No. 1055

Cross-Country Relative Price Volatility: Its Components and Effects of Market Strucuture

by

Yin-Wong Cheung and Eiji Fujii

August 2003

Cross-Country Relative Price Volatility: Its Components and Effects of Market Structure*

Yin-Wong Cheung
Department of Economics, SS1
University of California
Santa Cruz, CA 95064, U.S.A.

Eiji Fujii
Institute of Policy & Planning Sciences
University of Tsukuba
Tsukuba, Ibaraki, Japan

Abstract

Using data on nine manufacturing sectors across eighteen OECD countries, the article studies a) the composition of and b) the market structure effect on cross-country relative price variability. The decomposition result confirms the role of nominal exchange rate volatility and, at the same time, highlights the importance of the relative local price variation. These two factors contribute almost equally to the average cross-country relative price variability. The regression results are supportive of the presence of market structure effects. The estimated market structure effects on cross-country relative price variability are consistent with predictions from a standard markup pricing formulation. Further, the market structure effects are transmitted via two channels - the relative local price variance and the covariance between the relative local price and the nominal exchange rate. Subsample analyses affirm the significance of market structure effects.

JEL Classification: F31, F41

KeyWords: Relative price volatility, variance decomposition, market structure, price-cost margin

* We thank the participants of the 76th Annual WEA International Conference in San Francisco for their comments and suggestions.

Corresponding Author: Eiji Fujii, Institute of Policy & Planning Sciences, University of Tsukuba, Ibaraki, Japan. Email: efujii@sk.tsukuba.ac.jp.

1. Introduction

In their seminal paper, Engel and Rogers (1996) use city-level data from the US and Canada to compare intra- and inter-country price movements. By comparing the volatilities of relative prices (of similar goods and services) within each country and across the border, they found that crossing the border significantly increases the relative price volatility. The magnitude of the cross-border effect is far beyond what the physical distance between the U.S. and the Canadian cities can explain. Further, Engel (1993, 1999) show that the major determinant of real exchange rate variability is the relative price movement between similar goods, rather than between traded and non-traded goods, across countries. That is, goods markets separated by a national border are far less integrated than the equally distanced markets within a country – a result indicative of market segmentation and the violation of the law of one price.[1]

What economic factors constitute the border effect? Engel and Rogers (2000, 2001) emphasize the role of exchange rate volatility under sticky local prices. When local prices are sticky, higher nominal exchange rate volatility will lead to higher cross-country relative price variability. In their earlier study, Engel and Rogers (1996) tentatively assess that the sticky-price effect accounts for only 10% to 15% of the total cross-border relative price variation.[2] However, based on data from 55 locations in Europe, Engel and Rogers (2001) document a substantial part of cross-border relative price variation is due to variable nominal exchange rates under sticky prices. The effect of nominal exchange rate variability is also reported in Parsley and Wei (2001).[3]

Since prices are a fundamental economic variable, it is important to understand the

1. Violations of the law of one price are reported in, for example, Isard (1977) and Haskel and Wolf (2001). Goldberg and Verboven (2001), on the other hand, use a panel data on car prices in Europe and report strong evidence of the law of one price as a result market integration.
2. Engel and Roger (1996) suggest the sticky-nominal-prices story can explain about 30% to 43% of the border size, which accounts for 33.3% of the standard error of cross-border relative prices.
3. Parsley and Wei (2001) also find the unit shipping cost is a contributor to cross-border relative price variability. Engel and Rogers (1996, 2001) find some mixed results on the effects of (formal) trade barriers and relative wage

properties of cross-country relative price dispersion. The objective of this empirical exercise is to study a) the composition and b) the determinants of cross-country relative price variability. On the composition, we use the variance-covariance identity to study the components of cross-country relative price volatility. Since the cross-country relative price is composed of the nominal exchange rate and the relative local price, its variance can be equivalently expressed as the variances and the covariance of its components. Using the variance-covariance decomposition, we can calculate the exact proportions of cross-country relative price variability attributed to nominal exchange rate volatility and relative local prices.

In addition, the decomposition framework allows us to examine the association between nominal exchange rate and relative local price movements and its implications. Under the purchasing power parity assumption, the nominal exchange rate and the relative local price move in tandem, offset their impacts on the cross-country relative price, and give zero cross-country relative price volatility. If the nominal exchange rate is totally disconnected with the relative local price, then they affect cross-country relative price variation via their individual volatilities but not their comovements. It is also possible that the nominal exchange rate and the relative local price move together to aggravate their impacts on cross-country relative price volatility. The variance-covariance decomposition offers a convenient tool to investigate these possibilities.

The second objective of the study is to investigate the role of market structure as a determinant of cross-country relative price volatility. The potential influence of market structure on relative price volatility is mentioned in, for example, Engel and Rogers (1996, 2000). The pricing to market explanation for the border-effect, for example, is closely related to market structure and requires the presence of monopolistic competition. Recently, Bergin and Feenstra (2001) construct a pricing to market model that incorporates non-constant demand elasticity and

---

variability.

staggered contracts. These authors show that the model can reproduce volatility observed in actual real exchange rate data under plausible parameter values.

In contrast to Cheung, Chinn and Fujii (2001) who study the effect of market competitiveness on the *persistence* of deviations from purchasing power parity, we focus on the market structure effect on both cross-country relative price volatility and its individual components. The current exercise uses a standard markup pricing model to establish the relationship between cross-country relative price volatility and market structure. Following the literature, the price-cost margin variable is taken as a proxy for the degree of monopolistic pricing power. The model suggests that a more variable relative price-cost margin will lead to higher cross-country relative price variability. Further, we also investigate the effect of the covariance between price-cost margins and exchange rates according to the markup pricing model.

The remainder of this manuscript is organized as follows. Section 2 briefly describes the data. Section 3 discusses the decomposition of cross-country relative price volatility and the possible effects of market structure on relative price dispersion. In section 4, we report the variances of the cross-country relative price of nine manufacturing sectors across eighteen OECD countries. The components of these variances are also presented. Section 5 contains a preliminary regression analysis of the cross-country relative price variability. In section 6, the market structure effect is investigated. The regression analysis is extended to include proxies for market structure and other control variables as possible determining factors for relative price dispersion. Results from subsample analyses are also discussed in this section. Some concluding remarks are provided in section 7.

2. Data

In this study, we examine annual data on nine manufacturing sectors of eighteen OECD countries. The sample period is from 1970 to 1994. The sector and country coverage is determined by data availability.[4] The nine sectors (two-digit international standard industrial classification (ISIC) codes in parentheses) are: food (31); textiles, apparel, and leather (32); wood products and furniture (33); paper, paper products, and printing (34); chemical products (35); non-metallic mineral products (36); basic metal industries (37); fabricated metal industries (38); and other manufacturing (39). The country sample consists of Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, the United Kingdom, and the US. The countries are drawn from North America and Europe as well as Scandinavia, Asia, and Oceania, creating a geographically and culturally diverse sample.[5]

The OECD International Sectoral Database contains data on gross output, value added in gross output, and labor compensation. Data on the value added in current and 1990-constant prices are used to construct sectoral price indexes. Annual U.S. dollar exchange rates obtained from the International Financial Statistics are used to compute all the bilateral exchange rates considered in the subsequent sections. Following previous studies (Engel and Rogers, 1996; Parsley and Wei, 2001), we use the great circle distance between national capitals as a proxy for the distance between the countries.

3. Volatility Decomposition and Market Structure

For sector k, the relative price between countries i and j is given by

$$q^k_{i,j,t} = p^k_{i,t} - p^k_{j,t} - e_{i,j,t} \tag{1}$$

4. The data on the other manufacturing (39) sector of Austria, for example, are missing.

5. Most studies consider a small sample of countries. For example, Cecchetti *et al.* (2002) focus on US cities. Depken and Sonora (2002) examine data from US and Mexico. Engel and Rogers (1996) analyze data from the US and Canada. On the other hand, Engel and Rogers (2001) and Parsley and Wei (1995) consider a large sample of countries.

where $e_{i,j,t}$ is the log of the nominal exchange rate defined as the number of i's currency units per j's currency, $p^k_{i,t}$ and $p^k_{j,t}$ are the logs of the sector k local price indexes in countries i and j, and t is the time subscript. From (1), the variance of the cross-country relative price can be written as:

$$Var(q^k_{i,j,t}) \equiv Var(p^k_{i,t} - p^k_{j,t}) + Var(e_{i,j,t}) - 2Cov(e_{i,j,t}, p^k_{i,t} - p^k_{j,t}) \qquad (2)$$

The first term on the right hand side is the variance of the relative local price, which is the ratio of two national prices in their respective local currency units. The second term is the exchange rate variance, and the last term measures the comovement between the exchange rate and the relative local price.

In most of the existing studies, the regression approach is used to examine the factors, including the nominal exchange rate variability, affecting the cross-country relative price volatility (Engel and Rogers, 2000; Parsley and Wei, 2001).[6] The decomposition equation offers an alternative framework. As (2) is an identity and requires no behavioral assumption, we can compute the exact relative contributions of exchange rates and local prices to cross-country relative price variability. In addition to identifying the exchange rate and price effects, the framework allows us to investigate through which of these components/channels economic factors affect the cross-country relative price dispersion.

The exchange rate volatility-cum-sticky price factor discussed in the border-effect literature has some implications for the three right-hand-side components in (2). When prices in their local currencies are sticky, one expects $Var(p^k_{i,t} - p^k_{j,t})$ to have a limited contribution to the overall cross-country relative price volatility especially in the presence of a highly volatile exchange rate. Also, when there is a disconnection between exchange rates and relative local

6. Both the variance and standard deviation of the relative price have been used as the dependent variable.

prices, prices are not likely to move to offset changes in exchange rates. Under this circumstance, the covariance term $Cov(e_{i,j,t}, p_{i,t}^k - p_{j,t}^k)$ is expected to play only a secondary role in smoothing out cross-country relative price volatility to achieve price equality across geographical locations. In section 4, we decompose the cross-country relative price variability and assess the relative contributions of its components.

The potential effect of market structure on cross-country relative price volatility can be readily illustrated using the standard markup pricing formulation. Following Engel and Rogers (1996, 2000), we can write the price of sector *k* in country *i* as:

$$p_{i,t}^k = \mu_{i,t}^k + \tau w_{i,t}^k + (1-\tau) m_{i,t}^k \tag{3}$$

where $\mu_{i,t}$ is the monopolistic markup, $w_{i,t}$ is the cost of the non-traded service, $m_{i,t}$ is the cost of traded input, and τ is the share of the non-traded component in the total costs. All terms except τ are in logarithms. Similarly, the price in *j*'s market can be written in *i*'s currency terms as:

$$p_{j,t}^k + e_{i,j,t} = \mu_{j,t}^k + \tau w_{j,t}^k + (1-\tau) m_{j,t}^k + e_{i,j,t}. \tag{4}$$

From the standard demand analysis, it is known that the optimal markup is large (small) when the underlying demand elasticity is low (high). In a perfectly competitive sector *k*, $\mu_{i,t}^k$ and $\mu_{j,t}^k$ equal zero. If markets *i* and *j* are effectively segmented, monopolistic firms can determine the optimal markups according to the demand elasticities in these markets. In addition, monopolistic firms can stabilize local prices by adjusting the degree of exchange rate pass-through to prices. With such a pricing practice, markups can differ across markets ($\mu_{i,t} \neq \mu_{j,t}$) and vary according to market conditions. When prices in local currencies display a weaker response to exchange rate movements, exchange rate variability has a larger impact on cross-country relative price variability.

Since a greater degree of monopolistic market structure leads to a weaker connection between the exchange rate and the relative local price, we hypothesize a positive relationship between the extent of monopolistic behavior and cross-country relative price variability.

The role of relative markup can be illustrated as follows. Supposing the covariance terms are zero except for the one between the relative markup and the exchange rate, we obtain:

$$\begin{aligned} Var(q^k_{i,j,t}) &= Var(p^k_{i,t} - p^k_{j,t} - e_{i,j,t}) \\ &= Var(\mu^k_{i,t} - \mu^k_{j,t}) + \tau^2 Var(w^k_{i,t} - w^k_{j,t}) \\ &+ (1-\tau)^2 Var(m^k_{i,t} - m^k_{j,t}) + Var(e_{i,j,t}) - 2Cov(\mu^k_{i,t} - \mu^k_{j,t}, e_{i,j,t}) \end{aligned} \qquad (5)$$

Equation (5) shows that the relative markup, $\mu^k_{i,t}$ - $\mu^k_{j,t}$, impacts the cross-country relative price volatility directly via its own variability $Var(\mu^k_{i,t} - \mu^k_{j,t})$ and its comovement with the exchange rate $Cov(\mu^k_{i,t} - \mu^k_{j,t}, e_{i,j,t})$. The variance $Var(\mu^k_{i,t} - \mu^k_{j,t})$ depends on all factors affecting relative markup adjustment and exchange rate pass-through, for example, is just one of the possible factors. On the other hand, the covariance term $Cov(\mu^k_{i,t} - \mu^k_{j,t}, e_{i,j,t})$ isolates the association between exchange rate and relative markup and, thus, bears a more direct inference for the degree of exchange rate pass-through. In section 6, we investigate these potential market structure effects.

4. Decomposition Results

Following Engel and Rogers (1996), all the price and exchange rate variables are defined in terms of their first differences in logarithms. First, we calculate the sample variance of the cross-country relative price and its three components as given by (2). Table 1 presents the sample variances in percentage terms sorted by sectors and by countries. The sectoral relative price volatility ranges from 1.52% (Textile, apparel, and leather; ISIC 32) to 3.30% (Basic metal industry; ISIC 37). Cross-country comparison places Austria and Germany at the low end of volatility spectrum for their sample variances being less than 1.55%. Australia and Spain have the highest relative price variability in the sample and their relative price variances exceed three percent per year.

The percentages of cross-country relative price volatility $Var(q_{i,j,t}^k)$ accounted for by its components $Var(e_{i,j,t})$, $Var(p_{i,t}^k - p_{j,t}^k)$, and $Cov(e_{i,j,t}, p_{i,t}^k - p_{j,t}^k)$ are given in Table 2. In panel A, the sample statistics are sorted by sector. Consistent with the common belief, nominal exchange variability accounts for a good portion of total volatility. It constitutes more than ½ of the total cross-country relative price variance in 6 out of 9 sectors. The relative local price variation $Var(p_{i,t}^k - p_{j,t}^k)$, however, has a non-negligible effect. For the basic metal industry (ISIC 37) and the other manufacturing sector (ISIC 39), the relative local price effect dominates exchange rate effect and accounts for 63% and 74% of the total volatility, respectively. The fabricated metal products category (ISIC 38) has the least volatile relative local price component among the sectors. In this case, the relative local price volatility still constitutes about one-third of the total variability. In fact, the relative local price and exchange rate contribute almost equally to the average total variance. Apparently, the relative local price is not that sticky compared with the exchange rate.

Importantly, the relative local price seems to have little correspondence to the exchange rate movement. If changes in nominal exchange rates are immediately passed through to local prices and the relative purchasing power parity condition holds, then there will be no variation in the cross-country relative prices. Under such circumstances, $Cov(e_{i,j,t}, p_{i,t}^k - p_{j,t}^k)$ will completely offset $Var(e_{i,j,t})$ and $Var(p_{i,t}^k - p_{j,t}^k)$ and the total variance $Var(q_{i,j,t}^k)$ becomes zero. The results in Table 2, however, indicate that there is only a very weak association between nominal exchange rates and relative local prices across sectors. In fact, for the whole sample the two variables have a correlation coefficient of only 0.0572. In five out of nine sectors, the covariance term adds to instead of reducing overall volatility. In view of the enormous difficulty in finding empirical support for relative purchasing power parity (Rogoff, 1996; Froot and Rogoff, 1995), perhaps it is not so surprising to see the disconnection between nominal exchange rates and relative local prices.

The decomposition result by country (Panel B of Table 2) conveys a very similar message. Across countries, both the relative local price and exchange rate contribute significantly to the average relative price variance. The fraction of the total cross-country price variation accounted for by the relative local price variation ranges from ⅓ to ⅔. For the U.S., the nominal exchange rate volatility has the largest impact and makes up 65% of the total variance $Var(q^k_{i,j,t})$. It is interesting to note that for most of the non-G7 countries, more than ½ of $Var(q^k_{i,j,t})$ is attributable to the relative local price variability. The exchange rate volatility, even though important, does not appear to uniformly dominate the cross-country relative price volatility in our sample. With the exception of Greece, the comovement between exchange rates and relative local prices is very limited.

The decomposition results do not totally discredit the exchange rate volatility-cum-sticky local price story. There is only limited exchange rate pass-through to the relative local price. However, for both cross-sector and cross-country classifications, the relative local prices do not appear very sticky and their variation is comparable to that of the nominal exchange rate.[7] While

7. During the sample period, the EMS countries in the sample have a relatively stable exchange rate arrangement, with intervening realignments. The exchange rate variability effect may be hampered by the EMS exchange rate arrangement. To investigate the possibility, we classified the cross-country relative prices into three groups: a) EMS-EMS country pairs, b) EMS-nonEMS country pairs, and c) nonEMS-nonEMS country pairs. The sub-group analyses indicate that nominal exchange rate variability contributes the least to the EMS-EMS cross-country relative price volatility and the most to the nonEMS-nonEMS one. For all the sectors, nominal exchange rate variability accounts for, respectively, 37%, 51%, and 54% of the EMS-EMS, EMS-nonEMS, and nonEMS-nonEMS cross-country relative price volatilities. Compared these results with the one for the entire sample (50% as reported in

there may be local currency pricing activity, the relative local price variation remains an important determinant of the cross-country relative price volatility. The results further show that both the level and composition of relative price volatility are quite dissimilar across the sectors and countries. While the exchange rate effect varies only across country-pairs, the two other components of $Var(q^k_{i,j,t})$ change across both countries and sectors. Given the importance of the relative local price effect and its sector-specific nature, it is instructive to explore if the sector-specific market structure factors help explain the cross-country relative price volatility and to what extents these factors work through the relative local price channel. After some preliminary analyses in the next section, we examine the market structure effect in Section 6.

5. Preliminary Regression Results

In this section, we conduct some preliminary regression analyses of the cross-country relative price volatility. The basis regression equation is

$$Var(q^k_{i,j,t}) = \beta DIST_{i,j} + X\theta + \sum_{g=1}^{m} \alpha_g SD_g + \sum_{h=1}^{n} \gamma_h CD_h + u^k_{i,j,t} \qquad (6)$$

where $DIST_{i,j}$ is the geographical distance in logarithms between countries i and j, X is a vector containing explanatory variables that vary across specifications, SD_g and CD_h are the sector- and country-dummy variables, and $u^k_{i,j,t}$ is a disturbance term. The inclusion of the dummy variables allows the relative price volatility to assume different values among different countries and sectors.

the last row in Table 2A and in Table 2B), the contribution of nominal exchange rate variability is not affected too much by the presence of the EMS exchange rate arrangement in our sample. Further, nearly half of the EMS countries in the sample have nominal exchange rate volatility accounts for more than one-half of the total cross-country relative price variability. For brevity, the sub-group variance decomposition results are not reported but are available upon request.

The first specification considered is equation (6) without $X\theta$. The estimation result is summarized in the second column (labeled specification "1") of Table 3. Inferences about the statistical significance of the coefficient estimates are based on heteroskedasticity-consistent standard errors (White, 1980). In accordance with previous findings, the distance variable has a highly significant positive effect on relative price variability. Together with the sector and country dummies, the distance variable explains slightly more than half of the relative price variability as indicated by the adjusted R^2 of 56%.

The third column (specification "2") of Table 3 reports the coefficient estimates of the second specification, which includes the sample variance of nominal exchange rates in X as an explanatory variable. The effect of the nominal exchange rate volatility is highly significant, and its coefficient is greater than unity.[8] Compared with the identity (2), the estimation result suggests a bigger nominal exchange rate variability effect. The discrepancy is likely due to the different formulations of (2) and (6). In the presence of exchange rate variability, the distance variable is statistically insignificant. A similar replacement result is reported in some of the regressions in Engel and Rogers (2001).[9]

6. Market Structure Effects

As illustrated in Section 3, cross-country relative price volatility is affected by the pricing behavior in an imperfectly competitive market. While cross-country relative price volatility is also influenced by costs of non-traded and of traded components, these cost data are not easily

8. Similar results are found in Engel and Rogers (2001, Table 5). The exchange rate has two channels to affect the cross-country relative price volatility. Results in Table 2 indicate that the exchange rate effect via the covariance can also add to the relative price variability.

9. We do not have a persuasive explanation for the displacement result. However, it is noted that distance and nominal exchange rate variability have a sample correlation coefficient of 0.84. The high sample correlation is not likely to be driven by the EMS countries. In fact, the two variables have a sample correlation coefficient of 0.46, 0.90, and 0.82 for the EMS-EMS, EMS-nonEMS, and nonEMS-nonEMS country pairs, respectively.

available for the sample considered in the current study. Thus, in this section, we focus on the effects of market structure factors.

6a. *Price-Cost Margin*

In this exercise, we measure the markup using the price-cost margin (PCM) variable, which is commonly interpreted as a proxy for the degree of discriminatory pricing and monopolistic competition. The PCM for sector k of country i is defined as:

$$PCM_{i,t}^{k} = \frac{V_{i,t}^{k} - M_{i,t}^{k} - W_{i,t}^{k}}{V_{i,t}^{k}} = \frac{VA_{i,t}^{k} - W_{i,t}^{k}}{VA_{i,t}^{k} + M_{i,t}^{k}} \tag{7}$$

where $V_{i,t}^{k}$ is the value of total production, $M_{i,t}^{k}$ is the cost of material inputs, $W_{i,t}^{k}$ is labor compensation, and $VA_{i,t}^{k} = (V_{i,t}^{k} - M_{i,t}^{k})$ is the value added. Since the PCM can be derived from accounting data, it is widely used as a measure of market structure (Campa and Goldberg, 1995; Domowitz, Hubbard and Petersen, 1987). A larger value of the PCM means a greater elevation of the price over the cost and a greater degree of monopolistic power.

Using the PCM, we construct three variables:

$$APCM_{i,j}^{k} = (\overline{\ln PCM}_{i,t}^{k} + \overline{\ln PCM}_{j,t}^{k})/2 \tag{8}$$

$$VPCM_{i,j}^{k} = Var(\Delta(\ln PCM_{i,t}^{k} - \ln PCM_{j,t}^{k})) \tag{9}$$

and

$$CPCM_{i,j}^{k} = -Cov(\Delta(\ln PCM_{i,t}^{k} - \ln PCM_{j,t}^{k}), e_{i,j,t}). \tag{10}$$

Equation (8) defines the average markup of sector k in countries i and j, in logarithms, where the over-bar "‾" denotes the sample mean calculated for country i (j). The average markup $APCM_{i,j}^{k}$ measures the degree of imperfect competition in the sector. While the term is not in (5), we conjecture that sectors with a greater degree of monopolistic market structure are likely to be more segmented and have a more variable cross-country relative price fluctuation. The variance term $VPCM_{i,j}^{k}$ represents the relative markup volatility in equation (5). The variable $CPCM_{i,j}^{k}$ captures the covariance term in (5) and quantifies the association between the relative PCM and the nominal exchange rate. Variables in first differences in logarithms are used to define $VPCM_{i,j}^{k}$ and $CPCM_{i,j}^{k}$ since the relative (local) prices and exchange rates are expressed in first differences in logarithms. The pricing-to-market activity, for example, implies a negative covariance between relative PCM changes and exchange rate movements. To simplify the interpretation, we include a negative sign in defining $CPCM_{i,j}^{k}$ so that a more intensive pricing-to-market activity implies a larger value of $CPCM_{i,j}^{k}$. Indeed, $CPCM_{i,j}^{k}$ has a small but positive sample average suggesting that the interaction between relative PCM changes and exchange rate movements is likely to intensify cross-country relative price volatility. Further, $CPCM_{i,j}^{k}$ displays considerable variability as it has the largest coefficient of variation amongst the three market structure proxies.[10]

6b. Effects on Cross-Country Relative Price Volatility

In Table 3, the results of estimating (6) with $APCM_{i,j}^{k}$, $VPCM_{i,j}^{k}$, and $CPCM_{i,j}^{k}$ sequentially included in X are given under the headings of specifications 3 to 5. Specification 6 gives the result when all the three PCM variables are simultaneously included in *X*. All the PCM variables are significantly positive in these four specifications. The significance of $APCM_{i,j}^{k}$

10. The sample coefficients of variation of the three market structure variables are 0.14 ($APCM_{i,j}^{k}$), 1.99 ($VPCM_{i,j}^{k}$), and 28.26 ($CPCM_{i,j}^{k}$).

indicates that sectors with a greater elevation of prices over costs tend to have a more variable cross-country relative price. One possible interpretation is that, in addition to price adjustments to demand and supply conditions, a high PCM offers sellers an extra degree of freedom to strategically respond to market conditions by varying the markups. The signs of $VPCM_{i,j}^{k}$ and $CPCM_{i,j}^{k}$ are consistent with the predictions of equation (5). A more variable relative PCM leads to a more volatile cross-country relative price, *ceteris paribus*. For $CPCM_{i,j}^{k}$, the evidence suggests that the relative PCM and the nominal exchange rate comove in a way to amplify the variability of the cross-country relative price. The positive coefficient is in accordance with the notion that firms reduce the markups to weaken the pass-through of exchange rate effect to local prices.

The significance of all the three market structure variables under specification 6 indicates that these three variables have their own unique information on cross-country relative price variability. In addition to the general markup effects captured by $APCM_{i,j}^{k}$ and $VPCM_{i,j}^{k}$, the $CPCM_{i,j}^{k}$ estimate attests to the relevance of pricing-to-market behavior, which affect the comovement between exchange rates and relative markups, for determining the cross-country relative price variability.

To check the robustness of the result, we include a number of dummy variables to the *X*-vector in equation (6).[11] These dummy variables are ADJ, LAN, SEA, EEC, and EFTA. ADJ is the "adjacency" dummy that assumes the value of one if the two countries in the sample share a common border and zero otherwise. LAN is a language dummy variable that takes up the value of one if the countries share a common language. In some studies, this dummy variable is used to

11. We also considered the three subgroups (EMS-EMS, EMS-nonEMS, and nonEMS-nonEMS country pairs). The

capture some form of informal trade barriers. If the two countries are separated by an ocean, then SEA is set to one. EEC and EFTA are included to capture the possible effects of the two formal free trade agreements - the European Economic Community and the European Free Trade Agreement, respectively.[12] These additional dummies have been considered by, for example, Engel and Rogers (2001) and Parsley and Wei (1995). The marginal effects of the additional variables are presented in Table 4. While the ADJ and LAN dummy variables have the expected sign and the SEA variable has the wrong one, none of these three variables are significant when they are added to the equation individually or jointly. Similar insignificant results are also reported in Engel and Rogers (2001).[13] The two trade agreement dummy variables have the expected negative sign. Nonetheless, only the negative coefficient estimate of EFTA is statistically significant, indicating that this trade agreement reduces relative price volatility among its member countries. It is noted that the inclusion of these control variables, separately or jointly, exerts little influence on the PCM effects. Both the magnitude and significance of the effects of the three PCM variables remain virtually unchanged across various specifications in Table 4. In sum, the PCM effects appear fairly robust.

6c. Effects on Components

A natural question to ask is "Do the PCM variables affect the cross-country relative price volatility via their impacts on $Var(p_{i,t}^k - p_{j,t}^k)$ or on $Cov(e_{i,j,t}, p_{i,t}^k - p_{j,t}^k)$?" To gain some insight into this question, we consider

estimated market structure effects are qualitatively similar across the three subgroups.

12. Formally, the European Economic Community is more than a free-trade zone. It was first set up as a customs union with the intention of promoting additional economic integration among its member countries.

13. In Parsley and Wei (1995), which use the standard error instead of variance of relative prices as the regressand, LAN is insignificant and SEA is highly significantly positive. The coefficient estimates of ADJ and LAN have different signs and levels of significance across subsamples in Engel and Rogers (2001). In our sample, these dummy variables are individually significant when each of them is included in the regression separately.

$$Var(p_{i,t}^k - p_{j,t}^k) = \beta DIST_{i,j} + \theta X + \sum_{g=1}^{m} \alpha_g SD_g + \sum_{h=1}^{n} \gamma_h CD_h + u_{i,j,t}^k \tag{11}$$

and

$$Cov(e_{i,j,t}, p_{i,t}^k - p_{j,t}^k) = \beta DIST_{i,j} + \theta X + \sum_{g=1}^{m} \alpha_g SD_g + \sum_{h=1}^{n} \gamma_h CD_h + u_{i,j,t}^k . \tag{12}$$

To facilitate comparison, the explanatory variables considered in the previous subsection are also used here. The estimation results for equation (11) are given in Tables 5 and 6. A few observations are in order. First, the distance and the nominal exchange rate variance do not influence the relative local price volatility $Var(p_{i,t}^k - p_{j,t}^k)$. The exchange rate variance has the right sign, but the distance variable tends to have the wrong sign. The coefficient estimates of neither variable are significantly different from zero. Second, the three PCM variables appear to be important factors determining the relative local price variance. Both $APCM_{i,j}^k$ and $VPCM_{i,j}^k$ display significant positive effects in all specifications under consideration. The results bear out the relevance of market structure on price variation. On the other hand, the effect of $CPCM_{i,j}^k$ becomes significantly positive only in the presence of the other two PCM variables. Third, the ADJ, LAN, SEA, and trade agreement dummy variables do not affect the relative local price volatility. The regression results suggest that the PCM variables have a significant and robust influence on the relative local price volatility.

The estimation results for equation (12), which are given in Tables 7 and 8, can be summarized as follows. First, across all the specifications, distance and exchange rate volatility exhibit, respectively, a positive and a negative effect. Second, compared with $Var(p_{i,t}^k - p_{j,t}^k)$, $Cov(e_{i,j,t}, p_{i,t}^k - p_{j,t}^k)$ is affected by a smaller group of market structure variables. The linkage between $CPCM_{i,j}^k$ and $Cov(e_{i,j,t}, p_{i,t}^k - p_{j,t}^k)$ can be attributed to pricing to market. If $CPCM_{i,j}^k$

contains some information on exchange rate pass-through that influences $Cov(e_{i,j,t}, p_{i,t}^k - p_{j,t}^k)$, then it helps explain the comovement of the exchange rate and the relative local price. Indeed, $CPCM_{i,j}^k$ is the only PCM variable that displays a robust negative effect under specifications 3 to 6 (Table 7). The variable $APCM_{i,j}^k$ that measures the general level of non-competitiveness is insignificant across specifications. Fluctuations of the relative markup, $VPCM_{i,j}^k$, is significant with the expected sign only in the presence of $CPCM_{i,j}^k$.

Third, while the common-language and two trade agreement dummy variables are significant and have the expected sign, their presence does not alter the effects of the PCM variables on the covariance between exchange rates and relative local prices. The significance of EEC and EFTA is supportive of the view that free trade agreements make prices more responsive to exchange rate fluctuations.

Undoubtedly, the regression results lend considerable support for the market structure effect.[14] Apparently, the effects of $APCM_{i,j}^k$ and $VPCM_{i,j}^k$ on the cross-country relative price dispersion are mainly transmitted via the relative local price variation. On the other hand, the covariance $CPCM_{i,j}^k$ effect is channeled through both relative local price variation and exchange-rate-relative-local-price covariation. In general, the results illustrate the implications of market structures, in general, and pricing to market, in particular, for cross-country relative price variation.

6d. *Sub-sample Analysis*

14. We also estimated the equations (11) and (12) within the EMS-EMS, EMS-nonEMS, and nonEMS-nonEMS subgroups. The market structure effects are qualitatively similar across the subgroups.

During the sample period, we witness the dwindling of impediments to international trade and capital flows. The global economy appears to be increasingly integrated over time. In this subsection, we investigate whether the properties of cross-country relative price volatility and the market structure effect have changed over time. Constrained by the sample size, we repeated the preceding empirical exercise on only two subsamples: 1970-1982 and 1983-1994. The results were collected in the Appendix. The subsample analysis can be summarized as follows.

First, the average cross-country relative price volatility decreases over time. All the sectoral averages in the second subsample are smaller than those in the first one. For country averages, only Australia exhibits an increase. The general decline in cross-country relative price volatility is in accordance with the casual evidence of increasing integration between nations.

Second, there are some discernible changes in the composition of cross-country relative price volatility. While the cross-country relative price volatility decreases, the nominal exchange rate effect becomes more significant in the second subsample. In fact, during the second sample period, the proportion of the volatility due to nominal exchange rate variation expands uniformly for both the sector and country categories. On the average, the contribution of the nominal exchange rate effect surges from 40% to 62%. Nonetheless, the relative local price still accounts for a substantial portion of the overall volatility. Even in the second subsample, 40% of the average cross-country relative price volatility is attributable to the relative local price variability. The covariance term, in general, is small and displays an interesting change in its pattern. Over time, the covariance term has a tendency to change its sign and helps alleviate the cross-country relative price volatility. In fact, the covariance term adds to cross-country relative price volatility in the first subsample but reduces it in the second. Even though the absolute change in the magnitude is small, the evidence indicates that the local prices respond slightly better to exchange rate fluctuations in the second susbsample.

Third, the overall market structure effect is slightly more prominent in the first subsample than the second one. The PCM variables appear to have a marginally stronger impact on $Var(p_{i,t}^k - p_{j,t}^k)$ and a marginally weaker effect on $Var(q_{i,j,t}^k)$ and $Cov(e_{i,j,t}, p_{i,t}^k - p_{j,t}^k)$ in the second subsample than in the first one. In the second subsample, the effects of PCM variables on the components of $Var(q_{i,j,t}^k)$ are quite distinct. For instance, $Cov(e_{i,j,t}, p_{i,t}^k - p_{j,t}^k)$ is only affected by $CPCM_{i,j}^k$ while $Var(p_{i,t}^k - p_{j,t}^k)$ is influenced by $APCM_{i,j}^k$ and $VPCM_{i,j}^k$. One possible interpretation is that, with reduction in barriers to trade and capital flows, local prices become more responsive to exchange rates. Such a change will weaken the effect of the PCM variables, especially $APCM_{i,j}^k$ and $VPCM_{i,j}^k$ on $Cov(e_{i,j,t}, p_{i,t}^k - p_{j,t}^k)$ and hence, $Var(q_{i,j,t}^k)$. Importantly, the estimates of these market structure variables are insensitive to the presence of control variables. That is, the market structure effect is quite robust.

Finally, let us comment on the estimates of other regressors. The subsample analysis confirms the previous finding that the distance effect on cross-country relative price volatility $Var(q_{i,j,t}^k)$ is dominated by exchange rate variability. Once the exchange rate variability is included in the regression, the distance variable becomes insignificant. For the other two regressands, $Var(p_{i,t}^k - p_{j,t}^k)$ and $Cov(e_{i,j,t}, p_{i,t}^k - p_{j,t}^k)$, both the distance and exchange rate volatility play a limited role in the second subsample.

Compared with the trade agreement variables, the control variables ADJ, LAN, and SEA display a different pattern of changes. The statistical significance of both EEC and EFTA improves in the second subsample while the effects of ADJ, LAN, and SEA diminish. The decline in the relative importance of ADJ, LAN, and SEA can be accounted for by rapid advancements in the telecommunication and transportation technologies. The EEC and EFTA results attest to the effects of market integration on cross-country relative price volatility. In the latter part of our sample, the member countries of these two entities experienced a substantial progress in integration via, for example, dismantling formal and informal trade barriers and harmonizing national economic policies. To the extent that the integration process eliminates or mitigates factors creating price dispersion, we expect to observe both EEC and EFTA gaining significance over time.

7. Concluding Remarks

Prices are an important variable in economics. One intriguing price behavior is the resilient variability exhibited by the relative prices of similar goods across countries. The existing empirical literature suggests that a large portion of cross-country relative price variability is not explained by factors including nominal exchange rate variability, distance, formal and informal trade barriers, and relative wage variability. In this exercise, we use data on nine manufacturing sectors across eighteen OECD countries to study a) the composition of and b) the market structure effect on cross-country relative price variability.

The variance-covariance decomposition approach offers a direct way to quantify the relative contributions of the components to the total cross-country price volatility. The results reveal that both nominal exchange rate variability and relative local price variability are the major components and each of them account for about ½ of the total variability. The covariation of the nominal exchange rate and the relative local price has a very limited contribution to the overall variability. The evidence confirms the role of nominal exchange rate volatility and the disconnection between local prices and exchange rates. However, the relative local price appears not that sticky, and its degree of variability is comparable to that of the nominal exchange rate. The decomposition result highlights the importance of the relative local price variation and the potential role of sector-specific factors such as the market structure in explaining price variability.

Motivated by a standard markup pricing formulation, we investigate the role of market structure as a determinant of cross-country relative price variability. The price-cost margin (PCM) is used as a proxy for the degree of monopolistic behavior. The regression results are suggestive of market structure effects on cross-country relative price variability and on its components. In general it is found that the effects of market structure proxies, including the level of PCM, its variance, and its covariance with the nominal exchange rate are in accordance with the markup pricing equation and pricing to market behavior. Further, the results on market structure effects are robust to the inclusion of a number of control variables.

The subsample analysis indicates that, in the latter sample period, a) the cross-country relative price volatility is lower, b) the foreign exchange volatility plays an important role in determining the cross-country relative price volatility even though the relative local price remains a significant factor, and c) the comovement between relative local prices and nominal exchange rates marginally reduces the cross-country relative price volatility. The regression results from the subsample data, in general, affirm the market structure effect on cross-country relative price volatility and exemplify the effect of integration on relative price dispersion.

Overall, there is considerable evidence of market structure effects on cross-country price volatility. The results on the covariance of relative prices and exchange rates and the covariance of exchange rates and relative PCMs are also indicative of the pricing to market effect. It is noted that a non-negligible portion of cross-country relative price variability is unaccounted for by the factors considered in the regression exercise. The discussion in section 3 indicates that the costs of traded and non-traded inputs should be included in our analysis. It is also conceived that differences in distribution systems and in the relationships between firms, suppliers, wholesalers, and retailers are an important aspect of cross-country relative price variability.[15] Unfortunately, we do not have data on these variables. Given the importance of prices in economics, future research on economic determinants of the differences and variability of prices across national borders is warranted.

15. MacDonald and Ricci (2001) examine the impact of the distribution sector on real exchange rate dynamics and convergence.

References:

Bergin, Paul R. and Robert C. Feenstra. "Pricing to market, staggered contracts, and real exchange rate persistence." *Journal of International Economics*, 2001, 54: 333-359.

Campa, Jose M. and Linda S. Goldberg. "Investment in manufacturing, exchange rates and external exposure." *Journal of International Economics*, 1995, 38: 297-320.

Cecchetti, Stephen G., Nelson C. Mark, and Robert J. Sonora, "Price index convergence among United States cities." *International Economic Review*, 2002, 43: 1081-1099.

Cheung, Yin-Wong, Menzie Chinn and Eiji Fujii. "Market structure and the persistence of sectoral real exchange rates." *International Journal of Finance & Economics*, 2001, 6: 95-114.

Depken, Criag A. and Robert J. Sonora. "International price volatility: Evidence from U.S. and Mexican cities." *North American Journal of Economics and Finance*, 2002, 13: 179-193.

Domowitz, Ian, R. Glenn Hubbard and Bruce C. Petersen, "Oligopoly supergames: Some empirical evidence on prices and margins." *Journal of Industrial Economics*, 1987, 35: 379-398.

Engel, Charles. 1993. "Real exchange rates and relative prices: An empirical investigation." *Journal of Monetary Economics*, August 1993, 32 (1): 35-50.

Engel, Charles. 1999. "Accounting for the U.S real exchange rate changes." *Journal of Political Economy*, June 1999, 107(3): 507-538.

Engel, Charles and John H. Rogers. "How wide is the border?" *American Economic Review*, December 1996, 86(5): 1112-1125.

Engel, Charles and John H. Rogers. "Relative price volatility: What role does the border play?" in Gregory D. Hess and Eric van Wincoop, eds., *Intranational Macroeconomics*, Cambridge University Press, 2000: 92-111.

Engel, Charles and John H. Rogers. "Deviations from purchasing power parity: Causes and welfare costs." *Journal of International Economics*, 2001, 55: 29-57.

Froot, Kenneth A. and Kenneth Rogoff. "Perspectives on PPP and long-run real exchange rates," in Gene M. Grossman and Kenneth Rogoff, eds., *Handbook of International Economics*, Vol. 3. Elsevier: Amsterdam, 1995: 1647-1688.

Goldberg, Pinelopi Koujianou and Frank Verboven. "Market integration and convergence to the law of one price: evidence from the European car market." *National Bureau of Economic Research Working Paper* 8402, July 2001.

Haskel, Jonathan and Holger Wolf. "The law of one price – A case study." *CESifo Working Paper 428*, 2001.

Isard, Peter. "How far can we push the 'Law of one price'?" *American Economic Review*, December 1977, 67(5): 942-48.

MacDonald, Ronald and Luca Ricci. "PPP and the Balassa Samuelson effect: The role of the distribution sector." CESifo Working Paper, 2001.

Parsley, David C. and Shiang-Jin Wei. "Purchasing power disparity during the floating rate period: Exchange rate volatility, trade barriers and other culprits." *National Bureau of Economic Research Working Paper* 5032, February 1995.

Parsley, David C. and Shang-Jin Wei. "Explaining the border effect: The role of exchange rate variability, shipping cost, and geography." *Journal of International Economics*, 2001, 55: 87-105.

Rogoff, Kenneth. "The purchasing power parity puzzle." *Journal of Economic Literature*, 1996, 34: 647-668.

White, Halbert. "A heteroskedasticity-consistent covariance matrix and a direct test for heteroskedasticity." *Econometrica*, May 1980, 48 (4): 817-838.

Table 1. Relative Price Volatility by Sectors and Countries

ISIC	U.S.	Australia	Austria	Belgium	Canada	Denmark	Finland	France	Germany	Greece
31	2.4298	3.8320	1.3756	1.7617	2.1869	1.3128	1.6163	1.2613	1.6183	1.7261
32	1.8797	2.5381	0.9412	1.3791	2.0529	1.2348	1.3934	1.2692	1.0680	1.1296
33	2.2844	3.2896	1.3475	1.6870	2.4818	1.7828	2.6164	1.6394	1.5057	1.6167
34	2.0277	2.6600	1.2708	1.6233	2.0949	1.2952	2.1302	1.3502	1.3603	1.4868
35	2.2109	2.8547	1.8534	1.7573	2.7837	1.5107	2.1658	1.8365	1.6220	1.3875
36	1.9291	2.6418	1.1884	2.0660	2.0880	1.4351	1.8711	1.1909	1.2288	1.3119
37	2.9500	4.4165	2.2814	3.4024	3.2739	5.1140	2.5128	2.2150	2.2275	2.3181
38	2.0721	2.3277	1.1513	1.6487	2.0432	1.0886	1.5212	1.0759	1.11424	1.4443
39	2.8967	3.8316	n.a.	4.7215	3.1749	2.1108	2.2607	2.4265	2.0012	3.0517
31-39	2.2939	3.1551	1.4262	2.2110	2.4598	1.8746	2.0081	1.5794	1.5274	1.7104

(Table 1 continued)

ISIC	Italy	Japan	Netherla-nds	Norway	Portugal	Spain	Sweden	U.K.	All
31	1.5874	2.4156	1.5284	1.8780	2.1378	3.8456	1.7318	2.0527	2.0166
32	1.3736	2.0294	1.2921	0.9876	1.5540	2.0990	1.3126	1.9534	1.5295
33	1.6934	3.1455	1.7490	1.6585	3.1470	3.2928	2.2280	2.9029	2.2260
34	1.9510	2.2615	1.4754	1.4471	3.2821	1.9361	1.7366	2.3298	1.8733
35	1.3625	4.1797	1.5577	1.8230	2.9613	1.9608	1.9107	2.4439	2.1212
36	1.5501	1.9159	1.3845	1.5585	1.5328	2.1601	1.3989	2.1448	1.6998
37	2.8997	3.2009	2.9333	3.9009	6.1315	4.4980	2.2623	2.9266	3.3036
38	1.2586	1.8436	1.1868	1.1671	2.0532	2.8483	1.2557	1.9749	1.6169
39	3.4014	2.9795	2.8704	2.3288	4.1178	6.3215	3.1087	2.5595	3.1861
31-39	1.8876	2.6614	1.7681	1.8580	2.9834	3.1976	1.8747	2.3641	2.1621

Notes: The entries are sample variances of sectoral relative prices of the specified sectors and countries. Sectors are denoted by their international standard industry classification (ISIC) codes in the first column.

Table 2. Decomposition of Cross-Country Relative Price Volatility

A. By Sector

	$Var(q^k_{i,j})$	$Var(e_{i,j})/Var(q^k_{i,j})$	$Var(p^k_i - p^k_j)/Var(q^k_{i,j})$	$-2Cov(e_{i,j}, p^k_i - p^k_j)/Var(q^k_{i,j})$
31: Food, beverages and tobacco	2.0166	0.5312	0.4318	0.0370
32: Textiles, apparel and leather	1.5295	0.7004	0.3563	-.0566
33: Wood products and furniture	2.2260	0.4813	0.4658	0.0530
34: Paper, paper products and printing	1.8733	0.5719	0.4604	-.0323
35: Chemical products	2.1212	0.5050	0.4447	0.0503
36: Non-metallic mineral products	1.6998	0.6302	0.4088	-.0391
37: Basic metal industries	3.3036	0.3243	0.7373	-.0616
38: Fabricated metal products	1.6169	0.6626	0.3264	0.0111
39: Other manufacturing	3.1861	0.3362	0.6348	0.0157
31-39:	2.1621	0.4955	0.5055	-.0026

B. By Country

	$Var(q_{i,j}^k)$	$Var(e_{i,j})/Var(q_{i,j}^k)$	$Var(p_i^k - p_j^k)/Var(q_{i,j}^k)$	$-2Cov(e_{i,j}, p_i^k - p_j^k)/Var(q_{i,j}^k)$
U.S.	2.2939	0.6485	0.3291	0.0222
Australia	3.1551	0.6143	0.3765	0.0101
Austria	1.4262	0.5489	0.4997	-.0432
Belgium	2.2110	0.3688	0.5653	0.0636
Canada	2.4598	0.6217	0.3650	0.0134
Denmark	1.8746	0.3974	0.5612	0.0390
Finland	2.0081	0.4245	0.5484	0.0260
France	1.5794	0.5042	0.4760	0.0176
Germany	1.5274	0.5342	0.4634	-.0010
Greece	1.7104	0.5278	0.6465	-.1749
Italy	1.8876	0.5406	0.5582	-.0992
Japan	2.6614	0.6199	0.3913	-.0115
Netherlands	1.7681	0.4348	0.5540	0.0084
Norway	1.8580	0.3875	0.6031	0.0082
Portugal	2.9834	0.4158	0.6701	-.0857
Spain	3.1976	0.3248	0.6354	0.0391
Sweden	1.8747	0.4907	0.4826	0.0256
U.K.	2.3641	0.5325	0.4142	0.0525
All	2.1621	0.4955	0.5055	-.0026

Notes: $Var(q_{i,j}^k)$ gives the sample variances of cross-country relative prices. The proportions of $Var(q_{i,j}^k)$ explained by exchange rate volatility, relative local price variability, and the covariance of exchange rates and relative local prices are given by $Var(e_{i,j}) / Var(q_{i,j}^k)$, $Var(p_i^k - p_j^k)/Var(q_{i,j}^k)$, and $-2Cov(e_{i,j}, p_i^k - p_j^k)/Var(q_{i,j}^k)$.

Table 3. The Results of the Cross-Border Relative Price Volatility Regression

	Model Specifications					
	1	2	3	4	5	6
Distance	0.0048**	-0.0006	-0.0006	-0.0007	-0.0006	-0.0007
	(0.0004)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Exchange Rate Volatility		1.2622**	1.2769**	1.2575**	1.2460**	1.2565**
		(0.0806)	(0.0807)	(0.0794)	(0.0808)	(0.0785)
$APCM_{i,j}^{k}$			0.0049**			0.0064**
			(0.0018)			(0.0019)
$VPCM_{i,j}^{k}$				0.0053**		0.0083**
				(0.0017)		(0.0023)
$CPCM_{i,j}^{k}$					0.1015**	0.1633**
					(0.0354)	(0.0402)
Adjusted R^2	0.5594	0.6277	0.6281	0.6346	0.6326	0.6494

Notes: The estimation results of equation (6) in the text are presented. ** and * indicate statistical significance at, respectively, the 1% and 5% levels. Heteroskedasticity-robust standard errors (White, 1980) are provided in parentheses.

Table 4. The Results of the Cross-Border Relative Price Volatility Regression

	Model Specifications					
	7	8	9	10	11	12
Distance	-0.0011	-0.0008	-0.0006	-0.0010	-0.0013	-0.0013*
	(0.0006)	(0.0005)	(0.0005)	(0.0006)	(0.0006)	(0.0006)
Exchange Rate Volatility	1.2554**	1.2203**	1.2816**	1.2639**	1.2755**	1.2560**
	(0.0786)	(0.0821)	(0.0880)	(0.0888)	(0.0803)	(0.0933)
$APCM^k_{i,j}$	0.0064**	0.0064**	0.0064**	0.0064**	0.0064**	0.0064**
	(0.0019)	(0.0019)	(0.0019)	(0.0019)	(0.0019)	(0.0019)
$VPCM^k_{i,j}$	0.0083**	0.0083**	0.0083**	0.0083**	0.0083**	0.0083**
	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0023)
$CPCM^k_{i,j}$	0.1640**	0.1631**	0.1628**	0.1628**	0.1654**	0.1647**
	(0.0402)	(0.0403)	(0.0402)	(0.0403)	(0.0400)	(0.0401)
ADJ	-0.0012			-0.0008		-0.0000
	(0.0009)			(0.0010)		(0.0010)
LAN		-0.0014		-0.0014		-0.0012
		(0.0009)		(0.0010		(0.0010)
SEA			-0.0006	-0.0011		-0.0003
			(0.0012)	(0.0012)		(0.0013)
EEC					-0.0015	-0.0015
					(0.0009)	(0.0010)
EFTA					-0.0046**	-0.0042*
					(0.0014)	(0.0016)
Adjusted R^2	0.6496	0.6496	0.6492	0.6495	0.6511	0.6506

Notes: The estimation results of equation (6) in the text are presented. ** and * indicate statistical significance at, respectively, the 1% and 5% levels. Heteroskedasticity-robust standard errors (White, 1980) are provided in parentheses.

Table 5. The Results of the Relative Local Price Variability Regression

	Model Specifications					
	1	2	3	4	5	6
Distance	0.0003	-0.0000	-0.0001	-0.0000	-0.0000	-0.0001
	(0.0003)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Exchange Rate Volatility		0.0791	0.0927	0.0751	0.0716	0.0812
		(0.0639)	(0.0638)	(0.0624)	(0.0644)	(0.0625)
$APCM_{i,j}^{k}$			0.0041**			0.0057**
			(0.0117)			(0.0015)
$VPCM_{i,j}^{k}$				0.0044**		0.0062**
				(0.0016)		(0.0021)
$CPCM_{i,j}^{k}$					0.0470	0.0801*
					(0.0303)	(0.0359)
Adjusted R^2	0.6088	0.6089	0.6024	0.6170	0.6105	0.6185

Notes: The estimation results of equation (11) in the text are presented. ** and * indicate statistical significance at, respectively, the 1% and 5% levels. Heteroskedasticity-robust standard errors (White, 1980) are provided in parentheses.

Table 6. The Results of the Relative Local Price Variability Regression

	Model Specifications					
	7	8	9	10	11	12
Distance	-0.0003	-0.0001	-0.0001	-0.0003	-0.0003	-0.0005
	(0.0005)	(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0005)
Exchange Rate Volatility	0.0806	0.0798	0.0763	0.0755	0.0867	0.0705
	(0.0624)	(0.0658)	(0.0697)	(0.0706)	(0.0640)	(0.0741)
$APCM^k_{i,j}$	0.0057**	0.0057**	0.0057**	0.0057**	0.0057**	0.0057**
	(0.0015)	(0.0015)	(0.0015)	(0.0015)	(0.0015)	(0.0015)
$VPCM^k_{i,j}$	0.0062**	0.0062**	0.0062**	0.0062**	0.0062**	0.0062**
	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0021)
$CPCM^k_{i,j}$	0.0805*	0.0801*	0.0802*	0.0808*	0.0807*	0.0812*
	(0.0360)	(0.0359)	(0.0359)	(0.0360)	(0.0360)	(0.0360)
ADJ	-0.0007			-0.0008		-0.0005
	(0.0007)			(0.0008)		(0.0008)
LAN		-0.0000		0.0003		0.0003
		(0.0007)		(0.0008)		(0.0008)
SEA			0.0001	0.0003		0.0006
			(0.0009)	(0.0009)		(0.0010)
EEC					-0.0005	-0.0005
					(0.0007)	(0.0008)
EFTA					-0.0013	-0.0011
					(0.0011)	(0.0013)
Adjusted R^2	0.6184	0.6182	0.6182	0.6179	0.6182	0.6276

Notes: The estimation results of equation (11) in the text are presented. ** and * indicate statistical significance at, respectively, the 1% and 5% levels. Heteroskedasticity-robust standard errors (White, 1980) are provided in parentheses.

Table 7. The Results of the Exchange Rate – Relative Local Price Covariance Regression

	Model Specifications					
	1	2	3	4	5	6
Distance	-0.0000	0.0003*	0.0002*	0.0003*	0.0003*	0.0002*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Exchange Rate Volatility		-0.0915**	-0.0920**	-0.0911**	-0.0872**	-0.0876**
		(0.0227)	(0.0227)	(0.0227)	(0.0226)	(0.0225)
$APCM_{i,j}^{k}$			-0.0003			-0.0003
			(0.0004)			(0.0004)
$VPCM_{i,j}^{k}$				-0.0004		-0.1039**
				(0.0002)		(0.0003)
$CPCM_{i,j}^{k}$					-0.0272**	-0.0416**
					(0.0073)	(0.0073)
Adjusted R^2	0.1715	0.1826	0.1853	0.1835	0.1939	0.2086

Notes: The estimation results of equation (12) in the text are presented. ** and * indicate statistical significance at, respectively, the 1% and 5% levels. Heteroskedasticity-robust standard errors (White, 1980) are provided in parentheses.

Table 8. The Results of the Exchange Rate – Relative Local Price Covariance Regression

	Model Specifications					
	7	8	9	10	11	12
Distance	0.0003*	0.0003*	0.0002#	0.0003*	0.0005**	0.0004**
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Exchange Rate Volatility	-0.0874**	-0.0702**	-0.1026**	-0.0941**	-0.0944**	-0.0927**
	(0.0225)	(0.0230)	(0.0259)	(0.0256)	(0.0227)	(0.0264)
$APCM_{i,j}^{k}$	-0.0003	-0.0003	-0.0003	-0.0003	-0.0003	-0.0003
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
$VPCM_{i,j}^{k}$	-0.0010**	-0.0010**	-0.0010**	-0.0010**	-0.0010**	-0.0010**
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
$CPCM_{i,j}^{k}$	-0.0417**	-0.0415**	-0.0413**	-0.0410**	-0.0423**	-0.0417**
	(0.0073)	(0.0073)	(0.0073)	(0.0073)	(0.0072)	(0.0072)
ADJ	0.0002			0.0000		-0.0002
	(0.0002)			(0.0002)		(0.0002)
LAN		0.0006**		0.0008**		0.0008**
		(0.0002)		(0.0002)		(0.0002)
SEA			0.0003	0.0007*		0.0005
			(0.0003)	(0.0003)		(0.0003)
EEC					0.0005*	0.0004#
					(0.0002)	(0.0002)
EFTA					0.0016**	0.0015**
					(0.0003)	(0.0004)
Adjusted R^2	0.2088	0.2114	0.2087	0.2126	0.2159	0.2387

Notes: The estimation results of equation (12) in the text are presented. **, *, and # indicate statistical significance at, respectively, the 1%, 5%, and 10% levels. Heteroskedasticity-robust standard errors (White, 1980) are provided in parentheses.