage scheme was introduced in 2005 and has been repeated every year since. Therefore, our initial intention was to select only the period that was specifically designed to mitigate the effects of the economic crisis (similar to France, Portugal or Spain). In the case of Romania, however, no such period could be identified. We therefore decided to include all years in the model, taking advantage of the fact that the scrappage schemes in each year were not directly linked to each other. Therefore, it should be possible to ask how people behaved in the months when the scrappage scheme for that year was not yet in force.</p>			

	<p>However, because of the different range of data compared to other countries, Romania was eventually excluded from the model and no statistical analysis was performed for it.</p> <p>Note on the anticipation period: the scheme was launched in 2005. Although it was approved at the end of 2004, the increase in scrappage searches is not visible in Google Trends until April 2005. In 2006, the scheme was launched on 30 June; a noticeable increase in searches can be seen from May 2005. In 2007, there was noticeable search activity from the beginning of the year, so we set the anticipation period in March (the first two months are the pull-forward period from last year). In 2008, search activity bottomed out at the beginning of March, but then started to increase, so we include the months from March onwards in the anticipation period. In 2009, the new scheme started at the end of March, so we include March as the lead-in period (which corresponds to the increase in search activity). In 2010, we do not consider an anticipation period, as the scheme did not run for only the first two months, which we consider to be an anticipation of the previous year, in line with our chosen methodology. For similar reasons, we do not consider an anticipation period for 2011. In 2012, the new scheme started at the end of March, and we have therefore included March as an anticipation period (corresponding to the increase in search activity). In 2013, the search intensity started to increase at the beginning of March.</p> <p>Note on the treatment period: in 2005, the scrappage scheme was exhausted by the end of November 2005, so we added December. In 2010, not all scrappage vouchers were redeemed at the end of the year and their validity was extended until the end of January 2011; we therefore assume that some of the new car purchases were still made in January 2011.</p>			
Slovakia	Šrotovné	02/2009	03–09/2009	10–11/2009
	<p>A note on the anticipation period: The scrappage scheme was announced at the end of February 2009 (while in the first half of February the Slovak government rejected the idea). Google Trends shows no results yet in January 2009.</p> <p>Note on the treatment period: The scrappage scheme was effective in March and April 2009, with the possibility to register a new car until the end of 2009. The data show that although most new cars were registered by July, the effect lasted until September 2009.</p>			
Spain	Prever (1997–2007), VIVE (2008–2009), Plan2000e (2009–2010), PIVE (2012–2016) ²³	07/2008 10/2012	01/2005–12/2007 08/2008–06/2010 11/2012–12/2013	01–02/2008 07–08/2010
	<p>Introductory note: Spain has had a car scrappage scheme in one form or another since 1994. However, between 2008 and 2013 there were three scrappage schemes linked to the crisis in car sales. (The third continued after 2013, but this is outside the time horizon of our analysis). As all the schemes in 2008–2013 were linked to the economy, we have decided to include all of them in the analysis.</p> <p>Note on the anticipation period: The VIVE plan was approved on 27 June 2008. This corresponds to the increased intensity of Google Trends searches at the end of June and beginning of July. The plan itself was launched one month later. The PIVE plan was approved on 28 September 2012. This corresponds to the increased search intensity according to Google Trends in September/October. The plan itself was launched in the second half of October.</p> <p>Note on the treatment period: The Prever plan ran from 1997 until the end of 2007. The VIVE plan started accepting applications in 08/2008 and ran out of funds in 05/2009. It was</p>			

²³ The Spanish word for scrapping is “desguace”. However, in the context of the scrappage schemes, the names of the individual schemes tended to be used directly in documents and on the internet.

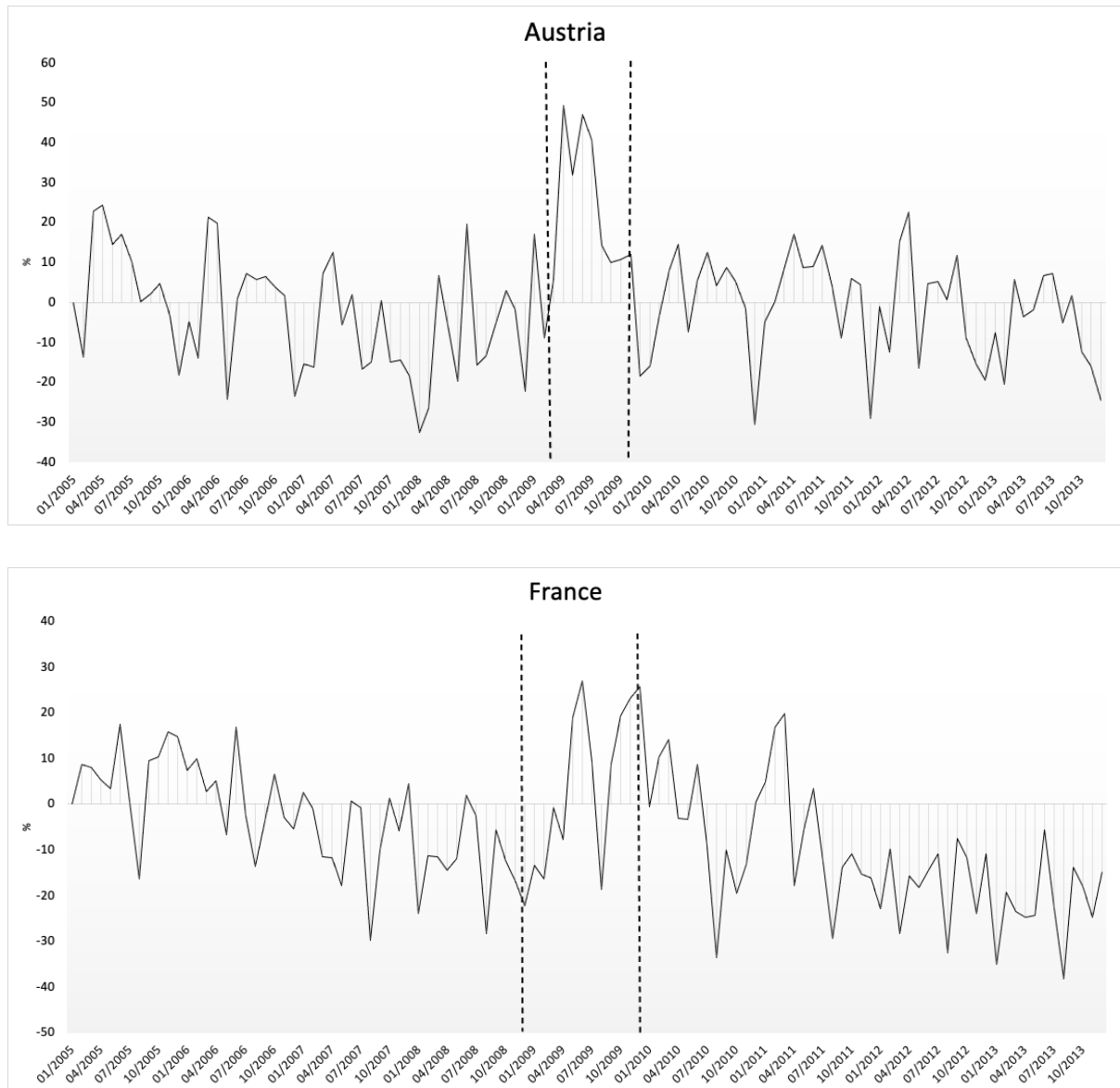
	immediately followed by the Plan 2000e from 05/2009, which was exhausted in 06/2010. The PIVE Plan only started in the second half of October and therefore we only started the treatment period in November 2012. Plans PIVE 2 to PIVE 4 were directly linked. (The following phases of the PIVE plan are outside our research period.)			
United Kingdom	Scrappage	04/2009	05/2009–03/2010	04–05/2010
	<p>Note on anticipation period: The scrappage scheme was announced in April 2009. Google Trends also shows increased search intensity in April 2009.</p> <p>Note on the treatment period: The scrappage scheme ran from 18 May 2009 to the end of March 2010.</p>			

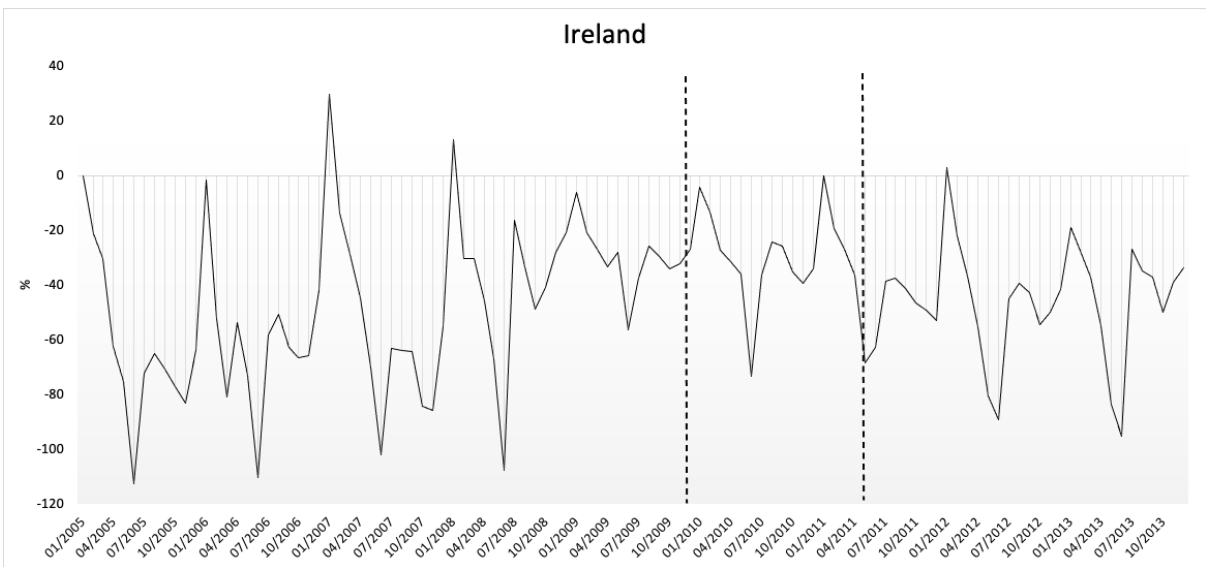
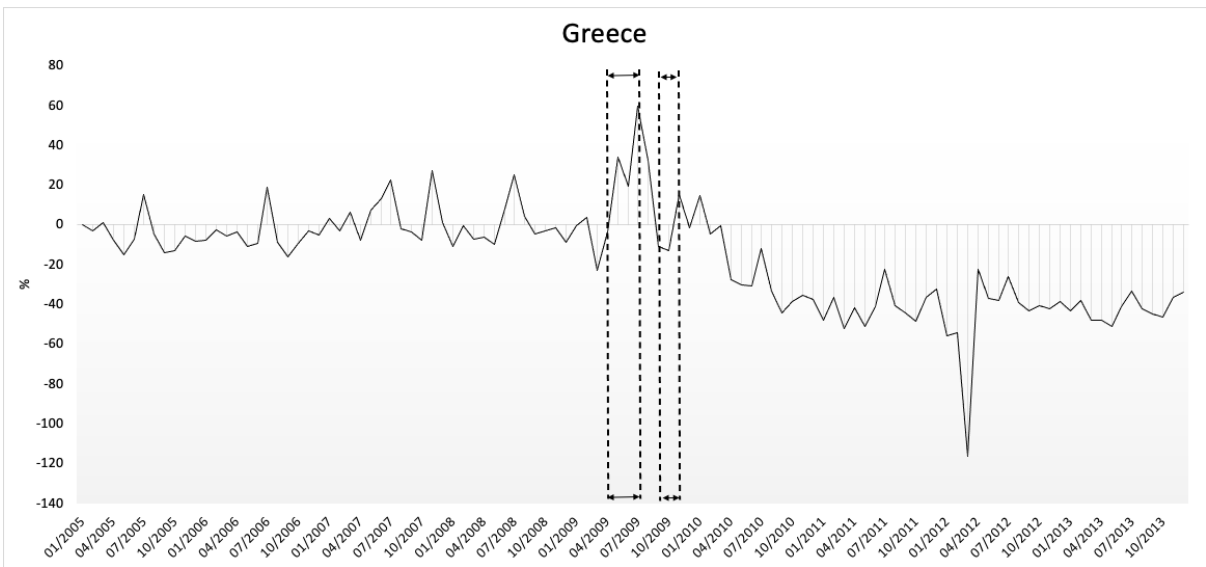
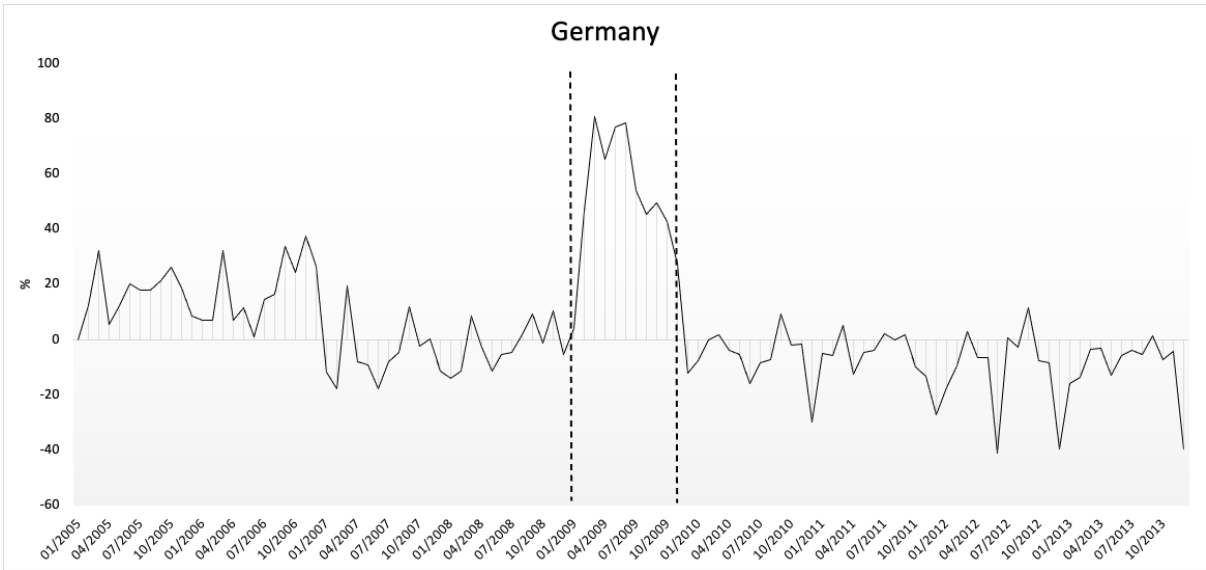
Annex 2: Country weights for the construction of the synthetic variable

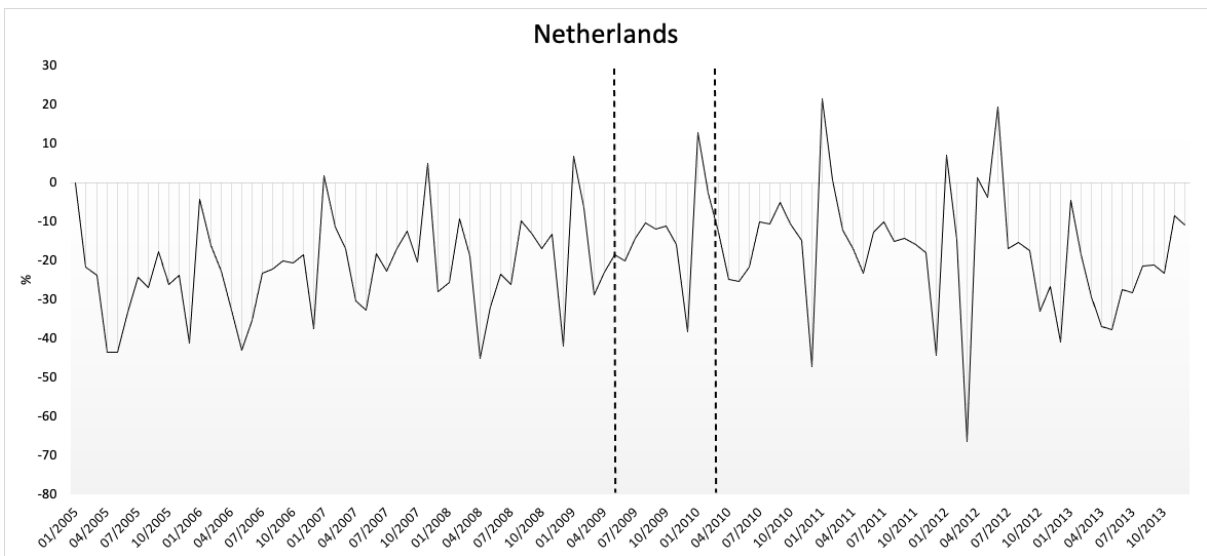
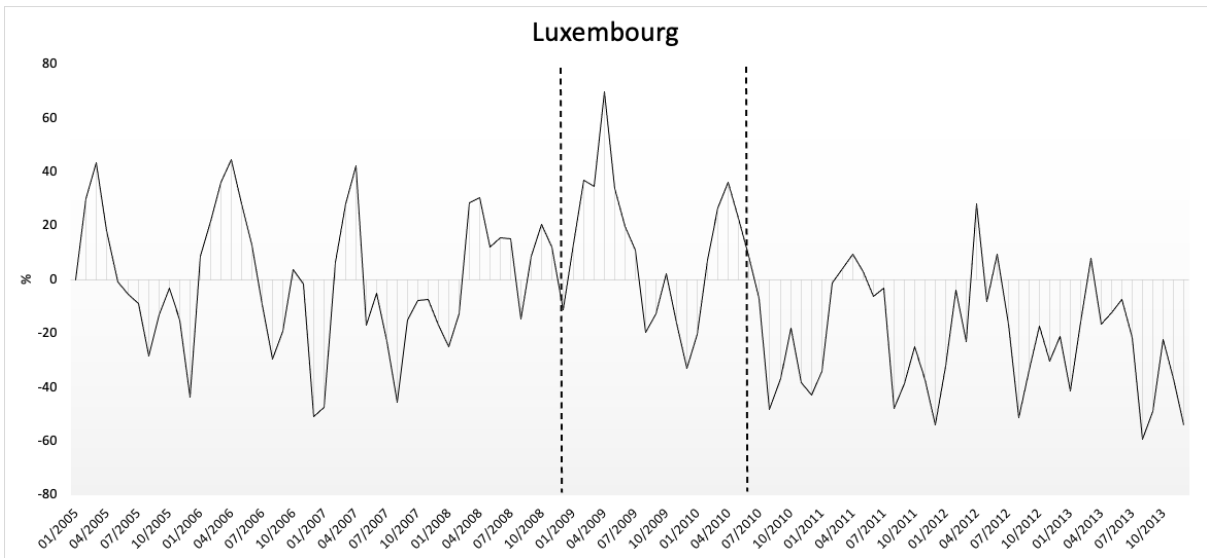
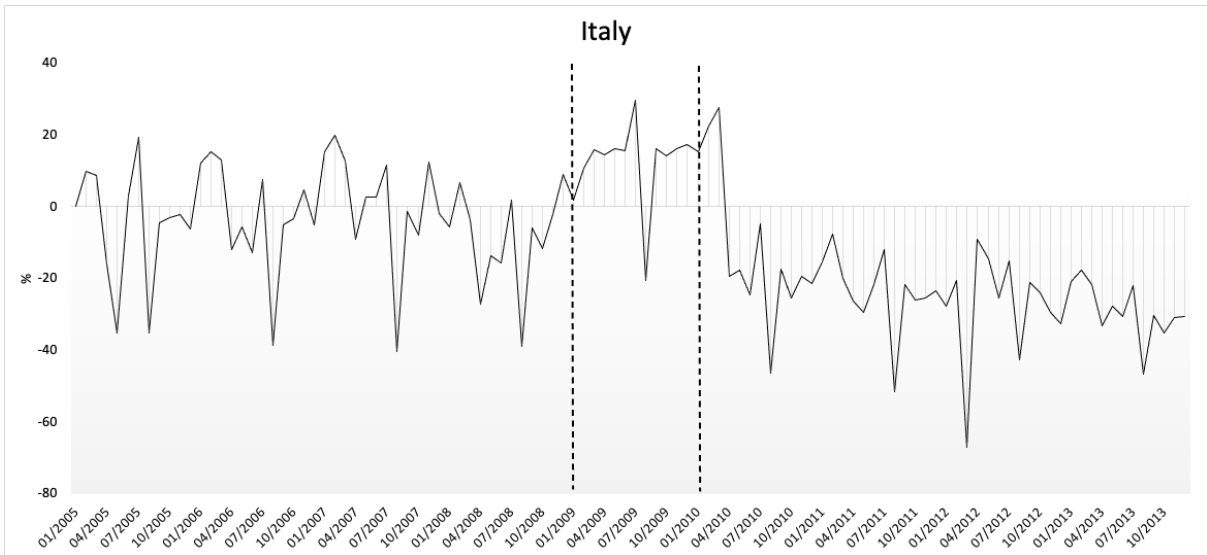
	Belgium	Czechia	Denmark	Estonia	Finland	Hungary	Latvia	Lithuania	Poland	Slovenia	Sweden	Iceland	Norway	Switzerland
Austria	0.226	0.163	0.202	0.004	0.000	0.003	0.001	0.003	0.025	0.005	0.003	0.003	0.009	0.354
France	0.248	0.001	0.001	0.001	0.005	0.001	0.001	0.001	0.412	0.001	0.009	0.001	0.002	0.320
Germany	0.023	0.021	0.024	0.016	0.016	0.017	0.010	0.016	0.025	0.018	0.135	0.017	0.025	0.639
Greece	0.000	0.000	0.000	0.000	0.885	0.000	0.000	0.000	0.000	0.000	0.115	0.000	0.000	0.000
Ireland	0.514	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.486	0.000	0.000
Italy	0.000	0.000	0.000	0.000	0.474	0.000	0.000	0.000	0.032	0.232	0.262	0.000	0.000	0.000
Luxembourg	0.000	0.000	0.000	0.000	0.273	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.727	0.000
Netherlands	0.000	0.000	0.000	0.000	0.747	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.252
Portugal	0.000	0.000	0.000	0.000	0.306	0.000	0.000	0.000	0.385	0.000	0.309	0.000	0.000	0.000
Slovakia	0.000	0.633	0.000	0.000	0.000	0.000	0.000	0.034	0.333	0.000	0.000	0.000	0.000	0.000
Spain	0.000	0.000	0.000	0.000	0.538	0.000	0.231	0.000	0.131	0.000	0.100	0.000	0.000	0.000

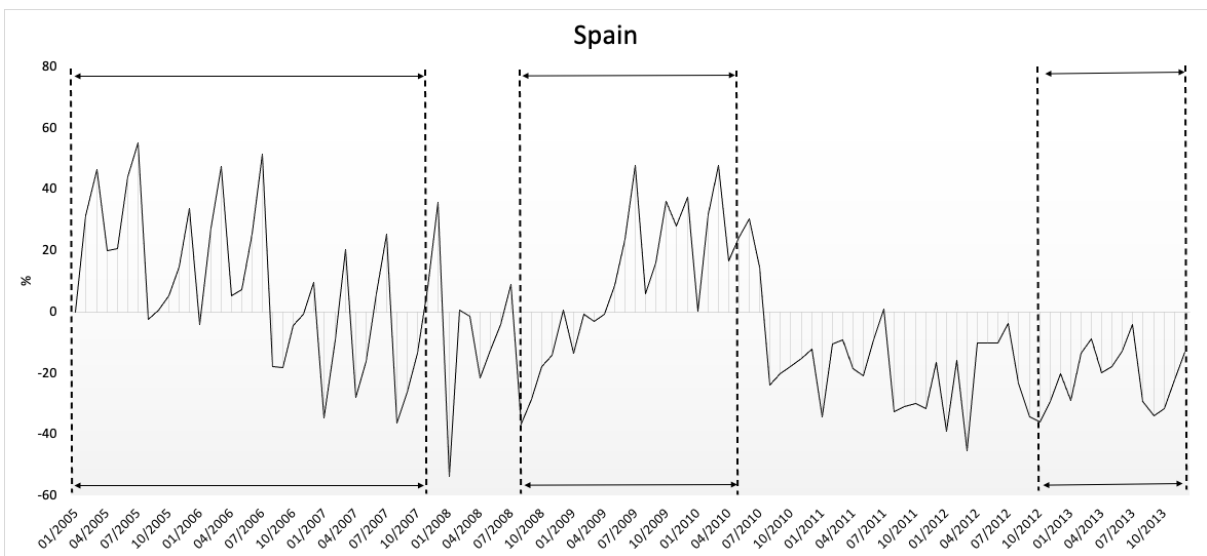
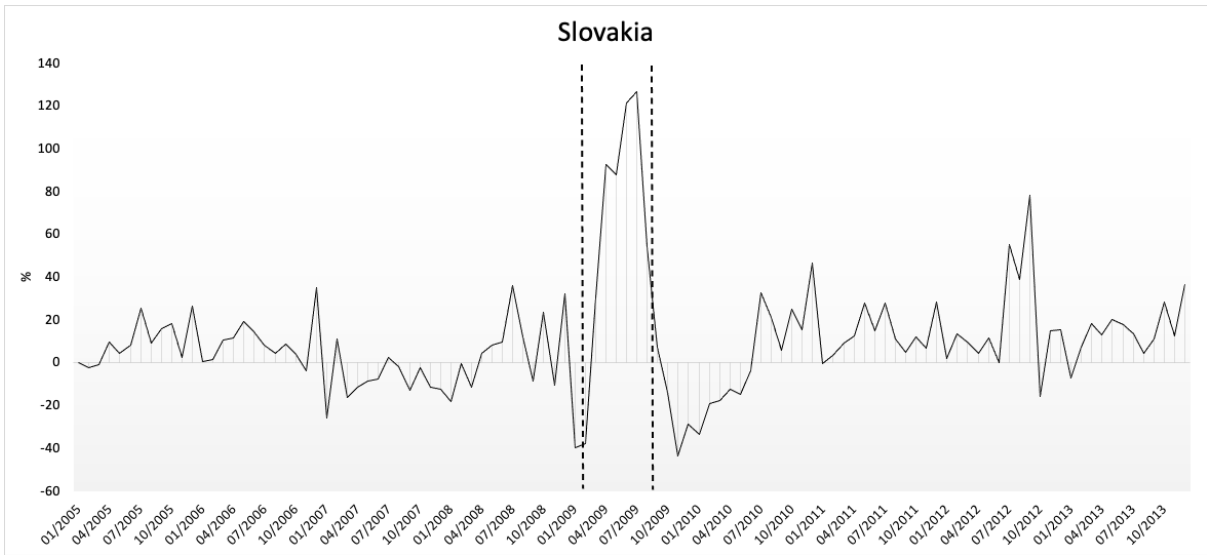
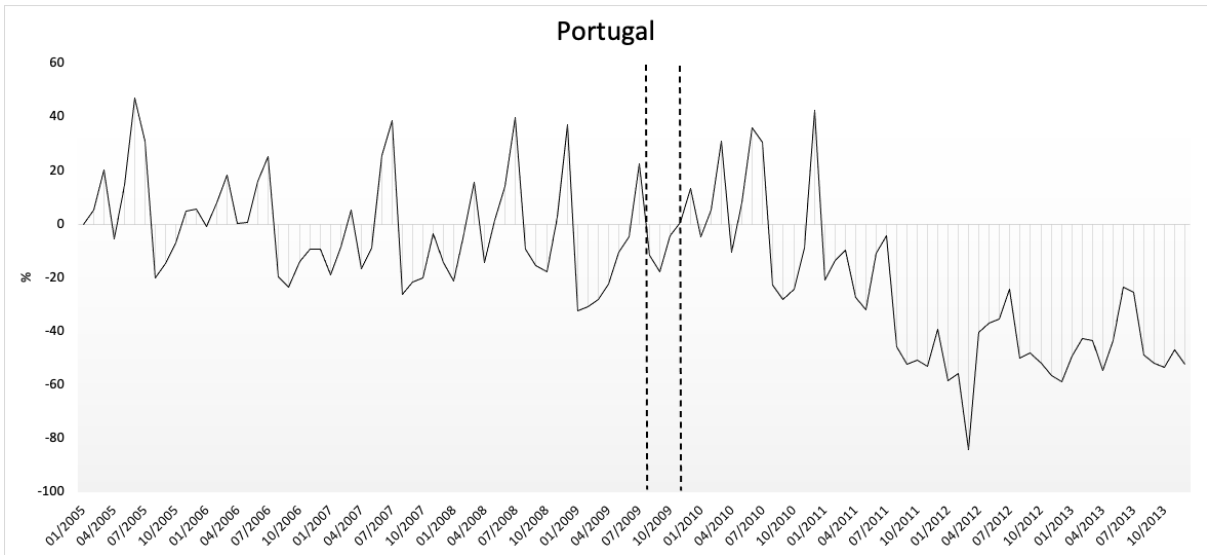
Annex 3: Further output analysis

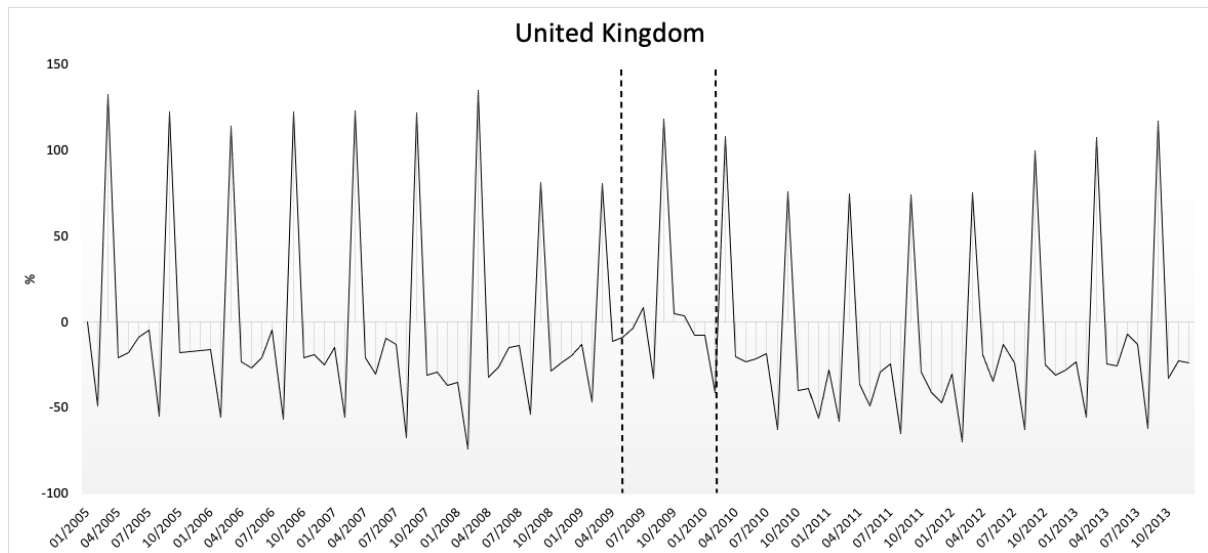
Figure 3: Differences (gaps) in the number of new passenger car registrations (country comparison with the synthetic variable, difference-in-differences)











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