The impact of online sales on consumers and firms – Evidence from household appliances*

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Abstract

In this paper we estimate a differentiated products demand model to ask three questions regarding the introduction of e-commerce. First, we ask whether the online distribution channel has increased total sales, or only diverted sales from traditional channels. We find that there is some market expansion effect but also a considerable sales diversion. Second, we ask who benefited most from online sales: consumers or firms. We find that consumers benefited more, which is entirely due to the appearance of an additional distribution channel and not due to increased competition. Third, we ask how the online channel has affected European market integration. We find that the international price differences for identical products are larger in the traditional channel than online. However, there is still substantial market segmentation in the online channel between the EU countries. The introduction of e-commerce therefore did not influence price levels and price dispersion in the traditional channel.

Key Words: *Online sales; offline sales; nested logit*

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*All errors are our own.

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1 Introduction

The rapid dissemination of information and communication technologies (ICT) and particularly the massive adoption of the Internet in the past decades have boosted the use of e-commerce as a distribution channel. The growing role of e-commerce resulted in unprecedented structural changes in many industries. These transformations are already generating a major reorganization in the way some products are manufactured, marketed and purchased, as exemplified by the travel and tourism or media industries. Today business to consumer (B2C) e-commerce represents only a small segment of total retail in most developed countries but it has been showing impressive growth rates even during the recent economic downturn-, auguring a rapid expansion in the years to come.

The expected benefits of e-commerce are manifold. For consumers, it provides a useful and convenient platform to buy an enlarged set of products and services from more vendors at presumably better prices. Consumers can use search engines and price comparison sites, which significantly reduce search costs, to find and compare many different offers for the same product. In addition, electronic markets allow consumers to shop at anytime from anywhere, avoiding the problem of opening hours, distance to shop or availability of items. E-commerce also benefits firms by providing a channel to better promote and distribute their products. Electronic markets allow sellers to efficiently transfer relevant product information to potential buyers, which reduces their search costs. Moreover, firms can use digital technologies to increase product differentiation and soften price competition; to differentiate themselves by superior interfaces with respect to competitors and create switching costs. Furthermore, electronic-mediated transactions offer new ways to gauge customer preferences more truthfully and hence to offer opportunities for targeted advertising, personalised marketing, product customisation and price discrimination. Hence, numerous reasons suggest that e-commerce can positively affect social welfare, although the question of who benefits more remains a matter of empirical analysis (Bakos, 2001).

In March 2015, the European Commission recognized that e-commerce plays a critical role

for the economic integration of the European markets and called for launching a sector inquiry into e-commerce with the aim to understand and eventually eliminate barriers that obstruct online trade between EU Member States. This inquiry poses a number of policy questions, some of which we try to address in this paper. First, it is important to understand to which extent e-commerce is considered as a substitute to traditional sales channels. Another question relates to the impact of e-commerce on prices in traditional shops and hence whether overall sales from the traditional channel are diverted to online or whether there is a market expansion effect. As we discuss above, e-commerce bring benefits for both consumers and producers but it has not yet been shown who benefits more. Finally, as noted by the Commission, the European market appears to be segmented due to existing barriers in purchases of products online across borders. It is therefore important to assess whether the online channel affects European market integration in that prices in both online and traditional stores converge across countries.

In this paper, we analyze the above questions with a focus on three different consumer electronics products, namely portable personal computers, portable media players and digital cameras, which are sold online and offline in several European countries.[1] We estimate a differentiated products demand model for each product category separately, and obtain the implied price elasticities and diversion ratios. Our estimates imply that there is considerable substitution between the online and traditional channel, but at the same time the online channel also leads to total market expansion. We subsequently use the estimates and the firms' first-order conditions under the assumption of Bertrand-Nash competition to simulate equilibrium prices in the absence of an online distribution channel. We summarize our results in three main findings.

First, we consider the impact of the online channel on total sales. Although the introduction of the online channel has not lead to lower prices in general, there is a considerable positive effect

[1]The sales of consumer electronics in the EU offer an interesting case to study the effects of the introduction of the online distribution channel. Consumer electronics is the second largest industry in e-commerce -just behind apparel and footwear- representing around 15% of total online sales in the EU as of 2014 (Duch-Brown and Martens, 2015). The three different product categories used in this study represent 30% of consumer electronics sales. Obviously, there are large differences between Member States.

on total sales because increased convenience. The online distribution channel partly swipes away traditional sales but also activates consumers who find the online channel more appealing. On average, 16.6% of online sales of portable computers, 36.1% of online sales of digital cameras and 37.9% of sales of media players would be lost without the online channel. Hence, e-commerce partly complements traditional sales rather than replacing them.

Second, we look at the relative gains from the online channel to consumers and producers. We find that the increase in consumer surplus due to the introduction of online sales is much larger than the increase in firms' profits (about twice as large for portable media players, four times larger for digital cameras and up to eight times larger for portable computers). These consumer benefits are entirely due to the positive valuation of an additional distribution channel and not due to increased competition, since all brands available online are also present in traditional channel.

Finally, we use our model to investigate whether the introduction of the online sales channel reduced price dispersion in the selected European countries. We find that the international price differences are larger in the traditional channel than online (for products which are sold in both channels). However, there is still substantial market segmentation in the online channel between the EU countries. Furthermore, the introduction of the online channel did not influence price levels and price dispersion in the traditional channel. We conclude that the online channel has so far not led to an improvement in market integration in the traditional channel.

Our paper contributes to the literature on the effects of the diffusion of e-commerce and electronic markets in general. There is a large body of literature analyzing the effects of the Internet on pricing and sales of different products based on reduced form models. However, to the best of our knowledge there are no empirical papers which use a structural model of differentiated demand and supply to analyze how the diffusion of e-commerce has influenced market equilibrium outcomes and impacted welfare.

The early literature on the effects of e-commerce focused almost exclusively on prices and price dispersion. The initial empirical evidence showed that Internet markets did not exhibit

smaller price dispersion than traditional markets (see Pan et. al., 2004 for a review of the early literature). More recent empirical evidence, however, tends to point to lower price dispersion online than in the traditional channel. Still, substantial online price differences persist (Duch-Brown and Martens, 2014). There is also an ongoing debate on the effects of e-commerce on market structure and welfare. Some empirical papers deal with competition effects (Goolsbee, 2001; Hackl et al., 2014); others focus on the analysis of the complementarity or substitutability of the online channel (Prince, 2007; Pozzi, 2013). Less abundant is the literature on the welfare effects of e-commerce (Gentzkow, 2007; Ellison and Ellison, 2014). Also, there are limited contributions regarding international online price differences (Duch-Brown and Martens, 2014; Gorodnichenko and Talavera, 2014) and European integration (Duch-Brown and Martens, 2015).

The remainder of the paper is organized as follows. Section 2 discusses the data used in the estimation and shows some descriptive statistics. Section 3 introduces the econometric framework. Section 4 presents the estimation results and discusses the different topics we pointed out previously. Finally, Section 5 concludes.

2 Data

We use data from GfK Retail and Technology which contains price and sales information on three different types of consumer electronics products in several EU countries: digital cameras, portable media players and mobile personal computers. The data comes from a representative number of traditional and online retailers and was collected during the period between April 2008 to March 2009.

The unit of observation is described by two identifiers: brand and model, which can be sold online or in traditional channel. The first identifier corresponds to brands such as Canon or Nikon for digital cameras, Apple or Creative for portable media players and Acer or Sony for mobile personal computers. The second identifier corresponds to models, for instance in the case of mobile computers Acer offers the Aspire 8920G model or the Travelmate 7720G one.

The original data consists of 47,149 observations on models of mobile portable computers,

24,939 of digital cameras and 17,952 of portable media players, which are sold online and/or offline in different EU countries. Since the vast majority of models has very small sales we drop 25% of models with the smallest sales, which in any case represent only about 0.15% of sales of portable computers in terms of units, 0.1% of sales of digital cameras and 0.1% of sales of portable media players. The number of observations is then reduced to 35,253 for portable computers, 18,689 for digital cameras and 13,394 for portable media players. Furthermore, we drop observations for unbranded products and a number of brands with small sales. In the data there is a large price variation and there are many niche products in each category with very low prices and quality or with very high prices and quality. We further removed observations from the top and bottom 5% of the price distribution. The purpose for this trimming is to focus on the brands and products which are at the core of consumer demand and competition. As shown in Table 1, the final data set consists of 28,173 observations for portable computers, 15,916 observations for digital cameras and 6,458 observations for portable media players, where an observation is a model sold either online or offline in a particular European country. These observations represent about 80% of sales in terms of units in the original data.[2] Some of the models are sold both online and offline, while others are available in only one of the sale channels.

The majority of manufacturers use both sales channels to distribute their products, but their strategies differ. Although the vast majority of sales are done in specialist retail stores, the share of non-store retail increased significantly since the early 2000s. Of course, the majority of non-store retail is done over the Internet, which reached over 70% of non-store retail in 2009. The most striking example is Apple, which dominates in the European market for portable media players with a share in the online market of above 70%, while its closest competitor has only 7%. However, in the majority of cases the data reveal that there is no a primary channel for retail distribution. Unfortunately, we cannot go beyond the breakdown into online and offline sale channels. A more detailed division of retail channels could shed more light on a richer set of retailing strategies.

[2]Besides, the original data covers -according to the provider- around 80% of the total EU market for the products considered. Hence, the coverage of the market is substantial.

Table 2 reports the descriptive statistics of the variables used in this study by product category. The number of non-price product characteristics used in our empirical model varies by product, ranging from 6 in the case of digital cameras to 19 for portable computers. We consider these product characteristics as the most relevant determinants of consumers' indirect utility (in addition to price). The other variables used in the empirical model are, as explained in the next section, the market shares as a fraction of the whole market and as a fraction of specified market segments.

3 Model

In this section we describe the model used to analyse the impact of the online distribution channel on demand, prices and consumer and producer surplus. We first describe the demand model and then explain the supply side market.

3.1 Demand

We consider the demand for three electronic products: digital cameras, portable media players and mobile personal computers. Consumers can choose among a large variety of products that are differentiated in quality. Furthermore, consumers can either purchase these electronic products in a traditional brick-and-mortar shop (offline) or they can purchase the products through an online distribution channel. Finally, consumers can also decide not to buy an electronic product at all, in which case they can spend their money on other goods. To model the substitution patterns, we specify a two-level nested logit model which allows for market segmentation according to two discrete dimensions: quality, which can be either high or low, and the distribution channel, which is either offline or online.

More precisely, the nested model can be described as follows. In a country c there are L_c potential consumers. Each consumer i in a country c can choose among J_c differentiated products, where a "product" refers to the combination of the electronic product and the distribution channel. Note that not every electronic product is necessarily sold through both the offline and

the online channel. The choice set is divided into different groups or nests g, which refer to (at least) two quality categories and one remaining category for the outside good. Each group (except the outside good category) is further divided in subgroups h of g. These subgroups refer to the distribution channel within the quality category. For example, in the case of mobile personal computers, the groups are categories of random access memory (RAM), and the subgroups indicate the offline or online sales channel within each quality category.

A consumer i in country c has the following indirect utility for product j:

$$u_{ijc} = \underbrace{x_{jc}\beta - \alpha p_{jc} + \xi_{jc}}_{\delta_{jc}} + \zeta_{igc} + (1-\sigma_2)\zeta_{ihgc} + (1-\sigma_1)(1-\sigma_2)\varepsilon_{ijc}, \tag{1}$$

The first part, δ_{jc}, is the mean utility for product j in country c. For the outside good, $j = 0$, we normalize the mean utility to zero, $\delta_{0c} = 0$. For the other goods, the mean utility depends on a vector of observed product characteristics x_{jc} (such as the speed or memory in case of mobile personal consumers), on the price of product j in country c, p_{jc}, and on an unobserved quality term ξ_{jc}. The second part is the individual specific-deviation of utility around that mean, modeled as a weighted sum of three random variables: ζ_{igc} is a common valuation across products in the same group g, ζ_{ihgc} indicates a common valuation for all products in the same subgroup h of g, while ε_{ijc} is an individual-specific valuation for product j. The random variable ε_{ijc} is i.i.d. extreme value, and ζ_{ihgc} and ζ_{igc} have a distribution such that the appropriate sums are i.i.d. extreme value (see Cardell, 1997). The nesting parameters σ_1 and σ_2 (with $0 \leq \sigma_2 \leq \sigma_1 \leq 1$) measure the degree of preference correlation for products of the same subgroup and group. At one extreme, if $\sigma_1 = 1$, consumers perceive all products of the same subgroup as perfect substitutes. If in addition $\sigma_2 = 1$, consumers view all products of the same group as perfect substitutes. At the other extreme, if $\sigma_1 = \sigma_2 = 0$, there is not preference correlation within subgroups and groups. The model then simplifies to a simple logit model and consumers consider all products as symmetric substitutes. More generally, for $0 < \sigma_2 < \sigma_1 < 1$, products in the same quality category and distribution channel are the closest substitutes; products in a different distribution channel but the same quality category are weaker substitutes; and products of a different quality category are the weakest substitutes. The nesting parameters thus enable one to

assess to which extent consumers view products in the same distribution channel and/or quality category as closer substitutes.

Assuming that consumers choose the product with the highest utility, one can obtain the well-known choice probabilities for every product j in every country c (including the probability of purchasing the outside good 0 (see e.g. McFadden, 1978). At the aggregate level, these choice probabilities can be equated to the market shares (relative to the potential market L_c). We assume that the market size for each product represents 40% of country population.[3] As shown by Berry (1994) for the nested logit, and extended by Verboven (1996) for a two-level nested logit, the market share system can be inverted to obtain the following estimating equation:

$$\ln s_{jc}/s_{0c} = x_{jc}\beta - \alpha p_{jc} + \sigma_1 \ln s_{j|hgc} + \sigma_2 \ln s_{hg|gc} + \xi_{jc}, \tag{2}$$

where $s_{jc} = q_{jc}/L_c$ is the market share of product j (sales volume divided by potential market of country c); s_{0c} is the market share of the outside good; $s_{j|hgc}$ is the market share of product j in the subgroup h of g; and $s_{hg|gc}$ is the market share of the subgroup h within the group g.

The demand model can be used to compute consumer surplus (see McFadden, 1978 or Anderson et al. (1992), and to compute the own- and cross-price elasticities of demand. Let $D^1_{jk} = 1$ if $j = k$ (and 0 otherwise). Similarly, let $D^2_{jk} = 1$ if j and k are in same subgroup, $D^3_{jk} = 1$ if j and k are in same group. The elasticity of demand for product j with respect to the price of product k is then given by (omitting the country subscript c):

$$\frac{\partial s_j}{\partial p_k}\frac{p_k}{s_j} = -\alpha\left(\frac{1}{1-\sigma_1}D^1_{jk} - \left(\frac{1}{1-\sigma_1} - \frac{1}{1-\sigma_2}\right)s_{j|hg}D^2_{jk} - \frac{\sigma_2}{1-\sigma_2}s_{j|g}D^3_{jk} - s_j\right)p_j. \tag{3}$$

This confirms how the preference correlations translate into aggregate substitution patterns. Products in the same subgroup have a higher cross-price elasticity than products in a different subgroup, especially if the gap between σ_1 and σ_2 is high. We can therefore assess to which extent the online distribution channel mainly substitutes for the traditional brick-and-mortar channel, or to which extent it provides a new source of differentiation that raises total sales for consumer electronics rather than displacing existing sales.

[3] Alternative definitions of the market size give similar results.

3.2 Supply

We add an oligopolistic supply side to infer marginal costs and current economic profits, and to perform policy counterfactuals to compute the impact of removing the online distribution channel. For simplicity, we remove the country subscript c in this section. Let F_f be the set of products sold by firm f. The profits of firm f are given by:

$$\Pi_f(\mathbf{p}) = \sum_{k \in F_f} (p_k - c_k)\, s_k(\mathbf{p}) L \tag{4}$$

where c_k is the marginal cost of product k in country c, and $s_k(\mathbf{p})$ is product k's market share in country c as a function of the price vector in country c. Assume firms choose prices to maximize profits. The first-order conditions that define the Bertrand-Nash equilibrium are given by

$$s_j(\mathbf{p}) + \sum_{k \in F_f} (p_k - c_k) \frac{\partial s_k(\mathbf{p})}{\partial p_j} = 0. \tag{5}$$

for products $j = 1, \ldots, J$. This can be written in vector notation as:

$$\mathbf{s}(\mathbf{p}) + \left(\theta^F \cdot \boldsymbol{\Delta}(\mathbf{p})\right)(\mathbf{p} - \mathbf{c}) = 0. \tag{6}$$

where $\mathbf{p}$ and $\mathbf{s}(\mathbf{p})$ are $J \times 1$ price and market share vectors, $\boldsymbol{\Delta}(\mathbf{p}) \equiv \partial \mathbf{q}(\mathbf{p}) / \partial \mathbf{p}'$ is a $J \times J$ matrix of own- and cross-price derivatives, θ^F is a $J \times J$ block-diagonal matrix, with ones for products of the same firm and zeros otherwise, and $\cdot$ denotes element-by-element multiplication of two matrices.

The system of first-order conditions (6) can be inverted at the current price and market shares to compute the current marginal costs $\mathbf{c}^0$:

$$\mathbf{c}^0 = \mathbf{p} + \left(\theta^F \odot \boldsymbol{\Delta}\right)^{-1} \mathbf{s}. \tag{7}$$

Furthermore, the system of first-order (6) can be used to perform policy counterfactuals, in particular the effects of removing the online distribution channel. More specifically, we suppose that the absence of an online distribution channel changes the marginal cost vector from $\mathbf{c}^0$ to a new vector $\mathbf{c}^1$: the elements are the same as in $\mathbf{c}^0$ for all products that are sold offline,

and the elements increase to prohibitively high levels for the products that are sold offline. Substituting $\mathbf{c}^1$, we can solve the system (6) to compute the counterfactual equilibrium price vector $\mathbf{p}^1$ if online products have become prohibitively costly. We can then, in turn, compute the counterfactual sales $\mathbf{s}^1 L$, profits (as given by (4), and consumer surplus (as given by the well-known "log sum" formula, normalized by the price coefficient, see McFadden (1978)).

4 Empirical Results

In this section we discuss the empirical results of the demand model for the three categories of consumer electronics products: portable computers, portable media players and digital cameras. We use the parameter estimates to calculate the price elasticities and diversion ratios, and we comment on the degree of substitution between online and traditional sales channels. We then simulate the equilibrium prices and sales in the absence of online distribution channel. The counterfactual simulations are used to assess the benefits from the introduction of the online distribution channel to producers and consumers. Finally, we use the results to evaluate the impact of the online distribution channel on the price convergence in the European markets.

4.1 Demand and substitution

We estimate the two-level nested logit demand model specified by equation (2), which segments products into groups and subgroups at the upper and lower level, respectively. First, portable computers at the upper level are grouped according to two RAM memory bands: (i) below 2.5MB; and (ii) above 2.5MB. Products within a group are allowed to be closer substitutes than products of different groups. In general, RAM memory is one of the main factors which consumers consider when buying a portable computer and a higher RAM memory corresponds to a higher price. At the lower level, the two groups of portable computers are subdivided into subgroups according to whether they are sold online or offline. This allows for for a higher substitution of products sold in the same distribution channel.

Second, portable media players at the upper level are grouped according to storage capacity

bands: (i) below 1GB; (ii) between 1GB and 2GB; (iii) between 2GB and 5GB; and (iv) above 5GB. Storage is one of the main decision factors when buying a media player and a higher storage is reflected in a higher price. At the lower level, the grouping is according to whether products are sold online or offline. Finally, digital cameras at the upper level are grouped according to four pixel bands: (i) below 7.9 pixels; (ii) between 8.0 and 8.9 pixels; (iii) between 9.0 and 9.9 pixels; and (iv) above 10.0 pixels. The number of pixels is one of the main decision factors when buying a digital camera and in general a higher number of pixels corresponds to a higher price. As with the other product categories, at the lower level digital cameras are grouped according to whether they are sold online or offline.

The demand equations for the three product categories are estimated using instrumental variables (IV) to account for the endogeneity of the price variable p_{jc} and the within group market shares in logarithm $log(s_{j|hgc})$ and $log(s_{h|gc})$, which may all be positively correlated with the error term. A positive unobserved shock to demand for a given product will result in a higher within group market share and at the same time in a higher price. As instruments we use variables suggested by Berry, Levinsohn and Pakes (1995) and Verboven (1996) for the nested logit: sums of the characteristics of the other products and counts of the number of products over all of the firm's products and and over all competing firms' products; and the sums and counts by groups. According to a Hausman specification test, the null hypothesis of the exogeneity of prices and within group market shares may be rejected at a significance level of 1%.

The estimation results for three product categories are reported in Table 3. For all product categories we find a significant and negative price coefficient and significant and positive nesting coefficients σ_1 and σ_2. These satisfy the inequalities $1 > \sigma_1 > \sigma_2 > 0$, consistent with the restrictions for the model to be consistent with random utility maximization. Intuitively, this implies that products of the same quality category and distribution channel (same subgroup) are the closest substitutes; products of a different distribution channel but the same quality category (same group) are weaker substitutes, and products of a different quality category are the weakest substitutes. The difference in the substitution between subgroups is greater when

the gap between σ_1 and σ_2 is higher. Hence, there is less substitution between subgroups for portable media players and digital cameras than for portable computers.[4]

Apart from price and within group market shares, the other explanatory variables are product characteristics, brand and country dummy variables. The product characteristics are usually significant and with the anticipated signs. For instance, as shown in the first column in Table 3, the utility of a portable PC is higher when it has a built-in DVD player, webcam, on-board graphics, multi-core processor and Intel processor. The utility also increases with a greater RAM, video RAM, speed performance, screen size and when the computer is a netbook. But it decreases for built-in dual processor, bluetooth, OS platform and for higher resolution. As shown in the second column, the utility of portable media players increases with a higher storage capacity, built-in photo viewer, digital rights manager, mpeg4, microphone and video playback features. Finally, the utility of a digital camera in the third column increases with a higher pixel resolution and when the camera has an optical zoom, allows for colour photos, has a single lens reflex and includes electronic stabilisation technology. The country and brand dummies included in the estimation are significant. Hence, there are significant differences in the utility of particular brands, which may be due to brand perception, quality and other factors which are not controlled by included product characteristics. There are also differences in the valuation of particular product categories across the EU countries. These differences may be due to income effect or other country-specific factors. For instance, there may be a higher utility from having portable PCs in Germany than in Romania because of higher income but also because consumers in Germany may in general value more the use of computers.

The dummy variable for the online distribution channel is highly significant and negative for all three product categories, which indicates that the online sales channel is on average less valued than traditional distribution and therefore has much lower sales. As shown in Table 4,

[4]We also considered an alternative nesting structure, where the upper level is the online/offline distribution channel and the lower level is the quality category. This specification was rejected because the order condition $\sigma_1 > \sigma_2$ was not satisfied. Hence, we find that the quality category is a more dominant form of segmentation than the distribution channel, which is consistent with intuition.

online sales in the selected EU countries represent on average only 6.6% for portable computers, 13.9% for portable media players and 6.6% for digital cameras. We also include in the estimation country-specific dummy variables for online sales. These are in general significant and suggest that there are demand differences in online sales across countries. These differences may be due to differences in the availability and quality of online sales.

The demand estimates are used to compute own- and cross-price elasticities at the product level. The own-price elasticities at the product level are in general greater than one in absolute terms. They are on average equal to -4.37 for digital cameras, -2.16 for portable computers and -2.68 for portable media players. The cross-price elasticities are the highest for product in the same subgroup, which indicates that there is strong substitutability between products which are in the same segment and channel. The average own-price elasticities at the country level differ by product category due to differences in the estimates of the parameters α, σ_1, σ_2, and the level of prices. The differences in the values of own-price elasticities for the same product category across countries are due to a different range of products which are available in particular countries and their price levels.

We use the estimates of demand elasticities to compute marginal costs for profit-maximizing multi-product firms under the assumption of Nash-Bertrand equilibrium using the system of equations (7). Since the prices used in this calculation are the final retail prices, the estimates of marginal costs include both the costs of manufacturing and sales. The imputed marginal costs are used to calculate markups, which on average for all the brands and models sold in the selected EU countries are 58% for portable media players, 59% for portable computers and 31% for digital cameras.

4.2 Impact of online channel

Diversion ratios We use the demand parameter estimates and the marginal costs (obtained from our system of first order conditions) to assess the impact of the introduction of the online distribution channel on the equilibrium prices and sales. More specifically, we simulate the

equilibrium prices and sales in the situation in which the online sales channel is not available at all. We implement this by setting the marginal costs for online products to a very high level, and then recompute the equilibrium prices and demand by solving the system of first order conditions (and at this high marginal cost level, the new demand for online sales becomes approximately zero).

[**MAKE THIS THE FIRST ALL EUROPE TABLE OF PRESENTATION AND REMOVE OTHER TABLE TO APPENDIX**] **Table 4** shows the share of online in total sales in the considered EU countries, the diversion ratios from online to offline, the estimated loss in offline sales and the estimated total sales increase due to the introduction of the online channel. Note first that in the considered EU countries online sales still represent a relatively small fraction of sales: 6.6% for portable computers, 13.9% for portable media players and 6.6% for digital cameras. This is because the data refer to the period April 2008–March 2009, when the share of online sales was certainly smaller than nowadays.

The diversion ratios measure the fraction of online sales that would go to offline if the online distribution channel would be removed. The diversion ratios in selected European countries are on average 83.4% for portable computers, 62.1% for portable medial players, and 63.9% for digital cameras. Hence, without the online distribution channel on average 16.6% of the online sales would be lost for portable computers, 37.9% for portable media players and 36.1% for digital cameras. The online distribution channel thus reduces traditional sales from brick-and-mortar shops, but at the same time activates new consumers. In the case of portable computers for the selected EU countries, the online distribution channel reduced traditional sales by -5.6% but it raised total sales by 1.1%. Similarly, for portable media players and digital cameras, the online channel reduced sales by respectively -9.1% and -4.3%, but raised total sales by 5.3% and 2.4%.

The diversion ratios and the scale of reductions in the traditional sales differ across countries, **as shown in Table 4 in the Appendix**. For instance, for portable media players the lowest diversion ratio is 53.6% for Poland and the highest is 63.3% for the UK. The reduction in

traditional sales is the highest in the UK (drop by 16.3%) and the lowest in Portugal (drop by 0.6%). In general, the loss in traditional sales is greater in countries with a higher percentage of online sales.

Consumer surplus and profits Another important question is who benefits more from the introduction of online sales: consumers or producers? To answer this question we compare consumer and producer surplus in the current situation with online sales to a counterfactual situation, in which the online channel is removed.

[**MAKE THIS THE SECOND ALL EUROPE TABLE FROM PRESENTATION AND REMOVE OTHER TABLE TO APPENDIX**] **Table 5** shows the changes in consumer and producer surplus (in absolute value) in the selected EU countries. For all three product categories consumer surplus and profits increase because of the introduction of the online distribution channel. More interestingly, for portable media players the increase in consumer surplus is about twice as large as the increase in profits. For digital cameras it is about four times larger and for portable computers it is even about eight times larger. These ratios show that consumers benefit more than firms from the introduction of the online distribution channel. Firms have only limited benefits because a lot of the online sales are mainly diversion from traditional sales. For the three product categories together, consumers obtain on average 83% of the total welfare gains induced by e-commerce.

The gain in total welfare mainly comes from benefits of increased product differentiation associated with a new distribution channel (as reflected earlier in the market expansion effect when online is introduced). In principle, the consumer welfare gains from the introduction of new products could also come from reduced prices due to more competition. However, it turns out that this source of gain is not relevant in our setting. The price effects are very small, since almost all the products which are sold online are also present in the traditional distribution channel.

Price convergence Finally, we analyze whether the introduction of the online distribution channel led to convergence of prices in the EU market. Since price become more easily comparable with an online distribution channel, one may expect that prices become less dispersed, as compared with the traditional channel. Because of competition between online and traditional sales, prices in the traditional sales channel may also become dispersed after the online distribution channel is introduced. To assess the impact of the online distribution channel on international price differences, we estimate for each product category three hedonic price regressions to construct quality-adjusted prices. The first two regressions consider the prices of products sold online and offline, respectively, as a function of product characteristics and country-specific dummy variables. The coefficients of the country-specific dummy variables are then used to construct the quality adjusted price differences for online and offline across the selected EU countries. The third regression is similar to the regression for offline products, but now based on the predicted offline prices when the online distribution channel is removed (instead of the actual offline prices). This third regression enables us to assess whether the removal of the online distribution channel would imply larger international price differences for offline products.

As shown earlier in Table 1, almost all the products which are sold online are also available offline, but there are many products which are only sold offline. To compare identical products, the hedonic price regressions focus only on those products which are available both online and offline. In the first regression as the dependent variable we use a logarithm of online prices and in the second regression a logarithm of offline prices. In the third regression, the dependent variable is a logarithm of offline prices which are predicted using our equilibrium model of demand and supply under the assumption that online sales are not available. The set of explanatory variables is the same as in the demand estimation, including product characteristics and dummy variables for brands and countries. The estimation results of the three hedonic price regressions for each product category are reported in Table 6.

In the integrated European market we should expect that price differences between identical

products are small or non-existent, which does not seem to be the case for selected consumer electronics products. In all three regressions for portable computers, almost all product characteristics are significant with either positive or negative signs. Most of the brand dummies are also significant. After controlling for product characteristics and brand dummies, significant coefficients on the country dummies indicate that on average there are differences in the quality-adjusted prices between countries, where the reference country is the UK. The estimates of country dummies in the regressions for observed online and offline prices (first and second regressions) are comparable. This means that international price differences are not smaller for products sold online than for products sold offline. Furthermore, the estimates in the third regression, for the predicted offline prices after removing the online distribution channel, are almost identical to the second regression. This means that the introduction of the online channel did not induce firms to reduce international price differences for their offline products. Figure 1 plots the estimates of the country dummy variables for three hedonic price regressions for portable computers.

The estimation results for the other product categories, digital cameras and portable media players, lead to similar conclusions. The estimates of product characteristics and brand dummies tend to be significant. The coefficients on the country dummies are also in general significant, which indicates that prices differ significantly across countries. As in the case of portable computers, these price differences apply both to products sold offline and to products sold online. Furthermore, also for these two product categories the introduction of the online distribution channel has almost no effect on international price differences .Figures 2 and 3 show estimates of country dummy variables for three regressions for portable media players and digital cameras, respectively.

5 Conclusion

Many arguments support the idea that the existence of digital markets may provide benefits to both producers and consumers. The internet offers much more information to the consumer and

at a lower cost, hence making price comparisons easier. A better informed consumer is more likely to find a product that exactly matches her preferred characteristics. Since in principle the internet has no borders, a larger market enhances competition as the number of suppliers bidding for a consumer's expenditure increases. At the same time, suppliers who successfully exploit this larger market can benefit from economies of scale to reduce production costs. Hence, in theory the use of digital markets should reduce market prices and increase welfare, both for consumers and producers. In practice, however, there remain many sources of market segmentation that effectively impede the realisation of these potential benefits. Among these, transport costs for the physical delivery of goods, some regulatory barriers to cross-border trade, and persistent language barriers to cross-border online shopping are the more relevant and hamper the full geographical integration of online markets in the EU.

In this paper we have estimated a differentiated products demand model to analyze some of the effects related to the introduction of e-commerce. We use a rich dataset on prices, quantities and characteristics of three different consumer electronics products in several European countries in the years 2008-2009. In this setting, we ask three questions. First, we are interested in determining whether the introduction of e-commerce increases total sales or, on the contrary, only crowds out sales from traditional channels. Second, we would like to know who benefited most (or was more affected) from the online sales: consumers or firms. Finally, we ask whether the adoption of e-commerce has had any effect on the European integration process.

Our estimation results for the three categories indicate that offline sales decrease to some extent due to the appearance of the online channel; this is the business stealing effect. However, there is also a market expansion effect: total sales increase, so that selling online allows retailers to expand their total sales. Moreover, our results indicate that consumers capture a much larger fraction of the surplus created by the online channel than firms. For the three product categories we studied in the selected EU countries, consumers obtain on average 83% of the total welfare gains induced by e-commerce, which is largely due the benefits from increased product differentiation (rather than reduced prices).

Finally, our results also point out to persistent quality-adjusted price differences for offline products even when e-commerce is removed. This means that the adoption of e-commerce does not induce price convergence of offline products. One reason could be that price dispersion in online prices is also high, although the pattern is different from offline.

If e-commerce expands the market, as our results show, then any barrier to e-commerce would have substantial negative effects in terms of revenue for producers and welfare for consumers. There is then a clear role for policy to design appropriate measures to help e-commerce thrive and in so doing generate jobs and boosting growth.

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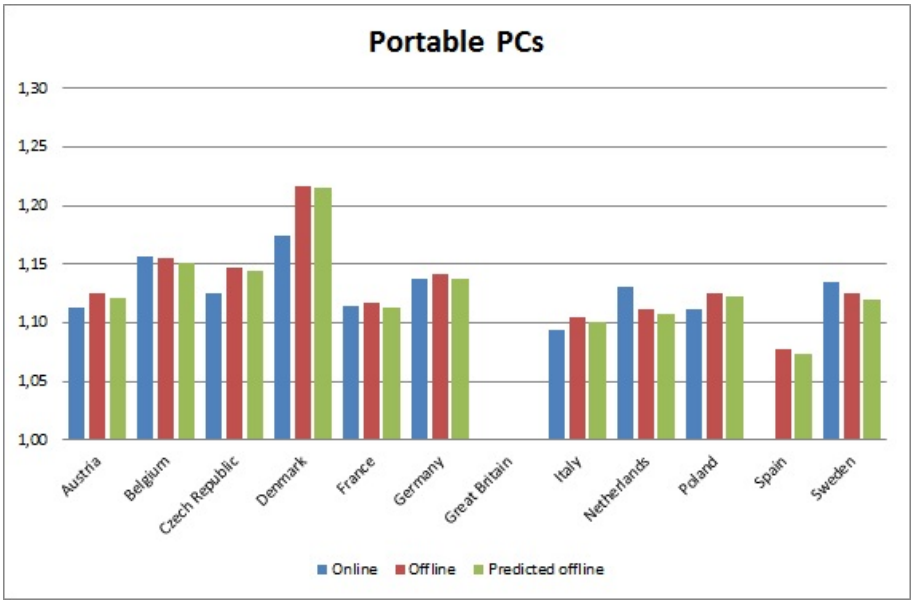
6 Appendix

Table 1: Number of models by product category and distribution channel

	Mobile PCs		Portable MPs		Digital cameras	
	Models	Sales (000)	Models	Sales (000)	Models	Sales (000)
Offline only	11,239	7,841	2,571	1,416	6,105	5,253
Online only	108	29	243	77	57	69
Offline + online	16,826	17,309	3,644	18,620	9,754	48,381
Total	28,173	25,179	6,458	20,113	15,916	53,704

The number of unique models which are sold online and offline in selected EU countries, and their total sales in thousands of units.

Figure 1: Cross-country price index for portable PCs



Differences in quality adjusted prices across selected EU countries based on hedonic price regressions for portable computers.

Table 2: Summary statistics

	Description	Obs	Mean	Std	Min	Max
Portable PCs						
price	Price	28,173	764	261	366	1555
online	Online sales dummy	28173	0.30	0.46	0	1
storagecap	Storage capacity (GB)	28,173	228	100	80	500
ram	RAM memory (MB)	28,173	2473	1041	1024	4096
size	Screen size (inch)	28,173	15.39	1.33	12.1	17
csp	Computer Speed Performance (MHz)	28,173	1966	239	1600	2400
netbook	Netbook dummy	28,173	0.03	0.16	0	1
proc_duo	Duo processor dummy	28,173	0.54	0.50	0	1
proc_intel	Intel processor dummy	28,173	0.81	0.39	0	1
cores	Multi-core processor dummy	28,173	0.91	0.29	0	1
chip_intel	Intel chip dummy	28,173	0.58	0.49	0	1
dvd	DVD player dummy	28,173	0.07	0.25	0	1
gpu_intel	Intel graphics processr unit dummy	28,173	0.34	0.47	0	1
onboardgraphics	Onboard graphics dummy	28,173	0.44	0.50	0	1
vram	Video RAM dummy	28,173	0.46	0.50	0	1
remote	Remote control dummy	28,173	0.11	0.31	0	1
osplatform	Microsoft Operating System dummy	28,173	0.94	0.23	0	1
bluetooth	Bluetooth dummy	28,173	0.53	0.50	0	1
resolution	High resolution dummy	28,173	0.28	0.45	0	1
webcam	Webcam dummy	28,173	0.74	0.44	0	1
Portable MPs						
price	Price	6,458	71.94	45.87	20	233
online	Online sales dummy	6,458	0.32	0.47	0	1
storagecap	Storage capacity	6,458	3281	2583	512	8192
mic	Microphone dummy	6,458	0.68	0.47	0	1
photoviewer	Photo viewer dummy	6,458	0.56	0.50	0	1
drm	Digital Rights Manager dummy	6,458	0.41	0.49	0	1
mpeg4	MPEG4 format dummy	6,458	0.25	0.43	0	1
videoplaybk	Video playback dummy	6,458	0.48	0.50	0	1
colordisplay	Color display dummy	6,458	0.58	0.49	0	1
Digital cameras						
price	Price	15,916	194.23	100.10	70	574
online	Online sales dummy	15,916	0.31	0.46	0	1
pixeltot	Pixels	15,911	8.63	2.16	4	15
type	Colout dummy	15,916	0.95	0.22	0	1
slr	Single lens reflex dummy	15,916	0.04	0.20	0	1
elect	Electronic stabilisation dummy	15,916	0.24	0.43	0	1
optical	Optical zoom	15,916	0.40	0.49	0	1

Summary statistics for the attributes of unique brands and models which are used in the demand and pricing regressions.

Table 3: Estimation results – nested logit

Portable PCs		Portable Mps		Digital cameras	
price	-0.0004***	price	-0.009***	price	-0.008***
	(0.000)		(0.001)		(0.001)
upper nest	0.842***	upper nest	0.765***	upper nest	0.650***
	(0.006)		(0.014)		(0.012)
lower nest	0.820***	lower nest	0.560***	lower nest	0.499***
	(0.013)		(0.034)		(0.043)
online	-0.296***	online	-0.816***	online	-1.075***
	(0.040)		(0.089)		(0.123)
netbook	0.129***	mic	0.093***	type	0.572***
	(0.016)		(0.022)		(0.037)
proc_duo	-0.020***	photoviewer	0.153***	slr	1.766***
	(0.007)		(0.054)		(0.145)
proc_intel	0.051***	drm	0.104***	elect	0.220***
	(0.007)		(0.020)		(0.021)
cores	0.026***	mpeg4	0.198***	optical	0.513***
	(0.008)		(0.031)		(0.033)
chip_intel	-0.007	videoplaybk	0.212***	pixeltot	0.155***
	(0.005)		(0.032)		(0.012)
dvd	0.023***	colordisplay	-0.083		
	(0.009)		(0.051)		
gpu_intel	-0.003	storagecap	0.000***		
	(0.008)		(0.000)		
onboardgraphic	0.073***				
	(0.008)				
vram	0.079***				
	(0.007)				
remote	-0.009				
	(0.007)				
osplatform	-0.054***				
	(0.009)				
bluetooth	-0.023***				
	(0.005)				
resolution	-0.013**				
	(0.007)				
webcam	0.069***				
	(0.005)				
storagecap	0.000***				
	(0.000)				
ram	0.000***				
	(0.000)				
size	0.010***				
	(0.002)				
csp	0.000***				
	(0.000)				
Brand dummies	yes	Brand dummies	yes	Brand dummies	yes
Country*online dummies	yes	Country*online dummies	yes	Country*online dummies	yes
Observations	28,173	Observations	6,458	Observations	15,911

Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 4: Diversion ratios from online to offline and percentage loss in offline sales from establishing online

	Portable PCs			Portable MPs			Digital cameras		
Country	Diversion ratio	% Loss in offline	Share of online	Diversion ratio	% Loss in offline	Share of online	Diversion ratio	% Loss in offline	Share of online
Austria	83.7%	-4.3%	5.1%	56.0%	-5.9%	10.1%	68.9%	-5.2%	7.4%
Belgium	84.1%	-1.6%	1.9%	61.9%	-1.3%	2.1%	64.5%	-2.3%	3.6%
Bulgaria							59.9%	0.0%	0.0%
Czech Republic	81.4%	-10.1%	12.2%	54.9%	-6.5%	11.2%	60.2%	-5.7%	9.1%
Denmark	82.0%	-1.2%	1.5%				53.5%	-6.5%	11.5%
Finland							66.0%	-0.4%	0.6%
France	84.5%	-6.8%	8.0%	60.6%	-7.4%	11.6%	64.9%	-6.3%	9.3%
Germany	83.5%	-10.1%	11.9%	62.2%	-11.4%	17.2%	67.7%	-5.3%	7.7%
Great Britain	79.0%	-12.8%	15.7%	63.3%	-16.3%	23.5%	59.0%	-7.8%	12.6%
Greece							62.5%	0.0%	0.0%
Hungary				54.9%	-2.8%	5.0%	57.4%	-3.7%	6.3%
Ireland							58.9%	-3.6%	6.0%
Italy	83.8%	-2.8%	3.3%	62.1%	-3.0%	4.7%	62.8%	-1.8%	2.8%
Netherlands	85.5%	-3.9%	4.5%	60.1%	-7.0%	11.2%	69.2%	-3.8%	5.5%
Poland	83.5%	-1.8%	2.1%	53.6%	-2.4%	4.3%	58.5%	-3.6%	6.0%
Portugal				61.8%	-0.6%	1.0%	60.2%	-1.7%	2.8%
Romania				57.7%	-1.2%	2.0%	52.7%	-1.8%	3.3%
Slovakia				56.1%	-2.0%	3.5%	54.5%	-2.6%	4.7%
Slovenia				54.5%	-2.5%	4.5%	59.0%	-4.3%	7.1%
Spain	84.6%	-0.9%	1.1%	62.2%	-3.6%	5.7%	63.4%	-1.4%	2.1%
Sweden	85.5%	-3.2%	3.7%				68.5%	-5.4%	7.7%
Total	83.4%	-5.56%	6.6%	62.1%	-9.09%	13.9%	63.9%	-4.32%	6.6%

Diversion ratios: a share of online sales which would go to off-line if there was no online distribution channel. Loss in offline: percentage loss in offline sales from establishing online channel. Share of online: the share of online in total sales.

Table 5: Changes in consumer surplus and profits after removing online channel

	Portable PCs (tsd)		Portable MPs (tsd)		Digital cameras (tsd)	
Country	CS	Profits	CS	Profits	CS	Profits
Austria	-10,927	-1,316	-1,740	-192	-6,452	-1,548
Belgium	-5,187	-712	-460	-164	-3,066	-838
Bulgaria					-7	-3
Czech Republic	-14,178	-2,190	-762	-63	-5,898	-1,602
Denmark	-2,432	136			-1,939	-599
Finland					-276	-63
France	-173,808	-19,256	-18,444	-6,058	-52,481	-11,847
Germany	-265,828	-37,051	-38,666	-16,449	-59,108	-14,575
Great Britain	-70,659	-6,373	-57,314	-38,670	-45,348	-13,217
Greece					-16	-10
Hungary			-328	-60	-2,903	-793
Ireland					-1,461	-414
Italy	-48,325	-6,519	-5,383	-2,733	-11,259	-2,769
Netherlands	-24,682	-4,370	-4,754	-799	-9,513	-1,867
Poland	-14,211	-2,671	-1,363	-52	-11,529	-3,275
Portugal			-148	-66	-1,642	-478
Romania			-57	-14	-1,254	-420
Slovakia			-93	-11	-840	-244
Slovenia			-102	-1	-746	-252
Spain	-12,066	-2,246			-7,121	-1,853
Sweden	-12,171	-1,966	-3,485	-2,630	-7,247	-1,928
Total	-654,474	-84,532	-133,100	-67,961	-230,106	-58,593

The changes in consumer and producer surplus in thousands Euros after removing online sales channel.

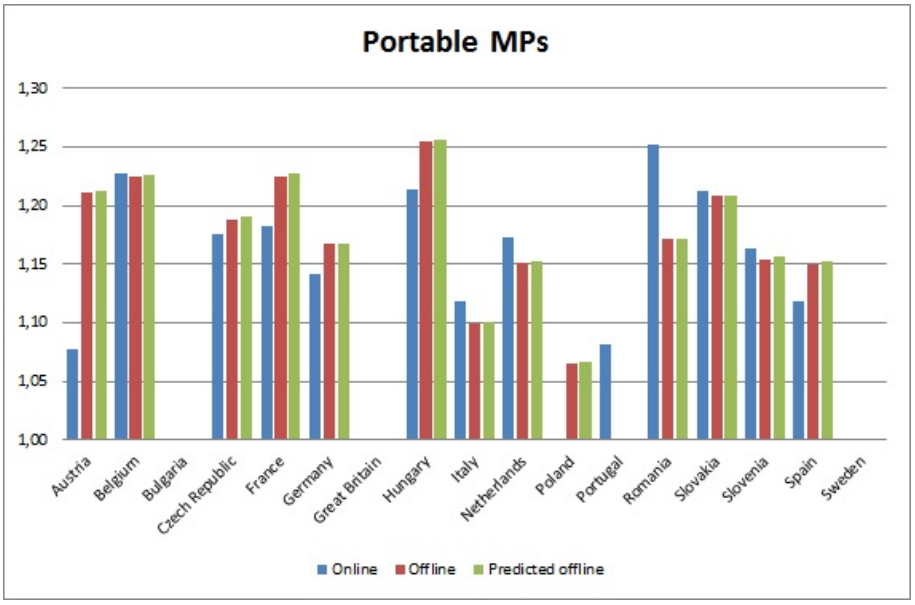
Table 6: Hedonic price regressions

Portable PCs	offline	online	pred online	Portable MPs	offline	online	pred online	Cameras	offline	online	pred online
netbook	-0.220***	-0.228***	-0.228***	mic	0.016	0.033*	0.033*	type	0.068***	0.088***	0.088***
	(0.016)	(0.016)	(0.016)		(0.020)	(0.019)	(0.019)		(0.022)	(0.022)	(0.022)
proc_duo	0.194***	0.196***	0.196***	photoviewer	0.191***	0.222***	0.223***	slr	0.749***	0.712***	0.712***
	(0.006)	(0.006)	(0.006)		(0.065)	(0.059)	(0.059)		(0.022)	(0.021)	(0.021)
proc_intel	-0.015**	-0.017**	-0.017**	drm	0.116***	0.146***	0.145***	elect	-0.011	-0.007	-0.007
	(0.008)	(0.008)	(0.008)		(0.018)	(0.017)	(0.017)		(0.013)	(0.013)	(0.013)
cores	0.129***	0.134***	0.134***	mpeg4	0.076***	0.103***	0.103***	optical	0.259***	0.262***	0.262***
	(0.010)	(0.010)	(0.010)		(0.022)	(0.021)	(0.021)		(0.013)	(0.013)	(0.013)
chip_intel	0.015***	0.017***	0.016***	videoplaybk	0.138***	0.177***	0.176***	pixeltot	0.088***	0.088***	0.088***
	(0.005)	(0.005)	(0.005)		(0.026)	(0.026)	(0.026)		(0.003)	(0.003)	(0.003)
dvd	0.106***	0.105***	0.105***	colordisplay	0.082	0.071	0.071				
	(0.008)	(0.008)	(0.008)		(0.062)	(0.056)	(0.056)				
gpu_intel	-0.031***	-0.037***	-0.037***	storagecap	0.000***	0.000***	0.000***				
	(0.008)	(0.008)	(0.008)		(0.000)	(0.000)	(0.000)				
onboardgraphic	-0.076***	-0.062***	-0.062***								
	(0.010)	(0.010)	(0.010)								
vram	0.010	0.020**	0.020**								
	(0.008)	(0.008)	(0.008)								
remote	0.075***	0.074***	0.075***								
	(0.008)	(0.008)	(0.008)								
osplatform	0.102***	0.093***	0.093***								
	(0.010)	(0.010)	(0.010)								
bluetooth	0.067***	0.072***	0.071***								
	(0.005)	(0.005)	(0.005)								
resolution	0.181***	0.180***	0.180***								
	(0.005)	(0.005)	(0.005)								
webcam	-0.005	-0.002	-0.002								
	(0.006)	(0.005)	(0.005)								
storagecap	0.000***	0.000***	0.000***								
	(0.000)	(0.000)	(0.000)								
ram	0.000	-0.000	-0.000								
	(0.000)	(0.000)	(0.000)								
size	-0.058***	-0.057***	-0.057***								
	(0.002)	(0.002)	(0.002)								
csp	0.000***	0.000***	0.000***								
	(0.000)	(0.000)	(0.000)								
Austria	0.113***	0.125***	0.121***	Austria	0.078**	0.211***	0.212***	Austia	0.145***	0.144***	0.144***
	(0.013)	(0.012)	(0.012)		(0.034)	(0.033)	(0.033)		(0.030)	(0.029)	(0.029)
Belgium	0.156***	0.155***	0.151***	Belgium	0.227***	0.225***	0.226***	Belgium	0.159***	0.199***	0.200***
	(0.013)	(0.013)	(0.013)		(0.039)	(0.038)	(0.038)		(0.031)	(0.030)	(0.030)
								Bulgaria	-0.108	-0.034	-0.034
									(0.080)	(0.080)	(0.080)
Czech Republic	0.125***	0.147***	0.144***	Czech Republic	0.176***	0.188***	0.190***	Czech Republic	0.154***	0.149***	0.149***
	(0.013)	(0.013)	(0.013)		(0.035)	(0.034)	(0.034)		(0.029)	(0.029)	(0.029)
Denmark	0.174***	0.217***	0.215***					Denmark	0.250***	0.226***	0.226***
	(0.017)	(0.017)	(0.017)						(0.030)	(0.030)	(0.030)
								Finland	0.179***	0.167***	0.167***
									(0.035)	(0.035)	(0.035)
France	0.115***	0.117***	0.113***	France	0.183***	0.225***	0.227***	France	0.051*	0.085***	0.085***
	(0.012)	(0.012)	(0.012)		(0.036)	(0.034)	(0.034)		(0.029)	(0.029)	(0.029)
Germany	0.138***	0.142***	0.138***	Germany	0.141***	0.167***	0.168***	Germany	0.098***	0.076***	0.076***
	(0.012)	(0.012)	(0.012)		(0.034)	(0.032)	(0.032)		(0.029)	(0.029)	(0.029)
								Greece	-0.109	0.008	0.008
									(0.080)	(0.080)	(0.080)
				Hungary	0.214***	0.254***	0.256***	Hungary	0.121***	0.049	0.049
					(0.037)	(0.036)	(0.036)		(0.030)	(0.030)	(0.030)
								Ireland	0.082**	0.129***	0.129***
									(0.040)	(0.040)	(0.040)
Italy	0.094***	0.105***	0.101***	Italy	0.118***	0.100***	0.101***	Italy	0.158***	0.184***	0.184***
	(0.013)	(0.013)	(0.013)		(0.037)	(0.035)	(0.035)		(0.029)	(0.029)	(0.029)
Netherlands	0.131***	0.112***	0.108***	Netherlands	0.173***	0.151***	0.152***	Netherlands	0.116***	0.103***	0.103***
	(0.013)	(0.013)	(0.013)		(0.035)	(0.034)	(0.034)		(0.029)	(0.029)	(0.029)
Poland	0.112***	0.125***	0.122***	Poland	0.053	0.066*	0.067*	Poland	0.062**	0.082***	0.083***
	(0.013)	(0.013)	(0.013)		(0.038)	(0.037)	(0.037)		(0.030)	(0.030)	(0.030)
				Portugal	0.081*	0.054	0.055	Portugal	0.158***	0.167***	0.167***
					(0.047)	(0.046)	(0.046)		(0.032)	(0.032)	(0.032)
				Romania	0.252***	0.171***	0.171***	Romania	0.191***	0.110***	0.111***
					(0.047)	(0.045)	(0.045)		(0.034)	(0.033)	(0.033)
				Slovakia	0.212***	0.208***	0.209***	Slovakia	0.220***	0.191***	0.191***
					(0.037)	(0.036)	(0.036)		(0.030)	(0.030)	(0.030)
				Slovenia	0.163***	0.154***	0.157***	Slovenia	0.263***	0.211***	0.211***
					(0.043)	(0.041)	(0.041)		(0.030)	(0.030)	(0.030)
Spain	0.015	0.077***	0.073***	Spain	0.118***	0.150***	0.152***	Spain	0.033	0.122***	0.122***
	(0.014)	(0.014)	(0.014)		(0.046)	(0.044)	(0.044)		(0.032)	(0.031)	(0.031)
Sweden	0.135***	0.125***	0.120***					Sweden	0.180***	0.174***	0.174***
	(0.018)	(0.017)	(0.017)						(0.031)	(0.031)	(0.031)
Constant	6.271***	6.278***	6.281***	Constant	3.827***	3.941***	3.937***	Constant	3.670***	3.663***	3.663***
	(0.045)	(0.045)	(0.045)		(0.040)	(0.038)	(0.038)		(0.050)	(0.050)	(0.050)
Brand dummies		yes		Brand dummies		yes		Brand dummies		yes	
Observations	8,418	8,410	8,410	Observations	1,822	1,822	1,822	Observations	4,877	4,877	4,877
R-squared	0.720	0.721	0.721	R-squared	0.769	0.777	0.777	R-squared	0.582	0.589	0.589

Hedonic price regressions for the set of products which are sold both online and offline: (i) offline prices; (ii) online prices; (iii) predicted offline prices in the absence of the online channel.

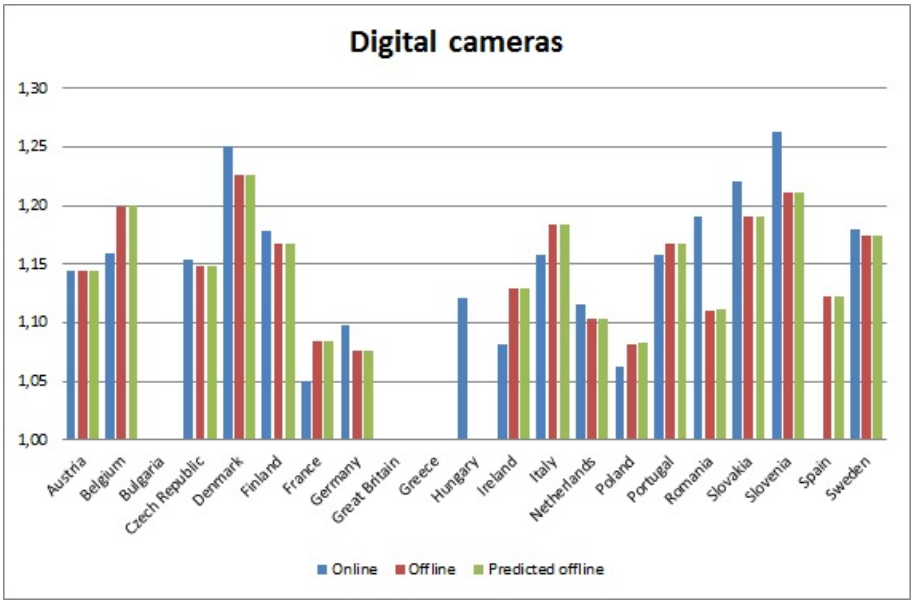
Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Figure 2: Cross-country price index for portable MPs



Differences in quality adjusted prices across selected EU countries based on hedonic price regressions for portable media players.

Figure 3: Cross-country price index for digital cameras



Differences in quality adjusted prices across selected EU countries based on hedonic price regressions for digital cameras.