Online Pricing and the Euro Changeover: Cross-Country Comparisons*

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Abstract

We study the impact of the Euro on prices charged by online retailers within the EU. Our data spans the period before and after the Euro was introduced, covers a variety of products, and includes countries inside and outside of the Eurozone. Our main finding is that the Euro changeover in 2002 neither mitigated price differences nor resulted in purchasing power parity for products sold online. In fact, evidence suggests that online prices in the Eurozone actually increased compared to prices of EU countries outside the Eurozone. Further, contrary to the predictions of purchasing-power-parity, we find significant differences in the prices charged by firms both within and across seven countries in the European Union. We also find significant differences in both the average price charged and the best price available in these countries. These conclusions are robust to a variety of controls.

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1 Introduction

The Euro became a reality for consumers in twelve nations on 1 January 2002, when it was introduced for retail transactions in all the participating countries.[1] Prior to this, retail transactions were conducted in local currencies. The main arguments made in favour of the Euro's introduction were that a single currency would facilitate the transparency of prices across Europe and reduce transactions costs associated with currency exchange. Pedro Solbes, the EU Commissioner for Economic and Financial Affairs, suggested that, "Trading in the same currency across borders lowers costs while cross border price transparency encourages competition."[2]

One might expect that Internet price comparison sites would enhance any pro-competitive effects of price transparency by making it easier for consumers to identify "bargains" and arbitrage price differences within and among Eurozone countries. Hence, if one is going to see the presumed gains of this improved transparency, Internet markets would be a logical place to look. In this paper, we study the dynamics of online retail pricing in the period immediately before and immediately after the retail introduction of the Euro to assess its impact. Our analysis is based on retail price data we collected from Kelkoo—the leading Internet price comparison site in the EU.

Contrary to what one might expect based on theories of competitive markets and purchasing-power-parity, we find significant differences in the prices charged by firms both within and across seven countries in the European Union. We also find significant differences in both the average price charged and the best price available in

[1] The Euro was actually introduced as a currency in January 1999, but was not legal tender for use by consumers in retail transactions until January 2002. Between January 1 and February 28, 2002 all retailers were required to accept payments in both their own local currency and the Euro. From March 1, 2002, the Euro became the only legal currency in all members of the Eurozone.

[2] *Inf€uro,* Volume 15, 2000.

these countries. Cross-country price differentials are prevalent for products that are language specific and those that are not, and persist regardless of whether one views different firms as selling homogeneous or differentiated products. Our main finding is that the Euro changeover in 2002 neither mitigated price differences nor resulted in purchasing power parity for products sold online. In fact, evidence suggests that online prices in the Eurozone actually increased compared to prices of EU countries outside the Eurozone.

Our analysis is based on a dataset that has several features that distinguish it from the extant literature.[3] We collected firm and price information from the Kelkoo sites in the seven EU countries: four in the Eurozone and three outside it. Our study looked at pricing for 28 products across a variety of product categories and price points. We obtained price information during a period that straddled the introduction of the Euro; thus, we are able to look at variation both pre and post Euro introduction as well as variation between pricing inside and outside the Eurozone. To our knowledge, this is the first study that offers as many cross-country comparisons and covers as broad a range of products.[4] More importantly, we believe ours is the first academic study of the impact of the introduction of the Euro on retail pricing. By including four Eurozone and three non Eurozone countries in the study, we examine what some might view as a "natural experiment" on the impact of this important monetary

[3] A growing number of studies have examined pricing on the Internet. For studies based on online markets in the US, see Bailey (1998a,b); Bakos and Brynjolfsson (2000); Baye, Morgan, and Scholten (2001, 2002, 2003); Baylis and Perloff (2002); Bergen, Dutta, and Shugan (1996); Brown and Goolsbee (2002); Brynjolfsson and Smith (2000b); Clemons, Hann, and Hitt (2000); Dellarocas (2001); Ellison and Ellison (2001); Morton, Zettelmeyer and Silva-Risso (2001); Resnick and Zeckhauser (2002); Resnick *et al.* (2002); Scholten and Smith (2002); Smith (2001); and Ward and Lee (2000). For an excellent survey of this literature, see Elberse, Barwise and Hammond (forthcoming).

[4] However, Lehman (2001) studies prices for package holidays from German online travel agencies. Latcovich & Smith (2001) study online book markets in the UK. Clay and Tay (2001) examine the prices of textbooks sold by nine online bookstores in North America, the United Kingdom and Germany, and report substantial cross-country price dispersion.

reform on pricing behavior.

Our analysis recognizes differing views of the relevant transaction price to use in comparing prices in online markets. Some have taken the position that identical products sold by different firms in online markets are homogeneous, and therefore that a majority of consumers using a price comparison site will purchase at the minimum listed price (Baye and Morgan, 2001). In this case, the relevant price to compare pre and post-Euro is the minimum price. On the other hand, one might reasonably argue that price differences for identical products stem from heterogeneities in service or reputations, and firms charging higher prices also enjoy sales (Narasimhan, 1988; and Pan *et. al*, 2001). In this case, the natural comparison is the average price charged by all firms in the market. While the absence of sales data precludes us from discriminating between these two extreme views, our main finding is invariant to the use of minimum or average prices. We find higher average prices post Euro, regardless of whether one views products as identical or differentiated.

The remainder of the paper proceeds as follows. In section 2, we describe the nature of the data used in our study. Section 3 presents summary measures of price competition in EU online markets as well as statistical analysis of pricing before and after the Euro changeover. The statistical analysis shows that our main findings are robust to a variety of controls, including product life cycle effects (prices of all products in our sample tended to decline over time), market structure (average and best prices are generally decreasing in the number of firms selling products in each country), heterogeneities in exchange rates, tax rates, and controls for other dynamic changes (such as consumer access to the Internet). In section 4, we offer several possible explanations for why the introduction of the Euro resulted in higher online prices within the Eurozone. Finally, section 5 concludes.

2 Data

The price data for this study were downloaded from Kelkoo.[5] It is now the dominant price listing service in Europe, operating in eight countries—more than any other price listing service in Europe. Across Europe, over 1 million distinct users access Kelkoo sites every month.[6] Of the eight countries in which Kelkoo presently operates, seven are members of the European Union (France, Italy, Netherlands, Spain, Sweden, UK, Denmark), and four (France, Italy, Netherlands, Spain) are members of the Eurozone.

The layout and structure of the Kelkoo web pages are very similar in all countries, although obviously the language used on each national web site varies. This similarity in structure is an important aspect of the data collected as it hopefully minimizes any behavioral differences amongst consumers that may be generated by different web page layouts. Consumers on each site are offered a broad range of product categories, ranging from music and books to financial services, telephones and telephonic services, household appliances, computers, clothing, cars, cosmetics and so on. There are several ways of searching for particular products within each category, but once a product is identified, Kelkoo provides a list of firms selling the product, the prices charged, and additional information such as delivery costs.

Figure 1 shows a screenshot of the prices listed for the Palm m505 PDA in the UK on 1 March 2002. Seven firms offer the product, at seven different prices ranging from £281.99 to £ 349.99. With one further mouse-click, the consumer can enter the

[5] Specifically, the program GoZilla! was used to download the relevant pages from the various Kelkoo sites. These files were then converted from html code into a format suitable for econometric analysis by a specialist software company in India, Cordiant Interweb Technologies.

[6] Kelkoo was founded in France in 1999 and, through mergers and acquisitions, rapidly expanded into other European markets over the following two years. Within France, it now has the same name recognition amongst Internet users as Amazon.com. Kelkoo is ranked as either the first or second most accessed price listing service in all eight countries, and is the leading price listing service in the two countries with the most developed Internet retail markets (France and the United Kingdom). It is accessed by over twice as many individual users each month as its next closest rival in these two countries. (Statistics from Jupiter MMXI and Hitwise Statistics)

Kelkoo site in six other EU countries and repeat the search. Consumers interested in purchasing an item 'click through' from the Kelkoo page to the firm's own web site using the 'More' button. Kelkoo's revenue is generated by charging firms a fee for each consumer 'click through' generated to the firm's web page. The fees charged vary between product categories and countries, but range from €0.30 to €1.50 per 'click through'. Firms are not charged a fixed fee to list on Kelkoo, although there is an implicit cost of formatting data on the web site for access by Kelkoo. Consumers are not charged any fees to access Kelkoo.

All prices used in this study include local sales taxes, exclude transportation and delivery charges, and have been converted into Euros at the relevant daily exchange rate.[7] Tax rates on retail transactions vary across the countries monitored, ranging from 16% in Spain to 25% in Denmark and Sweden.[8] Including transportation charges into the analysis has no impact on the results reported, as these charges are small relative to the observed price variation.

We collected firm and price information from the Kelkoo sites in these seven EU countries for 28 specific and well-defined products across six main product categories, Games, Games Consoles, Music, PDAs, Printers, and Scanners—a full list of the products selected appears in Appendix 1. The categories were selected to reflect areas where Internet retailing was strongest and where product differences across countries were smallest.[9] Within categories, all the products selected were identified to be selling well in at least three countries at the start of the study. For each of

[7] On all Kelkoo websites, Euro pricing was also phased in over the period. In October, all sites reported prices in the domestic currency only. In December and January, prices in the Eurozone member countries were reported in both the domestic currency and Euros. By May, the prices in all Eurozone countries, except France, were being quoted in Euros only. Oddly, the French site was still reporting prices in both Euros and Francs.

[8] Sales tax rates in the relevant countries are: Denmark 25%, Sweden 25%, Italy 20%, France 19.6%, Netherlands 19%, Britain 17.5%, and Spain 16%.

[9] Books, for example, suffer from language specificity and the product range for household appliances vary greatly between countries.

these 28 products, firm-specific price quotations were downloaded from the Kelkoo websites on four dates: 25 October 2001, 14 December 2001, 11 January 2002 and 3 May 2002.[10] This resulted in 2633 price observations.

3 Results

As mentioned above, Kelkoo is one of the leading price comparison sites in many countries in Europe. Compared to the US, however, Internet retailing and price comparison sites are relatively less developed in Europe. This difference in development may be readily seen in the average number of firms listing prices at Kelkoo for the products in our study. As shown in Table 1, the average number of firms listing prices for specific products in a given country is never more than seven. This is considerably lower than the average of 20 or so listings reported in Baye, *et al.* (2001) for similar products at the US price comparison site, Shopper.com.[11] By May 2002, fewer firms were listing prices on Kelkoo than was the case in October 2001. This might be explained by the rapid product life cycle typical of the basket of items we study, or by the 'shake-out' in Internet related businesses that occurred over the period.[12]

The second panel of Table 1 reports price indices for our (equally weighted) commodity basket of 28 products, across countries and dates (normalized by French prices in October). Notice that in October, the prices in *all* non-Eurozone countries were higher than in *every* Eurozone country. Given the nature of the products selected, one might expect prices to fall over time due to technological or "fad" obsolescence. By

[10] For some products, where downloading difficulties occurred, web pages were downloaded the following day.

[11] The number of firms listing prices at Kelkoo ranges from 0 to 13, compared to US sites where the number of sellers ranges from 0 to 63 (see Baye, *et al.*, 2001).

[12] Another possible explanation for this change is that, post-Euro, sellers within the Eurozone were effectively competing with each other in all Eurozone countries, and this increased competition led to net exit and consolidation (cf. Sutton (1998)). This explanation is not consistent with the data; Table 1 shows that the decline in the number of firms is similar inside and outside the Eurozone.

May, France experienced a 7% decline in average prices, and all non-Eurozone countries witnessed even greater price declines. In the Eurozone, prices rose marginally in the Netherlands, and substantially in Spain.

The picture is the same when we consider indices for minimum prices, constructed again for our commodity basket with product-wise minimum prices in France as the base. The third panel of Table 1 shows that, in October, minimum prices in non-Eurozone countries were higher than in Eurozone countries. By May, the index of minimum prices in France fell by 8%. Between October and May, the minimum price index fell in every non-Eurozone country by more than in any Eurozone country. In Spain, minimum prices increased.

The price differences observed in both mean and minimum prices can be partially explained by differences in sales tax rates among countries. However, even when sales tax is excluded, the overall pattern prevails; see the italicized columns in panels 2 and 3 of Table 1. In October, Spain remains the cheapest, Denmark the most expensive, and both average and minimum prices indices remain higher in the UK and Denmark than in any Eurozone country. By May, products sold in Eurozone countries are more expensive, strikingly so in the case of minimum prices. Of course, differences in sales tax rates (which were constant over the period) have no impact on the *movement* of the price indices over the period.

One similarity between US and European price comparison sites is the presence of dispersed prices for virtually identical products.[13] One measure of price dispersion frequently used in the literature (see, for instance, Carlson and Pescatrice, 1980) is the coefficient of variation, which is defined as the sample standard deviation in prices

[13] Of course, while the products themselves are identical, the firms might well differ in return policies, shipping speed, ease of buying at their sites, and so on. In principle, these heterogeneities could be responsible for the price dispersion observed on price comparison sites in both Europe and the US.

divided by the sample mean. Dispersion using this measure is reported in the fourth panel of Table 1. The levels of price dispersion in Europe are comparable to what has been observed for similar items offered on price listing services in the US. Interestingly, by May, price dispersion increased in five of the seven countries studied compared to the levels of price dispersion observed in October. The May price dispersion figures are somewhat higher than US levels of price dispersion in online markets, but lower than the levels of price dispersion found in conventional retail markets in the EU prior to the Euro changeover (see Commission of the European Communities, 2001). Another measure of price dispersion that has been reported for online US markets is the range. Brynjolfsson and Smith (2000a) report price ranges of about 33% in their study of online pricing of books and CDs sold in the US. Our basket of products displays similar ranges in prices. Analogous to the changes observed in the coefficient of variation, the range in prices tends to be higher in May than it was in October, increasing in all of the countries studied except Italy.

Table 2 examines the dynamics of pricing for a particularly popular item, the Palm M505. The numbers of firms listing prices for this product tend to be somewhat higher than the averages reported in Table 1. The average price tends to differ quite a bit between countries. As the table shows, in October, the lowest average price for the Palm occurs in Spain, where it is offered for €479 as compared to Denmark, where it is offered at €565. The differences in prices for the Palm in October seem related to whether the country is in the Eurozone. The lowest average price offered outside the Eurozone is higher than the highest average price offered inside the Eurozone. This difference is still present after the Euro changeover, although by this time the prices inside the Eurozone have generally gone up. In two of the four Eurozone countries, the average price is essentially unchanged; in the other two Eurozone countries, the price has increased. No similar upward trend in prices can be seen outside the Eurozone.

Prices go down in Denmark and the UK, and stay the same in Sweden. This increase in prices after the changeover is puzzling in view of the aging of the product and the heightened transparency from the single currency.

The situation is similar when one examines the lowest prices charged for the Palm M505. In October, Spain had the lowest *average* price. France had the lowest *listed* price on that date (at €410). Again, the lowest price outside of the Eurozone is higher than the highest minimum price within the Eurozone. By May, there is an upward trend in prices in the Eurozone. The lowest price is now in Italy, but it is 11% higher than the French price in October. Further, the lowest overall price is now in Denmark (at €454). Thus, minimum prices are also higher in the Eurozone after the changeover than they were a few months before.

The number of firms listing prices varies across countries. One might expect that when the number of competing firms in a given country becomes larger, prices will tend to become more competitive. One sees this, to some extent, in Table 2. For instance, in Spain, the lowest price is high when only two firms list prices, and drops when five or six firms list prices. Similarly for the Netherlands, a decline in the number of firms from four in October 2001 to two in May 2002 coincides with an increase in average price. The correlation, however, is far from perfect.

Of course, this is merely suggestive. Both the change in numbers of firms and the Euro changeover were happening simultaneously, so it is difficult to disentangle these effects by simply looking at the lowest and average prices across countries and dates. Further, product heterogeneity may explain the differences in prices for the Palm M505 across countries. A Palm will typically be configured to operate in the language of the country where the listing occurs. Thus, a Palm offered by an Italian seller will have menus in Italian, which makes it less useful for a Dutch buyer. Of course, it is possible to reconfigure the Palm to the desired language, but this hassle

alone may explain the price differences. This explanation, however, has no bearing on why prices generally trended up in Eurozone countries and not in non-Eurozone countries. We explore this issue in greater detail in section 4.

Given the language issues associated with the Palm, in Table 3 we also show the price trends for a less language specific product, a music CD by Shaggy, which was quite popular at the end of 2001. While the language used on the packaging of this item differs across countries, the content is identical. Presumably, consumers mostly care about the content—the songs—contained on the CD. As Table 3 shows, the number of firms listing prices for this item differs substantially across countries and across time. In October, the number of price listings in non-Eurozone countries is higher than the number of listings in Eurozone countries; however, by May, this has evened out.

In the non-Eurozone countries, average prices are lower in May than in October. This is not unexpected, given the short product life cycles of popular music CDs. What is curious is that average prices within the Eurozone tended to *increase* between October and May. In three of the four Eurozone countries, the average price of the CD went up—increasing by 9.9% in France and by 7.4% in Spain. Only in Italy was any price decline registered, and this by only 1.3%. In contrast, average prices fell in all of the non-Eurozone countries. The smallest such price decline was registered in the UK, and here the average price still dropped by 10%.

The tendency for prices to decline by much less for countries inside the Eurozone compared to those outside it is also reflected in changes in minimum prices. In October, there was no clear difference between Eurozone and non-Eurozone prices. By May, the lowest price offered in each of the non-Eurozone countries decreased by at least 21%. Similar price declines did not occur inside the Eurozone. In two countries, minimum prices either remained the same or increased slightly. The remaining two,

Spain and the Netherlands, showed declines of 10.1% and 1.7%, respectively. The upshot is that by May minimum prices inside the Eurozone tended to be higher than those outside it.

Thus, price dispersion for similar products is prevalent within and across EU countries at levels that are comparable to online and conventional retail markets in the US. There are differences in average and best prices in Europe, and this is true of products that are language specific and those that are not. Price differences across countries do not disappear within the Eurozone after the currency changeover. While one argument in favor of the single currency was that it would promote competition, the data suggest that online prices in the Eurozone generally went up after the changeover. Finally, it appears that the number of competing firms within a country impacts the competitiveness of prices: The more firms listing prices, the lower the product price. We explore all of these issues in greater detail in the next section.

3.1 Statistical Analysis

The tables and graphs in the previous section are merely suggestive and do not account in a systematic way for dynamic changes in such key variables as the number of consumers or firms with Internet access, costs, reservation prices, or differences in products (such as product popularity). To attempt to control for these potentially important factors, we use a simple regression model to study the relationship between the prices (expressed in logs) and the number of firms listing the product on Kelkoo, the timing of these price offers relative to the Euro changeover, and the countries where the products were being offered. To attempt to control for unobserved differences in demand, costs and market structure, we use country, product and date indicators. Date fixed effects control for unobserved changes over time in the number

of potential firms and the number of consumers with Internet access. Interacting date indicators with product indicators provides a crude control for differences in the demand and costs for different products and product specific life cycle effects, while interacting country indicators with date indicators allows us to examine the effect of the Euro-changeover on different countries. We use robust estimation to control for heteroscedasticity and autocorrelation. Below, we report results for a variety of specifications. We first examine the effects of market structure on price, and then examine the effects of the Euro-changeover on price.

Number of Firms

Table 4 presents several models examining the effect of the number of competing firms on average prices. Model 1 suggests that average prices are declining, as expected, in the number of firms listing prices on the comparison site. Relative to the case where only one firm lists its price, there is a 3.1% decline in average prices when a second firm is added, a 4.0% decline when three firms list prices and a 6.1% decline when more than three firms list prices (controlling for differences in products, countries, and time). The coefficient associated with more than 3 firms is significant at the 1% level. Model 2 distinguishes listings by up to 6 firms. The same general trend toward lower average prices occurs when more firms list prices; however it is apparent that the reduction in price tapers off once one gets beyond 4 firms. This is consistent with findings reported in Bresnahan and Reiss (1991) for conventional retail markets. Finally, Model 3 distinguishes market structures up to the maximum number of 13 firms observed in the data. Again, the results are consistent with the trend toward price reductions with more firms.

Models reported in Table 5 are for minimum prices.[14] Model 1 displays coefficients

[14] Specifically, the unit of observation is the minimum price listed by any firm for the single product within a country on the particular date.

associated with 2, 3 and more than 3 firms in the market, relative to the monopoly case. The effect on minimum price with increased competition is more pronounced than the effect on average price. The addition of a second firm leads to an 11.9% reduction in the minimum price. When three firms list prices, there is an 15.9% reduction, and when more than three firms list prices, the minimum price falls by 20.3%. All of these coefficients are significant at the 1% level.

The differences in the magnitude of the coefficients in Tables 4 and 5 are consistent with statistical as well as economic intuition. First, the reductions in average price already observed in Table 4 will likely carry over when considering the minimum price. Second, because prices are dispersed, the minimum price will fall with an increased number of listings purely through an order statistic effect. That is, even if firms use exactly the same (possibly mixed) pricing strategy regardless of how many firms list prices, there will be a reduction in the minimum price offered as the number of firms rise.

Euro Changeover

Table 6 shows the difference in average prices between Eurozone and non-Eurozone countries across the changeover period. Model 1 groups countries according to whether they are in the Eurozone. The table shows that, in October, prices in Eurozone countries are on average 5.9% lower than prices in non-Eurozone countries controlling for product and market structure effects. This price advantage disappears by May, with prices in the Eurozone rising by 6.3% compared to non-Eurozone countries between October and May. Contrary to the expectation that the introduction of the single currency would lower prices within the Eurozone, the opposite seems to be true for the online markets in our study.

Model 2 of Table 6 explores this effect at the country level. In this regression, the baseline for comparison is France in October. As the table shows, October prices in

Spain are 9.8% lower than in France. Clearly, the lower average price in Spain is not due to a greater number of firms. In contrast, Denmark, a non-Eurozone country, has the highest average price in October, at 7.9% above the French level. While prices in most countries inside and outside the Eurozone move at about the same rate as France, there are two notable exceptions. Relative to France, prices in Spain increased by 10% by the end of the period, eradicating the price advantage Spain held originally. In Denmark, in contrast, prices fell unusually rapidly, declining by 9.7% more than French prices over the period October to May. The relative experiences of Denmark and Spain strongly influence the magnitude of the results reported in Model 1; however a general trend for prices within the Eurozone to rise with respect prices outside the Eurozone remains even when these countries are excluded from the analysis.

Table 7 examines minimum prices between Eurozone and non-Eurozone countries with the changeover. As the table shows, the story is qualitatively similar: minimum prices in all Eurozone countries were lower in October than minimum prices in any non-Eurozone country, but by May 2002 precisely the opposite is observed. Specifically, in October minimum prices were on average 8.9% lower within the Eurozone (controlling for product, life cycle, and market structure), but by May, they were 2.6% higher.

To summarize, consistent with economic intuition, we find that prices become more competitive as the number of competing firms increases. This is true whether one considers the average price level in a given country for a given product or the minimum price offered. Contrary to our expectations, we find little evidence of increased competitiveness owing purely to the effect of introducing a single currency. While average prices in Eurozone countries were significantly lower than those outside the Eurozone prior to the changeover, by May, the gap had been eroded. If one

considers minimum prices, the story is even more striking. During the changeover period, relative to non-Eurozone countries, minimum prices in the Eurozone rose by 11.5%.

4 Why Have Online Prices Increased in the Eurozone?

We were puzzled by our finding that prices within the Eurozone increased relative to the non-Eurozone countries. As a consequence, we examined numerous specifications – some of which were reported in the previous section. Our conclusion is that this finding is robust to a variety of controls.

One might speculate that the increase in retail prices observed in the Eurozone stems from adverse movements in exchange rates that increased Eurozone retailers' costs relative to their non-Eurozone counterparts. Higher retailer costs within the Eurozone relative to outside firms would lead to higher relative retail prices in a variety oligopoly models (including differentiated product Bertrand competition and Cournot competition). As shown in Appendix 2, however, exchange rates were quite stable, fluctuating by less than 1% against any of the non-Eurozone currencies throughout the period. Thus, while it is possible that the observed price increases stemmed from unobservable increases in the costs of retailers within the Eurozone, the "anti-competitive effects" observed in our data are not driven by a depreciation of the Euro relative to other currencies.

A second possible explanation, which has received attention in the popular press, is that menu costs of adjusting prices led online retailers within the Eurozone to delay making price changes until just after the changeover. While we doubt that the costs

of adjusting prices are very great in the online markets we study, even if menu costs do play a significant role, the pattern of prices implied by this explanation is inconsistent with the data. Specifically, since the products we study tend to have short life-cycles, we would expect that, just prior to the changeover, Eurozone retailers would choose to delay passing on price *decreases* to consumers until just after the changeover period. Thus, one would expect to see relatively higher prices within the Eurozone just prior to the changeover, followed by large price decreases post-changeover. This is the opposite of the pattern we observe.

For these reasons, we do not view asymmetric cost shocks or menu costs as particularly plausible explanations for the relative price increases observed in online markets within the Eurozone. Below, we offer two theoretical explanations that are consistent with the pricing patterns observed.

A Competitive Explanation

Several leading models of price competition predict there are two effects of innovations such as the Euro that transform segmented retail markets (which use different currencies) into one market (with a common currency). First, a common currency makes price differentials more transparent, thereby making it possible for consumers who observe prices charged by firms in different countries (through sites such as Kelkoo) to purchase at the lowest (global) price. This leads to a greater number of "informed" consumers, which tends to lower prices. On the other hand, consumers unaware of price comparison sites or those with a preference for purchasing only from firms located in their home country, will be unaffected by this transparency.

The dilemma facing firms is whether to charge lower prices (in an attempt to win the increased number of informed consumers) or to raise prices to earn higher margins on each locked-in customer. Below we show that, in the Varian (1980) and Narasimhan (1988) models, the latter effect dominates: The increased competition

induced by the opening of markets makes it less likely that any existing firm sets the lowest price in the market, and thus the firms' equilibrium response is to charge higher average prices.

To see this, consider Varian's (1980) seminal model of sales. This model highlights the tension between two types of consumers – those who will purchase at the lowest listed price and those who are either "uninformed" about the lowest price or are loyal to a particular firm.[15] Suppose that before the introduction of the Euro, there is set $M = \{1, 2, ..., m\}$ of countries. In each country $c \in M$, there are $I_c > 0$ consumers with online access who will purchase from the firm in their country charging the lowest price. Transactions costs preclude consumers in country c from purchasing from an online seller who quotes prices in another currency. In addition, there are $L_c > 0$ consumers who purchase from specific firms in country c (either because they are brand loyal or they are unaware of the comparison site and therefore shop at a random firm in their country). In each country $c \in M$, there is a set $N_c = \{1, 2, ..., n_c\}$ of identical firms who produce a homogeneous product at a constant marginal cost, θ. Each firm $f \in N_c$ enjoys an equal share $U_c = L_c/n_c$ of that country's loyal (or uninformed) consumers. Consumers will buy one unit of the good provided the price does not exceed r, where $\infty > r > \theta$. Firms set prices, and these prices are listed at the comparison site (e.g., Kelkoo).

The expected profits of a firm $f \in N_c$ in country c charging a price p when other firms in country c choose a price from $F_c(p)$ are given by

$$E\pi_f^c(p) = \left(U_c + I_c\left(1 - F_c(p)\right)^{n_c - 1}\right)(p - \theta).$$

[15] The Varian and Narasimhan models are mathematically equivalent but have differing interpretations. Varian interprets locked-in consumers to be "uninformed," while Narasimhan interprets them to be "brand loyal." Varian also assumes free entry, while Narasimhan assumes there are only two firms. Baye, Kovenock, and de Vries (1993) provide a general treatment of n-firm variants of these models.

One can show that, in a symmetric equilibrium, the expected profits of each firm in country c is given by

$$E\pi_f^c(p) = (r-\theta)\,U_c,$$

and that the pre-Euro equilibrium distribution of prices in country c is given by

$$F_c^{\text{Pre-Euro}}(p) = \left(1 - \left(\lambda_c \frac{(r-p)}{(p-\theta)}\right)^{\frac{1}{n_c-1}}\right) \text{ on } \left[\frac{\theta+\lambda_c r}{\lambda_c+1}, r\right],$$

where $\lambda_c = U_c/I_c$. Note that the distribution of prices in each country is independent of the total number of consumers in that country. For simplicity, assume $U_c = U$ for all c. One can show that this is actually an implication of an entry model where firms may enter each local market by paying a nonrecoverable entry cost that is identical across countries. In this case, countries with a greater total number of loyal (or uninformed) consumers will attract more firms, such that, in equilibrium, the number of loyal (or uninformed) consumers per firm is the same across countries.

Consider how the environment changes when the Euro is introduced. Post Euro, each firm's number of loyal (or uninformed) customers remains at U. However, with prices quoted in a common currency, the I_c consumers in each country who visit the Kelkoo site can now choose the lowest price charged globally (within the Euro zone). Thus, in the post-Euro model, there are a total of $I_T = \sum_{c=1}^{m} I_c$ consumers who will purchase at the lowest price charged by the $n_T = \sum_{c=1}^{m} n_c$ firms competing in the global (Eurozone) market. In other words, the post-Euro equilibrium is an equilibrium of the Varian/Narasimhan model with I_T informed consumers, U uninformed consumers per firm, and where the total number of firms is n_T. It follows that, in a symmetric post-Euro equilibrium, the expected profits for each firm in country c

remains

$$E\pi_f^c(p) = (r-\theta)\,U,$$

while the equilibrium distribution of prices in country c becomes

$$F_c^{\text{Post-Euro}}(p) = \left(1 - \left(\lambda\frac{(r-p)}{(p-\theta)}\right)^{\frac{1}{n_T-1}}\right) \text{ on } \left[\frac{\theta+\lambda r}{\lambda+1}, r\right],$$

where $\lambda = U/I_T$.

Thus, viewed in the context of the Varian/Narasimhan models, the Euro changeover has two effects. First, since the firm charging the lowest price within the Eurozone gets an increased number ($I_T > I_c$) of informed consumers, the lower bound of the distribution of prices declines. This is a pro-competitive effect, stemming from heightened competition for the informed consumers. However, since each firm's chance of capturing these consumers declines from $1/n_c$ to $1/n_T$ in a symmetric equilibrium, each firm is less likely to capture them. This increases firms' incentives to raise prices charged in an attempt to extract rents from their locked-in (uninformed or loyal) customers. This is an anti-competitive effect. For this reason, the Euro changeover has opposing effects on the expected "best price" (the average price paid by informed or price-conscious consumers) and the "average price" (that paid by uninformed or loyal customers).

The simplest way to see these competing effects is to consider a symmetric environment where $I_c = I$, $n_c = n$ and marginal cost is zero. In this case, each firm earns expected profits of rU before and after the introduction of the Euro. Pre and and post-Euro industry profits, aggregated across all firms in all countries, may be written as

$$
\begin{aligned}
Ep_{\min}^{\text{Pre-Euro}} mI + Ep^{\text{Pre-Euro}} nmU &= mnrU \\
Ep_{\min}^{\text{Post-Euro}} mI + Ep^{\text{Post-Euro}} nmU &= mnrU,
\end{aligned}
$$

where $Ep_{\min}^{\text{Pre-Euro}}$ is the expected "best price" and $Ep^{\text{Pre-Euro}}$ is the "average price" in the pre-Euro constellation of prices, and similarly for means of the post-Euro equilibrium price distribution. One can show that $Ep^{\text{Post-Euro}} > Ep^{\text{Pre-Euro}}$—the Varian/Narasimhan models predict that a movement to the Euro increases the average prices charged by firms in the Eurozone.[16] It follows from the above expressions that the Euro changeover has differing effects on the expected "best price" and the "average price." In particular, since the Euro changeover raises the average prices paid by uninformed consumers ($Ep^{\text{Post-Euro}}$), it necessarily lowers the expected price paid by informed consumers ($Ep_{\min}^{\text{Post-Euro}} < Ep_{\min}^{\text{Pre-Euro}}$).

Thus, the Varian and Narasimhan models provide a possible explanation for the observed increase in average prices within the Eurozone compared to non-Eurozone countries. These models suggest that the creation of the Euro has both competitive and anti-competitive effects: The creation of the Euro lowers the average prices paid by informed or price conscious consumers, but raises the average prices paid by uninformed consumers as well as consumers with preference for buying from a particular firm. Notice that this theoretical prediction that informed consumers benefit from the creation of a Eurozone assumes that such consumers are able to purchase at the lowest global price charged by all firms in all Eurozone countries. Since the average best price *within* a Eurozone country exceeds the average best price across *all* Eurozone countries, these models suggest that price-conscious consumers who shop for the best price within their home country rather than globally may actually pay higher

[16] To see this, let $z = nm$ denote the total number of competitors, write the distribution of prices as a function of z only, and apply Proposition 3 in Morgan, Orzen, and Sefton (2002).

prices post-Euro than pre-Euro.[17]

A Collusive Explanation

The above explanation ignores the role that dynamics and repeated interaction might play in affecting competitiveness. Indeed, with repeated interaction, it might be that the improved transparency of the Euro has the perverse effect of facilitating anti-competitive practices by firms. One way this might happen is to make it easier for firms to monitor and punish their rivals for "cheating" by lowering prices. Whereas such monitoring may be difficult if rival firms compete by offering large product lines in a variety of local currencies, the single currency may well lessen this monitoring problem. It is well-known that improved monitoring permits the implementation of more carefully calibrated punishment strategies and thereby facilitates high price equilibria under parameters where this would not be possible with imperfect monitoring. This change in the monitoring technology of firms is one possible explanation for the higher prices in the Eurozone post-changeover and the differential experience in pricing between the opaque non-Eurozone countries compared to the transparent Eurozone.

5 Conclusions

This study spans the introduction of the Euro, on 1 January 2002, and monitors prices in a subset of Eurozone and non-Eurozone countries using the popular Internet price comparison site, Kelkoo. Our main finding is that, after controlling for market structure, time, and product fixed effects, online prices in the Eurozone increased rel-

[17] We note that the minimum price regressions reported in the previous section indicate that the average best prices within Eurozone countries actually increased, controlling for life-cycle and industry structure effects, which is also consistent with the theory.

ative to non-Eurozone countries during the changeover period.[18] Specifically, relative to non-Eurozone countries, average prices in the Eurozone rose by 6.3% and minimum prices in the Eurozone rose by 11.5% during the changeover period. We also find that markets with four or more firms listing prices have average prices nearly 7% lower than monopolistic markets, and that the minimum prices are about 20% lower. These effects are non-linear, with the marginal benefit of additional firms tapering off dramatically and, in both cases, being close to zero for more than four firms.

The increased price transparency and the reduction in foreign exchange charges stemming from the introduction of the Euro was not associated with a reduction in average or minimum prices online, nor reductions in levels of price dispersion. We showed that there are both competitive and collusive explanations for the price increases observed in online markets within the Eurozone. In future research, it would be useful to develop and test competing ancillary hypotheses to discriminate among these and other potential explanations.

In concluding, it is important to stress that our results are based on only 28 products sold online within the EU. It is an open question whether the changes observed in our data extend to conventional retail markets within the Eurozone. In light of the relatively short duration of our study, it is also an open question whether the observed effects are short-term or lasting. The results presented here suggest that these are potentially important avenues for future research.

[18] This is also consistent stories in the popular press that conventional retail prices have risen in the Eurozone post-changeover.

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Figure 1: Screenshot from Kelkoo.com (UK site)

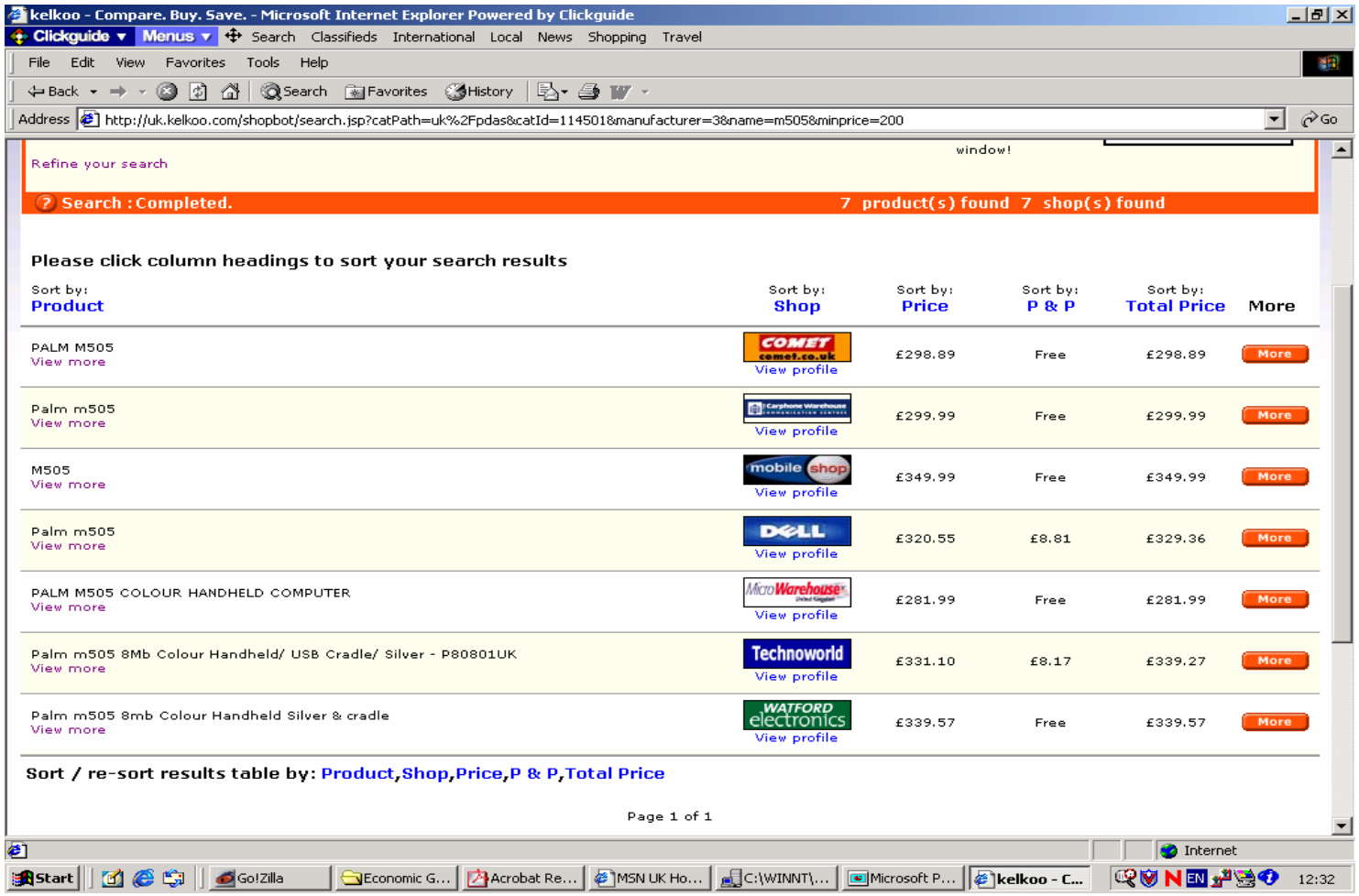

Table 1: Summary Statistics

	25-Oct-01	14-Dec-01	11-Jan-02	3-May-02
Average number of firms listing prices per product				
France	7	6	6	5
Italy	4	3	3	3
Netherlands	3	2	2	3
Spain	4	3	3	3
Sweden	5	4	5	4
UK	5	5	4	4
Denmark	5	3	4	3

Average Price Indices including and excluding sales tax (ST)

	with ST	*w/o ST*	with ST	*w/o ST*	with ST	*w/o ST*	with ST	*w/o ST*
France	1.00	*1.00*	1.02	*1.02*	1.07	*1.09*	0.93	*0.91*
Italy	1.02	*1.02*	1.02	*1.02*	1.01	*1.01*	0.92	*0.90*
Netherlands	0.99	*1.00*	1.00	*1.01*	0.96	*0.96*	1.00	*1.01*
Spain	0.88	*0.90*	1.00	*1.04*	0.96	*1.00*	0.97	*1.01*
Sweden	1.04	*0.98*	1.06	*1.01*	1.07	*1.02*	0.95	*0.87*
UK	1.02	*1.02*	0.99	*0.99*	0.97	*0.96*	0.95	*0.94*
Denmark	1.13	*1.09*	1.10	*1.06*	1.10	*1.06*	0.94	*0.86*

Minimum Price Indices including and excluding sales tax (ST)

	with ST	*w/o ST*	with ST	*w/o ST*	with ST	*w/o ST*	with ST	*w/o ST*
France	1.00	*1.00*	1.03	*1.04*	0.99	*0.99*	0.92	*0.90*
Italy	1.05	*1.06*	1.05	*1.06*	1.08	*1.09*	0.97	*0.96*
Netherlands	1.04	*1.06*	1.04	*1.06*	1.01	*1.02*	0.95	*0.95*
Spain	0.92	*0.95*	1.05	*1.11*	0.98	*1.02*	1.00	*1.04*
Sweden	1.05	*1.00*	1.11	*1.07*	1.05	*1.00*	0.94	*0.86*
UK	1.05	*1.06*	1.01	*1.01*	0.98	*0.98*	0.89	*0.86*
Denmark	1.14	*1.11*	1.14	*1.11*	1.12	*1.08*	0.93	*0.85*

Coefficient of Variation of prices (average over all products: expressed as a percentage)				
France	8.64	8.41	16.92	12.89
Italy	9.38	9.12	7.40	5.36
Netherlands	8.42	9.99	15.20	20.83
Spain	6.33	7.80	9.08	11.41
Sweden	11.96	9.64	11.04	11.60
UK	9.20	8.77	10.44	14.70
Denmark	10.90	9.68	11.33	16.31

Range in Prices (average over all products: expressed as a percentage)				
France	28	26	97	38
Italy	23	22	17	14
Netherlands	19	19	33	68
Spain	16	19	22	24
Sweden	37	23	29	41
UK	29	24	29	46
Denmark	32	24	30	52

Table 2: Descriptive Statistics for the Palm M505

	25-Oct-01	14-Dec-01	11-Jan-02	3-May-02
Number of Firms				
France	10	8	10	10
Italy	5	3	5	7
Netherlands	4	3	3	2
Spain	5	6	2	2
Sweden	6	6	8	10
UK	5	6	5	3
Denmark	6	5	5	5
Average Price in €				
France	499	513	515	493
Italy	482	482	477	483
Netherlands	494	484	481	508
Spain	479	482	498	498
Sweden	558	599	593	557
UK	527	501	503	514
Denmark	565	527	527	522
Minimum Price in €				
France	410	473	485	459
Italy	464	455	455	455
Netherlands	443	443	442	490
Spain	448	448	486	486
Sweden	521	557	560	511
UK	491	490	490	490
Denmark	495	488	488	454

Table 3: Descriptive Statistics for the CD Hotshot by Shaggy

	25-Oct-01	14-Dec-01	11-Jan-02	3-May-02
Number of Firms				
France	4	6	5	7
Italy	5	5	5	4
Netherlands	4	2	1	6
Spain	5	3	2	3
Sweden	8	4	5	4
UK	7	7	5	4
Denmark	3	2	2	2
Average Price in €				
France	17.39	18.76	19.09	19.12
Italy	17.95	17.95	17.29	18.18
Netherlands	18.30	19.43	17.22	18.02
Spain	17.39	17.32	21.87	18.67
Sweden	16.75	19.15	18.25	14.17
UK	17.11	17.58	16.87	15.41
Denmark	20.27	20.36	19.02	16.96
Minimum Price in €				
France	13.60	13.70	17.50	13.87
Italy	16.43	16.43	16.42	16.43
Netherlands	14.55	16.82	17.22	13.08
Spain	16.23	15.31	20.73	15.96
Sweden	14.09	16.14	14.63	10.69
UK	14.50	14.50	14.50	11.27
Denmark	20.13	20.16	17.47	15.75

Table 4: Log (Price) and number of firms listing prices in national markets

	Model 1		Model 2		Model 3	
	Coeff.	*t* -statistic	Coeff.	*t* -statistic	Coeff.	*t* -statistic
Dep. variable	Log(Price)		Log(Price)		Log(Price)	
No of firm dummies:						
2 firms	-0.031	-1.12	-0.033	-1.17	-0.033	-1.17
3 firms	-0.040	-1.63	-0.042 *	-1.70	-0.042 **	-1.72
4 firms			-0.068 ***	-2.88	-0.072 ***	-3.03
5 firms			-0.049 **	-2.15	-0.052 **	-2.28
6 firms			-0.069 ***	-2.87	-0.073 ***	-3.02
7 firms					-0.062 **	-2.41
8 firms					-0.058 **	-2.26
9 firms					-0.114 ***	-3.87
10 firms					-0.041	-1.56
11 firms					-0.151 ***	-4.58
12 firms					-0.096 ***	-2.76
13 firms					-0.102 **	-2.37
more than 3 firms	-0.061 ***	-2.72				
more than 6 firms			-0.068 ***	-2.85		
Country/Time dummies	Yes		Yes		Yes	
Product/Time dummies	Yes		Yes		Yes	
constant	5.931 ***	153.59	5.940 ***	152.19	5.957 ***	150.34
No of Obs.	2633		2633		2633	
F	(143,2489) =	3737.23	(146,2486) =	3634.61	(152,2480) =	3511.52
Prob>F	0		0		0	
R-squared	0.99		0.99		0.99	
Root MSE	0.17		0.17		0.17	

Note: Robust standard errors are calculated, allowing for heteroscedasticity and first order serial correlation.

* p-value of hypothesis test < 0.10

** p-value of hypothesis test < 0.05

***p-value of hypothesis test < 0.01

Table 5: Log (Min Price) and number of firms listing prices in national markets

	Model 1		Model 2		Model 3	
	Coeff	*t* -statistic	Coeff.	*t* -statistic	Coeff.	*t* -statistic
Dep. variable	Log (Min Price)		Log (Min Price)		Log (Min Price)	
No of firm dummies:						
2 firms	-0.119 ***	-3.41	-0.122 ***	-3.47	-0.122 ***	-3.46
3 firms	-0.159 ***	-4.33	-0.162 ***	-4.38	-0.162 ***	-4.36
4 firms			-0.191 ***	-5.69	-0.193 ***	-5.74
5 firms			-0.181 ***	-5.67	-0.183 ***	-5.71
6 firms			-0.230 ***	-6.02	-0.231 ***	-6.08
7 firms					-0.252 ***	-5.16
8 firms					-0.225 ***	-4.70
9 firms					-0.318 ***	-5.86
10 firms					-0.229 ***	-4.42
11 firms					-0.348 ***	-6.06
12 firms					-0.304 **	-4.18
13 firms					-0.257 ***	-3.95
more than 3 firms						
more than 6 firms	-0.204 ***	-6.60	-0.254 ***	-6.49		
Country/Time dummies	Yes		Yes		Yes	
Product/Time dummies	Yes		Yes		Yes	
constant	5.966 ***	118.22	5.989 ***	119.24	6.000 ***	112.66
No of Obs.	673		673		673	
	F(138,529)=		F(141,526)=		F(146,520)=	
Prob>F						
R-squared	0.99		0.99		0.99	
Root MSE	0.19		0.19		0.19	

Note: Robust standard errors are calculated, allowing for heteroscedasticity and first order serial correlation.

* p-value of hypothesis test < 0.10

** p-value of hypothesis test < 0.05

***p-value of hypothesis test < 0.01

Table 6: Log(price) by regions

	Model 1		Model 2	
	Coeff.	*t* -statistic	Coeff.	*t* -statistic
Dependent variable	Log(Price)		Log(Price)	
Regional dummies:				
Eurozone	-0.059 ***	-4.63		
Italy			-0.019	-1.03
Netherlands			0.003	0.10
Spain			-0.098 ***	-2.62
Sweden			0.023	1.17
UK			0.004	0.23
Denmark			0.079 ***	4.51
Region/date dummies:				
Eurozone*Dec	0.027	1.54		
Eurozone*Jan	0.012	0.64		
Eurozone*May	0.063 ***	2.80		
Italy*Dec			-0.009	-0.37
Italy*Jan			0.002	0.09
Italy*May			0.002	0.05
Netherlands*Dec			-0.037	-1.03
Netherlands*Jan			-0.072 *	-1.65
Netherlands*May			0.045	0.98
Spain*Dec			0.059	1.36
Spain*Jan			0.053	1.11
Spain*May			0.101 *	1.94
Sweden*Dec			0.006	0.24
Sweden*Jan			0.035	1.29
Sweden*May			-0.017	-0.50
UK*Dec			-0.022	-0.93
UK*Jan			-0.025	-1.03
UK*May			0.015	0.46
Denmark*Dec			-0.045 *	-1.67
Denmark*Jan			-0.023	-0.78
Denmark*May			-0.098 **	-2.33
Product/Date dummies	Yes		Yes	
Firm dummies	Yes		Yes	
Constant	5.958 ***	156.87	5.940 ***	152.19
No. of Obs.	2633		2633	
F	(126,2506) =	3973.09	(146,2486) =	3634.61
Prob>F	0		0	
R-squared	0.99		0.99	
Root MSE	0.17		0.17	

Note: Robust standard errors are calculated, allowing for heteroscedasticity and first order serial correlation.
* p-value of hypothesis test < 0.10
** p-value of hypothesis test < 0.05
***p-value of hypothesis test < 0.01

Table 7: Log(min price) by regions

	Model 1		Model 2	
	Coeff	*t* -statistic	Coeff	*t* -statistic
Dependent variable	Log (Min Price)		Log (Min Price)	
Regional dummies:				
Eurozone	-0.089 ***	-2.98		
Italy			-0.058	-1.32
Netherlands			-0.035	-0.55
Spain			-0.144	-1.61
Sweden			-0.005	-0.10
UK			0.012	0.28
Denmark			0.091 *	1.85
Region/date dummies:				
Eurozone*Dec	0.032	0.84		
Eurozone*Jan	0.024	0.56		
Eurozone*May	0.115 **	2.48		
Italy*Dec			-0.009	-0.16
Italy*Jan			0.013	0.21
Italy*May			0.015	0.21
Netherlands*Dec			-0.047	-0.60
Netherlands*Jan			-0.113	-1.30
Netherlands*May			0.004	0.04
Spain*Dec			0.072	0.70
Spain*Jan			0.045	0.40
Spain*May			0.148	1.30
Sweden*Dec			0.015	0.25
Sweden*Jan			0.025	0.37
Sweden*May			-0.004	-0.06
UK*Dec			-0.032	-0.54
UK*Jan			-0.066	-1.04
UK*May			-0.053	-0.76
Denmark*Dec			-0.069	-1.04
Denmark*Jan			-0.049	-0.68
Denmark*May			-0.159 *	-1.84
Product/Time dummies	Yes		Yes	
Firm dummies	Yes		Yes	
Constant	5.987 ***	189.56	5.989 ***	119.24
No. of Obs.	673		673	
F	(121,546)		(141,526)	
Prob>F				
R-squared	0.98		0.99	
Root MSE	0.19		0.19	

Note: Robust standard errors are calculated, allowing for heteroscedasticity and first order serial correlation.

* p-value of hypothesis test < 0.10

** p-value of hypothesis test < 0.05

***p-value of hypothesis test < 0.01

Appendix 1: The Products List

Gaming Consoles
Playstation 2
Ninetendo Gameboy Advance
Sega Dreamcast

Games
Super Mario Advance (Gameboy Advance)
Fifa 2001 (PC)
Black & White (PC)
Pokemon Gold (Gameboy Color)
Gran Turismo 3 (Playstation 2)

Music CDs
Gorillaz (Gorillaz)
No Angel (Dido)
Hot Shot (Shaggy)
Hybrid Theory (Linkin Park)
All That You Can't Leave Behind (U2)

PDAs
Palm Vx
Palm 505
Compaq iPaq H3630
Handspring Visor Delux
HP Jordana 720

Printers
Epson Stylus Color 1160
Epson Sylus Photo 1290
Canon S600
Canon S800
HP Deskjet 840

Scanners
Epson 1640SU Photo
Cannon CanoScan N656U
HP ScanJet 5370C
Epson Expression 1600 Pro
HP ScanJet 5300C

Appendix 2: Exchange rates, Domestic currency compared to €

Exchange rates of non Eurozone currencies

	Sweden	Denmark	UK
25-Oct-01	9.4482	7.4362	0.624
14-Dec-01	9.4642	7.4475	0.6217
11-Jan-02	9.1505	7.4335	0.6179
3-May-02	9.2645	7.4334	0.6192

Fixed Exchange rates of Eurozone currencies

France	Italy	Netherlands	Spain
6.55957	1,936.27	2.20371	166.386

Note: All exchange rates at 2.15p.m. (C.E.T) on date. Data Source, ECB.