

Cross-sectional variation in European real exchange rates: 1975-1990.*

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Abstract

Using a panel of over 5,000 local currency prices of retail goods and services sold in the capital cities of Europe in 1975, 1980, 1985 and 1990, we characterize the behavior of average relative prices — ‘real exchange rates’ — as well as dispersion around these averages. We find that the averages are surprisingly close to what purchasing power parity would suggest. In other words averages of ratios of foreign to domestic prices (across goods for a particular pair of countries) provide relatively accurate predictions of most nominal cross-rates. Variation around the averages, however, is large but is found to be related to economically meaningful characteristics of goods such as measures of international tradeability, the importance of non-traded inputs into production and the competitive structure of the markets in which the goods are sold. Using data on product brands, we find that product heterogeneity is at least as important as geography in explaining relative price dispersion. These findings are quite robust for all four years contained in our panel.

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1 Introduction

The lion's share of available data on international prices is either in the form of price indices, sometimes over a broad set of goods and services, or price levels over a narrow set of goods and services. The combination of both breadth and absolute prices has been hard to come by. This represents an important impediment to understanding real exchange rate behavior, both at the aggregate level and the disaggregate level. For example, Engel and Rogers (1999) find that, across U.S. cities, the variability of *changes* in relative prices is larger for traded goods than for non-traded goods. Is this evidence of segmented markets? Or are markets for traded goods well integrated while prices for non-traded goods just don't move around very much? As Engel and Rogers (1999) note, it is difficult to know without data on absolute price levels. A relatively small amount of dispersion in the relative prices of traded goods, for instance, would be supportive of integrated markets for traded goods in spite of the fact that their relative prices display higher time series volatility.

We hope to fill this void in the empirical exchange rate literature by using what is arguably the best international price survey in existence. Eurostat, the statistical agency of the European Community, has conducted retail price surveys comparable in scope to those conducted by the Bureau of Labor Statistics across major cities in the United States. The Eurostat surveys present international price data that satisfy virtually every item on our wish list: prices are in absolute terms, identical goods are priced in each location, data exists for multiple years and over 5,000 items are enumerated, including everything from whiskey to VCR's to haircuts.

While we address many of the traditional questions posed in the international finance literature, such as how closely PPP holds, our main focus is on the relationship between international price dispersion and the economic characteristics of particular subsets of goods. While we do not deny that goods and their prices have a location-specific component, it seems reasonable to expect that the quantitative importance of location will differ across goods. Certainly there are a number of well-founded theoretical reasons why this should be so, including (among many others) papers by Alessandria (1999), Betts and Kehoe (1999), Balassa (1964), Baumol-Bowen (1966), Harrod (1933), Knetter (1989, 1993), Krugman (1987), Samuelson (1964), Ethier (1979), Stockman and Dellas (1989) and Stockman and Tesar (1995). These authors argue persuasively that things like tradeability and industrial organization should help explain both disaggregate and aggregate price dispersion.

Our goal is to ask to what extent these viewpoints are supported by our European micro-data. In previous work (Crucini, Telmer and Zachariadis (2000)), we addressed the issue of absolute dispersion in international relative prices using a single cross-section from 13 European countries taken in 1985. Our results fell into two categories. First, we found that for most countries vis-à-vis Belgium, there were roughly as many overpriced goods as there were underpriced goods. That is, an equally-weighted average of good-by-good real exchange rates was surprisingly consistent with PPP. This result was somewhat sensitive to alternative weighting schemes, something we address further here. Second, we found the absolute level of dispersion in relative prices to be related to characteristics of goods in a textbook manner. Price dispersion decreased with tradeability, increased with the extent to which non-traded goods were used as inputs, and was larger for services, more differentiated goods and heavily taxed goods such as liquor and tobacco. We also found price dispersion for identical brands of the same good across countries to be small relative to dispersion for different brands within countries.

An obvious limitation of our previous study was that it involved a single cross-section for 1985. In this paper we supplement the original 1985 cross-section with highly comparable cross-sections from 1975, 1980 and 1990. We find that our results for 1985 hold up very well in these additional years.

The remainder of the paper is organized as follows. Section 2 describes the original sources of our price data and some basic information about the four cross-sections. In section 3 we study purchasing power parity using aggregative real exchange rates that we construct by weighting our good-by-good real exchange rates. Section 4 studies the variation around this mean, relating the dispersion of real exchange rates good-by-good to various economic characteristics of the good. We also consider the role of market power by focusing on a subset of our commodities that involve brand differentiation. Section 5 concludes with a discussion of the implications of our results for three prominent theoretical approaches to real exchange rate determination.

2 The Data

The original source of the price data is the same as for our earlier study that focused on 1985; namely, a set of extensive retail price surveys conducted by Eurostat, the statistical agency of the European Community. In addition to the survey we found for 1985 we have now located comparable surveys for 1975, 1980 and 1990.

The retail prices appearing in the survey are cash prices paid by final consumers and therefore will include taxes, such as VAT. Except for Germany, where the price survey is conducted country-wide, the prices are

drawn from their respective capital cities. As is true in any price survey, the prices are themselves averages of the surveyed prices across different city-wide sales points with more observations collected for goods having greater price dispersion within the city. Sales points were selected by the national statistical offices so that the sample is representative of the distribution of prices in the capital city.

This data source is ideal for the study of international relative prices, including real exchange rates, for a number of reasons. The first is that it permits us to measure the deviations from the law-of-one-price in absolute terms making it possible to consider the potential for things like transportation costs to account for the magnitude of the deviations. Second, because the survey is as extensive as those used to construct domestic consumer price indices, the heterogeneity of goods in the sample is sufficient to allow us to relate the extent of deviations from the law-of-one-price to those characteristics that theory suggests will be important, such as tradeability. Third, the survey is expressly designed to promote international price comparisons because the national agencies were instructed to collect price observations on identical goods in each location.

Table 1 reports a number of individual records from the 1985 survey with the goods chosen to be representative of the various overall categories contained in our dataset. As is evident from the sample of goods reported in this table the price surveys that Eurostat conducts are as comprehensive as retail price surveys developed to construct national consumer price indices. In the sample presented we see food items, clothing, major appliances, automobiles and services.

The breadth of the survey will be of no surprise to readers familiar with efforts to create a system of harmonized consumer price indices for European Union countries. The Eurostat price surveys are an integral part of the effort to achieve this goal. All the surveys have a similar structure involving a Eurostat code, a detailed description of the particular good, the units of measure and columns of price data. Although Eurostat reports the latter in local currency units, Table 1 represents prices in Belgian francs to facilitate comparisons. The deviations we see from the law-of-one-price are suggestive of what is to come. The rental cost of a television, for instance, varies widely across countries whereas the dispersion in the cost of rice is much smaller.

The careful reader will also notice that the level of detail of the descriptions varies to some extent. Goods can be placed into two categories: those indicated as selected brands (s.b. in Table 1) and those without such a designation. Eurostat explains the reason for the selected brand designation is the need for confidentiality. Thus while we might like to know which automobiles are Mercedes and which are Volvos the

record does not provide us with the necessary details. However, when a selected brand is indicated we know that it is the same brand in each country. This presents certain challenges in constructing an actual panel dataset though we are in the process of doing so. For the purposes of this paper we study the cross-sections separately to see if our results for 1985 hold up robustly over time.

One last important issue concerns the exact timing of the price surveys. While we find it convenient to refer to our cross-sections by year, in reality the price data for each cross-section is collected in a sequence of surveys. For example what we refer to as the “1985 cross-section” is actually a set of six separate surveys conducted over the period 1984-1986. During each sub-period, a price survey is carried out for a particular category of goods in each of the capital cities. Clothing, footwear and household textiles were surveyed in Autumn 1984; durable household goods in Spring 1985; services in Summer 1985; glassware and other household articles in Autumn 1985; food, beverages and tobacco in Spring 1986 and health services in Summer 1986.

The 1980 and 1990 surveys have a similar timing structure in the sense that different categories of goods are surveyed in all locations at about the same time. The 1975 cross-section differs in that all goods prices were collected in a given interval of time with the exact timing differing across countries rather than across goods. For example in Germany all prices were obtained in a survey conducted between September 15, 1975 and September 26, 1975 while for France all prices were obtained in a survey conducted between November 10, 1975 and November 21, 1975. The nominal exchange rate data with which we convert prices into a common currency takes explicit account of this timing, taking the form of averages of daily data over the relevant time intervals.

Table 2 presents basic information about what our cross-sections entail. We have detailed retail prices at five year intervals between 1975 and 1990. Both the number of items in the price surveys and the countries included vary over the sample period. In 1975 nine European countries are included, in 1980 Greece, Portugal and Spain are added while in 1985 Austria is added. Thus the sample of countries grows from 9 to 13 over the sample period of study. The number of goods included in the survey also grows over time from 658 items in 1975 to 1,896 items in 1990.

In Table 1, missing data were indicated with a ‘-1.’ As Table 2 indicates there are a great number of missing observations in the price surveys, 13% are missing in 1975 and the number increases abruptly in 1980 to 36% and remains at about that level. The number of missing observations differs systematically across countries from a low of about 25% to a high of about 50%. Belgium is consistently the country with

the fewest missing observations while Ireland is consistently the country with the most missing observations.

Since our main focus is on explaining price dispersion across countries we eliminate any good which has an insufficient number of cross-country observations, which we define as 4 in 1975, 5 in 1980, and 6 in 1985 and 1990. The increments to our criteria reflect the fact that the number of countries increases over time. We also control for gross measurement error by eliminating any particular observation in which the common-currency price differs from the good-specific median by a factor of 5 or more. These filters reduce our sample of goods from a total of 5,449 to 3,545 with the details for individual years provided in Table 2. Of these remaining data, the proportion of missing observations never exceeds 25%. For calculations which require a numeraire to be defined, we use Belgium for the simple reason that it has the fewest missing observations (less than 10% of the 3,545 goods remaining after applying our filters). Our survey data also contain a large number of branded goods, typically accounting for about one-third of the price data that we utilize.

3 Purchasing Power Parity

Virtually all studies of PPP use an aggregate real exchange rate defined as $q_{jt} = e_j p_{jt} / p_{nt}$, where e_j is the spot exchange rate for country j in units of the numeraire country during period t and p_{jt} and p_{nt} are price indices, typically consumer price indices. Unfortunately, the purchasing power of a currency cannot be determined from this measure since its level depends on an arbitrary choice of units used to define each of the price indices. As a consequence economists have been forced to study PPP indirectly by characterizing the persistence and volatility properties of the real exchange rate as opposed to measuring its absolute level.¹ One attractive feature of our data is that we can compute the level of the real exchange rate for each good in our sample and aggregate them to determine overall purchasing power. Not only does this provide an estimate of the level of the real exchange rate it also allows us to investigate how different methods of aggregation impact the estimate.

Some notation is useful at this point. Let N be the number of goods, M the number of countries and p_{ij} the local currency price of good i in country j . The real exchange rate for good i in country j (relative to the numeraire country, n) is then $q_{ij} = e_j p_{ij} / p_{in}$, where e_j is the spot exchange rate for country j in units of the numeraire country and p_{in} is the local currency price of good i in the numeraire country. Thus when

¹An obvious exception is the remarkable work of Lipsey, Summers and Heston. In creating their system of internationally comparable national accounts they constructed PPP indices. As far we know their indices have not been utilized for the study of real exchange rate behavior.

q_{ij} exceeds unity, good i is more expensive in country j compared to Belgium (our numeraire).

We summarize the empirical distribution of these good-by-good real exchange rates in Figure 1. Each chart in the figure presents four lines, each is a smoothed kernel estimate of the distribution of log real exchange rates (compared to Belgium, the numeraire) for a particular country and specific time period except for the chart in the lower right-hand corner which pools all countries together at each time period. In the interest of space and to maintain comparability across time we focus on the 9 countries for which we have 4 time series observations.

The fact that the densities are difficult to distinguish from each other in the figure is reassuring in the sense that 1985 appears not to be special, each of the distributions has a strong central tendency toward zero and considerable variance. As we shall see, the symmetry of the distributions around zero is troublesome for aggregative tests of goods market integration because substantial law-of-one-price deviations at the level of individual goods will tend to average out in the process of aggregation. We could easily end up rejecting the law-of-one-price and not PPP.

Before delving into our analysis of PPP a remark is in order regarding the distributions for Luxembourg which is found in the middle right-hand panel of the figure. Recall that Luxembourg and Belgium (our numeraire) have a fixed exchange rate. The impact of this feature of exchange rate arrangements may explain why the law-of-one-price deviations for Luxembourg are so concentrated around zero. This tendency is clearly evident in Figure 1 where the peak in Luxembourg's density at zero is much sharper than in any of the other cases. Using 1985, for example, about 40% of Luxembourg's prices are within 10% of those in Belgium compared to half that many for the remaining 11 countries. Our finding of less real exchange rate dispersion in a fixed exchange rate regime is reminiscent of the finding of lower time series variability in the aggregate real exchange rate during Bretton Woods compared to the period of floating exchange rates that followed. The fact that substantial differences in real exchange rates across goods remain suggests that more is going on, however, than local currency pricing.

We turn, now, to PPP which we examine by averaging the underlying log real exchange rates good-by-good,

$$q_j = \sum_{i=1}^N \gamma_{ij} \log q_{ij} , \quad (1)$$

where γ_{ij} are weights which sum to unity. We consider both equal weighting, $\gamma_{ij} = 1/N$ and value weighting,

the latter being defined as:

$$\gamma_{ij} = \frac{1}{2} \left(\frac{p_{ij}}{\sum_{i=1}^N p_{ij}} + \frac{p_{in}}{\sum_{i=1}^N p_{in}} \right). \quad (2)$$

From the point of view of PPP we should weight goods by something like their shares in national consumption which will of course differ from either of the weighting schemes described above.² Equal weighting would be equivalent to consumption expenditure weighting if the representative consumer purchased every item in the survey in each time period. For perishable items such as food this may be a reasonable approximation but for durable goods such as automobiles the expenditure weight is grossly overestimated. Consider a bread roll, the least expensive item in the price survey and a luxury car, the most expensive item. Based on value weights luxury automobiles receive a weight 2 million times greater than bread rolls. Suppose the average household purchased ten bread rolls per day and a luxury car every ten years, the consumption expenditure weights should be on the order of 70 to 1. Typically, then, equal weighting assigns too large a weight to small ticket items while value weighting does the reverse. Assuming that the absolute deviations from the law-of-one-price are not independent of the size of the purchase, the choice of weights will matter.

We implement these weighting methods as follows. For each bilateral calculation we include all goods prices for which we have an observation for both countries. However, to avoid double counting similar items, we eliminate multiple brands. That is, given some good for which we have multiple brands, we keep the good which has the maximum number of observations across the countries. In the event of a tie, we randomly choose which good to keep. The resulting samples contain differing numbers of observations for each bilateral comparison, typically exceeding 500 good-specific relative prices.

Table 3 reports the results for each year in our cross-section. Beginning with the results based on equal weighting of good-by-good real exchange rates we see that PPP is rejected in 30 out of 43 bilateral comparisons. The frequency of rejection is similar across the four years of the panel though it is somewhat lower in 1980 with 7 of 12 bilateral comparisons rejecting the PPP hypothesis.

Figure 2 presents all of the equally weighted results plotted in rank order from highest to lowest real exchange rate in 1985. The position of this line is not very interesting since it simply reflects the fact that Belgium tends to be on the expensive side. The ranking of countries is consistent with the well known positive correlation between price levels and per capita income (see Summers and Heston (1991), for example). The poorer countries: Spain, Greece and Portugal all have below average real exchange rates.

²We are currently in the process of constructing a highly disaggregated system of consumption expenditure weights to define the aggregate real exchange rate.

Comparing value weighting to equal weighting we find that automobiles explain much of the difference. The reason for this is that automobiles tend to have prices that differ more across countries than other retail items and these deviations exert an enormous influence on the mean real exchange rate under value weighting. As we would expect, value weighting produces estimates of aggregate real exchange rates that differ from estimates produced using equal weighting and the differences are statistically significant. Under value weighting the estimated real exchange rate mean is different from equal weighting in 39 out of 43 cases when automobiles are included and 30 of 43 cases when automobiles are excluded. However, the difference between the two weighting methods is not all that economically significant when automobiles are excluded. In only 13 of 43 cases does the mean real exchange rate differ by more than 10% across the two weighting schemes.

Our results are consistent with the time series literature in some ways and quite different in others. We find overwhelming statistical evidence that mean real exchange rates deviate from the PPP prediction consistent with the rejections of PPP in the time series literature. We also find the deviations are persistent in the sense that when the real exchange rate is positive in one year it tends to be positive in a subsequent year. In fact, out of the 43 available estimates of the mean real exchange rate (using equal weighting), 38 have a consistent sign over time. Virtually identical results obtain for other weighting schemes.

The main difference between our findings and existing work on PPP appears to be the quantitative magnitude of the deviations. Looking at the numbers in Table 3 the absolute differences in mean real exchange rates appear modest, often trivial, especially after considering the possible effect of wealth levels on price levels. Thus the prevailing view that real exchange rate deviations grow over time, possibly without bound, is grossly at odds with our findings using micro-data. Ironically the view that international goods markets are segmented finds considerable support in our data not because of strong rejections of PPP but rather due to failure of the law-of-one-price on a good-by-good basis. Our goal in the remainder of the paper is to account for these patterns of law-of-one-price deviations using insights from several branches of the theoretical literature.

4 Understanding Dispersion

One prevalent view in the literature is that real exchanges are all alike in the sense that a nominal depreciation makes all goods more expensive in one country compared to another. For example, goods and services are more expensive in Belgium than most countries in our sample (exceptions are Denmark and France). This

‘country effect’ — something emphasized by Cumby (1996) and Rogoff (1996) in a time series context for Big Mac prices — is one of the first ‘economic’ characteristics we deal with below.

The next obvious question is whether or not theories that differentiate goods by their economic characteristics can account for the real exchange rate dispersion remaining after controlling for these country effects. For instance, does a mechanic have more or less latitude in setting price than the producer of a highly traded manufactured good? Does beer purchased in a café exhibit more international price dispersion than beer purchased at a supermarket? Do goods for which corporations find it profitable to establish trademarks exhibit more price dispersion than goods without trademarks? Or, in contrast, are the locations of the markets in which goods are sold of primary importance?

Prior to answering these questions, we define exactly what we mean by price dispersion. Recalling that p_{ij} are the local currency prices and e_j are the nominal exchange rates, we define z_{ij} as the percentage by which p_{ij} deviates from the cross-country, good-specific mean,

$$z_{ij} = \frac{e_j p_{ij}}{\sum_{j=1}^{M_i} e_j p_{ij} / M_i} - 1,$$

where M_i is the number of cities for which we have price observations on good i . Note that, unlike our analysis in the previous section, these measures of price dispersion are independent of the numeraire, for which $e = 1$.

We begin by asking how much of the variation in the z_{ij} ’s is attributable to a ‘country effect:’ variation across countries which is common for all goods. Such effects may arise as a result of nominal exchange rate movements, country-specific VAT’s or differing levels of wealth, to name a few. In Table 4 we report the country-specific means of the price deviations,

$$z_j = \sum_{i=1}^{N_j} z_{ij} / N_j,$$

where N_j is the number of price observations we have on country j . These country effects differ somewhat from the mean real exchange rates reported in Table 2 because we normalize by the cross-country mean for each good not the price of each good in Belgium. In addition, we do not remove data on goods for which we have multiple brands.

We see that there are some important country effects. Goods are really expensive in Denmark and relatively inexpensive in Portugal, for instance, but the key implication is that somewhere between 80 and 90 percent of the variation in our data goes beyond country effects.

We therefore proceed by removing the country means and analyze the data,

$$\hat{z}_{ij} = z_{ij} - z_j.$$

The implication is that all subsequent analysis is net of cross-country variation in prices that apply uniformly across goods.

We now transform our data into a single vector of good-specific measures of relative price dispersion. Defining $mad(\cdot)$ as the mean absolute deviation, we work with,

$$y_i = mad(\hat{z}_{ij}),$$

which is less sensitive to large outliers than is the standard deviation. The vector, y , of mean absolute deviations is what we seek to explain. We have one vector for each time period in our panel, a total of four, varying in length depending on the number of goods available. Figure 3 plots a smoothed density of these data for each year. If the law-of-one-price held for each good and in each period, these distributions would be degenerate at zero. In contrast, we see that geographic price dispersion is economically significant and varies considerably across goods. Looking at this figure, we see that on average the percentage deviation of national prices from the European mean is on the order of 25%. Geographic price dispersion is noticeably lower in 1975 compared to the remaining years. We suspect that this is due to the addition, in 1980, of Greece, Portugal and Spain, countries with relative prices quite different from the rest of Europe.

4.1 Explanatory Variables

Our choice of explanatory variables is guided by insights from a rich theoretical literature but is constrained to some degree by the available of data. We focus on three factors emphasized in the international trade and industrial organization literature: the extent to which final goods are internationally traded, the intensity with which non-traded inputs are used in the production process and the competitive structure of the markets in which final goods are sold.

With regard to tradeability, a large literature in international economics dichotomizes goods as traded or not traded, with the law-of-one-price holding for the former but not the latter. A provocative example is provided by Rogoff (1996), who shows that deviations from the law-of-one-price are insubstantial for gold bullion but enormous for MacDonalds Big Mac hamburgers. Related evidence is provided by Cumby (1996).

Tradeability in inputs has also seen attention, for example in the theory of trade in ‘middle products’ (e.g. Sanyal and Jones (1982)). In this context, we would expect international price dispersion to be present

for all retail prices but that it would be larger for goods requiring larger amounts of domestic non-traded inputs. As far as we know ours is the first attempt to distinguish between the extent to which goods are traded and the role of non-traded goods in the process of producing final goods.

Finally, the industrial organization of the markets in which final goods are sold is receiving growing attention in the international literature (see Krugman (1995) and Feenstra (1995) for comprehensive reviews of this literature). These papers introduce imperfect competition in final goods markets such that price differences are sustained across national boundaries, perhaps indefinitely. Based on insights from this literature we expect the magnitude of the differences in international prices to be related to the extent of competition at the industry level and the elasticity of product demand. We utilize a subset of our data that contains brand-name goods to gain insight into the industrial organization aspect of our data.

Beginning with our measure of tradeability, we aggregate over countries and compute the trade share as,

$$\theta_k = \frac{\sum_{j=1}^{m_k} (X_{kj} + M_{kj})}{\sum_{j=1}^{m_k} Y_{kj}}, \quad (3)$$

where X_{kj} (M_{kj}) denotes exports (imports) of sector k in country j expressed in U.S. dollars and Y_{kj} is gross output of sector k in country j . The index m_k accounts for the fact that we do not have the same amount of sectoral data for all countries (see the appendix). We employ this as our tradeability proxy though in cases where trade data is not available and the degree of tradeability is obvious, an index of zero is assigned. The sectors assigned zero trade shares are: restaurants and hotels, transport, storage and communication, inland transport, maritime transport, communication, financing, insurance, real estate and community, social and personal services. The other trade shares range from a low of 20% for tobacco and manufactures to a high of 140% for office, computing and accounting machinery.

The second characteristic of goods that we measure has to do with the fact that all retail goods involve some type of transformation in the process of moving from the port of importation to the destination of final sale. Even a good, such as corn, which is traded in highly competitive global markets must undergo a number of transformations before reaching the final consumer. While we might expect corn to have similar prices at ports in Europe once transport costs and insurance are accounted for, substantive price differences may arise at the retail level due to differences in rental costs, transportation from the port to final destination of sale and marketing costs, to name just a few. Our second measure of the characteristic of a good is the

cost share of non-traded intermediate inputs computed as,

$$\Phi_k = \sum_{s=1}^S \phi_{ks} , \quad (4)$$

where ϕ_{ks} is the share of non-traded intermediate input s in the total cost of the output of sector k . Non-traded inputs are assumed to include: utilities, construction, distribution, hotels, catering, railways, road transport, sea transport, air transport, transport services, telecommunications, banking, finance, insurance, business services, education, health and other services. The cost share of non-traded intermediate inputs ranges from a low of 0.11 for motor vehicles to a high of 0.32 for transport, storage, and communication.

4.2 Regression Framework

Given our measures of price dispersion, with N observations on y , our goal is to characterize the variation in y in terms of some vector of explanatory variables, x , on which we have N observations. Assuming that the regression of y on x is linear, we have,

$$y_i = \alpha + x_i \cdot \beta + u_i , \quad (5)$$

where u_i is *i.i.d.*. The main problem we have — and one that any study of highly disaggregate data is likely to have — is that our observations on x are aggregated to a larger extent than those on y . Take for example, our measure of international tradeability. While we have data on price dispersion of, say, many different types of electronic goods, our measure of tradeability is limited to one aggregative value for electronic goods in general. In a nutshell, the variable we seek to characterize — good-specific price dispersion — is observable at a much ‘finer’ level than the variables we seek to characterize it with.

This type of aggregation has important consequences for statistical inference. In general, it will generate a heteroskedastic pattern in the variance of regression error terms (especially in finite samples) and, just as importantly, make goodness-of-fit measures difficult to interpret. In Appendix B of Crucini, Telmer and Zachariadis (2000) we formulate a statistical framework that allows us to obtain consistent, efficient estimates of β , it’s standard errors, and meaningful goodness-of-fit measures. We briefly review some of the statistical issues in what follows. Readers familiar with our earlier paper may wish to proceed directly to the next sub-section.

We define our data as being partitioned into G distinct ‘groups,’ $g \in \{1, 2, \dots, G\}$, containing N_g sample observations. Examples of groups are textiles, automobiles and personal care products. We modify the

population regression, (5) as follows,

$$y_{ig} = \alpha + x_{ig} \cdot \beta + u_{ig} , \quad (6)$$

where the subscript i, g denotes the i th observation on a good from group g . Define the within-group sample mean for x as $\bar{x}_g$,

$$\bar{x}_g = \frac{1}{N_g} \sum_{i=1}^{N_g} x_{ig} . \quad (7)$$

The regression equation, (6), can be written,

$$y_{ig} = \alpha + \bar{x}_g \cdot \beta + (x_{ig} - \bar{x}_g) \cdot \beta + u_{ig} , \quad (8)$$

which is a statistical regression of y onto $\bar{x}_g$. Sampling variation in $\bar{x}$, however, generates heteroskedasticity in the error term, $(x_{ig} - \bar{x}_g) \cdot \beta + u_{ig}$, a feature which is particularly important in our dataset, where there is a great deal of variation in the within-group sample size. We take two approaches in estimating the parameters of (8), each of which turn out to yield qualitatively similar results. First, we estimate the regression (8) using generalized least squares (GLS), having characterized the exact form of the heteroskedastic covariance matrix for the errors.

Second, we average our disaggregate data, y , within groups, g , dictated by our aggregative data, x . Specifically, we average across equation (8) and estimate the following,

$$\begin{aligned} \frac{1}{N_g} \sum_{i=1}^{N_g} y_{ig} &= \alpha + \bar{x}_g \cdot \beta + \frac{1}{N_g} \sum_{i=1}^{N_g} u_{ig} \\ \Rightarrow \bar{y}_g &= \alpha + \bar{x}_g \cdot \beta + \bar{u}_g , \end{aligned} \quad (9)$$

where the sample averages, $\bar{y}_g$ and $\bar{u}_g$ are defined in the obvious way and are understood to depend explicitly on the values N_g . Estimates based on equation (9) are also obtained using feasible GLS, given our knowledge of the covariance matrix of $\bar{u}$, which is a simple function of the values N_g . The main disadvantage associated with equation (9) is that it averages away potentially informative variation in y . The advantages are a simpler form of the covariance matrix and a more easily interpretable goodness-of-fit, due to the fact that we are not trying to explain variation in y with variation in x , after having removed a great deal of the latter (something inherent in equation (8)).

It is worth noting that GLS estimates of β based on equation (9) will be numerically identical to OLS estimates based on equation (8). Standard errors, however, may be quite different owing in large part to a much smaller number of observations associated with (9).

Turning to specifics, we use trade shares and cost shares of non-tradeable inputs as our x variables. Both these measures are more aggregative than our underlying price data so we grouped our price observations into ISIC revision 3 categories which could then be reconciled with the trade and input-output measures: details are provided in the data appendix.

4.3 Regression Results

Table 5 reports the results of estimating equation (8) using both the tradeability and cost share of non-tradeable inputs as regressors. The regression results support the hypothesis that both the share of trade and the cost share of non-tradeable inputs matter for international price dispersion.

Taking the results for 1985, for example, the coefficient on the trade share suggests that if we consider two goods, both with the minimum amount non-traded inputs (0.10), one non-tradeable and one with an average level of tradeability (0.75 using our metric), price dispersion will fall by roughly 24 percent, so the average percentage deviation from the European mean falls from 22.1 percent to 16.8 percent. The coefficient on non-traded inputs implies that, for a non-traded good, if the cost share of non-tradeable inputs used to produce a good doubles, from 10 to 20 percent, price dispersion increases by about 9 percent, and the average percentage deviation from the European mean price rises from 24.3 to 26.6 percent.

Looking across the years of the cross-section we see that these results are very robust. In each year, the coefficients on the trade shares and non-tradeable input shares are of the expected sign, highly statistically significant and comparable in magnitude. One exception is 1980 where the coefficient on the trade share is about one-half the magnitude of that found in the other years. Averaging across the four time periods we account for about one-third of the heterogeneity in price dispersion across goods. The R^2 from the GLS regression ranges from a low of 0.25 in 1980 to a high of 0.44 in 1990. We also report the fraction of variance explained based on the raw data, which is not as informative since it primarily reflects the different levels of aggregation of the regressors and regressand.

4.4 Pricing to Market

Arthur Pigou (1920) defined price discrimination as being present when different groups of consumers pay different prices for identical goods. In the “pricing to market” literature (e.g. Krugman (1987)) price discriminating oligopolist suppliers use their market power to sustain price differences across national boundaries. Identical goods, then, could sell at different prices across countries even when converted to a common cur-

rency. Alternatively, the goods might not actually be identical in which case monopolistically competitive firms could charge different prices depending on the elasticity of substitution between them. Assuming that international goods are homogenous when in fact they are different varieties of the same good would, under monopolistic competition, lead to unfounded rejections of the law-of-one-price.

Our panel data is sufficiently rich that we can shed light on these two alternative views of the microeconomic structure of goods markets. The procedure comes down to a two-way analysis of variance. The first dimension of the variance captures the price differences across brands of the same good within a country. We refer to these as brand effects: the price differences domestic consumers pay for differentiated brands of the same good. The second dimension of the variance captures the differences in price of the same brand across countries. We refer to these as country effects: the price differences international consumers pay for identical brands of a particular good. We gauge the relative importance of product heterogeneity and geographic price discrimination by comparing their contributions to total price variance.

Turning to specifics, we convert each national currency price in our sub-sample to a common numeraire and then take the log of these prices to obtain, $y_{ij}^h = \log(e_j p_{ij}^h)$, the log price for brand h of good i , in country j . Next we estimate three linear regressions for each good separately. The first regression includes both a brand and country dummy:

$$y_{ij}^h = \alpha_i + d_j \beta_j + d_h \delta_h + \varepsilon_{ij}^h \quad (10)$$

where i denotes the good, α_i is a constant scalar. Defining H_i as the number of brands of good i , y_{ij}^h is the $H_i N \times 1$ vector of log prices, d_j is an $H_i N \times N$ matrix of country-specific dummy variables for country j capturing country effects common across brands, d_h is an $H_i N \times H_i$ matrix of brand-specific dummy variables capturing effects specific to brand h but common to all countries, β_j and δ_h are the respective $N \times 1$ and $H_i \times 1$ coefficient vectors for each of the two effects, and ε_{ij}^h is the $H_i N \times 1$ vector of residuals.

In order to enable estimation for each good i , we set β_2 , the country-specific parameter for Belgium, and δ_1 , the parameter for the first brand of each good, equal to zero. Thus we estimate deviations from the first brand of each good in Belgium. The decomposition results were not sensitive to the choice of country.

Next we regress the price observations for each good i on country-specific dummy variables,

$$y_{ij}^h = \gamma_i + d_j \theta_j + v_{ij}^h \quad (11)$$

and then on brand-specific dummy variables,

$$y_{ij}^h = \mu_i + d_h \phi_h + u_{ij}^h . \quad (12)$$

In the absence of missing observations these last two regressions are unnecessary because the explanatory variables would be orthogonal and estimating the effect of brand and country separately leads to the same answer as estimating them jointly (using equation (10)). In this case, the sum of squares explained by the full model is equal to the sum of squares explained by the other two.

We refer to the sum of squares for the regression using country dummy variables as the primary measure of the sum of squares explained by country-specific effects alone, and similarly the sum of squares from the second univariate regression is referred to as the primary measure of the sum of squares explained by brand-specific effects alone. We refer to secondary measures of the sum of squares explained by country or brand-specific effects as the difference between the sum of squares explained by each of the univariate models and that explained by the full model. For example the secondary measure of the sum of squares explained by country-specific effects is obtained as the increment to the explained sum of squares achieved by running the full model with both country-specific and brand-specific dummy variables on the residuals of the model with only brand-specific effects. We report the average of the primary and secondary measures of brand and country effects in the results.

The sub-sample we use in our regression analysis consists of those goods in our dataset for which prices are collected for multiple brands of otherwise homogeneous products. Using the entire collection of goods for which brands are indicated would allow us to include 1,535 goods. Due to the sparseness in available data for some individual brands or entire categories of goods we have adopted the following criteria for selecting data into this part of our analysis. First, we exclude a good if the price survey contains less than four different brands since this would limit our ability to infer the variance of price across brands for that good. Second, we exclude a brand when price observations are available for less than four countries since including it would limit our ability to infer variance of its price across countries.

Table 6 summarizes our findings for each year of the sample, detailed results good-by-good for each year follow in Table 7. Table 6 reports the unweighted mean of the statistics obtained estimating (10)-(12) good-by-good and the results of pooling all goods together. When we pool the goods, we remove a good-specific mean from all brands of a particular good and then treat all prices as if they were different “brands” of a single good.

The first row of the table is the variance of real exchange rates to be explained by brand and country effects. In the case of the results which are not pooled across goods, we compute the variance of each of the y_{ij}^h and then report the average across h . For the pooled results we report the variance of real exchange rates across all goods in a particular year after having removed a good-specific mean from all brands of a particular good. We see that both variances increase as we move from 1975 to 1990. The increased variance across brands and countries primarily reflects changes in the composition of the sample of brands over time rather than fundamental changes in the importance of brand and country effects for individual goods. We see some indication of this change in the last three rows which report the dimension of our sample across each time period. We begin in 1975 with 16 goods and a total of 77 brands and end in 1990 with 42 goods with a total of 421 goods. Some of this evolution may reflect more extensive surveys by Eurostat over time but it also likely reflects growth, over time, in varieties of goods found in the marketplace.

The reason that the changing sample alters price dispersion can be seen by comparing 1975 and 1980, for example. Using the detailed results in Table 7 we see that large automobiles (those with engine sizes between 1800 and 2700 cc) and spectacles have variances that far exceed the typical good in either cross-section and since they appear in 1980 and not 1975 the 1980 cross-section appears to have more price variance. Examples can be found in other years as well and therefore does not necessarily indicate an increase in price dispersion across brands as time progresses.

Turning to the decomposition of variance into brand and country effects we see that on average the two effects are very close quantitatively but when one dominates it is the brand effect. In 1975 we find that brand effects account for almost 60% of the dispersion in relative prices compared to 30% for country effects while in the remaining years the two effects are almost equal in importance. Together, brand and country effect explain about 85% of the relative price variance. We also present results using a simple rule to determine which effect dominates on a good-by-good basis. We record “brand dominant” when the proportion of variance explained by brand effects exceeds the proportion of variance explained by country effects by more than the variance left unexplained. The term country records the opposite result while the term ambiguous is left for the remaining cases. Using this metric brand effects dominant in 61 out of 100 cases that are not ambiguous. The pooled results differ from the results using individual goods in that country effects decline significantly in relative importance. Instead of accounting for about one third of the variance of relative prices the country effects now account for less than 10%. Brand effects now dominate country effects in each year of the sample.

There are some interesting differences across the individual goods. Goods with particularly strong country effects include whiskey, cigarettes, various services related to automobile maintenance and automobiles themselves. In the case of cigarettes, between 93% and 95% (depending on the year of examination) of the price dispersion is accounted for by country effects. The numbers are almost identical for whiskey. Our suspicion is that the large country effects for these commodities reflect differing levels of excise tax on these goods across countries.

The group of goods with the next highest geographic price dispersion are services associated with automotive repair. We expected this to be the case given that automobile repair is a classic example of a non-traded service. For these types of services, it is not unusual to find more than 80% of the dispersion attributable to country effects. Consider the replacement of clutch linings for a given make and model in 1985. The total variance of price is about 25% and only about 5% of this is accounted for by price differences across suppliers within the city while more than 90% is due to price differences across European cities.

Similarly automobiles exhibit substantial geographic price dispersion, with about two-thirds of the dispersion accounted for by country effects and one-third accounted for by brand effects, though there are greater differences across categories of automobiles and time periods than for the vice goods. These findings are broadly consistent with work by Knetter that emphasizes the role of market power in accounting for international price dispersion in the automobile industry. Most of the remaining goods have larger brand effects than country effects and are also less differentiated (i.e. have lower absolute price dispersion across brands within a country).

Returning to our original motivation, namely, relating price dispersion to industrial organization, we conclude that much of the variance in price across brands of individual goods is due to product differentiation, not geographic price discrimination. Virtually all cases in which a substantial amount of price dispersion is accounted for by country effects involve the following categories of goods: vice goods, automobile repair services and automobiles. Only in the cases of automobiles does the finding appear related to industrial organization since taxes and the absence of trade probably account for much of the geographic price dispersion observed in vice goods and services, respectively.

5 Conclusion

This paper followed up on our earlier work examining real exchange rates across European Community countries in 1985. The richness of our cross-sectional data allows us to venture where studies based on more

aggregative data have not: a characterization of what determines the good-by-good dispersion in absolute deviations from the law-of-one-price. We find that, with the exception of the relatively poor countries, EC currencies had comparable purchasing power in 1975, 1980, 1985 and 1990. This is to say, average real exchange rates are surprisingly close to unity. In contrast, dispersion around these averages is large, implying, for example, that someone living in Germany faces a distinctly different set of relative prices vis-à-vis someone living in France. The bulk of our paper is dedicated to characterizing this dispersion in terms of factors emphasized by economic theory: tradeability, non-traded inputs into production and brand differentiation. Taken as a whole, our evidence suggests that a substantial fraction of what determines dispersion in real exchange rates is attributable to these types of factors. In a nutshell, while there is certainly some degree of location specificity to what defines ‘a good,’ there is also an important degree of good specificity which links prices across national markets in a manner which is consistent with basic microeconomic principles.

Our findings have a number of implications for recent theoretical work on the determination of real exchange rates. Currently there are three branches of the literature at various stages of development. The first branch of the literature introduces price rigidities into dynamic equilibrium models. These models were developed to study monetary policy over the short to medium run and they have proven useful for that purpose. We doubt, however, that such models provide a plausible mechanism for sustaining deviations from the law-of-one-price of the magnitude observed in our data. What they do provide is a possible way to reconcile our results with those based upon the time series properties of aggregative price indices. At the risk of oversimplifying, suppose that all prices are fixed in terms of home currency for only one period but the exchange rate adjusts to maintain covered interest parity. In such an environment the entire distribution of real exchange rates will shift with the nominal exchange rate, creating perfect collinearity between the nominal and real exchange rate within the period. The fact the much of the time series literature fails to find differences in the behavior of real exchange rates across goods may reflect this collinearity at high frequencies.

A second strand of literature builds microfoundations of the price adjustment process by considering the role of imperfect competition in sustaining price differences across countries. These models have the ability to distinguish the behavior of real exchange rates across industries based on their industrial structure and may generate sustained deviations from the law-of-one-price. Our analysis of the international pricing of brand goods provides support for this approach provided some discipline is imposed on the classification of the goods. For example, allowing for the same amount of market power in all goods markets is a very

inadequate description of the level of competition across industries. Our findings indicate that even among brand name goods, where market power is arguably the greatest, substantial geographic price discrimination appears to be isolated to a subset of goods such as automobiles. While automobiles are large ticket items, they receive a weight of only 5% in the U.S. CPI, roughly equal to that for food consumed outside the home. The practical importance of drawing an accurate dividing line between sectors with different industrial structures is emphasized in a recent paper by Betts and Devereux (2000).

Finally, a third strand of literature incorporates transportation costs. These models predict that real exchange rates will vary within the limits of arbitrage bounds. Provided the arbitrage costs are interpreted broadly, to include transportation and costs of bringing goods to final markets, our results tend to favor this approach which has been used in international finance by Uppal and his co-authors in a series of papers (see for example, Apte, Sercu and Uppal (1996)). More recently this approach has met with some success in papers by Betts and Kehoe (1999) and Crucini (2000) who study the evolution of disaggregate real exchange rates in Mexico and Europe, respectively.

Determining which of these three models will emerge as the work-horse of international macroeconomics remains uncertain. Perhaps each will serve a different purpose. What is certain is the need for more absolute price data to effectively assess their relative merits.

Data Appendix

National retail price data. The retail price data are found in: “Price Structure of the Community Countries in 1985,” compiled and published by Eurostat, Brussels, Luxembourg, 1988. The surveys were carried out by Eurostat between the end of 1984 and the beginning of 1986 as follows: Autumn 1984, clothing, footwear, household textiles; Spring 1985, durable household goods; Summer 1985, services; Autumn 1985, glassware, other household articles; Spring 1986, food, beverages, tobacco; and Summer 1986, health services. All prices refer to cash prices paid by final consumers, including taxes, both VAT and any others paid by the purchaser. Sales points are selected in such a way that the sample selected is representative of the distribution in the capital city. Few prices vary by less than $\pm 15\%$ within cities and there is commonly a spread of $\pm 50\%$, even for very precisely defined articles, in some cases with make and model. Prices are collected at different locations so that the average price is representative of the distribution within the city. The original project involved a sample of nearly 2,800 prices but only 1,805 are in the printed source.

The panel data were not available electronically so we had a private firm key-punch the data and commodity descriptions into a spreadsheet. There are 1,805 individual retail prices for

the twelve European Community price plus Austria. Entries involve a Eurostat code, a detailed description of the commodity (e.g. long grained rice), the units purchased (in cartons of 500 grams) and the local currency prices of each country. Missing observations are indicated with a -1 .

Data Reconciliation. In order to explain the price dispersion across countries that exists in our detailed dataset of 1,805 commodity prices in thirteen European countries as of 1985, we constructed variables that measure tradeability, and measures of costs of non-traded inputs into production. To accomplish this we assigned each one of the 1,805 commodities to a unique International Standard Industrial Classification (ISIC) Revision 2 sector. In order to reconcile the data as accurately as possible, we used the ISIC codes and descriptions available in the User Guide of the OECD International Sectoral Database.

The constructed variables for tradeability, and non-traded inputs from input-output tables are available at different levels of detail. For this reason, and in order to make the most of the information available for each of these factors, we matched the commodity price data with each of the variables using two-digit, three-digit, and four-digit classifications depending on the level of detail available for each of the variables rather than attempting to match all variables using the same level of detail. The input-output data are also available at a three-digit level of detail that extends to four-digits for some industry groups.

Tradeability. We obtained data on imports, exports, gross output, and exchange rates for the period 1980 to 1987 from the OECD STAN Database 1994. This contains data on forty-nine overlapping subdivisions of manufacturing (sector 3) mostly at a three-digit level of detail that extends to four-digits for some industry groups. We use thirty-two non-overlapping subdivisions of manufacturing for which sufficient data are available and to the extent that they are relevant to the commodities in our price dataset. We also construct additional tradeability indices for Agriculture (sector 1) and Electricity, Gas, and Water (sector 4) using the OECD Sectoral Database of 1994 which provides value-added instead of gross output data but we have this data only for six countries: Germany, France, Italy, Belgium, the UK, and Denmark.

The sector Electricity, Gas, and Water requires special attention. Using value-added data from the OECD Sectoral Database, the 1985 value of the tradeability index is 0.97 and the average for the period 1980 to 1987 is 1.03. The average for 1970 to 1990 equals 0.72 and reflects more accurately the tradeability of this sector's product since looking at the tradeability series for the period 1970 to 1990 it is evident that the values for the period 1980 to 1985 are outliers.

We do not need information on Mining (sector 2), and Construction (sector 5) since there are no commodities from these sectors in our price data. For Services (sectors 6, 7, 8, and 9) there are no exports and imports data to the best of our knowledge. We assume that commodity services provided by these sectors are not traded and set the tradeability indices equal to zero.

In order to obtain tradeability indices for as many industries as possible we limit the time period to 1980-1987. For 24 of the 32 manufacturing sectors, the number of countries we aggregate over is $m_j = 8$ (the countries are: Austria, Belgium, Denmark, France, Germany, Italy, Spain and the United Kingdom); for 5 sectors the number of countries is 7 and for the remaining 3 manufacturing sectors the number of countries is 6.³ For agriculture, and electricity, gas, and water we aggregate over 6 countries as data are missing for Spain and Austria.

We construct a variable that captures the degree of tradeability for each industry's commodity as follows:

$$\theta_k = \frac{\sum_{j=1}^{m_k} (X_{kj} + M_{kj})}{\sum_{j=1}^{m_k} Y_{kj}} \quad (13)$$

where for each sector k we sum over all countries j which have data for that sector. X_{kj} (M_{kj}) stands for exports (imports) of sector k from country j and Y_{kj} stands for the gross output of sector k by country j .

Input-Output Data. We use the input-output matrix for the United States in 1987. Non-traded inputs are assumed to include: utilities, construction, distribution, hotels, catering, railways, road transport, sea transport, air transport, transport services, telecommunications, banking, finance, insurance, business services, education, health and other services. We thank Tom Prusa for pointing us to this data which is available at the National Bureau of Economic Research home page.

³For industry 3540 we are missing France, for industries 3832, 3839, and 3842 Belgium, and for 3900 Austria. Moreover, for industries 3825, and 3844 we are missing both Belgium and Austria, and for 3843 both Belgium and Denmark.

Table A-1. Trade Shares by ISIC Category

Description	ISIC Code	Input Share	Trade Share
Agriculture, hunting, forestry and fishing	1000	0.17	0.40
Food (3110+3120)	3115	0.16	0.28
Beverage industries	3130	0.17	0.27
Tobacco manufactures	3140	0.15	0.20
Manufacture of textiles	3210	0.14	0.60
Manufacture of wearing apparel except footwear	3220	0.12	0.54
Manufacture products except footwear and apparel	3230	0.17	0.70
Manufacture of footwear except rubber or plastic	3240	0.12	0.68
Manufacture of furniture and fixtures except primarily metal	3320	0.21	0.27
Manufacture of paper and paper products	3410	0.15	0.51
Printing, publishing and allied industries	3420	0.24	0.15
Manufacture of industrial chemicals (3511-3513)	3510	0.22	0.85
Manufacture of other chemical products	3520	0.30	0.51
Drugs and medicines	3522	0.30	0.44
Chemical products, n.e.c.	3529	0.21	0.56
Misc. products of petroleum and coal	3540	0.14	0.40
Rubber products	3550	0.16	0.56
Plastic products, n.e.c.	3560	0.16	0.29
Pottery, china and earthenware	3610	0.22	0.26
Glass and glass products	3620	0.22	0.47
Other non-metallic mineral products	3690	0.25	0.20
Iron and steel basic industries	3710	0.31	0.46
Non-ferrous metal basic industries	3720	0.20	0.70
Fabricated metal products except machinery and equipment, n.e.c.	3810	0.17	0.38
Manufacture of machinery except electrical (3820-24 and 3829)	3820	0.15	0.71
Office, computing and accounting machinery	3825	0.14	1.41
Other machinery and ordinance	3829	0.16	0.59
Electrical machinery	3830	0.19	0.49
Radio, TV., and communications equipment and apparatus	3832	0.14	0.54
Electrical apparatus and supplies, n.e.c.	3839	0.17	0.43
Shipbuilding	3841	0.14	0.34
Motor Vehicles	3843	0.11	0.64
Motorcycles and bicycles	3844	0.14	0.52
Professional, scientific, measuring and control equipment	3850	0.18	1.39
Other manufacturing industries	3900	0.23	1.35
Electricity, gas and water	4150	0.26	0.72
Restaurants and hotels	6300	0.26	0.00
Transport, storage and communication	7000	0.32	0.00
Inland Transport	7110	0.28	0.00
Maritime Transport	7120	0.27	0.00
Communication	7200	0.20	0.00
Financing, insurance, real estate and business services	8000	0.30	0.00
Community, social and personal services	9000	0.31	0.00

References

- [1] Alessandria, George, 1999, "Deviations from the law-of-one-price: preserving market share under the threat of search," mimeograph.
- [2] Apte Prakash, Piet Sercu and Raman Uppal, 1996, "The equilibrium approach to exchange rates: theory and tests," National Bureau of Economic Research Working Paper No. 5748.
- [3] Balassa, Bela, 1964, "The purchasing power parity doctrine: A reappraisal," *Journal of Political Economy* 72, 584-596.
- [4] Baumol, William J. and William G. Bowen, 1966, *Performing arts: The economic dilemma*. New York: Twentieth Century Fund.
- [5] Betts, Caroline and Michael B. Devereux, 2000, "Exchange rate dynamics in a model of pricing-to-market," *Journal of International Economics* 50, 215-244.
- [6] Betts, Caroline and Timothy J. Kehoe, 1999, "Tradeability of goods and real exchange rate fluctuations," mimeograph.
- [7] Crucini, Mario J. "Dispersion in Real Exchange Rates: The Role of Arbitrage Costs," mimeo November 2000.
- [8] Crucini, Mario J., Chris I. Telmer and Marios Zachariadis, "Dispersion in Real Exchange Rates," Vanderbilt University Working Paper No. 00-W13, May 2000.
- [9] Cumby, Robert, 1996, "Forecasting exchange rates and relative prices: Is what you want what you get with McParity?" NBER Working Paper 5675, July.
- [10] Engel, Charles, 1993, "Real exchange rates and relative prices: an empirical investigation," *Journal of Monetary Economics* 32, 35-50.
- [11] Engel, Charles and John Rogers, 1999, "Violating the law of one price: Should we make a Federal case out of it? National Bureau of Economic Research Working Paper No. W7242.
- [12] Ethier, Wilfred, 1979, "Internationally decreasing costs and world trade," *Journal of International Economics* 9, 1-24.
- [13] Eurostat, 1988, "Price structure of the Community countries in 1985," Luxembourg: Offices of Official Publications of the European Community.
- [14] Feenstra, Robert, 1995, "Estimating the effects of trade policy," in Gene M. Grossman and Kenneth Rogoff, eds., *Handbook of International Economics*, vol. 3. Amsterdam: North Holland.
- [15] Harrod, Roy F., 1933, *International Economics*. London: James Nisbet and Cambridge University Press.

- [16] Knetter, Michael, 1993, "International comparisons of pricing-to-market behavior," *American Economic Review* 83, 473-486.
- [17] Krugman, Paul, 1987, "Pricing to market when the exchange rate changes," in *Real-financial linkages among open economies* Cambridge:MIT press, 49-70.
- [18] Krugman, Paul, 1995, "Increasing returns, imperfect competition and the positive theory of international trade," in Gene M. Grossman and Kenneth Rogoff, eds., *Handbook of International Economics*, vol. 3. Amsterdam: North Holland.
- [19] Organization for Economic Co-operation and Development, 1995, *STAN Database for Industrial Analysis*, computer diskettes, Paris: OECD.
- [20] Pigou, Arthur, 1920, "Some problems of foreign exchange," *Economic Journal* 30, 460-472.
- [21] Richardson, 1978, "Some empirical evidence on commodity arbitrage and the law of one price," *Journal of International Economics* 8, 341-351.
- [22] Rogoff, Kenneth, 1996, "The purchasing power parity puzzle," *Journal of Economic Literature* 34, 647-668.
- [23] Samuelson, Paul A., 1964, "Theoretical notes on trade problems," *Review of Economics and Statistics* 46, 145-154.
- [24] Sanyal, Kalyan K. and Ronald W. Jones, 1982, "The theory of trade in middle products," *American Economic Review* 72, 16-31.
- [25] Stockman, Alan, and Harris Dellas, 1989, "International portfolio nondiversification and exchange rate variability," *Journal of International Economics* 26, 271-289.
- [26] Stockman, Alan, and Linda Tesar, 1995, "Tastes and technology in a two-country model of the business cycle," *American Economic Review* 85, 168-185.
- [27] Summers, Robert and Alan Heston, 1991, "The Penn World Table (Mark 5): An Expanded Set of International Comparisons: 1950-1988," *Quarterly Journal of Economics* 106, 327-368.

Table 1
Sample records from price survey

Code	Good description	Units	Austria	Belgium	Denmark	France	Germany	Greece	Ireland	Italy	Lux.	Neth.	Portugal	Spain	U.K.
11111	Long grained rice - in carton	500 g	26	50	48	52	52	42	51	35	52	36	-1	39	32
11251	Chicken - fresh, presentation 70 %	1.2 kg	107	204	208	206	-1	116	159	165	-1	-1	89	-1	149
11421	Milk, condensed unskimmed 9-10 % butterfat	410 g	-1	48	-1	-1	56	32	-1	-1	-1	54	56	42	43
11621	Dried almonds	100 g	28	54	-1	62	34	28	43	35	54	49	37	50	50
11911	Ground blended coffee	1 kg	234	439	426	355	-1	-1	-1	590	-1	355	456	438	447
13112	Liqueur - s.b.	0.7 L	801	645	1190	609	611	468	975	532	498	609	-1	330	936
21112	Mans jacket type k-way	1 nb	1582	544	1598	1021	823	1368	1332	874	996	1195	900	714	-1
22121	Ladies boots, box caf	1 pr	3716	4027	4100	3730	3687	2635	2362	-1	4422	2611	2731	2958	3153
41112	Chest of drawers	1 nb	2832	6988	-1	-1	4880	2996	5058	7297	3990	7724	3577	4659	3934
42111	Spring mattress: s.b.	1 nb	-1	-1	-1	-1	-1	-1	5383	-1	-1	-1	-1	-1	4680
43121	Dishwasher: 5 programs: s.b.	1 nb	-1	23480	-1	-1	-1	-1	-1	23912	-1	-1	23014	22966	-1
43161	Iron: steam, s.b.	1 nb	1678	2580	-1	2200	1247	3194	1647	1554	-1	1190	-1	1336	1441
45111	Washing powder: s.b.	700 g	100	75	98	68	88	44	59	77	82	85	-1	-1	-1
52211	Heating aid: s.b.	1 nb	-1	-1	-1	32715	28864	-1	24426	35348	19400	24354	-1	-1	26287
61113	Car: engine 1200 and 1700 cc, s.b.	1 nb	467864	387740	770809	481011	403928	-1	-1	533097	369000	464874	-1	-1	514101
61212	Bicycle: racing, s.b.	1 nb	-1	12206	-1	-1	-1	16716	-1	-1	-1	11351	-1	-1	-1
62111	Bus: single ticket with transfer, about 6 km	1 ticket	52	30	50	-1	43	-1	-1	-1	25	39	-1	-1	51
71131	Record player, stereo, s.b.	1 nb	7085	5190	-1	5144	4164	-1	-1	4792	4848	4849	4252	7877	-1
71311	Cassette for game: s.b.	1 nb	873	850	-1	1295	-1	-1	944	1089	1066	-1	-1	-1	740
72221	Rental of television	1 month	-1	2296	1339	1630	1190	2981	1382	1294	-1	1488	1678	1804	1481

Note: The table presents a sample of 20 records from the original 1,805 records. Records are exactly as they appear in the original source except the currencies have been converted to Belgian francs to facilitate comparisons. The commodities from rows (1,90,180,...1,800) were selected into the table based on the original order of goods in the Eurostat survey. Missing data are indicated as '-1.'

Table 2
Scope of the Price Surveys

Item	1975	1980	1985	1990
Raw survey data				
Number of countries	9	12	13	13
Number of goods	658	1090	1805	1896
Proportion missing	13%	36%	38%	44%
Least missing ^a	9%	23%	25%	32%
Most missing ^a	27%	47%	53%	55%
Number of brand goods	31%	42%	48%	54%
Data after eliminating outliers				
Number of countries	9	12	13	13
Number of goods	594	686	1164	1101
Proportion missing	10%	17%	19%	23%
Least missing ^a	4%	3%	7%	9%
Most missing ^a	22%	28%	37%	34%
Number of brand goods	31%	28%	33%	38%

^aBelgium is the country with the least number of missing observations in every year and Ireland is the country with the fewest missing observations in each year except for 1990 in which case the United Kingdom has the most missing.

Note: Number of brand goods means “number of goods for two or more brands exist in the price survey.” In order of appearance in the surveys, the countries are: Belgium, Denmark, France, Germany, Ireland, Italy, Luxembourg, Netherlands, United Kingdom (all years) Greece, Portugal, Spain (added in 1980) and Austria (added in 1985).

Table 3
Log Real Exchange Rates (numeraire is Belgium)

Country	1975				1980				1985				1990			
	Equal Weights	Value Weights	Value ^a Weights	N	Equal Weights	Value Weights	Value ^a Weights	N	Equal Weights	Value Weights	Value ^a Weights	N	Equal Weights	Value Weights	Value ^a Weights	N
Austria	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.029 (0.015)	0.152	0.086	717	0.020 (0.017)	0.056	-0.033	603
Denmark	0.137 (0.017)	0.472	0.031	405	0.175 (0.018)	0.642	0.105	505	0.166 (0.018)	0.444	0.258	663	0.162 (0.019)	0.672	0.237	531
France	0.077 (0.012)	0.161	0.116	433	0.067 (0.014)	0.134	0.015	450	-0.001 (0.014)	0.104	0.018	750	0.016 (0.015)	0.069	-0.028	654
Germany	0.025 (0.014)	-0.058	-0.080	438	0.043 (0.016)	-0.041	-0.120	474	-0.048 (0.013)	-0.054	-0.100	762	-0.004 (0.014)	-0.059	-0.043	647
Greece	n.a.	n.a.	n.a.	n.a.	-0.194 (0.025)	1.035	0.007	435	-0.253 (0.022)	0.712	0.051	691	-0.236 (0.023)	0.704	0.076	570
Ireland	-0.239 (0.020)	0.058	-0.189	379	-0.073 (0.020)	0.253	-0.043	403	-0.025 (0.019)	0.200	-0.005	579	-0.041 (0.018)	0.387	0.015	579
Italy	-0.090 (0.019)	-0.009	-0.037	423	-0.124 (0.019)	0.054	-0.157	529	-0.077 (0.019)	0.101	0.045	745	-0.035 (0.018)	0.012	0.013	596
Luxembourg	-0.049 (0.011)	-0.071	-0.076	439	-0.019 (0.010)	-0.047	-0.039	513	-0.092 (0.011)	-0.064	-0.106	712	-0.074 (0.012)	-0.098	-0.094	580
Netherlands	-0.023 (0.012)	0.031	-0.110	434	-0.018 (0.014)	0.155	-0.060	515	-0.109 (0.014)	0.048	-0.101	771	-0.057 (0.014)	0.096	-0.056	657
Portugal	n.a.	n.a.	n.a.	n.a.	-0.288 (0.028)	0.584	0.034	431	-0.264 (0.024)	0.363	-0.015	641	-0.320 (0.024)	0.398	-0.143	514
Spain	n.a.	n.a.	n.a.	n.a.	-0.130 (0.021)	0.354	0.072	475	-0.165 (0.019)	0.132	-0.185	696	-0.128 (0.019)	0.205	0.044	586
United Kingdom	-0.241 (0.019)	-0.088	-0.160	390	-0.005 (0.019)	0.258	0.017	434	-0.062 (0.016)	0.088	-0.130	755	-0.087 (0.021)	0.152	-0.098	514

^aExcludes automobiles.

Note: Entries are q_j the weighted average for country j of good-specific log relative prices. Denoting q_{ij} as the real exchange rate for good i in country j and γ_{ij} as the weighting scheme (described explicitly in the text) we compute q_j as $\sum_{i=1}^N \gamma_{ij} \log q_{ij}$. For these calculations we eliminate multiple brands of the same good.

Table 4
Country Effects

Country	1975	1980	1985	1990
Austria	n.a. n.a.	n.a. n.a.	0.077 (0.008)	0.070 (0.010)
Belgium	0.020 (0.007)	0.002 (0.009)	0.025 (0.009)	-0.003 (0.008)
Denmark	0.189 (0.013)	0.240 (0.015)	0.251 (0.012)	0.267 (0.015)
France	0.109 (0.009)	0.073 (0.011)	0.043 (0.009)	0.037 (0.009)
Germany	0.039 (0.010)	0.055 (0.012)	-0.024 (0.008)	0.009 (0.008)
Greece	n.a. n.a.	-0.090 (0.017)	-0.083 (0.014)	-0.073 (0.014)
Ireland	-0.167 (0.012)	-0.029 (0.013)	0.043 (0.013)	0.018 (0.012)
Italy	-0.034 (0.012)	-0.086 (0.012)	-0.004 (0.011)	0.012 (0.011)
Luxembourg	-0.027 (0.007)	-0.020 (0.009)	-0.085 (0.007)	-0.072 (0.007)
Netherlands	0.007 (0.008)	0.000 (0.010)	-0.066 (0.008)	-0.026 (0.008)
Portugal	n.a. n.a.	-0.132 (0.019)	-0.102 (0.016)	-0.160 (0.012)
Spain	n.a. n.a.	-0.057 (0.013)	-0.065 (0.011)	-0.043 (0.010)
United Kingdom	-0.167 (0.011)	0.020 (0.013)	0.001 (0.011)	-0.025 (0.014)
Percent Explained	20.90	10.13	9.13	11.53
Percent Unexplained	82.60	91.46	93.10	92.17
Residual	-3.49	-1.59	-2.23	-3.70

Note: Entries represent the average, across goods for a particular country, of the percent by which each price deviates from its good-specific mean. Specifically, given the price of the i th good in the j th country, and the nominal exchange rate, e_j , the means are calculated as

$$\text{Mean} = \frac{1}{N_j} \sum_i^{N_j} \left(\frac{e_j p_{ij}}{\sum_{j=1}^{M_i} e_j p_{ij} / M_i} - 1 \right).$$

The residual associated with the variance decomposition is due to missing observations or, equivalently, an unequal number of observations, N_j , for each country, j .

Table 5
Price Dispersion and Characteristics of the Goods

Variable	1975	1980	1985	1990
Intercept	0.162 (0.0118)	0.185 (0.0136)	0.221 (0.011)	0.201 (0.0106)
Trade share	-0.062 (0.0102)	-0.036 (0.0107)	-0.070 (0.0085)	-0.074 (0.0089)
Non-tradeable inputs	0.179 (0.051)	0.292 (0.0601)	0.224 (0.0485)	0.296 (0.0465)
R^2 aggregated data	0.29	0.25	0.33	0.44
R^2 dissaggregated	0.09	0.06	0.09	0.14

Note: The table presents the coefficients of estimating regression equation (8) in the text. R^2 (aggregate data) is the R^2 measure of fit from the GLS regression. R^2 (aggregate data) is the fraction of variance explained based on the raw data which is necessarily lower because we cannot explain intrasectoral dispersion in prices given the more aggregate nature of our explanatory variables.

Table 6
Variance Decomposition

	1975		1980		1985		1990	
	Mean	Pooled	Mean	Pooled	Mean	Pooled	Mean	Pooled
Total real exchange rate variance	2.9	62.2	7.4	187.5	12.0	469.1	13.6	616.1
Decomposition of variance:								
Brand effect	0.58	0.69	0.42	0.46	0.49	0.56	0.46	0.59
Country effect	0.30	0.11	0.47	0.08	0.39	0.08	0.40	0.07
Residual	0.12	0.20	0.12	0.46	0.12	0.36	0.14	0.33
Brand dominant	10	x	10	x	18	x	23	x
Ambiguous	3		1		5		5	
Country dominant	3		10		12		14	
Total number of goods	16		21		35		42	
Total number of brands	77		122		290		421	
Total number of observations	511		1013		2926		4542	

Note: The figures in the table summarize the results from estimating equations (10)-(12) for each year. The first row gives the total variance across goods and brands of the real exchange rate. The next three rows decompose the variance of real exchange rates for each good into brand, country and residual components. The numbers reported under the heading “mean” are averages across all goods in the cross-section. The individual results from which these means are computed follow in Table 7. The numbers reported under the heading “pooled” are computed from a single regression that pools all the goods after having removed good-specific means. The next three rows indicate whether there is a dominant component to the variance. Ambiguous here is defined as cases in which the difference in the proportions of the variance explained by the two effects is less than the proportion of the variance unexplained. The last three rows provide detail about the number of goods, brand and observations included in the analysis.

Table 7
Variance Decomposition (1975)

Good	Variance	Decomposition of Variance			Number of		Dominant Factor
		Brand	Country	Residual	Brands	Obs.	
Chest freezers, 320-400 L	0.31	0.42	0.16	0.42	4	16	Ambiguous
Crystal-ware (drinking glasses)	0.58	0.92	0.04	0.04	4	16	Brand
Cylinder vacuum cleaners	1.55	0.75	0.15	0.09	5	30	Brand
Detergents for linen	13.88	0.97	0.01	0.01	4	20	Brand
Dishwashers fully automatic	4.71	0.75	0.16	0.09	7	56	Brand
Auto (1000cc to 1499cc)	3.86	0.24	0.70	0.06	8	72	Country
Auto (1500cc to 1999cc)	0.75	0.81	0.18	0.01	4	16	Brand
Classical record 33rpm-30cm single,	0.99	0.34	0.50	0.16	4	36	Ambiguous
Refrigerators (table-top), 255-305L	1.05	0.53	0.26	0.22	5	30	Brand
Refrigerators (table-top), 45-160L	0.68	0.76	0.16	0.08	4	16	Brand
Replacement, front wing ^a	7.90	0.76	0.11	0.14	4	36	Brand
Table radio set	1.46	0.41	0.48	0.10	5	30	Ambiguous
Toilet soap, selected brand	1.35	0.16	0.71	0.13	5	35	Country
Toothpaste, selected brand	2.83	0.06	0.83	0.11	5	45	Country
Tires	1.34	0.62	0.28	0.10	4	32	Brand
Washing machines fully automatic	2.85	0.79	0.13	0.08	5	25	Brand
Mean	2.9	0.58	0.30	0.12			Brand
Pooled results	62.22	0.69	0.11	0.20			Brand

^aRepairs are on a selected make and model and involve only labor costs.

Note: The figures in the table summarize the results from estimating equations (10)-(12). The first column identifies each of the goods for which multiple brand observations are available. The second column is the total variance of price across brands and countries. The next three columns report the fraction (in percent) of this variance attributable to brand effects, country effects, and a residual term. The next two columns report the number of brands per good and the number of observations per good. The final column indicates the relative importance of brand or country effects unless the implications of the variance decomposition are ambiguous. Ambiguous here is defined as cases in which the difference in the proportions of the variance explained by the two effects is less than the proportion of the variance unexplained (the column labelled residual).

Table 7 (continued)
Variance Decomposition (1980)

Good	Variance	Decomposition of Variance			Number of		Dominant Factor
		Brand	Country	Residual	Brands	Obs.	
Cigarettes, light tobacco with filter	5.02	0.09	0.83	0.08	5	60	Country
Deep-freezer	0.74	0.78	0.17	0.05	4	16	Brand
Fridge-freezer, combined	5.65	0.58	0.38	0.04	6	36	Brand
Hearing aid,	1.68	0.10	0.78	0.12	6	24	Country
Car, main service	10.09	0.07	0.76	0.18	5	40	Country
Auto with diesel engine	12.10	0.39	0.58	0.02	6	66	Country
Auto, 850-1100 cc	4.87	0.14	0.83	0.03	6	60	Country
Auto, 1300-1600 cc	9.85	0.17	0.79	0.03	13	143	Country
Auto, 1800-2700 cc	17.62	0.53	0.44	0.03	9	99	Brand
Motorcycle	5.83	0.84	0.06	0.10	9	72	Brand
Out-board motor	8.30	0.71	0.11	0.18	4	20	Brand
Replacement of a broken windscreen ^b	12.76	0.16	0.75	0.10	5	40	Country
Replacement of linings on 4 brakes ^b	8.82	0.14	0.78	0.09	4	36	Country
Replacement of linings on clutch discs ^b	9.53	0.26	0.67	0.07	4	36	Country
Sewing machine	2.73	0.69	0.08	0.22	5	35	Brand
Spectacle lens	27.70	0.83	0.10	0.07	5	45	Brand
Three-drawer base pack	2.82	0.69	0.18	0.14	5	20	Brand
Toilet soap	2.33	0.10	0.41	0.49	5	45	Ambiguous
Tire	1.33	0.28	0.57	0.15	4	48	Country
Vacuum cleaner	1.91	0.64	0.19	0.17	5	30	Brand
Washing machine	3.10	0.63	0.32	0.05	7	42	Brand
Mean	7.4	0.42	0.47	0.12			Ambiguous
Pooled results	187.5	0.46	0.08	0.46			Ambiguous

^bService by official dealers, selected brand.

Notes: See notes at end of table.

Table 7 (continued)
Variance Decomposition (1985)

Good	Variance	Decomposition of Variance			Number of		Dominant Factor
		Brand	Country	Residual	Brands	Obs.	
Beer in bottle	5.23	0.07	0.45	0.48	7	35	Ambiguous
Car battery	1.45	0.71	0.11	0.18	4	16	Brand
Cigarettes light, with filter	7.44	0.06	0.84	0.10	7	77	Country
Coffee maker	19.02	0.91	0.08	0.01	5	30	Brand
Colour film	1.24	0.63	0.26	0.11	4	32	Brand
Dishwasher 3 + 3 programs	7.49	0.78	0.14	0.08	8	96	Brand
Electric razor	5.60	0.78	0.15	0.06	5	40	Brand
Fridge-freezer 299 l	2.38	0.71	0.18	0.11	8	64	Brand
Garden chair	5.91	0.67	0.23	0.10	4	16	Brand
Garden table	3.29	0.88	0.02	0.09	5	25	Brand
Hair dryer	2.49	0.83	0.14	0.03	5	35	Brand
Hearing aid	7.54	0.23	0.62	0.15	14	168	Country
Hi-fi cassette, unrecorded	5.15	0.79	0.17	0.04	4	32	Brand
Auto diesel	5.34	0.72	0.25	0.03	8	72	Brand
Auto, less than 1200 cc	12.67	0.31	0.66	0.03	23	299	Country
Auto, 1200-1700 cc	19.57	0.31	0.65	0.04	28	364	Country
Auto, more than 1700 cc	30.30	0.40	0.58	0.02	13	143	Country
Motorcycle	105.53	0.90	0.09	0.02	25	300	Brand
Portable typewriter	20.63	0.86	0.06	0.08	5	50	Brand
Reflex camera	1.13	0.63	0.18	0.18	4	24	Brand
Car, first main service ^c	19.37	0.09	0.49	0.41	5	60	Ambiguous
Car, replacement of 4 tires ^c	12.74	0.01	0.98	0.02	5	60	Country
Replacement of brake linings ^d	27.58	0.06	0.79	0.15	9	117	Country
Replacement of clutch linings ^d	26.00	0.04	0.93	0.03	10	120	Country
Slide film	1.82	0.13	0.64	0.23	4	28	Country
Spark plug	2.28	0.34	0.32	0.34	5	35	Ambiguous
Television color	4.22	0.72	0.24	0.04	8	48	Brand
Tennis racket	14.50	0.70	0.14	0.16	7	70	Brand
Toilet soap	1.68	0.00	0.77	0.23	5	40	Country
Tumble dryer 4 kg	8.90	0.90	0.06	0.04	7	49	Brand
Tire	4.00	0.38	0.44	0.19	9	117	Ambiguous
Vacuum cleaner, cylinder	11.11	0.42	0.24	0.34	10	120	Ambiguous
Video recorder	5.51	0.28	0.69	0.04	8	48	Country
Washing machine 1.2 kg	7.71	0.84	0.13	0.03	8	64	Brand
Whisky	3.89	0.05	0.88	0.07	4	32	Country
Mean	12.0	0.49	0.39	0.12			Ambiguous
Pooled results	469.07	0.56	0.08	0.36			Brand

^c Service in garage.

^d Service by mechanic.

Table 7 (continued)
Variance Decomposition (1990)

Good	Variance	Decomposition of Variance			Number of		Dominant Factor
		Brand	Country	Residual	Brands	Obs.	
Alpine skis	1.61	0.70	0.19	0.11	4	16	Brand
Bra SB1 to 4sm	4.87	0.70	0.14	0.16	6	54	Brand
Car battery: 44 to 88Ah	2.24	0.51	0.26	0.23	5	30	Brand
Car hire, specific company and car	17.78	0.53	0.26	0.21	8	96	Brand
Car radio	9.90	0.97	0.01	0.02	5	25	Brand
Cigarettes, light tobacco, filter	7.38	0.03	0.95	0.02	7	77	Country
Coffee maker	20.17	0.79	0.12	0.09	8	80	Brand
Compact disc	0.32	0.10	0.61	0.30	5	60	Country
Cooker hood, 3 speed	1.97	0.57	0.15	0.28	6	30	Brand
Dishwasher, 4 to 7 programmes	2.93	0.53	0.34	0.13	7	56	Brand
Electric drill	0.97	0.65	0.21	0.14	5	25	Brand
Electric razor	6.66	0.63	0.17	0.19	6	60	Brand
Fridge-freezer, 256-360 L	3.06	0.50	0.35	0.15	9	90	Brand
Hair dryer	5.00	0.66	0.21	0.13	8	88	Brand
HIFI cassette	4.18	0.46	0.30	0.24	5	35	Ambiguous
Iron	5.06	0.74	0.18	0.08	8	72	Brand
Liqueur	1.45	0.02	0.88	0.09	4	16	Country
Microwave oven	1.26	0.42	0.11	0.46	5	25	Ambiguous
Auto, less than 1.2 L, 954-1198 cc	18.65	0.26	0.67	0.07	27	324	Country
Auto, 1.2-1.7 L, 1275-1595 cc	23.73	0.36	0.57	0.06	29	377	Country
Auto, 1.7 L or higher, 1779-2494 cc	43.44	0.43	0.51	0.05	31	403	Country
Auto, diesel, 1595-2500 cc	30.68	0.67	0.28	0.06	20	240	Brand
Motorcycle	156.9	0.92	0.05	0.03	35	455	Brand
Radiator, electric	2.09	0.78	0.14	0.08	7	28	Brand
Reflex camera	15.82	0.60	0.32	0.08	9	117	Brand
Replacement of 4 brake linings ^e	26.83	0.03	0.81	0.15	12	144	Country
Replacement of clutch linings ^e	23.38	0.02	0.96	0.02	12	120	Country
First main service ^e	14.79	0.03	0.77	0.20	6	78	Country
Replacement of 4 tires and balancing ^f	17.36	0.00	0.96	0.03	6	78	Country
Slide film, 36 exposures	1.48	0.05	0.63	0.32	4	24	Country
Sparking plug	1.93	0.10	0.71	0.19	5	30	Country
Television: colour	29.82	0.83	0.13	0.04	16	192	Brand
Tennis balls	4.90	0.53	0.45	0.01	4	28	Brand
Tennis racket	7.38	0.63	0.17	0.21	7	63	Brand
Toaster	0.26	0.14	0.63	0.22	5	30	Country
Tumble dryer, 4.5-5 kg	12.02	0.78	0.17	0.05	8	80	Brand
Tire	4.74	0.39	0.42	0.19	11	143	Ambiguous
Vacuum cleaner, 1100 W	8.09	0.34	0.45	0.22	11	132	Ambiguous
Video camera	3.16	0.29	0.49	0.22	10	110	Ambiguous
Video recorder	15.45	0.62	0.30	0.07	16	208	Brand
Washing machine, 4.5 to 5 kg	9.39	0.75	0.16	0.09	14	168	Brand
Whisky	2.04	0.13	0.77	0.09	5	35	Country
Mean	13.6	0.46	0.40	0.14			Ambiguous
Pooled results	616.14	0.59	0.07	0.33			Brand

^e Service by mechanic dealer, for car S.B., without parts. ^f Service in garage.

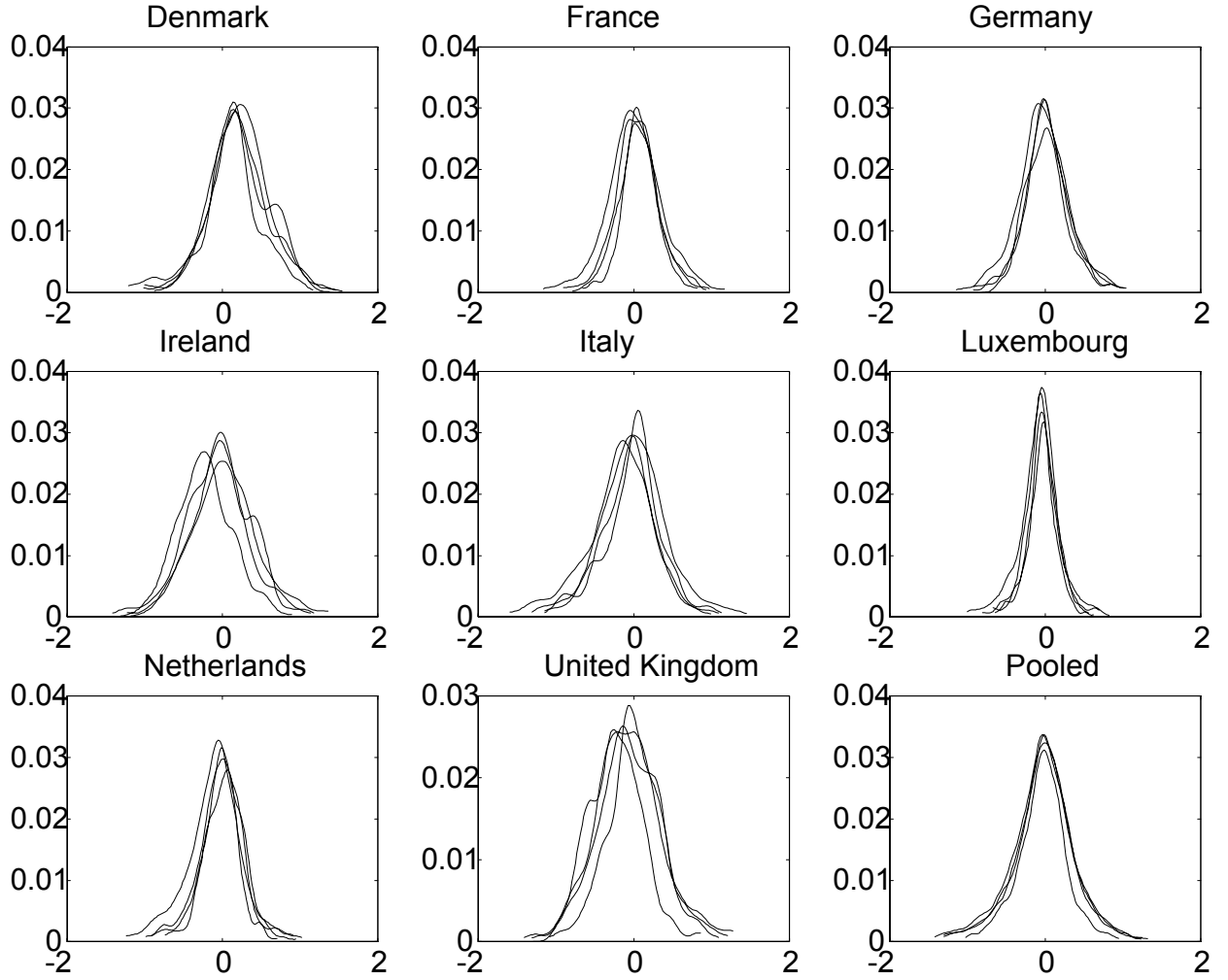


Figure 1: Empirical Distributions of Log Real Exchange Rates

Each line represents an estimate of the density of the log relative price, good-by-good, between Belgium (the numeraire) and some other EC country. More specifically, each line is an estimate of the density, for country j , of $\log q_{ij} = \log(e_j p_{ij}/p_{in})$, where p_{ij} is the price of good i in country j , denominated in domestic currency and e_j is the spot exchange rate between country j and Belgium. Each chart contains a bilateral comparison between Belgium and one other EC country for each year in our panel. We present the individual country densities only for those countries with 4 years of available data. However, the lower right-hand chart presents an estimated density for each year (1975, 1980, 1985 and 1990), pooled across all countries with data available for the year under examination.

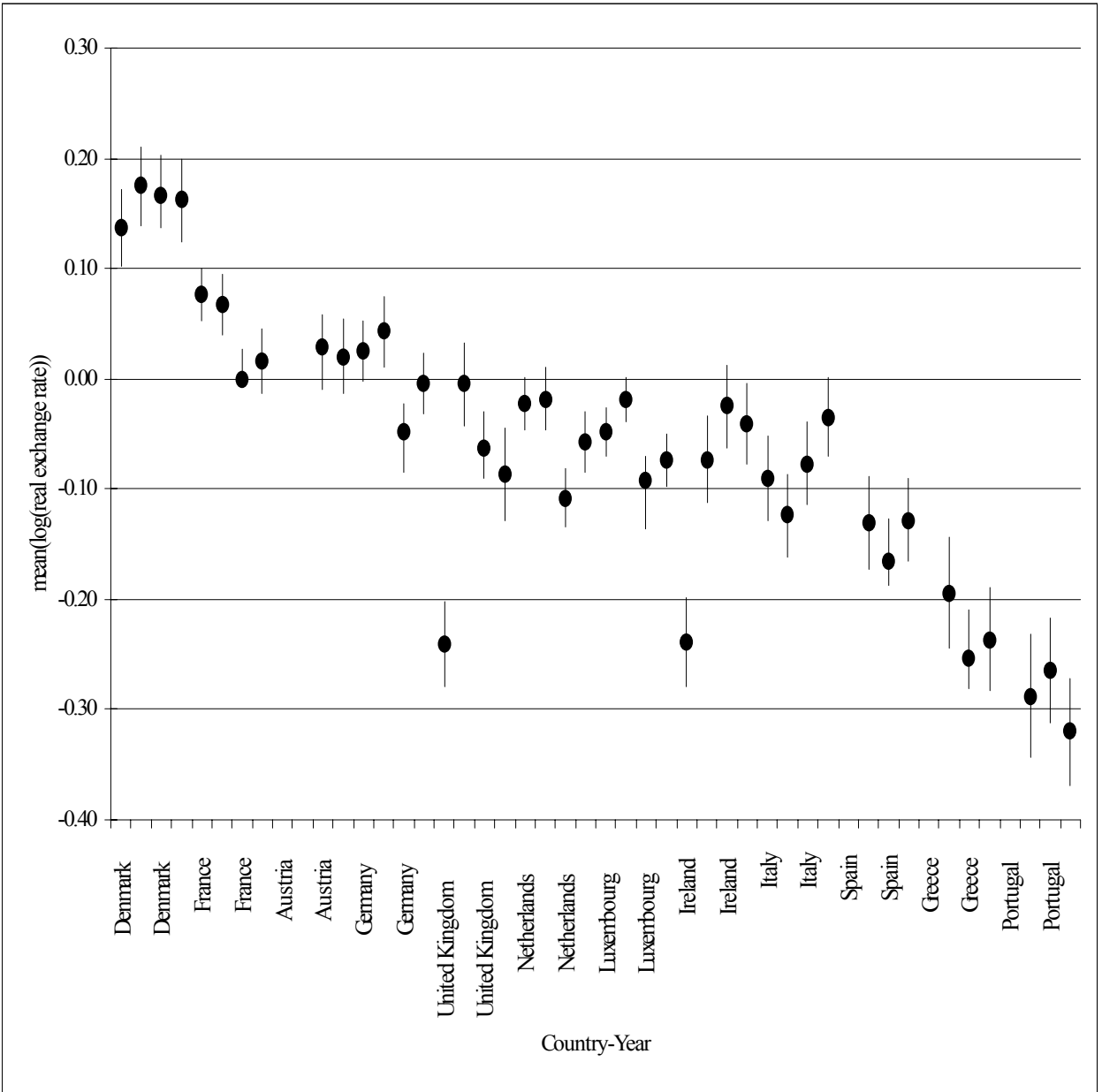


Figure 2: Mean Log Real Exchange Rates

Each vertical bar is represents a point estimate and standard error for the mean log real exchange rate of a particular country and year vis a vis Belgium. The dot represents the mean real exchange rate calculated on an equally-weighted basis while the end points of the bars are plus and minus twice the estimated standard error of the mean. The means are presented in rank order from highest to lowest using 1985 as the point of reference. There are four entries per country where the data permit and these are presented sequentially in the figure . For example, the mean real exchange rates for Denmark in 1975, 1980, 1985 and 1990 are the first four points in the plot. Denmark appears first because in 1985 it had the highest mean real exchange rate of all the countries while Portugal appears last because it had the lowest mean real exchange rate.

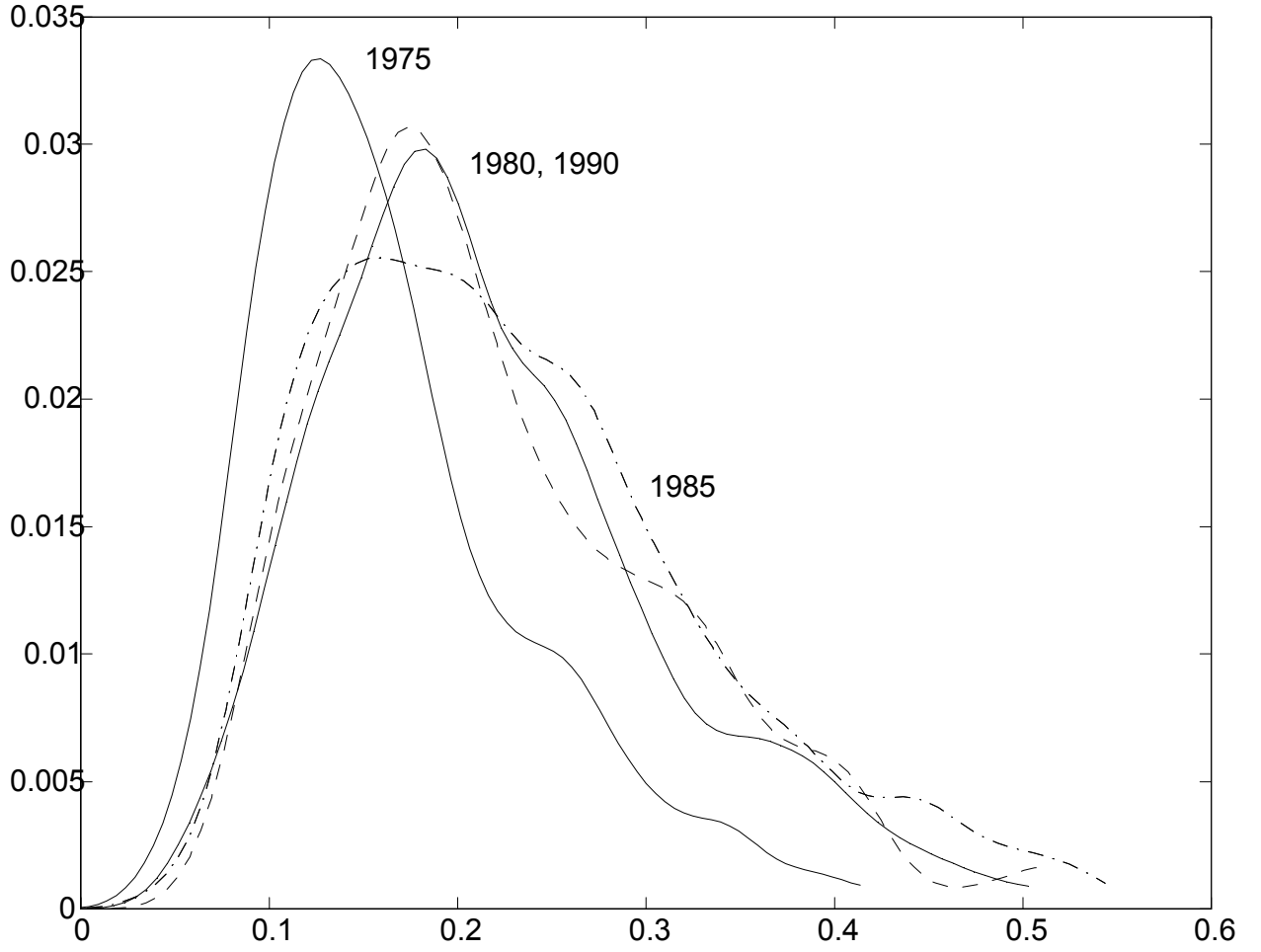


Figure 3: Empirical Distributions of Geographic Real Exchange Rate Dispersion

Each line represents an estimate of the density of the mean absolute deviation of national prices compared to the cross-country mean, good-by-good for a particular year in the cross-section. Specifically, the dispersion measure is defined as: $y_i = mad(\hat{z}_{ij})$, where $z_{ij} = \frac{e_j p_{ij}}{\sum_{j=1}^{M_i} e_j p_{ij} / M_i} - 1$ and $z_j = \sum_{i=1}^{N_j} z_{ij} / N_j$.