Price Convergence: What's on TV?*

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Abstract

We use a unique dataset on television prices across European countries and regions to investigate the sources of differences in price levels. Our findings are as follows: (i) Quality is a crucial determinant of price differences. Even in an integrated economic zone as Europe, rich economies tend to consume higher quality goods. This effect accounts for the lion's share of international price dispersion. (ii) However, sizable international price differentials subsist even for the same television sets (the average bilateral price difference is as high as 80 euros, or 8% of the average TV price in our sample). (iii) EMU countries display lower price dispersion than non-EMU countries (iv) Price dispersion tends to be smaller regionally than internationally. Regional price dispersion is comparable to intra-EMU dispersion (v) Absolute price differentials and relative price volatility are positively correlated with exchange rate volatility. (vi) Brand premia and relative rankings of brands differ markedly across borders. (vii) Structural estimates allow a more precise quantification of preference heterogeneity across borders.

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1 Introduction

This paper uses an exceptional panel database on prices of television sets across Europe. We examine the characteristics and evolution of price differentials for one of the most widespread consumer durable goods, in a panel consisting of both European countries and regions. The sources and extent of good price differences across markets is a topic of crucial importance for a number of reasons. At the most basic level, large and persistent price differentials signal the joint possibility of market power, as firms display their ability to price discriminate, and of transactions costs that prevent consumers (and/or grey importers) from exploiting arbitrage opportunities. Significant price differentials may entail large social costs due to the distortion introduced by price discriminating producers (or retailers) and may be of concern to regulators and policymakers alike. There is furthermore some evidence that the second moments of international price differentials are affected by nominal exchange rate movements [1]. This has provided guidance on modelling strategies in international macroeconomics, and on the implied welfare effects of various exchange rate arrangements. Very little is known however on the first moments of price differences in relation to the presence of a border and on the exact source of absolute price differentials.[2] The present exercise contributes to filling this gap.

The evolution of price differentials over time is of particular interest in European countries, which provide a natural laboratory to study the effect on price convergence of a monetary union, where international relative prices can no longer adjust through the nominal exchange rate. It is therefore potentially informative to track the trend in price differentials throughout the EMU period. Our sample contains members of the euro area as well as non euro area countries; it also has the three main new EU members (the Czech Republic, Hungary and Poland). The television market is of particular interest since TVs have been present in the shopping basket of European consumers for many years, and almost every household in Europe owns at least one TV set. Furthermore, the good's price is substantial enough to warrant some reflection (and, possibly, some international comparisons) before the actual purchase decision. Finally, the production and distribution of TV sets across European countries are actually the object of very little regulation. This stands in stark contrast with existing work, which either focused on low unit costs goods, or on expensive yet heavily regulated durable goods.[3] Thus, our data single out a good where large price differences would be particularly intriguing as arbitrage is likely both intense and relatively unfettered.

[1] See Engel and Rogers (1996).

[2] Goldberg and Verboven (2002), Crucini and Shintani (2002), Parsley and Wei (2004) and Rogers (2004) are important first contributions.

[3] See Haskel and Wolf (2001) or Goldberg and Verboven (2002), respectively, for studies on Ikea mirrors and automobile sales. Nevo (2001) focuses on ready-to-eat cereals.

Our data are remarkable in that they supplement actual sale price data with detailed information on the characteristics of the TV sets sold and on brands. Those characteristics are refined enough to allow us to actually control for variations in quality both across regions and over time.[4] Thus, we bring the focus on the remaining possible explanations for differences in prices, over and beyond the usual argument that standard data unduly compare apples with oranges. In particular, we consider market power, differences in production costs, or heterogeneous preferences and especially differences in the national perception of a given brand. The richness of our data enables us to compare the prices of the exact same TV set across countries and regions. We can ask all these questions both within and without EMU, and thus we can investigate the extent to which price differentials respond to changes in the monetary standard. The corollary question of whether price differences are larger within or between countries can be addressed as well, thanks to the regional dimension in (some of) our data. Finally, the availability of actual prices makes it possible to investigate whether price differentials are related in any systematic manner with goods' unit prices, as would be the case if arbitragers needed to pay a setup cost to take advantage of price differences. These costs could help explain some of the remaining cross-sectional variation in prices, once differences in quality and in costs are controlled for.

The rest of the paper proceeds as follows. We next describe our dataset in more details. In Section 3, we investigate the impact of quality adjustment on international price differentials. We document dramatic reversals in countries expensiveness rankings. Section 4 compares intra to international price differentials and assess whether EMU countries can be considered as integrated as regions within the same country. Section 5 uses hedonic regressions to investigate the role of exchange rates in explaining price differentials and estimate the extent of passthrough. Section 6 studies the dispersion of the prices of the same television sets across countries. We find sizable differences as well as different relative rankings across countries. The average bilateral price difference between two countries is as high as 80 euros (8% of the average price), when the same set of televisions is compared. These absolute price differences are positively correlated with exchange rate volatility. In section 7, we propose that heterogeneous brand effects are one of the main sources of these big price differentials. In an attempt to quantify further the magnitude of preference heterogeneity across countries we resort to structural estimation in section 8. Finally section 9 concludes.

2 Data

[4] This corresponds to another desirable feature of the good we are investigating. Most of the production costs of TV sets appear to depend on the tube used in the device, whose type is included in our dataset and whose production location can be traced.

Our data were obtained from GfK France. GfK is a private company selling market surveys based on high quality and very disaggregated data. The traditional focus of GfK has been on consumer electronics and especially the TV market. Their data cover no less than 80 percent of all TV sales in the countries considered, and up to 95 percent for some markets. Duty free shops as well as small outlets are excluded. We have data on countries which belong to the EU and the euro area (Austria, Belgium, France, Germany, Greece, Italy, the Netherlands, Portugal, Spain); on countries belonging to the EU but that have not adopted the euro (Sweden, the United Kingdom and the accession countries, Hungary, the Czech Republic and Poland); and finally on Switzerland. For the majority of these countries, the data are national averages (weighted by sale volumes), collected bi-monthly (6 observations per year).[5] The period considered is 1999 till end of 2002. We also have regional information for Germany (4 regions), Italy (4 regions), Spain (4 regions) and Switzerland (2 regions).

The data are reported in national currency and we use market exchange rates to convert price levels into a common currency, which we choose to be the Euro. For each market we have information on the prices of TV sets, and on a variety of their characteristics. These include the TV screen size (28 inches, 29 inches, or more than 29 inches), the tube dimension (4:3 or 16:9), the type of the tube (50 or 100 Hertz), and the brand, which is separated into 24 individual brands and an aggregate of all others. To maximize the number of characteristics available for each TV set, we restrict our sample to televisions whose screen size is above 28 inches. Combining the country and good dimensions, our international cross-sectional dimension is as large as 4,500 goods. The coverage of these data is summarized in Table 1. In Table 2, we show the list of brands and their country of origin. The regional data do not have all the characteristics we study in the country sample. But they still allow us to perform some hedonic regressions and to gain some insights in the degree of regional price convergence and the magnitude of national border effects.

3 International Differences in TV Prices

In this section, we focus on cross-country price differences. Our data have 27,760 observations, the average TV price is 992 euros, the minimum price is 69 euros and the maximum 8205 euros. We first focus on raw, uncorrected prices. We then perform hedonic regressions to investigate the importance of quality and other observed characteristics.

[5] For Switzerland, the data are four-monthly, i.e. three observations per year.

3.1 Uncorrected Prices 1999-2002

In Figure 1 we plot the average raw TV price in each of the 15 countries for the period 1999-2002.[6] According to these measures, the three most expensive countries in the sample are Switzerland, the Netherlands and the United Kingdom, while Poland, Hungary and the Czech Republic, three accession countries, are the cheapest. Average price differentials are substantial even among the richest European countries. For example, in the early part of 2002, the average TV price in Switzerland was almost twice as high as in Italy (approximately 1,100 vs. 580 Euros). Furthermore, the pictures do not reveal any significant evidence of convergence of TV prices even though the country rankings of average TV prices change over time.

We investigate the evidence on price convergence in raw prices more rigorously by estimating

$$\overline{p}_{it} = \alpha_i^0 + \alpha^1 \overline{p}_{it-1} + \varepsilon_{it} \tag{1}$$

where $\overline{p}_{it}$ is the (logarithm) average TV price (expressed in Euro) in country i at date t and α_i denotes a country specific fixed effect. We estimate equation (1) using the level of uncorrected prices, since Figure 1 suggests non-stationarity does not appear to be a major concern.[7] The major difference between our approach and most of the literature is that we have information on price levels. This makes is possible to directly assess the permanent differences in international TV prices, given by $\exp\left(\frac{\hat{\alpha}_i^0}{1-\hat{\alpha}^1}\right)$.[8] Table 3 reports our estimates per country.

The first and foremost result in Table 3 pertains to large persistent differences in TV prices across countries. TV sets in Switzerland, the most expensive country in our sample, are persistently almost twice as expensive as in the Czech Republic, Hungary or Poland. Switzerland is also substantially ahead of the rest of Western Europe, 20 percent more expensive than the Netherlands or the United Kingdom, and a good 40 percent above the European average. These are persistent differences, and thus they point to little convergence in prices across European countries. Of course, these discrepancies could simply reflect differences in the characteristics and quality of TV sets across Europe. For instance, it is entirely possible that the typical TV set sold in Switzerland is simply not available (or has a very thin market) in Poland or Hungary. Price differences could simply reflect differences in quality. We next investigate this possibility.

[6] The average prices are computed by weighting the prices of TVs by the volume of sales.

[7] We also implemented all standard stationarity tests, and rejected in all cases the hypothesis of non-stationarity in raw prices.

[8] We also tested whether $\alpha_i = \alpha$ for all countries in the sample, and were unable to reject the hypothesis of permanent country specific differences in almost all cases.

3.2 Hedonic Regressions: Corrected Prices 1999-2002

In this section we explore the extent to which quality-adjusted prices differ across markets. We adopt an hedonic price adjustment approach expressing the prices of the products as

$$p_{imt}^{euro} = \omega_{imt}\ \gamma + \theta_{st} + \theta_{mf} + \theta_{mt} + \varepsilon_{imt} \tag{1}$$

where p_{imt}^{euro} is the logarithm of the euro price of product i in market m at date t, ω_{imt} is a vector of product characteristics that may be different across markets, θ_{st} is the source country-time dummy, θ_{mf} a market/firm supplier dummy (i.e. brand dummy), and θ_{mt} is a market-country time dummy[9]. A similar formulation has been implemented by Goldberg and Verboven (2002), among others, in their study of the European car market. Hedonic regressions model prices as a function of observable product characteristics that might affect the costs of supplying the good, and consumers' evaluation of the product. The market-country time dummies θ_{mt} capture therefore the residual cross-country price differences that are unrelated to the observed variables meant to explain differences in good's quality.

Product characteristics are included in order to control for *observable* differences which may affect the consumer's evaluation of the TV set. But they may also reflect the retailer's choice of prices, over and above the direct effect of quality differences themselves. For example, small screens may not be a simple substitute for large screens. As mentioned above, our list of observable product characteristics is relatively short. We include the size of the screen, the tube dimension, and the picture renewal rate. It seems reasonable to assume that, all other things equal, larger or more sophisticated TV sets are more expensive. The screen sizes are divided into three categories, 28", 29" and larger than 29".[10] Tube dimension is defined as either the traditional 4:3 ratio, or the newer widescreen format, 16:9. Given the versatility of wide-screen formats, we would expect TV sets equipped with 16:9 tubes to be more expensive than those with 4:3 tubes. We also include information on picture quality, by distinguishing between traditional 50 hz and more recent 100 hz TV sets. The higher renewal rate frequency is supposed to reduce the flicker normally observed on 50 hz TV sets. Unfortunately, the data does not include other relevant variables such as the quality of the audio or the number of tuners. However, the variables that we include are those that the industry believes to be the most important observable product characteristics.

Television production is a highly globalized activity. Television sets are often produced by multinationals whose headquarters are usually located in their country of origin (source

[9]There is very little variation in the TV tax rates in our sample. We therefore did not include a tax variable.

[10]We also have data on smaller TV sets but for these products information is missing on other key variables.

country), while key TV components, i.e. tubes, are purchased in another country and the final assemblage of the TV sets is performed in yet another one. The identification of the production country is therefore not straightforward. We scanned thoroughly the annual reports for each TV producer we have data on, as well as outsourcing announcements in the financial press. At this stage we decided to choose as the source country the country of origin of the firm since a non negligible part of the activity of the company, such as marketing and advertising decisions and some stages of production are made in the firm's country of origin (see Table 2). In subsequent specifications we will also include controls for the actual production locations of some subcomponents of the different television sets (tubes in particular).

The inclusion of brand dummies is traditionally meant to reflect unobserved quality differentials. In particular, if certain producers are renowned for high (or low) quality TV sets, their reputation can be expected to affect consumers' perception of the product. Furthermore, TV sets differ not only in the quality of their components but also in their design. For example, producers such as Bang and Olufsen (B&O) or Loewe are well-known for desirable modern design which increase consumers' willingness to pay. Other aspects such as the degree to which TV sets may be integrated with other audio-visual products may have similar consequences. Brands may also be related to after-sales service, reliability and durability of the product. Many of these aspects are hard to measure directly, but will be captured through the inclusion of market specific brand dummies.

Finally, the country-time effect θ_{mt}, which pick up residual cross-country price differentials, may reflect either local costs at the retail level, or price differentials due to general differences in the willingness to pay for TV sets across markets. In particular, differences in the costs of distribution at the retail level are likely to affect the choice of retail prices through their effect on retailer margins. Similarly, countries with higher income may also be countries in which consumers have a higher demand for durable goods, that is, markets where producers may be able to set higher prices.

Table 4 reports the results of our hedonic price regression. The validity of an hedonic regression is commensurate to its goodness-of-fit. In the present case, we obtain R^2 around 80 percent, a rather good fit given the somewhat limited set of observable product characteristics included. Observable product characteristics all enter the hedonic prices with significant coefficients and with signs consistent with our priors. The results imply that TV sets with larger than 29 inch screen command a premium of around 32 percent relative to 29 inch television sets and a premium of 53 percent relative to 28 inch television sets. Similarly, we find that TV sets with 16:9 tubes are sold with a premium of approximately 26 percent relative to TV sets with 4:3 tubes. The higher price for widescreen TV sets are in line with standard industry wisdom. Finally, TV sets with 100 hz picture renewal rate carry a premium of approximately 38 percent relative to traditional 50 hz TV sets.

We also find highly significant source country-time effects indicating that our modeling of the source country appears to have an effect on the prices of the TV sets. Likewise, the country-time dummies are highly significant indicating that there are important differences in the general level of prices across markets that are not explained by differences in the product and/or production characteristics. Finally, the hedonic regressions include a measure of brands in order to control for unobserved product charateristics. The brand dummies are in fact highly significant and the hypothesis that brands do not affect prices is resoundingly rejected. In Figure 2 we illustrate the size of the estimated brand effects. The largest effect is estimated for Bang & Olufsen (B&O) TV sets, a brand that is known for high quality and attractive design. Once observable product charateristics are accounted for, the premium on B&O remains very large, with prices around 150 percent higher than comparable products. Loewe, Sony and Panasonic are also highly priced, but their brand premia are considerably lower than those of B&O. At the other extreme, Mivar, Orion and Daewoo do not appear to possess much brand value. Clearly, part of the product price differentials are related to unobservable differences in product characteristics, very that brand effects capture well.

3.3 Rankings and Dispersion

We now use our corrected prices to investigate the ranking and dispersion of prices across European countries, once differences in the TV sets' main characteristics are accounted for. In particular, as before we estimate the following fixed effects regression

$$p_{i,t} = \beta_i^0 + \beta^1 p_{i,t-1} + v_{i,t}$$

where $p = \ln(\frac{\theta_i}{\theta^{uk}})$ denotes country i's hedonic price relative to the UK. The estimation is now performed in relative terms, for non-stationarity in hedonic prices cannot be rejected. Figure 3 illustrates graphically our estimates for quality adjusted prices, which display a clear downward trend, in contrast with raw prices which were overall stationary. A variety of (unreported) tests confirm that the hypothesis of non-stationarity is significantly harder to reject for quality adjusted prices than for their raw counterpart. This suggests that the bulk of the time-variation in TV prices comes from quality improvements. Thus, we investigate the dynamic properties of quality adjusted *relative* prices, and we choose the United Kingdom as the numeraire. As before, a measure of persistent deviation in corrected (relative) prices is given by $\exp\left(\frac{\hat{\beta}_i^0}{1-\hat{\beta}^1}\right)$. We report our estimates in Table 5.

The ranking of TV prices changes dramatically. The UK, true to its reputation, is still found to be above the European mean, with only two countries scoring more higly on the expensiveness scale. Those are surprisingly the Czech Republic and Greece. Controlling for quality, TV sets in the Czech Republic and Greece are found to actually be more

expensive than in the UK, by 2 percent and 0.7 percent, respectively. Both countries were at the bottom of the ranking of uncorrected prices. This suggests that TV sets sold in the Czech Republic and Greece score low on most of the product characteristics we observe, to such an extent that they are actually overpriced relative to other countries. Switzerland on the other hand remains an expensive country, just behind the UK. This implies that the high uncorrected prices we observe there are - partly, but not completely - due to high quality TV sets. Quite strikingly, the countries with cheapest TV sets in our sample are now Germany, Austria and the Netherlands. Raw Dutch prices were amongst the highest in our sample: Table 5 means therefore that the TV sets sold in the Netherlands are of such good quality as to be actually cheap relative to an European average, 15 percent below a similar TV set sold in the UK, for instance.It is also striking that the three newcomers in the EU (the Czech Republic, Hungary and Poland), which were the three cheapest countries when our ranking was conducted using raw prices are now among the most expensive ones once quality of the TV sets is accounted for.

Finally, the cross-sectional dispersion in prices seems substantially lower once quality differences are accounted for. On average, TV sets are 8.5 percent cheaper than in the UK, and the maximal discrepancy occurs between Germany and the Czech Republic, with (quality adjusted) price differences equal to 22 percent. In contrast, Table 3 pointed to differences close to a ratio of one to two, between Switzerland and the Czech Republic. We now know part of this huge discrepancy stems from particularly low quality TVs in the Czech Republic.

In Figure 3, we plot hedonic prices for all countries in our sample. A one-time fall in prices can be observed in all countries around July 2000, and, to a lesser extent, toward the end of 1999. Our conversations with TV manufacturers unanimously suggest the former was largely due to massive discounts across Europe following immediately the European football Championship, and disappointing TV sales. The fall in November-December 1999 is ascribed to a re-positioning of the main European manufacturers (Thomson, Sony and Phillips) into the high-end TV market - indeed a price war. Furthermore, σ-convergence is apparent on the graph, with some price convergence towards a low common level.

We investigate the possibility in more details on Figure 4, borrowing from the literature on economic growth, and computing a time-varying measures of σ-convergence.[11] We compute the cross-sectional variance of the measure of quality-adjusted prices $\widetilde{\theta}_{it}$,

$$\sigma_t^2 = E_t \left(\widetilde{\theta}_{it} - \mu \left(\widetilde{\theta}_{it} \right) \right)^2$$

at each time t, where $\mu \left(\widetilde{\theta}_{it} \right)$ denotes the cross-country average of quality adjusted prices. We plot the corresponding series in Figure 4, both for EMU and non-EMU countries. The

[11] See Sala-i-Martin (1996) for a discussion.

results are surprising. First, there are no apparent trends in either of the two series. This suggests the cross-sectional dispersion in quality adjusted prices has not experienced any marked change in our sample. Second, however, dispersion is systematically lower within the European Monetary Union, with the short-lived exception of February 2000. This does suggest economic integration is more prevalent between EMU economies, but not necessarily because of the Monetary Union.

In fact the absence of downard trend in dispersion since 1999 suggests that most of the price convergence between EMU countries was a reality before the introduction of euro[12]. EMU countries may be better integrated with each other for trade to start with.[13] Deep integration on the goods market could actually explain why these countries chose to have a common currency in the first place. Or alternatively, preferences in EMU countries may be more similar than the preferences among non-EMU countries, a group that includes economies as different as Switzerland, the UK and poorer countries like Poland and Hungary. Given our finding that intra EMU price dispersion is smaller than average price dispersion in our sample, it is now worth investigating whether intra-EMU price dispersion is of the same order of magnitude as regional price dispersion, i.e. whether EMU countries can be considered as integrated as regions within the same country.

4 Regional Price Differences vs. Cross-Country Price Differences

For four of the countries in our sample we have information on regional prices for the post 1999 period. This dimension is available for Germany, Spain, Italy and Switzerland.[14] The regional dimension makes it possible to investigate whether absolute price differences are smaller within regions of countries that across national borders. We stress again that this hypothesis can only be investigated because our data is denominated in absolute prices rather than indexed.

Engel and Rogers (1996) examine price differences across city pairs located in Canada and in the United States using CPIs for 14 categories of consumer goods. They find that distance between markets matters for cross-market price variation, but most importantly

[12]In that sense our results are consistent with Engel and Rogers (2004).

[13]Switzerland, the UK and Sweden are part of a free trade zone with EMU countries but the Czech Republic, Poland and Hungary had to comply to the restriction of the "rule of origin" during the period considered.

[14]The regions in these countries are: Germany: North - NorthWest - Middle - South; Spain: North - NorthEast - Middle - South; Italy: North - NorthWest - Middle - South and Switzerland: French - German parts.

that the price variation between cities located in two different countries is much higher than the price variation between equidistant cities located in the same country. Since these authors examine CPIs their data do not allow them directly to investigate the extent to which absolute price differ across markets. Our data allows us to shed some new light on these issues and in particular to investigate whether borders matter for absolute price differences or not, a possibility that could partly explain their importance in explaining relative price volatility.[15]

In Figure 5, we plot both intra-regional and international price dispersion. International price dispersion is, as before, measured as $\sigma_t^2 = E_t\left(\widetilde{\theta}_{it} - \mu\left(\widetilde{\theta}_{it}\right)\right)^2$. To compute regional price dispersion, we calculate the cross-sectional variance of prices of the regions of each of the four countries and then average this variance across the four countries for which we have regional data. Figure 5 corroborates the view that regions within a country are more integrated than countries within Europe. This suggests that at the national level, strong forces of integration are at work, whether they be common currency, common preferences, ease of trade, integrated labour markets or common distribution networks. Such forces do not seem to exist or to be as strong at the international level, except perhaps among EMU countries.

In Figure 6, we plot the evolution of price dispersion for the three countries of our sample belonging to EMU and for wich we have regional data (Italy, Spain and Germany). We compare price dispersion within these three countries and between those same countries. Figure 6 shows quite clearly that there is a tendency for regional price differentials to be smaller than cross-country price differentials, although it might not be significant.[16] This suggests that the historic process of convergence among EMU countries, which has culminated in the Common Market initiative of 1992 and the introduction of the euro in 1999 has borne fruit, at least for the TV market. The absolute deviations of quality-adjusted prices are no bigger across EMU-nations than among Spanish regions say. This is a remarkable result that can only be established on the basis of highly disaggregated price *level* data, both for regions and nations.

Whether the explanation for this fact should rest on arbitrage arguments, greater similitude in distribution and pricing strategies, or more homogeneous preferences within EMU countries remains to be determined. In the next section we seek to shed some light on the role of the "EMU border effect" by studying in more details the role of the exchange rate.

[15]Furthermore, as we have discussed above, the goods characteristics matter very significantly for the evidence on the LOP. Engel and Rogers (1996) use CPI data from the BLS and Statistics Canada. While they attempt to control for differences in the goods definitions as rigorously as possible, their data -and most alternatives in this literature- just do not lend themselves to this type of thorough and accurate correction.

[16]A formal test for equality of the cross-sectional variances shows that regional price dispersion and intra-EMU price dispersion are of the same magnitude.

5 Passthrough

We next ask to what extent observed price differences may be due to pricing to market and incomplete exchange rate pass-through. To investigate this issue we run the following regression, similar to Goldberg and Verboven (2002)

$$p_{imt}^{source} = \omega_{imt}\ \gamma + \theta_{st} + \theta_{fm} + \alpha S_{smt} + \varepsilon_{imt} \tag{3}$$

where, unlike equation (1), the left-hand side is expressed in the currency of the source country. On the right hand side, the destination market time effects are dropped. Instead, we include the log of the exchange rate of each source country vis-a-vis the destination market, S_{smt}. This regression allows us to investigate how much of the time variation in TV prices can be attributed to changes in the exchange rate, once we control for observable characteristics, source market effects and brands. Changes in the exchange rate should be reflected one for one in the TV price, expressed in the exporter's (source) currency. Then, there is zero passthrough and $\alpha = 1$. All the currency risk is borne by the exporter. At the other extreme, if there is complete passthrough and prices are fixed in the currency of the exporter, $\alpha = 0$ and prices in the export market fully respond to exchange rate changes.

In Table 6, we impose α to be the same across all bilateral exchange rates and estimate an average pricing to market coefficient of 0.174 (with a standard deviation of 0.003). On average, there is a relatively high degree of passthrough for television sets. In our sample, many observations concern fixed exchange rates, for instance when both the source and destination countries are within the euro area. The main time varying exchange rates are yen/euro, sterling/euro or South Korean won/euro. One caveat is that it is of course entirely possible that for Japanese firms for instance, the relevant exchange rate for pricing decisions is not merely the yen euro/exchange rate but it includes third currencies, because of the geographical dispersion of production. Such would be the case if some sizable portion of marginal costs were incurred in third currencies.

There is reason to expect however that the extent of passthrough varies across markets and source countries. Indeed it is well-known that larger markets (or markets whose currency is more internationalized) tend to benefit from a higher degree of pricing to market. In turn, the source country can matter since different brands do not internationalize production to the same extent when they serve the European market, depending for example on their geographical location. Furthermore, firms having a larger market share in a given country may be able to adjust their prices when exchange rate fluctuates without losing their customers. Less established firms may have to absorb exchange rate movements to a larger extent in order to stabilize their market share.

Therefore, we also allowed passthrough coefficient to vary across source countries. But the two source countries commanding the highest market shares (41 percent in Japan

and 21 percent in South Korea) did not yield dissimilar passthrough estimates. Some further decomposition of the passthrough coefficient into a source country and a market destination effect may be warranted.

This section provided some preliminary evidence that part of the "EMU border effect" on price dispersion may be due to incomplete pass through. In the next sections we focus more on explanation based on heterogeneous preferences. We also investigate in more detail the actual sources of price differentials in our sample.

6 One TV, One Price?

Given our detailed data on TV sets, an alternative to hedonic regressions is to actually track price differences of the exact same TV over time and across locations. We follow that route in this section, and construct a sample formed by the prices of TV sets with *identical* characteristics, among those we observe. In other words, remaining differences have to originate in unobserved differences, such as brand perception, habit persistence or distribution and after-sale services. We use this sample to answer two questions, that correspond to the dimensions of our data. First, we investigate whether price differences across countries can be linked to standard economic variable such as proximity in trade or exchange rate volatility. This should allow a preliminary assessment of the importance of arbitrage as a price equalizing force across borders. Sizable price differentials would hint at the existence of sizable non-traded local costs such as retailing, distribution or at country specific unobserved differences in preferences.

Second, we ask whether the dispersion in international prices relates with the actual average TV price. On the one hand, if setting up an arbitrage business entails a fixed cost, one would expect that TV prices are more homogeneous across countries at the high end of the market. But on the other hand, the prices of high-end TV sets could be more dispersed if differences in after-sales services were most prevalent in high-end products, or if differences in brand perception were more important for expensive TV sets.

We first construct a measure of bilateral price dispersion by computing the variance of the relative prices for the same television set across country pairs. More precisely, we use the time average of p_{ik} (resp. p_{jk}), price of television k in country i (resp. j) to calculate the ij specific volatility of relative television prices

$$var_{ij} = \frac{1}{K(K-1)} \sum_k \bar{s}_k \left(\frac{p_{ik}}{p_{jk}} - m_{ij} \right)^2$$

where mij is the mean of the relative prices for country i and j, and $\bar{s}_k$ denotes the average share of the TV set of type k in sales in countries i and j. Since our mesure of

dispersion could be biased by differences in the number of common television sets across country pairs, we truncate our sample to ensure that K is the same across pairs. We are left with around 90 different television sets for each country pair.

Our results are reported in Table 7. We confirm the well-known result in Engel and Rogers (1996). Relative price volatility mirrors to some extent the movements in the nominal exchange rate. In particular, we find high volatilities between pairs of countries where the exchange rate fluctuates, involving for instance Switzerland or the UK. The highest average volatility of relative prices can be found for the UK-France country pair, while in contrast the Austrian-German couple or the trio Spain, Portugal, France who all share the euro, seem much more in phase.

Since one of the major advantage of our data is to include the actual price of each TV sets, we can also compare average television price differences *in levels* across country pairs. We construct a simple bilateral price differential measure as

$$\Delta_{ij} = \frac{1}{K} \sum_{k} \bar{s}_k \left(p_{ik} - p_{jk} \right)$$

where the set of televisions is also restricted to include solely the ones common across all country pairs.

The results presented in Table 8 are striking. They confirm the existence of important average price differences between European countries, even between TV sets that are as similar as an econometrician can know. On average the absolute price difference between the average price of the same televisions across pair of countries is as high as 80 euros, or a bit less than 8 percent of the average price. The highest differentials can be found between the UK and the Netherlands, the UK and France, the UK and Germany, or Switzerland and Germany. British customers pay an amount in excess of 257.9 euros on average when they purchase a television set compared to Dutch customers; they also put on the table 224.2 euros more on average than their friends from across the Channel. This amount is comparable to the 225.4 euro the Swiss customers disburse in excess of their German neighbors. The correlation between the absolute values of the price differences and the bilateral volatility measure is high, approximately 0.74. In particular, the highest average price differentials can be found across the same markets for which the variance of relative prices is the highest.

We next attempt to relate our measures of relative prices variances and mean differentials to traditional measures of economic and/or cultural integration. We simply regress $X_{ij} = var_{ij}$ or $|\Delta_{ij}|$ on variables traditionally used as indicators of cultural or economic affinities such as distance d_{ij}, a common language dummy L_i and exchange rate volatility $vole_{ij}$ (or, alternatively, an EMU dummy). We include country fixed effects to account

for the possibility prices be systematically higher, for instance in rich economies. We estimate

$$X_{ij} = \alpha_i + \alpha_j + d_{ij} + L_i + vole_{ij} + \varepsilon_{ij}$$

The results, presented in Table 9 suggest very little geographical pattern of relative price volatility and of average price differences, with significant coefficients on the exchange rate volatility, or an EMU dummy variable, but no significant effect of geographic proximity variables. Both the first and second moments of price differentials are increasing in absolute value with exchange rate volatility, or, alternatively, a variable capturing membership to EMU.

Figure 7 plots the average price of one among 300 TV sets, as against its coefficient of variation measured across countries. There are clear outliers, but the relation is clearly and significantly positive. TVs that are expensive on average also tend to have more widely dispersed prices across countries. This is a puzzling result for the arbitrage based explanation of price differences. If there is a fixed cost to set up an arbitrage business, arbitrage forces should presumably be stronger for high-end goods, which command a higher price. But, as our previous findings make clear, arbitrage forces seem weak to start with (10 percent average difference in price across markets is a large number) and are therefore unlikely to shape the pattern of price dispersion. The positive correlation between price level and coefficient of variation could occur because manufacturers in the high-end market have the option of seconding their sales with services, such as on call repairs or servicing at home, and do so differentially across countries. But this fact is of course also compatible with heterogeneous preferences across countries. We have every reason to believe for example that there are important national differences in brand perceptions (see the next section). These differences in brand valuations may be more pervasive for expensive television sets, which is the segment of the market in which TV producers strive to build their image.

Altogether these results constitute strong evidence in favor of market segmentation (lack of arbitrage, different local costs) and/or differences in consumer valuation across countries. These in turn could be due either to unobserved differences in product quality (differential customer service, advertising across countries) or to preference heterogeneity (including different brand perception or habit formation). In what follows we try to disentangle some of these explanations, with a special emphasis on the demand side. We first additional descriptive information to investigate the important role that brands play in product valuation. We then turn to a structural model of demand in the last section of the paper.

7 Brands 1999-2002

Our hedonic equation

$$p_{imt}^{euro} = \omega_{imt}\gamma + \theta_{st} + \theta_{pt} + \theta_{mf} + \theta_{mt} + \varepsilon_{ikt}$$

allows for market specific brand dummies. In Table 4, we report the outcome of an F-test on the null hypothesis that $\theta_{mf} = \theta_f$ for all m, f. The hypothesis is strongly rejected. While brands may reflect unobserved quality differences, which are good-specific, the variable appears to affect prices in a manner that varies across markets, and therefore cannot be explained just by unobserved goods characteristics. They may also reflect international differences in brand perception. By contrast, our regression coefficients on the physical characteristics are not significantly different across countries.

Figure 8 illustrates the dispersion of the brand effects across the 15 markets in our sample[17]. The figure shows the range (from minimum to maximum) of brand effects across markets. Contrary to what one would expect if brands reflected only unobserved quality, the dispersion of the brand effects is large. In particular, some brands carry a positive premium in some markets but negative premia in others and the range of values are in some cases quite wide.

Of course, price differ across markets, but these differences, captured by our country-time fixed effects (i.e. local costs like rents, or retail margins) should not affect the ranking of prices of individual TV sets. A more precise insight on the extent to which there are cross-market price differentials can therfore be gained by checking rank correlations of individual TV sets. Figure 9 plots the distribution of Spearman rank correlations of prices for identical products in each of the fifteen markets. We ranked the TV sets from cheapest to most expensive in each of the fifteen markets in our sample. We then computed Spearman rank correlations between the rank of product i in market m and its rank in the other markets.

If TV sets were priced similarly across markets we would expect the rank correlation distributions to be narrow and with a high positive mean. Instead we find that the distributions of the rank correlations are very wide, include positive as well as negative values, and with modes that often are close to zero. In other words, even when comparing identical products, we observe a large amount of dispersion across markets. Since we cannot reject commonality in the valuation of tube size, frequency, and screen size across countries, these international differences in valuations have to be related to more subjective characteristics of the television set, most prominently its brand.[18]

[17] We excluded all the brands which were not present in all markets.

[18] A caveat is in order. Our result could be explained by an omitted variable bias in the hedonic equation. If the unobserved physical characteristic is differently distributed across countries, it could account for part of the residual variation in the brand effect. There is little we can do against this here, given the data limitations. That said, our structural estimation moves us one step closer, as it allows us to reject other alternative explanations, such as after-sales services or advertisement strategies.

Brands are perceived differently across countries and this difference in valuation does influence both the premium that a brand carries in different countries and the relative ranking of TV sets across countries. There remain however several alternative explanations for this fact: i) brands do not offer the same level of customer service across countries; ii) there is habit persistence at the brand level and the stock of habit is different across countries; iii) national tastes are heterogeneous.

While giving a definite answer as to which of these explanations is the most convincing seems out of reach given the data restrictions and the state of the art in the design of structural estimation, we aim here at offering a more precise description of the particular ways in which brand valuations differ across countries. Of potential interest is the existence of a geographical pattern in brand valuations across Europe. We construct a brand affinity measure B_{ij} across pair of countries. Let b_{kj} denote the value of brand k in country j, we define the brand affinity between country i and j as the euclidian distance in the space of brand values (weighted by sales)

$$B_{ij} = \frac{1}{K_{ij}} \sqrt{\sum_{k=1}^{K_{ij}} \bar{s}_k \left(b_{kj} - b_{ki}\right)^2}$$

where K_{ij} is the total number of brands present both in countries i and j, and we weight bilateral discrepancies by average market shares.

We then simply regress B_{ij} on variables traditionally used as indicators of cultural or economic affinities such as distance d_{ij} and exchange rate volatility $vole_{ij}$. We also include country fixed effects, and estimate

$$B_{ij} = \alpha_i + \alpha_j + d_{ij} + L_i + vole_{ij} + \varepsilon_{ij}$$

The results, presented in Table 9 are surprising. The cross-section of brand perception appears to be largely unrelated with any obvious economic variables. Remarkably given the previous evidence on average price differentials, the behaviour of the nominal exchange rate seems irrelevant to how brands are perceived. More generally, EMU is insignificant as well, and so are standard gravity variables. This is surprising, for it suggests that even though price differentials present a systematic pattern where market segmentation plays a role through exchange rate volatility, the perception of brands does not. The perception of brands across countries seems heterogeneous, but the sources of that heterogeneity seem independent from those affecting price differences.

Therefore, in case it is national tastes that are heterogeneous, heterogeneity in preferences seems to be randomly distributed internationally. Hence the pattern we uncovered is consistent with an explanation of differential brand valuations based on random taste heterogeneity. But these findings are certainly not sufficient to fully dismiss alternative

hypotheses. We could also make the argument that distribution networks, customer service or advertising are different across countries in a way also uncorrelated with disatnce. Similarly it is also possible that TV sets are "experience goods" so that people are hooked on a specific brand: there is habit formation at the brand level. If this is the case, then current TV purchases depend on past market shares of the various brands, as shown in Ravn *et al* (2004). These two alternative explanations appear to be also compatible with our finding. And nothing excludes of course the possibility that all three explanations play.a role. In the next section, we resort to structural estimation to quantify precisely the importance of preference heterogeneity across European countries.

8 Structural Estimation

The past sections have brought forward the following facts: (i) a large part of international price differences can be explained by differences in the quality of the goods purchased; (ii) EMU countries display considerably smaller price dispersion (indeed comparable to within country regional price dispersion) than countries external to the monetay union. (iii) price differences for the same set of televisions are sizable. We also find (iv) different relative rankings of the same television sets across countries, and (v) incomplete exchange rate passthrough, that can account for some international price differences. (vi) absolute price differentials and relative price volatility are positively correlated with exchange rate volatility, and (vii) Differences in brand valuations across countries seem to be an important source of price variation.

So far however, we have been unable to fully ascribe differences in prices either to heterogeneity in preferences (or habit persistence) or to differences based on local costs. Furthermore, our evidence has necessarily been silent on the importance of unobserved differences in customer services or advertising, which would not necessarily be picked up by the brand effect. We now turn to a structural model that brings us closer to discriminating between these alternatives.

Our model finds inspiration in Berry, Levinsohn and Pakes (1999) and Nevo (2001) in the treatment of brands, and Goldberg and Verboven (1999) in its international dimension. The use of cross-country data helps us inform, in a structural sense, the very large literature on international price divergences, their sources and their welfare consequences. Armed with structural estimates of own- and cross-price elasticities, we are able to quantify the magnitude of international price differentials that can be ascribed to heterogeneous preferences, and, by default, to alternative explanations such as differences in distribution costs. As is common in this literature, we treat separately the structural

estimations for the demand and supply sides, with initial emphasis on the demand.[19] We derive preference parameters for goods and brands across countries, and feed them into a variety of models of the supply with a view to obtaining estimates of price-cost margins across countries. However, estimates for the demand side of the model do already provide in isolation a metric for international heterogeneity in preferences. Since the bulk of our estimation rests on the demand side, that is where we spend more time.

8.1 Demand

We follow Nevo (1998) and assume utility is heterogeneous. In particular, we define the utility derived from consumption of a good j in market c as

$$u_{ijc} = x_j\beta_i + p_{jc}\alpha_i + \gamma_j + \varepsilon_{ijc}$$

Consumers can differ in two ways. First, the perception of each observable good's characteristic β_i and the demand elasticity α_i are allowed to vary across consumers i. Second, utility may also vary across consumers because of unobserved product characteristics. γ_j denotes the overall mean valuation of such unobserved (by the econometrician) product characteristics. ε_{ijc} is a zero-mean error term.[20]

Since our set up is largely standard, we review the building blocks of the demand side rather quickly. We assume the vector of observed heterogeneous perception (α_i, β_i) depends on demographic variables D_i, including for instance income, and let the corresponding mapping be given by $(\alpha_i, \beta_i)' = (\bar{\alpha}, \bar{\beta})' + \Pi D_i + \Sigma\upsilon_i$. υ_i is a normally distributed disturbance. Then, utility can be decomposed into a mean utility, specific to each good, and random deviations from this mean, specific to each consumer. In particular, rewrite

$$u_{ijc} = \delta_{jc}\left(x_j, p_{jc}, \alpha_i, \beta_i, \gamma_{jc}\right) + \mu_{ijc}\left(x_j, p_{jc}, D_i, \upsilon_i, \Pi, \Sigma\right) + \varepsilon_{ijc}$$

where $\delta_{jc} = x_j\bar{\beta} + p_{jc}\bar{\alpha} + \gamma_j + \gamma_{jc}$ and $\mu_{ijc} = (x_j, p_{jc})' . (\Pi D_i + \Sigma\upsilon_i)$. Utility can be decomposed into a linear component, δ_{jc}, and a non-linear one, μ_{ijc}. Mean valuations across consumers are linear.

The rest of the set up makes use of this decomposition to compute analytically the market shares implied by the demand side. In particular, assuming consumers buy TV sets that give them the highest utility, we can define the set of unobserved characteristics

[19] Admittedly, a simultaneous estimation of the demand and supply sides of the economy would afford efficiency gains in the precision of our estimates. We follow the literature in treating the two separately. See for instance Goldberg and Verboven (1999).

[20] As in all this literature, a market here is defined as a country in a given year.

that will lead to the purchase of good j as a function of the model's parameters and the mean utility level. Formally,

$$A_{jc}\left(x, p_{1c}...p_{Jc}, \Pi, \Sigma, \delta_{1c}...\delta_{Jc}\right) = \left\{(D_i, \upsilon_i, \varepsilon_{ijc}) \mid u_{ijc} \geq u_{ikc}\ \forall k\right\}$$

Letting $P(.)$ denote the population distribution functions, we have an analytical expression for market shares in function of the mean valuation of all goods, given by

$$s_{jc}\left(\Pi, \Sigma, \delta_{1c}...\delta_{Jc}\right) = \int_{A_{jc}} dP(D)\ dP(\upsilon)\ dP(\varepsilon)$$

Under specialized preferences and some distributional assumptions, it is possible to obtain an analytical expression for the market shares, as for instance Goldberg and Verboven (2000), who consider a Nested Logit special case. The drawbacks implied by these parametric choices are well-known, and developed for instance in Nevo (1999) or Pakes (2004). For instance, introducing heterogeneity through a separable additive shock severely restrains the parametrization of own- or cross-price elasticities. Here we follow Nevo (1999) in implementing Pakes (1986) simulation technique to compute market shares numerically.

8.2 Identification

As in the literature, our estimation purports to identify the set of parameters that equalize observed and analytical market shares. The methodology implemented in practice is simpler, and makes use of the linearity present in the model. In particular, the system of equations $s_{jc}\left(\Pi,\ \Sigma,\ \delta_{1c}...\delta_{Jc}\right) = S_{jc}$, where S_{jc} denotes the observed market share for all j, can be solved numerically for the mean valuation δ_{jc}, as a function of the *observed* market shares and the model's parameters. Then define a residual error term for each good j as

$$\omega_{jc} = \delta_{jc}\left(S_{jc}, \Pi, \Sigma\right) - \left(x_j\bar{\beta} + p_{jc}\bar{\alpha}\right)$$

The residual ω_{jc} captures the difference between mean valuation as implied by the model and observed mean valuation as implied by good j's observable characteristics. A standard GMM estimator can be implemented on these residuals, provided a set of appropriate instruments can be identified. We next turn to this issue.

In most of the literature, the residual contains all unobserved characteristics specific to each good, i.e. γ_j. As in Nevo (1999), however, the richness of our data makes it possible to improve on this residual, including a variable γ_b capturing the brand of the manufacturer of each TV set. Our unobserved residual, therefore, only contains deviations from the average brand valuation in each market, γ_{bc}. Our data are actually richer than Nevo's, since we actually observe different goods in each markets sold under the same brand. Our hypothesis that all unobserved characteristics are summarized in γ_{bc} is

akin to assuming away any complementarities between brands and characteristics. For instance, the evidence we developed in the previous sections suggests that brand perceptions for Toshiba or Samsung TV sets vary widely across countries. We assume here this variation does not depend on the (observed) characteristics of each TV set: for instance, the perception of Samsung TV sets is equally heterogeneous across markets regardless whether they come with small or large screen. Under this assumption, deviations from brand dummies capture all the unobserved features affecting utility.[21]

Valid instruments should (i) be uncorrelated with the residual ω_{jc}, (ii) affect utility u_{ijc} meaningfully and systematically, but (iii) not because of shifts in demand. The most usual instrument set, used for instance in Goldberg and Verboven (2001), contains the actual good's characteristics x_j, which are is by definition orthogonal to ω_{jc}, do affect valuation, and are a priori exogenous to demand shifts. Often, measures of market structure are added to the list, and include the number of goods or brands per market, and/or the proximity of other goods with similar characteristics. However, Nevo (2001) argues the features of demand that are unobserved by the econometrician are actually available to the manufacturer, who may therefore take the information on board when choosing on a product mix, and its geography across markets. In other words, condition (iii) may not be fulfilled for the classical instruments just listed.

Instead, an alternative makes use of the richness of the data, and the identifying assumptions on the residual γ_{bc}. By definition, γ_{bc} is uncorrelated across markets. Thus, while the domestic price is obviously endogenous and not a valid instrument, international prices are valid instruments for domestic valuation. Condition (i) is fulfilled by definition, except in the presence of internationally correlated demand shocks. As mentioned, there are no football World Cups in our sample, but there is a European Championship in 2000. We experiment with excluding the relevant period in what follows. We also include time dummy variables, which control for any world shocks, and in particular demand ones.

Condition (iii) requires that no systematic manipulation of demand affect the dispersion of brand perceptions across countries. In particular, it requires that differences in distribution networks and/or advertisement budgets and strategies be independent across markets, in our case, across countries. Notice that this choice of instruments is perfectly consistent with the possibility that advertisement and/or after-sales services affect prices, demand and utility, provided that they be market -specific and independent across countries. For language, cultural or historical reasons, advertisement and distribution service strategies tend to follow national borders. In other words, our demand estimates account for the possibility that prices and demand should vary across countries because unob-

[21] This is related to the question of what defines a brand. Nevo (2001) considers for instance that Kellogg Corn Flakes and Kellogg Special K are two different brands. On the other hand, both Sony Large Screen and Sony 28 inch TV sets come under the Sony brand in our classification.

served brand-specific characteristics do, and that includes, in particular, differences in advertising or after-sales services.

In what follows, we experiment with a variety of instrument sets. We also include direct measures of marginal costs, such as wages in the relevant manufacturing sectors in the market we cover. Finally, we follow Goldbert and Verboven (2001), and include the nominal exchange rate.

8.3 Results

TO BE COMPLETED.

9 Conclusion

TBC

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Table 1

Country	Time Series	Regional Data	$\hat{NT}$ $[NT]$
Germany	1993-2002	N,NW,M,S	310 [399]
France	1999-2002		124 [147]
Spain	1995-2002	S,N,NE,M	151 [315]
Italy	1999-2002	NW,NE,M,S	146 [147]
Switzerland*	1993-2002	F,G	211 [399]
Austria	1999-2002		125 [147]
Belgium	1999-2002		119 [147]
UK	1999-2002		128 [147]
Netherlands	1999-2002		128 [147]
Portugal	1999-2002		121 [147]
Greece	1999-2002		83 [147]
Sweden	1999-2002		122 [147]
Hungary	1999-2002		108 [147]
Czech Rep.	1999-2002		109 [147]
Poland	1999-2002		118 [147]

Notes: * implies data is available every 4 months. N=north, NW=North West, M=Middle/Center, S=South, F=French Part, G=German Part. $\hat{NT}$ are total available observations, while the numbers in parenthesis report potential maximum observations.

Table 2

Brand	Country of origin (source country)	Purchased by
aristona	NETH	
brandt	GER	Thomson (FRA)
B&O	DEN	
Ferguson	UK	
Grundig	GER	
Loewe	GER	
Mivar	ITA	
Philips	NETH	
Radiola	FRA	Philips (NETH)
Saba	GER	Thomson (FRA)
Schneider	FRA	Philips (NETH)
Telefunken	GER	Thomson (FRA)
Thomson	FRA	
Hitachi	JAP	
JVC	JAP	
Orion	JAP	
Panasonic	US	
Sanyo	JAP	
Sharp	JAP	
Sony	JAP	
Toshiba	JAP	
Daewoo	SKOR	
LG	SKOR	
Samsung	SKOR	

Notes: The information on country of origin and owbenership have been obtained from various issues of the business newspaper "Les Echos" between 1993 and 2003 and from websites of the TV manufacturers.

Table 3: Long Run Coefficients (Average Prices)	
Country	Long Run Effect
Switzerland	1156.222
Netherlands	986.6138
United Kingdom	944.2861
Greece	863.2629
Belgium	855.8381
Portugal	829.775
Sweden	776.5889
Austria	769.3651
Germany	762.993
Spain	753.3398
Italy	722.7224
France	712.5274
Poland	686.5289
Hungary	635.7281
Czech. Rep.	625.613
Average	805.427

Notes: The long run coefficients are obtained from an AR1 fixed effects model using average uncorrected prices for each country. The average TV price is constructed using weights derived from sales.

Table 4: Hedonic Regression	
Variable	Coefficient
Constant	7.480 (0.009)
28 inches	−0.528 (0.003)
29 inches	−0.315 (0.005)
Tube	−0.257 (0.003)
Hertz	−0.384 (0.003)
Source(time) Dummies[a]	41.279 (0.000)
Brand (Country) Dummies[a]	21.820 (0.000)
Country (time) Dummies[a]	6.386 (0.000)
F-test*	4.224 (0.000)
$\overline{R}^2$	0.784
NT	27760

* *The F-test is for the equality of brand dummies across countries*
[a] *F-Tests*

Table 5: Corrected Long Run Coefficients	
Country	$\exp\left(\frac{\hat{\beta}_i^0}{1-\hat{\beta}^1}\right)$
Czech. Rep.	0.020
Greece	0.007
Switzerland	-0.012
Hungary	-0.016
Poland	-0.022
Belgium	-0.086
France	-0.097
Portugal	-0.100
Spain	-0.115
Sweden	-0.125
Italy	-0.129
Netherlands	-0.151
Austria	-0.162
Germany	-0.198
Average	-0.085

Notes:Ranking using hedonic prices.The table lists the LR Coefficients from the following fixed effects regression $p_{i,t} = \lambda p_{i,t-1} + \alpha_i + v_{i,t}$ where $p = \ln(\frac{p^*}{p^{uk}})$ i.e. the hedonic prices relative to the UK.

Table 6: Hedonic Regression. Passthrough	
Variable	Coefficient
Constant	8.767 (0.019)
E.rate	0.174 (0.003)
28 inches	−0.530 (0.007)
29 inches	−0.300 (0.009)
Tube	−0.248 (0.007)
Hertz	−0.370 (0.006)
Source(time) Dummies[a]	309.41 (0.000)
Brand (Country) Dummies[a]	127.95 (0.000)
$\bar{R}^2$	0.97
NT	25576

Table 7.

	DE	FR	IT	CH	PL	CZ	HU	SE	GR	PT	NL	UK	BE	AT
DE														
FR	0.038													
IT	0.033	0.051												
CH	0.072	0.089	0.076											
PL	0.062	0.043	0.051	0.032										
CZ	0.054	0.066	0.031	0.042	0.009									
HU	0.039	0.053	0.032	0.019	0.012	0.011								
SE	0.044	0.062	0.031	0.049	0.030	0.027	0.021							
GR	0.024	0.057	0.028	0.051	0.061	0.032	0.026	0.040						
PT	0.035	0.015	0.031	0.045	0.038	0.030	0.025	0.029	0.050					
NL	0.026	0.033	0.027	0.090	0.055	0.042	0.037	0.037	0.036	0.025				
UK	0.097	0.100	0.087	0.039	0.030	0.028	0.024	0.053	0.079	0.059	0.098			
BE	0.036	0.039	0.034	0.044	0.031	0.014	0.028	0.022	0.032	0.022	0.024	0.063		
AT	0.010	0.022	0.027	0.057	0.040	0.034	0.026	0.032	0.017	0.031	0.014	0.060	0.020	
ES	0.039	0.019	0.042	0.064	0.037	0.062	0.038	0.054	0.035	0.016	0.032	0.080	0.039	0.024

Table 8

	DE	FR	IT	CH	PL	CZ	HU	SE	GR	PT	NL	UK	BE	AT
DE														
FR	-50.3													
IT	-29.6	0.9												
CH	-225.4	-132.1	-161.4											
PL	-163.6	-98.7	-138.4	-16.0										
CZ	-102.4	-69.4	-79.5	1.77	2.7									
HU	-113.1	-59.7	-77.0	-15.4	47.4	21.4								
SE	-92.3	-54.8	-52.9	68.8	80.5	44.8	46.9							
GR	-64.7	-5.0	-22.4	173.8	167.5	116.3	119.6	-3.6						
PT	-84.4	-32.8	-22.7	138.4	118.3	55.9	72.7	23.5	-2.5					
NL	-16.5	18.3	30.1	258.5	151.4	97.3	95.5	81.3	96.5	83.1				
UK	-205.2	-224.2	-178.7	-54.6	-10.2	-41.8	-29.9	-122.2	-156.7	-201.3	-257.9			
BE	-103.9	-2.1	-46.6	140.0	88.0	29.3	54.7	12.4	-4.5	-8.2	-78.8	153.8		
AT	-35.2	8.5	-5.5	204.3	137.3	85.8	94.6	51.3	20.2	31.0	-36.4	173.4	64.9	
ES	-76.2	-32.9	-39.9	124.3	104.9	89.9	65.3	21.9	-28.5	-25.9	-90.8	152.7	-0.3	-34.8

Table 9	$volij$	$volij$	$\|\Delta_{ij}\|$	$\|\Delta_{ij}\|$	B_{ij}	B_{ij}
	(1)	(2)	(1)	(2)	(1)	(2)
Distance	-0.004	-0.003	-0.32	-0.25	-0.14	-0.014
	(0.004)	(0.003)	(0.21)	(0.17)	(0.08)	(0.08)
Volatility	6.235**		334.43**		1.34	
	(1.60)		(63.43)		(1.75)	
EMU		-0.055**		-3.44**		-0.001
		(0.009)		(0.52)		(0.016)
language	-0.006	-0.009	0.398	0.24	-0.026	-0.027
	(0.008)	(0.006)	(0.58)	(0.43)	(0.017)	(0.17)
R-squared	0.83	0.86	0.62	0.74	0.67	0.66
N	55	55	55	55	55	55

Notes: The table below gives the results of regressions of bilateral volatility of relative prices and of the log of absolute average price differences on log(distance), exchange rate volatility (standard deviation of the first difference of bilateral exchange rates), language and EMU dummies. * and ** denote significance at the 5%, and 1% levels respectively. Robust standard errors are shown within brackets. Fixed effects are not reported.

Figure 1: Average Raw Prices

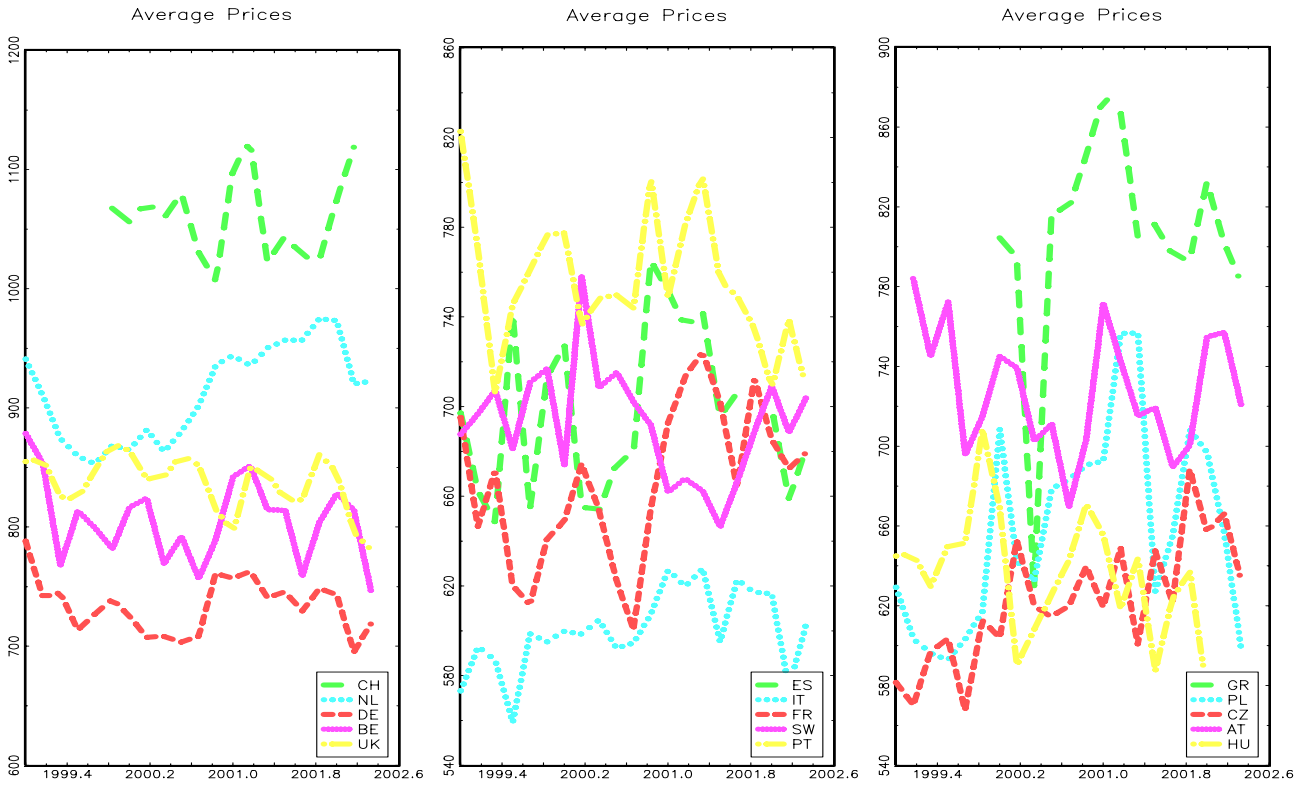


Figure 1

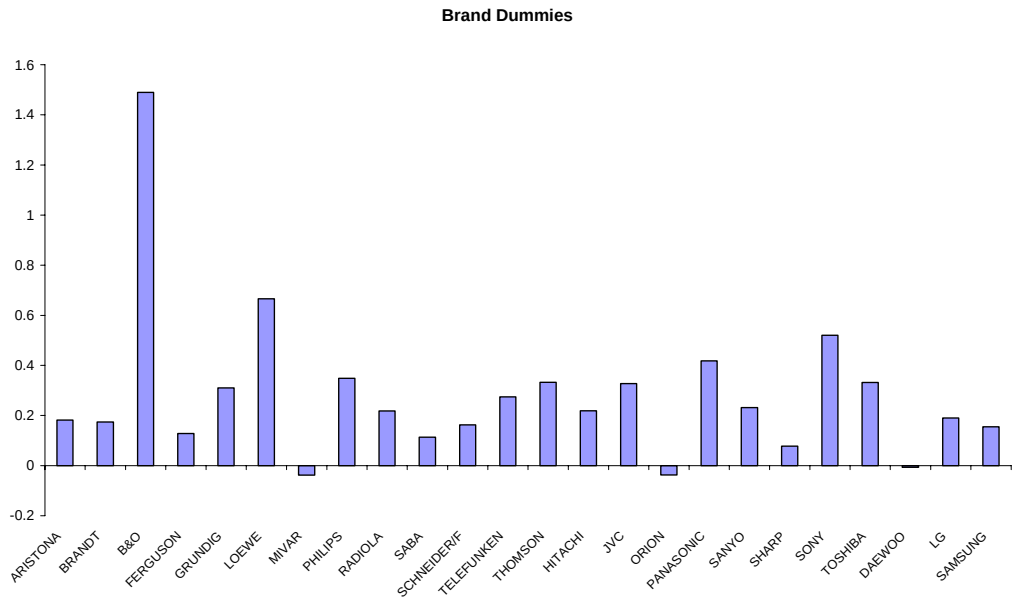


Figure 3

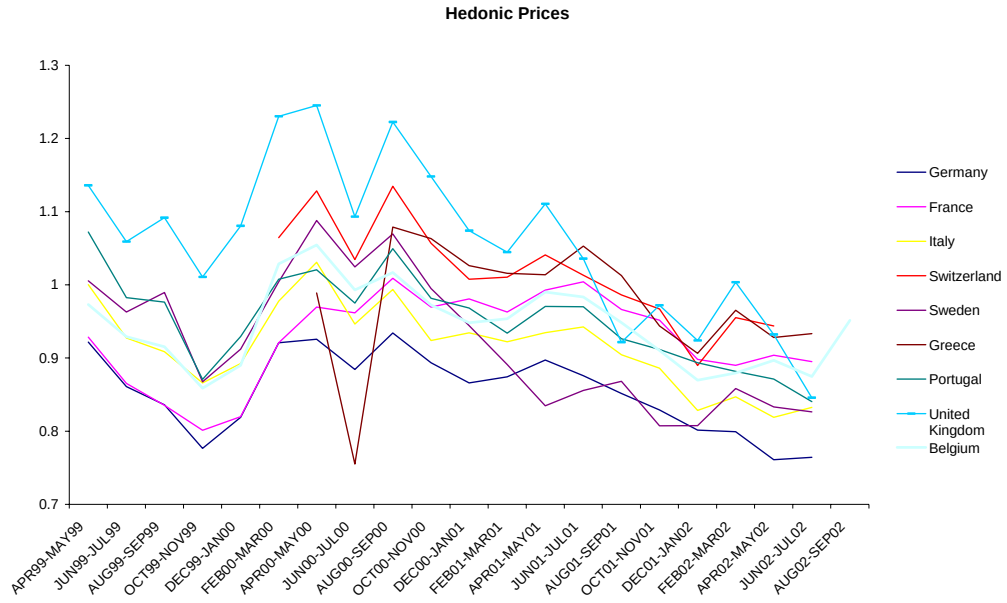


Figure 4: σ-Convergence Inside and Outside of EMU

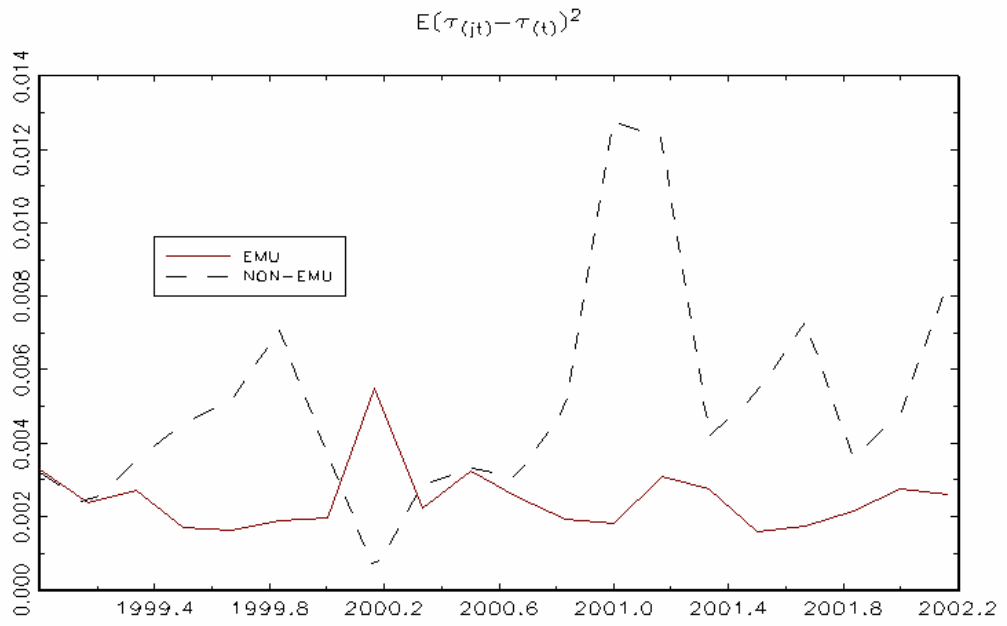


Figure 5: International and Inter-Regional σ-Convergence

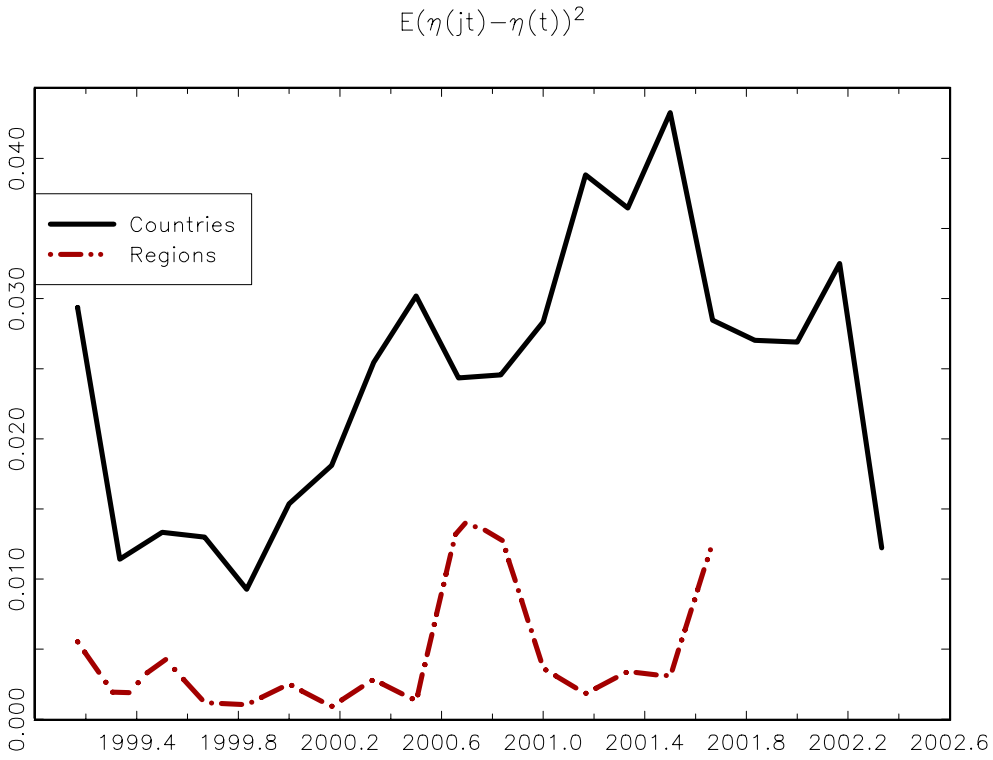


Figure 6 (Italy, Spain, Germany)

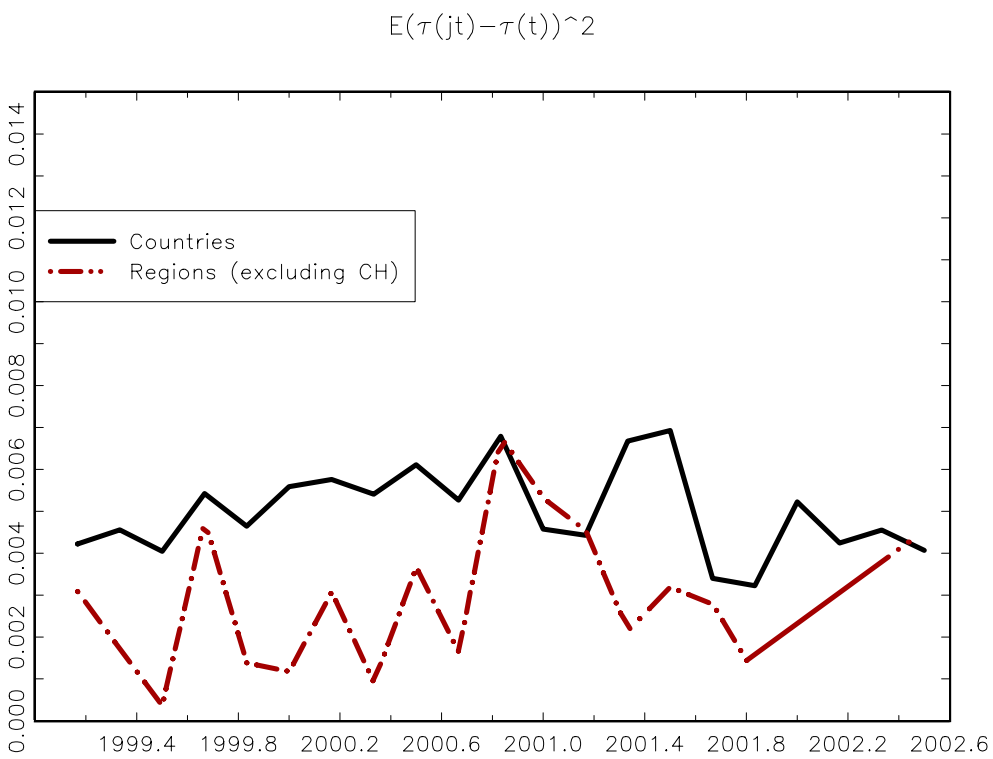
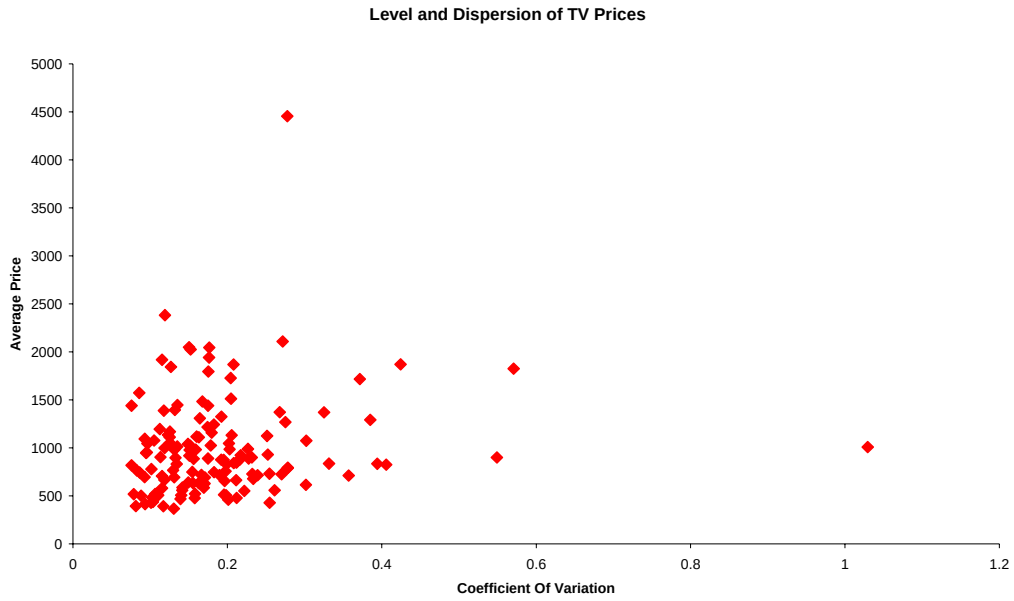
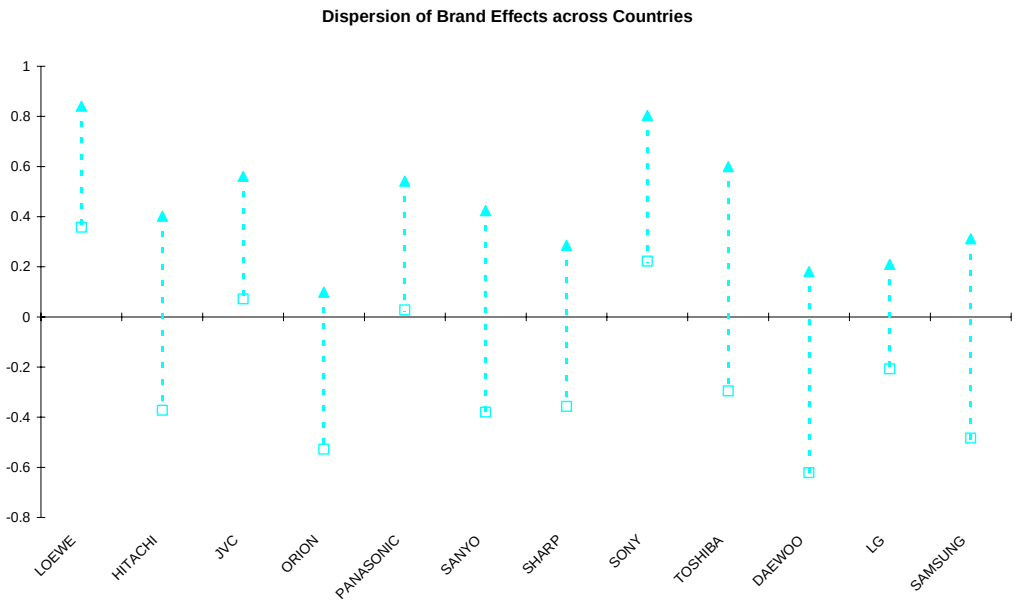


Figure 7



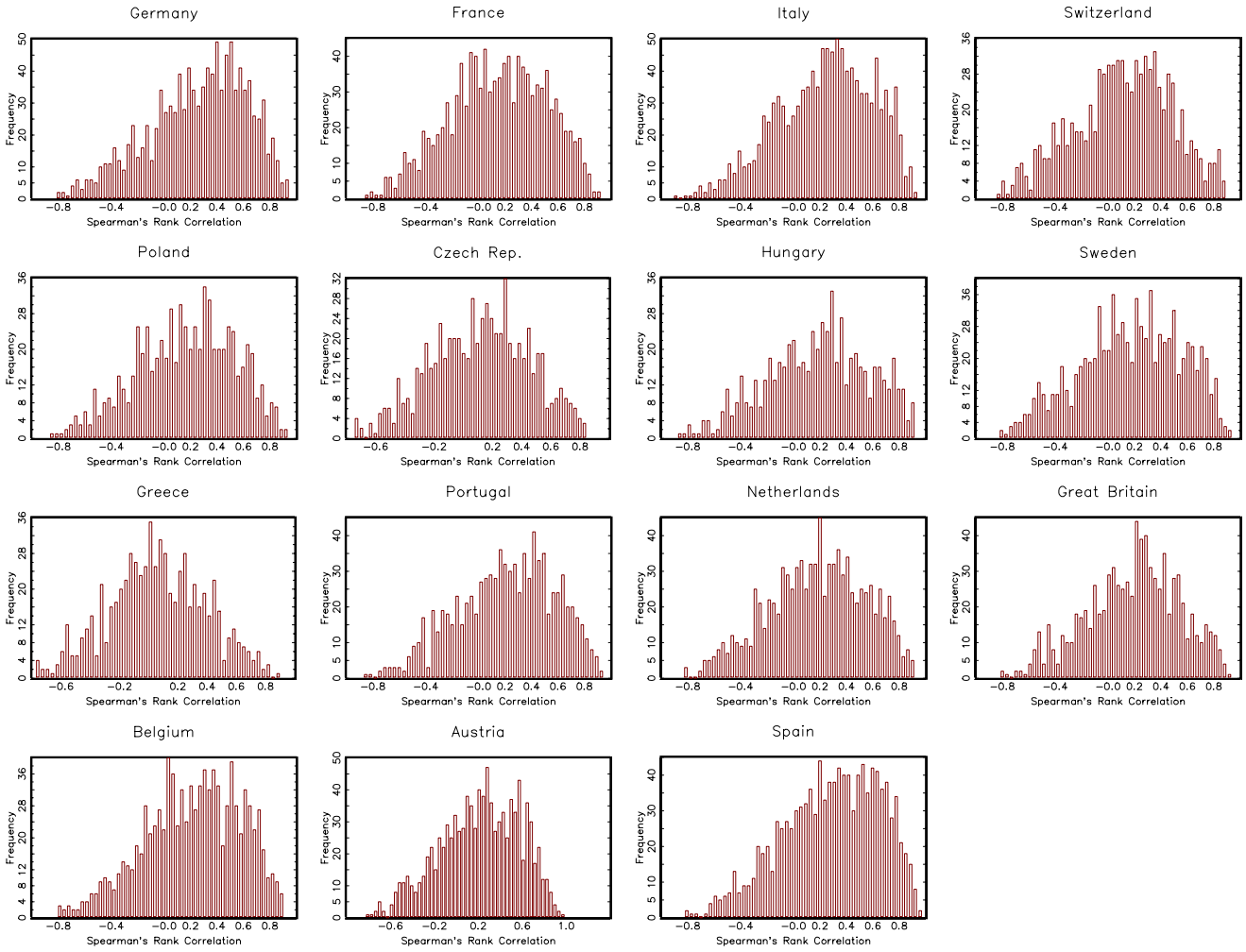
Notes: The figure is constructed in the following way. There are 300 types of TV's in each country. For each type i the price is averaged over time. Then, for each average price, the dispersion (coefficient of variation) and the mean is calculated across countries. The figure plots the relationship between these two for all available [i].

Figure 8



Notes: Sample restricted to the brands present in all our 15 countries.

Figure 9


Germany
France
Italy
Switzerland
Poland
Czech Rep.
Hungary
Sweden
Greece
Portugal
Netherlands
Great Britain
Belgium
Austria
Spain
Frequency
Spearman's Rank Correlation