Exchange Rate Pass-Through in a Small Open Economy: Panel Evidence from Hong Kong

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Abstract

This paper presents estimates of exchange rate pass-through derived from a panel of very disaggregated import unit-values to Hong Kong. The estimation approach builds on that utilized by Knetter (1989, 1993) to study export pricing and pricing to market. The three-dimensional data set examined comprises Hong Kong's top eight floating exchange rate trading partners, and twenty-one of the top five-digit SITC imports since 1992. Pass-through estimates for Hong Kong imply relatively faster import price adjustment than is typically found for larger, less open economies. These estimates are robust to a number of sensitivity tests. Finally these results confirm, from a different perspective, findings by Parsley (2001) that deviations from the law of one price play a relatively smaller role in real exchange rate movements for Hong Kong than for other East Asian countries.

The views presented in this paper are those of the author and do not necessarily reflect those of the Hong Kong Institute for Monetary Research, its Council of Advisors or Board of Directors.

1. Introduction

The transmission of exchange rate changes to import prices is the subject of active discussion in both academic and policy-making circles. Besides the obvious implications for the path of domestic inflation and the possible response of monetary policy, analysts are interested in pass-through because exchange rate changes can potentially impact domestic market structure (Baldwin 1988, Froot and Klemperer 1989). More recently, studies have considered whether pass-through can impact domestic market structure in ways that influence optimal monetary policy (see e.g., Taylor 2000, Campa and Goldberg 2000).

At a more fundamental level, the rate of exchange rate pass-through is a key determinant of real exchange rate movements. In a recent study, Parsley (2001) finds that typically over 95% of real exchange rate movements among East Asian countries are attributable to failures of the law of one price. The only exception is for Hong Kong - where the corresponding number is only 50 to 75%. Hong Kong's experience with pass-through is of interest due both to its long-standing peg to the U.S. dollar, and to its very high degree of price flexibility (Zitzewitz 2000). On the one hand, this suggests that we should expect a higher degree of pass-through to Hong Kong than is typically found. However, working against this is the anecdotal evidence of widespread invoicing in U.S. dollars. If Hong Kong's imports are invoiced in dollars, bilateral variation in non-dollar exchange rates might have little impact on Hong Kong prices.

Unfortunately empirical estimates of pass-through are often unstable; that is the estimates change over time. It is generally not clear whether this instability is due to changes in the commodity composition of trade (Campa and Goldberg 2000), changes in the relative importance of trading partners, or to structural instability in the estimated pass-through equations themselves. That is, differences in pass-through across commodities, or across countries can change aggregate pass-through simply due to the changing composition of trade. However a general presumption is that changes in trade patterns and composition are generally second-order considerations for pass-through, at least in the short-run. Purely statistical problems, however, are pervasive.

The primary empirical difficulty researchers face in obtaining estimates of aggregate exchange rate pass-through is that import prices, exchange rates, and the additional variables on which pass-through depends are simultaneously determined as part of a general equilibrium system. One potential implication is that estimated coefficients will display instability.[1] Hence traditional estimates are derived from empirical models violating one of the key assumptions of the classical linear regression model. While we know that the resulting OLS estimates will be biased, we do not know the magnitude or the sign of this bias.

This study takes a different approach to estimating exchange rate pass-through to import prices. Building on the approach advocated by Knetter (1989, 1993) to study export pricing, pass-through is estimated using a three-dimensional panel of very disaggregated import unit-values. Empirically, pass-through to Hong Kong is estimated using a panel data set comprising roughly 85% (by volume) of Hong Kong's floating exchange rate trading partners, and imports of twenty-one of the top five-digit SITC products

1 Campa and Goldberg (2000), and Taylor (2000) discuss additional reasons for instability in pass-through estimates.

since 1992. Consistent with other evidence for the Hong Kong economy, pass-through estimates for Hong Kong imply relatively quick import price adjustment. Indeed, it is generally not possible to reject the hypothesis that estimated pass-through is 100% within one year. This is considerably faster than is typically found in studies of larger, less open (typically G7) countries. The results in this study are found to be robust to a number of sensitivity tests.

The next section sketches the textbook derivation of pass-through in the simplest possible context. The resulting first order condition is well known and surprisingly general; perfect competition and monopoly are special cases. This section also discusses estimation issues and the advantages that a combined cross-section time-series approach affords. Section 3 discusses the data examined. Section 4 presents the estimation results and a final section concludes.

2. The Textbook Model

In the simplest textbook model of perfect competition, profit maximization by an exporter with prices set in foreign currency implies price equals marginal cost, or, $P_i = C_i$, where, P_i is the price of the i^{th} good. If the good is traded internationally, the price in foreign currency, P_i^*, is simply $P_i^* = C_i/S$, where S is the domestic currency price of foreign exchange. With constant marginal cost, pass-through, i.e., the elasticity of foreign currency price with respect to the exchange rate ($d\ln P^*/d\ln S$), is equal to one (in absolute value). Thus, in the small country, perfect competition benchmark, local currency import prices fully reflect exchange rate changes.[2]

If we relax the perfect competition assumption, the first order condition must include a markup:

$$P_i^* = \lambda C_i/S, \tag{1}$$

The markup (λ) is a function of the elasticity of demand (ε), $\lambda = \varepsilon_i/(\varepsilon_i - 1)$. Thus, pass-through can be less than complete if the markup varies. Markups can vary due to strategic interactions (see, e.g., Froot and Klemperer 1989). Note that the perfect competition case is also a special case of equation (1) when the demand elasticity is infinite.

Thus to estimate pass-through, empirical measures of marginal cost and factors influencing markups need to be obtained. Traditional estimates of pass-through, e.g., Mann (1986), are derived from linear regressions of equation (1) using aggregate (e.g., import price index) data.[3] Typically these equations include a cost index, e.g., a domestic wholesale price index, and import demand shifters, e.g., a competing price and importer's income. In these studies, pass-through to the U.S. typically was found to be around 60%. This implies that changes in markup thus accounted for the residual 40% of the exchange rate change.

2 A more complete treatment is presented in Goldberg and Knetter (1997).

3 Typically, estimations are in percentage change form, i.e., variables included in regression equations are first-differenced, natural log values.

As noted, two problems with these estimations include measurement error and simultaneity bias. First, cost indices typically available may not approximate marginal costs very well. If this measurement error is correlated with the equation disturbance, then OLS estimates will be biased. Goldberg and Knetter (1997) suggest this type of measurement error may actually be correlated with exchange rates such that pass-through estimates are biased downward. In their example, foreign outsourcing increases this problem. The second, related problem, afflicting early estimations was simultaneity bias. At the aggregate level, exchange rates and prices are both endogenous variables. Thus by definition, the exchange rate will be correlated with the disturbance term and, as before, OLS estimates will be biased (see, e.g., Parsley and Popper 1998).

Both of these issues suggest that a different estimation procedure is appropriate. Consequently, the empirical approach adopted here builds on that developed in Knetter (1993). In his study of export pricing, Knetter argues that observing exports to several destination countries allows the identification of marginal costs (and common movements in markups) as that part of the price change common across destinations. Specifically, he estimates the following model:

$$\Delta p_{jt} = \theta_t + \beta_j \Delta s_{jt} + \mu_{jt} \tag{2}$$

This is a generalization of equation (1) in that the condition now considers an exporter selling the same product to multiple markets. Equation (2) relates the change (Δ) in the price of the import good to country j at time t, to the bilateral exchange rate (s_{jt}) between home and country j. At this level of disaggregation exchange rate changes can arguably be treated as exogenous. Note that lower case letters indicate natural logarithms, and the error term μ_{jt} is assumed to be independently and identically distributed with mean zero and variance σ^2_μ.

A key aspect of equation (2) is that it identifies changes in marginal costs with common (across destination) movements in price.[4] That is, each period we observe *n* separate price changes for an exporter selling to *n* separate markets. Estimates of cross-country differences in pass-through are provided by β_j. Thus this empirical model recognizes explicitly that markups and marginal costs are not directly observable, but utilizes the cross-sectional information present when a single product is simultaneously imported to several destinations. As noted by Knetter (1993), the interpretation of the time effects as capturing the behavior of marginal cost is oversimplified when more than one firm is in the import sector. He notes that the model still controls for common, underlying changes in industry cost.

The strategy employed in this paper is to use a variant of this approach to study import pass-through. In particular, import unit-value data is pooled across products from a given destination. Thus, for imports, equation (2) becomes:

$$\Delta p_{it} = \alpha_i + \beta \, \Delta s_t + \mu_{it} \tag{3}$$

4 These time dummies also capture common movements in markups.

In equation (3) the α_i are good-specific fixed effects. Unfortunately, this model cannot identify time variation in marginal costs and changes in markups - they are both lumped into the exchange rate effect. We can, however, gain more information by incorporating another dimension. If we stack the data from different destinations we can include a full set of good-, country-, and time-specific controls.

$$\Delta p_{ijt} = \alpha_i + \delta_j + \theta_t + \beta_j \Delta s_t + \mu_{it} \quad (4)$$

In equation (4), the coefficients β_j will measure pass-through from country j. The time dummies, θ_t, now measure aggregate changes in foreign cost conditions, while the parameters δ_j and α_i, control for country- and good-specific effects. As noted by Knetter, other factors such as income and competitors' prices in the destination market may be important for establishing the absolute level of prices in the import market, but (relative) changes in these variables will generally be of much smaller magnitude than the corresponding bilateral exchange rate. The model is estimated using a panel of disaggregated import unit-value data from Hong Kong's top eight floating rate source countries, and twenty-one of Hong Kong's top import goods simultaneously.

The model is estimated using annual data due to several considerations. First, recent research has indicated that short-run exchange rate changes may not be passed through if they are thought to be temporary (e.g., Froot and Klemperer 1989). Related is the problem of invoicing currency. If exporters invoice in the importer's currency, estimates of pass-through using high frequency data are spuriously biased downward, simply because of infrequent price adjustment (see e.g., Marston, 1990, and Bleaney 1997). Annual data have the further benefit that measurement issues are less severe, since in higher frequency data could more easily be influenced by reporting fluctuations, and month-to-month variation in the composition of imports within a given five-digit category. That is, the unit-values are likely to have a higher noise content at higher frequencies.

3. Data

The original source data for this study are domestic imports (Hong Kong dollar) value and quantity, disaggregated to the five-digit SITC commodity level, from the *Hong Kong Trade Statistics: Country by Commodity Domestic Imports and Re-imports*, published by the Census and Statistics Department of Hong Kong SAR. For this study, the data were taken from the CD-ROM, *Hong Kong External Trade, Volume 5 (1992-2000)*.

Unit-value data have well known limitations as proxies for price (see e.g., Kravis and Lipsey 1974). In particular, unit-values may change due to changes in the commodity composition of trade. The problem is especially salient at the aggregate level. Hence the focus of this study is on unit-values at the most disaggregated level possible in the data. The level of aggregation in this study is similar to other recent studies (see e.g., Knetter 1989, 1993, and Takagi and Yoshida 1999).

For this study the top eight import partners were chosen, ignoring the fixed exchange rate partners China and the United States. Twenty-one five-digit import commodities were chosen from across the full spectrum of import (type) classifications. Overall, the aim was to provide variation in terms of the types of products chosen, and to include important import sectors. Thus despite using micro-data, the goal was to be representative - and, not dependent on a particular product or single import partner. Finally, the goal in choosing the largest import partners was to improve the accuracy of the unit-value data as a measure of price and to minimize the number of missing observations.

Econometrically, a key requirement of the data is for the commodities to be imported from as many of the import partners as possible. This is the important variation that enables the country-specific changes in marginal cost to be more accurately estimated. Unit-values were constructed as the value of imports of the good divided by the quantity imported.

Table 1 lists the countries and goods included in this study. Imports from the Mainland of China and the United States account for the lion's share of Hong Kong's imports - roughly 54% of total imports come from these two source countries. The eight floating-rate trading partners that we consider in this study account for roughly 85% of the remainder.

The nominal exchange rate data were obtained from the CEIC database provided by the Hong Kong Institute for Monetary Research. Real exchange rates were constructed as equal to the nominal exchange rate deflated by the wholesale price index in the exporting country.

4. Estimation Results

Table 2 reports the basic pooled regression results constraining the pass-through coefficients to be equal across countries - i.e. initially we constrain $\beta_j = \beta$ in equation 4. In Panel A, we report results for nominal exchange rate pass-through and in Panel B, results for real exchange rates are reported. In column 1 only country dummies are included in the regressions, and columns 2 and 3 add good and time dummies respectively. Column 4 reports results from an estimation with observations on the dependent variable greater than the 99th and smaller than the 1st percentile dropped.

Looking across the first three columns of Table 2, we see that aggregate import pass-through into Hong Kong is quite high. The point estimates range from 80 to 94%, and are statistically significant; in fact for nominal exchange rate pass-through (and for real exchange rate pass-through in column 3) we cannot reject the hypothesis that aggregate pass-through is equal to one. Dropping extreme values lowers pass-through estimates significantly (column 4) however the adjusted R-squared statistic - not large to begin with - falls substantially. These findings are consistent with evidence of much higher price flexibility in Hong Kong than in most OECD countries (Zitzewitz 2000).

We next explore the sensitivity of these estimates to the specification. A lagged dependent variable is added to the regressions in Table 3. The lagged dependent variable is statistically significant in all equations, and the R-squared statistics increase appreciably. However the pass-through estimates are remarkably stable between the tables and they remain statistically significant. Moreover, now we cannot reject that pass-through is equal to one in any of the first three columns - real or nominal.[5] Finally, the

5 The significance levels of the chi-squared test statistics are 0.78 and 0.93 for the nominal and real estimates in column 3.

results excluding extreme values are similar to those in Table 2. In particular the estimates are smaller and the fraction of the variance explained by the regression declines in the final column. Hence, in the remainder of the analysis we report regressions using all of the data.

Table 4 adds an additional explanatory variable - a lag of the change in the exchange rate. The table reports coefficient estimates and standard errors for the sum of the coefficients on the contemporaneous and lagged exchange rate. The point estimates for pass-through are all quite close to one, and indeed for nominal exchange rate pass-through (in column 3), the point estimate is closer to 1.5; however due to the greater standard error we cannot reject the hypothesis that the sum equals one.[6]

Despite the arguments above that the prices of imports of very disaggregated commodity groupings should not be jointly determined with the exchange rate, we want to determine whether the estimates hinge on the assumption that the error is uncorrelated with the exchange rate. Hence in Table 5 we instrument the nominal exchange rate using the other independent variables plus two lagged values of the exchange rate.[7] The point estimates of pass-through are actually larger in Table 5 than those in Table 2. The standard errors are much larger in Table 5; hence the pass-through estimates are significant only at the 10% level. Thus, the evidence in Table 5 suggests that correlation between the exchange rate and the error term in previous tables is not seriously impacting the estimates.

Finally, in Table 6 we examine pass-through on a country-by-country basis. Column 1 presents the estimates for nominal exchange rate pass-through, and column 2 presents those for the real exchange rate. In the table results are presented only for the regressions including the full set of dummies (i.e., including country, good, and time dummies); the intermediate regressions yielded no surprises. As might be expected, allowing the coefficients to be estimated separately reduces statistical power. In particular, the individual pass-through coefficient is significant only for the Netherlands in both real and nominal equations. The only other statistically significant pass-through coefficient is that for Germany, for the real exchange rate regression.

Judging by the point estimates, however, variation in pass-through related to country of origin of imports appears bimodal. In particular, Australia and the United Kingdom have the two lowest pass-through estimates by far. This wide range of point estimates is consistent with the hypothesis that changes in the country composition of trade can affect aggregate pass-through estimates. Also, it is worth noting that according to the point estimates, Japan is not an outlier in its pass-through behavior toward Hong Kong. Thus the widely documented empirical regularity that Japan's pass-through into the United States is below other countries' pass-through does not apply to Hong Kong.

5. Summary and Conclusions

This study has examined aggregate import pass-through for Hong Kong. The empirical strategy makes use of a three-dimensional panel of very disaggregated (five-digit SITC level) import unit-values from

6 The significance levels of the chi-squared test statistics are 0.31 and 0.17 for the nominal and real estimates respectively.

7 None of the estimates was significantly different from zero in an estimation using only one lag of the exchange rate. The point estimates for pass-through from that estimation were only slightly smaller than those in Table 2.

Hong Kong's top eight floating rate partners and twenty-one import products for the years 1992-2000. The simple, competitive model predicts complete pass-through to local currency prices. Most existing evidence, taken from large, western (generally G7) countries, finds varying (incomplete) degrees of exchange rate pass-through. For example, imports from Japan to the U.S. are typically found to demonstrate pass-through in the neighborhood of 30%. This compares to pass-through rates of 50 to 60% for other countries into the U.S. market.

Empirically, Hong Kong's import pass-through is quite rapid. Point estimates for aggregate pass-through are typically between 80 and 95% for nominal exchange rates, and range from 65 to 70% for real exchange rates for the basic specifications. However, statistically it is not possible to reject the hypothesis that it is 100% after the first year following a change in either the real or nominal exchange rate.

These findings go a long way toward understanding why Hong Kong was a statistical outlier in Parsley (2001). In that study, nearly all real exchange rate variation (at short, medium, and long horizons) was driven by deviations from the law of one price - except for Hong Kong. In the case of Hong Kong, law of one price deviations drove a still substantial 50-75% of real exchange rate movements. However, relative price movements between prices of traded and non-traded goods were also an important source of real exchange rate movements for Hong Kong. Thus, the price flexibility observed by Zitzewitz (2000) and others translates into greater exchange rate pass-through and fewer deviations from the law of one price. Finally, these results suggest that U.S. dollar invoicing-currency effects do not inhibit pass-through in the case of Hong Kong.

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Table 1: Countries and Goods Included

	Countries Included
1	Germany
2	Netherlands
3	France
4	United Kingdom
5	Taiwan
6	Japan
7	Singapore
8	Australia

	Goods Included	
1.	g03412	fresh or chilled salmonidae
2.	g04610	flour of wheat or meslin
3.	g05910	orange juice
4.	g05994	apple juice
5.	g06221	chewing gum
6.	g07529	other spices; mixtures of two or more from group 075
7.	g09101	margarine (excluding liquid margarine)
8.	g09850	soups and broths and preparations thereof
9.	g11230	beer made from malt
10.	g12220	cigarettes containing tobacco
11.	g33450	lubricating petroleum oils and oils obtained from bituminous minerals and other heavy oils; preparation thereof
12.	g51136	other saturated chlorinated derivatives of acyclic hydrocarbons
13.	g51229	other acyclic alcohols
14.	g51376	palmitic acid, stearic acid, their salts and esters
15.	g51377	saturated acyclics monocarboxylicic acid, nes; anhydrides, halides, peroxides, peroxyacids and their derivatives
16.	g51389	polycarboxylic acids, nes; angydrides, halides, peroxides, peroxyacids and their derivatives
17.	g51391	lactic acid, tartaric acid, citric acid and their salts and esters
18.	g57211	polystyrene, expansible, in primary forms
19.	g57311	polyvinyl chloride, not mixed with any other substances, in primary form
20.	g65112	yarn of carded wool, containing 85% or more, by weight of wool, not for retail sale
21.	g65113	yarn of combed wool, containing 85% or more, by weight of wool, not for retail sale

Table 2: Benchmark Regressions

	Equation 1	Equation 2	Equation 3	Equation 4
Panel A:				
Nominal Exchange	0.816	0.799	0.938	0.521
Rate	(0.270)	(0.250)	(0.389)	(0.252)
Country dummies	yes	yes	yes	yes
Good dummies	no	yes	yes	yes
Time dummies	no	no	yes	yes
Adjusted R-squared	0.01	0.05	0.05	0.01
Number of obs.	1284	1284	1284	1251
Panel B:				
Real Exchange	0.644	0.631	0.715	0.362
Rate	(0.240)	(0.221)	(0.327)	(0.214)
Country dummies	yes	yes	yes	yes
Good dummies	no	yes	yes	yes
Time dummies	no	no	yes	yes
Adjusted R-squared	0.01	0.05	0.05	0.01
Number of obs.	1284	1284	1284	1251

*Robust standard errors in parentheses. Equation 4 reports a regression with values of the dependent variable more than 3 standard deviations above the mean and less than 3 standard deviations below the mean removed.

Table 3: Robustness - Include Lagged Dependent Variable

	Equation 1	Equation 2	Equation 3	Equation 4
Panel A:				
Nominal Exchange	0.864	0.828	0.894	0.548
Rate	(0.276)	(0.248)	(0.386)	(0.253)
Lagged Dependent	-0.179	-0.242	-0.242	-0.285
Variable	(0.033)	(0.033)	(0.033)	(0.035)
Country dummies	yes	yes	yes	yes
Good dummies	no	yes	yes	yes
Time dummies	no	no	yes	yes
Adjusted R-squared	0.05	0.11	0.11	0.10
Number of obs.	1227	1227	1227	1165
Panel B:				
Real Exchange	0.679	0.654	0.678	0.363
Rate	(0.245)	(0.219)	(0.334)	(0.215)
Lagged Dependent	-0.180	-0.243	-0.242	-0.285
Variable	(0.033)	(0.034)	(0.033)	(0.035)
Country dummies	yes	yes	yes	yes
Good dummies	no	yes	yes	yes
Time dummies	no	no	yes	yes
Adjusted R-squared	0.04	0.11	0.11	0.09
Number of obs.	1227	1227	1227	1165

*Robust standard errors in parentheses. Equation 4 reports a regression with values of the dependent variable more than 3 standard deviations above the mean and less than 3 standard deviations below the mean removed.

Table 4: Robustness Check - Include Lagged Dependent Variable and Exchange Rate

	Equation 1	Equation 2	Equation 3
Panel A:			
Nominal Exchange	1.101	1.101	1.468
Rate ($\sum$ current + 1 lag)	(0.277)	(0.263)	(0.459)
Lagged Dependent	-0.182	-0.246	-0.247
Variable	(0.033)	(0.034)	(0.033)
Country dummies	yes	yes	yes
Good dummies	no	yes	yes
Time dummies	no	no	yes
Adjusted R-squared	0.05	0.11	0.11
Number of observations	1227	1227	1227
Panel B:			
Real Exchange	0.919	0.931	1.167
Rate ($\sum$ current + 1 lag)	(0.274)	(0.254)	(0.406)
Lagged Dependent	-0.184	-0.248	-0.247
Variable	(0.032)	(0.034)	(0.033)
Country dummies	yes	yes	yes
Good dummies	no	yes	yes
Time dummies	no	no	yes
Adjusted R-squared	0.05	0.11	0.11
Number of observations	1227	1227	1227

*Robust standard errors in parentheses.

Table 5: Robustness - Instrumental Variable Estimation

	Equation 1	Equation 2	Equation 3
Panel A:			
Nominal Exchange	1.025	1.037	0.933
Rate	(0.636)	(0.622)	(0.544)
Country dummies	yes	yes	yes
Good dummies	no	yes	yes
Time dummies	no	no	yes
Adjusted R-squared	0.01	0.05	0.05
Number of observations	1276	1276	1276
Panel B:			
Real Exchange	0.743	0.738	0.749
Rate	(0.402)	(0.393)	(0.418)
Country dummies	yes	yes	yes
Good dummies	no	yes	yes
Time dummies	no	no	yes
Adjusted R-squared	0.01	0.05	0.04
Number of observations	1276	1276	1276

*Robust standard errors in parentheses. In these estimations the exchange rate is instrumented with two lags of the exchange rate.

Table 6: Country-Specific Pass-Through Estimates

	Nominal ExchangeRate	Real Exchange Rate
Germany	1.378	1.259
	(0.695)	(0.631)
Netherlands	1.361	1.093
	(0.617)	(0.498)
France	1.056	1.133
	(0.769)	(0.739)
United Kingdom	0.237	0.261
	(1.121)	(0.775)
Taiwan	0.970	0.519
	(1.038)	(0.779)
Japan	0.858	0.623
	(0.566)	(0.513)
Singapore	1.577	1.282
	(0.925)	(0.868)
Australia	0.051	0.022
	(0.678)	(0.606)
Lagged Dependent	-0.239	-0.239
Variable	(0.033)	(0.032)
Country dummies	yes	yes
Good dummies	yes	yes
Time dummies	yes	yes
Adjusted R-squared	0.11	0.11
Number of observations	1227	1227

*Robust standard errors in parentheses.