Cross-country price dispersion and the Euro

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24 December 2003

SUMMARY

This paper investigates the effects of the European Monetary Union (EMU) on cross-country price differences in the European car market. The analysis utilizes disaggregate, bi-annual data on the prices of almost all car models sold in the 15 countries of the European Union over 1993-2003. The data refer to identical models, with identical specifications and options. To identify the EMU effect, we exploit the fact that out of the 15 countries in our sample, 12 joined the EMU at the beginning of 1999 and officially adopted the Euro as their national currency at the beginning of 2002, while 3 countries remained outside the monetary union. We investigate whether there is a systematic difference in the evolution of cross-country price dispersion between EMU members and non-members following the formation of the EMU. Our analysis distinguishes between Phase I (EMU with national currencies preserved, 1999-2001) and Phase II of the Euro (official adoption of the Euro as a national currency in 2002). We examine the evolution of both the absolute price differentials across countries, and the speed with which deviations from the long-term cross-country differentials get eliminated. We find that in the pre-EMU era, countries that later joined the EMU exhibited lower price differentials relative to the base country of the Netherlands, by approximately 6%. The EMU further reduced these differentials by a small but significant percentage (ca. 1.5%) between 1999 and 2001; this reduction in EMU countries happened while the price differentials in non-EMU countries relative to the Netherlands increased during this period. The price differentials in EMU countries further decreased following the official Euro adoption in 2002. However, we cannot attribute this decline to the Euro, as we witness an even faster decrease of price differentials in non-EMU countries over 2002-2003. Despite these reductions, cross-country price differences remain large, even among EMU members. Regarding the speed of convergence, we find that the half-life of price shocks is substantially shorter in EMU countries compared to non-EMU countries (0.5 versus 1.2 years). However, we do not find that the EMU further increased the speed of convergence -- if anything the half-life of shocks slightly increases in EMU countries after 1999. We attribute this finding to non-linearities in the price adjustment process, implying that small price shocks get eliminated more slowly than large shocks. Overall our results suggest a big role for exchange rate stability in reducing international price dispersion, a smaller role for a monetary union, and the need of additional measures towards integration (e.g., liberalization of the distribution system, reduction of high registration taxes in particular countries) to further reduce international price differences.

Contents - Overview:

1. INTRODUCTION

Large and persistent deviations from the Law of One Price in international markets have been one of the major puzzles in International Economics. Among the various explanations suggested in the literature (trade barriers, transportation costs, language and other cultural differences across countries, etc.), nominal exchange rate volatility has always played a prominent role. The transition to the European Monetary Union (EMU) in the 1990's and the subsequent official adoption of a common currency (Euro) by the EMU member countries offer a unique historical experiment for the purpose of assessing the validity of this explanation.

The particular question this paper hopes to address is "Have the EMU and subsequent Euro adoption made a difference regarding convergence to the Law of One Price?" The EMU and the Euro may affect convergence in two senses. First, one could claim that with integrated markets, prices of identical products should be equal across countries. This is the absolute version of the Law of One Price. The EMU and the Euro have an impact on convergence to the absolute version of the Law of One Price if they lead to a reduction, in absolute terms, of the price differentials across countries. Second, it is possible that even with integrated markets, some cross-country price dispersion remains, reflecting local factors (costs, minor differences in product specifications in response to local demand conditions or regulation, etc.) that cannot be arbitraged away. These price differences are expected to be small, similar in magnitude to the ones observed across different locations within national borders; nevertheless, they would be permanent. This is the relative version of the Law of One Price. In the context of this, less stringent, version of the Law of One Price, the EMU and the Euro may still have an impact on the speed with which temporary deviations from the long-term cross-country price differentials are eliminated. Accordingly, this paper focuses on two sub-questions: (a) "Has the EMU/Euro led to a decrease in absolute price differentials?", and (b) Has the EMU/Euro affected the speed with which deviations from long-term price differentials are eliminated?"

While most empirical work in International Economics has focused on the relative version of the Law of One Price, we believe that an assessment of the impact of the EMU should involve an investigation of both versions. Conclusions regarding the

impact of the EMU based on the relative version alone can be misleading. Suppose, for example, that we find that the EMU has caused cross-country price differentials to converge fast to their long-term levels; still, we would hardly characterize the corresponding markets as integrated, if these long-term price differentials were exceedingly large. Despite the importance of investigating absolute, in addition to relative, price differences in international markets, data constraints have in the past prevented researchers from doing so. The data usually employed in international price comparisons are fairly aggregate price data, or price indices, not suited to an examination of the absolute version of the Law of One Price[1]; even when disaggregate data are available, it is rarely the case that the *identical* goods assumption needed for the absolute version holds.

In this study we examine the impact of the EMU and the Euro on absolute price convergence and on the speed of convergence using data from the European car market over 1993-2003. By confining our analysis on one particular market we are able to utilize the kind of disaggregate data one needs in order to investigate absolute differences in the prices of identical products; in particular, we use the bi-annual car price data collected by the European Commission that refer to identical models with identical specifications and identical options. Our focus on automobile prices specifically is motivated by the fact that the international car market has been a notorious example of deviations from the Law of One Price. Given that automobiles constitute one of the most significant consumer purchases, these deviations have important implications for consumer welfare and are thus economically significant.

The large and persistent cross-country differences in the prices of virtually identical products in Europe have prompted several investigations by the European Commission in recent years, and they have been the center of intense public debate. Consumer organizations have argued that the price differences are the result of price discriminating practices by auto manufacturers, while industry representatives have defended them as the result of tax differences and exchange rate fluctuations. The Commission has viewed price differentials as a potential threat to the European market integration, and has taken concrete measures to eliminate such differences (e.g., monitoring of prices, harmonization requirements, etc.). In addition to these

[1] However, disaggregate data have become more widely available in recent years. See for example Engel and Rogers (2003) for a recent study of related issues using product-level data from the Economist Intelligence Unit.

measures, the participation of many European countries in the EMU is presumed to have facilitated price convergence, since it has eliminated one of the main suspects for international price differences, namely nominal exchange rate volatility.

So, we ask, what has happened to the cross-country price differentials in Europe in the last decade? Were they reduced? And, if so, what role have the EMU and Euro played in this reduction? In investigating the role of the EMU, we face the challenge of isolating the pure EMU or Euro adoption effects from other concurrent developments that have affected cross-country price dispersion, most importantly the set of measures that the European Commission took in the 1990's in order to reduce car price differentials in Europe. In principle, one could exploit the timing of the various policy changes to this end, as most integration measures were put in effect in the early 1990's, while the EMU did not become effective until January 1, 1999, and the Euro was not officially adopted by the member countries until January 1, 2002. However, many integration policies could have affected the car market with a lag, while the EMU was anticipated in advance. To identify the EMU and Euro effects we therefore rely on a different identification strategy and exploit the difference between EMU and non-EMU countries in conjunction with the timing of the EMU to infer whether there was a different pattern in the evolution of price dispersion in EMU members after the launch of the EMU (and subsequently after the Euro adoption) compared to non-EMU members – a sort of difference-in-differences approach.

This work can inform the current policy debate on integration in Europe in several ways. First, the comparison between countries that have joined the EMU and countries that have not, has implications for the role of exchange rate policy. Evidence that price differentials across EMU-members become smaller over time, and/or get eliminated faster than in the other countries of the European Union would suggest that exchange rate stability has contributed to market integration beyond the role of other integration measures. Furthermore, evidence that price differentials in EMU countries decline even further once the Euro replaces the national currencies of the member countries would suggest that the Euro had a distinct effect on market integration, beyond the effect of exchange rate stability (e.g. through increased price transparency). In this case, the adoption of the Euro by countries that have not yet joined the EMU, would be an important step towards further market integration in Europe.

Second, to the extent that we find that price differences across countries that have joined the EMU remain large, one would have to conclude that fixed exchange rates alone do not lead to price convergence. Additional measures (such as the elimination of the restrictive distribution system or tax harmonization) would be called for.

Finally, our results have potential implications for a bigger debate concerning the role of competition policy in Europe and the U.S. It is often claimed that, while competition policy in Europe is in principle supposed to protect consumer interests and promote European integration, in practice it serves firm interests primarily (the restrictive distribution system that effectively constrains dealer competition across European countries, is often mentioned as an example of this latter policy). Finding that the EMU was not sufficient to eliminate cross-country price dispersion would make the case for a more consumer-oriented competition policy in Europe stronger.

The rest of the paper is organized as follows. We start by providing an overview of the European car market in section 2, focusing in particular on the economic incentives and institutions generating deviations from the Law of One Price. In the same section we discuss the measures that the European Commission has taken to promote integration in this market, and the potential role of exchange rate stability, the EMU, and the Euro adoption in reducing price dispersion. In section 3 we discuss the data that the European Commission has made available to us, and offer some preliminary evidence on the evolution of price dispersion based on graphs and tables of raw price data. Section 4 discusses our methodology and identification strategy in detail, and presents the results, first on the absolute, and then on the relative version of the Law of One Price. Section 5 summarizes our findings and discusses their policy implications.

2. CONDITIONS FOR INTERNATIONAL PRICE DISPERSION

Two conditions are required for the existence of international price differences. First, firms should find it *profitable* to set different prices in different countries. This is generally the case if local cost or demand conditions vary across countries. Second, it should be *feasible* to set different prices across countries. Price differences that only stem from international differences in local costs (and thus not markups) are feasible in both segmented and integrated markets, since arbitrageurs may not be able to

arbitrage away the local cost differences. However, price differences that reflect cross-country markup differences, or international price discrimination, are only feasible in markets that are segmented. Without cross-border trade restrictions, differences in markups would be eliminated quickly by large-scale arbitrage activities organized by professional parallel importers of cars.

We start this section with a discussion of the profit incentives to set different prices in different countries. Next, we discuss the institutions that generate market segmentation in the European car market, to assess the feasibility of international price discrimination. Finally, we discuss three channels through which the EMU may have reduced international price dispersion: (1) a direct reduction of cross-country differences in the (Euro denominated) local costs through the permanent elimination of exchange rate volatility; (2) a direct reduction of market segmentation, because of an increased price transparency and reduced transaction costs; and (3) a reduction in the firms' incentives to erect trade barriers in the first place, by reducing the profit incentives to generate international price differences.

2.1 Profit incentives for international price dispersion

Why would firms want to charge different prices across markets? Conceptually, international price differences can be decomposed into two components: differences in local costs and differences in markups.[2] We discuss both in turn.

Local cost differences

In the European car market, local costs are estimated to account for a large fraction of the price of a car, between 35 and 40%. Most of these local costs can be attributed to various kinds of distribution costs (the costs of advertising, marketing, servicing and selling cars incurred by the national importers and dealers). While this number may appear large, it is comparable to the local distribution costs in other industries. To the extent that local costs differ across national markets, firms have incentives to charge

[2] For a more detailed analysis of the role of differences in local costs and markups, we refer the reader to Goldberg and Verboven (2001), and the references therein. They estimate a structural model of automobile demand and oligopoly pricing to quantify the importance of locals costs and markups in generating cross-country price differences (conditional on markets being segmented). Their results on the relative importance of local costs are broadly consistent with estimates from industry sources, and estimates for other sectors in the economy, e.g., the findings of Burstein, Neves and Rebelo (2001) on local distribution costs.

different prices for otherwise identical models.[3] While it is reasonable to expect that local distribution costs would not differ dramatically across integrated markets in the long run (due to factor price equalization), there are reasons to expect that local cost differences still matter at present. A first source of local cost differences comes from the large and persistent car tax differences across the countries of the European Union. While several attempts have been made to harmonize value-added taxes, differences in the range of 5-10% points remain. More importantly, several countries have increasingly applied additional taxes, such as registration taxes, special car taxes, and environmental taxes. As a result, overall taxes account for over 50% of the purchase price in several European countries (i.e., Finland, Greece, Ireland, the Netherlands, and especially Denmark). This is illustrated in Table 1, which shows no evidence of cross-country tax convergence. Since all these car taxes are to be paid in the country of use, they constitute a major source of differing local costs across countries.

Table 1. Car taxes, as a percentage of the purchase price

	May 1999		November 2002	
	Mean	**St. Dev.**	**Mean**	**St. Dev.**
Austria	32	4	32	5
Belgium	21	2	22	7
Finland	80	20	74	7
France	21	3	21	5
Germany	17	4	17	5
Greece	56	19	44	18
Ireland	57	9	59	8
Italy	23	4	23	7
Luxembourg	16	3	16	3
Netherlands	50	6	51	8
Portugal	51	13	60	11
Spain	26	3	26	4
Denmark	170	29	182	27
Sweden	27	4	26	3
U.K.	18	0	20	10

Source: Own calculations, based on the European Commission database.

[3] If the model specifications were not identical across countries, this would obviously generate an additional source of cost differences. For example, due to environmental regulations, some countries (e.g., Germany), introduced catalytic converters earlier than other European countries. We do not further elaborate on this source of cost differences, since our data set contains prices for car models that are identical in all their specifications.

A second source of local cost differences may stem from nominal exchange rate volatility. Purchasing power parity theory teaches us that local costs should not be affected by exchange rates in the long run (since nominal exchange rates and factor prices would change proportionally). However, in the short-run, exchange rate fluctuations may generate substantial differences in local costs. For example, the weak value of the lire during the beginning of the 1990's implied temporarily low local distribution costs in Italy. Similarly, the sudden depreciation of the pound during the first part of the 1990's and its large appreciation at the end of the decade, have resulted in large fluctuations in the Euro denominated value of local costs in that country.

When local costs differ across markets, firms have an incentive to charge different prices for otherwise identical models. Price differences that solely reflect cost differences can occur even when markets are integrated, since arbitrageurs will generally not be able to arbitrage these differences away.[4]

While local cost differences can generate cross-country price differences in both segmented and integrated markets, the degree to which these differences are passed through onto final consumer prices depends on the existence of market segmentation and the ability of firms to set different prices in different countries. We discuss this issue next.

Markup differences

As documented in our previous work, in segmented markets price differentials may be due to markup differences for a variety of reasons. First, demand conditions may differ across national markets. For example, consumers may have a strong preference for domestically produced goods, implying a lower price elasticity of demand for these goods. This would induce firms to charge higher markups for these products (e.g., Fiat and Renault could charge higher markups in their respective home markets, Italy and France). Second, the import quota regimes used to differ across European countries until they were abandoned in 1999. To the extent that the national import

[4] When the cross-country cost differences are short-lived, as for example is the case with cost differences generated by exchange rate fluctuations, it is of course possible for arbitrageurs to import cars into the relatively expensive countries from the relatively cheap countries. But in this case arbitrageurs essentially free-ride on the services provided by the local dealers (marketing, cost of showrooms, etc.), and it is not clear that their activity can co-exist with the current structure of the distribution system in the long run.

quotas were binding, Japanese firms were capacity constrained locally, and responded by charging consumers higher local markups. This phenomenon has been relevant in explaining the higher prices for Japanese cars in France and Italy.

Third, markup differences across countries could be due to incomplete pass-through of the differing local costs discussed above. In a country with higher local costs, firms may have an incentive to partly absorb the higher cost by adjusting their markups downwards. (This requires that the price elasticity of demand is increasing in price). This behaviour is known as markup adjustment, or pricing to market, and is particularly relevant in explaining the low pre-tax prices in the high tax countries Denmark, Finland, Ireland, and Portugal; in addition, it can explain the local currency price stability in countries with volatile exchange rates, such as the U.K. and Italy, which translates into pronounced fluctuations in the Euro-denominated prices of cars sold in these markets.

2.2 Sources of market segmentation

We now turn to a discussion of the sources of market segmentation in the car market, and the continuing efforts by the European Commission to promote integration.

Since the removal of tariff barriers in 1968, segmentation in the European auto market has been driven by three distinct factors: the differing national systems of type approval, the distribution system, and the requirement of national registration. These factors add to the transportation costs, information costs and language barriers that are also present in many other European industries.

Type approval

The differing national systems of type approval have formed until recently a major impediment to consumers seeking to purchase a car abroad. Each European country typically had its own set of vehicle requirements. Costly modifications of the imported vehicle were often needed. Moreover, in most countries the job of checking and certifying the conformity of an imported car was entrusted to the official importers. There is no doubt that this procedure enabled them to control and monitor

the cross-country trade in the cars they were selling. The granting of a certificate often took several weeks, involved costly trips, and required fees that bore no relationship to the services provided.[5]

To eliminate this source of market segmentation, the European Commission aimed to harmonize the set of vehicle requirements across countries. A common list of so-called "essential requirements" for new car models was set out as early as 1970. Yet the implementation process has been very slow and gradual. For a long time countries could allow their national type approval standards to co-exist with the European directives. By 1987, only Italy had adopted the European directives as the single local standard. But the harmonized type approval directives eventually became mandatory, and fully replaced the national systems in 1993.

National registration

A second obstacle to cross-border trade has been the system of national registration. Apart from creating additional administration costs, this system had the effect of limiting trade of foreign, mainly Japanese models. Quantitative restrictions on imports from third countries, in particular Japan, had long existed in five European countries (i.e., France, Italy, Portugal, Spain, and the U.K.). These restrictions took the form of import quotas or voluntary export restraints. The problem is, of course, that parallel imports from other European countries can undo national restrictions. The requirement of national registration solved this problem, since it allowed governments to control the cross-border trade of Japanese cars. In Italy, for example, there existed a tight quota of 3300 cars that could be directly imported from Japan. The total number of Japanese cars that could be officially registered in Italy, including cars from other European countries, was limited to 23000 (slightly more than one percent of the Italian market). The other countries with import quotas applied similar cross-border restrictions.

In 1993, the national quotas were replaced by a common import quota for the European Union as a whole. Nevertheless, the five European countries that previously

[5] For example, the general importer of General Motors in Belgium was convicted in 1975 for demanding excessive fees with the evident intention to discourage parallel imports. BEUC (1982) reports that one importer even charged the difference between the two countries' local prices as a fee for issuing the type-approval certificate.

had national quotas were still able to use the system of national registration as a way of maintaining unofficial national quotas. In 2000, the common import quota was eventually banned. Since that time the system of national registration no longer serves as a way of limiting the cross-border trade of Japanese cars (although it remains, of course, an administrative hurdle for parallel importers).

Selective and exclusive distribution

The third and most debated obstacle to cross-border trade stems from the distribution system. Already during the 1970s and early 1980s many suppliers instructed their dealers (threatening to withdraw their concessions) not to sell to unauthorized resellers, in particular if the purchase was intended for export. Discrimination against resellers also occurred in more subtle forms: excessive delivery lags, high deposit requirements, and higher prices. In addition, it was a regular practice not to carry out after-sales services on imported cars, even if these services fell under the guarantee period. Regulation 123/85 subsequently institutionalised several of these practices as a block exemption to the European competition rules. This regulation was initially approved for 1985-95. It effectively introduced a system of selective and exclusive distribution. Selectivity implies that manufacturers can choose their dealers and prohibit them from selling to independent resellers. (Territorial) exclusivity refers to the manufacturers' right to appoint only one authorized dealer in a geographically limited territory, and prohibit the dealers from active selling policies (such as targeted advertising) outside their assigned territory. Because of the combination of selectivity and exclusivity, neither independent resellers nor authorized dealers can engage in cross-border arbitrage activities to exploit international price differentials. End-consumers could in principle take advantage of international price differentials, but in practice consumers face many obstacles, some of which can be directly attributed to the distribution system (e.g., the system of sales targets, which gives dealers incentives to rather serve local than foreign consumers).[6]

In 1995, the distribution system was renewed for another 7 years (Regulation 1475/95), with some preliminary attempts to liberalize the system (e.g., dealers could

[6] The Regulation stated that the benefits from the distribution system could be withdrawn if price differences between two member states (excluding the high tax countries of Denmark and Greece) exceeded 12% over a period of 6 months, or 18% at any point in time. In practice, however, these threats were not enforced.

more easily advertise outside their own territory). At the same time there were also indications of a stronger enforcement of the existing rules. For example, in 1998 Volkswagen was accused and convicted of putting pressure on Italian dealers not to sell to German and Italian customers. Similar investigations were undertaken for several other companies.

A more drastic liberalization of the distribution system was introduced in 2002, with a transition period of one year, and additional transition periods regarding specific reform measures (such as the location clause); see Brenkers and Verboven (2002) for a detailed discussion. When fully effective, the new distribution system allows manufacturers to grant their dealers either selectivity or territorial exclusivity, but no longer the combination of both. This implies that larger scale cross-border trade activities will eventually become possible, by either independent resellers (if selectivity is abandoned), or by the authorized dealers themselves (if territorial exclusivity is abandoned).

2.3 The role of the EMU/Euro

The above discussion highlighted the key elements that explain the evolution of price differentials in the car market over the last decades. The discussion suggests that the EMU may reduce international price dispersion through three channels: (1) a direct reduction of cross-country differences in the (Euro denominated) local costs through the permanent elimination of exchange rate volatility; (2) a direct reduction of market segmentation, because of increased price transparency and reduced transaction costs; and (3) a reduction in the firms' incentives to erect trade barriers in the first place, by reducing the profit incentives to generate international price differences. We discuss these channels in turn.

The elimination of exchange rate volatility in EMU countries implies that short-term differences in local costs, generated by exchange rate fluctuations, would be permanently eliminated too. Of course, the same effect could be achieved through the adoption of fixed exchange rates; in fact, most EMU member-countries had almost fixed exchange rates in the 1990's, even prior to joining the EMU. Nevertheless, one could argue that a monetary union could have an additional effect, as it makes the fixed exchange rate regime credible in the long run. To the extent that the benefits of

the fixed exchange rate regime were fully realized without participation in the EMU, we would expect EMU countries to have lower price dispersion than non-EMU countries, but we would not expect to see an additional effect once membership in the EMU became official. If, on the other hand, the membership in a monetary union has a distinct effect, we would expect price dispersion in EMU countries to further decline relative to non-EMU countries after 1999.

Policy makers have typically argued that that the Euro will reduce international price dispersion because of the increase in price transparency and reduced transaction costs; see for example Pons and Lucking (1999) for a summary of this view expressed by European policy makers. With a single currency, consumers can compare prices in a common currency and are therefore more likely to shop abroad when price differentials become large. Furthermore, consumers no longer incur transaction costs associated with converting currencies. This argument essentially assumes that the Euro will directly reduce cross-border trade costs and therefore diminish the feasibility of setting different prices. Obviously, to the extent that this argument is relevant to the car sector, it would only apply during the second phase of the EMU, i.e., after 2001, when the Euro currency was introduced.

A somewhat different, more recent line of thinking comes from Friberg (2001, 2003), and Anderton, Baldwin and Tagliatoni (2003). They argue that firms may want to endogenously create market segmentation when the economic circumstances make it profitable to set different prices across countries. Specifically, they show that under a volatile exchange rate regime firms prefer to set different prices across countries (when expressed in a common currency), rather than to maintain a uniform price in all countries. The possibility of maintaining international price differentials, allows firms to keep prices more stable in the local currencies, and hence partially absorb the external shocks.

The implication of this recent research is that the introduction of the EMU will reduce market segmentation indirectly, rather than directly through increased market transparency. Because of the fully and credibly fixed exchange rate regime, firms will simply have reduced incentives to maintain and enforce the cross-border trade restrictions that they have previously advocated. One may interpret the recent reforms to liberalize the distribution system as consistent with this theory: without the creation of EMU, the firms' incentives to lobby for maintaining the old regulation would have

been greater. As opposed to the increased market transparency effect, one would expect the effect of reduced market segmentation incentives to play a role already in the first phase of the Euro.

3. A FIRST LOOK AT THE EFFECTS OF THE EMU/EURO

3.1 The data set

Our data set is based on the bi-annual car price reports collected by the European Commission since May 1993. The Commission decided to publish these reports on a systematic basis, after having been confronted with a variety of studies from consumer organizations and competition authorities that used different methodologies. The data set consists of pre-tax and post-tax car prices for most car models sold in Europe, and the prices of several pieces of optional equipment (air conditioning, automatic gearbox, power steering, ABS and driver airbag), if these prices are available, and the equipment is not included in the standard model specifications. In addition, there is information on the surcharge for a right hand-drive car. Prices are converted to Euros using the current exchange rate. Our study is based on the pre-tax car price data.

The pre-tax car prices are available for about 90 models sold during the period 1993-2003 in the 15 countries of the European Union. Hence, our data set is a panel with the following three dimensions:

Models: The car models are chosen to represent the best-selling models of 18 European and 8 Japanese manufacturers. The models are assigned to one of 7 possible market segments.

Periods: The data are available between May 1993 and May 2003, for the months of May and November of each year.

Countries: The pre-tax car prices are available since May 1993 for 10 European countries, i.e. Belgium, Germany, Spain, France, Ireland, Italy, Luxembourg, the Netherlands, Portugal and the U.K. For Denmark and Greece

pre-tax prices are available since November 1994, while for Austria, Finland and Sweden pre-tax prices are available since May 1995.[7]

The main strength of the data is that the European Commission has made a special effort to make sure that the data refer to absolutely identical products. That is, all products are "quality-adjusted": models sold in different countries have exactly the same characteristics and the same optional equipment; if certain models were not available with the same optional equipment in some of the countries, a price correction was made using the price of the optional equipment.

The main potential weakness of the data is that prices are based on the list prices and not on the transactions prices. To the extent that consumers obtain discounts or other financial benefits, and such benefits differ across countries, the true cross-country price differences will not be adequately captured. Unfortunately, information on discounts and other financial benefits (such as trade-ins) is not available for all models/markets/years. However, we do have partial information on percentage discounts from the list prices and on gross dealer margins; the latter are a proxy for the maximum discounts and other financial benefits dealers can offer to their customers without realizing losses. We refer to Degryse and Verboven (2000) for a detailed overview of this evidence, which can be summarized as follows:

(a) Although discounts and other financial benefits do differ across countries, these differences are too small in comparison to the observed price differences to explain the significant deviations from the Law of One Price observed in the past.

(b) More importantly, discounts and financial benefits appear to be stable over time, so that price convergence cannot be attributed to changes in dealer discounts over time.

Based on this information we conclude that differences in discount practices across countries are in practice unlikely to affect our conclusions in a significant manner.

[7] For three countries, post-tax prices became available for the first time in May 1999 (Denmark, Finland and Greece).

3.2 Preliminary evidence on price dispersion

To introduce the issues, it is instructive to consider the cross-country price differentials of a few well-known models over the 1993-2003 period. Table 1 presents percentage car price differentials relative to the Netherlands for a BMW 3, a Renault Clio, a Volkswagen Golf and a Honda Accord. While it is difficult to draw strong conclusions from this table, a few clear patterns seem to emerge. The first obvious pattern is that there are large international price differentials. The price difference between the cheapest and most expensive country exceeds the 10% mark for all models in every single year. The most extreme example on the table is the Volkswagen Golf in May 1998, for which the price in Finland is 23% below that of the Netherlands, while the price in the United Kingdom is 44% above the Netherlands.

Second, for some countries there appears to be a systematic and persistent price differential with respect to the Netherlands. Austria, France and Germany appear to be more expensive for all models during 1993-2003, while Denmark appears to be consistently less expensive. For the other countries, however, there does not immediately appear to be both a systematic (i.e., for all models) and a persistent (i.e., for all years) price difference with respect to the Netherlands.

Third, exchange rates appear to matter in explaining the volatility in price differentials over time. This is illustrated more clearly by the pattern in Italy and the United Kingdom. The high prices in the U.K. in 1998 are the result of the strong pound during that time, combined with the manufacturers' policy of local currency price stability. Similarly, the low prices in Italy during 1993 are the result of the weak lire.

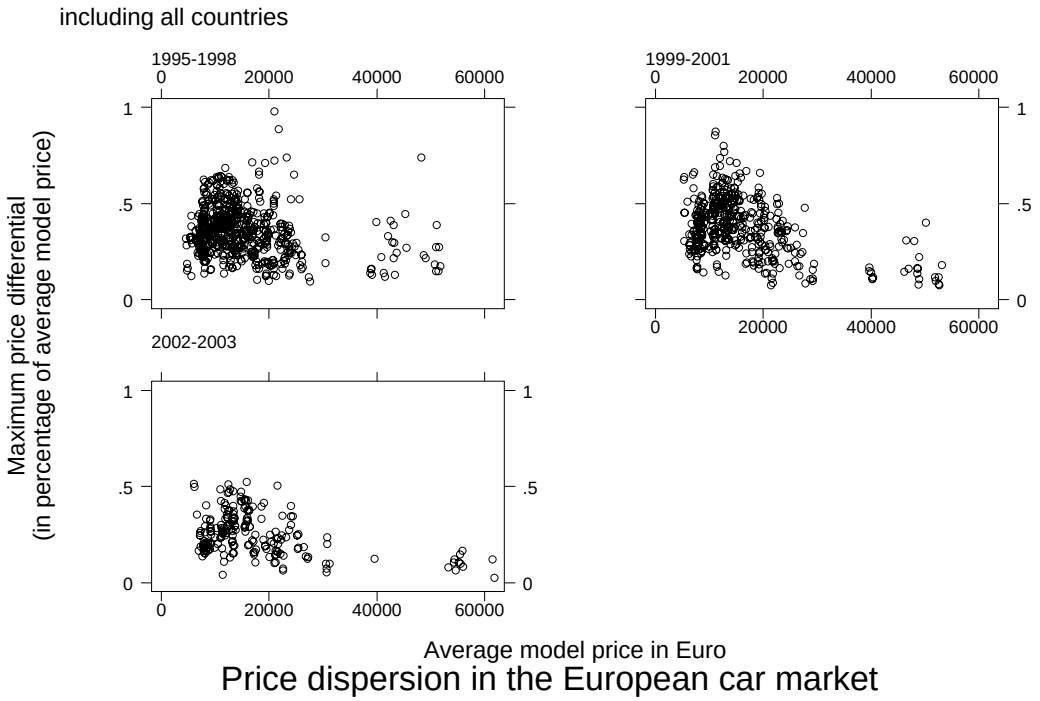
Table 1. Percentage price differentials, relative to the Netherlands

	BMW3			Renault Clio			VW Golf			Honda Accord		
	1993	1998	2003	1993	1998	2003	1993	1998	2003	1993	1998	2003
Austria	n.a.	10	10	n.a.	4	7	n.a.	7	0	n.a.	9	5
Belgium	-4	7	4	-1	-4	4	2	6	0	9	-3	1
Finland	n.a.	-2	-5	n.a.	-6	0	n.a.	-23	-15	n.a.	-1	-12
France	3	10	8	1	3	9	0	6	0	n.a.	9	-3

Germany	1	12	11	4	6	10	4	14	10	7	18	6
Greece	n.a.	10	7	n.a.	-10	-4	n.a.	-8	-14	n.a.	-8	-6
Ireland	-8	n.a.	7	-5	7	10	-1	8	-8	n.a.	20	1
Italy	-2	9	7	-16	-8	-2	-15	9	3	0	17	-2
Luxembourg	0	10	9	-1	-4	4	-2	8	7	9	2	1
Portugal	7	6	9	-14	-7	0	-3	3	0	n.a.	9	-7
Spain	-5	2	1	-14	-1	0	-3	5	3	7	2	-9
Denmark	n.a.	-8	-1	n.a.	-17	-3	n.a.	-14	-15	n.a.	-17	-16
Sweden	n.a.	9	0	n.a.	8	17	n.a.	14	1	n.a.	15	-4
U.K.	-4	n.a.	4	-2	24	-2	12	44	-7	10	31	4

Source: own calculations based on European Commission's data set. The periods refer to May of each year.

To obtain a more complete picture of the international price dispersion, we now summarize the apparent price dispersion for all models in our data set. Figure 1 presents the price range as a function of the average price of each model. The price range (or maximum price differential) is the percentage price difference between the most expensive and the cheapest country. Several conclusions can be drawn from these plots. First, the figure confirms that the high price dispersion is not limited to the above selected four models. Price differentials are easily 20% or larger through the entire period. Second, the figure indicates that percentage price differentials are model-specific, with a tendency for the most expensive models (the ones exceeding €30,000) to exhibit lower dispersion. Third, a comparison across various sub-periods suggests that there is a tendency for price dispersion to decline over time. During the pre-EMU era, price differentials above 50% are a common phenomenon, even for models with an average price over €20,000. During the first phase of the Euro (1999-2001), with fully fixed exchange rates among the EMU-countries, the number of models for which there is a 50% price range remains at least as large (although there appears to be a decline for the models in the high-price category, with an average price above €20,000). However, since the start of the second phase of the Euro (2002-2003), when the common currency was introduced, models with a price range above 50% have become rare exceptions in all price categories.



Price dispersion in the European car market

Figure 1

As mentioned above, part of the price dispersion may be due to exchange rate volatility combined with a manufacturers' policy of local currency price stability. To obtain a better understanding of the evolution of price dispersion, Figure 2 presents new plots, but now limited to the countries that have participated in the EMU; hence Figure 2 excludes Denmark, Sweden and the United Kingdom. Figure 2 thus indicates the evolution of price dispersion among countries with small (even before 1999) or zero exchange rate volatility. As one would expect when looking at this more limited set of countries, the amount of price dispersion is smaller during all three periods. The drop is especially due to the exclusion of Denmark (a country with very how car taxes and correspondingly low pre-tax prices), and the United Kingdom (a country with substantial exchange rate volatility, and a particularly strong pound during the first phase of the Euro that translated into higher Euro-denominated car prices). More importantly, Figure 2 suggests a decline in price dispersion among the Euro countries, after the start of first phase of the Euro. Maximum price differentials over 40% were not uncommon before 1999, but they became rare exceptions after the start of the first phase of the EMU in 1999 and during the second phase of the Euro since 2002.

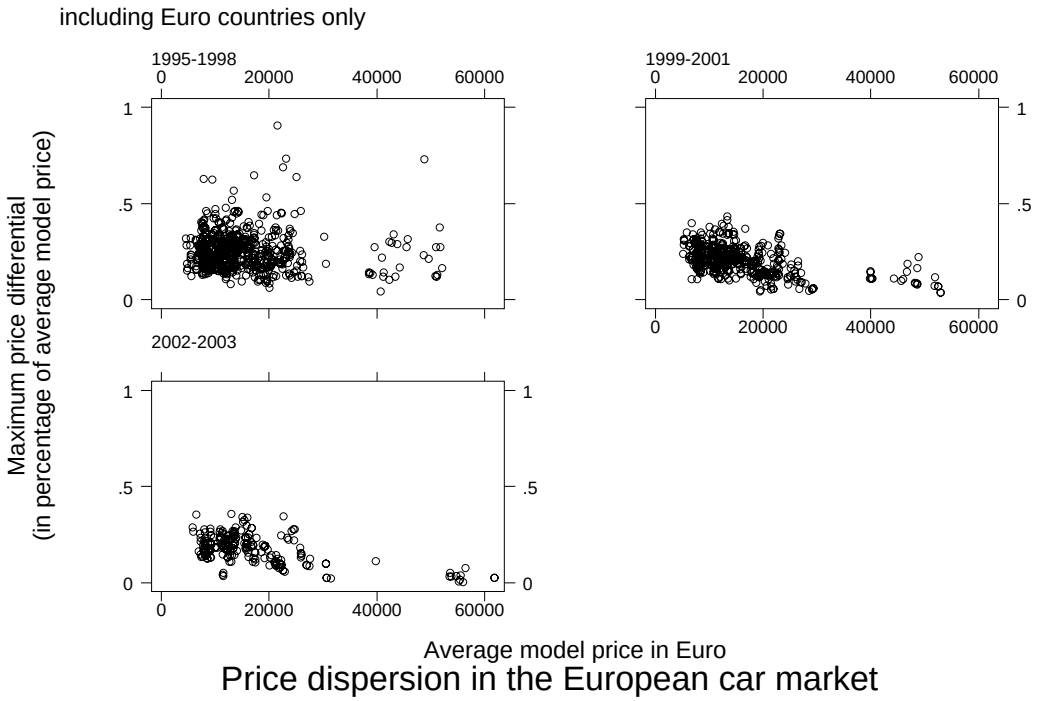


Figure 2

The histograms in Figures 3 and 4 more accurately present the distribution of price dispersion across models. Figure 3 includes all European Union countries, while Figure 4 only considers the Euro countries. Let us first look at the right tail of the distribution. Figure 3 shows that the price range is over 50% for about 10% of the models during the pre-EMU area; for about 20% of the models during the first phase of the Euro, and for less than 3% of the models during the second phase of the Euro. The increase in the number of models with a high price range during the first phase of the Euro is entirely due to the strong value of the pound. This is shown in Figure 4, which excludes the U.K. and the other non-Euro countries. The fraction of models with a high price range among the Euro countries (i.e., maximum price differential over 40%) is lower during both phases of the Euro.

We can draw additional inferences by looking at the left tail of the distribution of price dispersion. Figures 3 and Figure 4 show that price differentials less than 10% occur for a very small fraction of models before the start of the Euro, but for a non-negligible fraction after its introduction.

Finally, Figures 3 and 4 reveal where the majority of the price differentials are situated (by considering the peaks in the distributions). When all countries are included, the majority of the models show price ranges of about 35% before the Euro was introduced and during phase 1 of the Euro. After phase 2 of the Euro, the majority of the models show price ranges of around 20%. When we exclude the non-EMU countries a somewhat similar evolution emerges: the majority of the models show price ranges of around 25% before the Euro and during phase 1 of the Euro, while the majority of models show price ranges around 20% after phase 2 of the Euro.

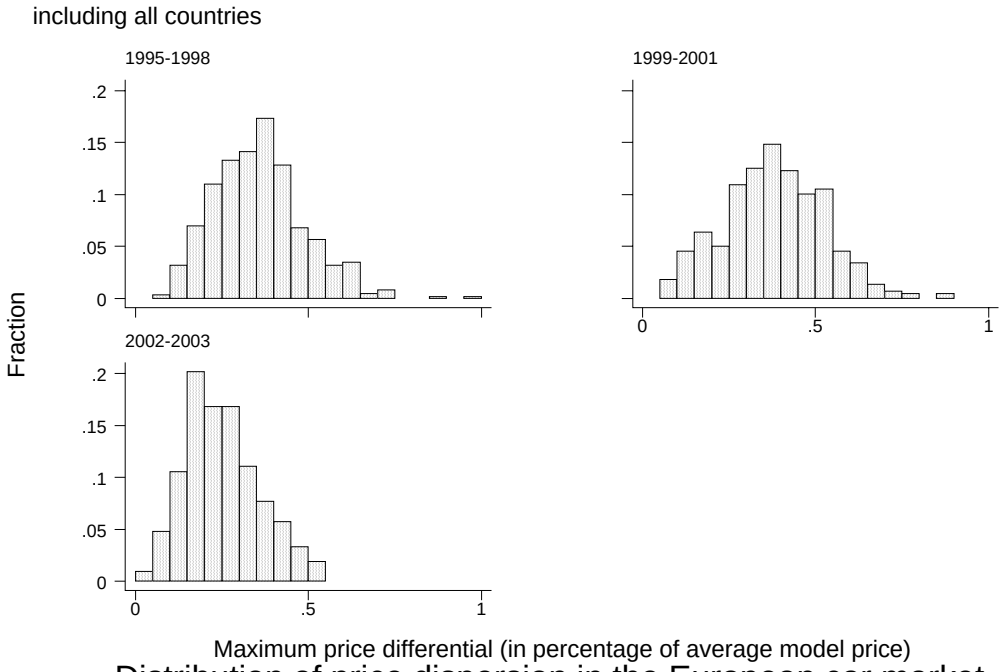


Figure 3

Note: each bar refers to a 5% range (hence there are 10 bars between 0 and 50%).

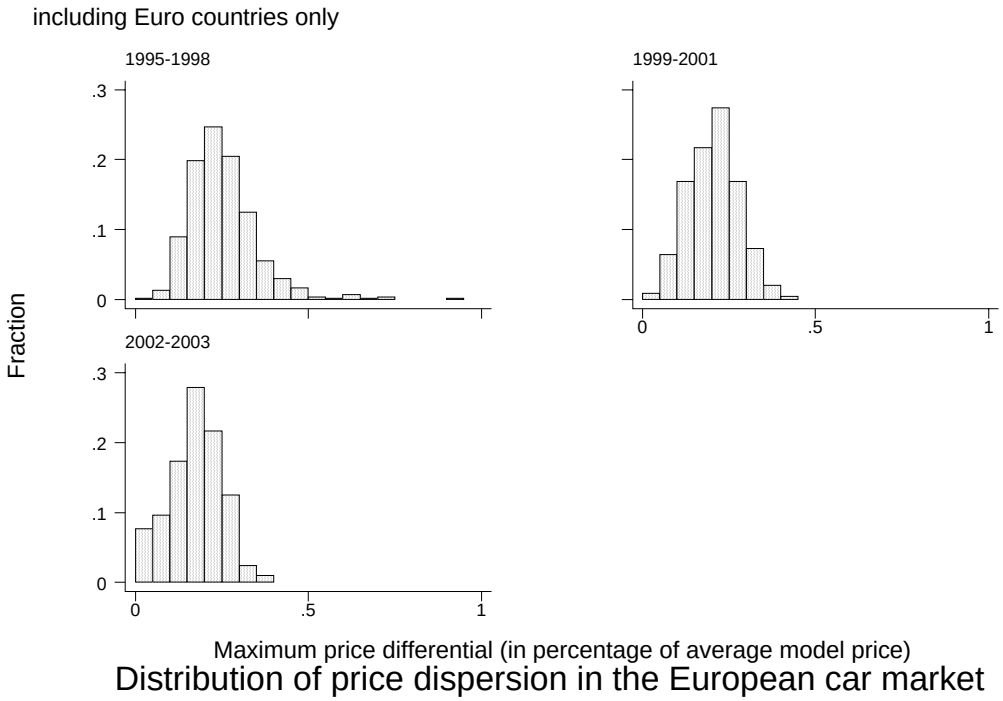


Figure 4

Note: each bar refers to a 5% range (hence there are 10 bars between 0 and 50%).

Perhaps the best way to summarize the information on the distribution of price dispersion across models is by looking at averages. This is done in Table 2, for three alternative measures of price dispersion. Our first measure is the one we have used up to now, i.e., the price range or maximum percentage bilateral price differential. Our second measure is closely related: the price range or maximum percentage price differential after excluding the cheapest and the most expensive country for each model (for several models this implies excluding the price in Denmark and the Netherlands, though this is not always the case). Our third measure of price dispersion is the coefficient of variation, i.e., the variance in the price of each model across countries divided by the average price of each model. The patterns that emerge based on all three measures are similar:

Table 2. Price dispersion in the car market, summary statistics

	All countries		
	1993-1998	**1999-2001**	**2002-2003**

Range, all countries	36.0	38.1	25.4
Range, excl. most expensive and cheapest	20.7	19.7	15.9
Coefficient of variation	9.8	9.6	7.0
	Euro countries only		
Range, all countries	25.3	20.6	17.6
Range, excl. most expensive and cheapest	14.8	13.2	12.1
Coefficient of variation	7.7	6.2	5.5

Note: averages across models.

- When all countries are included, the measured price dispersion is higher than when only the Euro countries are included (that is Denmark, Sweden and the U.K. are excluded).
- If all countries are included, the measured price dispersion appears to decline after the introduction of phase 2 of the Euro, but not yet after the introduction of phase 1 of the Euro.
- If only the Euro countries are included, the measured price dispersion appears to start declining immediately after the introduction of phase 1 of the Euro.

These conclusions roughly hold irrespective of which of the three dispersion measures one uses.

This preliminary analysis suggests that the Euro may have had some effect on the degree of price dispersion. Nevertheless, while these patterns are telling, they need further statistical support, and more accurate measurement before they can be used as the basis for policy recommendations. The differences in the decline of price dispersion between EMU-members and countries that did not participate in the EMU also suggest that it is particularly important to distinguish between these two groups of countries in a statistical analysis of price dispersion.

4. FURTHER ANALYSIS

4.1 Overview of Methodology

We now turn to a more systematic investigation of price dispersion in the European car market and its evolution in the last decade. The two questions we hope to address

in the course of this investigation are: (a) Does the price dispersion documented in the previous section reflect systematic cross-country price differences, in the sense that some countries are on average more expensive than others? (b) To the extent that we do find systematic cross-country price differences, how are these affected by the integration process of the last decade, the European Monetary Union in particular?

To answer the above questions we proceed in several steps. We start by employing a simple regression framework in which we relate cross-country price differences to country-specific dummies and interactions of these dummies with time effects capturing the stage of the integration process. This framework is inherently static, since it abstracts from short-run deviations of prices from their long-term levels due to temporary shocks. Nevertheless, the static approach gives us a first idea as to how the price differentials evolved during the 1993-2003 period, and provides a convenient framework for explaining the strategy we use to identify the effects of the EMU. Next, we consider a dynamic framework in which we allow prices to slowly adjust to their long-term levels. We use the dynamic framework to investigate how fast temporary shocks get eliminated in the European car market, and to what levels prices converge in each country. In the same step, we also re-examine the question initially posed in the static framework; that is, we ask how the implied cross-country price differentials have evolved over time, and whether they were affected by the EMU and introduction of the Euro. Finally, we investigate whether the integration process has increased the speed at which deviations of price differentials from their long-term levels get eliminated. The following subsections describe each approach and the obtained results in detail. Before we do this however, it will be useful to discuss some general issues we face in our empirical analysis.

Choice of the Base Country: Our data allow us to compute bilateral price differences for all car models and all countries in our sample. However, making these bilateral price differences the focus of our statistical analysis would not be meaningful, since our sample would then include a bunch of dependent observations. There are two possible approaches to proceed. The first one is to define the dependent variable as the deviation of the car price observed in a particular country from the European average for this model. The second approach is to choose a particular country as the

"base", and define the dependent variable as the difference between the price of a car in a particular country from the price observed in the base country.

We chose the second approach, with the Netherlands as the base country, for two reasons. First, the use of a base country facilitates the exposition of the results as we compare prices in each country to actual prices observed in the base market, as opposed to a theoretical construct. Second, to the extent that the ultimate policy concern in the integration debate is consumer welfare, it is useful to compare the prices observed in individual markets to "an ideal" that would be achieved if markets were not distorted by trade restrictions, the presence of significant market power, impediments to arbitrage, etc. By choosing Netherlands as the benchmark we make this country in some sense the "ideal" against which other countries are measured. The Netherlands seem an obvious choice, as this country does not have domestic auto production that could result in lobbying for protective measures, has not had any significant trade restrictions in the past, is characterized by low concentration, and is (on average) among the cheapest countries in Europe for car purchases. Belgium is another country that fits this profile; we did in fact experiment with Belgium as an alternative base, and our results were virtually unchanged. We should point out that the base should not necessarily be the cheapest country. The cheapest country in our sample - in terms of pre-tax car prices - is Denmark. However, the low pre-tax prices reflect the fact that the registration tax in Denmark is exceedingly high. It would not be terribly meaningful to choose the highest tax country as the benchmark in a study of market integration.

Definition of the Dependent Variable: The choice of the Netherlands raises another issue: since some countries (e.g., Denmark) may have lower car prices on average than the Netherlands, the price differentials for these countries relative to the Netherlands are negative. This may also be true for individual car model observations in markets that are on average more expensive than the Netherlands. In such cases an increase in the price difference relative to the Netherlands would indicate price convergence across the two countries. We therefore start our analysis by focusing on the *absolute* values of price differences relative to the Netherlands. All prices are in logs, so that the differences are expressed in percentage terms. Later in our analysis, we split the sample by distinguishing between car models that on average have

positive price differences relative to the Netherlands, and car models that on average have negative price differences relative to the Netherlands. This allows us, among other things, to investigate whether there was a different pattern of convergence depending on whether the country was relatively expensive or relatively cheap.

Identification Strategy: Most of the measures towards integration discussed in the previous section were taken prior to 1999; this could in principle be used to identify the EMU effect, since the EMU did not become effective until 1999. However, many of these policies may have affected the car market with a lag; similarly, the EMU was anticipated in advance, so that it may have affected price differentials prior to its official launch in 1999. We therefore make only limited use of the timing of the EMU and Euro adoption, and rely mainly on a different identification strategy.

To identify the effects of the EMU on cross-country price dispersion we employ a difference-in-difference approach that relies on the distinction between countries participating in the EMU, and countries not participating. The group of non-participating countries constitute the control group, while the group of countries that adopted the Euro are the treatment group. As members of the European Union, *all* countries in our sample benefited from the process of integration outlined in the previous section. However, only those countries that joined the EMU could reap the potential benefits of reduced nominal exchange rate volatility. In this context, the following notes are necessary.

First, the number of non-participating countries (3) may at first sight appear small. However, for each country we have approximately 80 observations on different car models in each year. This gives us many useful observations for the purpose of identifying the EMU effect.

Second, the inclusion of the U.K. in the control group may seem problematic since right-hand-side driving differentiates this country from the rest. Note, however, that right-hand-side driving is also used in Ireland, which joined the EMU. In addition, it is estimated that the ex-ante cost of the right-hand-side wheel is very small (ca. $100), so this cannot be blamed as the source of price dispersion.

Third, a usual concern in this type of analysis is that the self-selection into the two groups may introduce selection bias in the estimation. However this is unlikely to be

of importance here, as our analysis focuses only on one market, and the hypothesis that a country's decision to join the EMU was related to price differentials in the car market is rather implausible.

In addition to exploiting the difference between countries that did, and countries that did not join the EMU for identification purposes, we also make use of the timing of the Euro introduction. The EMU may have affected price dispersion in two stages. First, there is a potential effect from introducing the fixed exchange rate (since January 1999), while still keeping national currencies. Second, there is the effect of actually introducing the Euro as a common currency (since January 2002), and the associated potential transparency effects. To analyse the second stage we exploit the data for the periods May 2002, November 2002, and May 2003. Although the number of post-Euro introduction periods is small, our data include a large number of models and a large number of countries so that the Euro effects may be precisely estimated.

We now discuss the details of the implementation of the above approach and report our findings.

4.2 Static Framework

Our identification strategy can be best explained using the following simple regression:

(1)

$$| p^{j}{}_{m,t} | = \alpha * EMU_{m} + \beta * P98_{t} + \gamma * Nonemu\_p98_{m,t} + \mu^{j} + \varepsilon^{j}{}_{m,t}$$

where: $p^{j}{}_{m,t}$ denotes the log-price of car model *j* in country (or market) *m* in period *t*, *relative* to the log-price of the same car model in the base market *b*; μ^{j} are car model fixed effects; EMU_{m} is a dummy variable that takes the value of 1 if market *m* joined the EMU in 1999; $P98_{t}$ is a dummy variable indicating whether our observation is from a period after the EMU became effective; and $Nonemu\_p98_{m,t}$ is an interaction of a dummy indicating whether the country *m* is not in the EMU, with a dummy that takes the value of 1 for the periods after the EMU introduction. This last variable captures the essence of the difference-in-difference

approach: while the *EMU* dummy controls for characteristics common to all EMU members that affect price differentials, and $P98$ controls for events that may have affected all European countries after 98, the $Nonemu\_p98$ dummy captures the differential effect that the EMU had on non-EMU versus EMU members after 1998.

The results from this basic regression are displayed in the first column of Table 4 (standard errors in parentheses). All coefficients in this and subsequent tables are highly significant, so we focus the rest of our discussion on economic rather than statistical significance. The coefficient estimate for the *EMU*-dummy indicates that price differentials in EMU member countries relative to the Netherlands *over the entire 1993-2003* period, were on average lower by approximately 6%, compared to price differentials of non-EMU members. This estimate may in part reflect the fact that, even in the pre-EMU period, exchange rate volatility was substantially lower for future EMU members than non-EMU members. In addition, the lower price differentials may reflect an "EMU anticipation" effect, or simply the fact that countries that joined the EMU were more integrated to start with. Finally, they could be due to the fact that taxes are lower among EMU countries. This effect should not be exaggerated, however. While Denmark is a non-EMU country with high taxes, the other non-EMU countries have taxes similar to the EMU-members; furthermore, there are several EMU-countries with high taxes (Finland, Ireland and Portugal). At any rate, the magnitude of the EMU coefficient indicates that the countries that have joined the EMU are systematically different than non-EMU members in terms of the price differentials observed in these markets.

The P98 dummy is also negative, indicating that after the launch of the EMU, price differentials decrease by approximately 1.4%. While this number clearly suggests that Europe is becoming more integrated over this period, it is not clear whether one can attribute the decline in the price dispersion to the EMU; if, for instance, this decline were evident in non-EMU countries as well, one would attribute it to the general policies towards integration implemented in the 1990's rather than the EMU per se. The third dummy Non-emu_p98 however clearly shows a differential pattern between EMU and non-EMU countries. *Relative to EMU* countries, price differentials in non-EMU countries decline by 1.9% less. Put differently, while price differentials in EMU members decline by ca. 1.4% after the EMU became effective, price differentials in non-EMU countries do not change much, if anything they slightly increase by 0.5% (-

1.4% + 1.9%). These results suggest that the EMU had a small, yet statistically significant effect on reducing price dispersion in the car market.

Our basic regression did not differentiate between pre-Euro and post-Euro years. To examine whether the official introduction of the Euro had a distinct effect, possibly because of increased transparency, we further break down the time dummy, into a post-98 (post-EMU) and post-01 (post Euro) dummy. Our modified regression takes the form:

(2)

$$| p^{j}{}_{m,t} | = \alpha * EMU_{m} + \beta_1 * P98_{t} + \beta_2 * P01_{t} + \gamma_1 * Nonemu\_p98_{m,t} + \gamma_2 * Nonemu\_p01_{m,t} + \mu^{j} + \varepsilon^{j}{}_{m,t}$$

where all variables are defined as before. The $P01$ dummy indicates whether the observation comes from the post-Euro years, and the interaction of the $P01$ dummy with the *Non-EMU* dummy ($Nonemu\_p01$) captures the differential impact that the Euro introduction may have had on EMU versus non-EMU members. The results from this specification are shown in the second column of Table 4.

There are two patterns worth noting. First, the coefficient of the $P01$ dummy suggests a further decline in price differentials in EMU countries of approximately 0.8%. Hence, price differentials relative to the Netherlands decline by 1.9% in the 2001-2003 period. One would be tempted to interpret this as a Euro effect. However, the second pattern worth noting in Table 4 suggests otherwise: the large negative coefficient on the $Nonemu\_p01$ dummy indicates that price differentials in non-EMU members decline during 2001-2003 by 1.6% (=5.1%-3.5%) more than in EMU-members. Or, to summarize the information of Table 4 in a different way: Between 1999 and the beginning of 2002, price differentials in EMU countries decline by ca. 1.1%, while price differentials in non-EMU countries *rise* by 2.4% (= -1.1%+3.5%). Between 2002 and 2003, price differentials in EMU countries decline by 1.9%, while price differentials in non-EMU countries decline much faster by approximately 3.5% (= -1.9%+3.5%-5.1%). This is a rather surprising result that invites further exploration. One possibility is that the increased transparency associated with the Euro introduction indirectly affected price differentials in non-EMU countries as the comparison of prices in such countries to prices denominated in a single Euro

currency became easier. Another possibility is that the decline in price differentials documented for the non-EMU countries post-2001 reflects the depreciation of the pound during this period, which substantially decreased the (in Euro denominated) U.K. car prices.

To examine these possibilities, we consider an extended version of (2) in which we split the Non-EMU dummy (and all associated interactions of this dummy) to three country dummies, each corresponding to one of the non-EMU countries: U.K., Sweden, and Denmark. Then we examine the differential impact of the EMU and Euro introduction on each of these markets using the same difference-in-difference approach described above. To be consistent in our treatment of country fixed effects in the estimation, we also replace the EMU dummy by 12 separate dummies, one for each EMU country. The results from this exercise are displayed in column 3 of Table 4.

What these results clearly show is that the pattern of fast convergence documented for non-EMU countries in the 2001-2003 period is entirely driven by Denmark. Compared to the EMU countries, price differentials in the U.K. increase by an additional 11% in the 1999-2001 period, and by an additional 1.4% during 2001-2003 (relative to 1993-1998). This rather bizarre pattern of U.K. car prices (they rise sharply relative to the Netherlands in 1999-2001, and subsequently fall to a level that is closer to their pre-99 level) most likely reflects fluctuations in the value of the pound relative to the Euro. The pound sharply depreciated during 2002-2003 (by about 13%). As we have documented in our earlier work, local currency prices do not fully respond to exchange rate fluctuations, so that the pound depreciation translates into lower, in Euro denominated, car prices in the U.K. In Sweden they increase by 1.7% in 1999-2001, and remain unchanged in 2001-2003 (relative to 1993-1998). In contrast, in Denmark price differences relative to the Netherlands decrease by 2.4% in 1999-2001 and 5.8% in 2001-2003. Given that prices in Denmark are lower than in the Netherlands, the decline in absolute price differentials implies that prices in Denmark actually rise substantially during this period.

A plausible explanation for this finding would be that taxes in Denmark decreased post-1998 allowing producers to increase their pre-tax prices to bring them closer to the prices observed in other European countries. However, an examination of the figures in Table 1 reveals that taxes in Denmark actually *increased* during this period,

making the higher pre-tax prices observed in Denmark even more puzzling. Note however, that even though Denmark has not joined the EMU, its exchange rate has been almost fixed to the Euro since the start of the EMU in 1999. During the period 1993-1998, the Danish Krone still fluctuated of up to 5%; since 1999 the maximal variation has been less than 0.5%. The large decline in absolute price differentials we document for this country could thus reflect the increased exchange rate stability this country has enjoyed since the start of the EMU.

Table 4. Results on Systematic Cross-Country Price Differentials (Static Framework)

Dep. Variable: Absolute Value of Log-price Difference Relative to the Netherlands

Number of observations: 17,756

Independent Variables	Spec. 1	Spec. 2	Spec. 3
EMU-member	-0.059	-0.059	--
	(0.002)	(0.002)	
P98	-0.014	-0.011	-0.013
	(0.001)	(0.001)	(0.001)
P01	--	-0.008	-0.008
		(0.002)	(0.002)
Non-emu_p98	0.019	0.035	--
	(0.002)	(0.003)	
Non-emu_p01	--	-0.051	--
		(0.004)	
P98U.K.	--	--	0.107
			(0.004)
P01U.K.	--	--	-0.093
			(0.006)
P98SW	--	--	0.017
			(0.005)
P01SW	--	--	-0.017
			(0.006)
P98DK	--	--	-0.024
			(0.004)
P01DK	--	--	-0.034
			(0.006)
Market fixed effects	No	No	Yes
Model fixed effects	Yes	Yes	Yes

Overall, the results displayed in Table 4 seem to reconfirm the pattern documented in Figures 1 and 2: Price differentials in EMU member countries decline during the 1998-2003 period, by a small (ca. 1.5%) but statistically significant percentage. Within the set of non-EMU countries, in the U.K. and Sweden price differentials widen between 1999 and 2001 (with the increase in the U.K. being substantial), but

roughly revert back to the pre-1999 levels during the 2002-2003 years. For Denmark we document a sharp decline of price differentials in both sub-periods. These results provide some support for the claim that the EMU decreased price dispersion, although the case of Denmark seems to suggest that other countries can indirectly benefit from the monetary union by fixing their exchange rate to the new currency. Even though price differentials in EMU countries further decrease after the Euro introduction, we are hesitant to interpret this decline as a pure Euro effect, as an even large decline during this period is documented in Denmark, the non-Euro country with a fixed exchange rate.

4.3 Dynamic Framework

4.3.1 How fast do temporary shocks to prices get eliminated?

Our discussion so far has abstracted from dynamic considerations that may introduce short run deviations of prices from their long-run levels implied by market fundamentals. A question that has received considerable attention in International Economics is how fast transitory shocks to prices get eliminated. This question is addressed by testing the hypothesis of convergence to the relative version of the Law of One Price. To this end, people usually estimate an equation of the form:

$$\Delta p^{j}_{m,t} = \alpha^{j}_{m} + \beta p^{j}_{m,t-1} + \varepsilon^{j}_{m,t} \quad (3)$$

where $p^{j}_{m,t}$ denotes the price of product *j* in country *m* relative to the base country *b*, in period *t;* $\Delta p^{j}_{m,t}$ is the first difference of this price differential; the parameter α^{j}_{m} captures the product-country fixed effect; and the parameter β denotes the speed of convergence. Usually a lag structure $\sum_{l=1}^{L} \gamma_l \Delta p^{j}_{m,t-l}$ is added to the specification above to account for serial correlation in the error term. Due to the limited number of years in our sample, we omit such lags from our subsequent specifications; however, we experimented with including 2-3 lags, and the results reported below remained robust. Convergence to the relative version of the Law of One Price implies a negative β, with the approximate half-life of a shock to $p^{j}_{m,t}$ given by $-\ln(2)/\ln(1+\beta)$. The

expression $-\frac{\alpha^{j}{}_{m}}{\beta}$ captures the long-term systematic price differential for product j across countries m and b.

The first question of interest in the context of market integration is whether car prices in Europe adhere to the relative version of the Law of One Price, and if so, what the speed of convergence is. We should note that despite the fact that the data given to us by the European Commission refer to physically identical products, we do not necessarily expect the fixed effects $\alpha^{j}{}_{m}$ to be zero across European countries. Even with integrated markets, there could be systematic price differences across countries, due, for example, to differences in discount practices across markets, local marketing and distribution services, etc. Nevertheless, in such cases we would expect the implied long-term price differentials to be relatively small. In contrast, large long-term differentials are indicative of market segmentation. We examine these long-term differentials and their evolution over time in the next subsection. For now, we are focusing on a more narrow definition of convergence, namely how fast price differences converge to their long-run levels; or, in other words, how fast transitory shocks to prices get eliminated in the car market.

According to our estimates of equation (3), β is 0.38, with a standard error of 0.006, implying a half-life of price shocks of approximately 1.4 half-years (note that our observations are bi-annual), or 0.7 years. We should note that this half-life is considered extremely short in the context of international markets, where half-lives are traditionally estimated to be 5 to 6 years (see Obstfeld and Rogoff (2000)). We attribute this high speed of convergence to the fact that European markets are, despite the presence of many remaining restrictions to arbitrage, considerably more integrated than other markets. Interestingly, the estimated half-life of 0.7 years is about half as large as the half-life we estimated in an earlier paper (1.3 to 1.5 years) looking at slightly different data from five European countries for the period 1970-2000 (see Goldberg and Verboven (2003)). The faster speed of convergence over 1993-2003 likely reflects the high exchange rate stability in most European countries during this period, combined with the further progress towards integration.

Nevertheless, the focus on the speed of convergence alone as a sign of market integration can be misleading, if the long-term price differentials remain large. We turn our attention to these differentials next.

4.3.2 Did the EMU reduce the long-term cross-country price differentials?

We now re-examine the question we addressed earlier in the static framework, i.e. did the EMU reduce the long-term cross-country price differentials? As pointed out above, the long-run differentials relative to the Netherlands are computed in the above framework as $-\frac{\alpha^{j}{}_{m}}{\beta}$. These differentials can be either positive or negative, given that some countries are systematically more expensive while others are systematically cheaper than the Netherlands. Even within countries that tend to be more expensive, individual car models may be cheaper than in the Netherlands rendering the associated long-run price differentials negative. While this poses no problems when we compute the average price differentials over the entire period, it makes tracing the movement of the long-term price differentials over time cumbersome: convergence implies a decline of positive, but an increase of negative price differentials relative to the Netherlands.

To examine how price differentials evolved over the 1993-2003 we therefore split our sample into two sub-samples: one that consists of car models which have on average positive price differentials relative to the Netherlands, and one that includes all car models with negative (on average) price differentials. For each sub-sample, we then estimate a regression of the form:

(4)

$$\Delta p^{j}{}_{m,t} = \alpha^{j}{}_{m} + \beta p^{j}{}_{m,t-1} + \zeta^{1} * P98_{t} + \zeta^{2} * P01_{t} + \sum_{n \notin EMU} \theta_{n}^{1} * D\_p98_{n,t} + \sum_{n \notin EMU} \theta_{n}^{2} * D\_p01_{n,t} + \varepsilon^{j}{}_{m,t}$$

Note the similarity of (4) to the static equation (2). Equation (4) actually closely corresponds to the specification estimated in column 3 of Table 4, the essential difference being here the presence of dynamics. As before, the identification strategy relies on a difference-in-difference approach, reflected in the interactions of the post-

1998 and post-2001 dummies respectively with country dummies for the *n* countries that did not join the EMU (n: U.K., Sweden, Denmark). Furthermore, the separate estimation for the sub-samples of positive and negative price differentials allows us to examine whether there is a differential pattern of adjustment depending on whether price convergence implies an increase or decrease of prices.

The results from this exercise are displayed in Table 5. Note that to compute the increase (or decrease) of the long-term price differentials over the relevant period the parameter estimates corresponding to interactions of market fixed effects with time dummies need to be divided by the parameter β. The half-life to price shocks implied by β is slightly lower for those cases where prices are lower than in the Netherlands (0.6 versus 0.7 years), but the estimates are of the same order of magnitude.

Let us first look at the changes in long-run price differentials for those car models that on average showed a positive price differential with respect to the Netherlands (i.e., the first column in Table 5). The coefficients of the P98 and P01 dummy variables imply that the price differentials in the EMU countries have declined by 1.4% during 1999-2001, and by 2.6% during 2002-2003 (as compared to 1993-1998). These numbers are somewhat larger, though of a comparable order of magnitude, as the results obtained from the static framework. To put these numbers in context, it is again appropriate to check how they compare to the effects estimated for the non-EMU countries. The estimates show that the (positive) U.K. price differentials increase by an additional 11.3% during 1999-2001, but decrease by an additional 7.2% in 2002-2003 (relative to 1993-1998). As pointed out above, this pattern in the U.K. is likely due to the strong fluctuations of the pound (first an appreciation, and subsequently a depreciation). In Sweden, the price differentials decrease by an additional 6.0% during 1999-2001, and by 5.2% during 2002-2003 (again relative to 1993-1998). In Denmark, the price differentials increase by 0.5 and 1.7%, but these changes are insignificant. This probably reflects the fact that - due to the high taxation - most car models in Denmark are cheaper than in the Netherlands, so that the number of observations with positive price differentials relative to the Netherlands is very small in that country.

Now consider the changes in the long-run price differentials for the (substantially smaller) subset of cars that on average showed a negative price differential with respect to the Netherlands (second column of Table 5). The coefficients of the P98 and P01 dummy variables again show that price differentials with respect to the base country have declined: the negative price differentials for EMU countries increase by 3.7% during 1999-2001, and by 4.6% during 2002-2003. We can again use these estimates in combination with the effects estimated for non-EMU countries, to infer the differential pattern of convergence in the non-EMU countries. In the U.K., the (negative) price differentials now become smaller relative to the Netherlands during 1999-2001 (i.e., the negative price differentials increase by 11.4%), and widen during 2002-2003 (i.e., they decline by 5.5%). This confirms the role of the fluctuations in the pound: for those car models with a positive price differential, there is divergence during 1999-2001 and convergence during 2002-2003, while for cars models with a negative price differential the opposite happens. In Sweden, the (negative) price differentials increase by an additional 7.1% during the entire 1999-2003 period. In Denmark the additional effects are negligible during 1999-2001; during 2002-2003 they are significant: prices increase relative to the Netherlands by 3.9%. The rapid price convergence we saw for Denmark in the static regressions is now more precisely identified to occur only after 2001, and only for car models that have on average a negative price difference relative to the Netherlands (which however represent the majority of models).

These findings are broadly consistent with our earlier conclusions obtained from the static equation: price differentials among EMU-members declined by a small but significant amount after the start of the EMU. Price differentials among non-members with a volatile exchange rate (Sweden and especially the U.K.) show a more erratic pattern. Following the fluctuations of the pound, positive price differentials in the U.K. further increased during the first phase, but declined since the second phase; negative price differentials in the U.K. narrowed during the first phase, but widened again during the second phase. The non-member country with a fixed exchange rate, Denmark, did show a conversion pattern comparable to those of the member countries, though this was materialized only after 2002, and only for the car models that have negative price differentials relative to the Netherlands (the majority of models in Denmark).

Table 5. Results on Systematic Cross-Country Price Differentials

(Dynamic Framework)

Dep. Variable: First Difference of Log-price Difference Relative to the Netherlands
Number of observations: 10,416 for positive differences
5,512 for negative differences

Independent Variables	Positive Price Difference On Average	Negative Price Difference On Average
$p^{j}_{m,b,t-1}$	-0.396	-0.437
	(0.008)	(0.011)
P98	-0.006	0.016
	(0.001)	(0.002)
P01	-0.005	0.004
	(0.002)	(0.003)
Non-emu_p98	--	--
Non-emu_p01	--	--
P98U.K.	0.045	0.050
	(0.004)	(0.012)
P01U.K.	-0.073	-0.074
	(0.006)	(0.016)
P98SW	-0.024	-0.031
	(0.005)	(0.010)
P01SW	0.003	-0.002
	(0.006)	(0.012)
P98DK	0.002	-0.002
	(0.016)	(0.005)
P01DK	0.005	0.017
	(0.012)	(0.007)
Model-Market fixed effects	Yes	Yes

4.3.3 Has the speed of convergence increased?

The final question we address within our dynamic framework is whether the speed of convergence was affected by the EMU. Answering this question sheds light on an additional effect that the EMU may have had on the integration process. While deviations of the price differentials from their long-term levels are always possible due to short-term rigidities, we would expect these deviations to vanish quickly as markets become more integrated. Alternatively, to the extent that the integration process has led to a significant decline in the long-term price differences across countries, it is possible that the speed with which short-term shocks to prices get eliminated decreases, reflecting non-linearities in the adjustment process; that is, large shocks get eliminated faster than small shocks, so that if the magnitude of the shocks

diminishes as a result of integration, the speed of convergence declines too. To assess the impact of the EMU on the speed of convergence, we generalize our differences-in-differences framework, applying it to the convergence coefficient β. Hence, we estimate an equation of the following form:

(5)

$$\Delta p^{j}{}_{m,t} = \alpha^{j}{}_{m} + \beta p^{j}{}_{m,t-1} + \gamma * EMU_{m,t} * p^{j}{}_{m,t-1} + \delta * P98_{t} * p^{j}{}_{m,t-1}$$
$$+ \xi * Nonemu\_p98_{m,t} * p^{j}{}_{m,t-1} + \zeta * P98_{t} + \sum_{n \notin EMU} \theta_{n} * D\_p98_{n,t} + \varepsilon^{j}{}_{m,t}$$

The parameter β by itself captures the base speed of convergence before the adoption of the EMU, while the parameter γ refers to the additional speed of convergence by countries that eventually became part of the EMU. Similarly, the parameter δ refers to the additional speed of convergence after the forming of the EMU, while ξ refers to the differential speed of convergence after the EMU by non-EMU countries. The terms $\zeta * P98_{t}$ and $\sum_{n \notin EMU} \theta_{n} * D\_p98_{n,t}$ are similar to our previous specification (4) and capture potential changes in the long-run price differentials over this period. We do not examine the speed of convergence separately for the years following the official Euro adoption, since we have two few periods to identify any changes in the speed of convergence between the end of 2001 and the middle of 2003.

Table 6 reports the relevant results on the speed of convergence (for expositional ease we omit the results referring to the long-run differentials and their changes over time which are consistent with what was reported earlier). The following observations are worth noting. First, EMU countries appear to converge substantially faster than non-EMU countries, already before the start of the EMU. (The half-life is estimated at 1.2 years for non-EMU countries, and at 0.5 years for EMU countries before the start of the EMU). Second, after 1998 the speed of convergence for EMU members slightly decreases (the half-life becomes 0.65 instead of 0.5 years), while for non-members the change in speed after 1998 is insignificant (0.079-0.088=close to 0). The slower speed of convergence after 1998 for EMU members could be interpreted as an indication of non-linearities in price adjustment: big shocks are eliminated more quickly than small

shocks. With EMU in place, non-EMU members still experience major price shocks induced by exchange rate fluctuations, but for EMU members shocks become smaller.

Table 6. Changes in the Speed of Convergence (Dynamic Framework)	
Dependent Variable: First Difference of Log-price Difference Relative to the Netherlands **Number of observations: 15,928**	
Independent Variables	
$p^{j}_{m,b,t-1}$	-0.243 (0.016)
$p^{j}_{m,b,t-1}$ ***EMU-member**	-0.244 (0.020)
$p^{j}_{m,b,t-1}$ ***P98**	0.079 (0.019)
$p^{j}_{m,b,t-1}$ *** Non-emu_p98**	-0.088 (0.032)
Model-market fixed effects	yes
Allow for changing long-term Price differentials	yes

5. SUMMARY OF FINDINGS AND POLICY IMPLICATIONS

5.1 Summary

We have studied the impact of the EMU on international price dispersion in the European car market. Our statistical analysis confirmed the patterns observed initially in graphs and tables, and yielded several additional insights. Our main empirical findings can be summarized as follows.

Impact of the EMU (phase 1 + phase 2) on cross-country price differences. We find that the EMU has resulted in a small but significant decline in international price dispersion. This is established by comparing the evolution of price differentials among EMU-members with that of the non-members with volatile exchange rates (i.e., Sweden and the U.K.). Price differentials among EMU-members declined by a statistically significant amount (in the range of 1-2%) after the start of the EMU in 1999, whereas price differentials with respect to the non-Euro members with volatile exchange rates showed an erratic pattern: they widened during the first phase of the EMU (1999-2001), and roughly reverted back to their old levels during the second

phase (2002-2003). A perhaps more surprising finding concerns the evolution of price dispersion in Denmark, a non-EMU country that nevertheless tightly manages its exchange rate to the Euro. Our estimates indicate that the price differences in Denmark narrowed to at least the same extent as price differences among EMU-members. This suggests that the EMU may have indirect effects on non-members, if these succeed in fixing their exchange rate to the Euro. Denmark has indeed been able to credibly commit to such a policy, as it has kept the Danish Krone virtually unchanged relative to the Euro, with a maximum volatility of only 0.5% since 1999, compared to a volatility of 5% during the period 1993-1998.

Additional impact of the Euro (phase 2) on international price dispersion. We find that international price differences between EMU-members have declined by a significant additional amount since the introduction of the Euro currency in 2002. However, the price differentials of the non-Euro countries also declined since 2002; in the case of Sweden and the U.K. this can be attributed to exchange rate fluctuations, but in the case of Denmark it cannot. It is therefore not possible to conclude that the additional price convergence post-2001 is due to the increased transparency or reduced transactions costs frequently associated with the Euro, as opposed to other factors that may have affected all countries of the European Union.

Impact of the EMU (phase 1 + phase 2) on the speed of convergence. We estimated the speed at which temporary price differentials revert back to their long-term levels. We find that the speed of convergence among EMU-members was substantially higher than that of non-members, already before the actual start of the EMU; after the EMU became effective, this speed slightly decreased. We interpret this as an indication of non-linearities in the price adjustment process: big shocks are eliminated more quickly than small shocks. With the EMU in place, non-EMU members still experience major price shocks due to exchange rate fluctuations, while for EMU-members shocks become smaller.

5.2 Policy implications

In section 2.3 we discussed two main channels through which the EMU may affect the degree of market segmentation (in addition to the direct effect of permanently eliminating local cost differences arising from nominal exchange rate volatility). One channel, which is potentially relevant during both phases of the EMU, is given by the

firms' reduced incentives to erect new trade barriers, or maintain and enforce existing ones, under a credible policy of full exchange rate stability. A second channel is the possible direct effect on market segmentation due to increased price transparency or reduced transaction costs. This channel is of course only relevant during the second phase, after the Euro currency was introduced.

Against this background, our first empirical finding, that international price dispersion among Euro-members has decreased already since the first phase of the Euro, may be interpreted as an indication that firms have indeed had reduced incentives to erect and maintain cross-border trade barriers since 1999. Furthermore, our second empirical result, that international price dispersion among EMU-members did not further decline relative to non-members in the second phase, indicates that the channel of increased price transparency or reduced transaction costs has not played a major role in reducing market segmentation. As the case of Denmark illustrates, countries may perform at least equally well in terms of price convergence by credibly pegging their exchange rates to the new monetary system.

The effects of the EMU on the degree of market segmentation should, however, be put in perspective. As mentioned above, we estimated the reduction of cross-country price differences in EMU-countries to be in the range of 1-2%. This is to be contrasted with the quite high international price differentials before the start of the EMU, amounting to an average of 25% among EMU-members (recall Table 2). It is thus clear that there is room for further measures to integrate the European car markets.

One such measure has been the recent liberalization of the selective and exclusive distribution system. Among other effects, the new system will create new opportunities for either independent resellers or the authorized dealers themselves to take engage in cross-border trade and take advantage of international price differentials. It remains to be seen whether the new system will be successfully implemented, and at how fast a rate. A one-year transition period has been allowed, and specific elements (such as the location clause) are subject to additional transition periods. Nevertheless, our empirical findings suggest that the sector will show less resistance in implementing the reforms than it has shown with previous attempts to reform, since exchange rate volatility, as a main source of the sector's interest to maintain market segmentation, has now been eliminated.

Nevertheless, there are a few specific issues that need to be addressed to ensure that the sector would not continue to resist policy measures towards reducing market segmentation. First, the continuing exchange rate volatility in the non-EMU countries, Sweden, but especially the U.K., continues to provide incentives for the sector to maintain the current trade restrictions (or erect new ones). Given the volatility of the pound, it is important for car manufacturers to be able to keep the United Kingdom segmented from the rest of Europe. The specific case of price dispersion in the car market does, of course, not warrant a conclusion that the other countries of the European Union should join the EMU, or (as Denmark) peg their exchange rates to the Euro. However, we may conclude that it is presumably unrealistic to further integrate the car sector for all countries of the European Union, since firms would always have an incentive to keep those markets, where exchange rats are still volatile, segmented. An appropriate policy may thus involve allowing non-EMU countries to be partially exempted from further measures promoting market integration, such as the new distribution system. While such a policy would not achieve the "first-best" of full integration across all countries, it would at least ensure that the sector does not resist the effort to integrate the EMU-member car markets.

Second, a motivation for keeping the car markets segmented is the current situation of high tax differences across countries. As discussed earlier, despite the Commission's efforts to harmonize value-added taxes, car tax differences remain very high, because several countries have imposed various kinds of additional car taxes (such as special car taxes, environmental car taxes and registration taxes). The high car taxes are most notable in Denmark, but they are also present in Finland, Ireland, and Portugal. Tax differentials make it in firms' interest to keep markets segmented: this allows them to absorb part of the taxes by lowering their margins in the high tax-countries to generate sufficient local demand, without inducing foreign consumers to shop at the low pre-tax prices. The existing tax differences may offer an argument for also exempting high-tax countries from further integration measures in the car market (an exemption analogous to the one for non-EMU members). However, we believe that the argument is less strong here. In contrast to the decision to become a member of the EMU, a policy of tax harmonization has less dramatic effects, and could be confined to only those sectors where the need for further integration is highest.

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