New Low Price! An Analysis of IKEA Pricing

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Abstract

IKEA is a multinational retailer of home furnishings. The dominant feature of IKEA advertising and market image is a reputation for low prices. IKEA's iconic catalog is the company's primary advertising device, representing 70% of IKEA's annual advertising budget. The catalog contains photos, prices, and written descriptions of items, with prices denominated in the customer's currency. IKEA prices are famous for remaining unchanged for the life of the catalog year. The IKEA data are free of two major problems that arise in other micro-pricing studies: product substitution and temporary sales.

This paper analyzes IKEA catalog price data for Germany, France, Italy, Sweden, UK, US and Canada. We find a substantial proportion of small price changes, as is common in micro price datasets, but we find that small price changes are overwhelmingly associated with the practice of "charm pricing"–adjusting ending digits to end in the numeral "9", with price changes less than one currency unit. Both intensive and extensive margins are important contributors to overall IKEA catalog price changes, in contrast to the prior literature which finds that only the intensive margin is important. We find near-zero pass-through of exchange rates to IKEA prices but approximately 100% pass-through of local prices, which is consistent with the illustrative model that we present that predicts this pattern for goods with a high component of local distribution costs. Our most novel results concern price coordination. IKEA price changes show low coordination across countries, even among countries in the Euro Zone. For example, prices for identical goods are no more likely to move together between Germany and France than between Sweden and Canada. We find evidence of significant price coordination with goods belonging to a product family such as the "BILLY" bookcases. However, the price coordination exists only within countries and not across countries. These facts suggest that there may be economies of scope in price setting as suggested by Midrigan (2011), but that these economies operate at the family level of goods and do not operate across countries.

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1 Introduction

IKEA is a multinational retailer of home furnishings, with 296 stores in 24 countries. IKEA's iconic catalog is the company's primary advertising device, representing 70% of IKEA's annual advertising budget. The catalog contains photos, prices, and written descriptions of items, with prices denominated in the customer's currency. IKEA's advertising encourages customers to focus on the item's price as the most important attribute. Large banners proclaiming "We design the price first!" and "New low price!" appear frequently throughout the catalog. IKEA prices are famous for remaining unchanged for the life of the catalog year (roughly June of one year to June of the next). The IKEA data are free of two major problems that arise in other micro-pricing studies: product substitution and temporary sales. A key component of IKEA's consumer goal is that the consumers know that the catalog prices will be the transaction prices throughout the year.[1]

IKEA releases its catalogs in the summer of the year preceding the year printed on the catalog, e.g., the 2010 catalog was released in summer 2009. The catalog prices are honored until the next catalog is released. This paper analyzes IKEA price data using a new dataset containing every price in the IKEA catalogs for seven North American and European countries from 2005-2014. The country list—Germany, France, Italy, Sweden, UK, US and Canada—includes IKEA's top six countries by revenue and accounts for about 2/3 of IKEA's annual sales.

The paper is structured as follows. Section 2 describes the construction and cleaning of the dataset and explains the relationship among subgroups of IKEA product classes that are critical to our analysis. Section 3 discusses the important role played by "charm pricing" in the IKEA catalogs and shows how the use of this pricing tool varies across countries. Section A examines the importance of extensive margin adjustment vs. intensive margin adjustment in explaining overall price inflation in the IKEA catalogs. This section conducts a variance decomposition familiar from the literature. We and finds a role for the extensive margin as well as the intensive margin in driving overall inflation. Section 3 also conducts detailed analysis of the intensive and extensive margins, respectively, focusing on the extent to which the IKEA decisions along these margins vary across time, country, and age of the good. Section B provides a benchmark partial-equilibrium model of price-setting in the presence of menu costs based on the model presented by Burstein and Gopinath (2014), which we use to interpret empirical results in the rest of the paper. Section 3.5 presents results from exchange-rate pass-through regressions, and finds results that are consistent with the model of Section B, namely, that the pass-through of local price inflation price inflation is about 100%, while the pass-through from the exchange rate to prices is very low. Section 4 studies price coordination in the IKEA data, focusing on (i) family

[1]The 2018 catalog states on the front cover that the catalog prices are the maximum prices for the year. Sales were few and far between over the period of study. A typical sale would be advertised in local newspapers and would involve a reduced price for a few goods for a few days or a week. The online dataset of daily web scraped prices provided by Cavallo, Neiman and Rigobon (2014) show that IKEA online prices remain fixed throughout the year, changing only at the time of the summer catalog release.

groups and (ii) coordination with the Euro zone. This section takes a disaggregated look at the pattern of bilateral price changes. The results suggest some coordination with family groups but none within the Euro zone. Section 5 conducts a formal estimation of coordination effects through estimation of Probit models inspired by the work of Midrigan (2011). These results confirm country-level coordination within product families and varieties, but no cross-country coordination, even within the Euro zone. Section 6 considers the question of which theory of price setting is consistent with the IKEA data, and Section 7 concludes.

2 The IKEA Universe

IKEA was founded in Sweden by Ingmar Kamprad in 1943. The IKEA catalog has been produced since 1951, and is currently circulated in 17 languages and 28 countries. The data set contains every price from IKEA catalogs in seven countries covering catalog years 2005 through 2014. The seven countries are the US, Canada, UK, Sweden, Germany, France, and Italy. These countries include IKEA's four largest markets –Germany, US, France, and the UK. North America accounts for about 15% of annual sales, Europe about 80%, and Asia the remaining 5%. The sample includes Sweden, IKEA's "home country," three countries in the European Monetary Union, the large and growing North American market, and the UK, which is physically close to the other European countries but which does not use the Euro. This sample provides the opportunity to study IKEA's pricing choices across countries with differing exchange-rate arrangements.

2.1 Relationships among IKEA goods

IKEA produces thousands of products. Many of these products are members of groups that we call "families," defined as a group of products that share a name, function, materials, and construction details. One example is the LACK table described above; perhaps the best-known example is the family of BILLY bookcases. The BILLY bookcases are produced in a range of sizes and in many materials. A third large family is the POANG family of chairs, produced in many types of cloth and leather, with different wood finishes. Figure 1 illustrates the relationships among products in the IKEA universe. We use the term "good" to mean a product within a family that has a specified set of dimensions. Figure 1 shows two "goods" within the BILLY family – two bookcases with similar design but different dimensions. We use the term "variety" to indicate the material used to cover or finish the good. For each of the two BILLY "goods" in Figure 1, we show two varieties: a black-brown painted finish and an oak veneer finish. Varieties are often shared across goods. For example, the PAX family of wardrobes contains several goods that are also produced with oak veneer finishes. The distinction between families, goods, and varieties is empirically important for the degree of price coordination.

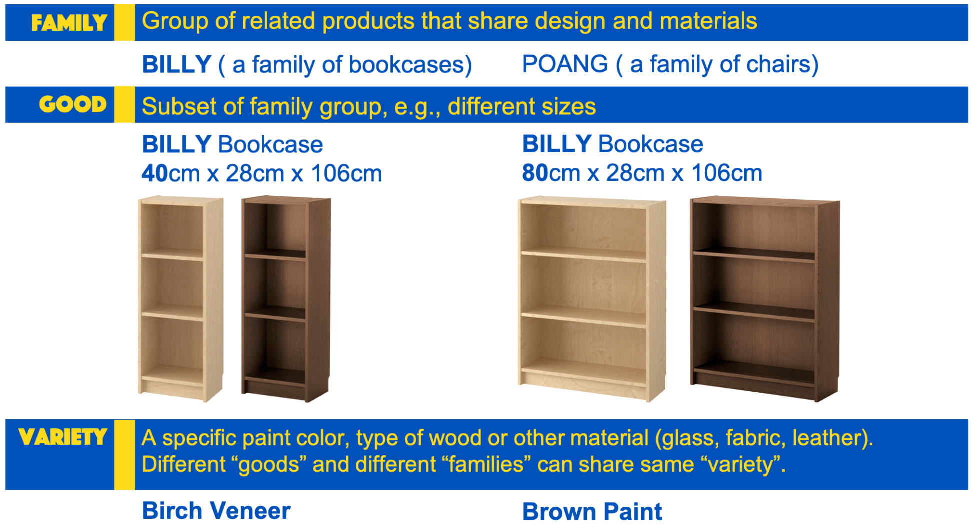

Figure 1: Ikea Universe

2.2 Dataset construction

Our dataset is different in many ways from those used in prior studies.[2] All information on each good in the catalog was professionally double-keyed from the physical catalogs with a guaranteed accuracy rate exceeding 99%. The information includes name, description, dimensions, color/fabric/finish, quantity, type of product (e.g., table) and a product code, if one exists. Goods with the same product code are identical, but often the same good can have different product codes in different years or different countries. Different colors of the same good have different product codes. We use information from the item's name, dimensions, color, and description to link observations on a single type of good and to link multiple varieties of the same good.[3]

We are particularly interested in tracking the prices of goods that remain in the catalogs for more than one year and are available in multiple countries. Fortunately, beginning in 2005 IKEA catalogs became much more standardized across countries, with a much higher fraction of common goods than previously. Beginning in 2005, IKEA assigned a unique key to some items; by 2007, nearly all items contained a key for at least one country. We matched goods that lacked product keys through comparison of other fields, such as name, dimensions, color,

[2]Burstein and Jaimovich (2009), Boivin, Clark, and Vincent (2010), and Gopinath, et al. (2011). The use of catalog prices was earlier implemented by Kashyap (1996) and Haskel and Wolf (2001). Related work using the posted prices of The Economist magazine was undertaken by Ghosh and Wolf (1994) and Knetter (1997).This growing literature includes contributions by Bils and Klenow (2004), Eichenbaum, Rebelo and Jaimovich (2010), Klenow and Kryvstov (2008), Midrigan (2011), Nakamura and Steinsson (2008, 2011), Gopinath and Rigobon (2008), Gopinath and Itaskhoki (2010) and many others.

[3]The web-scraped data of Cavallo, et al. (2014) generates much larger datasets and is excellent for analyzing prices at a point in time, although the fact that identical products in the same year can have different ID codes in different countries introduces a source of missing observations in the scraped data. Further, the scraped data cannot join together different varieties of the same good since different varieties carry different ID codes.

description, etc. A significant percentage of identical goods have different item keys in different countries. These matches were verified through clerical review. These procedures produced a panel across countries and years for each individual IKEA catalog good. In the second stage of the data assembly process, goods that were identical except for color or type of finish were identified. For example, the "LACK" table is a small table that has been offered in nearly a dozen colors at various times, e.g., it has been offered in black, red, white, pink, green, and many other colors. The item key for a black table is different from the item key for a white table. We used information from other fields, such as name, dimensions, and description to form a group of LACK tables that differed only in "variety" –the specific color or type of finish on that good.

Price-lines for individual products in a given country are sometimes interrupted by a year in which the product does not appear in the catalog. For example, a "POANG" chair may appear in the 2007 catalog as well as the 2009-2012 catalogs, but be absent from the 2008 catalog. We handle gaps in catalog availability as follows. If the good reappears in the catalog with an unchanged local currency price, then we assume that the price did not change during the time it was absent from the catalog. If the good reappears with a different price, we employ two approaches to inferring the price in the missing year. The first approach, which is standard in the literature, is to assume that the price did not change until the year it reappears (ee Klenow and Kryvstov (2008) and the survey by in Klenow and Malin (2013). We call the "fill-forward" approach. The second approach–the "fill-backward" approach, is to assume that the price changed to the new price in the first year that it was absent, and stayed at this level until it reappears in the catalog at this price. Goods that are absent for more than two years are assumed to be different goods when they reappear, even if they have identical ID code, dimensions, color, etc. A new price-line is created for a good reappearing after 3 or more years since the materials or technology for producing the good may have changed with an absence of 3 or more years, so the good is effectively different, even if this cannot be discerned from the catalog information. Throughout, we calculated our results using both the "fill-forward" and "fill-backward" methods. The results are very similar throughout for both methods, so we report only the results for the "fill-forward" method. About 10% of observations were filled using the fill-forward procedure described above. This fraction is quite consistent across years and countries.

3 Charm pricing

Economists have long been aware of the prevalence of the numbers "0", "5" and "9" as terminal digits in prices.[4] Schindler and Kirby analyze about 1500 prices found in newspaper ads on September 1, 1990. One hypothesis was that the use of 9-ending prices would decline as the

[4]See, for example, the work of Schindler and Kirby (1997) analyzing this effect in retail refereces; see also the references therein.

Table 1: Last digit of IKEA price, by country

	Percent of prices ending in digit			
	0	5	9	1-4,6-8
Canada	14%	10%	69%	7%
Germany	10%	19%	59%	12%
France	10%	32%	48%	10%
Italy	5%	29%	55%	11%
Sweden	10%	38%	49%	3%
UK	15%	19%	48%	19%
US	14%	6%	75%	6%

length (number of digits) of price increased, due to the lower potential gain to the seller from a customer's incomplete processing of the true price as the level of the price rose. Schindler and Kirby explored empirically the theory that 9-ending prices lead to a perceived gain by the seller according to Thaler (1985)'s work building on prior work by Tversky and Kahneman (1979). customers found that the fraction of 9-ending prices did fall as the length of the price rose, and that over 98% of these prices were changed to end in the digit "0", something theory did not predict.

The term"Charm" pricing refers to psychological theories of price-setting related to use of involving the digit "9", e.g., \$9.99 instead of \$10.00. Through natural experiments and laboratory investigations, charm prices have been shown to importantly affect consumers' perceptions of the level of prices.[5] In the IKEA catalogs, over half of all displayed prices end in the digit "9", as shown in Table 1.

A price is classified as ending in "9" if it is listed in the catalog as "199.-" or "9.99". IKEA typically does not print decimals for prices that are whole currency units, so a price of \$199 would appear as "\$199.-" instead of "\$199.00". IKEA also does not print trailing zeros after the decimal point, e.g., a UK price of 9 pounds and 50 pence would be displayed as "£9.5", not "£9.50." The use of "9" as the last digit is most common in the US (75%) and Canada (69%), and least common in the UK, Sweden and France (about 48% in each of these countries).

We found that many IKEA price changes involved changes of less than one currency unit, e..g, a US price that increases from \$5.00 to \$5.99. We therefore define a separate category of price changes, which we call "penny" price changes, for which the change in the price is less than one local currency unit (LCU). The use of penny price changes varies substantially across

[5] Anderson and Simester (2003) ran an experiment using prices in mail-order catalog where the price, and particularly the last digit, varied across customers. They found that demand was positively related to a price ending in a "9", but that apart from this effect, the price had no significant effect on demand (in this study, the variation in the price was +/-\$5 on an item priced at \$39). In the Anderson and Simester second experiment, the average product price was about \$50, and the price variation across experimental groups was \$3-\$5. They found that a 9-ending price led to a 15% higher level of sales for existing goods, and a 22% higher level of sales for new goods.

Table 2: Regular and penny price changes

	Distribution of price changes (%)						
	Decrease			Increase			No Change
	Regular	Penny	Both	Regular	Penny	Both	
France	11.17	2.63	13.80	15.56	6.23	21.79	64.41
Germany	9.20	4.31	13.51	19.87	6.86	26.72	59.77
Italy	13.30	2.86	16.17	10.23	10.40	20.64	63.20
US	9.41	1.03	10.45	17.04	2.70	19.73	69.82
Canada	12.22	2.12	14.34	16.93	3.80	20.73	64.93
UK	9.99	4.70	14.69	26.99	10.40	37.40	47.92
Sweden	13.03	0.00	13.03	18.48	0.00	18.48	68.49
All countries	11.19	2.53	13.72	17.85	5.80	23.66	62.63

countries, as shown in Table 2. In Sweden, the smallest coin in circulation is the 1-Krona coin, equivalent to 11 US cents. Fractional prices in Sweden are therefore not possible, and there are no penny price changes in Sweden.

3.1 "Penny" price changes

Table 2 shows that the use of penny price changes varies greatly across countries, with less prevalence in the US and Canada, and the highest use in the UK. Within the Euro zone, penny price changes are used more frequently in Italy than in Germany or France, suggesting a market-specific or culture-specific reason for the differential use of penny price changes in these countries. The process generating penny price changes could be due to managerial influences or decisionmaking processes that are separate from those determining other, "regular" price changes. Thus, where it may matter for our analysis,we separately analyze "penny" and "regular" price changes.[6]

3.2 Disguising price increase events

Literature... consumers scan prices, or round prices, and thus focus on a specific digit to estimate prices. We define the "critical digit" of a price to be the one that is important to consumer perception of a price change. For example, a consumer focused on the whole-dollar level of a price would not detect a price change from \$14.00 to \$14.99 since both prices would each be perceived as fourteen dollars, despite the increase of 99 cents. However, a price change from

[6] A similar distinction in the driving process for "sale" and "regular" price changes has been hypothesized by Kehoe and Midrigan (2008),Midrigan (2011).

Table 3: Small price changes

	Size of price change (absolute value)				
	<1%	1%-2.5%	2.5%-5%	5%+	All
A. % of all price changes of this size:	11%	7%	9%	73%	100%
B. Price changes of this size that are:					
Regular (>= 1 LCU)	17%	44%	74%	91%	78%
Penny (< 1 LCU)	83%	56%	26%	9%	22%

Table 4: Price changes and critical digits

	Type of price change			
	Decrease		Increase	
Change in critical digit	Regular	Penny	Regular	Penny
No	44%	56%	34%	73%
Yes	56%	44%	66%	28%

\$14.99 to \$15.00 would be perceived as an increase of \$1.00. For prices quoted in whole currency units, such as \$179, the critical digit would be the seven, as consumers exhibiting "leading digit bias" would evaluate this price as "about \$170", and would not distinguish between a price of \$172 and \$179. If consumers evaluate prices in this way, then a price-setting firm has an incentive to disguise price increases by leaving the critical digit unchanged. By contrast, a firm that attempts to focus consumer attention on prices would NOT disguise price decreases, implying that price decreases would be larger and that they would lead to changes in the price's "critical digit."

Table: price increases and decreases; penny and regular types; change in critical digit, or not. Info in table: size of price change (absolute value); % amount of price change.

3.3 Small price changes

Many previous studies of micro pricing behavior have noted that a significant fraction of price changes are small in absolute value. The large number of small increases combined with a large average increase was also noted by Midrigan (2011) in grocery store prices and by Klenow and Kryvstov in their study of goods in the U.S. CPI. These authors, as well as others including Dotsey, King and Wolman (2006), Goloslov and Lucas (2007), Klenow and Willis (2007) have argued that this evidence suggests the need for a departure from a standard menu cost story or the standard Calvo price-setting model.

Table 5: Small price changes by country

	Percent of all price changes (absolute value) less than cutoff		
	$< 1\%$	$< 2.5\%$	$< 5\%$
France	10.13	17.82	27.50
Germany	12.32	18.23	30.49
Italy	17.81	29.53	41.24
US	6.51	11.86	15.28
Canada	8.96	16.87	22.75
UK	14.11	20.02	29.40
Sweden	4.81	10.69	18.22

Table 5 presents summary statistics on small price changes. Following Klenow and Kryvstov (2008), we show the fraction of goods with price changes smaller than 5%, 2.5%, and 1%. Klenow and Kryvstov (2008) found that 44% of "regular price changes" were smaller than 5%, with 25% less than 2.5% and 12% less than 1%.[7] In the IKEA data, there are also substantial numbers of small price changes, although they represent smaller fractions of the total compared with Klenow and Kryvstov's data. Table 5 reports that 27.2% of all price changes are less than 5% in absolute value, with 18.3% smaller than 2.5% in absolute value and 11.1% smaller than 1%. of small prices. The prevalence of small price changes varies by country. Italy, Germany, France and the UK have higher fractions of small price changes compared with the US, Canada, and Sweden. These are also the countries with the highest fraction of "penny" price changes, as shown in Table 2. The heterogeneity across countries in the fraction of small prices suggests that country-specific factors, primarily in the decision to use "penny" pricing, are likely to be important to understanding why the fraction of small price changes varies across countries.

3.4 Reversion to reference prices

Many studies find that prices have a strong tendency to revert to previously-posted, "reference" prices.[8] Sometimes the temporary departure from the reference price is clearly due to sales; at other times, price reversion is less clearly linked to preannounced, temporary sales. Because of the importance of this phenomenon, we investigate whether IKEA prices show a tendency to revert to previous prices. Most datasets that find reversion to reference prices sample data at

[7]Klenow and Kryvstov (2008), Table IV.

[8]See, for example, Eichenbaum, Jaimovich and Rebelo (2011), Kehoe and Midrigan (2008) and Midrigan (2011). More recently, Ilut, et al. (2016) embeds Knightian uncertainty about demand into a firm's optimization problem and shows that firms face a kinked demand curve at the current price. The effect on equilibrium firm decisions is to reduce the frequency of price changes and also to give firms a reason to return to prices already posted since the firm has less uncertainty about demand at previously posted prices.

the weekly or monthly frequency.

We investigated whether the IKEA prices revert to previous prices in the way noted by these authors. We define a price reversion as a price change that sets the good's current price to any price previously posted in the catalog, not necessarily the most recently posted price. We define the percentage of possible reversions as total number of reversions as a fraction of the total number of all of price changes, defined over a particular good/variety/country. We found that price reversion does occur in the IKEA catalogs, but that it is very infrequent. Only 7% of all price changes that could have exhibited reversion actually do.The median number of price reversions for a price sequence is zero; the 75th percentile is also zero.

We noted earlier that many price changes, especially in the UK and the Euro zone countries, were "penny" price changes of less than one currency unit, usually involving a "charm price" with a last digit of 9. The use of these charm prices was often short-lived, for example, a price might change from 25.00 to 24.99, then to 24.95, then back to 24.99. Thus we examined price reversion for non-penny, or regular price changes. With penny price changes removed, only 3% of all price changes that could result in a reversion to a previous price actually do so.

Overall, the IKEA price data do not exhibit a tendency to for prices to return to a set of reference prices. Of those price changes that do revert to a previously-set price, the majority of these are penny changes less than 1 LCU in absolute value. The fact that prices are set for a year, instead of a month as in most of the literature is likely the reason for the difference between our results and those in the literature. We therefore conclude that price reversion, while very important in many other data sources, is of very minor importance in IKEA data.

3.5 Exchange-rate pass-through

Exchange-rate pass-through (ERPT) into local currency prices has been the subject of a very large literature. Empirically, ERPT is smaller when prices are set in the local currency (Gopinath Itskhoki and Rigobon (2010)). The model of the preceding section also predicts that ERPT is smaller, the larger is the share of local distribution costs in the final retail price. Since IKEA products are sold in large retail establishments, we expect low ERPT into IKEA prices, and for the same reason, expect high pass-through of local prices into IKEA retail prices.

The data are consistent with these hypotheses. Table 6 presents results from estimating a standard pass-through regression: the percentage change in the IKEA retail price is regressed on the previous year's local inflation rate and the previous year's depreciation rate. The timing of a "year" is chosen to correspond to the IKEA catalog release dates, in approximately June of each year, so that the lagged inflation and depreciation are computed as June-over-June rates.[9] As expected, the coefficient on lagged local price inflation is approximately one in all specifications,

[9]See, for example, Goldberg and Knetter (1997), Campa and Goldberg (2005), and Burstein and Gopinath (2014). Fitzgerald and Haller (2013), in a study of pricing by a single Irish firm setting prices in Ireland the UK, find essentially zero pass-through of exchange rate changes into UK prices.

Table 6: Baseline pass-through regressions

	Dependent variable: price change (t)				
Common independent variables: lagged inflation and depreciation					
Inflation ($t-1$)	1.025***	0.990***	0.951***	0.955***	0.954***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Depreciation ($t-1$)	0.078***	0.071***	0.076***	0.077***	0.077***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Fixed effects					
Country		Y	Y	Y	Y
Age			Y	Y	Y
Price decile				Y	Y
Variety					Y
Regression statistics					
Adjusted R^2 (%)	0.9	1.2	1.5	1.7	1.7
Observations	56,067	56,067	56,067	56,067	56,067

NOTE: Standard errors in parentheses. *** p<0.01; ** p<0.05; * p<0.1.

while the coefficient on the lagged depreciation rate is in the range 0.07-0.08. We estimated several specifications using country, age, price decile, and variety fixed effects, with little effect on the estimated coefficients of interest.

Pass-through of taxes is also important. European countries impose a Value Added Tax on sales of goods, while the US and Canada impose sales taxes. The VAT tax rate is large, ranging from 12%-25%, and is incorporated into the printed catalog price while sales taxes are not. Table 7 shows the statutory VAT rates in effect during our sample.

Adjustments to the VAT are infrequent and are widely discussed for up to two years before the change takes effect. In Germany, the standard rates of VAT plus insurance tax were raised from 16% to 19% on 1 January 2007. The increase in the German VAT was known well in advance. The governing parties had agreed on this measure in their coalition negotiations following the German general election in the autumn of 2005 and the announcement of the the VAT increase of Jan 1 2007 was announced in 2005.[10] The new VAT rate would affect IKEA's net-of-tax receipts for 2007 catalogs (in effect from July 2006-june 2007), and would affect the 2008 catalog prices from July 2008 onward. There was a detectable increase in the fraction of price increases in Germany in 2008 and 2009, as shown earlier in Table 16. The small increases in the Italian VAT did not produce dectectable changes in extensive or intensive margin of Italian

[10] Germany VAT announcement

Table 7: Value Added Tax (VAT)

	Country specific VAT across years						
	France	Germany	Italy	US	Canada	UK	Sweden
2005	.196	.16	.20	0	0	.175	.25
2006	.196	.16	.20	0	0	.175	.25
2007	.196	.16	.20	0	0	.175	.25
2008	.196	.19	.20	0	0	.175	.25
2009	.196	.19	.20	0	0	.175	.25
2010	.196	.19	.20	0	0	.175	.25
2011	.196	.19	.20	0	0	.175	.25
2012	.196	.19	.21	0	0	.2	.25
2013	.196	.19	.21	0	0	.2	.25
2014	.196	.19	.22	0	0	.2	.25

price changes.

The UK VAT increase in 2012 was the culmination of rumors of a VAT increase in the event of a Conservative victory that began prior to the 2010 UK general election in May 2010. Following the election, the Conservatives formed a coalition government wiht the Liberal Democrats, and an increase in the VAT from 17.5% to 20% was announced as part of the 2010 budget, with an effective date of January 4, 2011 was announced in the 2010 budget. The average rate of price increases in the UK catalog was 9.65% in the 2010 catalog year, spanning July 2009-June 2010. It is possible that IKEA was responding to early rumors of an upcoming increase in VAT of up to 22.5% to make up UK budget shortfalls as discussed in the UK press.[11] The articles in 2008 on the future change in VAT speculated that the VAT would rise in 2010 or 2011, and that consumers would respond to anticipation of this event or its announcement by increasing consumption in advance of the actual rise in VAT. This might explain the large increase in IKEA catalog prices in the 2010 catalog. IKEA's UK prices rose by less than 1% in the 2011 catalog and rose by about 4% (approximately the rate of inflation) in the 2012 catalog. It seems reasonable to conclude that IKEA raised UK prices in 2010 in advance of the probable VAT tax increase in an effort to capture an increase in consumer spending shifted to the period before the increase in VAT took effect. This intertemporal substitution is more likely to be important for durable and semi-durable goods of the type sold by IKEA.

Because the change in VAT is well-anticipated, the effect of the VAT can occur well before the imposition of the change in the tax rate. For this reason, when measuring prices, we have chosen not to net out the statutory VAT tax from the European prices. Instead, we directly account for anticipation effects of VAT changes on prices in the passthrough regressions.

[11]**The Guardian:** UK VAT increase.

Table 8: Pass-through regressions with Value Added Tax (VAT)

	Dependent variable: price change (t)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Common independent variables: lagged inflation and depreciation							
Inflation ($t-1$)	1.025***	1.028***	0.992***	1.144***	0.921***	0.917***	1.053***
	(0.06)	(0.06)	(0.06)	(0.08)	(0.06)	(0.06)	(0.08)
Depreciation ($t-1$)	0.078***	0.076***	0.075***	0.099***	0.086***	0.086***	0.105***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Robustness check: overall VAT change							
VAT Change (t)		-0.515***	-0.496***	-0.572***			
		(0.14)	(0.14)	(0.20)			
VAT Change ($t-1$)			1.145***	0.708***			
			(0.14)	(0.20)			
VAT Change ($t-2$)				1.340***			
				(0.19)			
Robustness check: country-specific VAT change							
VAT Change (t): Germany					-1.348***	-1.313***	-1.553***
					(0.17)	(0.17)	(0.25)
VAT Change (t): Italy					-0.860*	-0.745	-2.118***
					(0.50)	(0.54)	(0.79)
VAT Change (t): UK					1.584***	1.631***	1.514***
					(0.26)	(0.26)	(0.35)
VAT Change ($t-1$): Germany						1.371***	0.796***
						(0.15)	(0.23)
VAT Change ($t-1$): Italy						-0.005	2.699**
						(0.65)	(1.37)
VAT Change ($t-1$): UK						0.456	0.874*
						(0.34)	(0.46)
VAT Change ($t-2$): Germany							1.651***
							(0.21)
VAT Change ($t-2$): Italy							-3.581**
							(1.72)
VAT Change ($t-2$): UK							0.591
							(0.44)
Regression statistics							
Adjusted R^2 (%)	0.9	0.9	1.1	1.4	1.1	1.2	1.6
Observations	56,067	56,067	56,067	30,903	56,067	56,067	30,903

NOTE: Standard errors in parentheses. *** p<0.01; ** p<0.05; * p<0.1.

To test this hypothesis, we re-ran the pass-through regression using lags of the VAT rate. The results are shown in Table 8. As expected, the VAT change affects pricing up to two years before the change takes effect. However, including the current and lagged values of the VAT change does not alter the coefficients of interest: inflation passthrough is still about 100%, and exchange-rate pass-through is low, at about 8%-10%.

4 Price coordination

To what extent are IKEA's price changes coordinated within and across countries? We have documented high pass-through from local inflation to IKEA retail prices, as is predicted by standard menu cost models as summarized by Burstein and Gopinath (2014). For that reason, we expect that within-country measures of price coordination should be higher than an analagous measure of cross-country price coordination. We develop measures of price coordination that take account of price change 'events' as well as the direction of price changes. For most theories of price setting, what matters is the 'event' of a price change but not the direction since the price change 'event' signals that the value of changing the price is higher than the cost of the price change. However, coordination in the direction of the price change can be informative for determining the reason for the price change. If similar goods in two countries have price changes in the same direction, the reason could be a common cost shock. If similar goods' prices move in opposite directions in two countries, it is more likely that local conditions, such as local inflation or competitors' prices, have driven the desired local markups in opposite directions.

4.1 Within-country price coordination

To establish a within-country benchmark of price coordination we tabulate price coordination for random pairs of price changes within each country. Recall that a "product" is a specific variety of a specific good. For each product i, country c, and catalog year t, the direction of price change is recorded as one of three mutually exclusive values for the price change indicator: "D" (decrease), "N" (no change)" or "I" (increase):

$$
\begin{aligned}
D_{ict} &= 1 \text{ if } \triangle p_{ict} < 0 \\
N_{ict} &= 1 \text{ if } \triangle p_{ict} = 0 \\
I_{ict} &= 1 \text{ if } \triangle p_{ict} > 0
\end{aligned}
$$

Fixing country, c, and year t, and for $i \neq j$, we define indicators for the pairs of price changes building on the notation above. For example, $DD_{ijct} = 1$("DD" stands for decrease/decrease) if the prices of products i and j both decrease in country c in year t.

$$
\begin{aligned}
DD_{ijct} &= 1 \text{ if } \triangle p_{ict} < 0 \;\&\; \triangle p_{jct} < 0 \\
II_{ijct} &= 1 \text{ if } \triangle p_{ict} > 0 \;\&\; \triangle p_{jct} > 0 \\
DN_{ijct} &= 1 \text{ if } \triangle p_{ict} < 0 \;\&\; \triangle p_{jct} = 0 \\
IN_{ijct} &= 1 \text{ if } \triangle p_{ict} > 0 \;\&\; \triangle p_{jct} = 0 \\
DI_{ijct} &= 1 \text{ if } \triangle p_{ict} < 0 \;\&\; \triangle p_{jct} > 0 \\
NN_{ijct} &= 1 \text{ if } \triangle p_{ict} = 0 \;\&\; \triangle p_{jct} = 0.
\end{aligned}
$$

These are then summed over all years within the country and divided by the total number of ij observations for that country across all years. Thus, for each country, c, the column statistics for direction of price change are computed as

$$DD_c = \frac{\sum_{t=2006}^{2014} (DD_{ct})}{\sum_{t=2006}^{2014} (DD_{ct} + II_{ct} + DN_{ct} + IN_{ct} + NN_{ct} + DI_{ct})}.$$

These statistics are shown in Table 9 using all price changes. Overall, the table shows that coordination of price changes within countries is low. In France, for example, coordinated price decreases (DD) occur in 1.44% of all possible cases while coordinated price increases (II) occur in 2.24% of all possible cases. Prices in the French catalog move in opposite directions 3.14% of the time – a figure larger than either coordinated decreases or coordinated increases.

We know from the prior section on extensive margin price changes that most potential price changes result in no change. Thus the fraction of pairs in which one or both prices is unchanged represents a large fraction of all pairs. Continuing with the example of France, in 57.42% of cases neither price changes (NN). One price decreases while the other is unchanged (DN) in 16.99% of cases, one price increases with the other unchanged in 18.79% of cases. The other countries have results similar to those for France, in that coordinated decreases and increases represent small fractions of all price pairs. Prices move in opposite directions more frequently than price pairs exhibit coordinated decreases, and in Italy and France, opposite-direction movements are a larger fraction than coordinated increases as well. The UK has an unusually high fraction of coordinated increases, at 11.23%, which we attribute to the prevalence of penny price changes in this country.

4.2 Price coordination among related products

IKEA produces some very large classes of similar products. For example, the iconic "BILLY" bookcases and "LACK" tables are offered in many sizes and finishes. The "PAX" family of goods consists of wardrobes (tall cupboards) where the wardrobe frame is sold separately from doors, drawers, shelves, etc. The name "PAX" refers to the wardrobe frame. Two-word names, with "PAX" as the first name, refer to the fittings for the wardrobe. For example, "PAX

Table 9: Within country price coordination

	Direction of price changes (%)						Total
	DD	II	DI	DN	IN	NN	(%)
France	1.44	2.24	3.14	16.99	18.79	57.42	100.00
Germany	1.65	7.99	3.87	15.63	20.27	50.59	100.00
Italy	2.29	2.72	4.48	19.49	18.73	52.29	100.00
US	0.87	2.34	2.30	14.11	19.71	60.67	100.00
Canada	1.98	6.42	3.61	16.85	23.83	47.32	100.00
UK	2.11	11.23	6.34	15.37	28.60	36.34	100.00
Sweden	1.62	3.58	2.66	17.66	19.45	55.02	100.00
Average	1.71	5.22	3.77	16.59	21.34	51.38	100.00

NOTE: All price changes. Calculations as follows: For each country, select unique pairs of goods and tabulate their price changes, where D stands for decrease, I for increase, and N for not changed; therefore, DD represents the share of decrease-decrease price change pairs. For each country, aggregate the results across all years to yield a measure of within-country price coordination.

ARNSTAD" and "PAX ARDAL" are each pairs of sliding doors for wardrobes in the "PAX" family. We define a "family" of goods to be the set of goods that share all or part of a name. In the IKEA universe, the name also defines a type of product.[12] In some cases a single word, such as "LACK" or "BILLY" defines a family of goods. In other cases, as in the "PAX" examples, there are two-word names in which the first name identifies the family. Because goods within a family share design features and construction materials and techniques, the cost of goods within a family group should be highly correlated. For this reason, we expect higher price coordination within family groups than for random pairs of goods. Further, a price change for one good within a family is more likely to affect the demand for other goods within the same family since goods within a family are likely to be stronger substitutes than a random pair of goods –a 36" high bookcase more substitutible with a 42" high book case than it is with a Poang chair. Because a price change in the 36" high bookcase is more likely to affect the demand for the 42" bookcase, IKEA has incentive to minimize the within-family variation in prices.[13]

This section examines coordination of price changes within members of a family group. Table 10 presents price coordination statistics for family groups in a manner analagous to the previous section. As a benchmark, row (a) of the table shows sample-wide results for price coordination across random pairs, i.e., the cross-country observation-weighted averages of the statistics from Table 9, holding year and country fixed.

To determine the influence of "family" group on coordination, pairs are now formed by taking all combinations of goods within the given family, holding fixed the year and country. The price

[12]For example, beds and wardrobes are given Norwegian place names; rugs are given Danish place names. Bookcases are named for professions or Scandinavian boys' names. For more detail, see IKEA Product Names.

[13]Ref: Theory related to pricing of substitutes

Table 10: Price coordination within family groups

	Direction of Price Changes Pairs (%)						Total
	DD	II	DI	DN	IN	NN	(%)
Pairs with same:							
(a) country, year	1.71	5.22	3.77	16.59	21.34	51.38	100.00
(b) family,country, year	3.73	8.54	2.84	10.53	16.91	57.45	100.00
(c) good, family, country, year	7.42	12.91	1.30	6.24	7.69	64.43	100.00

NOTE: This table shows price coordination within family groups, where pairs are stratified in increasingly narrow groups: a family contains one or more "goods."

coordination statistics DD, II, etc. are then summed over all years.

Price coordination is substantially higher within family groups than for random pairs. When we form pairs within family groups only, coordinated decreases represent 3.73% of all pairs, compared with about 2% when not stratifying by family. Coordinated decreases represent 8.54% of all pairs, again, a higher fraction than with random pairs. The fraction of opposite-direction changes is 2.84%–much smaller than for random pairs. The fraction of coordinated "no change" price pairs, NN, is also higher at 57.45% when conditioning on family groups, compared with an average NN fraction of about 17% for the random pairs in Table 9. In short, constructing pairs within a family, year, and country generates increases in coordinated increases, decreases, and no change (DD, II, NN), and reduces opposite-direction price changes, DI, and price changes for which only one price changes (DN or IN).

To further investigate the finding that family-level prices move together more strongly than random prices, we further stratify our groups by dividing each family group into goods, each of which has one or more varieties. Recall that "goods" are defined by the item's name and dimensions. "Varieties" are defined as specific finishes applied to the good, e.g., different paint colors or types of wood for furniture such as the "BILLY" bookcase or the "LACK" table, or different fabrics for items such as the "POANG" chair. We continue to hold fixed the year, country, and family of goods. However, we now also hold fixed the type of "good", and form pairs by taking all combinations of "varieties" offered within that type of good. Goods offered in only one variety are thus dropped from these calculations. The results are shown in row (c). The finer division of families into goods leads to substantial increases in coordinated increases and decreases.[14]Specifically, we find that the fraction of coordinated dcreases rises to 7.42%,

[14]A spot check of large families of goods suggests that goods that represent distinct "varieties"–colors or surface treatments (fabrics) of otherwise identical goods frequently have prices that change together. The prices of different varieties for otherwise identical goods is related to the costliness of the materials. Leather varieties of POANG chairs cost more than fabric covers. Generally, the price of varieties within a given good are the same within a variety quality/cost group –all POANG chairs in similar quality of fabric cost the same. The Billy bookcases are offered in many varieties as well as many sizes, where 'variety' in the Billy bookcase refers to either a paint color, or a product simulating a wood finish (veneer, melamine, or foil). All paint colors typically have the same price, holding fixed dimensions, country and year, while all veneered products will have the same

compared with 3.73% (row (b)) when stratifying on family/year/country alone. Coordinated increases also increases dramatically, to 12.91% from 8.54% using family alone, and the fraction of opposite-direction changes falls from 2.84% to 1.30%. The fraction of coordinated "no change" pairs rises to 64.43%. The groups with offsetting declines are DN and IN, the groups in which only one price changes. These results illustrate clearly that price coordination rises as we look at pairs of goods that are more closely related.

There are several reasons to expect price coordination with a family of products, the first being the fact that families of products share highly correlated costs. Thus a cost shock to wood veneer that affects one item in the "BILLY" family of products would affect most or all products in this family. To the extent that changes in marginal cost drive price changes, we expect high coordination of price change within a family of goods. We know that IKEA prices tend to remain unchanged for a median period of two years, so we would expect to see a price change following a cost shock only if the profit from the price change exceeds the cost of changing prices. But when prices are changed because of a cost change, we expect prices to move in the same direction for goods within a family, holding fixed the country and year. Furthermore, goods within the same family are substitutes for each other (e.g., a 36" Billy bookcase is a substitute for a 42" Billy bookcase). A standard analysis of a monopolist producing two goods that are substitutes will set each good's price as a constant markup over marginal cost, however, the size of the markup increases the stronger is the substitution between the two goods. If the common marginal cost for the two goods increases, both prices will rise to restore the markup. In this simple model, the flexible-price monopolist would not choose to have the two goods' prices diverge. The second reason to expect enhanced price coordination within a family/year/country group is that the transportation costs in such a group will move together. Good-and-country specific markups can vary, but it is more likely that the target markup on the POANG chair will vary relative to the Lack table than the target markup for the 36" "Billy" bookcase will vary relative to the 24" bookcase. Given the similarity in the "Billy" bookcases, if IKEA has incurred the menu cost to change the price of one size of bookcase in a specific country and year, then following Midrigan (2011) it is reasonable that the menu cost for changing the prices of similar "BILLY" bookcases is negligible. Thus we expect to see the prices of "BILLY" bookcases within a given country and year moving in the same direction. We do, in fact, find higher coordination within families of products, and even higher coordination once we stratify groups at the level of a "good" as well.

---

price which is higher than the price of paint. For example, the Billy 106x60x39cm corner bookcase was available in gray; beech; birch; black-brown; white; and oak finishes in the US in 2005. The wood-grain veneer finishes for this specific Billy bookcase (beech, birch, oak) cost $80, while the painted finishes (gray, white) cost $60. In 2006, the price for each of the wood-grain finishes for the 106x60x39 bookcase fell by 1 penny to $79.99, while the price of the painted finishes fell by 1 penny to $59.99.

4.3 Cross-country price coordination and the Euro zone

The within-country price coordination statistics in the previous section provide a benchmark for evaluating cross-country price coordination. Several factors imply that within-country price coordination should be higher than cross-country price coordination. Most important of these is the influence of local price levels on the setting of the local retail price. Further, the influence of transportation costs affects goods within a country in the same way, while goods in different countries are subject to movements int he relative cost of transportation to the two countries. Also, demand shocks for goods are more likely to be correlated across goods within a country than across countries.

We construct a cross-country measure of comovement that is similar to the within-country measure above, except that pairs of goods are constructed so that each good is paired with all goods in the same year that are not in the reference country's catalog. Specifically, let c denote the reference country, and continue to let i index the good and let t denote the catalog year. he direction of price change is recorded as one of three mutually exclusive values for the price change indicator: "D" (decrease), "N" (no change)" or "I" (increase):

$$\begin{aligned} D_{ict} &= 1 \text{ if } \triangle p_{ict} < 0 \\ N_{ict} &= 1 \text{ if } \triangle p_{ict} = 0 \\ I_{ict} &= 1 \text{ if } \triangle p_{ict} > 0 \end{aligned}$$

The bottom panel of Table 11 shows cross-country price coordination statistics. As we noted earlier, most potential price changes result in no change ("N"). Price decreases are less frequent than price increases. The right-hand panel of this table shows within-country price coordination statistics. These statistics were formed as follows. Fixing country, c, and year t, pairs of goods (i, j), and countries $c' \neq c$, define indicators for the pairs of price changes as follows:

$$DD_{ij,cc',t} = 1 \text{ if } \triangle p_{ict} < 0 \ \& \ \triangle p_{jc't} < 0,$$

with the other indicators definied similarly, and the raw counts tabulated into population fractions by averaging across all possible pairs of goods and countries within a year, and then averaged over years, as in the within-country case.

Taking the case of the US as an example, the across-country share of "DD" observations is 1.0%, and the cross-country coordination of price increases (II) is 3.7%–these shares are very similar to the within-country shares for the US. The remaining statistics for the US measuring coordination between the US and other countries are also very similar to the corresponding within-US coordination statistics. A similar pattern holds for the other countries in our sample –there is little difference between within-country price coordination and cross-country price coordination. This is a surprising result since we expected higher within-country price coordi-

Table 11: Cross-country price coordination

	Direction of price changes pairs (%)						Total
	DD	II	DI	DN	IN	NN	(%)
A. Cross-country coordination: All unique pairs							
France	1.24	3.65	3.64	15.32	25.89	50.26	100.00
Germany	1.30	4.86	3.93	15.03	29.90	44.97	100.00
Italy	1.52	3.13	3.95	16.21	25.78	49.40	100.00
US	0.99	3.72	3.24	14.01	26.67	51.38	100.00
Canada	1.24	3.57	3.51	15.43	26.78	49.48	100.00
UK	1.42	5.50	4.59	14.57	31.31	42.61	100.00
Sweden	1.28	3.34	3.27	15.18	25.69	51.24	100.00
B. Cross-country coordination: Same family, good, variety							
France	3.27	5.62	3.68	11.09	22.28	54.06	100.00
Germany	3.05	6.36	3.40	11.98	24.71	50.50	100.00
Italy	3.59	5.22	4.31	11.61	22.01	53.26	100.00
US	2.17	5.07	2.87	11.64	22.63	55.61	100.00
Canada	2.85	5.04	3.85	11.95	22.89	53.42	100.00
UK	3.38	8.34	4.82	10.38	26.72	46.36	100.00
Sweden	3.29	4.89	3.20	11.41	22.01	55.20	100.00

NOTE: Within-year coordination between each country and all other countries. Panel A uses random pairs of goods, one from each country, for each named country (i) with all other countries (j). Results are aggregated aggregated across the other (j) countries to yield the percentages shown in the table. Panel B performs the same calculation except that pairs of goods from countries (i) and (j) are taken from the same family, good, and variety.

nation due to (i) the influence of local-currency price inflation on retail prices, as highlighted in the model of Section 5; (ii) greater within-country similarity in desired markups due to country-level demand shocks, also as highlighted in the model; and (iii) common within-country shocks to transportation costs. Our results show that these considerations do not lead to greater within-country comovement at the aggregate level.

4.4 International price coordination and the Euro zone

Three countries in our sample–France, Germany, and Italy–share a common currency. Models of price setting in a multi-country setting have the implication that local currency price changes should be related to exchange rate changes, although the "pass-through" coefficient can be less than one, as is the case in our data. To the extent there is any effect of the nominal exchange rate on local currency prices, we expect pairs countries that share a currency to have higher coordination than pairs of countries that do not. Specifically, we expect greater coordination of price changes among the Euro-zone countries–France, Germany, and Italy–compared with the non-Euro countries. Further, the three Euro zone countries are geographically close to each other, implying that transport costs from IKEA's production locations, many of which are in Eastern Europe or Asia, would be similar across these three countries. Thus shocks to transport costs should affect all three countries equally. We focus on the extensive margin of price changes, and ask whether the direction of price change is more likely to coincide between two Euro countries than between pairs of non-Euro countries, or between a pair of one Euro country and one non-Euro country.

The paired observations are constructed as follows. We hold fixed the year, good, and variety of good (if there is more than one variety), and form pairs of countries for which price changes are nonmissing for the given year, good, variety. This contrasts with the benchmark results in the previous subsection where pairwise observations were formed holding year fixed and taking all possible price pair observations for two countries without requiring that the same good and variety is used to form the pairs. The results are reported in Table 12. The first row repeats the statistics from the previous sub-section, where the country pair observations did not also condition on the good and variety. The second row show results for all country pairs where the good and variety are common across the country pairs. We find that standardizing by good/variety increases the fraction of goods with coordinated decreases and coordinated increases: the fraction of coordinated decreases rises from 0.013 to 0.031, and the fraction of coordinated increases rises from 0.040 to 0.058. The fraction of pairs for which neither price changes rises from 0.485 to 0.526. The fraction of price pairs for which prices move in opposite directions is unchanged at 0.037. Finally, the fractions of price pairs for which only one price changed are smaller when standardizing by good/variety.

The third row of the table show the price coordination statistics for price pairs formed within the Euro countries only (France, Germany, Italy). We expect higher coordination among these

Table 12: Regional coordination of price changes

	Direction of price changes pairs (%)					
	DD	II	DI	DN	IN	NN
A. Cross-country coordination: All unique pairs						
Within Euro zone	1.46	3.90	4.00	16.01	26.54	48.08
US & Canada	1.00	2.50	2.90	13.86	26.93	52.80
All non-Euro countries	1.16	4.21	3.56	14.30	27.72	49.05
World average	1.29	3.97	3.73	15.11	27.44	48.46
B. Cross-country coordination: Same family, good, and variety						
Within Euro zone	3.74	6.10	4.07	11.23	21.58	53.28
US & Canada	2.69	3.69	2.56	11.57	23.07	56.43
All non-Euro countries	2.81	6.19	3.75	10.91	23.38	52.96
World average	3.10	5.80	3.74	11.43	23.32	52.61

*NOTE:*Within-year coordination between pairs of countries in each region. Panel A uses random pairs of goods, one from each country, for each named country (i) with all other countries in the region (j). Results are aggregated aggregated across the other (j) countries to yield the percentages shown in the table. Panel B performs the same calculation except that pairs of goods from countries (i) and (j) are taken from the same family, good, and variety.

countries because of the influence of their shared exchange rate on the optimal price, as shown in the model presented earlier. These price coordination statistics are very similar to those presented in row 2 for all pairs of countries. Between pairs of Euro countries (France, Germany, Italy) coordinated price decreases occur in 3.7% of all cases; coordinated increases occur in 6.1% of all cases. The corresponding figures when considering all country pairs together was 3.1% and 5.8%–there is very little difference in coordination within the Euro countries. In the Euro countries, both prices are unchanged in 53.3% of all cases, compared with 52.6% of all country pairs. In the Euro zone, prices move in opposite directions 4.1% of the time, compared with 3.7% for all country pairs. In short, there is no discernible difference in the pattern of extensive margin price coordination within the Euro zone and in the sample as a whole.

There are also results displayed for "North America" (US-Canada), and here the price coordination looks noticeably lower than for the Euro zone and for all countries as a group. There are results also presented separately for all non-Euro countries, and these results look similar to the US-Canada results. For completeness, we also present statistics for two additional ways of forming country pairs. Row 5 has results for pairs in which one country is from the Euro zone and one country is from North America, and row 6 has results for pairs in which one country is from the Euro zone and the other country is a non-Euro country. Overall, we do not find a clear pattern of higher price coordination within the Euro zone countries. We do find a clear pattern of low price coordination between the US and Canada, but the expected influence of the common Euro exchange rate on Euro zone price coordination is not found in the data.

5 Estimation results on coordination

Midrigan (2011) proposed a theory highlighting economies of scope in price setting. In his model, once the producer pays the menu cost for one good, the prices of remaining goods can be adjusted at zero cost. In taking this theory to the data, at what level do the economies of scope operate? In Midrigan's analysis of grocery store prices, he found evidence that economies of scope existed at the level of the manufacturer and product category of the good. In the IKEA data, since a centralized authority sets prices in all countries and for all goods. However, it is likely that economies of scope in price setting might operate at the country level or the region level (in the case of the Euro zone) since IKEA prices move so closely with local currency prices and since managers with country-level expertise are undoubtedly instrumental in setting prices in coutries where they have expertise. It is also likely that economies of scope would operate at the level of the family group since marginal cost (the wholesale cost to the local IKEA store) will be highly correlated across goods within the same family and sharing the same destination.

Midrigan (2011) estimated a probit model in which the dependent variable was the event of a price change (taking the value 1 if the price changed and 0 otherwise), with independent variables meant to capture varying 'closeness' of the good to others that may capture the level at which economies of scope in menu costs might operate.[15] In our setting, IKEA's economies of scope in price setting could arise at the levels of the family, good, variety, country group (Euro zone; North America), as well at the country and year levels. We adapt Midrigan's approach to the IKEA framework in the following two sub-sections.

5.1 Family level results

Note: for updated table 14: USING * fractions for number of items in namegroup, (as fraction of all items) instead of raw number

* estimates are still not significant, but the range of the variable is the same as the other vars in probit, i.e. all fractions

* the estimates are positive as expected but not sig for all and regular price changes

* the estimates are negative but not sig for penny price changes; as if they should be hidden in smaller groups?

[15] Midrigan analyzes grocery store price data. He finds a large and significant positive marginal effect on the probability of a price change of the fraction of price changes posted for goods that have the same manufacturer and product category as the dependent variable. He finds a small marginal effect from the fraction of price changes posted by the same manufacturer but different product categories, and no effect from the same good category but other manufacturers. In one specification, there is a significant positive effect of the fraction of price changes storewide.

Table 13: Probit: Determinants of Price Changes

	All		Regular		Penny	
	(1)	(2)	(3)	(4)	(5)	(6)
Fractions changing price in:						
Family: worldwide	0.78***	0.19***	0.75***	0.18***	0.47***	0.16***
Family: country level		0.51***		0.49***		0.15***
Variety: worldwide	0.47***	0.00	0.40***	-0.08***	0.27***	-0.12***
Variety: country level		0.40***		0.43***		0.24***
Size of family (% all goods)	0.10	0.05	0.13	0.06	-0.08	-0.02

NOTE: Values are the marginal effect on the probability of price change. Families with fewer than 5 goods in a country/year pair are excluded. p-values: *** p<0.01, ** p<0.05, * p<0.1.

In the spirit of Midrigan (2011), we specify a probit model in which the dependent variable takes the value 1 if the product's price changed in the given year and country, and 0 if the price does not change. We distinguish between regular and penny price changes and report results for both definitions. The independent variables are as follows: (i) the fraction of all other goods in the same country, year and family that have price changes in that year; (ii) the fraction of products in the same level-2 variety group that change prices in the given year and country, and (iii) the fraction of level-2 varieties that change prices worldwide in the given year. These variables allow us to explore the level at which economies of scope may operate, depending on which groups of managers are responsible for which prices.[16] We also consider a specification in which the two variety variables are replaced by (i) the fraction of all goods changing price in the given country and year and (ii) the fraction of all goods changing price worldwide in the given year, since the focus of managers might be on country-level prices and not on variety-level prices. We find that the results are similar across the two specifications.

Penny price changes behave differently; smaller but still significant effects of family, country, year and variety, country, year. Table 13 shows the marginal effect of a change in the independent variables on the price change of the product. There is strong evidence of synchronization operating at the family/country level and also a significant effect of synchronization operating at the country level, and weak synchronization at the worldwide level. We find that a 1% increase in the fraction of price changes in all other goods in the family group leads to an increase in the probability of a price change in the same country and family group of 47%-69%, depending on the other explanatory variables and the measure of price changes (regular vs. all price changes). This is a very significant finding of within-group dependence of price changes that is suggestive

[16]Recall that an IKEA product appearing in a specific country's catalog in a specific year has the following attributes: family, good, and variety. Each family group (e.g., "BILLY" bookcases) contains one or more goods, where a good is a product within the family that has specified dimensions. Each good is produced in one or more varieties, e.g., the "BILLY" bookcases are available in black and white painted finished, and beech, birch, oak, and other wood finishes.

of economies of scope in price setting. However, it could also be due to a change in the cost of producing the specific family of goods. Table 13 uses three sets of controls for other factors that could affect the probability of a price change: the narrow and broad measures of variety by country/year and year, and just country/year and year on their own. Both measures of variety are significant, with the narrower definition carrying the larger coefficient. For example, a 1% increase in the fraction of price changes for a given variety/country/year is associated with a 19%-20% higher a price change for a good with the same variety/country/year. The last line in the table shows the estimated effect of the size of the family group within the given year and country. Because of concerns regarding the effect of scale on the estimated coefficient, we estimated this family size variable in two ways: (i) using the number of observations in the family group/country/year set, and (ii) the fraction of the family's observations in the country and year. In both specifications, the estimated coefficient was zero to at least four decimal places. We found this surprising as we expected that larger family groups would have higher price coordination, leading to a positive coefficient. If economies of scope in price setting operated at the family/year/country level, we expected that they would be stronger for larger family groups. However, our results show that this is not the case.

5.2 Cross-country results

This section uses a probit specification to estimate the extent of cross-country dependence in price setting. Table 14 contains our results.

A separate probit was run for each country. The dependent variable, as before, takes the value 1 if the product's price changed in the given year and country, and takes the value 0 if the price did not change. The independent variables are (i) the fraction of non-zero price changes in each country in the sample, including the country corresponding to the dependent variable, and (ii) the fraction of price changes in the specified country in the same year and with the same variety as the dependent variable. The model was estimated using all price changes (Panel A) and just regular price changes (Panel B). Using all price change data, (Panel A), we find a strong, positive, marginal effect of the same country's fraction of price changes in the same year/family as the dependent variable, with the size of the effect quite similar across countries, ranging from 0.40 to 0.44. Furthere, there is a strong marginal effect, quite similar across countries, of .50 to .57 of the fraction of price changes in the same year, country, and variety. We also find a strong pattern of no dependence of country-level price changes on the fraction of price changes in other countries, holding fixed year and family. This is striking, because it shows no dependence of price change decisions in the Euro countries on price changes in the other Euro countries, even when we stratify down to the family level. Although we found in the previous sub-section that there was within-country dependence on the fraction of price changes within a family group, this effect is absent when we look across countries. Thus, if we interpret the results as indicating the level at which economies of scope operate, the results tell us that potential economies of

Table 14: Synchronization in Price Changes at Country Level

		France	Germany	Italy	US	Canada	UK	Sweden
Panel (A). All price changes								
Fraction of price changes in same year and family:								
(a)	France	**0.41**	0.02	0.04	0.01	0.03	0.02	0.01
(b)	Germany	0.01	**0.40**	0.01	-0.03	0.01	0.01	0.00
(c)	Italy	0.03	0.03	**0.40**	0.01	0.03	-0.02	0.00
(d)	US	-0.01	-0.04	0.01	**0.39**	-0.01	0.00	0.02
(e)	Canada	0.03	0.01	0.04	0.00	**0.39**	0.01	0.01
(f)	UK	-0.02	-0.02	-0.04	-0.01	-0.02	**0.44**	-0.01
(g)	Sweden	0.02	0.01	0.02	0.00	0.02	0.02	**0.44**
Fraction of price changes in same year and variety:								
(h)	COLUMN country	**0.54**	**0.50**	**0.57**	**0.56**	**0.51**	**0.57**	**0.48**
Panel (B). Regular price changes								
Fraction of price changes in same year and family:								
(a)	France	**0.24**	0.01	-0.00	-0.00	0.02	0.01	-0.01
(b)	Germany	0.01	**0.27**	0.03	-0.01	0.01	0.01	0.01
(c)	Italy	0.01	0.05	**0.22**	0.03	0.04	0.00	-0.02
(d)	US	-0.01	-0.01	-0.00	**0.27**	0.00	0.03	0.04
(e)	Canada	0.02	0.02	0.02	0.01	**0.30**	-0.01	-0.04
(f)	UK	0.01	-0.00	0.01	-0.01	-0.02	**0.35**	0.01
(g)	Sweden	-0.01	0.00	-0.01	0.00	-0.01	0.00	**0.29**
Fraction of price changes in same year and variety:								
(h)	COLUMN country	**0.38**	**0.40**	**0.39**	**0.45**	**0.39**	**0.52**	**0.40**

NOTE: This table demonstrates the marginal effect of the probability of price changes using a probit model at the country/year level. Panel (A) uses all price changes, while panel (B) regular price changes. Each column contains results for a specific country. Read down the columns for each country's results. Rows indicates the right-hand-side variables of the country-level regression. Specifically, rows (a)-(g) are the fraction of price changes in the same year-family group of each country; hence, in all country-level regression specifications, each country's such fraction is included on the right-hand side. Row (h) is the fraction of price changes in the same year-variety group of the COLUMN country. All coefficients are statistically significantly different from 0 at 1% level unless underlined.

scope could be operating at the country/year/family/variety level, but that economies of scope do not operate across national borders.

6 Which theory?

The mainstream models of price-setting differ mainly in the form of the 'menu cost' that induces sellers to adjust prices infrequently. The form of the menu cost function varies from the Calvo (1983) and Taylor (1980) time-dependent models with a constant cost of adjustment, theories in which the cost is random and possibly state-dependent, as in Dotsey, et al. (1999). The prevalence of small price changes in many micro price datasets has led authors to argue that none of the variants of menu cost models is obviously dominant.[17] The IKEA data, similar to many previously studied datasets, contains a large share of small price changes, raising the same concerns about the applicability of models that fail to produce small changes. In contrast to most previous studies, we find that the predominance of small price changes are due to IKEA's use of "charm pricing" by which prices are changed to figures ending in the number "9", ostensibly to induce customers to commit errors in calculation of price changes, by overestimating price decreases and underestimating price increases.

In common with Klenow and Kryvstov (2008) and other researchers studying micro pricing, we find that the intensive margin of price adjustment explains a large fraction of overall price inflation for the goods in our sample. In contrast to previous research, however, we find an important role for extensive margin changes through their correlation with intensive margin changes. IKEA tends to simultaneously raise prices on goods receiving a price adjustment and also raises the fraction of goods with price changes. As noted by prior authors, an important role for extensive margin price adjustment is absent from models of time-dependent pricing, but is a hallmark of models of state-dependent pricing. The IKEA data thus would require a state-dependent pricing model.

IKEA famously sets prices for a year in advance, so that short-term sales or temporary price changes that are the hallmark of many previous studies are not found in this data. Because of the importance of temporary price changes in other data, many theories of price setting emphasize reversion to reference prices (Eichenbaum, Jaimowitz and Rebelo (2011)) and posit a different data generating processes for temporary sales and regular price changes (Kehoe and Midrigan (2008), Midrigan (2011)). Although IKEA does not have temporary sales, we studied the extent to which IKEA price changes revert to a previously-posted price, and found that price reversions were extremely rare, representing less than 3% of all regular price changes. As might be expected from price data for which prices are adjusted no frequently than once a year, reversion to reference prices does not play an important role.

Midrigan (2011) has argued for the importance of economies of scope in price setting. He

[17] See Klenow and Kryvstov (2008) for a discussion of the pros and cons alternative theories.

proposes that economies of scope in price setting can explain small price changes without a correspondingly small menu cost attached to each individual price change. In Midrigan's theory, paying the menu cost for one good means that there is zero marginal cost to changing other goods' prices. It is worth bearing in mind that changing prices in the IKEA catalog literally involves a 'menu cost' –the original definition of the term meaning the cost of changing the posted price on the 'menu' of items offered. In an age of digital layout and printing, the true cost of changing prices must have something to do with the cost of deciding whether to bother changing an item's price and, if it is changed, what should be the new price, keeping in mind that the price cannot be changed for a year after catalog release. Two pieces of evidence bear on the question of the existence and extent of economies of scope. First...that goods in a 'family' group (products of similar design and materials) have somewhat more coordinated price changes than random pairs of price changes. Second, goods with small price changes are not concentrated within categories where there are larger, 'regular' price changes, which one would expect if the menu cost were paid to permit the large price change, and the small price changes were accomplished due to the zero marginal cost of price changes after the first one. (It is not necessary that small price changes accompany large price changes for similar goods, since IKEA could pay the menu cost once and decide that all prices should be changed, but only by a small amount. Whether this is relevant depends on whether the menu cost is paid when the decision is made to consider what a new price should be, or if the menu cost is incurred only when the new price is chosen for the catalog. We believe the former is more relevant–that the real cost is deciding, not printing–which would allow a "name group" to have only small price changes. If the latter is true, however, then the menu cost is only worth incurring if there is a significant price change in at least some goods within the family group. Third, even narrowly-defined goods show very low price coordination price changes across countries. The lack of cross-country coordination could reflect the fact that different countries have different rates of inflation and depreciation. However, we found no higher price coordination within the Euro zone countries than in pairs of countries that have floating exchange rates vis-a-vis each other. Put differently, the exchange rate appears to play no role in price setting or price coordination in the IKEA data. While we expect that exchange-rate pass-through to local prices may be low when the goods contain a large fraction of local distribution services, as highlighed in the model presented earlier, it is very surprising that there is no higher coordination within the Euro zone. This is particularly surprising given the geographical proximity of these countries to each other, so that transportation and distribution costs to these countries must be very similar.

Midrigan's theory of economies of scope in price setting appears to have some explanatory power in our data. We found greater coordination of price changes within narrowly-defined product groups (holding fixed the country and year) relative to coordination across random pairs of goods. However, overall coordination of price changes, even within narrow groups, is very low. Specifically, even within narrow groups, some prices change–often by small percentage amounts–while the prices of very similar goods, being marketed in the same year and country, do not change. The combination of small price changes for one good in a group, with no price change for a good of nearly identical design and materials, being sold in the same store in the same year, is puzzling. Within the standard menu cost/variable markup story, this situation requires that the relative markups for related goods change by an amount larger than the menu cost, and in the opposite direction from the optimal reset price, but not by an amount so large that it is optimal to decrease the price of the related product. Alternatively, IKEA may value price stickiness in and of itself, so that they can advertise "Same price as last year!" –something commonly found in catalogs and in store signage. Future work is planned to explore the theory and empirical implications of the idea that stickiness is itself desirable because of its effect on customers' expectations.

7 Conclusion

This paper constructs a new dataset of IKEA pricing for seven countries covering a period of ten years. The IKEA data are exceptionally useful for studying pricing decisions because the listed prices are transaction prices –there are no sales. Further, there is no uncertainty about product definition, which can occur in some datasets when products are replaced by similar products. IKEA products are consistently defined through good-specific product codes, dimensions, color, description, and other attributeds listed in the catalog. Our analysis differs from previous analyses of IKEA data through its emphasis on continuity in product coverage over time and through linking of products into family and variety groups.

We find that both intensive and extensive margins of price adjustment are important, although the direct effect of the intensive margin is much larger, echoing previous findings by Klenow and Kryvstov (2018) and many others. The effect of the extensive margin operates through its covariance with the intensive margin. The importance of the extensive margin suggests that a model with a role for state-dependent pricing would be needed to explain the IKEA data. We found that IKEA price changes contain many small price changes, as has been found by many previous authors studying different datasets. We find that price increases are smaller on average, and more frequent, compared with price decreases. This finding, together with IKEA's advertising focus on price, suggets a possible role for psychological factors at work in pricing decisions.[18] In fact, our analysis of the data suggest that most small price changes arise from IKEA's experimentation with "charm pricing" –items with prices ending with the digit '9'. The existence of small price changes has suggested a variety of modeling approaches to explain small price changes within a menu cost model. Midrigan (2011) proposes a division of price changes into "regular" and "sale" price changes, and provides a model of strategic comple-

[18]Experimental results obtained by Danziger, S., L. Hadar and V. Morwitz, (2014) showed that consumers preferred stores with "everyday low prices" to stores that had infrequent and unpredictable sales with large price decreases.

mentarity under which the first price within a group incurs a menu cost, but that further items within the same group face a zero menu cost. We analyzed the IKEA data to determine whether the was evidence of price coordination that could represent economies of scope in price setting. We focused this effort on two main areas. First, are price changes coordinated for products sharing a family and variety, and does the coordination operate at the national or world level? Second, are price changes more highly coordinated within the Euro zone, as would be implied by a standard menu-cost model in which the exchange rate is one determinant of the optimal reset price? We found evidence of price coordination operating at the national level for products that share a product family (e.g., BILLY bookcases) and the same variety (color or type of wood). However, we found no evidence that the size of the product family had a significant effect on coordination, which we found surprising. With respect to coordination within the Euro zone, we found no evidence that prices are more coordinated across the Euro zone countries than across random pairs of countries. We found this surprising in part because these countries share an exchange rate, but also because the geographic proximity of the countries suggests that other factors that are important for pricing, such as transportation costs and local retail services, are more correlated within the Euro zone countries than for other pairs of countries. However, the data do not support this hypothesis.

A Price Changes: Intensive and Extensive Margin

The literature on price stickiness and inflation has emphasized the distinction between the extensive margin and intensive margin for price changes. An increase in overall inflation can be due to an increase in the extensive margin, meaning that a higher fraction of goods experience price increases. Inflation can also increase through the intensive margin: the same fraction of goods experience price changes, but the average size of the price change increases. In their survey of the literature on micro-pricing, Klenow and Malin (2011) cite the results of Klenow and Kryvstov (2008)'s analysis of supermarket prices and state that "the variance of aggregate inflation can be attributed almost entirely to the size of price changes (the intensive margin) rather than the fraction of items changing price (the extensive margin)." Klenow and Kryvstov (2008) find that inflation is strongly correlated with the intensive margin of price changes but has low correlation with the extensive margin of price changes. By contrast, the IKEA data show important effects stemming from both the extensive and intensive margins.

Adopting the notation of Klenow and Malin (2011), the annual inflation rate of an IKEA price in country c in year t, π_{ct} is the product of the average size of the price change, sz_{ct} and the fraction of all goods changing price, fr_{ct}:

$$\pi_{ct} = sz_{ct}?fr_{ct}.$$

Klenow and Kryvstov (2008) take a second-order expansion of this expression to decompose the variance of inflation into components due to the intensive and extensive margin, as follows:

$$var(\pi_{ct}) = var(sz_{ct})\overline{fr_c}^2 + var(fr_{ct})\overline{sz_c}^2 + 2\overline{fr_c}\,\overline{sz_c}cov(fr_{ct}, sz_{ct}) + O_{ct}$$

where $\overline{fr_c}$ denotes the sample mean of fr_{ct}, $\overline{sz_c}$ denotes the sample mean of sz_{ct} and O_{ct} denotes higher-order terms. Klenow and Kryvstov (2008) define intensive and extensive margin components as follows:

$$\begin{aligned} IM &= \overline{fr_c}^2 var(sz_{ct}) \\ EM &= \overline{sz_c}^2 var(fr_{ct}) + 2\overline{fr_c}\,\overline{sz_c}cov(fr_{ct}, sz_{ct}) + O_{ct}. \end{aligned}$$

This decomposition allocates the covariance term to the extensive margin component,which is unimportant in the Klenow and Kryvstov (2008) data where the covariance term is very small and the intensive margin component accounts for over 90% of the variance of inflation.

In the IKEA data, the covariance term accounts for a significant fraction of the overall variation in country-level price inflation. Thus, we report in Table 15 the fraction of variance explained by the intensive margin, the extensive margin, and the covariance term, where these are defined as follows:

$$\begin{aligned} IM &= \overline{fr_c}^2 var(sz_{ct}) \\ EM &= \overline{sz_c}^2 var(fr_{ct}) \\ cov(IM, EM) &= 2\overline{fr_c}\,\overline{sz_c}cov(fr_{ct}, sz_{ct}). \end{aligned}$$

We find that the the direct contribution of the intensive margin is about 60-75% of the overall variance of inflation, while the direct contribution of the extensive margin is only 4-6%. The covariance between the extensive and intensive margin has a substantial contribution to the overall variance of inflation, averaging about 25%. Although the covariance was unimportant in the Klenow/Kryvstov data, it is important here, and means that IKEA chooses positively correlated price changes on both the intensive and extensive margins.

Klenow and Kryvstov (2008) discuss the importance of extensive vs. intensive margin price changes for selecting among pricing models. Only state-dependent models (SDP), such as those by Dotsey, King and Wolman (2009) or Neiman (2011) can produce variation in the extensive margin, while time-dependent models (TDP), such as those of Calvo (1983) or Taylor (1980) produce variation at the intensive margin only. Based on these findings, a model involving some state-dependence in price setting would be needed to explain the IKEA data.

Table 15: IKEA price inflation: Intensive and extensive margins

	Corr. w/ inflation		Share of inflation variance explained by		
	IM	EM	IM	EM	corr(IM,EM)
	(1)	(2)	(3)	(4)	(5)
France	0.96	0.85	0.78	0.02	0.16
Germany	0.94	0.78	1.02	0.04	0.24
Italy	0.95	-0.20	0.74	0.03	0.01
US	0.98	0.83	0.74	0.04	0.28
Canada	0.94	0.80	0.74	0.01	0.14
UK	0.96	0.71	0.62	0.05	0.23
Sweden	0.96	0.75	0.74	0.00	0.04

NOTE: Columns (1) and (2) show the correlation between IKEA price inflation and the intensive and extensive margins of price changes. Columns (3)-(5) show the variance decomposition of inflation into components due to the intensive margin, the extensive margin, and the covariance between the intensive and extensive margins.

A.1 Extensive margin of price changes

As noted in the previous section, many price changes are changes of less than 1 local currency unit, which we call "penny" price changes because these price changes most often involve changing the last digit of a price, for example, from £2 to £1.99. Because the use of this pricing tool varies across the catalog years and across countries, "penny" price changes smaller than 1 LCU are shown separately.[19] Price changes greater than 1 LCU in absolute value are termed "regular"price changes.

Table 16 summarizes the behavior of extensive margin price changes by year; country; age of price; and price decile. Surprisingly, given IKEA's advertising focus on price reductions, price increases are actually much more frequent than price decreases when looking at the sample as a whole. Regular price decreases represent 9.09% of all possible price changes, while regular price increases represent are 14.50%. Penny price changes are about half as likely to be decreases (2.06%) as increases (4.71)%). These aggregate statistics may mask variation in price change behavior across years, countries, or characteristics of the individual good, such as the good's age and the level of the good's price. These detailed comparisons are provided below.

A.1.1 Year effects

Panel B of Table 16 shows the direction of price change statistics by catalog year. In the beginning of our sample, 2006 and 2007, prices went down more frequently than they went up.

[19] This is not the typical definition of "small price change" used in the literature–a cutoff value of, say, 5% would more commonly define "small." However, the importance of the 1-LCU cutoff point and its variation across countries makes this a more attractive definition in our setting. In practice, most price changes that are less than 1 LCU in absolute value are also small in percentage terms. See Section 3.2.3 below for more detail.

Table 16: Extensive margin of price changes

	Extensive margin: direction of price changes (%)						
	Decrease		Increase		Any change		No change
	Regular	Penny	Regular	Penny	Regular	Penny	
A. All data							
	9.09	2.06	14.50	4.71	23.59	6.77	69.64
B. Year							
2006	12.46	4.43	7.99	7.45	20.45	11.87	67.68
2007	12.91	2.85	6.16	4.93	19.07	7.78	73.15
2008	6.50	1.79	18.72	4.36	25.22	6.16	68.62
2009	4.68	1.57	21.24	4.87	25.91	6.44	67.65
2010	5.89	1.13	21.42	4.74	27.31	5.87	66.82
2011	10.86	2.13	8.29	1.37	19.15	3.50	77.36
2012	12.97	1.03	14.07	3.25	27.04	4.28	68.68
2013	7.10	1.34	14.45	8.47	21.55	9.81	68.64
2014	12.34	2.06	15.46	5.31	27.79	7.36	64.84
C. Country							
France	8.98	2.12	12.51	5.01	21.49	7.13	71.37
Germany	7.49	3.51	16.17	5.58	23.66	9.09	67.25
Italy	10.85	2.34	8.35	8.49	19.20	10.82	69.98
US	7.72	0.85	13.97	2.21	21.68	3.06	75.26
Canada	9.90	1.71	13.72	3.08	23.62	4.79	71.59
UK	8.10	3.81	21.88	8.43	29.98	12.24	57.78
Sweden	10.57	0.00	14.99	0.00	25.56	0.00	74.44
D. Age							
2	10.89	2.71	15.02	5.84	25.91	8.55	65.54
3	11.34	2.30	19.23	5.64	30.57	7.94	61.49
4	10.89	2.40	22.13	5.85	33.02	8.25	58.73
5	9.86	1.97	19.71	4.95	29.57	6.92	63.52
6	12.84	2.75	20.76	6.39	33.61	9.13	57.26
7+	14.42	3.10	19.05	6.93	33.47	10.04	56.50
E. Price decile							
1	3.58	5.60	5.70	11.01	9.28	16.61	74.11
2	7.37	2.69	11.08	7.06	18.45	9.75	71.81
3	8.67	1.75	12.17	5.82	20.84	7.57	71.59
4	7.75	1.80	13.50	4.89	21.25	6.69	72.06
5	7.96	1.48	14.50	3.93	22.47	5.41	72.12
6	7.91	1.77	14.54	3.60	22.45	5.37	72.18
7	9.15	1.66	16.38	3.98	25.52	5.63	68.84
8	12.73	1.10	20.89	1.69	33.62	2.79	63.59
9	14.19	0.45	22.13	0.60	36.32	1.06	62.62
10	16.55	0.20	19.60	0.48	36.15	0.68	63.17

This stands in contrast to the much larger share of increases relative to decreases in the sample as a whole.

This pattern changed dramatically in the 2008-2010 catalogs, where the fraction of regular price reductions fell markedly, while the fraction of regular price increases roughly tripled relative to the pre-2008 period. Did the change in the fraction of price increases coincide with the onset of the Great Recession? The NBER Business Cycle Dating Committee dates the US Great Recession as beginning in December 2007 and ending in December 2009. Recession dates for the other countries in our sample are different than for the US. For example, Canada entered the recession in the last quarter of 2008, with the recession ending on July 23, 2009. Germany's recession also began later than that of the US and was over more quickly. [20] The CEPR estimated that the Eurozone recession extended from the first quarter of 2008 to the second quarter of 2009.[21] The UK recession dates are about two quarters delayed from the Eurozone dates: 2008:3 to 2009:4.

Thus, the catalogs that would have been affected by IKEA's knowledge of the beginning of the recession period would be the 2008, 2009, and 2010 catalogs. Recall that these catalogs are released in June or July of the calendar year preceding the date on the catalog. Thus the 2008 catalog would have been printed and in the hands of customers by summer 2007. Possibly, IKEA's pricing in the 2008 catalog was influenced by growing uncertainty about the US mortgage market and the associated securitization boom. By the time that the 2009 catalog was released in mid-2008 the US recession was well underway and price expectations associated with the recession would have been reflected in the 2009 catalog.

IKEA undertook more price increases during the recession period of 2008 and especially 2009 and 2010, compared with other years. In catalog year 2008, the fraction of regular price changes was 18.72% of all possible price changes, a dramatic increase from 6.16% of all price changes in the 2007 catalogs. This fraction rose further to over 21% in catalog years 2009 and 2010. At the same, time, the fraction of goods with regular price decreases fell from 12.91% of all changes in the 2007 catalog to about 4%-6% in the 2008-2010 catalogs. The fraction of goods with unchanged prices fell during this period, while the fraction of goods with penny price changes remained about the same. Catalog year 2011 was also unusual in the larger fraction of unchanged prices, at 77.36% of all prices, and a correspondingly smaller fraction of regular price changes. After 2011, there is a relatively stable pattern of price changes in which price increases (both regular and penny) are more common than price decreases, and the fraction of unchanged prices stabilizes at about 69%.

The surprising finding here is that the frequency of price increases rose–quite substantially–during the Great Recession while the frequency of price dereases declined. This is unexpected, as it occurred at a time of presumably reduced consumer demand.

[20]http://www.economist.com/blogs/freeexchange/2010/11/cross-country_comparisons

[21]http://cepr.org/content/euro-area-business-cycle-dating-committee

A.1.2 Country effects

Panel C of Table 16 contains direction of price change statistics by country. The countries are roughly similar in their fractions of price decreases; there is more dispersion in the pattern of price increases. The UK has, by far, the highest fraction of regular price increases at 21.88%. The use of penny price changes varies substantially across countries. This practice is heavily used in the UK, Italy, Germany and France but is much less prevalent in Canada and the US. (Recall that "penny" price changes are impossible in Sweden since Sweden's smallest coin is worth 1 local currency unit.) Overall, both regular and "penny" prices change much more frequently in the UK than any other country. Regular prices change least frequently in Italy. Comparing the figures for Italy to those of its Euro Zone numbers, we do not see a pattern in France or Germany that mirrors that of Italy.

Age of the good

Panel D of Table 16 shows price change statistics broken down by the age of the good, defined the number of years since the good first appeared in the catalog. This can potentially shed light on the decision to incur a 'menu cost' to change a good's price. Differences in price changes across the age of the good would subbest that price changes were examined and potentially changed at specific points in the good's lifecycle. However, the age profile of price changes is quite flat, anticipating the relatively flat hazard rate of price changes shown in 2 below.

Price decile

Panel E of Table 16 presents extensive margin price statistics broken out by price decile. We defined price deciles using the prices of Swedish goods available in the 2010 catalog–the middle of our sample period. We use these deciles for all goods in Swedish catalogs for all years. We also use this information on the Swedish price of a product to assign non-Swedish goods to deciles according to their Swedish-kronor-equivalent price. This table shows a low fraction of regular price increases in the first decile, only 5.60%, compared with goods in higher price deciles. The fraction of regular price increases rises with the decile, from 11.08% in the second decile and over 20% in deciles 8-10. The fraction of regular price decreases shows the same pattern. This fraction is lowest in the first decile, at 3.58%, and highest for the top three deciles, averaging about 15%. Overall, we find that IKEA prices are adjusted more frequently in the upper deciles. It makes sense that IKEA would pay more attention to higher-priced goods since a 5% pricing error would have a greater effect on profits from a $1200 sofa than it would have on a $10 kitchen item. A menu cost model with a fixed menu cost per item, rather than a cost proportional to the value of the item, would predict that high-value products would have prices that adjust more frequently.

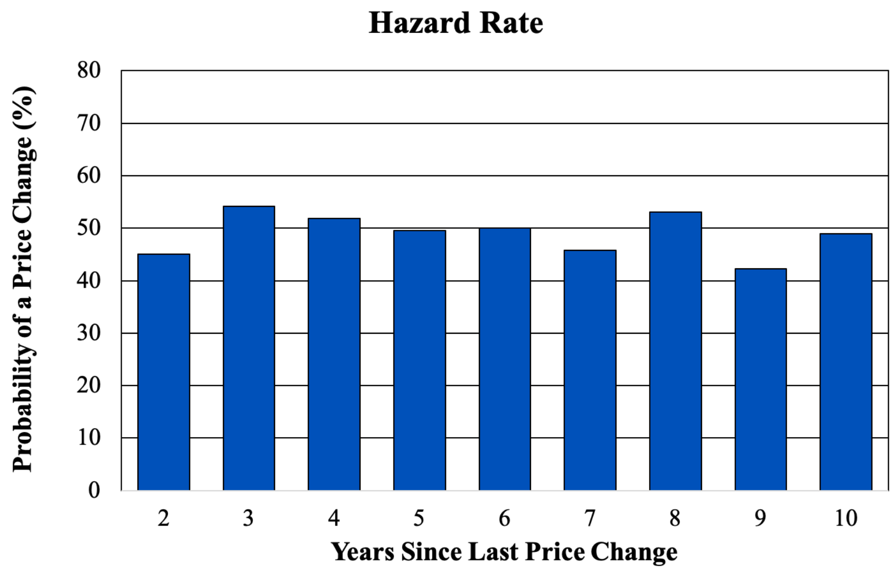

Figure 2: Hazard Rate

The Hazard Rate

The hazard rate–the probability of a price change as a function of the good's price–is potentially useful for distinguishing among models of price-setting. The model of Calvo (1983) predicts a flat hazard rate, while the model of Taylor predicts zero hazard except at dates corresponding to the dates of allowed adjustment. Models of state-dependent pricing and models with menu costs are consistent with a range of behaviors of the hazard rate. The hazard rate has been studied in a wide variety of micro price datasets, with the emerging view that hazard rates are roughly constant for periods beyond the first few weeks or months.

Figure 2 shows the hazard rate for IKEA price changes is essentially flat, as commonly found in the literature. The absence of an initial short period–a few weeks or months– of declining hazard that is found by some authors is likely due to the fact that prices in the IKEA catalog last for at least a year, well beyond the length of time over which hazard rates are found to decline.[22]

A.2 Intensive Margin of Price Changes

In the IKEA catalogs, price increases tend to be smaller than price decreases. For this reason, Table 17 presents results separately for price increases and price decreases as well as results for the absolute value of changes. We also separately report results for regular and "penny" price changes. Panel A of the table shows results for the full sample. Regular price changes are large:

[22]See Alvarez (2008), Klenow and Kryvstov (2008), Nakamura and Steinsson (2008) and Klenow and Malin (2011).

the average decrease in regular prices is -18.89%, while the average increase in regular prices is 16.84%. The mean absolute value of regular price changes is 17.63%. Penny price are small, on average, as would be expected: decreases average -6.81%, while penny increases average 5.42%.

In previous work using a range of different data sets, many authors have noted that price increases tend to be smaller than price decreases.[23] Panel A showed that this is true in the full sample of IKEA data as well. It remains overwhelmingly true whether we slice the data by year; by country; by age; or by price decile, as shown in panels B through E of Table 17. A menu cost model can produce this pattern in an environment with positive inflation; see, for example, Nakamura and Steinsson (2008). This would also predict that higher inflation would lead to relatively fewer price decreases and larger price decreases (in absolute value). We found no relationship between the rate of inflation (current or lagged) and the fraction of price decreases, or the relative size of price increases vs. price decreases (results not reported here). However, this could be due to the fact that the inflation rates did not vary greatly across countries or over time in our sample. Given IKEA's advertising, though, another possible explanation is that IKEA tries to mask price increases by making each price increase relatively small, but draws attention to price decreases through larger, and more noticeable, decreases. Frequently, the catalog will proclaim "New lower price!" to draw attention to reduced prices. Obviously, similar attention is not drawn to price increases.

A.2.1 Increases vs. decreases: A disaggregated look

Panel B of Table 17 presents results on the intensive margin broken out by year. We noted previously that there had been an increase in the extensive margin of price increases during the recession catalogs of 2009 and 2010. In Table 17-B we find that the average size of the price increases was also higher from 2008 onward. The size of the average price increase rose from 10% in the 2007 catalog to 13% in the 2008 and 2009 catalogs, and continued to rise still further in the next three years, to an average increase of 17% in the 2012 catalog. The average size of a price decrease was also larger (in absolute value) from 2010 onward. On net, however, the average price change was highest (3%) during the recession years, reflecting the combination of extensive margin and intensive margin price changes. There were more price increases during 2009 and 2010, and the average price increase was higher during these years. This was not offset by the higher absolute value of price decreases in the same period.[24]

Table 17-C presents intensive margin results at the country level. There are striking differences across countries. The three EMU countries–Germany, France, and Italy–do not look

[23]See, for example, Burstein and Hellwig (2006); Klenow and Kryvstov (2008), Kehoe and Midrigan (2008) Midrigan (2011), and Nakamura and Steinsson (2008).

[24]Nakamura and Steinsson (2008) find that inflation is strongly related to the fraction of goods experiencing price increases but no relationship between inflation and (i) the size of price changes or (ii) price decrease fractions. The findings of Klenow and Kryvstov (2008) are similar except that they find a significant effect of price decreases.

Table 17: Summary Statistics for intensive margin of price changes

	Intensive margin: size of price changes (%)					
	Decrease		Increase		Abs. value	
	Regular	Penny	Regular	Penny	Regular	Penny
A. All data						
	-18.89	-6.81	16.84	5.42	17.63	5.85
B. Year						
2006	-18.92	-4.59	19.05	3.68	18.97	4.02
2007	-18.10	-7.68	15.13	3.60	17.14	5.09
2008	-18.16	-9.37	15.38	4.46	16.10	5.90
2009	-16.62	-5.64	14.51	6.03	14.89	5.94
2010	-18.33	-7.86	16.89	6.85	17.20	7.05
2011	-19.01	-5.87	18.74	12.99	18.89	8.65
2012	-21.08	-12.35	20.94	9.65	21.01	10.30
2013	-20.97	-6.91	18.20	4.32	19.11	4.67
2014	-19.55	-5.91	20.72	4.79	20.20	5.10
C. Country						
France	-19.84	-8.73	19.17	5.83	19.45	6.69
Germany	-19.82	-5.34	14.01	5.82	15.85	5.64
Italy	-16.14	-8.45	15.00	2.72	15.64	3.96
US	-21.65	-7.10	21.72	7.06	21.69	7.08
Canada	-19.41	-3.45	18.41	4.82	18.83	4.33
UK	-17.97	-7.46	15.78	7.48	16.37	7.47
Sweden	-18.55	–	14.77	–	16.33	–
D. Age						
2	-18.17	-5.57	15.26	4.89	16.48	5.10
3	-18.59	-7.80	16.46	5.07	17.25	5.86
4	-18.88	-7.68	16.06	5.79	16.99	6.34
5	-20.00	-7.56	16.16	5.95	17.44	6.41
6	-20.88	-7.80	20.83	7.57	20.85	7.64
7+	-21.98	-9.72	29.46	7.41	26.24	8.12
E. Price decile						
1	-28.83	-14.17	37.70	11.84	34.28	12.63
2	-25.84	-6.44	25.52	4.88	25.64	5.31
3	-24.46	-2.40	26.46	2.45	25.63	2.44
4	-21.89	-2.02	17.56	2.05	19.14	2.04
5	-20.12	-1.24	15.49	1.73	17.13	1.60
6	-18.15	-1.21	14.02	1.49	15.47	1.39
7	-16.75	-0.85	14.66	1.10	15.41	1.03
8	-15.47	-0.69	13.04	0.75	13.96	0.73
9	-13.91	-0.36	11.53	0.36	12.46	0.36
10	-14.50	-0.15	8.70	0.19	11.36	0.18

particularly similar in terms of the pattern of their average price change statistics. The US has the largest average size of regular price increases and decreases (in absolute value).

The effect of product age on the size of price changes is shown in Table 17-D. The average size of regular price changes is lowest for goods of age two, are larger for goods aged 3-5, and are largest for goods older than six years. This is true for all measures of regular price changes and all measures of '"penny"price changes. As noted by Klenow and Malin (2011), many models predict a positive relationship between a price's age and the size of the subsequent price change. The Calvo (1983) model predicts this positive relationship if shocks to desired prices accumulate over time, or if shocks accumulate over time and the firm resets prices when drawing a low menu cost (Dotsey et al. 1999). Conversely, age would be unrelated to size if shocks did not accumulate.

This pattern could be consistent with a menu cost story in which the opportunity for price adjustment is random or state-dependent. With this story, IKEA may not have had the opportunity to reprice a particular the good for several years, so that price adjustment, when it occurs, is larger in absolute value. This story would also explain why the average price change does not depend on the age of the item.

Panel E of Table 17 breaks down price changes by price decile. The size of the price change is negatively related to the price decile. Lower-priced goods have larger percentage price changes. This is true for increases and decreases, and for regular and penny" price changes. For every price decile, the (absolute) size of the average regular price decrease is higher than the size of the average regular price increase.

There are several common-sense reasons to expect this pattern. First, the goods in low deciles have small prices–these tend to be inexpensive kitchen items, such as a spoon or a towel. A 50% increase in this price is still a low price, and involves a small dollar price change from the consumer's point of view. However, a 50% increase in the price of a sofa priced at $1000 would be much more noticeable. The more-expensive sofa likely contributes much more to IKEA profit, so large percentage price changes that would be acceptable or unimportant to the consumer when considering a $1 wooden spoon would be unacceptable and definitely important for the purchase decision when considering a sofa.

B A model of international price-setting

IKEA sells identical goods through stores located in dozens of countries. Each good is produced in a small number of locations. IKEA directly controls the product going to the stores and the pricing of the goods within the stores. Thus, it is a perfect laboratory to study IKEA's decisions regarding "pricing to market." Are prices similar across countries? Are price change decisions coordinated across countries? Do IKEA prices exhibit significant exchange-rate pass-through?

To answer these questions, we adopt the partial equilibrium model exposited by Burstein and Gopinath (2014). In their model, an exporter, Germany, produces goods in Germany, using

German labor and material inputs that are sourced in part from other countries and priced in dollars. Wages and exchange rates are exogenous. The final goods are exported, with prices specified in US dollars.

The good is sold to the consumer at a retail outlet through a production technology that combines the good with retail or distribution services according to a fixed-proportions production function with the addition of a retail markup. The log retail price of good i in family k in country c at time t, $p_{ct}^{retail,ik}$, is a weighted average of the dollar price of the good at the border, $p_{ct}^{border,ik}$ and the price of distribution services, d_{ct}^{ik} where ρ is the share of distribution services in the pre-markup retail price, assumed constant across all goods, plus the retail markup γ_{ct}^{ik}.[25]

$$p_{ct}^{retail,ik} = (1-\rho)\left(p_{ct}^{border,ik}\right) + \rho d_{ct}^{ik} + \gamma_{ct}^{ik}.$$

The empirical literature finds that retail markups do not vary much over time, and are largely uncorrelated with exchange rate changes. We follow Burstein and Gopinath in dropping the retail markup from the remainder of this analysis.

We assume that IKEA can effectively segregate national markets and can therefore charge different (common-currency) prices in each country. Letting $\tilde{p}_{ct}^{border,ik}$ denote the log of the optimal, flexible, local currency "border" or "wholesale" price for good i of family k appearing in the catalog of country c in year t. This log price depends on the marginal cost of production of the good, mc_t^{ik}, which is assumed to be independent of the final destination of the good, reflecting IKEA's centralized production, and the markup over marginal cost, μ_{ct}^{ik}.

$$\tilde{p}_{ct}^{border,ik} = mc_{ct}^{ik} + \mu_{ct}^{ik}.$$

Substituting for the border price, the retail price is:

$$\tilde{p}_{ct}^{retail,ik} = (1-\rho)\left(mc_{ct}^{ik} + \mu_{ct}^{ik}\right) + \rho d_{ct}^{ik}.$$

Burstein and Gopinath (2014) describe several models in which the markup charged by a producer/exporter of goods in a single industry depends on the price of the exporting firm relative to the price charged by local-market competitors in the same industry.[26] The analogous specification in the current setting relates the markup to competitor retailers in specific types of home furnishings in each market. Let $p_{ct}^{local,ik}$ denote the industry-average price charged by IKEA's local competitors in country c at time t for good i in family k. The markup is then a

[25] As described in Section 2, there are many product families within the IKEA product range, where the goods within the family share the same materials and overall function and design, but differ by color, dimension, or other minor attributeds. A family is identified by a common name carried by all goods within that family.

[26] Many recent contributions have shown how to generate variable markups, for example, through strategic complementarities. This literature owes a great deal to Kimball (1995); for a recent application see Amiti et al. (2018).

function of the difference between the border price of the imported good and the local price:

$$\mu_{ct}^{ik} = \mu_{ct}^{ik}\left(p_{ct}^{border,ik} - p_{ct}^{loca,ik}\right).$$

In the models of the classes summarized by Burstein and Gopinath (2014), the local currency marginal cost (i.e., the marginal cost, expressed in dollars, of a good produced by IKEA and sold in the US) is:

$$mc_{ct}^{ik} = mc_{ct}^{ik}\left(q_{ct}^{ik}, w_t^{ik}, e_{ct}\right)$$

where q_{ct}^{ik} is the quantity of good ik sold in country c at time t. The variable w_t^{ik} represents variables affecting marginal cost of producing good ik in the exporter's home country, thus including wages in the exporter's home country as well as total factor productivity. The exchange rate between the destination country and the producing country is denoted e_{ct}. In the Burstein and Gopinath (2014) model, all production takes place in the exporter's home country. But IKEA's home country is the Netherlands, which uses the Euro, while production is located in many other countries. In this setting, e_{ct} should be interpreted as a vector of exchange rates between sourcing countries and destination countries, as well as between the exporter and the destination to the extent that production requires management services provided at IKEA headquarters. Further, because IKEA outsources virtually all of its production, w_t^{ik} includes components of marginal cost from a range of source countries that are not affected by the destination exchange rate, including wage rates and other factor costs in the production countries, source-country variations in total factor productivity, and exchange rates of the source countries vis-a-vis IKEA's corporate home country. Since IKEA products are typically produced in one location for shipping world wide, we continue to use the notation above, keeping in mind that w_t^{ik} stands in for the euro-denominated cost of producing good ik, regardless of where in the world production is located.

Log demand for the good exported to country c is given by the following, where $\bar{q}_{ct}^{ik}$ is the log of the total quantity demanded in country c of good ik:

$$q_{ct}^{ik} = \boldsymbol{q}\left(p_{ct}^{border,ik} - p_{ct}^{local,ik}\right) + \bar{q}_{ct}^{ik}.$$

The log difference of demand is given by the following,

$$\triangle q_{ct}^{ik} = -\boldsymbol{\varepsilon_{ct}^{ik}}\left(\triangle p_{ct}^{border,ik} - \triangle p_{ct}^{local,ik}\right) + \triangle \bar{q}_{ct}^{ik}.$$

where $\varepsilon_{ct}^{ik} \equiv \partial \boldsymbol{q}/\partial p_{ct}^{border,ik}$. Using a first-order approximation to the equation for the border price, the solution for the border price change is:

$$\triangle \tilde{p}_{ct}^{border,ik} = \frac{1}{1+\Gamma_{ct}^{ik}+\Phi_{ct}^{ik}}\left[\Omega_t^{ik}\Delta w_t^{ik} + \alpha_{ct}^{ik}\Delta e_{ct} + \left(\Gamma_{ct}^{ik}+\Phi_{ct}^{ik}\right)\right]\Delta p_{ct}^{local,ik} + mc_q\triangle \bar{q}_{ct}^{ik} \qquad (1)$$

where $\Omega_t^{ik} = \partial\mu/\partial w_t^{ik}$ is the elasticity of marginal cost with respect to the vector w, and α_{ct}^{ik} is the partial elasticity of the destination-currency marginal cost with respect to the exchange rate.[27] Further, $\Gamma_{ct}^{ik} = \partial\mu/\partial\left(p - p\right)$ is the elasticity of the markup with respect to the relative price and Φ_{ct}^{ik} is the partial elasticity of marginal cost with respect to the relative price.

Combining the formula for retail pricing with the solution for the border price, and dropping terms involving variation in retail markups (as in Burstein and Gopinath) and dropping the quantity term in the border price (for which we have no data) and differencing, we arrive at:

$$\tilde{\Delta p}_{ct}^{retail,ik} = (1-\rho)\left(\triangle\tilde{p}_{ct}^{border,ik}\right) + \rho\Delta d_{ct}^{ik} \tag{2}$$

Local-market prices appear in equation (1) as the local price of competing goods, and also in equation (2) as the distribution cost. Our data do not allow us to observe these micro-level prices, so we assume that both $\triangle\tilde{p}_{ct}^{local,ik}$ and Δd_{ct}^{ik} are equal to the overall domestic rate of inflation in country c at time t: $\triangle\tilde{p}_{ct}^{local,ik} = \Delta d_{ikct} = \Delta p_{ct}^{local,ik}$. With this assumption, substituting equation (1) into (2) yields:

$$\tilde{\Delta p}_{ct}^{retail,ik} = (1-\rho)\left\{\left(\frac{\Omega_t^{ik}}{1+\Gamma_{ct}^{ik}+\Phi_{ct}^{ik}}\right)\left[\Delta w_t + \alpha_{ct}^{ik}\Delta e_{ct} + \left(\Gamma_{ct}^{ik}+\Phi_{ct}^{ik}\right)\right]\Delta p_{ct}^{local,ik}\right\} + \rho\Delta p_{ct}^{local,ik}$$

$$\tilde{\Delta p}_{ct}^{retail,ik} = \left(\frac{(1-\rho)\,\Omega_t^{ik}}{1+\Gamma_{ct}^{ik}+\Phi_{ct}^{ik}}\right)\Delta w_t^{ik} + \left(\frac{(1-\rho)\,\alpha_{ct}^{ik}}{1+\Gamma_{ct}^{ik}+\Phi_{ct}^{ik}}\right)\Delta e_{ct} + \left\{(1-\rho)\left(\frac{\left(\Gamma_{ct}^{ik}+\Phi_{ct}^{ik}\right)}{1+\Gamma_{ct}^{ik}+\Phi_{ct}^{ik}}\right) + \rho\right\}\Delta p_{ct}^{local,ik}$$

$$\tilde{\Delta p}_{ct}^{retail,ik} = \left(\frac{(1-\rho)}{1+\Gamma_{ct}^{ik}+\Phi_{ct}^{ik}}\right)\Delta w_t^{ik} + \left(\frac{(1-\rho)\,\alpha_{ct}^{ik}}{1+\Gamma_{ct}^{ik}+\Phi_{ct}^{ik}}\right)\Delta e_{ct} + \left\{1 - \left(\frac{1-\rho}{1+\Gamma_{ct}^{ik}+\Phi_{ct}^{ik}}\right)\right\}\Delta p_{ct}^{local,ik}$$

This equation forms the basis for empirical analysis of exchange-rate pass-through reported in the paper.

References

[27]Burstein and Gopinath (2014) assume without loss of generality that Ω_t^{ik} is equal to one, but when the good is sourced outside of the exporting country, using many inputs potentially in many currencies, the elasticity cannot be set to one through a judicious choice of numeraire.