Did the Euro Foster Online Price Competition? Evidence from an International Price Comparison Site*

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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. After controlling for cost, demand, and market structure effects, we show that the pure Euro changeover effect is to *raise* average prices in the Eurozone by 3% and average minimum prices by 7%. Finally, we develop a model of online pricing in the context of currency unions, and show that these price patterns are broadly consistent with clearinghouse models.

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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. While there were many macroeconomic and political reasons for the implementation of a single currency, one consumer-based argument made in favor of the Euro's introduction was 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]

Presumably, the mechanism Solbes has in mind by which price transparency encourages competition is through increasing the intensity of consumer search across countries. Internet price comparison sites offer a natural place to look for such effects since geographic boundaries are irrelevant online and price transparency in this setting makes it fairly easy for consumers to identify "bargains" and arbitrage price differences within and among Eurozone countries.[3] 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, using retail price data we collected from Kelkoo—the leading Internet price comparison site in the EU.

Our analysis is based on a dataset that has several features that distinguish it from

[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.

[3] By "arbitrage" we mean that, absent frictions, firms charging higher prices in one country would be forced to exit owing to international competition. De Vries (1990) offers a more thorough treatment of arbitrage in internatinoal markets.

the extant literature.[4] We collected firm and price information from the Kelkoo sites in seven EU countries: four in the Eurozone and three outside it. Our study focuses on 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 of online prices and covers as broad a range of products.[5] We believe this is one of the first academic studies of the impact of the introduction of the Euro on retail pricing.[6] 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 reform on pricing behavior.

We recognize that there are 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

[4] See Baye, Morgan, and Scholten (forthcoming) as well as Elberse, Barwise, and Hammond (2002) for a survey of the literature.

[5] See Gatti and Kattuman (2003) for a more detailed analysis. 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.

[6] There is an evident trend of reduction in price dispersion across all EU countries after 1995. Allington, Kattuman and Waldmann (2005) report that the EMU in 1999 triggered an acceleration of price convergence in the Eurozone. There is no evidence of any additional effect on price dispersion following the adoption of Euro as a retail currency in 2001. Mastrobuoni (2003) exmaines the difference betwee price perceptions and actual price changes following the Euro changeover.

or reputations, and firms charging higher prices also enjoy sales (Narasimhan, 1988; Pan *et. al*, 2001; and Baye, Morgan, and Scholten, 2004). In this case, the natural comparison is the average price charged by all firms in the market. The absence of sales data precludes us from discriminating between these two extreme views; therefore, we study both average and best-quoted (minimum) prices online.

Figure 1 depicts the trend in the difference in prices over time. In this figure, we plot the difference in the average price and the difference in the average minimum price between the Eurozone and the non-Eurozone on a weekly basis. Negative numbers indicate that prices in the Eurozone are lower than those in the non-Eurozone and positive figures indicate the reverse. As the figure shows, there is a clear upward trend for both average prices and average minimum prices in the post-changeover period. By the end of our study period, prices in the Eurozone are at least 10% higher than those in the non-Eurozone. Figure 1 suggests that, contrary to what one might expect based on the price transparency argument above, prices in the Eurozone increased relative to non-Eurozone countries post-changeover.

Did the Euro changeover really have anything to do with this price increase? Our main empirical finding is that even after controlling for a variety of demand, cost, and market structure based alternative explanations, both average and minimum prices increased in the Eurozone relative to the non-Eurozone post-changeover.

Are these results consistent with theoretical predictions? We offer a model of online pricing in which a currency union leads to the combination of (a) increased consumer search intensity and (b) higher prices charged by firms. We compare this model to a number of alternative models of strategic firm behavior that may also explain a post-changeover price increase. We devise a test based on the language-specificity of products to distinguish among these and find results that are supportive of the model of online pricing.

The remainder of the paper proceeds as follows. In Section 2, we develop the theoretical model of firm pricing. In Section 3 we describe the nature of the data used in our study. Section 4 presents our statistical analysis of online prices controlling not only for the Euro changeover, but also cost, demand, and market structure based alternatives. We show that the pure Euro changeover effect is to *raise* average prices in the Eurozone by 3% and minimum prices by 7%. In Section 5, we compare a number of alternative models of strategic firm behavior with the model in Section 2 and offer a test to distinguish among these. Finally, Section 6 concludes.

2 A Model of Online Price Transparency

In this section, we show that, even if Commissioner Solbes is correct and the introduction of the Euro fosters increased cross-country search on the part of consumers, the equilibrium strategic response of retailers can have the effect of *raising* prices charged in the market.

Consider a "clearinghouse" model of online price competition where consumers access the list of prices charged by different firms. Baye, Morgan, and Scholten (2004) show that this framework is useful for analyzing the competitive effects of price comparison sites, and that many standard models (including Varian, 1980) are subsumed as a special case of a more general clearinghouse model. Specifically, suppose that before the introduction of the Euro, there is a set $M = \{1, 2, ..., m\}$ of countries each of whom trades in a different currency. In each country $c \in M$, there is a set $N_c = \{1, 2, ..., n_c\}$ of identical firms who produce a product at a constant marginal cost, θ, with no fixed costs and no capacity constraints. Demand for the product in each country consists of a continuum of consumers each of whom wishes to buy at most one unit of the good valued at r. All consumers have zero search

costs. In country c, a mass I_c of these consumers are "shoppers". Shoppers view products as perfect substitutes. There are, however, considerable costs to purchasing a product in a currency other than that of their home country. Thus, these consumers will optimally search the price quotes of all firms in country c and buy from the firm offering the lowest price provided it does not exceed r. There is also a mass of customers L_c in country c who are "loyal" to some firm, f. These consumers value the good produced by firm f at r and the products produced by all other firms at zero. Thus, they will optimally search only firm f's price and buy provided that it does not exceed r. Suppose that loyal customers are evenly divided among the firms of a given country; that is, each firm $f \in N_c$ enjoys an equal share $U_c = L_c/n_c$ of loyal customers.

It is well-known (see Varian, 1980) that there is a unique symmetric equilibrium in this model. In this equilibrium, the expected profits of each firm in country c are given by

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

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

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

where $\lambda_c = U_c/I_c$. Notice that the price distribution only depends on the ratio of shoppers to loyal consumers in a given country and not on the overall size of the consumer market.

Now amend the model as follows: Suppose that as a consequence of currency unification across the m countries, the currency costs to consumers in buying a product sold outside their country drop to zero. This change clearly has no effect on optimal

search behavior of loyal customers, but does lead to increased search by shoppers. In particular, shoppers within the currency union now optimally search the prices offered by firms in *all* countries in the currency union and buy from the firm offering the lowest price. Notice that the intensity of consumer search unambiguously increases following this change, and thus the number of firms effectively competing for "shoppers" increases. Given optimal search behavior by consumers, it remains to characterize equilibrium prices. To analyze the effects of a currency union, we make the following additional assumptions, which we discuss below:

Assumption 1: $U_c = U$ for all c.

Assumption 2: The proportion of shoppers to firms remains constant before and after unification; that is $I_c/n_c = I_g/n_g$, where $I_g = \sum_{j=1}^{m} I_j$ and $n_g = \sum_{j=1}^{m} n_j$.

Clearly both assumptions are trivially satisfied if we consider symmetric countries forming the union. More generally one can show that these assumptions follow as implications of an entry model where firms may enter each local market by paying a nonrecoverable entry cost that is identical across countries, and the fraction of shoppers to loyals is the same across countries. In this case, countries with a greater total number of loyal consumers attract more firms, such that, in equilibrium, the number of loyal consumers per firm is the same across countries. If the *proportion* of loyal to informed consumers across markets is constant, then the proportion of firms to informed customers will also be constant.

Under Assumptions 1 and 2, it follows that, in the unique symmetric "post-Euro" equilibrium, the expected profits for each firm in country c remain

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

while the equilibrium distribution of prices in each country becomes

$$F^{\text{Post-Euro}}(p) = \left(1 - \left(\lambda \frac{(r-p)}{(p-\theta)}\right)^{\frac{1}{n_g - 1}}\right) \text{ on } \left[\frac{\theta + \lambda r}{\lambda + 1}, r\right], \tag{2}$$

where $\lambda = U/I_g$; thus, $\lambda < \lambda_c$.[7]

We are now in a position to state the main result, which is proved in the Appendix:

Proposition 1 *Suppose that Assumptions 1 and 2 hold. Then the formation of a currency union:*

a) Intensifies consumer search; and

b) Raises the average price charged by firms operating in the currency union. Furthermore,

c) For calibrated parameter values, the formation of a currency union raises the average minimum price charged by firms operating in the currency union.

There are two effects of a currency union. First, the firm in the Eurozone that charges the lowest price now attracts shoppers from *all* Eurozone countries. Since $\lambda < \lambda_c$, the lower bound of the equilibrium distribution of prices within the Eurozone declines as firms operating in the Eurozone compete more aggressively to "win" these shoppers—this is the price reducing effect, stemming from more intense search by shoppers. The offsetting effect arises because each firm's chance of capturing these shoppers declines from $1/n_c$ to $1/n_g$; thus, each firm competing in the Eurozone is less likely to "win" the shoppers post-union. This increases the incentives of firms in the Eurozone to raise prices to extract rents from their loyal customers.

Clearly, the overall effect depends on the relative size of the changes in the number of shoppers and the number of competing firms. Proposition 1 shows that whenever the two vary in the same proportion, the rent extraction effect dominates. Thus, the

[7] In particular, the profit function of the firms in the model is isomorphic to the profit function in the pre-Euro equilibrium shown above. Thus, we may directly apply the results of Varian (1980) to obtain the characterization of the unique symmetric equilibrium.

model outlined above points out that the strategic response of firms to a currency union is far from straightforward. Indeed, there is the clear possibility that prices might rise in e-retail markets following a currency union—even if the currency union facilitates transparency and intensifies consumer search. In the next sections, we investigate this possibility empirically.

3 Data

The price data for this study were downloaded from Kelkoo[8] — the dominant price listing service in Europe. Founded in France in 1999, Kelkoo rapidly expanded into other European markets through mergers and acquisitions over the following two years. Over the period of the study, Kelkoo was operating in eight countries—more than any other price listing service in Europe. Across Europe, over 1 million distinct users accessed Kelkoo sites every month. Based on statistics from Jupiter MMXI and Hitwise Statistics, Kelkoo had the same name recognition among French Internet users as Amazon. Kelkoo was ranked as either the first or second most accessed price listing service in all eight countries, and was the leading price listing service in the two countries with the most developed Internet retail markets (France and the United Kingdom). It was accessed by over twice as many individual users each month as its next closest rival in these two countries. Of the eight countries in which Kelkoo operated, 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.[9]

[8]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.

[9]Kelkoo also operated in Norway, and since the period of the study, has opened a price-listing site in Germany.

The layout and structure of the Kelkoo web pages are very similar in all countries, although the language used on each national web site varies. This similarity in structure is an important aspect of the data collected as it mitigates price differences stemming from 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 2 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 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.[10] Tax rates on retail transactions vary across the countries monitored, ranging

[10]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

from 16% in Spain to 25% in Denmark and Sweden.[11] Including transportation charges into the analysis has no impact on the results reported, as these charges are small and do not strongly negatively covary relative to the observed prices.

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, Game Consoles, Music, PDAs, Printers, and Scanners. Table 1 provides the complete list of products organized by category. These products were selected to reflect areas where Internet retailing was strongest and where product differences across countries were smallest. All the products selected were identified to be selling well in at least three countries at the start of the study. For each of these 28 products, firm-specific price quotations were downloaded weekly from the Kelkoo websites for the period 25 October 2001 until 7 June 2002, and we obtained 16,824 price observations.

4 Results

4.1 Overview

Table 2 provides summary statistics for the data. For each summary statistic, we separate the data into a set of 2×2 cells which divides the data into Eurozone/non-Eurozone and Pre/Post changeover groups, where Pre-changeover refers to observations collected prior to 1 January 2002. Notice that the average product in our dataset sells for between €250 and €274. Given that many of our products are subject to either (a) rapid technological obsolescence; or (b) rapid changes in popularity (i.e. games and music), one would expect that prices would fall over time. We see this

all Eurozone countries, except France, were being quoted in Euros only. Oddly, the French site was still reporting prices in both Euros and Francs.

[11] 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%.

price pattern for both the average price and average minimum price in non-Eurozone countries. In contrast, notice that within the Eurozone, both the average price and average minimum price actually increased after the introduction of the Euro. In fact, during the changeover period, average prices in the Eurozone increased by 3.4% relative to non-Eurozone countries. Likewise, the average minimum price in the Eurozone increased by 3.8% compared to non-Eurozone prices over the changeover period.

One similarity between US and European price comparison sites is the presence of dispersed prices for similar products.[12] 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 divided by the sample mean. Dispersion using this measure is reported in the fourth panel of Table 2. The levels of price dispersion in Europe are slightly lower than what has been observed for similar items offered on price listing services in the US.[13] Notice that the average product in our dataset exhibits a coefficient of variation between 6.9 and 9.3 percent. These levels of dispersion are also lower than the levels of price dispersion found in conventional retail markets in the EU prior to the Euro changeover.[14] Another measure of price dispersion that has been reported for online US markets is the range in prices—the percentage difference between the highest and lowest posted price. Brynjolfsson and Smith (2000) report price ranges of about 33% in their study of online pricing for books and CDs sold in the US. Our sample displays smaller price ranges—between 18 and 28 percent. As the products in our sample aged, average price dispersion, measured either by coefficient of variation or price range,

[12] 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.

[13] See Baye, Morgan, and Scholten (2004). See also the review of this literature in Gatti and Kattuman (2003).

[14] See Commission of the European Communities, 2001.

tended to increase; however, the rate of increase was higher in the Eurozone than in the non-Eurozone post changeover.[15] Thus, both price levels and price dispersion increased in the Eurozone relative to the non-Eurozone after the Euro changeover.

Finally, notice for a given product sold in a given country, an average of 3 to 4 firms list prices at the Kelkoo site. As one would expect given the life cycles of the products in our sample, the number of firms offering a product declines in the post changeover period. In the Eurozone, there is a 14% decline in the number of firms offering a typical product, while in the non-Eurozone, there is a 17% decline in the number of firms. Since many economic models predict that reductions in the number of competitors lead to higher prices, it will be important to control for this aspect of the structure of the market in examining the effect of the currency union.

4.2 Statistical Analysis

The model presented in Section 2 holds out the possibility that the strategic response of firms to a currency union is to raise prices. While the price increases in the Eurozone shown in Figure 1 and Table 2 are suggestive, they do not control for a variety of factors influencing price apart from the strategic effect identified above.

For this reason, we estimate the following equation

$$\ln p_{ict} = \beta D_{ict}^{EZ} \times D_{ict}^{Post} + \alpha_1 D_{ict}^{EZ} + \alpha_2 D_{ict}^{Post} + \gamma \mathbf{X}_{ict} + \varepsilon_{ict} \tag{3}$$

The left hand side of equation (3) is the natural logarithm of a price statistic for product i sold in country c at time t. Based on the model in Section 2, we run specifications with two different price statistics as the dependent variable. One specification uses the firm specific prices for product i in country c at time t as the dependent variable. In the other specification, the dependent variable is the minimum price charged

[15] A full analysis of changes in price dispersion over this period, using the same dataset, is reported in Gatti and Kattuman (2003)

for product i in country c at time t. Thus, the regression coefficients in these two specifications indicate the impact of the explanatory variables on the average price and average minimum price, respectively.

The right hand side of equation (3) captures the potential effects of the introduction of the currency union. The expression D_{ict}^{EZ} is a dummy variable that equals 1 if observation *ict* occurred in a Eurozone country and zero if not. The expression D_{ict}^{Post} is a dummy variable that equals one if observation *ict* occurred after the Euro changeover, and zero if not.[16] Proposition 1 predicts that, in both specifications, the coefficient on the interaction term is positive, i.e., $\beta > 0$. The value of β may be interpreted as the percentage increase in the average (or average minimum) price in the Eurozone relative to the non-Eurozone, post Euro. The expression $\mathbf{X}_{ict}$ is the following vector of controls used to isolate the strategic effects of a currency union from a variety of alternative explanations:

- *Product dummies:* We include product dummies to control for any heterogeneities across products that impact the level of prices. These dummies control for differences across products in costs, demand, product popularity, and so on.

- *Month dummies:* We include month dummies to control for factors that lead to general price variations across all countries, over time. Examples of such factors include seasonal demand fluctuations, such as Christmas, as well as cost shocks common to firms operating in all countries.[17]

- *Product and month interactions:* Different products in our sample are likely to

[16] We also run specifications where we interact the Eurozone dummy with a dummy for the month in which the observation occurs. This is a simply a more flexible form of the interaction term described in the text.

[17] Since D_{ict}^{Post} is a linear combination of month dummies occurring on or after January 2002, the coefficient α_2 is absorbed by the month dummies.

have different product-life cycles. To control for product-specific life cycle effects, as well as potential changes in product composition over time, we interact dummies for each product and each month in our dataset.

- *Numbers of competing firms:* Many economic models predict that price levels vary inversely with the number of competing firms. Thus, one possible explanation for the price increase shown in Table 2 is simply that the number of competing firms declined in the Eurozone at a faster rate than in the non-Eurozone countries. To control for this possibility, we include a vector of dummy variables for the number of competing firms. That is, we include a dummy, D^n_{ict} which is equal to one if the number of firms listing prices for product ict is exactly n and zero otherwise. This allows for the possibility of non-linear and non-monotonic price effects of different number of firms listing prices.

Finally, the expression ε_{ict} reflects the error term in the regression. To account for the possibility of heteroskedasticity in the error term, we report robust t-statistics in all regressions. To summarize, the remaining variation picked up in the β coefficient consists of price differences not attributable to product differences, time differences, product life cycle/product composition effects, or differences in the number of competing firms. The β coefficient is the first entry in each of the tables discussed below.

Table 3 reports coefficient estimates; note that Model 1 examines the impact of the currency union on average prices, while Model 2 examines the impact on average minimum prices. Model 1a in Table 3 shows that, controlling for the effects discussed above, post-changeover prices in the Eurozone increased by 2.3% relative to the non-Eurozone. Model 1b decomposes the currency union effect into price changes for each month. Here, we see that the bulk of the price increase occurred in May and June. Indeed, the coefficients for this regression show that by June, average prices in the

Eurozone increased about 7.8% relative to those in the non-Eurozone. Notice that the only coefficients attaining statistical significance are positive and occur in the post-changeover months. The magnitude of the regression coefficients is quite similar to the pattern we saw in Figure 1, suggesting that the pattern did not stem from product composition effects or changes in competition driven by differences in the number of firms quoting prices. Notice that the coefficient on α_1 reveals that average prices in the Eurozone were 4 to 5 percent lower than those in the non-Eurozone prior to the changeover.

Model 2a in Table 3 shows that similar results occur when one looks at minimum (or best-quoted) prices. Post-changeover, average minimum prices in the Eurozone increased by 5.6 percent compared to the non-Eurozone. Looking month by month in Model 2b, again we find that the only coefficients attaining statistical significance are positive and occur in the post-changeover period. Consistent with the results on average prices, the coefficient on α_1 reveals that average minimum prices in the Eurozone were 6 to 7 percent lower than those in the non-Eurozone prior to the changeover.

Taken together, the results in Table 3 suggest that the general pattern observed in Figure 1 and Table 2 is not an artifact of changes in market structure, product composition, product life cycle effects, or unobserved variables that covary with time (such as the number of Internet users in the Eurozone relative to non-Eurozone). Indeed, the positive and significant value of the β coefficients in these regressions is consistent with Proposition 1. However, these specifications leave open a number of other alternative explanations, which we discuss below.

Cost-Based Alternatives

While the above specifications control for common cost differences, it is possible that the creation of a currency union raised the operating costs of Eurozone sellers

differentially. This might occur due to the higher interest rates (and hence higher cost of working capital) that prevailed post-changeover as the European Central Bank struggled to stabilize the currency. It might also occur owing to different wholesale costs stemming from differential exchange rate fluctuations of the Eurozone and non-Eurozone countries with the US dollar—the currency of account for most wholesale transactions for the class of products we study. These exchange rate variations could, in principle, lead to higher costs for Eurozone retailers and these costs might simply be passed on to consumers. A third variant along these lines postulates that other costs of doing business became differentially higher in the Eurozone than in the non-Eurozone post-changeover. For instance, selling costs may have increased differentially in the Eurozone during the period in which both the Euro and the home currency co-circulated. Still another explanation is that macroeconomic shocks raised input prices differentially in the Eurozone compared to the non-Eurozone post-changeover.

To account for various cost-based alternatives, we add the following controls to the model:

- *Interest rate:* We include the weekly domestic savings interest rate on deposit accounts in a given country as a control for variation in the cost of working capital. This control has the advantage that it allows for differences in the cost of working capital between Eurozone members (unlike the Central Bank rate).

- *Dollar exchange rate:* We add the daily exchange rate between the domestic currency of country c and the US Dollar. A rise in the US Dollar exchange rate increases domestic costs for retailers. This variable attempts to control for differential effects of wholesale price shocks between Eurozone and the non-Eurozone retailers. Since orders for product are typically placed in advance, we

include lags of various lengths.

- *Producer Price Index for consumer durables*: We include the monthly, seasonally adjusted PPI for each country. This variable attempts to control for differential changes in the cost of goods over time and across countries.

- *Unemployment rate:* We add the monthly, seasonally adjusted, percentage unemployment rate for each country. The unemployment rate is a crude control for differences in direct labor costs across countries and across time.

- *Industrial Production Index:* We add the monthly, seasonally adjusted, Industrial Production Index to reflect general supply conditions in a country.

Demand-Based Alternatives

Suppose that, as a consequence of the currency union, consumer confidence rose and this led to a differential increase in consumer spending in Eurozone countries compared to non-Eurozone countries. In that case, the positive β coefficient observed in Table 3 could reflect a shift outward in the demand curve within Eurozone countries. Indeed, even under the assumption that retailers are perfectly competitive and non-strategic, one would observe a differential price increase under these circumstances. To account for demand based explanations, we add the following controls:

- *Retail Sales Index:* We include the monthly, seasonally adjusted Retail Sales Index for each of the countries in the study. In the story above, the demand shock would occur broadly in the economy and therefore, it should be captured by variation in the index.

- *Stock Market Index*: We include the daily closing value of the dominant (blue chip) index of stock market prices in each country. In the case of a positive

demand shock, the effects of an anticipated change in the stream of future discounted cash flows of companies in a given country should be reflected by a change in the index. Thus, this control discriminates between transitory and permanent demand effects.

Finally, to ensure that the β coefficient is not simply picking up changes in the exchange rates between the Eurozone and non-Eurozone countries, we include the daily close of the *Euro exchange rate* with the relevant domestic currency. Clearly this remains constant for all Eurozone members, but a rise in this variable will reduce the Euro denominated price of products denominated in other currencies. To allow direct comparison of changes in these variables over time, all variables are converted into indices and normalized to 100 for October 2001.

The results of this specification for equation (3) are shown in Table 4. Notice that the inclusion of controls for cost and demand based explanations does little to alter the magnitude or significance of the β coefficient. Indeed, after including these additional controls, we still find that average online prices within the Eurozone increased by about 3 percent relative to those outside of the Eurozone. Similarly, average minimum prices within the Eurozone increased by about 7 percent compared to non-Eurozone online prices.

5 Alternative Strategic Explanations

Having ruled out explanations for the observed price increase based on structural and macroeconomic changes in the retail environment, we turn now to alternative explanations based on strategic considerations by firms. Obviously, the model in Section 2 is one such example.

Menu Costs: At the time of the changeover the popular press documented

anecdotal evidence of price increases by conventional retailers, such as German ice cream sellers. The explanation typically given was that these price increases stemmed from menu costs. In particular, it was argued that the costs of adjusting prices to the new currency led 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 product characteristics of our dataset. Specifically, since the products we study tend to have short life-cycles, one would expect that Eurozone retailers would delay passing on price *decreases* to consumers until just after the changeover period. Thus, one should see relatively higher prices within the Eurozone pre-changeover, followed by large price decreases *immediately* after the changeover. This is the opposite of the pattern observed in our data.

Double Marginalization: In competitive models, as well as the oligopolistic Bertrand and Cournot models, increases in marginal costs are associated with higher prices. We have corrected for general wholesale price changes in our regression models. However, there may have been differential pricing responses to the changeover by retailers within and outside the Eurozone. The effective markup over wholesale price that retailers are able to sustain will depend (inversely) on the elasticity of demand in each market. For retail prices to have risen within the Eurozone it is necessary that demand within the Eurozone countries was relatively more inelastic following the changeover. This seems unlikely; if anything one would have expected demand to become more elastic with the currency unification.

Restart Effect: A behavioral rationale is that the observed price increases stemmed from a kind of "restart effect" triggered by the currency change. Restart effects have

been widely documented in repeated prisoner's dilemma type experiments.[18] The observed empirical regularity is that behavior is "cooperative" initially but becomes more "competitive" in later rounds. However, if the experimenter "restarts" the game after cooperation has broken down, behavior once again tends toward cooperation. While restart effects have not been studied in Bertrand laboratory experiments (to our knowledge), Baye and Morgan (2004) observe a similar evolution from cooperative to competitive behavior in these settings. Thus, to the extent that Kelkoo retailers are mainly competing on the basis of price, their situation has similar properties. Thus, it seems conceivable that the Euro changeover might have created a "restart effect" in online market—moving prices away from the competitive level and toward cooperative (collusive) levels.

Transparency and Collusion: A related rationale is that the improved transparency of the Euro acted as a facilitating practice making it easier for firms to monitor and punish their rivals for "cheating" by lowering prices. This explanation seems very unlikely given the already high levels of price transparency of online prices that existed prior to the changeover and the fact that most competition is within country. Nonetheless, it is theoretically possible that improved monitoring post-Euro permitted the implementation of more carefully calibrated punishment strategies and thereby facilitated high price equilibria.

Distinguishing Alternative Strategic Hypotheses

How can we distinguish among these competing alternative hypotheses and the model in Section 2? One useful way to proceed is to return to that model and amend it slightly as follows: Suppose that the product being sold by the competing firms is either language-specific or not. If it is not, then the amended model is identical to that in Section 2. For a language-specific product, however, all shoppers in country c view

[18] See Andreoni and Croson (forthcoming) for a useful survey.

the offerings of firms in country c to be perfect substitutes. However, products offered outside of country c, due to the language-specificity of the products, are useless to these consumers. It is straightforward to see that in the amended model, a currency union will have no effect whatsoever on the distribution of prices for language-specific products.

The key thing to notice is that none of the alternative explanations depended on the language-specificity of the product in question.[19] This suggests dividing the dataset between language-specific and non language-specific products and running separate regressions using equation (3) on each portion of the data.[20] We designated the categories games and PDAs as being language-specific owing to the fact that an otherwise identical product in these categories sold in different countries will differ significantly as language plays a key role in the displays of information. The remaining items we designated as non language-specific. Indeed, identical versions of these products are routinely sold across countries.

Table 5 reports the results for these regressions; all include the controls for product characteristics, seasonality, product life cycle effects, as well as the cost and demand controls discussed in the previous section. Notice that the β coefficients are positive and significant in the non language-specific regressions (Models 5b and 6b), but are not statistically different from zero in the language-specific regressions (Models 5a and 6a). These results suggest that the Euro changeover did not impact the average (or average minimum) prices of language specific products sold within the Eurozone, but did lead to increases in the prices of language-specific products sold within the Eurozone. Indeed, relative to prices outside of the Eurozone, the average price of non

[19] We gratefully acknowledge the suggestion of an anonymous referee for directing us to think along these lines.

[20] An alternative would be to run a single regression and add a dummy variable for whether a product was language specific or not. Note, however, that such an approach precludes adding product-month interactions which, we argued, are important to control for.

language-specific products increased by 6.1 percent after the changeover; the average minimum price increased by 7.4 percent. On balance, the results in Table 5 appear more consistent with the clearinghouse rationale presented in Section 2 than with the alternatives suggested above.

6 Conclusion

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 the introduction of the Euro was associated with an *increase*, rather than a reduction, in both average and average minimum prices online. This finding is robust to controls for cost, demand and market structure factors. Specifically, relative to non-Eurozone countries, average prices in the Eurozone rose by 3% and average minimum prices in the Eurozone rose by 7% during the changeover period.

We also showed that, somewhat surprisingly, these patterns are consistent with the predictions of so-called "clearinghouse" models of online price competition. In these models, a currency union reduces transactions costs and thereby permits a subset of consumers in the Eurozone (the "shoppers") to purchase from the firm offering the lowest (global) price within the currency union. For instance, prior to the introduction of the Euro, Dutch "shoppers" tended to purchase (in guilders) from the firm in the Netherlands offering the lowest online price; post-Euro, they were able to purchase (in Euros) from the firm in the Eurozone listing the lowest online price. The strategic response is to raise average prices: Any particular firm in the Eurozone is less likely to capture these "shoppers" (doing so requires it to beat the prices of firms in *all* Eurozone countries), and so responds by increasing prices to capture rents

from their loyal customers.

We note that a key element of this theoretical rationale is that, post-Euro, some "shoppers" in the Eurozone are willing to purchase from firms listing on a foreign language Kelkoo site; that is, a sufficient number of "shoppers" in our Eurozone countries (France, Italy, Netherlands, and Spain) are multilingual enough to navigate all of these sites.[21] How many "multilingual shoppers" would it take to induce the observed 3% increase in average prices? To address this issue, we calibrated the model in Section 2 with our data.[22] The calibration reveals that, to explain all of this increase, one would need 17 percent of the online consumers to be "multilingual shoppers." This does not seem entirely implausible — after all, the layout of the Kelkoo screens are similar across countries (thus a shopper need not be fluent in these four languages to realize the significant cost savings), and "wired" (online) customers tend to be better-educated than their offline counterparts. Even if only 10% of the online consumers in these four countries were "multilingual shoppers," the calibration reveals that the Euro changeover would have increased average prices by about 1.5 percent. The calibration exercise, coupled with our findings in Table 5, suggests that at least part of the observed increase in average prices may stem from the effects summarized in Proposition 1.

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

[21] We are indebted to an anonymous referee for forcing us to more carefully think about this issue.

[22] The calibration is based on the following parameter values: $n_c = 4$ (the average number of firms per country in our sample), $m = 4$ (the number of Eurozone countries in our sample), $r =$€270 (the average maximium price in our sample), and $\theta =$€127 (the average minimum price in our sample).

the observed effects are short-term or lasting. The results presented here suggest that these are potentially important avenues for future research.

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Appendix

Proof of Proposition 1. a) Follows from the argument for optimizing consumer behavior given in the text.

b) Given an atomless price distribution $F(p)$ on $[a,b]$, the average price is

$$E[p] = \int_a^b p dF(p) = b - \int_a^b F(p)dp$$

Using equations (1) and (2), we obtain:

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

$$E^{\text{Post-Euro}}[p] = r - \int_{\frac{\theta+\lambda r}{\lambda+1}}^{r} \left(1 - \left(\lambda \frac{(r-p)}{(p-\theta)}\right)^{\frac{1}{n_g-1}}\right) dp$$

By assumption, $n_g/n_c = I_g/I_c = v$, so $n_g = vn_c$ and $\lambda = \lambda_c/v$. Thus we can write

$$E^{\text{Post-Euro}}[p] = r - \int_{\frac{\theta+\frac{\lambda_c r}{v}}{\frac{\lambda_c}{v}+1}}^{r} \left(1 - \left(\frac{\lambda_c}{v} \frac{(r-p)}{(p-\theta)}\right)^{\frac{1}{vn_c-1}}\right) dp$$

Thus, it is sufficient to show that $dE^{\text{Post-Euro}}[p]/dv > 0$. To establish this, let $z = vn_c$ 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 (forthcoming).

c) Recall that the c. d. f. of the lowest of n draws from F is:

$$\begin{aligned} F_{(n)}(x) &\equiv \Pr(\min(p_1, ..., p_n) < x) \\ &= 1 - (1 - F(x))^n \end{aligned}$$

Thus, the distribution of the country specific lowest price before unification is

$$F_{(n_c)}^{\text{Pre-Euro}}(p) = 1 - \left(\lambda_c \frac{(r-p)}{(p-\theta)}\right)^{\frac{n_c}{n_c-1}}$$

while the distribution of the country specific lowest price after the introduction of the Euro is (assuming symmetry, so that $v = m$):

$$F_{(n_c)}^{\text{Post-Euro}}(p) = 1 - \left(\frac{\lambda_c}{m} \frac{(r-p)}{(p-\theta)}\right)^{\frac{n_c}{mn_c-1}}$$

Based on the data, the calibrated values of the parameters are (see Section 6 of the text) $m = 4, n_c = 4$, $\theta = 127$, and $r = 270$. Furthermore, $\lambda_c = 1.22$ corresponds to the environment where 17 percent of online consumers are "shoppers." Numerical integration reveals that, for these parameter values

$$E_{(n_c)}^{\text{Pre-Euro}}[p_{\min}] = r - \int_{\frac{\theta+\lambda_c r}{\lambda_c+1}}^{r} \left(1 - \left(\lambda_c \frac{(r-p)}{(p-\theta)}\right)^{\frac{n_c}{n_c-1}}\right) dp = 226.81$$

$$E_{(n_c)}^{\text{Post-Euro}}[p_{\min}] = r - \int_{\frac{\theta+\lambda_c r/m}{\lambda_c/m+1}}^{r} \left(1 - \left(\frac{\lambda_c}{m} \frac{(r-p)}{(p-\theta)}\right)^{\frac{n_c}{mn_c-1}}\right) dp = 230.31$$

Thus, for calibrated parameter values, the expected minimum price charged in each country increases as a result of a currency union. ■

Figure 1: Percentage Difference between Eurozone and Non-Eurozone Prices

Figure 2: Screenshot from Kelkoo.com (UK site)

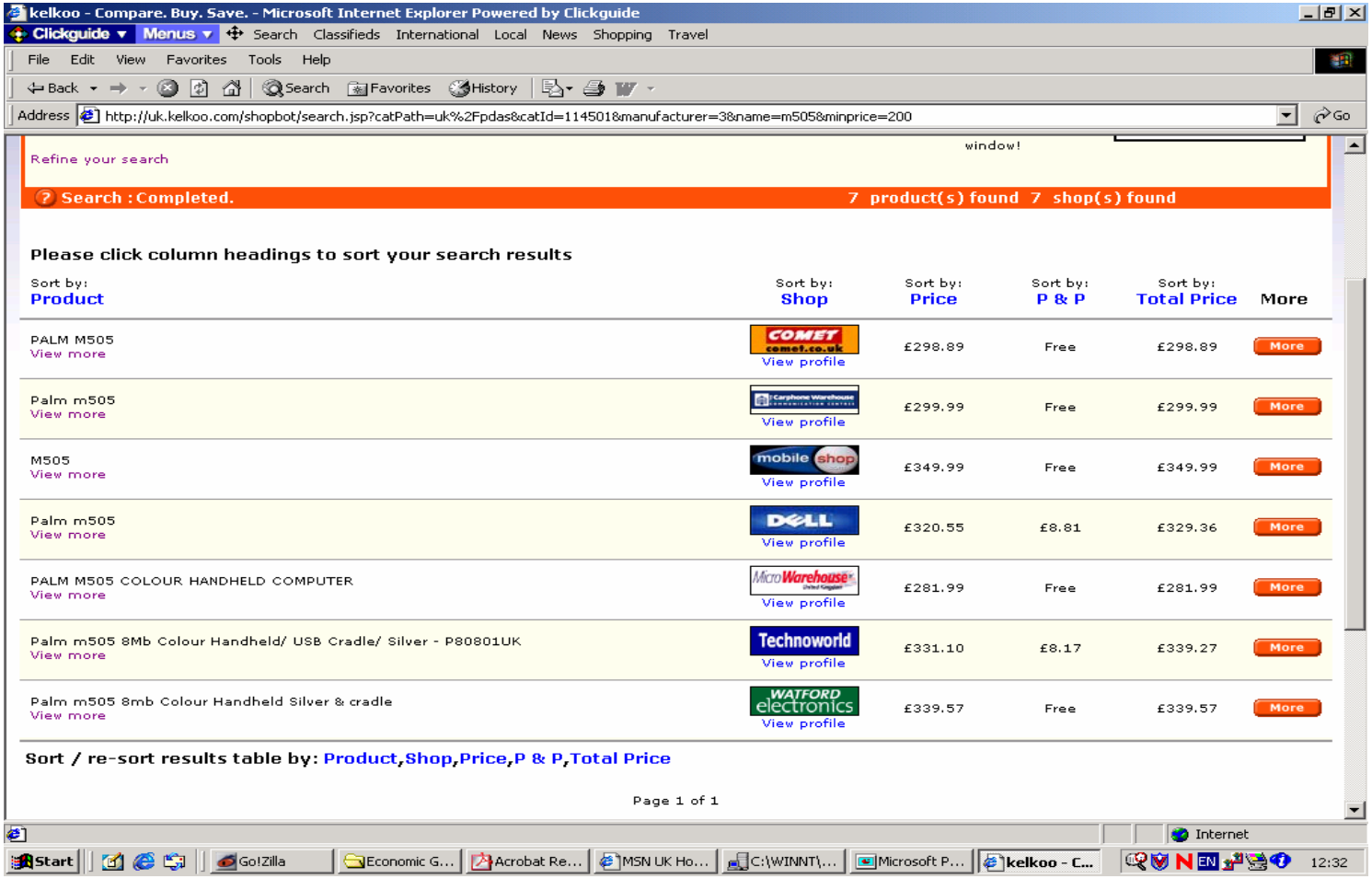

Table 1. List of Products in Kelkoo Dataset
Gaming Consoles
Playstation 2
Ninetendo Gameboy Advance
Sega Dreamcast
Games
Super Mario Advance (Gameboy Advance)
Fifa 2001 (PC)
Black & White (PC)
Pokemon Gold (Gameboy Color)
Gran Turismo 3 (Playstation 2)
Music CDs
Gorillaz (Gorillaz)
No Angel (Dido)
Hot 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

Table 2: Summary Statistics		
Statistic	Pre-Changeover	Post-Changeover
Average Price in Euros		
Eurozone	250	253
Non-Eurozone	274	268
Average Minimum Price in Euros		
Eurozone	231	238
Non-Eurozone	256	254
Average Maximum Price in Euros		
Eurozone	270	270
Non-Eurozone	297	287
Coefficient of Variation**		
Eurozone	6.9	8.1
Non-Eurozone	8.8	9.3
Price Range (Range normalised by Min Price)**		
Eurozone	0.18	0.22
Non-Eurozone	0.25	0.28
Average Number of Firms		
Eurozone	4.01	3.43
Non-Eurozone	4.37	3.64
Number of Price Observations		
Eurozone	3862	5341
Non-Eurozone	3318	4303

* Note that all prices include sales tax for the relevant country of origin.
Excluding sales taxes does not affect the statistics.
* * Includes zero values for single firm listings

Table 3: Effects of the Euro changeover on Prices

Dependent Variable:	Model 1a (Log Price)		Model 1b (Log Price)		Model 2a (Log Minimum Price)		Model 2b (Log Minimum Price)	
	Coefficient	t-statistics	Coefficient	t-statistics	Coefficient	t-statistics	Coefficient	t-statistics
β: Eurozone interacted with dummy for dates after 1 Jan 2002	0.023	(4.50)***			0.056	(-5.51)***		
Eurozone interacted with dummy for dates in November 2001			0.006	(0.53)			0.004	(0.2)
Eurozone interacted with dummy for dates in December 2001			0.016	(1.29)			0.019	(0.83)
Eurozone interacted with dummy for dates in January 2002			0.009	(0.69)			0.034	(1.44)
Eurozone interacted with dummy for dates in February 2002			0.046	(3.73)***			0.07	(2.98)***
Eurozone interacted with dummy for dates in March 2002			0.004	(0.31)			0.04	(1.64)
Eurozone interacted with dummy for dates in April 2002			0.021	(1.34)			0.056	(2.03)**
Eurozone interacted with dummy for dates in May 2002			0.056	(4.06)***			0.094	(3.61)***
Eurozone interacted with dummy for dates in June 2002			0.078	(3.88)***			0.162	(3.50)***
α_1: Eurozone	-0.041	(-11.61)***	-0.049	(-4.74)***	-0.061	(-8.63)***	-0.071	(-3.75)***
Product dummies	Yes		Yes		Yes		Yes	
Month dummies	Yes		Yes		Yes		Yes	
Product life cycle effects: Product dummies*Month dummies	Yes		Yes		Yes		Yes	
Number of firms dummies	Yes		Yes		Yes		Yes	
Observations	16824		16824		4461		4461	
Adjusted R-squared	0.99		0.99		0.99		0.99	

Robust t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Effects of the Euro changeover on Prices

Dependent Variable:	Model 3a (Log Price)		Model 3b (Log Price)		Model 4a (Log Minimum Price)		Model 4b (Log Minimum Price)	
	Coefficient	t-statistics	Coefficient	t-statistics	Coefficient	t-statistics	Coefficient	t-statistics
β: Eurozone interacted with dummy for dates after 1 Jan 2002	0.033	(4.54)***			0.072	(4.88)***		
Eurozone interacted with dummy for dates in November 2001			0	(0.02)			0.008	(0.35)
Eurozone interacted with dummy for dates in December 2001			0.012	(0.91)			0.027	(1.09)
Eurozone interacted with dummy for dates in January 2002			0.022	(1.58)			0.04	(1.44)
Eurozone interacted with dummy for dates in February 2002			0.054	(3.77)***			0.087	(3.05)***
Eurozone interacted with dummy for dates in March 2002			0.009	(0.6)			0.057	(1.95)*
Eurozone interacted with dummy for dates in April 2002			0.02	(1.19)			0.069	(2.16)**
Eurozone interacted with dummy for dates in May 2002			0.047	(3.11)***			0.112	(3.79)***
Eurozone interacted with dummy for dates in June 2002			0.068	(3.25)***			0.171	(3.59)***
α_1: Eurozone	-0.054	(-10.64)***	-0.059	(-5.46)***	-0.071	(-7.13)***	-0.086	(-4.36)***
Cost Side Controls								
Interest rate on Deposits (Index Oct2001=100)	0.001	(3.18)***	0.001	(2.50)**	0.001	(1.62)	0	(0.46)
Dollar exchange rate (Index Oct2001=100): Lagged 4 wks	-0.001	(-0.7)	-0.001	(-0.99)	-0.004	(-1.55)	-0.005	(-1.84)*
Dollar exchange rate (Index Oct2001=100): Lagged 12 wks	0.002	(1.57)	0.001	(0.94)	0	(0.05)	-0.001	(-0.59)
Dollar exchange rate (Index Oct2001=100): Lagged 20 wks	0.003	(2.78)***	0.003	(3.03)***	0.004	(1.93)*	0.005	(2.07)**
Producer price index (Oct2001=100)	0.005	(1.43)	0.006	(1.62)	0.001	(0.19)	0.003	(0.38)
Unemployment rate (Index Oct2001=100)	0.001	(1.96)*	0	(1.41)	0	(0.49)	-0.001	(-1.67)*
Industrial production (Index Oct2001=100)	0	(1.5)	0	(1.34)	-0.001	(-2.88)***	-0.001	(-2.08)**
Demand Side Controls								
Retail sales (Index Oct2001=100)	-0.001	(-3.84)***	-0.001	(-2.76)***	-0.001	(-0.93)	0	(0.13)
Stock market Index (Oct2001=100)	0	(0.69)	0	(0.75)	0	(0.46)	0	(0.08)
Euro exchange rate (Dom/Euro: Index Oct2001=100)	-0.004	(-1.62)	-0.001	(-0.43)	-0.008	(-1.73)*	-0.002	(-0.3)
Product dummies	Yes		Yes		Yes		Yes	
Month dummies	Yes		Yes		Yes		Yes	
Product life cycle effects: Product dummies*Month dummies	Yes		Yes		Yes		Yes	
Number of firms dummies	Yes		Yes		Yes		Yes	
Observations	16824		16824		4461		4461	
Adjusted R-squared	0.99		0.99		0.99		0.99	
Robust t statistics in parentheses								
* significant at 10%; ** significant at 5%; *** significant at 1%								

Table 5: Effects of the Euro changeover on Prices (Language Sensitive Product Categories vs. Categories that are not Language Sensitive)

Dependent Variable:	Model 5a : Language-Specific Products (Log Price)		Model 5b : Non Language-Specific Products (Log Price)		Model 6a : Language-Specific Products (Log Minimum Price)		Model 6b : Non Language-Specific Products (Log Minimum Price)	
	Coefficient	t-statistics	Coefficient	t-statistics	Coefficient	t-statistics	Coefficient	t-statistics
β: Eurozone interacted with dummy for dates after 1 Jan 2002	-0.008	(-0.15)	0.061	(2.66)**	0.063	(0.53)	0.074	(2.33)**
α_1: Eurozone	-0.035	(-0.92)	-0.063	(-3.68)***	-0.034	(-0.94)	-0.09	(-3.54)***
Cost side controls								
Interest rate on Deposits (Index Oct2001=100)	0	(0.26)	0.001	(1.58)	-0.001	(-0.44)	0.002	(1.89)*
Dollar exchange rate (Index Oct2001=100): Lagged 4 wks	-0.005	(-0.65)	0.002	(0.8)	-0.008	(-0.67)	-0.002	(-0.56)
Dollar exchange rate (Index Oct2001=100): Lagged 12 wks	0.002	(0.63)	0.001	(1.19)	0.001	(0.23)	-0.001	(-0.53)
Dollar exchange rate (Index Oct2001=100): Lagged 20 wks	-0.001	(-0.4)	0.006	(3.92)***	-0.004	(-1.03)	0.01	(4.44)***
Producer price index (Oct2001=100)	0.006	(0.38)	0.001	(0.18)	0.013	(0.76)	-0.009	(-0.71)
Unemployment rate (Index Oct2001=100)	0.001	(0.45)	0	(0.53)	0	(0.02)	0	(0.43)
Industrial production (Index Oct2001=100)	-0.001	(-0.75)	0	(0.21)	-0.003	(-1.25)	0	(0.31)
Demand Side controls								
Retail sales (Index Oct2001=100)	-0.001	(-0.5)	-0.001	(-2.29)**	0.002	(0.8)	-0.002	(-1.43)
Stock market Index (Oct2001=100)	0.001	(1.4)	0	(0.69)	0.001	(0.73)	0	(0.03)
Euro exchange rate (Dom/Euro: Index Oct2001=100)	-0.003	(-0.82)	-0.005	(-1.26)	-0.007	(-0.82)	-0.01	(-1.43)
Product dummies	Yes		Yes		Yes		Yes	
Month dummies	Yes		Yes		Yes		Yes	
Product life cycle effects: Product dummies*Month dummies	Yes		Yes		Yes		Yes	
Number of firms dummies	Yes		Yes		Yes		Yes	
Observations	6808		10016		1730		2731	
Adjusted R-squared	0.97		0.99		0.97		0.99	
Robust t statistics in parentheses								
* significant at 10%; ** significant at 5%; *** significant at 1%								