Some Puzzles Related to Exchange Rate Pass-Through

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The value of the Canadian dollar has moved more than most other major currencies over the past twenty-five years, yet the observed effect on domestic prices -- or pass-through -- appears to have been much smaller than most economists would have expected (see Figures 1 and 2). Indeed, in recent years exchange rate pass-through seems to have essentially disappeared. This would be of limited interest to people outside Canada, were it not for the fact that the same phenomenon has been observed in many other countries.

For those countries with depreciating currencies this might seem like a good thing, allowing them to avoid any implied loss of real income or rising inflationary pressures. However, any suggestion that the price mechanism is not working (either domestically or internationally) could be cause for concern. Exchange rate changes and related movements in relative prices play an important role in the adjustment of global trade imbalances and the international allocation of resources, as well as in inflation dynamics and the conduct of monetary policy. Any interference with this crucial market mechanism, or undetected shift in its behaviour over time, could have serious consequences.

The purpose of the present paper is two-fold. The first is to review the recent empirical evidence on exchange rate pass-through (ERPT) and determine if, and by how much, it might have declined. The second is to review the various explanations that have been put forward to resolve the pass-through conundrum. The paper begins with a brief review of what economists mean by exchange rate pass-through and how standard theory predicts it should operate. Important distinctions are drawn between producer currency pricing (PCP) and local currency pricing (LCP), and the related concepts of import- and export-price pass-through. Section 2 explains why economists care about ERPT and the problems that might arise from any disruption or unanticipated change in the linkages between domestic and foreign prices, on the one hand, and the exchange rate, on the other. This is followed by an overview in Section 3 of the latest empirical evidence on pass-through, taken from a number of different country studies. Competing explanations for the observed changes in pass-through behaviour are then examined in Section 4, with a view to gauging which of them seems to be most convincing or persuasive. Section 5 looks at why any empirical evidence drawn from reduced-form models should be treated with caution, and Section 6 provides some concluding thoughts.

As suggested in the opening passage of this paper, causal observation and extensive empirical work both give broad support to the notion that exchange rate pass-through has declined dramatically and in an essentially monotonic fashion since the 1970s. While there is some dissenting evidence, most economists believe pass-through has fallen. Several different and, at times, conflicting theories have been offered by way of explanation, but one of the most attractive, at least from a central banking perspective, focuses on the effect that more disciplined and successful monetary policy might have had on exchange rate pass-through. Other complementary and convincing explanations point to the changing mix of international trade and the impact of globalization, in particular, the emergence of countries such as China and their growing influence on world trade.

Before concluding that the pass-through puzzle has been solved, however, one important caveat needs to be noted; that is, the recent disappearance of ERPT may be more apparent than real. More specifically, it is possible that the reduced-form equations typically used to estimate exchange rate pass-through provide a misleading picture of the true underlying relationships. Two examples, using Canadian data, are provided towards the end of the paper to show how this could occur, and how more disaggregated structural models might overcome this problem. Exchange rate pass-through, in other words, may not have disappeared; it might just be hiding.

1. What Is Exchange Rate Pass-Through?

Before reviewing the empirical evidence on ERPT, it is perhaps useful to clarify what economists mean when they use this term, and what sort of relationship they expect to observe between movements in the exchange and movements in domestic and foreign prices. ERPT, in the context of the recent literature, usually refers to the direct effect that an increase (or decrease) in the external value of a currency has on the domestic price of imported goods and services, and on domestic price indices more generally. Any second-round or indirect price effects associated with resulting changes in aggregate output and demand are typically ignored in this context.

In the simplest of all worlds, with perfect competition and no impediments to trade, one would expect to see the Law of One Price (LOP) satisfied. Arbitrage behaviour, in such a perfect setting, would ensure that the domestic price of any traded good, p_d, was equal to the foreign price of an identical good, p_f, times the exchange rate, e (where e is defined as the domestic price of one unit of foreign exchange; so increases in e represent depreciations). In other words, the common-currency price of identical goods sold at home and abroad should be the same.

$$(1)\quad p_d = e p_f$$

In practice, of course, this is almost never observed. First, very few domestic and foreign goods are truly identical. Second, frictions, such as tariff and non-tariff

barriers, as well as transportation, insurance and distribution costs, often create a sizable wedge between domestic prices and foreign prices. Indeed, a number of studies using micro-data have documented how large these wedges can be, even between cities in the same country, where none of the usual international trade impediments or currency conversions should apply.[1] Large and persistent discrepancies in the prices charged for similar products across local markets often dominate any additional differences that might be caused by border effects in international markets, and raise new questions about how integrated and efficient markets really are. Nevertheless, there is an expectation, backed by years of experience, that exchange rate movements should still have a noticeable effect on domestic prices, at both the micro and macro level. While the process may take several years to complete, relative prices should eventually re-equilibrate following a shock, assisted by movements in the exchange rate.

Some encouraging evidence in this regard has recently been reported by Baldwin and Yan (2004), who use disaggregated price data for 160 different products to test for deviations from the Law of One Price[2] between Canada and the United States. Their results suggest that, at least in the long run, the global economy operates much like theory says it should. Baldwin and Yan begin their analysis by dividing the 160 products in their sample into three broad categories: homogeneous tradable goods; differentiated tradable goods; and non-tradable goods. Then they calculate cross-border price deviations for pairs of similar Canadian and US goods in 5 benchmark years: 1985, 1990, 1993, 1996, and 1999.

Interestingly, Baldwin and Yan find that the average price discrepancies they uncover are much larger for non-tradables than for tradables, and that discrepancies among homogeneous tradables goods are not statistically different from zero. Discrepancies on differentiated tradable goods, in contrast, average about 4 per cent across the entire sample and are statistically significant. It is important to note, however, that much larger discrepancies are recorded across all product categories in each individual year, with the discrepancies often changing signs depending on whether the Canadian dollar is depreciating or appreciating. In some years, almost all of the goods are much cheaper in Canada; in other years they are typically much more expensive. The more encouraging figures that I first mentioned represent averages across all 5 benchmark years. It is only in the long run, in other words, that the expected relationships hold and that a rough sort of equilibrium is achieved.

Unlike the research conducted by Baldwin and Yan, most of the empirical work reported in the rest of the present paper uses aggregate price indices, such as the consumer price index or the industrial price index. This literature usually finds a positive and statistically significant relationship between changes in domestic prices and movements in the exchange rate. For the reasons identified earlier, however, the coefficient linking domestic prices and the exchange rate has typically been less than

1. See, for example, Crucini and Telmer (2007), Engel and Rogers (1996).
2. The Law of One Price is often referred to as Absolute Purchasing Power Parity.

one, especially if one is looking at a price index such as the CPI, which includes a mixture of traded and non-traded goods. The same is true, but to a lesser extent, even if one looks at the retail price of imported goods. The domestic labour and capital necessary to bring an imported good to a retail outlet, coupled with local taxes and profit margins, can often account for 50 or 75 per cent of the final price. A 10 per cent depreciation of the exchange rate, therefore, would only be expected, to push up local prices by 2.5 to 5 per cent, assuming full exchange rate pass-through. In many cases, of course, the response will be even smaller. Foreign producers and domestic retailers may decide that it is in their interest not to pass all of the additional costs onto purchasers. Alternatively, market conditions might simply preclude it.

In extreme cases, none of the exchange rate changes will be passed along. This is often referred to as local currency pricing (LCP), since foreign suppliers fix their prices in the local currency of the market to which they are selling, and absorb any changes in the exchange rate themselves. This behaviour manifests itself in the form of smaller or larger profit margins, depending on the direction of the exchange rate change, and clearly requires a degree of imperfect competition and pricing power on the part of the supplier. It may nevertheless make sense in terms of maximizing profit or preserving market share. The more traditional situation, in which domestic prices are assumed to adjust one-for-one in response to changes in the exchange rate, is referred to as producer currency pricing (PCP). Here, the supplier sets prices in terms of the home currency where the good is produced, leading to a full pass-through. The extent to which LCP or PCP dominates can obviously shift over time and across products.

Macro-economists often try to estimate the degree of pass-through using a reduced-form equation like the one shown below,[3]

$$(2)\quad \ln(p_i) = \mu_i + \beta_i \ln(MC) + (1-\beta_i)\ln(pc_i/e_i)$$

where p_i is the price charged in market i, MC is marginal cost expressed in the exporter's home currency, pc_i is a competitor's price expressed in the ith country's currency, and e_i is the ith country's exchange rate. μ_i and β_i represent destination specific parameters determined by the demand curve in each market, where differences in μ_i reflect differences in mark-ups across markets that are not related to prices or costs. β_i determines the response of mark-ups to changes in marginal cost and competitors' prices in the ith market. In most situations βi will have a value between 0 and 1, where a value equal to 1 indicates a constant mark-up over marginal cost and full exchange rate pass-through, while 0 indicates a variable mark-up which varies one-for-one with marginal costs and implies no pass-through. Expressing (2) as the price of imports in terms of country i's currency, we get equation (3).

3. This section borrows heavily from an excellent paper by Marazzi et al. (2005).

(3) $\ln(e_i p_i) = \mu_i + \beta_i \ln(e_i MC) + (1 - \beta_i)\ln(pc_i)$

The direct effect of movements in the exchange rate on the price of imports is therefore β_i, while the effect on the price of exports (defined in terms of the exporter's home currency) is simply $\beta_i - 1$. This highlights an important fact: any exchange rate changes that are not passed through to the price of imports must be absorbed by exporters as a change in the home currency price of their goods. Declining pass-through from the importers' perspective, therefore, must be mirrored by increased exchange rate sensitivity with regard to export prices. As we shall see, this will have particular significance for Canada when we examine recent developments in Canada-US trade.

2. Why Do We Care about Exchange Rate Pass-Through?

If exchange rate movements were regarded simply as additional noise -- distorting domestic price signals and subverting market efficiency -- any decline in pass-through could be treated as a positive development. However, to the extent exchange rates are believed to move for a reason, in response to underlying fundamentals, any interference in this transmission mechanism would be cause for concern. Changes in relative prices are important for allocative efficiency and are a critical element of the international trade adjustment process.

The US economy, for example, currently faces an unsustainable current account deficit, mirrored by unsustainable surpluses in many of its trading partners. While reduced domestic absorption in the United States, coupled with expanded domestic demand in other countries, will no doubt be required to correct the situation, a significant (real) effective depreciation of the US dollar and associated changes in the relative price of domestic and foreign goods are also viewed as an important part of the adjustment process. Relying on one without the other would impose serious costs on the global economy. These expenditure-switching effects help redirect consumption and investment in the deficit country away from imports, as the exchange rate depreciates, and makes the deficit country's exports more attractive to foreigners.

Betts and Devereux (2002) have shown how the choice of a fixed or flexible exchange rate regime can depend importantly on whether agents are assumed to follow a PCP rule or a LCP rule. The principal, if not only, macroeconomic advantage that a flexible exchange rate provides is its ability to facilitate relative price adjustment in situations where nominal prices display some stickiness. If nominal prices (and wages) are perfectly flexible, there is no need for a flexible exchange rate. Necessary relative price adjustments are achieved instantly and completely through the internal flexibility of prices. Similarly, if exchange rate changes are not reflected in domestic wages and prices, or only with a considerable lag, a flexible exchange rate will not offer any advantage. The resulting relative price adjustment would not be any faster than if sticky nominal wages and prices were forced to do all of the adjustment on their own.[4]

In this regard, it is important to note one aspect that is often overlooked in the standard approach to current account correction. It is that changes in export price margins as well as import price margins can affect behaviour. If pass-through into import prices declines, reducing the expenditure-switching effect, pass-through onto the export prices received by producers in their home currency must, by definition, have increased. Changes in this mark-up will induce a supply response, either encouraging extra output (in the case of a depreciation) or discouraging it (in the case of an appreciation). In this regard, it is important to keep track of both parts of the Marshallian scissors. At some point, if their margins are squeezed far enough, producers will be forced to abandon a market or adjust their prices in order to recover their costs. If profit margins become too large, other producers will be encouraged to enter the market.

Exchange rate pass-through is also important from a monetary policy perspective. Movements in the exchange rate can have a significant influence on inflation dynamics, both in terms of their direct effect on prices and their indirect effect through changes in aggregate expenditure and production. Policymakers must be able to gauge how large these effects are likely to be, in order to determine the size and persistence of underlying inflation pressures and any monetary policy responses that might be required to deal with them. Changes in pass-through behaviour make it difficult to distinguish between persistent, but essentially one-off, movements in prices caused by exchange rate movements, and those associated with output gaps or changes in inflation expectations. Although these three factors are intimately related, from a policy formulation perspective the differences can be significant. This simple tri-variate view of the inflation determination process is often captured in a Phillips curve.

$$(4)\ \pi_t = \pi^e + \lambda(gap)_t + \gamma(\Delta \ln p_i e_t) + \varepsilon_t$$

where π represents period t inflation, π^e is expected inflation, *gap* is the difference between actual and potential output, e is the exchange rate, and ε captures of the effects of other, unidentified, random influences. Unfortunately, two of the three explanatory variables in this relationship are unobservable. Any assistance the policy-maker can get from informed estimates of the pass-through effect coming from e would therefore be extremely valuable. Increased uncertainty about the size and stability of the direct effect of exchange rate changes on prices and inflation makes it difficult to distinguish between one-off exchange rate effects and changes in inflation expectations or the output gap, thereby complicating the policy-maker's task.

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4. Dong (2007) has estimated structural sticky-price models for Australia, Canada, and the United Kingdom, to test for the size of the expenditure-switching effect in these three (relatively) small open economies. She finds that the degree of domestic expenditure-switching is relatively small in the United Kingdom, but relatively large in Canada. However, expenditure-switching by foreign distributors in Australia and Canada is comparatively small.

3. Some Recent Empirical Evidence

Several authors have estimated reduced form equations like (3) over the past few years. Although there are some notable differences in the reported results and the authors' interpretations, the consensus view that emerges can be summarized as follows.

First, there are sizable differences in the estimated pass-through coefficients across countries. However, estimates drawn from extended samples covering the mid-1970s through to the early 2000s, usually report average values for β of approximately 0.50 (i.e., significant but less than full pass-through into import prices). Estimates for the United States are often much smaller than those for other countries, but there does not seem to be any direct relationship between the size of a country size and the size of its pass-through coefficient. Germany, for example, usually has much larger parameter estimates than those obtained for many smaller countries. The lower pass-through values typically found for the United States are thought to reflect the privileged position of the U.S. dollar in international trade, and the pre-eminent importance of the U.S. market.

Second, evident differences are observed, as one would expect, when different price indices are used in the estimation of the pass-through equations. Indices defined in terms of the import prices for a limited set of manufactured goods typically have much lower pass-through coefficients than those on more homogeneous goods, such as oil and other primary products. Much lower values are also reported when the consumer price index (CPI) is used as the dependent variable rather than a narrower import price index, owing to the addition of non-tradeable goods and services as well as the extra charges associated with moving the products from dock-side onto retail shelves. Focusing on core-CPI measures as opposed to headline CPI measures reduces the coefficients even further, as volatile raw materials prices are usually excluded, and these are the sorts of imports that usually have much larger pass-through coefficients.

Third, and most important for present purposes, is the declining trend that is observed in virtually all pass-through coefficients over time. Independent of which country one examines, or which price index is used, the result is the same. There is a clear downward trend in the estimated pass-through coefficient when rolling regressions are run, sequentially dropping observations at the start of the sample and adding more recent observations at the end. The results reported by Campa and Goldberg (2005) are representative of those found in the broader literature, and have been reproduced on Table 1. Twenty-three OECD countries were included in their sample, which runs from 1977 to 2001, and Canada is one of them. The authors use import price indices for their study and find that the average ERPT coefficient is 0.46 in the short-run and 0.64 in the long run.[5] If the estimation period is restricted to more recent years, the average size of the coefficients declines, but the authors in

5. The short run, for purposes of Campa and Goldberg's work, is defined as one quarter.

this case are not able to reject the hypothesis of long-run stability in the parameters. One curious result is worth highlighting because of its relevance to Canada. The short-run pass-through coefficient over the entire sample period, is found to be larger than the long-run coefficient (0.75 versus 0.65), though once again the difference is not statistically significant.

The results reported by two colleagues at the Bank of Canada, Bailliu and Fujii (2005), are broadly similar to those of Campa and Goldberg. However, their pass-through estimates are somewhat lower, since their tests were run using CPI indices for the 11 industrial countries in their sample, as opposed to import prices. Bailliu and Fujii decided to use CPI data rather than import price data because they realized that reliable import price data were not available for all the countries in their sample, including Canada.

In the case of Canada, Baillui and Fujii discovered that roughly two-thirds of the products included in Statistics Canada's aggregate import price series were obtained by simply multiplying the foreign price by the current exchange rate, in order to convert it into Canadian dollars. Complete and immediate exchange rate pass-through is therefore assumed by construction. While this might have seemed like a reasonable assumption for a small open economy like Canada, when the series was first developed, evidence from other small open economies suggests that this extreme assumption does not hold in practice, and makes research using the reported import numbers impossible. It also accounts for the strange results reported by Campa and Goldberg, in which the short-run coefficients were approximately the same size as the long-run coefficients.

Gagnon and Ihirg (2004), like Bailliu and Fujii (2005), use CPI indices for their tests, and thereby avoid the problem of contaminated import price series. They find an average long-run coefficient of 0.23 for their sample of 20 industrial countries, over the entire 1971-2003 period, roughly half the size of the coefficient obtained by Campa and Goldberg.

Marazzi et al. (2005) side-step the problem described above by using U.S. export and import price data, which are more reliable than those for many other countries. In every case, there is evidence of partial pass-through with a declining trend through time. Typical results, taken from Gagnon and Ihirg, are shown in Table 2. The fact that pass-through is incomplete and often sluggish is not surprising. One would expect a delayed response owing to hedging activity and other trade frictions. Exporters and importers might also want to see if exchange rate movements are temporary or persistent before changing their prices, to avoid incurring unnecessary menu costs. Less than full price pass-through, even in the long-run, might also be expected depending on market conditions and the existence of less than perfectly elastic (or inelastic) demand and supply curves. This does not explain why pass-through seems to have declined through time, however -- a task to which we now turn.

4. Why Has Exchange Rate Pass-Through Declined?

A variety of explanations have been offered for the observed decline in pass-through coefficients, not all of them mutually exclusive. Some explanations focus on the changing composition of trade and the increased importance of high-end, manufactured products. Others credit the decline to the growing importance of emerging market economies such as China. The explanation that has attracted the greatest attention in central banking circles, however, concerns the improved performance of monetary policy in many countries and the changing behaviour of inflation over time.

(a) Monetary policy and reduced exchange rate pass-through

The economist most closely associated with the monetary policy explanation of reduced ERPT is John Taylor (2000), whose influential article was among the first to draw a connection between improved inflation performance and declining exchange rate effects. Taylor's argument is based on the reduced persistence of inflation in economies where inflation has been kept low and stable, and where inflation expectations are well-anchored owing to the enhanced credibility of monetary authorities.

Taylor contrasts the present situation in many countries with those that existed in the 1970s and the days of the so-called Great Inflation. During this earlier period of high and volatile inflation, expectations were not only unanchored, but often seen as extrapolative. Exchange rate movements had exaggerated effects on import prices in such an environment, as agents were unable to distinguish between permanent and temporary movements in prices, and authorities all too often validated (positive) relative price shocks through accommodative monetary policies. Macro economists talked about virtuous and vicious circles, with the latter more closely approximating the situation that existed in the 1970s and the early 1980s. Exchange rate depreciations were viewed as destabilizing catalysts, in which higher import prices fed into inflation expectations, causing prices to rise more generally. Authorities were afraid to the resist these price movements for fear of generating higher unemployment -- and so inflation spiralled out of control.

In many of today's economies, the picture is quite different. Monetary authorities, often assisted by an explicit inflation targeting framework, have delivered low, stable, and predictable inflation for several years. Inflation expectations are well-anchored, policy credibility has been enhanced, and the persistence of inflation, as measured by the auto-correlation coefficient on an inflation time series, has been dramatically reduced. Canada serves as an extreme example of this, with the measured persistence of inflation dropping through time from values of 0.7 to 0.8 in the 1975-1985 period to essentially zero in the last ten years (see, Lafleche (1997), Coletti and Demers (2004), and Murchison (2005a)).

Exchange rate pass-through, Taylor argues, is less significant now for two related reasons. First, confidence that inflation will not be allowed to move persistently above target keeps inflation expectations from becoming extrapolative, thereby minimizing the propagation of exchange rate shocks. Second, agents are less inclined to raise prices in the presence of shocks that are believed to be temporary, since two sets of menu costs have to be incurred -- one to raise prices and another to lower them a short time after.[6] In this regard, Canada's experience probably warrants special attention. It is an extreme example of what has happened in many other (inflation targeting) countries.

As predicted by Taylor, Canada's more disciplined and effective monetary policy framework has been matched by a significant fall in measured inflation persistence, to the point where it is effectively zero. In addition, estimated pass-through has also fallen and is, in a statistical sense, not insignificantly different from zero. The effect has gone even further than this, however. Couched in terms of the traditional Phillips curve, the pass-through coefficient as well as the coefficient on the output gap term have both become insignificant, and even the inflation expectations terms has now disappeared. The latter has been replaced by a constant term, with a value at or close to the Bank of Canada's 2 per cent inflation target. The apparent demise of the Phillips curve in Canada has been documented by Demers (2003), Khalaf and Kichian (2006) and others, and seems to have occurred in three stages. The first structural break appears to have taken place in the mid- to late-1980s with the loss of the pass-through term. This was followed in the early- to mid-1990s with the departure of the output gap term. Finally, towards the end of the 1990s the inflation expectations term also lost significance.

One interpretation of the evolution described above would be that inflation targeting has been so successful that the best predictor of inflation in Canada is now the 2 per cent inflation target itself. Inflation expectations have gravitated to this number, and have shown very little movement over time; the exchange rate pass-through effect as noted earlier has also disappeared; and the output gap has lost influence as the public is convinced that any demand-supply imbalance will be short-lived -- offset by policy actions designed to keep inflation on course. Effective inflation targeting, in other words, has affected much more than the results of our exchange rate pass-through equations.[7]

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6. Some authors, such as Devereux and Yetman (2002), have noted that lower inflation can lead to more persistence in prices and wages, and in turn cause pass-through to decline as wage and price contacts are changed less often. Others point out that countries with lower rates of inflation should find that their currencies are used more often to price goods, leading to more local currency pricing in these favoured spots.

7. If the Phillips curve were the only guide that the Bank of Canada had for policy formulation, one might worry that we had become a victim of our own success. Monetary policy was so credible that we were now flying blind, without any guidance from the three traditional elements of inflation determination as embodied in the Phillips curve. We have sometimes referred to this dilemma as the "dark side of policy credibility." Fortunately, the Phillips curve is not the only tool used for policy guidance here and elsewhere. Information is gathered from a host of other sources. Moreover, the primary base for the Bank's projection exercises is a fully articulated, five sector structural, model called ToTEM, which avoids many of the problems associated with simpler reduced-form relationships. We shall have more to say about this later.

While Taylor's argument has a great deal of intuitive appeal, some macroeconomists remain sceptical, and note that many other things have occurred over the last twenty years. It is difficult to credit any one development with the success that we and other central banks have enjoyed. Some macro-economists even question whether improved monetary policy has had much to do with the Great Moderation that many countries have experienced (e.g., Ball (2002)). Lower and more stable inflation, coupled with strong and steady growth, are perhaps the product of other developments such as a more benign external environment and globalization.

In an effort to shed more light on this debate, some authors have tested for the existence of discrete break-points in the pass-through estimates, and then checked to see whether the break-points coincided with significant changes in the way monetary policy was conducted.[8] The results were very supportive of Taylor's view. In almost every case, the authors found a close correspondence between the timing of the shifts in ERPT and the introduction of a new monetary policy framework, such as inflation targeting, or a notable change in the way monetary policy was being conducted. In some cases, the changes appeared to be more gradual, however, and might have reflected the growing credibility of monetary policy as authorities delivered on their promise of a lower and more stable inflation rate.

This is not to suggest that debates over the existence, size and determinants of exchange rate pass-through have now been resolved. Other theories, backed by seemingly supportive evidence, have also been advanced and are briefly reviewed below.

(b) Shifts in the Composition of Trade

An alternative, and potentially complementary, explanation for the decline in ERPT concerns the composition of international trade. Campa and Goldberg (2005) are the two authors most closely associated with this work, and have uncovered convincing evidence that international trade has become increasingly dominated by differentiated high-end manufactured goods, at the expense of more homogeneous products, such as raw materials and low-end manufactured and industrial goods. Trade liberalization, technological improvements, and the reduced costs of transportation and communication have gradually expanded the range of goods and services that can now be exchanged internationally. This expansion of imports at the extensive rather than the intensive margin has allowed greater price discrimination across markets and given producers more monopoly power, as trade is increasingly characterized by imperfect competition. In earlier years, when homogeneous products like oil, wheat, and wood accounted for a larger share of the trade, there was little opportunity for price discrimination as producers faced relatively flat demand curves and much greater competition.

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8. See the studies mentioned earlier by Bailliu and Fujii (2005) and Gagnon and Ihirg (2004).

The emergence of finely differentiated products, combined with a more concentrated global industrial structure, have given producers more opportunities to optimize profits by adjusting their margins in response to changing cost and demand conditions. The domestic transportation and distribution costs required to bring these imported products to the final purchaser are also much higher than for bulk industrial materials, implying wider cushions of domestic cost and less overall sensitivity to exchange rate movements. Although the pass-through associated with each narrowly defined class of goods and services might not have changed, the fact that differentiated goods have grown in importance means that, in aggregate, pass-through should have declined.

Campa and Goldberg have tested this hypothesis in several papers and have concluded that much of the ERPT decline can be explained by changes in the composition of trade.

(c) Globalization and the Emergence of China

The final explanation that we will examine concerns globalization and, most particularly, the emergence of China. While China is the most obvious example of the new competitive forces that industrial countries have faced, it should be thought of in a more generic sense for purposes of this analysis -- representative of a class of countries, whose growing importance has had important knock-on effects for the structure and (in)stability of the global economy.

In this regard, there are at least three effects that warrant close attention from the standpoint of ERPT. First, the arrival of the emerging market economies (EMEs) has produced an enormous and persistent positive supply shock, exerting sizable downward pressure on the prices of many, but certainly not all, traded goods. To the extent these shifts in the home currency price of EME products are clearly distinguished from concurrent changes in exchange rates, measures of exchange rate pass-through should not have been affected. As a practical matter, however, there is strong reason to assume that the two effects have been commingled with the result that ERPT might appear to have fallen. The effect of this should be asymmetric, however, masking the price increases that should have resulted from currency depreciations while magnifying the price decreases that one would have expected from currency appreciations. Countries like the United States, in other words, whose currencies have been depreciating on an effective basis should have seen their estimated pass-through coefficients fall, but countries like Canada should have experienced dramatic increases in their estimated pass-through coefficients, at least over the last five years. This does not seem to have been the case. The United States is special in another sense, of course, because many of the EMEs have elected to peg their exchange rates, de jure or de facto, to the US dollar. This means that, as the importance of these countries increases, an ever larger fraction of US trade is not subject to ERPT effects, except to the extent emerging market economies import a significant number of intermediate products for use in the manufacture of their export goods.

A second aspect of globalization that could have a dampening effect on the estimated pass-through coefficients concerns the competitive reaction that they might induce on the part of other exporting countries as well as domestic producers. The growing importance of China and other EMEs should affect not only the pricing of products imported directly from these countries, but the prices that competitors in third countries feel that they can charge for similar goods. Canadian and European producers, for example, may feel more constrained in their ability to pass on price increases tied to appreciations of their home currencies, if they know China and certain other EMEs will not follow. Indeed, this effect could be present even in markets where the EMEs do not have an evident presence, since the possibility that they might enter a market could serve as a sufficient deterrent to dampen exchange rate pass-through. Local currency pricing would begin to increase, therefore, at the expense of producer currency pricing.

Marazzi et al. (2005b) test for a "China effect" by estimating pass-through equations for the United States, with goods separated into different groups based on their characteristics and estimated from the perspective of export price pass-through rather than import price pass-through. They find the following: First, export price pass-through has been increasing, just as one would expect if import price pass-through has been declining. In other words, countries such as Canada, which are important exporters to the United States, have been absorbing more of the exchange rate movements in the export prices that they charge, as opposed to passing them on through changes in import prices. Second, those classes of goods where Chinese and other EMEs have a growing market share tend to display greater export price pass-through on the part of other industrial countries. As a result, the China effect extends well beyond the direct impact coming from goods imported from China. Both American producers and other foreign producers are feeling the effects, and reacting to the competitive challenge by engaging in more LCP (i.e., reduced import price pass-through).

In fact, Marazzi et al. (2005b) point to Canada as a prime example of the defensive reaction described above. Looking at their export price equations for goods coming from Canada, they detect a sharp change in behaviour depending on whether the Canadian dollar is depreciating or appreciating against the US dollar. When the Canadian dollar is depreciating, Canadian producers seem reluctant to capitalize on the implied competitive advantage in the US market by raising their Canadian dollar export prices. Export prices appear to be set in Canadian dollar terms (i.e., exporters engage in producer currency pricing). In contrast, in the more recent period when the Canadian dollar has been appreciating, Canadian producers have cut their margins and appear to engage in LCP, in order to protect their U.S. market share.

A third and final effect of globalization, which might operate in a more symmetric manner, is linked to the de-construction or decomposition of supply chains, and the increased ability of firms to out-source activities and shift the

location of their production to other countries. The increased flexibility and price responsiveness that globalization provides with regard to the distribution of production activities across countries, means it is easier for firms to minimize the effects of costly exchange rate changes by shifting production. In this regard, one might think that firms which were already multinational would have a certain advantage; however, the ease with which alliances between unrelated parties can be formed might reduce its significance. Lai and Secrieru (2006) have reported some interesting results in this regard, showing that the presence of multinational enterprises increases the sensitivity of domestic market prices to exchange rate movements, but reduces the sensitivity of foreign market prices relative to arms-length trade.

5. Potential Pitfalls of Reduced-Form Models

At several points in earlier sections of the text, concerns have been raised about the potential risks of relying on reduced-form models to draw strong conclusions about exchange rate pass-through and other related issues. These concerns are well documented in a working paper by Steve Murchison (2005b), who uses an open economy dynamic stochastic general equilibrium (DSGE) model to illustrate the sorts of misleading results that can be generated from such simple, black-box, specifications.

Murchison constructs a DSGE model that is able replicate the behaviour of an open economy like Canada's in response to a variety of shocks. Wages and prices display some short-run stickiness, but adjust completely in the long run to ensure homogeneity in response to nominal shocks. Exchange rate shocks, for example, accompanied by an accommodative monetary policy, are eventually matched by proportionate change in import prices. The latter are in turn fully reflected in consumer prices and other aggregate price indices. In this sense, exchange rate pass-through is complete by assumption.

Murchison uses his model to generate 10,000 stochastic synthetic time series under alternative assumptions about the monetary authority's reaction function. The simulated results are then used to estimate a reduced-form pass-through equation for each monetary policy regime to see how the estimated coefficients on the exchange rate term behave. When the monetary authority's reaction function is fully accommodative, the estimated pass-through coefficient is close to one; but when the reaction function becomes less accommodative, the estimated coefficient declines dramatically. Because policymakers resist any increase in observed inflation with higher interest rates, the reduced-form model linking exchange rate movements with subsequent changes in inflation record a muted response (see Table 3).

A value of one for Θ in the left-hand column of Table 3 corresponds to a situation in which monetary policy is perfectly accommodative. As the reader can see, the estimated pass-through coefficient attains a maximum value. More aggressive policy responses, denoted by higher values of Θ, cause the pass-through

coefficient to fall. Since the policy reaction follows the observed increase in prices with a lag, the offset is not complete in the case of a pure exchange rate shock (column 3), but is merely dampened. If monetary policy were forward-looking, and could anticipate future exchange rate shocks, the offset would be complete.

It is also possible to make the pass-through coefficient disappear, or even go negative, using a backward-looking Taylor rule. Adding a separate price mark-up shock to the system, and imposing the reasonable assumption that monetary policy will be used to resist it, creates a situation in which the positive correlation between domestic prices and the exchange rate is further reduced and, in a number of cases, pushed below zero (see column 2, Table 3). This may create the misleading impression that a more aggressive monetary policy can eliminate pass-through even for moderate increases in the degree of policy aggressiveness.

In the presence of price shocks, two competing forces are operating on the exchange rate. A Purchasing Power Parity (PPP) effect tries to push the nominal exchange rate in the same direction as the price shock, and produces a positive correlation between the price level and the exchange rate (thereby increasing the measured pass-through). However, this is offset by an Uncovered Interest Parity effect. The UIP effect, which links the exchange rate to interest rate movements, creates a negative correlation between the exchange rate and the price level, since a positive price shock causes interest rates to rise and leads to an exchange rate appreciation. When the policy response to inflation is very weak, so is the UIP effect, and the PPP effect dominates. But as the monetary policy response becomes stronger, the roles are reversed and the UIP effect dominates.

One of the problems that might arise in such a situation is that monetary authorities would become complacent. Central banks would assume incorrectly that ERPT had vanished, and respond less aggressively to exchange rate shocks. As soon as they did so, however, ERPT would reappear. It is only be the conscientious actions of central banks that produce the false impression of a more benign environment, without inflation risks.

Bouakez and Rebei (2005) extend Murchison's work and reach a similar conclusion. They estimate a DSGE model for Canada using actual data drawn from two different sub-samples, covering the periods before and after Canada adopted inflation targeting. The experiments that they run indicate that the change in Canada's monetary policy in the late 1980s-early 2000s is responsible for most of the observed decline in the pass-through into Canadian consumer prices during the last 15 years. Moving to inflation targeting seems to have had a significant effect on the way the consumer price index responds to technology shocks, in particular, relative to the way it responded in the pre-targeting regime. Interestingly, the import price index appears to have unaffected.[9]

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9. It is important to note, in this regard, that Bouakez and Rebei (2005) conduct their tests in a way that avoids the problem associated with Canada's import price data.

6. Conclusions

What can one reasonably conclude from all of this? Bearing in mind the cautionary note presented in Section 5, the following general points can be made:

First, the balance of evidence would appear to suggest that exchange rate pass-through, as reflected in import price behaviour, has declined.

Second, improved monetary policy and enhanced credibility have probably played an important contributing role in the decline, along with significant shifts in the composition of trade and increased globalization.

Third, exchange rate pass-through may nevertheless remain larger than the estimated parameters would indicate, owing to econometric biases in the results. Taking liberties with the warning that is often written on the rear-view mirrors of cars, one might say that "the price effects caused by exchange rate movements may be larger than they appear."

Fourth, the benefits of a flexible exchange rate may also be larger than they appear. Since the existence of expenditure-switching effects are often cited as an critical element in the case for flexible exchange rates, and expenditure-switching effects depend on exchange rate pass-through for their genesis, any result that increases the probability of producer pricing at the expense of local currency pricing strengthens the case for flexible rates. Turning the argument around, relying on simple correlations between exchange rate movements and import prices to determine which exchange rate system you should operate under could be dangerous.

Figure 1: Canadian Dollar / U.S. Dollar Exchange Rate

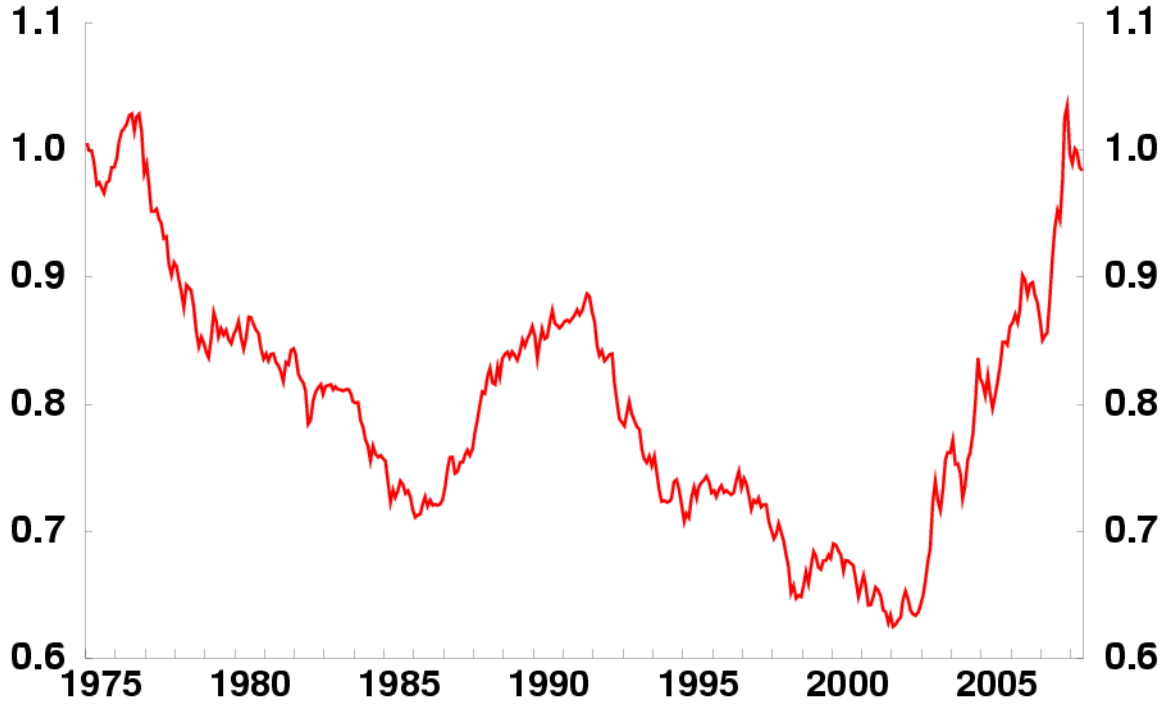
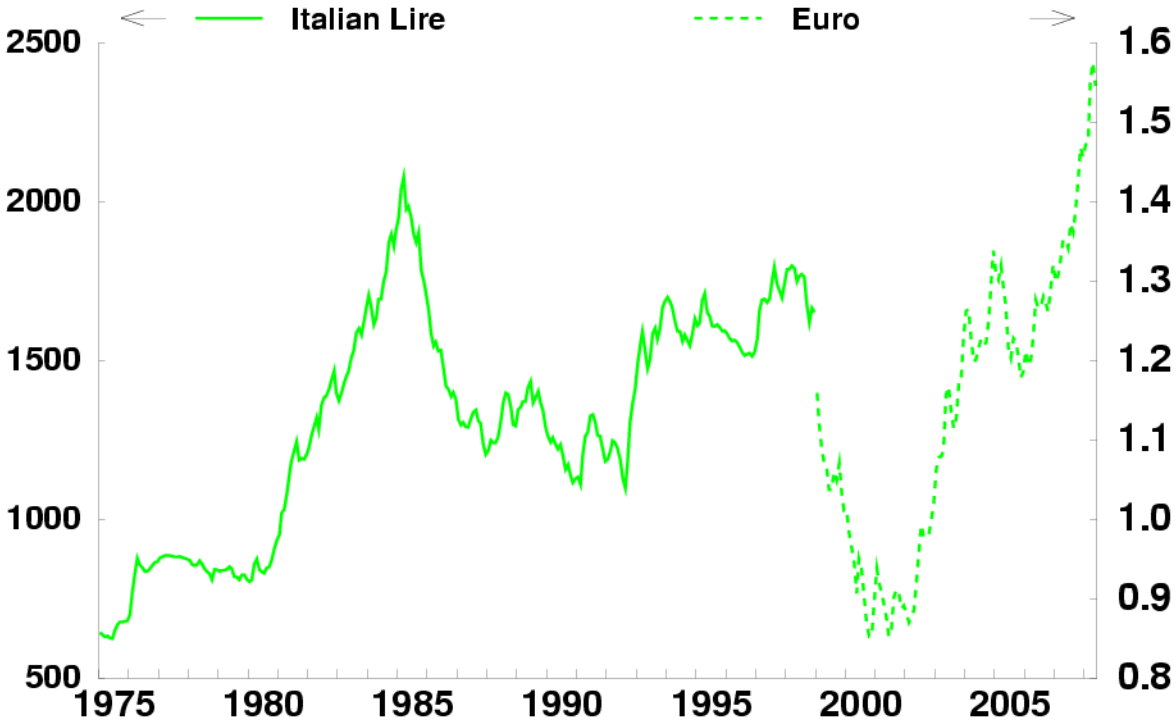


Figure 2: Italian Lire* / U.S. Dollar Exchange Rate



*Euro after 1998

Table 1: Elasticities of Exchange Rate Pass-Through into Aggregate Import Prices

Country	Elasticity	
	Short Run	Long Run
Australia	.56*†	.67*†
Austria	.21†	.10
Belgium	.21†	.68
Canada	.75*†	.65*†
Czech Republic	.39*†	.60*
Denmark	.43*†	.82*
Finland	.55*	.77*
France	.53*†	.98*
Germany	.55*†	.80*
Hungary	.51*†	.77*
Ireland	.16†	.06
Italy	.35*†	.35†
Japan	.43*	1.13*
Netherlands	.79*†	.84*
New Zealand	.22*†	.22†
Norway	.40*†	.63*
Poland	.56*†	.78*
Portugal	.63*†	1.08*
Spain	.68*†	.70*
Sweden	.48*†	.38*†
Switzerland	.68*†	.93*
United Kingdom	.36*†	.46*†
United States	.23*†	.42*†
Average	.46	.64

Note: * (†) implies that an elasticity different from 0 (1) at the 5% level.
Source: Campa and Goldberg (2005)

Table 2: Long-Run Rates of Pass-Through into Consumer Prices Indices

	Entire sample	First sample	Second sample
Australia	0.14 (0.07)	0.09 (0.08)	0.01 (0.04)
Austria	0.11 (0.07)	0.06 (0.10)	0.04 (0.02)
Belgium	0.20 (0.08)	0.21 (0.09)	0.02 (0.02)
Canada	0.37 (0.11)	0.30 (0.14)	0.04 (0.06)
Finland	0.01 (0.14)	-0.11 (0.21)	0.00 (0.03)
France	0.23 (0.12)	0.17 (0.07)	0.01 (0.03)
Germany	0.11 (0.04)	-0.13 (0.11)	0.12 (0.03)
Greece	0.52 (0.11)	0.28 (0.12)	0.27 (0.21)
Ireland	0.29 (0.09)	0.18 (0.11)	0.06 (0.04)
Italy	0.37 (0.12)	0.33 (0.09)	0.08 (0.06)
Japan	0.21 (0.09)	0.26 (0.12)	0.02 (0.02)
Netherlands	0.16 (0.07)	0.08 (0.11)	0.06 (0.03)
New Zealand	0.42 (0.10)	0.29 (0.09)	0.01 (0.05)
Norway	0.28 (0.15)	0.11 (0.17)	-0.05 (0.06)
Portugal	0.43 (0.08)	0.37 (0.08)	0.17 (0.16)
Spain	0.18 (0.09)	0.14 (0.07)	0.03 (0.03)
Sweden	0.02 (0.07)	0.05 (0.05)	0.02 (0.02)
Switzerland	0.15 (0.09)	0.18 (0.14)	0.07 (0.08)
United Kingdom	0.15 (0.05)	0.18 (0.08)	0.08 (0.05)
United States	0.27 (0.12)	0.19 (0.36)	0.03 (0.06)
Average	0.23	0.16	0.05
Inflation targeters	0.22	0.18	0.03
Non-targeters	0.23	0.15	0.06

Note: Standard errors in parentheses.
Source: Gagnon and Ihrig (2004)

Table 3: Exchange Rate Pass-Through in a DSGE Model

Policy Aggressiveness (Θ)	**Pass-through** ($\Pi(\Theta)$) **(%. rel. to** $\Theta = 1.0$**)**		
	All Shocks	Just exchange rate shocks	All but price mark-up
1.00	1.00	1.00	1.00
1.10	0.56	0.81	0.83
1.25	0.22	0.65	0.70
1.50	~0.0	0.53	0.60
1.75	-0.19	0.50	0.55
2.00	-0.25	0.50	0.52
2.50	-0.28	0.53	0.49
3.00	-0.26	0.57	0.48

Source: Murchison (2005b)

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