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For Peer Review

CONVERGENCE IN CAR PRICES AMONG EUROPEAN COUNTRIES*

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Abstract

This paper contributes to the literature on price convergence in Europe by investigating the existence of stochastic and deterministic convergence of car prices in the EU15 countries. We apply recently developed econometric techniques that allow for multiple structural breaks to an up-to-date dataset. We find considerable evidence of both types of convergence in our sample of countries and car models, therefore suggesting a tendency for relative prices to equalise over time. In addition, we find evidence regarding the importance in this convergence process of both legislative changes taking place in the years 1996 and 2002, and the implementation of EMU.

JEL classification numbers: C23, F15, F30.

Key Words: Market integration, Automobiles, European Union, Stochastic convergence, Deterministic convergence, Panel stationarity.

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1. Introduction

During the last five decades, the European Union (EU) has advanced to a closer integration by the removal of trade barriers, the establishment of a single market and the creation of the Economic and Monetary Union (EMU). In addition, there have been attempts towards tax harmonisation and structural reforms in product markets to increase competition and reduce potentially harmful distortions caused by different forms of government intervention. One expected effect of all these initiatives is the decline in price dispersion across EU Member States.¹

One market that has attracted a special attention in both political and academic spheres is the European car market. The existence of large and persistent cross-country price differentials in the automobile industry has been, over the last two decades, an important source of concern under the European Commission (EC)'s competition policy. Since the completion of the single market programme in 1993, the EC has monitored the motor vehicle industry to check for differences in car prices across EU countries. Additionally, it has commissioned several studies from external consultants to detect factors that were behind car price differentials (see, for example, Degryse and Vervoben, 2000).² Among the various explanations suggested by the literature, nominal exchange rate volatility and the specific regulatory regime in the car industry have always played a prominent role. However, after the introduction of the euro policy-makers' attention has mainly focused on regulation of the industry, although for non-EMU countries exchange rate volatility is still a source of concern since it prevents the full market integration across all EU countries.

A number of academic studies have also investigated price convergence in the European car market (see, for example, Gaulier and Haller, 2000; Lutz, 2004a and 2004b; Goldberg and Verboven, 2001, 2004 and 2005; Gil-Pareja and Sosvilla-Rivero, 2008).³ Overall, these studies reveal that exchange rate fluctuations explain a large share of the price dispersion dynamics and that the introduction of the euro has had visible effects on cross-country price dispersion even though price convergence has not yet been completed. To the extent that, despite the evidence of convergence, price differences across EMU countries remain significant after some years from the introduction of the euro, Goldberg and Verboven (2004) and Gil-Pareja and Sosvilla-Rivero (2008) conclude that additional measures to promote integration are needed to achieve full integration of the European car markets. In addition to tax harmonization, one of such measures, often pointed out by researchers, has been the liberalization of the car distribution system in the EU.

Despite the removal of a great part of the barriers within the EU in 1993, some obstacles to cross-border trade have remained until the first half of the 2000s. In particular, the major obstacle to cross-border trade came from the selective and exclusive distribution system authorised by Regulation 123/85 (from 1985 to 1995) and 1475/95 (from 1995

¹ Price convergence in the European Union has been widely tested. Some recent examples are, among others, Dreher and Krieger (2010), Robinson (2007), Roos (2006), Kasman, Kirbas-Kasman and Turgutlu (2005) and Sosvilla-Rivero and Gil-Pareja (2004).

² The external studies are provided at http://ec.europa.eu/competition/sectors/motor_vehicles/overview_en.htm.

³ See Gil-Pareja and Sosvilla-Rivero (2008) for a review of the literature on price convergence in the European car market.

up to 30 September 2002). This distribution system aimed to restrict sales of new cars in the EU to dealers chosen by manufacturers, becoming very difficult for independent wholesalers to buy cars in bulk in one country and resell them in another. An important liberalization of the distribution system was introduced by the Regulation 1400/2002 that became fully operative in October 2005. The new distribution system allows manufacturers to grant either selectivity or territorial exclusivity, but not the combination of both. It remains an open question whether the new system has led to a decrease in absolute price differentials. The sample period considered in previous studies does not allow answering this question.

Our study makes several contributions to the area of testing the degree of car price convergence across the fifteen EU member countries (EU15) prior to the 2004 and 2007 enlargements. First, we apply recently developed econometric techniques to test panel stationarity that assume a highly flexible trend function by incorporating multiple structural breaks positioned at different unknown dates, as well as accommodating general forms of cross-sectional dependence and controlling for finite-sample bias through bootstrap methods (Carrion-i-Silvestre *et al.*, 2005). Second, we use an up-to-date dataset, covering several years after the introduction of the new regulatory framework. Finally, we consider two different notions of convergence, stochastic and deterministic through the inclusion or not of linear trends and slope shifts in the specification.

The remainder of the paper is organised as follows. Section 2 briefly describes the data and the empirical strategy employed in the analysis. In Section 3 we present the results of the analysis of both stochastic and deterministic convergence across EU15 countries. Finally, Section 4 makes some concluding remarks.

2. Data and methodology

2.1. Data description

The data used in this paper comes from the car price report published twice a year by the EC since 1993. From May 2007 the report is published once a year. This initiative was launched following numerous complaints from consumers about differences in car prices between Member States and obstacles placed in the way of those consumers that wished to buy in another EU country.

The car price report is based on standardised data provided by European and Japanese car manufacturers in co-operation with their respective associations and is widely distributed and made available on the EC Directorate General for Competition's website. The number of car models included in these surveys ranges from 72 to 91. The prices are adjusted for equipment differences and are given in local currency and in ECU/euros, both before and after tax. It should be noted that actual retail prices may differ from recommended list prices, as dealers are free to set their own prices.

Although the car price report provides data for all 27 EU Member States, we only analyse data for the EU15, since the sample for those countries that joined the UE in 2004 and 2007 is very small. In particular, we use pre-tax prices for the following 15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the United Kingdom. The car models considered are those with appropriate data in the range of countries and periods for the purposes of this paper. As a result, we have selected a sample of 45 models covering all segments of the market (mini cars, small cars, medium cars, large cars, executive cars, luxury cars and multi purpose and sports utility).

2.2. Empirical strategy

We start by computing, for each observation, the log-difference in the price of a specific car model in a given country relative to the average price level for such model in the sample of EU15 countries:

$$p_{i,t}^m = \ln(P_{i,t}^m) - \ln(\bar{P}_t^m) \quad (1)$$

where $P_{i,t}^m$ denotes the price of model m in country i at time t , \bar{P}_t^m is the average price of model m for the sample of EU15 countries, $i=1, \dots, 15$ stands for the number of countries, $m=1, \dots, 45$ for the number of car models and $t=1, \dots, 30$ stands for the time periods.

According to Bernard and Durlauf (1995) there is time-series convergence in our context when the long-run forecasts of $p_{i,t}^m$ tend to zero as the forecasting horizon tends to infinity:

$$\lim_{k \rightarrow \infty} E(p_{i,t+k}^m / I_t) = 0 \quad (2)$$

Therefore, tests for the time series notion of convergence require $p_{i,t}^m$ to be stationary.

Carlino and Mills (1993) proposed a weaker definition of convergence in time series analysis: *stochastic convergence* or *catching-up*. In our case, there is stochastic

convergence if $p_{i,t}^m$ is trend stationary, allowing for permanent differences in car prices with respect to the EU15 average across countries through the presence of a linear trend in the deterministic component of the trend function. Without stationarity, shocks in relative car prices could lead to permanent deviations in any tendency towards convergence.

In contrast, Li and Papell (1999) postulated a stronger definition of convergence, called *deterministic convergence*, which in our context implies that $p_{i,t}^m$ is mean stationary. This requires the elimination of both deterministic and stochastic trends, thereby entailing the price of a given car model in one country move in parallel over the long run relative to that in the EU15 average. Therefore, deterministic convergence implies stochastic convergence, but not the other way around.

Our empirical strategy is based on investigating both time series definitions of convergence taking a panel approach to exploit the time series and cross-section dimensions of the data.

2.3. Panel stationary test with multiple structural breaks

The panel stationarity test developed by Carrion-i-Silvestre *et al.* (2005) is a generalization for the case of multiple changes in levels and slope of the panel stationarity test proposed by Hadri (2000).

Under the null hypothesis of a stationary panel, the data generating process for $p_{i,t}^m$ is assumed to be:

$$p_{i,t}^m = \alpha_{i,0} + \sum_{k=1}^{l_i} \gamma_{i,k} DU_{i,k,t} + \beta_i t + \sum_{k=1}^{l_i} \theta_{i,k} DT_{b,k,t}^* + \varepsilon_{i,t} \quad (3)$$

with the dummy variable $DT_{b,k,t}^* = t - T_{b,k}^i$, for $t > T_{b,k}^i$ and 0 elsewhere, and another dummy variable $DU_{i,k,t} = 1$ for $t > T_{b,k}^i$ and 0 elsewhere, with $T_{b,k}^i$ denoting the k th date break for the i th individual, $k=1, \dots, l_i$, $l_i \geq 1$. The model (3) includes individual effects, individual structural breaks effects, temporal effects (if $\beta_i \neq 0$) and temporal structural effects (if $\gamma_{i,k} \neq 0$). In this case, non-rejection of the null hypothesis implies stochastic convergence in car prices for all countries, while rejection implies divergence for at least one (but not necessarily all) countries forming the sample.

When investigating deterministic convergence for all countries, we drop from equation (3) both country-specific time trends and slope shifts such that

$$p_{i,t}^m = \alpha_{i,0} + \sum_{k=1}^{l_i} \gamma_{i,k} DU_{i,k,t} + \varepsilon_{i,t} \quad (4)$$

In this case, non-rejection of the null hypothesis implies deterministic convergence in car prices for all countries, while rejection implies divergence for at least one country in the sample.

Carrion-i-Silvestre *et al.* (2005) compute their panel stationary test as the average of univariate Kwiatkowski *et al.* (1992, KPSS hereafter) tests, taking in our case the following expression:

$$LM(\lambda) = 15^{-1} \sum_{i=1}^{15} (\hat{\omega}_i^{-2} 30^{-2} \sum_{t=1}^3 \hat{S}_{i,t}^2) \quad (5)$$

where $\hat{S}_{i,t}^2 = \sum_{j=1}^t \hat{\varepsilon}_{i,j}^2$ denotes the partial sum process that is obtained using the estimated

OLS residuals from equation (3) or (4), depending on the specification. $\hat{\omega}_i^2$ represents an autocorrelation and heteroskedasticity consistent estimate of the long-run variance of the residuals. Equation (5) allows for heterogeneity in the estimation of the long-run variance across countries, but homogeneity can also be imposed, reformulating it as $LM(\lambda) = 15^{-1} \sum_{i=1}^{15} (\hat{\omega}_i^{-2} 30^{-2} \sum_{t=1}^{30} \hat{S}_{i,t}^2)$ with $\hat{\omega}^2 = 15^{-1} \sum_{i=1}^{15} \hat{\omega}_i^2$. For the sake of robustness, we will compute the panel KPSS tests under both assumptions.

Note that λ is used in equation (5) to denote the dependence of the test on the dates of break. For each i , it is defined as the vector $\lambda_i = (\lambda_{i,1}, \dots, \lambda_{i,m_i})' = (T_{b,1}^i / 30, \dots, T_{b,m_i}^i / 30)'$ which indicates the location of the breaks relative to the whole period (30 in our case). This vector of break locations is unknown a priori and must be estimated for each individual time series before the panel statistic can be assembled. We select the appropriate number of structural breaks using the sequential procedure of Bai and Perron (1998).

Once $\hat{\lambda}_i$ is obtained, $i=1, \dots, 15$, we compute the normalised test statistic as follows:

$$Z(\hat{\lambda}) = \frac{\sqrt{15}(LM(\hat{\lambda}) - \bar{\xi})}{\bar{\zeta}} \quad (6)$$

where $\bar{\xi}$ and $\bar{\zeta}^2$ are computed as averages of individual means and variances of univariate KPSS tests for country i . Carrion-i-Silvestre *et al.* (2005) show that $Z(\hat{\lambda})$ has a standard normal distribution with a good finite sample performance.

Finally, note that the computation of the $Z(\hat{\lambda})$ statistic requires that individual series are cross-section independent. Since this assumption is rarely found in practice, especially in integrated economies like the EU15, to account for cross-section dependence of the statistic, we have computed the bootstrap distribution following the bootstrap procedure suggested by Maddala and Wu (1999).

3. Empirical results

3.1. Stochastic convergence

Let us start by considering a weaker definition of convergence in time series context, stochastic convergence, which postulates convergence if the log of relative price is trend stationary. Table 1 reports the results from the panel stationarity test proposed by Carrion-i-Silvestre *et al.* (2005) that allows for multiple level and slope shifts in the trend function. We allow for up to 5 structural breaks affecting the time series and using the modified Schwarz information criterion of Liu *et al.* (1997) to determine the number of structural breaks. As can be seen, with the panel KPSS test assuming normality and

cross-independence, we strongly reject the null of regime-wise trend stationarity in car prices at the 1% level, regardless of the car model and of the degree of homogeneity in the estimation of the long-run variance. Therefore, there is a clear evidence supporting divergence in car prices for our sample of EU countries. However, this conclusion is radically altered when comparing the results with the critical values from the bootstrap distribution. As a consequence, we are no longer able to reject the null of stochastic convergence in car prices, suggesting that the (log of) relative prices is trend stationary.

It should be notice that if there is a linear trend when ‘stochastic convergence’ cannot be rejected, car prices could still be diverging, depending on the sign of the time trend. Nevertheless, we find negative time trends, indicating that prices are converging during the sample period. Moreover, all individual coefficients in the time trends, which are allowed to be country-specific, are negative, obtaining once again support for our conclusion on the overall price convergence.

[Table 1, here]

The break points, as identified, vary from model to model and from country to country in general. Recall that these breaks are searched endogenously from the data and our procedure does not rely on pre-test information to determine them, thereby avoiding the possible problem of “data mining”. The average number of breaks, it goes from 0.46 in the case of the Seat Cordoba to 2.31 for the Honda Accord. The detailed results, not reported to save space but available from the authors upon request, suggest that most of the 895 breaks identified occurred in the years 1996 and 2002 and in the 1998-2000 period. The breaks detected in 1996 and 2002 coincide with the implementation of main legislative changes regarding the elimination of the selective and exclusive distribution system authorised by Regulation 123/85 (from 1985 to 1995) and 1475/95 (from 1995 up to 30 September 2002), that allowed manufacturers to fragment the Single Market and artificially keep prices high in certain countries. Special consideration is due to the distribution system introduced by the Regulation 1400/2002 that, although was supposed to became fully operative in 2005, the significance of the 2002 break could be reflecting the fact that car makers anticipated the effects on prices of the greater competition that was expected as a result of such regulation. Furthermore, the 2002 break could also be associated with the euro cash changeover that led to a reduction of information costs and an increase of price transparency. Regarding the breaks found for the 1998-2000 period, they are associated with the introduction of EMU.

3.2. *Deterministic convergence*

Having established the existence of stochastic convergence in European car prices, we shift the focus to investigate deterministic convergence, requiring that the log of relative prices be level stationary. Hence it is considered a stronger notion of time series convergence than stochastic convergence.

Table 2 reports the results from the panel stationarity test proposed by Carrion-i-Silvestre *et al.* (2005) for the specification with country-specific intercepts and mean shifts. As can be seen, we are able to reject the null of joint regime-wise mean stationarity at the 1% level for the asymptotic case in some car models when assuming homogeneity in the estimation of the long-run variance and in most of the cases when assuming heterogeneity in the estimation of the long-run variance. Nevertheless, as with

the case of stochastic convergence, these results are completely overturned when we compare the panel KPSS statistics with the bootstrap critical values, except for the Toyota Starlet/Yaris case when assuming homogeneity in the estimation of the long-run variance and the cases of Ford Escort/Focus, Range Rover, Toyota Starlet/Yaris, Volvo 440/s40, VW Polo and VW Passat when assuming heterogeneity in the estimation of the long-run variance.

But once more, even in the case of ‘deterministic convergence’ there could be a rise in price dispersion when some of the coefficients on DU are positive. Nevertheless, our results suggest that those coefficients are all negative, further reinforcing our conclusion on the overall price convergence.

[Table 2, here]

As for the average number of detected breaks, it goes from 0.40 in the case of the Nissan Primera to 2.00 for the Audi A6 and the Mercedes 320S/S350. We find a high heterogeneity between series regarding the dates in which the break points are located (detailed results are available upon request). Nevertheless, most of the 745 breaks identified occurred in the years 1996 and 2002 and in the 1998-2000 period, being generally consistent the previously reported breaks for stochastic convergence and being associated as before both with main legislative changes aimed to eliminate major obstacles to cross-border trade and with the implementation of EMU.

4. Concluding remarks

During the past five decades, EU countries have made a major effort to integrate their national economies. The signing of the Treaty of Rome creating the European Community (1957), the establishment of a single market ensuring the free movement of goods, services, capital and people (1993), and the recent introduction of EMU and the euro (1999) have been landmarks in the process towards a deepening and widening European integration, making Europe a particularly interesting case to study the convergence of price levels.

This paper has offered empirical evidence of price convergence in one market that has attracted special attention during the last decade: the European car market. In particular, we have examined whether the EU15 car market have become integrated making use of recently developed econometric techniques and an up-to-date dataset. Therefore, and in contrast to previous papers, our empirical strategy makes use of time series techniques which incorporate structural breaks to explore both deterministic and stochastic convergence to analyse the most recent sample. In these techniques, the breaks are searched endogenously without using a priori information, allowing for multiple structural breaks positioned at different unknown dates for each car market under study. It is also interesting to note that, by adopting a disaggregated approach focusing in the car market, we analyse homogeneous categories of goods and therefore taking greater consideration of the issue of comparability that is usually done in the case of available studies that are based on price measures with higher level of aggregation.

We find considerable evidence of both types of convergence in our sample of countries and car models, therefore suggesting a tendency for relative prices to equalise over time. In addition, we find ample evidence regarding the importance in this convergence

process of both legislative changes opening up markets in terms of geography, products and competitors taking place in the years 1996 and 2002, and the implementation of EMU. This conclusion on the impact of EMU is consistent with previous results in the literature, whereas to our knowledge the importance of regulatory regimes is a novelty. Nevertheless, it is worth noting that institutional idiosyncrasies or major economic events could be still at play given the heterogeneity of break points detected both within models and across countries. The reason for this heterogeneity is reserved for future research.

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Table 1: Stochastic convergence: Panel KPSS stationary test with structural breaks

Model	$Z(\hat{\lambda})$ (homogeneous)					$Z(\hat{\lambda})$ (heterogeneous)				
	Tests	p-value	Bootstrap critical values			Tests	p-values	Bootstrap critical values		
			10%	5%	1%			10%	5%	1%
Alfa 145/147	10.0575	0.0000	15.1049	17.1501	21.6199	12.9560	0.0000	31.8311	36.2285	46.1580
Alfa 155/156	9.0849	0.0000	13.4900	15.9553	21.6099	17.7419	0.0000	18.0319	20.4414	25.5264
Audi A4	8.5018	0.0000	20.1185	22.8437	25.9502	32.4404	0.0000	33.5260	38.1383	48.9453
Audi A6	6.1351	0.0000	18.3043	21.3672	28.6048	14.7854	0.0000	36.7194	41.3363	52.2404
BMW 3-series	13.5949	0.0000	20.4320	24.0798	33.1554	18.1414	0.0000	30.6480	38.2202	47.9026
BMW 5-series	7.5138	0.0000	12.3490	14.6031	19.5852	11.8731	0.0000	20.2947	23.5241	30.7345
BMW 7-series	7.7633	0.0000	23.7069	28.2559	39.0826	23.8723	0.0000	40.3344	45.7623	59.3330
Citroën AX/saxo/C2	1.2526	0.1052	11.2551	13.9531	19.9028	7.1908	0.0000	5.3540	19.3505	30.4672
Citroën ZX/ Xsara/C4	4.2217	0.0000	24.4593	29.2742	41.7639	16.6271	0.0000	55.0019	64.9429	89.1282
Citroën Xantia/C5	7.0876	0.0000	11.0841	12.8343	16.6810	19.9059	0.0000	21.0785	24.3558	32.2775
Fiat Cinq./Seicento/Panda	6.5237	0.0000	18.1873	21.1318	27.6727	15.9600	0.0000	44.2399	50.9888	67.2851
Fiat Punto	4.1996	0.0000	9.6947	11.1009	14.0665	6.3823	0.0000	18.1999	20.7382	25.9332
Fiat Bravo/Stilo	6.1791	0.0000	10.4410	11.9812	15.1893	9.7487	0.0000	18.5439	21.1092	26.9148
Ford Fiesta	6.2129	0.0000	10.1996	11.4160	14.1863	17.7386	0.0000	20.3443	22.3443	25.6468
Ford Escort/Focus	13.2310	0.0000	12.0044	13.4584	16.6466	17.0880	0.0000	24.1812	27.2166	34.6583
Ford Mondeo	9.6170	0.0000	11.8151	13.0254	15.9290	16.9809	0.0000	25.7706	29.0749	36.7762
Honda Civic	18.6678	0.0000	16.0759	18.2733	22.9178	64.4946	0.0000	32.9544	37.0700	47.2870
Honda Accord	17.9981	0.0000	25.8938	30.8390	41.6855	32.4838	0.0000	55.5966	65.8596	93.7447
Mazda 3-series	5.9535	0.0000	10.2534	11.6925	14.4564	9.2109	0.0000	19.1983	21.9692	28.3366
Mercedes 180/c180	4.2997	0.0000	12.9748	15.1052	19.9050	10.6713	0.0000	19.7804	22.4613	28.3812
Mercedes 200E/E220	3.4377	0.0003	11.8566	13.9140	18.4347	22.8848	0.0000	23.4719	27.2302	37.0124
Mercedes 320S/S350	10.4022	0.0000	19.0123	22.8351	31.5169	52.9155	0.0000	32.8985	37.7965	49.5313
Nissan Micra	7.3199	0.0000	11.1833	12.7424	16.3514	9.7019	0.0000	21.5370	24.7484	33.8722
Nissan Sunny/Almera	7.8818	0.0000	10.4501	12.1149	15.5882	9.9334	0.0000	19.2858	22.1289	28.9618
Nissan Primera	8.8054	0.0000	10.3814	11.6123	14.5838	14.1598	0.0000	19.8582	22.7210	28.9571
Opel Corsa	6.0895	0.0000	11.9387	13.5948	17.0721	12.6829	0.0000	19.8821	22.5125	27.9026
Opel Astra	6.9591	0.0000	8.6332	9.7623	12.4368	15.1122	0.0000	17.7030	20.1566	25.9628

Opel Vectra	5.9918	0.0000	11.8017	13.5013	17.1391	18.5755	0.0000	20.8119	23.3062	29.4250
Opel Omega/Signum	4.4206	0.0000	12.2514	13.8367	17.3702	15.5610	0.0000	26.4486	30.1777	39.1516
Peugeot 306/307	2.5268	0.0058	11.1295	13.1619	17.8827	12.8351	0.0000	16.1627	18.6900	24.7659
Peugeot 405/406/407	7.7485	0.0000	19.2399	22.4928	30.5181	35.4790	0.0000	43.6203	50.1752	67.0210
Renault Clio	4.2394	0.0000	12.5983	14.3693	18.5958	14.5891	0.0000	26.7532	30.5428	38.9293
Renault 19/Megane	5.6054	0.0000	12.3423	14.4103	19.0955	11.6504	0.0000	24.6751	28.1244	36.8950
Renault 21/Laguna	11.7039	0.0000	14.2095	16.5294	21.3500	16.9757	0.0000	27.8993	31.7878	40.5860
Range Rover	12.9248	0.0000	38.4280	46.9396	68.1298	145.3944	0.0000	183.7544	228.3422	382.0095
Seat Ibiza	4.0873	0.0000	10.5656	12.0531	15.3560	9.9015	0.0000	19.1059	21.6606	27.6314
Seat Cordoba	5.5657	0.0000	10.0198	11.3273	14.2305	9.1113	0.0000	22.4447	25.4979	33.6115
Seat Toledo	7.3870	0.0000	11.9026	13.3338	16.6049	12.3074	0.0000	23.1987	26.3176	33.3570
Toyota Starlet/Yaris	8.6830	0.0000	10.7054	12.5342	16.6993	9.2246	0.0000	19.3857	22.8612	31.1036
Toyota Corola	3.0501	0.0011	11.9719	14.9131	21.1316	5.5108	0.0000	20.3678	23.3408	30.1940
Toyota Carina/Avensis	9.7582	0.0000	12.2232	13.9021	17.5765	12.0321	0.0000	26.2787	29.8183	37.9578
Volvo 440/s40	3.4720	0.0003	10.9367	12.5431	15.8925	9.8519	0.0000	18.8913	21.3713	26.9432
VW Polo	10.2838	0.0000	13.2800	15.5521	20.7887	24.9213	0.0000	30.2544	34.4611	44.0007
VW Golf	14.5081	0.0000	20.8252	24.0230	31.5623	27.9248	0.0000	38.0633	42.6754	53.4940
VW Passat	7.2116	0.0000	15.5328	17.7924	22.7087	17.1996	0.0000	42.1883	49.3055	67.7623

Table 2: Deterministic convergence: Panel KPSS stationary test with structural breaks

Model	$Z(\hat{\lambda})$ (homogeneous)					$Z(\hat{\lambda})$ (heterogeneous)				
	Tests	p-value	Bootstrap critical values			Tests	p-values	Bootstrap critical values		
			10%	5%	1%			10%	5%	1%
Alfa 145/147	1.2811	0.1001	5.3770	6.3610	8.8201	4.1669	0.0000	7.3780	8.6907	11.8821
Alfa 155/156	1.1229	0.1307	3.9848	4.7798	6.4437	1.0917	0.1375	5.6636	6.7086	9.3900
Audi A4	0.8834	0.1885	9.3920	11.4134	16.3980	5.9889	0.0000	8.4352	9.8539	13.1866
Audi A6	-0.2968	0.6167	7.9385	9.6036	13.4348	4.7119	0.0000	8.5736	10.0712	13.8510
BMW 3-series	4.4515	0.0000	6.8145	8.5277	12.6888	6.6990	0.0000	8.6905	10.3223	14.0421
BMW 5-series	6.7838	0.0000	7.8287	10.3491	16.0799	6.2057	0.0000	8.2402	10.1644	14.9226
BMW 7-series	4.8111	0.0000	4.9393	6.4680	10.0551	7.8100	0.0000	7.0335	8.9604	13.1972
Citroën AX/saxo/C2	-0.3547	0.6386	3.4484	4.2219	5.9104	0.1287	0.4488	4.2376	5.1823	7.5259
Citroën ZX/ Xsara/C4	1.5490	0.0607	7.8127	10.3193	16.3767	5.9157	0.0000	5.9975	7.3667	10.7838
Citroën Xantia/C5	1.0105	0.1561	10.1125	13.7502	23.7160	5.9531	0.0000	10.0276	11.8065	15.9572
Fiat Cinq./Seicento/Panda	1.7661	0.0387	6.4217	7.8909	11.1701	8.8648	0.0000	8.4638	10.1197	13.9716
Fiat Punto	-0.4130	0.6602	7.9925	10.0628	14.5913	0.1638	0.4349	7.3529	8.6707	11.6804
Fiat Bravo/Stilo	-0.4542	0.6752	4.4028	5.5086	8.0179	4.6755	0.0000	5.8363	7.0846	9.9913
Ford Fiesta	4.5181	0.0000	6.0798	7.5773	10.8330	7.4411	0.0000	8.0974	9.6913	13.4821
Ford Escort/Focus	3.5107	0.0002	5.0329	6.3665	9.6228	12.1652	0.0000	6.6887	8.2229	11.9750
Ford Mondeo	2.9322	0.0017	5.9415	7.5795	11.4737	4.9662	0.0000	6.4180	7.8023	11.1003
Honda Civic	2.9291	0.0017	5.6923	6.6763	8.7000	4.2069	0.0000	7.6089	8.8651	11.6570
Honda Accord	1.3850	0.0830	6.8307	8.4019	12.0775	0.6636	0.2535	10.0416	11.9551	16.2667
Mazda 3-series	3.0018	0.0013	4.8317	6.0159	8.6014	2.5320	0.0057	6.6793	8.0040	11.4559
Mercedes 180/c180	4.7436	0.0000	5.1903	6.8743	11.0204	4.0384	0.0000	5.9920	7.5679	11.0812
Mercedes 200E/E220	7.0474	0.0000	6.4651	8.3418	12.7930	7.6664	0.0000	7.6730	9.7583	14.2630
Mercedes 320S/S350	6.2350	0.0000	7.5567	9.4348	14.1550	19.9740	0.0000	10.8074	12.9553	18.4234
Nissan Micra	0.1130	0.4550	4.0887	5.1677	7.4274	5.3849	0.0000	5.2946	6.5156	9.4002
Nissan Sunny/Almera	2.0771	0.0189	3.6110	4.3902	6.1261	6.3104	0.0000	6.2545	7.3745	10.0110
Nissan Primera	3.8167	0.0001	4.1750	5.2968	7.8888	4.8940	0.0000	6.0614	7.4138	11.0149
Opel Corsa	2.9797	0.0014	4.9753	6.1313	8.5299	2.7336	0.0031	5.9714	7.0959	9.6776
Opel Astra	1.1203	0.1313	5.0812	6.1406	8.7234	3.0250	0.0012	7.6188	8.9658	11.9371

Opel Vectra	0.5995	0.2744	4.5734	5.5890	7.9748	1.6527	0.0492	6.2503	7.5002	10.4881
Opel Omega/Signum	0.0199	0.4921	5.2724	6.4517	8.9414	3.1210	0.0009	6.6478	7.9161	11.0713
Peugeot 306/307	0.0478	0.4810	4.2953	5.5003	8.5757	0.8291	0.2035	6.0802	7.5061	11.2231
Peugeot 405/406/407	-0.3515	0.6374	4.9037	6.1277	9.1010	0.7614	0.2232	6.3560	7.8318	11.6661
Renault Clio	-0.0077	0.5031	5.0108	5.9706	8.1590	3.7327	0.0001	7.7931	9.2412	12.9551
Renault 19/Megane	1.9251	0.0271	5.4642	7.0434	10.7953	3.2957	0.0005	7.4159	8.9789	12.7255
Renault 21/Laguna	-1.0670	0.8570	6.7192	8.7191	13.3277	0.1768	0.4298	7.1882	8.8035	12.6467
Range Rover	2.5187	0.0059	11.1261	16.5915	27.4000	3.6060	0.0002	15.3723	18.7831	25.9916
Seat Ibiza	0.4875	0.3130	3.1858	3.9404	5.4912	3.4517	0.0003	4.9991	5.9584	8.5155
Seat Cordoba	5.1654	0.0000	5.9163	7.1483	9.7657	7.1729	0.0000	8.6017	10.0739	13.7430
Seat Toledo	2.5903	0.0048	5.1179	6.2183	8.5974	5.3924	0.0000	6.3436	7.4481	10.0409
Toyota Starlet/Yaris	9.9406	0.0000	6.8189	8.9864	14.8644	5.7499	0.0000	6.3482	7.9209	11.4175
Toyota Corola	2.4852	0.0065	5.5855	7.6539	12.1794	2.8603	0.0021	7.4112	9.2348	13.3794
Toyota Carina/Avensis	2.6051	0.0046	3.9168	4.8516	7.0224	3.3202	0.0004	7.6520	9.3629	13.0244
Volvo 440/s40	6.1218	0.0000	5.6873	7.2772	12.0075	6.3015	0.0000	6.7256	8.0051	11.1010
VW Polo	2.4284	0.0076	7.6802	9.9520	15.6727	4.8937	0.0000	7.0270	8.7641	13.6186
VW Golf	4.5681	0.0000	11.1080	15.2777	26.4963	7.1335	0.0000	7.6770	9.1673	12.9726
VW Passat	1.9075	0.0282	8.7564	11.8048	19.9021	4.1922	0.0000	7.4264	9.0850	13.4762