Exchange Rate Pass-Through:Evidence Based on Vector Autoregression with Sign Restrictions

An, Lian

24 October 2006

Exchange Rate Pass-Through:

Evidence Based on Vector Autoregression with Sign Restrictions[1]

Lian An

Department of Economics
University of Kentucky
Lexington, KY, 40506

October 2006

Abstract:

This paper provides cross-country and time-series evidence on the extent of exchange rate pass-through at different stages of distribution - import prices, producer prices and consumer prices - for eight major industrial countries: United States, Japan, Canada, Italy, UK, Finland, Sweden and Spain. The analysis is based on a vector autoregreesion (VAR) model that includes the distribution chain of pricing. Instead of the conventional choleski decomposition as used in the literature, I propose to identify the exchange rate shock by the more recent sign restriction approach. For the first time in the literature, estimates of pass-through based on the sign restriction procedure are provided. I find exchange rate pass-through incomplete in many horizons, though complete pass-through is observed occasionally. The degree of pass-through declines and time needed for complete pass-through lengthens along the distribution chain. Furthermore, I find that a greater pass-through coefficient is associated with an economy that is smaller in size with higher import shares, more persistent and less volatile exchange rates, more volatile monetary shocks, higher inflation rate, and less volatile GDP.

Keywords: pass-through, vector autoregression, sign restrictions, exchange rates

JEL Classification: F31, F41

---

1 I am indebted to Tom Doan and Tom Maycock for their invaluable help on RATS programming. And I would like to thank Jonathan McCarthy, Faruqee Hamid, Jay C. Shambaugh and Nikolay Gueorguiev for their helpful comments via email correspondences. Thanks also go to participants of the Kentucky Economic Association conference.

1. Introduction:

The relationship between exchange rate movement and price adjustments of traded goods, which is termed as “exchange rate pass-through”, has long been debated in academic and policy circles. When exchange rates changes, foreign firms can choose to pass exchange rate changes fully to their selling prices in export markets (complete pass-through), to bear exchange rate changes to keep selling prices unchanged (zero pass-through), or some combination of these (partial pass-through). It has been widely recognized that exchange rate pass-through is a time-consuming process, and it appears to vary a lot across countries and time as well as across industries within a country. The total effects of exchange rate pass-through are dependent on micro factors such as market structure, the pricing behavior of firms, as well as macroeconomic conditions.

Thorough understanding of exchange rate pass-through is of extreme importance for several reasons: first, the knowledge of the degree and timing of pass-through are essential for the proper assessment of monetary policy transmission on prices as well as for inflation forecasting. Second, the adoption of inflation targeting requires knowledge of the size and speed of exchange rate pass-through into inflations. Finally, the degree of exchange rate pass-through has important implication for “expenditure-switching” effects from the exchange rate. In other words, a low degree of exchange rate pass-through would make it possible for trade flows to remain relatively insensitive to changes in exchange rates, though demand might be highly elastic. If prices respond sluggishly to changes in exchange rates and if trade flows respond slowly to relative price changes, then the overall balance of payments adjustment process would be severely stalled, which will produce a certain degree of “exchange rate disconnect”. Therefore, the degree and timing of aggregate exchange rate pass-through, as well as its determinants, are important.

Given the importance of the pass-through issue, a sizeable literature has developed over recent years, and basically we can divide them into two strands. The first strand literature have drawn heavily on models of industrial organization and focused on the impact of market structure and foreign firms' pricing behavior. They analyze pass-through to disaggregate import prices of different products or industries on the micro level[2], such as Yang (1998), Kardasz and Stollery (2001), Campa and Goldberg (2005), etc. While the finding of the nature of pass-through of the disaggregate studies are very interesting in themselves, the result should not be adduced as evidence that carries over to the broader macro economy[3]. In contrast to the first strand of literature, the second strand studies the effects of exchange rate pass-through on the macro level using aggregate price measures. And they pay more attention to the impact of macroeconomic conditions on exchange rate pass-through. As they aim at providing evidence that is more relevant for macroeconomic policy, pass-through of exchange rate changes to import, producer and consumer price are all of interest[4]. So many studies follow the broad definition[5] of pass-through and measure the pass-through rates of exchange rate changes to not only import price, but also producer and consumer prices. My paper falls into this category.

One dominant branch of this strand assumes the "distribution chain of pricing" to study exchange rate pass-through to prices at different stages of the distribution chain, that is, import price index, PPI and CPI. They typically use a vector autoregression (VAR) model taking up six to eight endogenous variables for an analysis of pass-through of exchange rate shocks to domestic inflation by examining the impulse response and variance decomposition. Examples are McCarthy (2000), Hahn (2003), and Faruqee (2004).

However, the dominant majority of this type of empirical studies using VAR models makes recursive ordering procedures that assume some variables can or cannot respond to other variables in the first period of a shock. The assumptions regarding the short-run behavior of money, prices and other variables, which are very

2 Some also analyze the pass-through to import price at aggregate level as well as the disaggregate level, for example, Campa and Goldberg (2005).
3 See Kenny and McGettigan (1998).
4 For example, Obstfeld (2002) argues that for a strong expenditure-switching effect, a high exchange rate pass-through to import price and a low pass-through to consumer price must be satisfied.
5 The textbook definition of exchange rate pass-through is "the percentage change in local currency import prices resulting from a one percent change in the exchange rate". Changes in import prices are, nevertheless, to some extent passed on to producer and consumer prices. Therefore, they are using a broader definition of exchange rate pass-through, which is seen as the change in domestic prices (import prices, producer prices and consumer prices) that can be attributed to the change in the nominal exchange rate.

stringent but needed for statistically identify the shocks, have a substantial impact on the results. Those standard recursive identifying assumptions may be over-identifying restrictions that have been developed over time in a data-mining like manner as researchers looked for restrictions that can provide sensible results (See Rudebush (1998)). Also, the zero restrictions on the contemporaneous impact of shocks might not be consistent with a large class of general equilibrium models (see Canova and Pina (1998)). Even there are occasionally some studies resorting to long-run restrictions or combination of short and long-run identifying restrictions, such as Shambaugh (2003) and Hahn (2004)[6], those assumptions are hard to justify and should vary across the countries depending on the specific economic structure. From an empirical point of view, Faust and Leeper (1997) show that substantial distortions in the estimations are possible due to small sample biases and measurement errors when using zero restrictions in the long run.

As an alternative, I pursue the more recent sign restriction approach proposed by Uhlig (2005) to identify exchange rate shocks. There are several advantages of the sign restriction approach. First, compared to the traditional structural VAR model, restrictions which are often used implicitly, consistent with the conventional view, are made more explicit in the sign restriction approach. Second, in estimating impulse responses, it takes into account of both data and identification uncertainty by simulation, drawing from the posterior distribution of the reduced form VAR covariance matrix and coefficients and from the set of structural matrices consistent with the assumed sign restrictions. Third, sign restrictions are weak in the sense that they do not lead to exact identifications of the reduced form VAR. I regard this as an important advantage, since it circumvents “incredible” zero restrictions on the contemporaneous and long-run impact of shocks. Furthermore, Peersman (2004) finds impulse responses based on traditional zero restrictions can be considered as a single solution of a whole distribution of possible responses that are consistent with the imposed sign constraints. He also shows that a number of impulse responses based on zero restrictions are located in the tails of the distributions of all possible impulse

6 Hahn (2004) employs a mixture of short and long-run identifying restrictions in the robustness check.

responses. As such, results from the sign restriction approach are more convincing and at least can serve as a robustness check for the past empirical works.

In this paper, by imposing the sign restrictions on impulse responses, I successfully identify the exchange rate shock. I then quantify the extent and speed of exchange rate pass-through to prices along the distribution chain by examining the impulse response functions. I study eight major industrial countries, which are: United States, Japan, Canada, Italy, UK, Finland, Sweden and Spain[7]. I then explore the macroeconomic factors that affect the exchange rate pass-through to explain the cross country differences using Spearman rank correlation. To my best knowledge, this is the first attempt to study exchange rate pass-through with this alternative strategy. The main conclusions drawn from this empirical work, detailed subsequently, are the following: first, for most of the countries, I find partial pass-through to be the most common phenomenon, though complete pass-through is observed occasionally. Second, the extent of pass-through declines and the speed slows along the distribution chain. Third, I find that a greater pass-through coefficient is associated with an economy that is smaller in size with higher import shares, more persistent and less volatile exchange rates, more volatile monetary shocks, higher inflation rate, and less volatile GDP.

The rest of the paper is organized as follows. In section 2, a comprehensive theoretical background and literature review is provided. In section 3, a VAR model based on micro import-price determination and macroeconomic factors are constructed. Implementation of the sign restrictions is discussed. Section 4 reports the results of estimation and examines the determinants of exchange rate pass-through. Section 5 is for robustness check and section 6 concludes.

2. Theoretical Background and Literature Review

The increased openness of most economies with the incidence of large fluctuations in nominal exchange rates has evoked interest in the exchange rate

7 Germany is a large country, I should have included it. However, due to the lack of data for more than 200 observations compared to other countries, I have to exclude it from our study.

pass-through relationship. There has been growing body of literature on this topic. This section is aimed to provide a brief yet comprehensive review of these literatures.

I first provide some theory background about the determinants of exchange rate pass-through in section 2.1; in section 2.2, I enumerate the empirical studies, summarizing the salient features of these works, and explaining how my research fits into the literature.

2.1 Theoretical Background

There are many factors--both micro and macro—affecting exchange rate pass-through. On the micro level, the most well-known factors are: the responsiveness of mark-ups, the degree of returns to scale in production and the demand elasticity of the imported goods.

In a hypothetical monopoly market, where a foreign firm is able to maintain a constant mark-up, the exchange rate pass-through would be complete. However, this is not the case in reality. The markup will adjust in response to changes in exchange rates in order to keep the prices in destination markets constant, which is termed as "pricing to market". Foreign firms usually sustain substantial shifts in profit margins as exchange rate changes, because they want to keep constant the market share, thus, exchange rate pass-through is dampened. The markup response is often interpreted as an indicator of changes in competitive conditions confronting foreign exporters in the destination market. Several studies, such as Dornbusch (1987), Hooper and Mann (1989), observed that the adjustment of mark-up to exchange rate movements is dependent on the extent of product homogeneity and substitutability, the relative market shares of domestic and foreign firms, the market concentration and the extent of price discrimination possible. A general result in the literature is that a more differentiated (or the less substitutable) products in an industry, a larger share of foreign exporters relative to domestic producers, a higher degree of price discrimination or a higher concentrated market will lead to greater ability to maintain markup, thus higher pass-through rates.

The degree of returns to scale will affect the pass-through. According to Olivei (2002), if a typical foreign firm sets the price of a good exported to the destination market as a constant mark-up over marginal costs (with price and marginal costs measured in domestic currency), then complete pass-through will occur when returns to scale are constant. In this scenario, a m percent domestic currency appreciation lowers the foreign firm's marginal costs measured in domestic currency by m percent. In the case of decreasing returns to scale, pass-through will be less than full. The increase in domestic demand for the imported good brought by the domestic currency appreciation will put upward pressure on the foreign firm's marginal costs. Thus, marginal costs decline by less than m percent in response to a m percent domestic currency appreciation, which leads to incomplete pass-through. In a similar vein, Yang (1997) also reports that exchange rate pass-through is negatively related to the elasticity of marginal cost with respect to output.

Demand elasticity affects exchange rate pass-through as well. An exporting firm's pricing reaction to an exchange rate change depends on the curvature of its perceived demand elasticity. If demand becomes more elastic as price goes up, it is to firms' benefit to refrain from fully passing through the exchange rate shock to purchasers' prices (see Yang (1997)).

Several studies, such as Mann (1986) and Taylor (2002), have identified several factors affecting exchange rate pass-through on the macro level. They are: the size of a country, the openness of a country, exchange rate shock volatility and persistence, aggregate demand volatility, inflation environment and monetary policy environment.

In a large country, the inflationary effect of a currency depreciation on domestic prices is counteracted by a decline in the world price (because of lower world demand), reducing the measured pass-through. For a small country, currency depreciation would have no effect on world prices, and pass-through would be complete. (See McCarthy (2000))

Openness can be linked to the "ratio of importers to domestic producer" on the micro level, which can be proxied by trade share (or import share) in total production. It is intuitive that the more open the country (or the higher the import share to total production), the greater the exchange rate pass-through.

Using the pricing to market principle, Mann (1986) discusses that exchange rate shock volatility is negatively related to pass-through. There is cost involved in adjusting prices[8]. If exporters perceive a shock to be transitory, they would refrain from changing prices by shifting the markup and adopt the "wait and see" approach, thus reducing the pass-through. On the other hand, if firms expect exchange rate shocks to be persistent, they are more likely to change prices rather than adjust profit margins.

Another economic variable put forward by Mann (1986) is aggregate demand uncertainty. Exporters will alter the profit margins when aggregate demand shifts in tandem to exchange rate fluctuations in an imperfectly competitive environment, thus reducing measured pass-through. So pass-through should be less in countries where aggregate demand is more volatile.

A further determinant of pass-through—inflation environment—is brought forward by Taylor (2000). According to Taylor (2000), perceived persistence of cost changes[9] is likely to be positively related to the persistence of aggregate inflation, which also tends to be positively correlated to the inflation. So in a macroeconomic environment with a great deal of price stability, an increase in (nominal) marginal cost will have less persistence than in an environment with little aggregate price stability. While firms adjust their prices (pass-through) to a lesser extent to cost and price developments that are expected to be less persistent, so a low inflation environment may entail a lower pass-through of (exchange rate) shocks to prices via a reduction in the expected persistence of shocks.

A related factor to inflation environment is relative stability of monetary policy. Deverux, Engel and Stogaard (2003) develop a model of endogenous exchange rate pass-through within an open economy macroeconomics framework. They find that countries with relatively low volatility of money growth will have relative low rates of exchange rate pass-through, and vice verse. Because the lower variability of

8 The cost includes re-tagging goods, revising and reprinting catalogues and advertising.

9 Exchange rate changes are usually perceived as cost shocks for a foreign firm producing in its home country and selling in its export market. (see Yang (1997))

monetary shocks would decrease the information content of exchange rate in predicting monetary shocks and this effect suggests another reason for the pass-through to be smaller under a low inflation environment.

Besides these theoretical underpinnings of exchange rate pass-through in general, a more differentiated analysis regarding exchange rate pass-through at different stages of the distribution chain is of great interest. Exchange rate shocks may affect prices at different stages both directly and indirectly through previous price stages. To be more specific, exchange rate movements are transmitted to PPI and CPI through three channels: (i) through prices of imported intermediate goods, which is reflected by the share of imports in PPI; (ii) through prices of imported consumption goods, which is reflected by the share of imports in the CPI baskets; (iii) through prices of domestically produced goods. The extent of pass-through to PPI and CPI will therefore depend on the rate of pass-through to import price, the share of imports in PPI and CPI, and responses of prices of domestically produced goods to movements in exchange rates.

Assuming for a moment that prices of domestically produced goods do not respond to exchange rate changes, the degree of exchange rate pass-through to PPI and CPI is declining. There are several reasons. First, the share of imported goods that are affected by exchange rate shocks seems to decrease along the distribution chain, pointing to a declining pass-through along the distribution chain (see Clark (1999)). Second, as discussed in Bacchetta and van Wincoop (2002), differences in the optimal pricing strategies of foreign wholesalers and domestic retailers explains why pass-through to PPI and CPI is lower than the share of imports in the index even when pass-through to import prices is complete, thus lower pass-through rates for PPI and CPI. Third, given incomplete pass-through at individual stages, accumulation over different stages also implies a decline in the pass-through along the distribution chain. However, it is worth emphasizing that prices of domestically produced goods typically do respond to movements in exchange rates. For example, if depreciation results in higher prices for imported goods, production cost of domestically produced good increases via increased price of imported intermediate. In addition, demand for domestic goods that compete with imports will increase. As a result, there will be upward pressure on domestic prices.

With regards to the adjustment speed, adjustment lags at different stages of distribution chain might accumulate in the presence of price stickiness, which imply a decline in the adjustment speed of prices along the distribution chain (see Blanchard (1987)).

2.2 Previous Findings:

Having provided the theoretical background underlying pass-through, I now proceed to examine the empirical evidence on the issue. While I can broadly characterize the empirical works into two strands—the micro or macro level--according to their perspective, the data and methodology vary a lot among those works even in the same strand. As Menon (1995) points out "the significant differences in the estimate of pass-through obtained by different researchers studying the same country, commodity and time period highlight the importance of choice of data and methodology". For ease of reference, these studies are summarized in tabular form in Table 1, with separate columns identifying the study, the data, the methodology and the key findings. These studies are listed in chronological order, based on the year of publication, or the year that they are available on the internet as working papers.

In summarizing the findings of previous studies, I concentrate on the following two issues: (i) the degree and dynamics of pass-through; (ii) pass-through across countries and products;

(i) Pass-through degree and dynamics: It is clear from Table 1 that incomplete pass-through is a persuasive phenomenon across a broad range of countries and industries, but still a number of studies have found full pass-through for certain countries and industries, such as Faruqee (2004), Kenny and McGettigan (1998), etc. Majority of the studies find adjustment lags in exchange rate pass-through, the lags vary across the countries and industries, even vary among different studies for the same country and industry. In addition, most studies find that the degree and speed of exchange rate pass-through is greatest and fastest on import price, then on PPI and third on CPI.

(ii) Pass-through across products and countries: At the micro level, there are significant differences in the rate of pass-through across industries. This is quite clear from the multi-industry study, such as Yang (1997), Camp and Goldberg (2005), etc. At the macro level, pass-through rates also vary a lot from country to country. For example, Choudhri, Faruqee and Hakura (2004) finds that pass-through ranges from a low 0.47 for Czech Republic to full pass-through in Slovenia. In addition, results from some of the multi-country studies provide conflicting signals with regard to some theoretically widely-accepted relationship. For example, Jonathan (1998) finds that pass-through tends to be inversely correlated with the size of the country, while Hung, Kim and Ohno (1993) and Campa and Goldberg (2005) hardly find any relationship between pass-through and the country size.

As can be noticed in Table 1, empirical literature on pass-through has mainly focused on three approaches, namely, standard single-equation regression techniques, stationary VAR and cointegration.

The earliest researchers have employed OLS to estimate pass-through, with polynomial distributed lags used to capture the dynamic response of traded goods prices to exchange rate changes. However, those researchers have not paid attention to the time series properties of the data. A considerable body of literature suggests that a large number of macroeconomic series and asset prices such as exchange rates are non-stationary. Hence, the assumptions of OLS estimation are violated, creating the problems of spurious regression. By employing first differences of the variables, this problem can most probably be avoided, but information in levels is lost. What is more, estimates of pass-through obtained from a single-equation model are based on a ceteris paribus interpretation of coefficients. It thus assumes that there is no endogenous adjustment in prices accompanying changes in exchange rates. Thus, the estimation suffers from inconsistency problems due to endogenous determination of exchange rates and prices.

McCarthy (2000) pioneers the stationary VAR framework that incorporates a recursive distribution chain of pricing. Using differenced VAR models have several advantages compared to previous single-equation-based methods. First, it solves endogeniety problem inherent in the single-equation-based methods. Second, it allows us to incorporate prices along the distribution chain in a unifying model, while the previous studies typically focus on exchange rate pass-through to import prices. Even some papers study the pass-through to both import prices and consumer prices, they do so in separate models. By investigating exchange rate pass-through to a set of prices along the pricing chain, the VAR analysis characterizes not only absolute but relative pass-through in up-streaming and down-streaming prices. Third, estimated impulse response functions trace the effects of a shock to one endogenous variable on other variables through the structure of VAR, which allows us to assess not only pass-through within a specific time period, but also its dynamics through time. So they are a convenient measure of the degree and speed of pass-through parameters.

However, there are shortcomings associated with a differenced VAR system. Differencing throws information away while produces no gains, which may cause the results, such as impulse response functions, to lack statistical significance (See Fuller (1976) and RATS User's Guide (2004)). Furthermore, Bache (2005) generates data from a dynamic stochastic general equilibrium model and use Monte Carlo techniques to draw inferences about the performance of different VARs. He finds that impulse response functions from a VAR in first difference are biased, even when the VAR is specified with a large number of lags. By contrast, a low order vector cointegration model is a good approximation to the data generating process, and cointegration can capture the equilibrium relationships among the variables. However, it is greatly doubted whether an econometrician would be able to infer the correct rank or identifying the true cointegration relations (see Bache (2005)).

Based on these, I will estimate the VAR in levels with sign restrictions. The sign restrictions method involves Bayesian Monte Carlo procedure. According to Sims (1988), the Bayesian method does not require differencing, which justify adopting VAR in levels. What is more, using sign restrictions can avoid the zero restrictions of choleski decomposition that is prevalent in previous studies.

As my work is from macroeconomic standpoint, I follow the broad definition of exchange rate pass-through, and measure the exchange rate pass-through to the three aggregate price indices, i.e. import price, producer price and consumer price.

3. A Simple VAR Model with Sign Restrictions

The model draws loosely on the "distribution chain" model introduced by McCarthy (2000), but differs from his model in several aspects. Firstly, I include one important variable omitted by him, i.e. foreign price level. Secondly, he use oil price in local currency, while I use oil price in US dollar. The fluctuation of local currency oil prices largely reflects not oil price fluctuation per se but the variability of bilateral exchange rate vis-à-vis the US dollar. I do not want the oil price series to capture exchange rate changes. Hence, I choose the US dollar denominated oil price for my analysis. Thirdly, to make the model as simple as possible, I include only short-term interest rate to capture monetary policy shock, instead of including both the interest rate and money supply as he does. Fourthly, while I incorporate the distribution chain, I do not have to make recursive assumptions in the distribution chain.

This section comprises two parts. The first part of the section refers to the setup of the baseline model. The second part illustrates the implementation of the sign restriction approach.

3.1 The VAR Model

I set up a VAR model with eight endogenous variables: price of oil (P_{oil}), short-term interest rate (S), output gap (Gap), nominal effective exchange rate

(NER), foreign export price indices (FP), import price indices (IMP), PPI and CPI.

Output gap is included to capture demand shocks; while oil price is added to balance the model with supply shocks. I follow McCarthy (2000) to estimate the output gap[10]. Specifically, output gaps are calculated as the residuals from a regression of the log of industrial production indices on a constant plus linear and quadratic time trends. A positive variation indicates that the country is growing faster than the trend, while a negative variation represents the opposite. This variable acts as a proxy for the business cycle, which can capture the notion that pass-through of increases in costs to final prices is affected by aggregate demand. For example, large depreciations sometimes do not imply large price increases because the economy is in recession and firms do not adjust their prices proportionally to increases in costs.

A short-term interest rate is included in the model to allow for the effects of monetary policy. The countries' monetary policies are concerned with keeping domestic inflation within their target ranges, so it is likely to offset the effects of exchange rate fluctuation on domestic prices. As such, the underlying relationship between changes of exchange rates and domestic prices may be masked if monetary policy is excluded from the analysis (see Hahn (2003)). Neglecting the short-term interest rate will result in the common omitted variables problem.

The great majority of previous literature fails to include foreign export price level, such as McCarthy (2000), Hahn (2003), Ito, Sasaki and Sato (2005), to name but a few. I think it is essential to incorporate the foreign export price levels. The microfoundations of pricing behavior by exporters are useful for understanding the inclusion of the variable.

The import price for any country i, $P^{m,i}$, are a transformation of the export prices of that country's trading partners, $P^{x,i}$, using the exchange rate, ER, which is expressed in domestic currency per unit of foreign currency.

$$P^{m,i} = ER^{i} P^{x,i} \qquad (1)$$

The export prices, in turn, are a mark-up ($markup^{x}$) over exporter marginal

[10] I employ the industrial production index because I want to use monthly series for the empirical analysis.

costs MC^x . Using lower letters to reflect logarithms, I rewrite equation (1) as:

$$p^{m,i} = er + markup^x + mc^x \qquad (2)$$

While exchange rate will have direct effect on import prices, it can also affect mark-up and marginal costs of exporting firms, which will in turn affect the domestic prices. Kim (1990) shows that in the presence of short-run cost price rigidity, the mark-up will fall with exporting firms' currency appreciation and rise with a depreciation. Also marginal cost tends to increase with exporting firms' currency depreciation because of more expensive imported inputs, and vice versa. Therefore, I choose to add foreign export price index for each country, which will allow us to control the indirect transmission of exchange rate change to domestic price levels through mark-up and marginal costs of trading partners.

Exchange rate, import price[11], PPI and CPI are the center of the analysis, they are included naturally.

I choose to use effective nominal exchange rates and effective foreign export price indices, as I think effective exchange rates will better reflect the situation of a country that is trading with many other countries. So it remains to choose the weighting scheme for effective exchange rates and effective export price indices of trading partners. Different weighting schemes generate very different time series of effective exchange rates. Although indices based on multilateral shares of major industrial countries are often used to measure the extent of real appreciation or depreciation of the currency, they are not ideal for this case (see Kim (1990)). Pauls and Helkie (1987) reports that an index based on bilateral import shares of developing countries as well as industrial countries forecasts import prices better than indices based on multilateral trade shares or excluding developing countries in weighting. As such, the nominal effective exchange rates are constructed by weighting the bilateral exchange rate of trading partners using import share for each country[12] according to

11 I have used import price index or unit value of import, whichever is available.

12 The trading pattern is quite spread out for some countries while concentrated for other countries, so I do not use the same number of trading partners for all the countries. Instead, I include enough number of trading partners for each country to ensure at least 80% of the total imports is captured. The weights are calculated based on the average of 1989-1998 year trade data available from DOTS. Although Taiwan China, mainland China are

the formula:

$$NER = \Pi_{i=1}^{n} \left(\frac{ER_d}{ER_i} \right)^{\omega_i}$$

where ER_i is the nominal exchange rate of currency *i*, expressed as units of currency *i* per US dollar, ER_d is the nominal exchange rate of domestic currency, expressed as units per US dollar, ω_i is the share of domestic country's import from country i in domestic country's total import with its n largest trading partners. So the effective exchange rates are constructed in such a way that an increase in the index implies a depreciation of the domestic currency. The effective export price indices are calculated with the export price indices[13] of foreign producers by the same weightings and same formula as nominal effective exchange rate. Both nominal effective exchange rates and foreign export price indices are normalized so that the year 2000 is equal to 100.

The model is summarized in the reduced-form VAR:

$$Y_t = \Gamma_0 + \sum_{i=1}^{n} B_i Y_{t-i} + u_t \qquad (3)$$

Where Y_t is an 8*1 vector of variables $[Poil, S, GAP, NER, FP, IMP, PPI, CPI]$, B_i are coefficient matrices of size 8×8 and u_t is the one-step ahead prediction error with variance-covariance matrix Σ, Γ_0 is the intercept. All variables are in logarithms except the short-term interest rate.

3.2 Implementation of Sign Restrictions

Disagreement starts when researchers discusse how to decompose the prediction error u_t in equation (3) into economically meaningful fundamental

important exporters to many countries, they are not included due to the absence of some data in International Finance Statistics.

13 I will use export price index or unit value of export, whichever is available. If they are not complete or not available, I will use producer price index or consumer price index instead.

innovations. Most works rely on choleski decomposition assuming different orders among the variables, about which disputes exist. Here I will implement the sign restriction approach, which will make use of some weak restrictions that have achieved agreement among most researchers. For example, a depreciation of domestic currency will lead to an increase in import price, PPI and CPI.

There are two branches of sign restrictions. Canova and De Nicolo (2002) imposes sign restrictions on cross-correlations of variables in response to shocks, adding restrictions until the maximum number of shocks is uniquely identified. Uhlig (2005) imposes sign restrictions differently "by using impulse responses rather than cross-correlations, by using other criteria used to select among orthogonal decompositions satisfying the restrictions, and by not imposing increasingly stringent restrictions to eliminate candidate orthogonalizations" (see Uhlig (2005)). They do not aim at a complete decomposition of the one-step ahead prediction error into all components due to underlying structural shocks, but rather concentrate on identifying only one shock. Their intention is to be minimalistic and to impose not much more than the sign restrictions themselves, as they can be reasonably agreed upon across many economists. In this paper, my primary interest is to obtain evidence on how exchange rate shocks affect different prices over time. I do not attempt to identify all structural disturbances, but introduce minimal restrictions that are sufficient to identify the exchange rate shock and quantify the extent of price changes in response to exchange rate changes. So the method of Uhlig (2005) suits best here.

The method involves a rejection based Bayesian Monte Carlo procedure, which consists of "outer-loop draws" and "inner-loop draws". I will briefly describe it.

To identify the exchange rate shock, I must identify the impulse vector[14] corresponding to the exchange rate shock, er, which is a column of A, and $AA' = \Sigma$. A can be any factor of permissible decomposition of Σ, such as those based on choleski decomposition, eigen decomposition or structural decompositions. The product of the factors with identity matrix is also a permissible factor.

14 According to Uhlig (2005), a vector a is called an impulse vector, iff there is some matrix A, so that $AA' = \Sigma$ and so that a is a column of A.

The impulse vector corresponding to exchange rate shock, er, can be characterized as follows. Let $\tilde{A}\tilde{A} = \Sigma$ be the choleski decomposition of Σ, Then er is the impulse vector if and only if there is an eight-dimensional vector α of unit length, so that

$$er = \tilde{A}\alpha$$

Given the impulse vector for exchange rate shocks, I can calculate the appropriate impulse response as follows. Let $r_i(k)$ be the vector response at horizon k to the exchange rate shock in a choleski decomposition of Σ. The impulse response of the variables to a exchange rate shock at horizon k, $r_{er}(k)$ is then given by:

$$r_{er}(k) = \sum_{i=1}^{8} \alpha_i r_i(k) \qquad (4)$$

And the fraction $\phi_{er,j,k}$ of the variance of this forecast error for variable j explained by exchange rate shock at horizon k is given by:

$$\phi_{er,j,k} = \frac{(r_{er,j}(k))^2}{\sum_{i=1}^{8}(r_{i,j(k)})^2} \qquad (5)$$

So as the first step of the simulation, which is "outer-loop draws", I take n_1 random draws from the posterior distribution of the reduced form VAR coefficients, B_i, and the covariance matrix of disturbance, Σ [15]. For each draw from the posterior distribution of the VAR parameters, I decompose it with choleski decomposition and get the choleski factor $\tilde{A}$. In the second step, I randomly take n_2 draws from the unit sphere assuming a flat prior[16], getting a eight-dimensional vector of unit length, α, which is the "inner-loop draws". And construct the impulse vector

15 The posterior distribution is derived under the assumption of a diffuse Jeffries prior over the parameters of the VAR. Following Zellner (1971), if the joint distribution of the VAR disturbances is $i.i.d$ normal and the elements of B_i are independent of elements of Σ, then a Jeffries prior implies B_i has a normal conditional posterior distribution and Σ has an Inverse Wishart conditional posterior distribution (See RATs User's Guide (2004)).

16 Drawing from flat prior on the unit sphere is appealing, because the results will be independent of the chosen decomposition of Σ. So reordering the variables and choosing different choleski decomposition in order to parameterize the impulse vectors will not yield different results.

according to: $er = \tilde{A}\alpha$. From there, I can get the corresponding impulse response and forecast error variance according to equation (4) and (5).

I generate $n_1 \times n_2$ draws[17], thus $n_1 \times n_2$ exchange rate impulse vectors and $n_1 \times n_2$ corresponding sets of impulse responses and forecast error variance decompositions. If the range of impulse response is compatible with the sign restriction, I keep it, otherwise I discard it. So I keep the draws that satisfy the sign restrictions while discarding the ones that do not, and calculate the median impulse response and probability bands.

The sign restrictions I impose on impulse responses here are:

1. Output gaps will not decrease (≥ 0) in response to positive exchange rate shocks, i.e. exchange rate depreciation. As exchange rates depreciate, imported goods are more expensive, while exported goods will be less expensive, so domestic demands increase, and output gaps increase.
2. Short-term interest rates will not decrease (≥ 0) in response to the positive exchange rate shock, as monetary policies will be exercised in a way to back up exchange rate depreciation.
3. Exchange rates will not decrease (≥ 0) in response to its their positive shocks.
4. Foreign export price indices will not increase (≤ 0) in response to positive exchange rate shocks. As mark-ups and marginal costs are going to decrease when foreign firms' currencies appreciate.
5. The import prices, PPIs and CPIs will not decrease (≥ 0) facing an exchange rate depreciation.

The identification of exchange rate shocks seems neat to me as it only makes use of a priori appealing and consensual views about the effects of exchange rate shock on demand, monetary policy and various prices. However, there

17 I make $n_1 = n_2$=500, so there are 250000 draws in total.

remains one degree of the choice here: the horizon K for the sign restriction. I follow the convention of choosing $K=5$, i.e. six month horizon. And leave the other possible values of K to the robustness check.

4. Results

As discussed in Section 3, the model is estimated as a VAR consisting of eight variables: oil price, the output gap, short-term interest rate, nominal effective exchange rate, foreign export price level, import prices, PPI and CPI. And I use sign restrictions to identify exchange rate shocks.

For each country except the US, the number of lags in the VAR is set at 6, the shortest lag that can produce white noise residuals[18]. And the model is estimated over the period 1976:01 to 2005:08. In this section, I first report the impulse responses of import price indices, PPIs and CPIs to an exchange rate shock, and I calculate the pass-through ratios of exchange rate shocks to the price indices. Secondly, I explain the cross-country difference by calculating the Spearman rank correlation between the pass-through ratios and the macro factors discussed in section 2. Thirdly, I present variance decompositions, which are assessments of the importance of exchange rate shocks in explaining movements of price measures.

4.1. Impulse Responses and Pass-Through Ratios

Figure 1-4 display the impulse responses of the nominal exchange rate, import price indices, PPIs and CPIs to positive exchange rate shock. The solid line in each graph is the estimated response while the dashed lines denote the one standard error confidence band around the estimate. It is interesting to note that the error bands are typically symmetric around the median. The results can be described as follows:

1. The nominal exchange rates increase instantly and significantly in response to its own shocks in all countries, and remain significant for a while, with those in Japan, Spain and Finland reverse the sign at some

18 I choose lag 5 for US, since lag 5 is the shortest lag length that can produce white noise residuals for the US.

late horizons.

2. The import price indices in all countries react largely and positively immediately following the shock. Most of the impulse response functions remain significant till horizon 8 to 15, with those of the US, Italy and the UK remaining significant almost for all horizons. However, the impulse response of Japan reverses the course around one year.

3. The PPIs and CPIs react similarly as import price indices, but with smaller magnitude. The import price indices and PPIs in Japan reverse the course in two years, but not significantly. For CPI, the responses in all countries remain significant for almost all horizons except for Spain.

It is unclear to compare the pass-through ratios of import price indices, PPIs and CPIs by just examining the impulse response functions, because the initial exchange rate shocks in the countries are not of equal size. For easy comparison, I calculate the pass-through rates according to the impulse response functions of exchange rates and price indices. The pass-through ratio is defined as $PT_{t,t+i} = \frac{P_{t,t+i}}{E_0}$, where $P_{t,t+i}$ is the change of price indices in the period i in response to the initial exchange rate shocks, E_0 is the impact change of exchange rates to their own shocks. Table 2 displays the pass-through ratios for the horizon 0, 3, 6, 9, 12, 15 in each country. Several main characteristics emerge:

1. Incomplete pass-through is the most observed phenomenon across the countries and horizons. But I do find complete pass-through from several countries at some horizons, such as import price of Canada at horizon 0, 3 and 6. Yet, those estimates are within the ranges of previous works.

   However, it should be noticed that there are some cases where the pass-through ratios are greater than one, indicating that foreign exporters are overreacting to exchange rate shocks. Many previous studies also have the similar finding, such as Campa and Goldberg

(2005). Although such rates are unlikely to be observed, it is possible to justify. There are mainly two reasons. First, as I discussed in section 2, the degree of returns to scale will affect pass-through, when returns to scale is increasing, changes in exchange rates are more than fully passed through to import prices. Second, demand elasticity affects exchange rate pass-through as well. If demand curve becomes less elastic, pass-through ratios will be greater than one (Yang (1998)). In addition, the results should be interpreted with the caution that the error bands are wide in some cases, rendering the estimates less accurate.

It is also interesting to note that, in several countries, such as Canada and Spain, I find pass-through overshoots. The rates of pass-through decline after reach the maximum. Choudhri, Faruqee and Hakura (2005) also finds similar overshooting pattern in exchange rate pass-through.

2. In most countries, pass-through ratios are largest for import price indices, second largest for PPI, and smallest for CPI, confirming the previous finding that the pass-through ratios decline along the distribution chain. The main exceptions are in the UK and Sweden, in which countries the pass-through to CPI is larger than that to PPI.

   Since CPI is the principal concern for monetary policy, and exchange rate pass-through to CPI appears to be modest in most of these countries (except in Sweden), it suggests that monetary policy may not need to be over sensitive to exchange rate fluctuations resulting from turmoil in emerging markets.

3. As to the speed of pass-through adjustment, it is not hard to find that pass-through to import price indices reach the maximum (or complete) first, then for PPI and last for CPI. The results are in line with the previous finding that the speed of pass-through declines along the distribution chain.

4.2. Spearman Rank Correlation

Though the pass-through ratios of all countries share some common characteristics, there are noticeable differences across countries. To explain the differences, I calculate the Spearman rank correlation between the pass-through ratios at various horizons and some factors that are expected to influence pass-through.[19] From discussion in section 2, the factors at the macro level are: (1) size of a country, I use average real GDPs during the sample period as approximation for each country, which is the nominal value in national currency deflated by CPI and converted into U.S. dollar at the average 2000 nominal exchange rate. (2) The openness of a country, which is approximated by import share in GDP. (3) Exchange rate shock volatility measured by the variance of the residuals from the exchange rate equation in the VAR system. (4) Exchange rate persistence measured by the impulse response at the 12-month horizon of the exchange rate to its own initial shock.[20] (5) Aggregated demand volatility measured by the variance of real GDP during the sample period. (6) Inflation environment, which is measured by the annualized inflation rate based on consumer price indices (in logs). (7) Monetary policy environment, which is measured by the monetary shock volatility. I use the variance of the residuals from the short-term interest rate equation as the approximation. Table 3-5 present the Spearman rank correlation statistics between pass-through ratios at the horizons 0, 3, 6 and 12 with the above factors for each price index.

The rank correlations are mostly in accord with that discussed in section 2. Country size is inversely related with pass-through ratio. Because foreign exporters are more willing to maintain market shares in large markets, thus they exercise pricing-to-market to large countries and reduce the pass-through. The correlations between pass-through ratios and country size are all correctly signed and quite significant in some cases. The more open the country (the higher import share), the higher is the pass-through, with the only exception being the import price index at the horizon 12. The more volatile the exchange rate shocks, the less the exchange rate

19 McCarthy (2000) also calculates the Spearman rank correlation, but I choose slightly different factors.
20 I follow McCarthy (2000) to measure the exchange rate volatility and exchange rate persistence.

pass-through, as foreign exporters hesitate to change prices if they perceive a shock is transient. The only exception is for CPI at the horizon 12. The more persistent an exchange rate shock, the higher is the pass-through ratio, except for import price index at the horizons 0, 3, 6. Aggregate demand volatility, which is approximated by the real GDP volatility, is negatively correlated with pass-through ratios in most of cases, which is in line with the notion that the more volatile the aggregate demand, the lower the pass-through. Inflation rate is positively correlated with pass-through in most cases, though the relationship is not strong. The results give some support to Taylor (2000). Also, the more volatile the monetary policy shocks, the higher the pass-through, and the signs of the correlation coefficients are all correct and quite significant in several cases, which give strong support to the finding of Deverux, Engel and Stogaard (2003).

In summary, higher import shares, more persistent exchange rate shocks, higher inflation rate, more volatile monetary shocks are related with higher pass-through. While a larger economy, more volatile exchange rate shocks and aggregate demand (GDP) are correlated with lower pass-through.

4.3. Variance Decompositions

While impulse response functions provide information on the extent of exchange rate pass-through to domestic prices, they yield no information about how important exchange rate shocks have been for movements of the price indices. In the case that pass-through is large, but exchange rate shocks are small, exchange rate shocks will not have much impact on domestic prices. Therefore, it is necessary to investigate the importance of exchange rate shocks. For this purpose, I examine the variance decompositions[21] of the price indices. Table 6 presents the percentage of forecast error variance for the price indices attributed to exchange rate shocks at horizon 0, 3,

21 It should be noted that it is harder to interpret the results of forecast error variance decomposition in sign restrictions, because the percentage often have a very skewed distribution. One cannot interpret the results without also considering the significance of the impulse responses. The results of variance decomposition are more meaningful for steps that have well-defined strict positive or negative responses. In our case, most steps I reported have significant impulse responses, so the results are quite plausible.

6, 12, 15.

For import prices, exchange rate shocks are most important in Canada and Japan, where their share ranges 24-30% and 20-35%, respectively. In other countries, exchange rate explains from 12-28% of forecast error variance. For PPIs and CPIs, similar patterns exist as for import prices. What is more, the share of exchange rate shocks in the three price indices is usually comparable within each country, and the percentage is quite stable across different horizons.

In sum, the variance decompositions indicate that exchange rate shocks explain non negligible—though not dominant—proportion of the forecast error variance of the price indices, thus exchange rate shocks are quite important in domestic price fluctuations.

5 Robustness Check

In this section, I will do some robustness check to my baseline model. As there are two widely used methods of calculating exchange rate pass-through ratio, I firstly use the alternative way to calculate the pass-through ratios as robustness check. Secondly, I will change the horizon K for sign restriction to see how sensitive the results are to the choice of the horizon.

5.1 Alternative Measure of Defining Pass-Through Ratio

In the VAR literature, two measures are widely used in defining the pass-through ratio. The first is what I adopted in getting the baseline results, defined as $PT_{t,t+i} = \frac{P_{t,t+i}}{E_0}$, where $P_{t,t+i}$ is the change of price indices in the period i in response to initial exchange rate shocks, E_0 is the impact change of exchange rates to their own shocks. The second is defined as $PT_{t,t+i} = \frac{P_{t,t+i}}{E_{t,t+i}}$, where $E_{t,t+i}$ is the change of exchange rate in the period i in response to initial exchange rate shocks.

People who propose the second measure of defining pass-through ratios argue that this way will account for the secondary exchange rate dynamics generated by initial shocks. However, I think this way of measurement mixes in a systematic way changes in exchange rates from changes in the other variable with the pure exchange rate shocks. As I regard pass-through as the effect of a pure exchange rate change rather than changes from other sources, I prefer the first measure of defining exchange rate pass-through ratios. Yet, it is very interesting to use the second measure as a robustness check.

Table 6 presents the pass-through ratios for eight countries. Table 7-9 present the Spearman rank correlations between the pass-through ratios and the discussed factors. The basic characteristics as to the speed and magnitude of pass-through along the distribution chain tend to hold though not as clear as in the baseline results. But strange results emerge with this alternative definition, such as implausible pass-through ratios of -956.924, 483.27 in Japan. As to the Spearman rank correlation, most results are in agreement with those from baseline measure except for the exchange rate persistence. In most cases, exchange rate persistence is negatively correlated with pass-through ratios, which is in contradiction to theory.

In general, the first measure of defining exchange rate pass-through ratio is preferred.

5.2 Different Horizon K

How sensitive are the results to the changes in horizon K for the sign restrictions? In this part, I present the results for 3-month (K=2) and 12-month (K=11) horizon restriction.

Figure 5 and 6 show the impulse response functions of import price to positive exchange rate shocks for K=2 and K=11, respectively[22]. The results are quite similar to that of the baseline setup, especially for K=2. Only for Sweden with K=11, the accepted draw from sign restrictions is 1, which does not allow the impulse

22 For the sake of brevity, I do not present the impulse response functions of PPI and CPI. But the same conclusion can be drawn as that of import price. The results are available from the author upon request.

responses to generate the error bands. This is not unreasonable, the restriction horizon is quite long for K =11, and the actual data pattern of Sweden may not generate enough draws that are compatible with the sign restrictions for such long horizon. Table 11 shows the forecast error variance decompositions for import price[23] with K =2 and K =11. Still, there is not much difference between these results and that from my baseline setup.

Table 12 and 13 presents the pass-through ratios of the price indices for K =2 and K =11 respectively. As my expectation, the main characteristics are the same as in my baseline setup, only the magnitude differs a little.

In general, the results are quite robust to different horizons. So the outcome from the sign restriction approach will be quite stable and sensible given the reasonable choice of K .

6 Conclusion

This paper has examined the pass-through of exchange rate changes to domestic prices for several industrialized economies. Using a VAR model with sign restrictions, I successfully identify the exchange rate shock. Information on the size and the speed of exchange rate pass-through is then derived from impulse response functions. According to my results, pass-through is incomplete in many horizons, though there is occasionally complete pass-through; the magnitude decreases and speed slows along the distribution chain. These results seem to be broadly in line with previous findings. I further find that a greater pass-through coefficient is associated with an economy that is smaller in size with higher import shares, more persistent and less volatile exchange rates, more volatile monetary shocks, higher inflation rate, and less volatile GDP.

The robustness was tested in two ways. First, by estimating the pass-through using alternative measure, the robustness of results over different definition of pass-through ratio is analyzed. Most of the findings are robust to different definition

23 The results of PPI and CPI are available upon request.

of pass-through, yet I give preference to the definition in the baseline setup. Second, I change the horizon restriction of K , and find that the outcomes are quite stable across different horizons.

Nevertheless, the sample period is quite long, several financial and economic crises have happened in this period, which has effects on the global prices of some goods. So a natural extension to this model is to incorporate time variation in some of the parameters, and I leave this for future research.

Reference:

Bache, I.W., 2005 “Assessing the Structural VAR Approach to Exchange Rate Pass-through,” Norges Bank Working Paper, No. 31

Bacchetta, P., and Van Wincoop, E., 2002 “Why Do Consumer Prices React Less than Import Prices to Exchange Rates?” NBER Working Papers, No. 9352

Balliu. J. and Bouakez., H. 2004 “Exchange Rate Pass-through in Industrialized Countries,” *Bank of Canada Review*, pp.19-28

Berben, R., 2004 “Exchange Rate Pass-through in the Netherlands: Has it Changed?” *Applied Economics Letters,* 11, 141-143.

Billmeier, A. and Bonato, L., 2004 “Exchange Rate Pass-through and Monetary Policy in Croatia,” *Journal of Comparative Economics*, 32, 426-444.

Campa, J.M. and Goldberg, L.S., 2005 “Exchange Rate Pass-through into Import Prices,” *The Review of Economics and Statistics*, 87, 660-679

Campa, J.M.,Goldberg, L.S. and Gonzalez-Minguez J.M., 2005 “Exchange Rate Pass-through to Import Prices in the Euro Area,” NBER Working Papers, No.11632.

Choudhri, E.U. and Hakura. D.S., 2001 “Exchange Rate Pass-through to Domestic Prices: Does the Inflationary Environment Matter?” IMF Working Papers, No.01/194..

Choudhri, E.U., Faruqee, H. and Hakura, D.S., 2005 “Explaining the Exchange Rate Pass-through in Different Prices,” *Journal of International Economics,* 65, 379-374

Canova, F., and G.De Nicolo, 2002 “Monetary Disturbances Matter for Business Fluctuations in the G-7,” *Journal of Monetary Economics*, 49, 1131-1159.

Coricelli, F., Jazbec, B. and Masten, I., 2006 “Exchange Rate Pass-through in EMU Acceding Countries: Empirical Analysis and Policy Implications,” *Journal of Banking and Finance*, 30, 1375-1391

Dornbusch, R., 1987 “Exchange Rates and Prices,” *American Economic Review*, 77, 93-106.

Doan, T., 2004 “RATS User’s Guide” Version 6, Estima.

Doyle, E., 2004 “Exchange Rate Pass-through in a Small Open Economy: the

Anglo-Irish Case," *Applied Economics,*36, 443-455.

Faruqee, H., 2004 "Exchange Rate Pass-through in the Euro Area: The Role of Asymmetric Pricing Behavior," IMF Working Paper, No.04/14.

Fuller, W., 1976 "Introduction to Statistical Time Series," Wiley, New York.

Goldberg, P.K. and Knetter, M.K.,1997 "Goods Prices and Exchange Rates: What have we Learned?" *Journal of Economic Literature,* 35, 1243-1272.

Gagnon, J. E., and J. Ihrig (2004): "Monetary Policy and Exchange Rate Pass-Through," *International Journal of Finance and Economics*, 9, 315-338.

GoldFajn, I. and Werlang, S.R.C., 2003 "The Pass-through form Depreciation to Inflation: A Panel Study," Banco Central de Brasil Working Paper, No. 5

Elke Hahn "Pass-through of External Shocks to Euro Area Inflation," European Central Bank Working Papers, No. 243.

Gueorguiev N., 2003 "Exchange Rate Pass-through in Romania," IMF Working Papers, No. 03/130

Hung W., Kim Y. and Ohno K., 1993 "Pricing Exports: a Cross-country Study," *Journal of International Money and Finance*, 12, 3-28

Ito T., Sasaki Y.N. and Sato K., 2005 "Pass-through of Exchange Rate Changes and Macroeconomic Shocks to Domestic Inflation in East Asian Countries," RIETI Discussion Paper Series , No. 05-E-020.

Kara, H. and OGUNC, F., 2005 "Exchange Rate Pass-through in Turkey: It is Slow, but is it Really Low?" Central Bank of the Republic of Turkey Working Paper, No. 0510

Kenny, G. and McGettigan, D., 1998 "Exchange Rates and Import Prices for a Small Open Economy: the Case of Ireland," *Applied Economics*, 30, 1147-1155.

Kikuchi, A. and Sumner, M., 2002 "Exchange Rate Pass-through in Japanese Export Pricing," *Applied Economics*, 34, 279-284.

Kim, Y., 1990 "Exchange Rates and Import Prices in the United States: A Varying-Parameter Estimation of Exchange-Rate Pass-through," *Journal of Business and Economic Statistics*, 8, 305-315

Kiptui, M., Ndolo, D. and Kaminchia, S., 2005 "Exchange Rate Pass-through: to

What Extent Do Exchange Rate Fluctuations Affect Import Prices and Inflation in Kenya?" Central Bank of Kenya Working Papers, No.1.

Mann, C.L., 1986 "Prices, Profit Margins and Exchange Rates," *Federal Reserve Bulletin* 72 , 366-79.

McCarthy, J., 2000 "Pass-through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies," BIS Working Papers, No.79.

Menon J., 1995 "Exchange Rates and Import Prices for a Small Open Economy," *Applied Economics*, 27, 297-301.

Menon, J., 1995 "Exchange Rate Pass-through," *Journal of Economic Surveys*, 9, 197-231

Olivei, G.P., 2004 "Exchange Rates and the Prices of Manufacturing Products Imported into the United States," New England Economic Review, issue Q 1, 3-18..

Pauls, B.D. and Helkie, W.L. "A reassessment of Measures of the Dollar's Effective Exchange Value," International Finance Discussion Paper 306, Board of Governors of the Federal Reserve System, Washington, DC.

Peersman, G., 2004 "What Caused the Early Millennium Slowdown? Evidence Based on Vector Autoregressions," CEPR Discussion Paper, No. 4087

Rowland, P., 2003 "Exchange Rate Pass-through to Domestic Prices: The Case of Colombia," Banco de la Republica Working Papers, No. 001635

Rudebusch, G. D., 1998 "Do Measures of Monetary Policy in a VAR make sense?" *International Economic Review*, 39, 907-931.

Shambaugh, J., 2003 "A New Look at Pass-through," Dartmouth College Working Papers.

Sims, C., 1988 "Bayesian Skepticism on Unit Root Econometrics," *Journal of Economic Dynamics and Control*, 12, 463-474.

Taylor, J.B., 2000 "Low Inflation, Pass-through, and the Pricing Power of Firms," *European Economic Review,* 44, 1389-1408.

Toh, M.H and Ho, H.J., 2001 "Exchange Rate Pass-through for Selected Asian Economies," *The Singapore Economic Review*, 46, 247-273

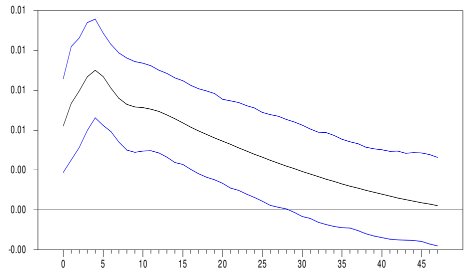
Uhlig H., 2005 "What are the Effects of Monetary Policy on Output? Results from an

Agnostic Identification Procedure," *Journal of Monetary Economics*, 52, 381-419.

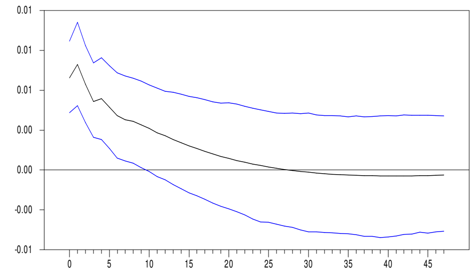
Yang J.W., 1997 "Exchange Rate Pass-through in U.S. Manufacturing Industries," *The Review of Economics and Statistics*, 79, 95-104

Yang J.W., 1998 "Pricing-to-Market in U.S. Imports and Exports: A Time Series and Cross-Sessional Study," *The Quarterly Review of Economics and Finance*, 38, 843-861

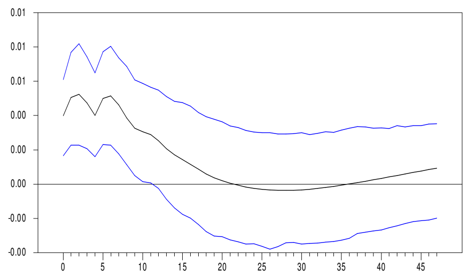
Figure 1. Impulse Responses of Exchange Rates to a Positive Exchange Rate Shock



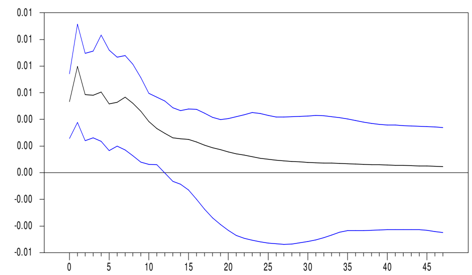
United States



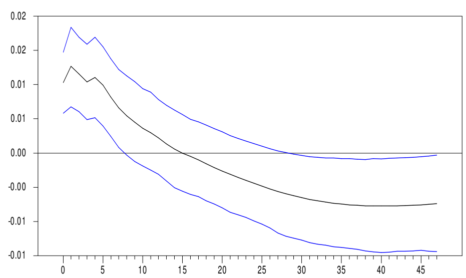
Canada



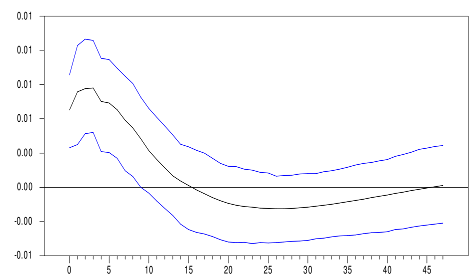
Finland



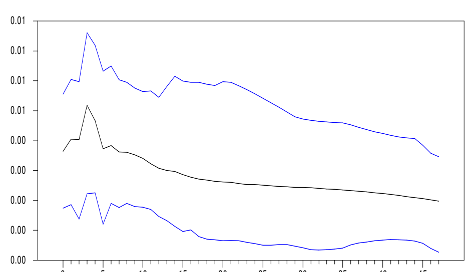
Italy



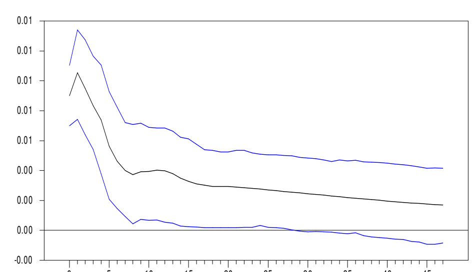
Japan



Spain



Sweden



United Kingdom

Figure 2. Impulse Responses of Import Prices to a Positive Exchange Rate Shock

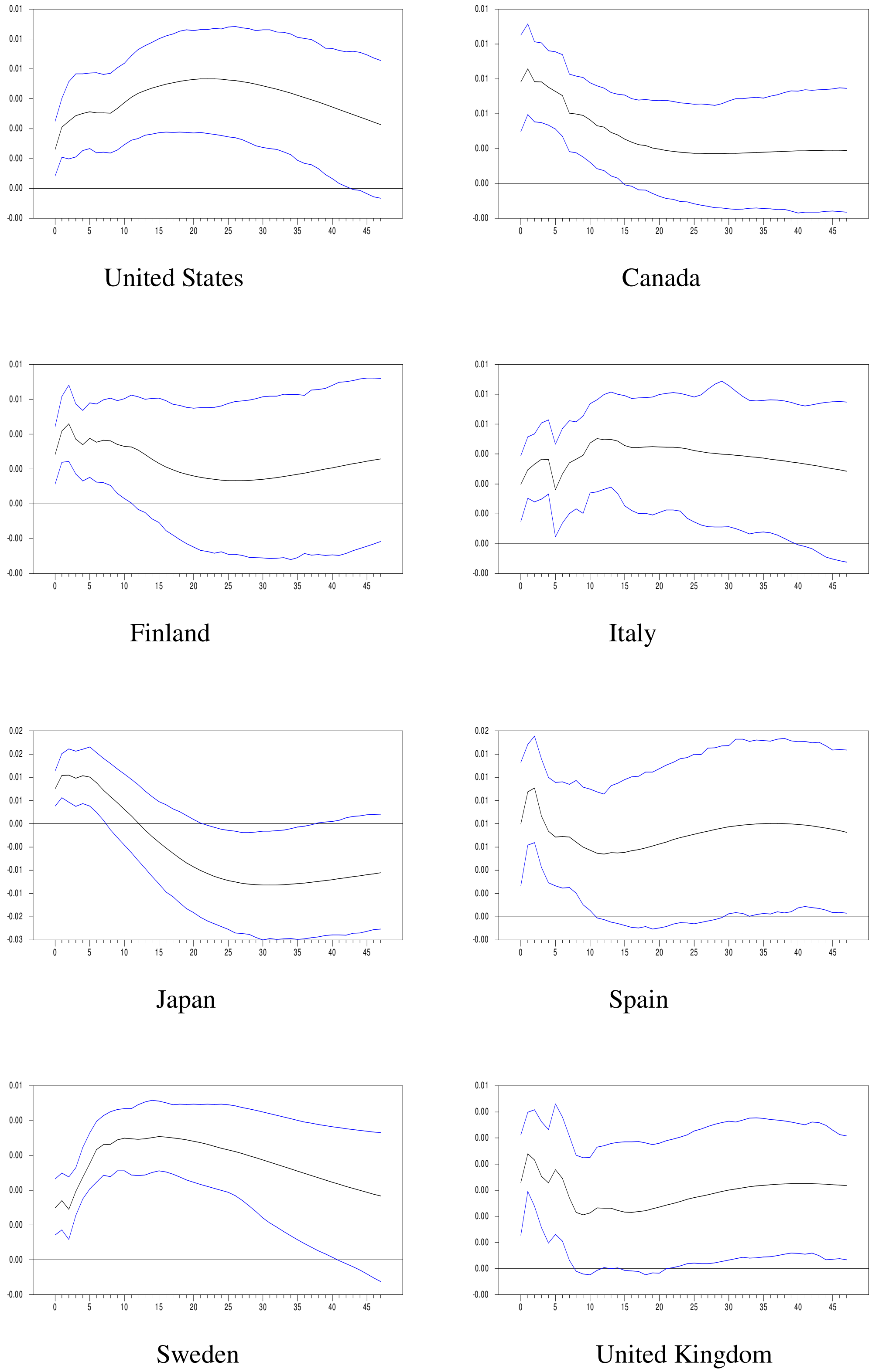
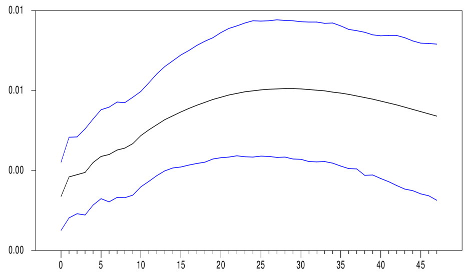
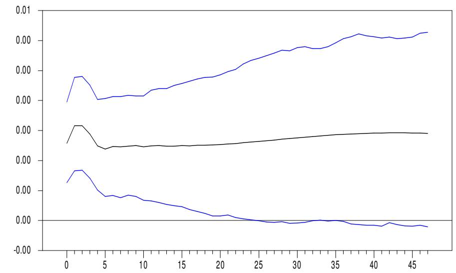


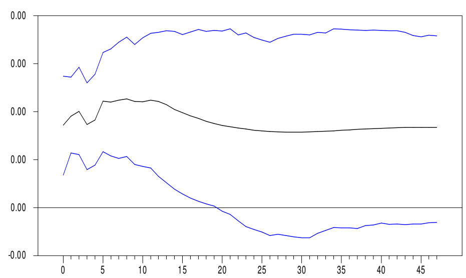
Figure 3. Impulse Responses of PPIs to a Positive Exchange Rate Shock



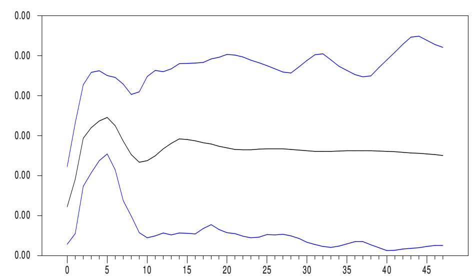
United States



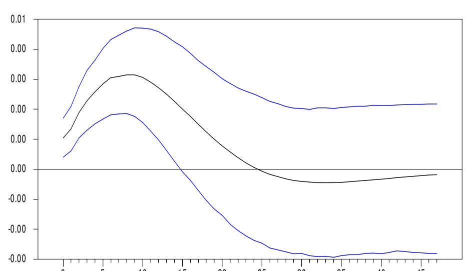
Canada



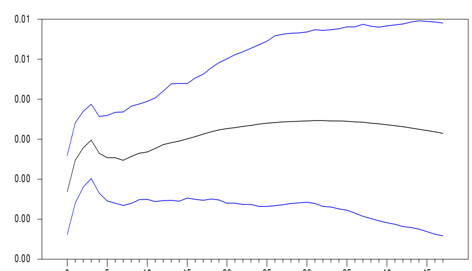
Finland



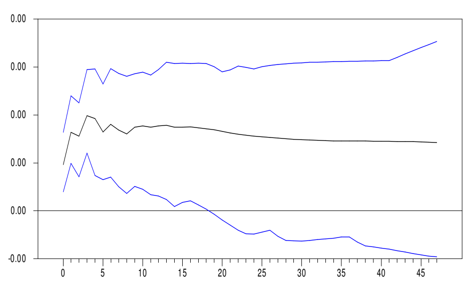
Italy



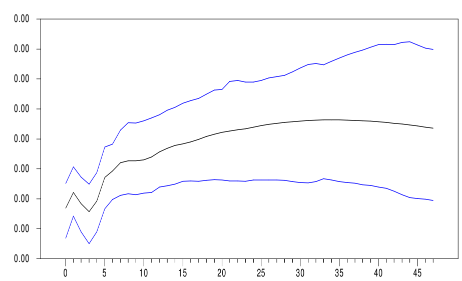
Japan



Spain



Sweden



United Kingdom

Figure 4. Impulse Responses of CPIs to a Positive Exchange Rate Shock

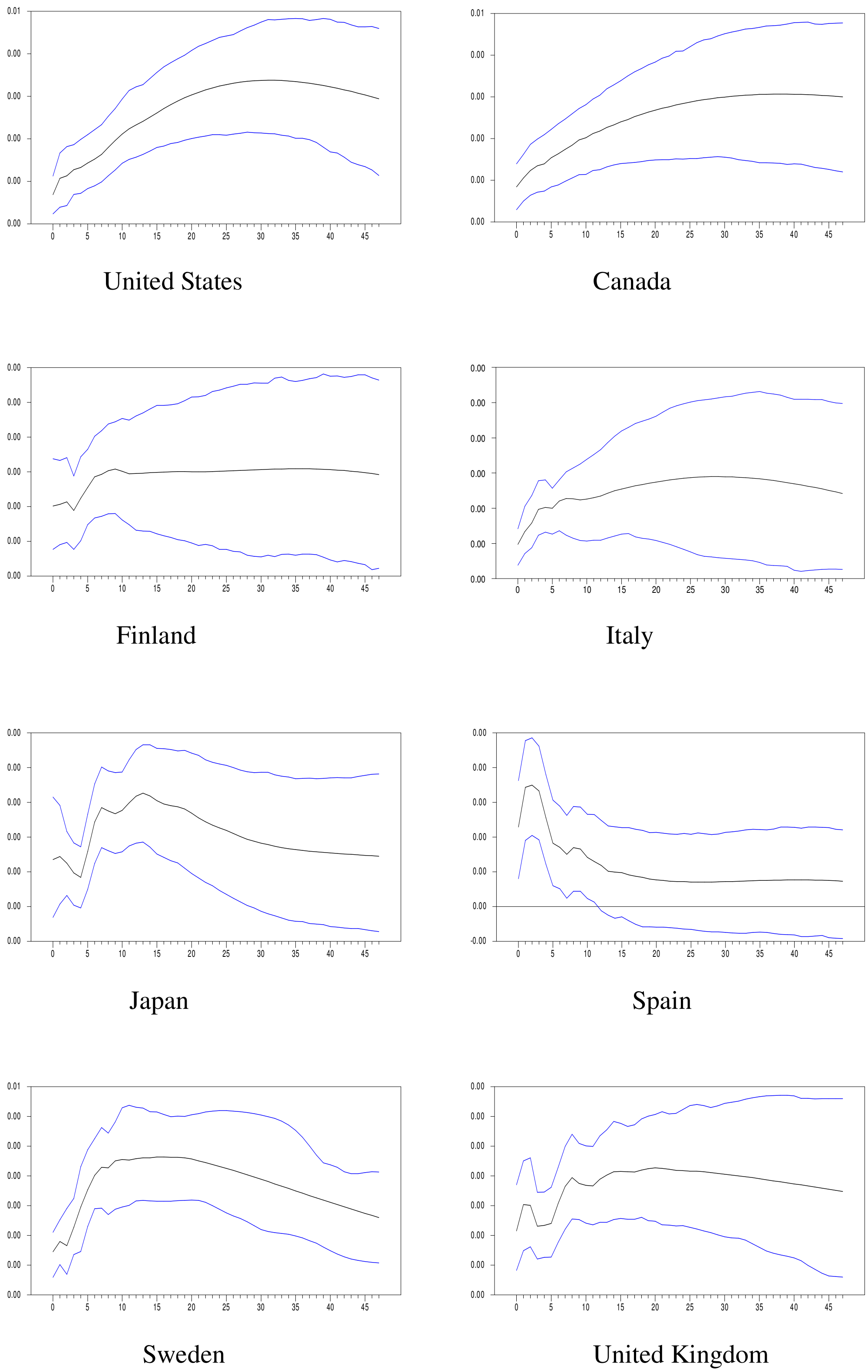
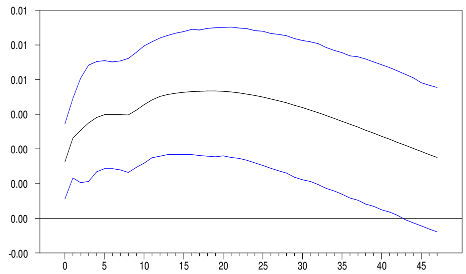
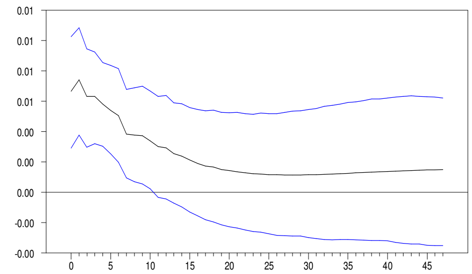


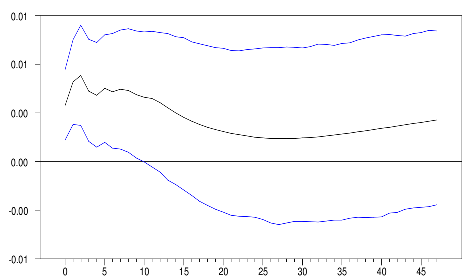
Figure 5. Impulse Response of Import Prices to a Exchange Rate Shock with $K=2$



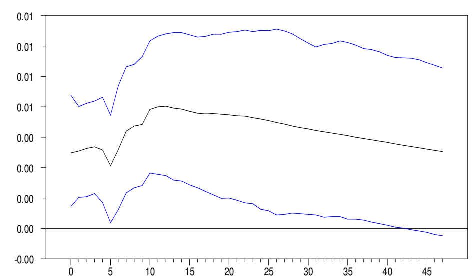
United States



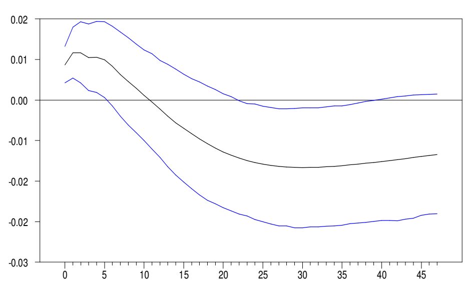
Canada



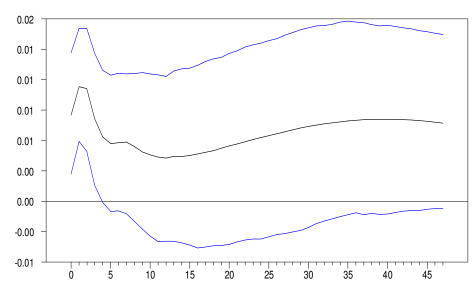
Finland



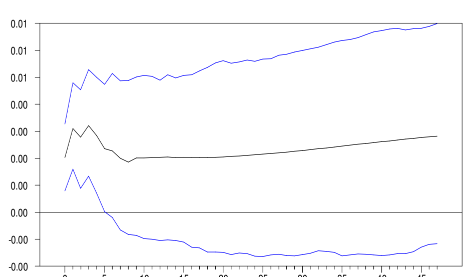
Italy



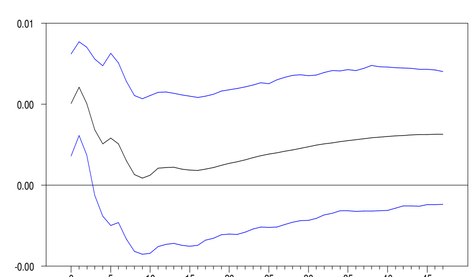
Japan



Spain

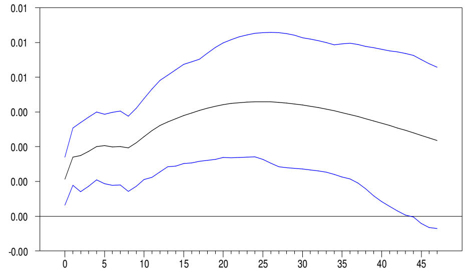


Sweden

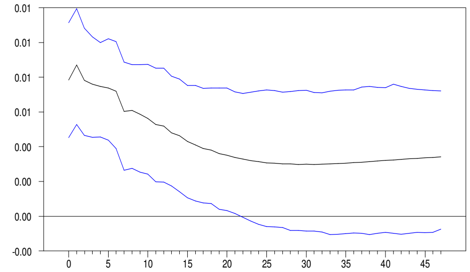


United Kingdom

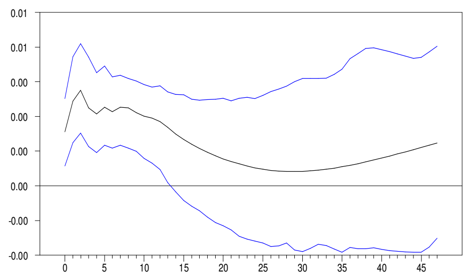
Figure 6. Impulse Responses of Import Prices to a Positive Exchange Rate Shock with $K = 11$



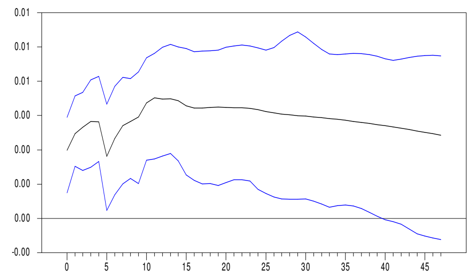
United States



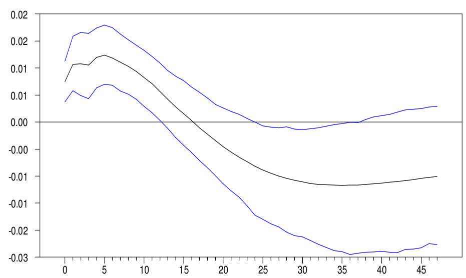
Canada



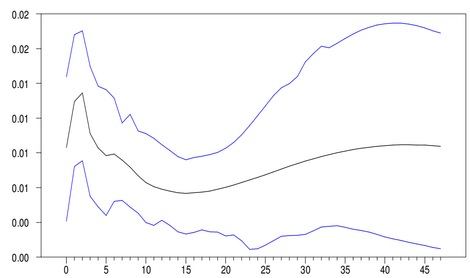
Finland



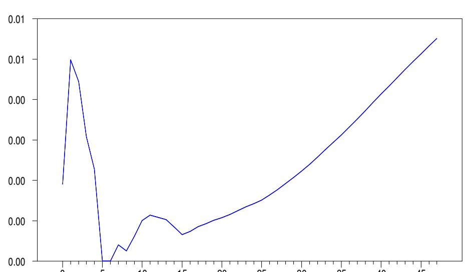
Italy



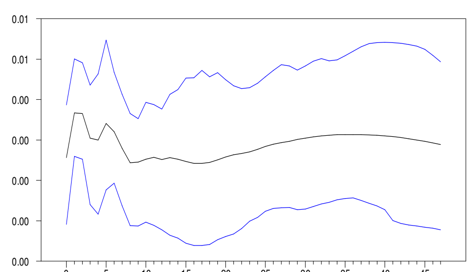
Japan



Spain



Sweden



United Kingdom

Table1: The Empirical Literature on Exchange Rate Pass-through

Study	Data	Method	Findings
Kim (1990)	Quarterly import unit values of the US.	Varying parameter approach in the form of the Kalman filter	Sensitivity of import prices to exchange rate changes reduced in the 1980s, with significant 'pricing to market' behavior.
Hung, Kim and Ohno (1993)	Quaterly export unit values of 16 countries.	Cointegration and error correction model	Export prices increase significantly only in Belgium, the Netherlands, Japan and Taiwan China. Other countries' export prices are little affected. There is hardly any correlation between the size of country and the extent of export price adjustment.
Menon (1995)	Import prices of the Australian manufactured imports.	Johansen Maximum Likelihood procedure	The pass-through is incomplete, around 66%.
Yang (1997)	Quarterly import price indices of the three- and four-digit SIC industries in the manufacturing sector in the US.	Two stage single equation method	The short run exchange rate pass-through elasticities range from 16.25% to 42.85% across the industries, while the long run elasticities range from 21.23% to 75.59%. The pass-through is positively correlated to product differentiation, and negatively to the elasticity of marginal cost.
Yang (1998)	Import and export price indices covering 2-,3-,4-digit industries in the manufacturing sector in the US.	Two stage single equation method	Pass-through is incomplete, and is larger for the U.S. exports than for the U.S. imports.

Table 1 (continued.)

Study	Data	Method	Findings
Kenny and McGettigan (1998)	Import unit values and domestic manufacturing output price indices of Ireland.	Vector error correction mechanism	Pass-through to import unit values and domestic competing prices are close to full.
McCarthy (2000)	Quarterly import price, PPI and CPI of nine developed countries	Stationary VAR model	Pass-through is very small, and largest on import price, second on PPI, and then on CPI. Pass-through is larger in countries with a larger import share and more persistent exchange rate shocks.
Kardasz and Stollery (2001)	Import prices of 33 Canadian manufacturing industries at L-level of aggregation	Two-stage single equation estimation procedure	First, pass-through is small, averaging 25.5%. Second, pass-through elasticities vary a lot across industries.
Toh and Ho (2001)	Quarterly export prices on several different main products of 4 newly industrialized countries	Vector error correction model	The aggregate pass-through elasticities for Malaysia, Thailand, Singapore and Taiwan are 0.63, 0.997, 0.807 and 0.127, respectively.
Choudhri and Hakura (2001)	Monthly CPIs of 71 countries	Single equation model	For high inflation regimes, exchange rate pass-through is higher.
Hufner and Schroder (2002)	Monthly CPI of the Euro area.	Vector error correction model	In response to a 10% depreciation of euro exchange rate, CPI tends to increase by 0.4% and complete after three years.
Olivei (2002)	Quarterly import prices that the BLS produces using the Standard International Trade Classification structure in the US.	Single equation model	Pass-through estimates are usually less than full and the hypothesis that pass-through is full in the long-run is rejected in all but three industries.

Table 1 (Continued..)

Study	Data	Method	Findings
Kikuchi and Sumner (2002)	Quarterly export prices of total manufactured goods in Japan.	Vector error correction model	In the long-run exchange-rate pass-through is complete.
Gueorguiev (2003)	Monthly PPI and CPI of Romania	Stationary VAR model	Pass-through to both CPI and PPI has been large and fast, ranging between 60-70% for PPI and 30-40% for CPI.
Hahn (2003)	Quarterly import price index, PPI and CPI of the Euro area	Stationary VAR model	Pass-through of exchange rate to import price index, PPI and CPI are 50%, 28% and 8% for one year horizon, respectively. The speed of pass-through slows along the distribution chain of pricing.
Rowland (2003)	Monthly import prices, PPI and CPI in Colombia	Stationary VAR model and vector error correction model	The pass-through coefficient of import prices is 0.48 after three months and 0.80 after one year. The pass-through rates of PPI and CPI are 0.28 and 0.15, respectively.
Billmeier and Bonato (2004)	Monthly manufacturing price index (MPI) and retail price index (RPI) of Croatia	Stationary VAR model and cointegrated VAR	For stationary VAR model, MPI responds to exchange rate significantly but not RPI. For cointegrated VAR, the authors find the pass-through coefficient of 0.3 for RPI in the long run.

Table 1 (Continued..)

Study	Data	Method	Findings
Berben (2004)	Monthly CPI-inflation differential between Netherlands, Germany, UK and the US.	Stationary VAR model	The response of price differential between the Netherlands and Germany is larger compared to Netherlands with the US and the UK.
Faruqee (2004)	Monthly import and export unit value, PPI and CPI of the Euro area.	Stationary VAR model	After 18 months, pass-through rates of export and import prices are about 0.5 and 1, respectively. Pass through to PPI and CPI are nearly 0.2 and 0.02, respectively.
Doyle (2004)	Quarterly bilateral import unit values between Irish and the UK at five-digit level.	Cointegration and error-correction model	Full pass-through from the bilateral Irish Pound-Sterling exchange rate could not be rejected for total and sectoral import unit values.
Ito, Sasaki and Sato (2005)	Monthly import prices, PPIs and CPIs of the crisis-hit east Asian countries	Single equation method and stationary VAR model	The degree of exchange rate pass-through to import prices is quite high, ranging from 23-127% in the short-run, but is generally low to the CPIs with the exception of Indonesia.

Table 1(Continued..)

Study	Data	Method	Findings
Kara and Ogunc (2005)	Monthly core CPI measure	Stationary VAR model	74% pass-through to core CPI in 6 months for pre-float period, and 50% pass-through in 15 months for after float period. Pass-through slows down and decreases after floating exchange rate regime.
Kiptui, Ndolo and Kaminchia (2005)	Monthly import price index and CPI of Kenya	Vector error correction model	1% depreciation of the exchange rate results in 0.71% increase in import price. Consumer price also increases sharply, but the increase dissipates by the end of the fourth quarter.
Campa, Goldberg and Gonzalez-Minguez (2005)	Monthly import unit values across industries and countries in the Euro area	Single equation model	Unweighted average pass-through rates by country and by industry within one month are 0.66 and 0.56 respectively; In the long run, the average rate is 0.8 across countries.
Campa and Goldberg (2005)	Quarterly import price indices of 23 OECD countries.	Single equation model	Unweighted average pass-through rate across countries is 0.46 in the short run and 0.64 in the long run, but the pass-through rates vary a lot among those countries.
Choudhri, Faruqee and Hakura (2005)	Monthly CPI of the four acceding countries in EMU	Vector error correction model	The CPI pass-through rates of Slovenia, Hungary, Poland and Czech Republic are 1, 0.97, 0.8 and 0.47, respectively.

Table 2. Pass-through Ratios of Import Price Indices, PPIs and CPIs

		Horizons					
Country	Price indices	0	3	6	9	12	15
US	IMP	0.40	0.74	0.77	0.82	0.97	1.04
	PPI	0.32	0.46	0.57	0.64	0.75	0.82
	CPI	0.13	0.24	0.29	0.37	0.44	0.50
Canada	IMP	1.26	1.26	1.09	0.84	0.70	0.55
	PPI	0.36	0.40	0.34	0.34	0.34	0.35
	CPI	0.15	0.23	0.28	0.34	0.38	0.42
Finland	IMP	0.71	0.93	0.89	0.85	0.78	0.58
	PPI	0.43	0.43	0.55	0.55	0.56	0.50
	CPI	0.25	0.24	0.36	0.39	0.37	0.37
Italy	IMP	0.69	1.06	0.83	0.94	1.14	1.10
	PPI	0.14	0.34	0.35	0.25	0.28	0.31
	CPI	0.13	0.20	0.17	0.18	0.19	0.23
Japan	IMP	0.73	0.95	0.85	0.44	0.20	-0.38
	PPI	0.10	0.22	0.30	0.30	0.26	0.20
	CPI	0.11	0.09	0.16	0.18	0.20	0.19
Spain	IMP	1.41	1.54	1.22	1.07	0.96	0.98
	PPI	0.30	0.53	0.45	0.47	0.51	0.53
	CPI	0.20	0.29	0.15	0.15	0.11	0.09
Sweden	IMP	0.67	1.36	1.13	0.98	0.93	0.91
	PPI	0.33	0.69	0.62	0.60	0.61	0.61
	CPI	0.40	0.63	1.11	1.23	0.13	1.28
UK	IMP	0.29	0.31	0.31	0.18	0.21	0.19
	PPI	0.09	0.09	0.16	0.18	0.20	0.21
	CPI	0.12	0.13	0.17	0.21	0.22	0.23

Note: IMP denotes “import price index”.

Table 3. Spearman Rank Correlation Between Import Price Pass-Through Rates and Factors Influencing Pass-Through

Factors \ Horizons	0	3	6	12
Country size	-0.36	-0.53*	-0.71**	-0.07
Country openness	0.10	0.31	0.45	-0.14
ER shock volatility	-0.30	-0.21	-0.21	-0.57*
ER persistence	-0.67**	-0.29	-0.24	0.54*
AD volatility	0.21	-0.07	-0.02	0.33
Inflation rate	0.05	0.38	0.23	0.45
MSvolatility	0.12	0.54*	0.64**	0.04

Table 4. Spearman Rank Correlation Between PPI Pass-Through rates and Factors Influencing Pass-Through

Factors \ Horizons	0	3	6	12
Country size	-0.64**	-0.50*	-0.40	-0.28
Country openness	0.62**	0.29	0.17	0.17
ER shock volatility	-0.59**	-0.21	-0.28	-0.28
ER persistence	0.43	0.45	0.73**	0.71**
AD volatility	-0.12	-0.05	-0.07	-0.09
Inflation rate	-0.19	0.16	0.02	-0.14
MSvolatility	0.38	0.62**	0.36	0.33

Table 5. Spearman Rank Correlation Between CPI Pass-Through Rates and Factors Influencing Pass-Through

Factors \ Horizons	0	3	6	12
Country size	-0.83**	-0.52*	-0.36	-0.07
Country openness	0.67**	0.38	0.54**	0.45
ER shock volatility	-0.43	-0.24	-0.14	0.13
ER persistence	0.45	0.52**	0.81**	0.69**
AD volatility	0.00	0.00	-0.45	-0.71**
Inflation rate	0.26	0.29	-0.29	-0.5*
MSvolatility	0.74**	0.71**	0.31	0.31

Notes: (1) ER denotes “exchange rate”, AD denotes “aggregate demand”, MS denotes “monetary shocks”.
(2) *Significant at the 10% level (critical value=0.467)
** Significant at the 5% level (critical value=0.583)

Table 6. Percentage of Forecast Error Variance Attributed to Exchange Rate Shocks

Country	Horizons	Import Price	Producer Price	Consumer Price
US	0	0.17	0.16	0.20
	3	0.18	0.19	0.20
	6	0.17	0.19	0.18
	12	0.17	0.20	0.20
	15	0.18	0.21	0.20
Canada	0	0.29	0.20	0.20
	3	0.30	0.19	0.19
	6	0.30	0.17	0.19
	12	0.26	0.16	0.18
	15	0.24	0.16	0.18
Finland	0	0.17	0.20	0.25
	3	0.20	0.17	0.19
	6	0.18	0.13	0.17
	12	0.16	0.11	0.15
	15	0.16	0.11	0.14
Italy	0	0.12	0.11	0.13
	3	0.18	0.14	0.14
	6	0.18	0.15	0.15
	12	0.19	0.16	0.15
	15	0.2	0.16	0.15
Japan	0	0.35	0.26	0.28
	3	0.28	0.25	0.26
	6	0.27	0.25	0.26
	12	0.22	0.25	0.27
	15	0.20	0.25	0.28
Spain	0	0.26	0.24	0.24
	3	0.23	0.20	0.27
	6	0.20	0.18	0.26
	12	0.15	0.15	0.24
	15	0.14	0.15	0.23
Sweden	0	0.14	0.12	0.17
	3	0.20	0.15	0.18
	6	0.19	0.13	0.20
	12	0.18	0.12	0.25
	15	0.18	0.12	0.26
UK	0	0.19	0.26	0.21
	3	0.26	0.19	0.19
	6	0.27	0.16	0.16
	12	0.27	0.17	0.15
	15	0.28	0.18	0.15

Table 7. Pass-through Ratios of Import Price Indices, PPIs and CPIs using Alternative Measure

		Horizons					
Country	Price indices	0	3	6	9	12	15
US	IMP	0.40	0.47	0.53	0.66	0.82	1.00
	PPI	0.32	0.29	0.39	0.52	0.64	0.79
	CPI	0.13	0.15	0.20	0.30	0.38	0.48
Canada	IMP	1.26	1.69	1.85	1.72	1.88	2.10
	PPI	0.36	0.54	0.58	0.71	0.93	1.32
	CPI	0.15	0.32	0.48	0.70	1.01	1.59
Finland	IMP	0.71	0.78	0.69	1.04	1.22	1.62
	PPI	0.43	0.37	0.43	0.68	0.87	1.38
	CPI	0.25	0.20	0.28	0.47	0.58	1.04
Italy	IMP	0.69	0.94	0.76	0.99	1.93	2.37
	PPI	0.14	0.30	0.32	0.26	0.48	0.66
	CPI	0.13	0.18	0.16	0.18	0.33	0.50
Japan	IMP	0.73	0.94	1.08	1.00	0.09	-956.90
	PPI	0.10	0.22	0.37	0.70	1.23	483.27
	CPI	0.11	0.09	0.21	0.41	0.94	485.67
Spain	IMP	1.41	1.19	1.21	1.69	3.80	44.65
	PPI	0.30	0.41	0.45	0.75	2.01	24.26
	CPI	0.20	0.22	0.15	0.23	0.42	3.94
Sweden	IMP	0.67	0.77	0.77	0.78	0.95	1.03
	PPI	0.33	0.39	0.43	0.48	0.62	0.68
	CPI	0.40	0.36	0.76	0.99	1.28	1.45
UK	IMP	0.29	0.34	0.60	0.42	0.46	0.53
	PPI	0.09	0.09	0.32	0.42	0.45	0.58
	CPI	0.12	0.14	0.33	0.48	0.49	0.63

Note: IMP denotes “import price index”.

Table 8. Spearman Rank Correlation Between Import Price Pass-Through Rates and Factors Influencing Pass-Through

Factors \ Horizons	0	3	6	12
Country size	-0.36	-0.26	-0.33	-0.55*
Country openness	0.1	0.14	0.31	0.33
ER shock volatility	-0.3	-0.4	-0.06	-0.79**
ER persistence	-0.67**	-0.62**	-0.69	-0.05
AD volatility	0.21	0.083	-0.19	0.48
Inflation rate	0.05	0.07	0.07	0.67**
MSvolatility	0.11	0.06	0.33	0.38

Table 9. Spearman Rank Correlation Between PPI Pass-Through Rates and Factors Influencing Pass-Through

Factors \ Horizons	0	3	6	12
Country size	-0.64**	-0.67**	-0.55*	-0.14
Country openness	0.62**	0.64**	0.58**	-0.12
ER shock volatility	-0.59**	-0.54*	-0.29	-0.01
ER persistence	0.43	-0.05	-0.09	-0.57*
AD volatility	-0.12	-0.05	-0.11	0.14
Inflation rate	-0.19	0.24	-0.04	-0.23
MSvolatility	0.38	0.64**	0.63**	0.05

Table 10. Spearman Rank Correlation Between CPI Pass-Through Rates and Factors Influencing Pass-Through

Factors \ Horizons	0	3	6	12
Country size	-0.87**	-0.76**	-0.29	-0.33
Country openness	0.67**	0.78*	0.71**	0.43
ER shock volatility	-0.48*	-0.45	0.25	0.46
ER persistence	0.42	0.24	0.21	-0.19
AD volatility	0.02	-0.19	-0.73**	-0.67**
Inflation rate	0.32	0.33	-0.31	-0.43
MSvolatility	0.73**	0.81**	0.41	0.33

Notes: (1) ER denotes "exchange rate", AD denotes "aggregate demand", MS denotes "monetary shocks".
(2) *Significant at the 10% level (critical value=0.467)
** Significant at the 5% level (critical value=0.583)

Table 11. Percentage of Error Variance Attributed to Exchange Rate Shocks with K =2 and K =11.

Country	Horizons	Import Price (K =2)	Import price (K =11)
US	0	0.21	0.14
	3	0.20	0.16
	6	0.20	0.14
	12	0.19	0.14
	15	0.20	0.14
Canada	0	0.26	0.32
	3	0.26	0.31
	6	0.26	0.31
	12	0.24	0.28
	15	0.23	0.27
Finland	0	0.17	0.14
	3	0.20	0.20
	6	0.18	0.18
	12	0.17	0.16
	15	0.17	0.16
Italy	0	0.21	0.13
	3	0.16	0.21
	6	0.14	0.18
	12	0.15	0.17
	15	0.16	0.17
Japan	0	0.31	0.36
	3	0.25	0.31
	6	0.23	0.30
	12	0.19	0.26
	15	0.17	0.22
Spain	0	0.23	0.25
	3	0.20	0.23
	6	0.16	0.18
	12	0.12	0.14
	15	0.11	0.12
Sweden	0	0.15	0.17
	3	0.20	0.23
	6	0.19	0.14
	12	0.18	0.11
	15	0.18	0.12
UK	0	0.20	0.20
	3	0.21	0.28
	6	0.22	0.29
	12	0.22	0.28
	15	0.22	0.28

Table 12. Pass-Through Ratios of Import Price Indices, PPIs and CPIs with $K=2$

		Horizons					
Country	Price indices	0	3	6	9	12	15
US	IMP	0.58	0.98	1.07	1.11	1.26	1.30
	PPI	0.44	0.62	0.76	0.82	0.93	0.99
	CPI	0.17	0.33	0.38	0.47	0.54	0.59
Canada	IMP	1.28	1.22	0.97	0.72	0.56	0.41
	PPI	0.37	0.38	0.29	0.29	0.28	0.27
	CPI	0.17	0.26	0.31	0.37	0.41	0.45
Finland	IMP	0.80	1.00	1.00	0.96	0.85	0.64
	PPI	0.56	0.54	0.69	0.69	0.68	0.61
	CPI	0.28	0.27	0.40	0.43	0.42	0.42
Italy	IMP	0.92	0.99	0.96	1.27	1.48	1.42
	PPI	0.21	0.40	0.39	0.33	0.39	0.41
	CPI	0.14	0.24	0.20	0.20	0.23	0.26
Japan	IMP	0.77	0.93	0.74	0.26	-0.20	-0.50
	PPI	0.11	0.24	0.31	0.31	0.26	0.20
	CPI	0.13	0.10	0.18	0.19	0.22	0.20
Spain	IMP	1.46	1.40	0.99	0.84	0.74	0.78
	PPI	0.29	0.51	0.40	0.43	0.46	0.48
	CPI	0.24	0.29	0.15	0.15	0.10	0.09
Sweden	IMP	0.57	0.90	0.63	0.56	0.57	0.57
	PPI	0.40	0.56	0.45	0.42	0.42	0.41
	CPI	0.44	0.60	0.87	0.89	0.87	0.87
UK	IMP	0.35	0.24	0.18	0.03	0.07	0.06
	PPI	0.12	0.11	0.18	0.19	0.20	0.21
	CPI	0.15	0.18	0.22	0.27	0.27	0.29

Note: IMP denotes “import price index”.

Table 13. Pass-Through Ratios of Import Price Indices, PPIs and CPIs with $K = 11$

		Horizons					
Country	Price indices	0	3	6	9	12	15
US	IMP	0.34	0.59	0.63	0.67	0.82	0.91
	PPI	0.33	0.45	0.56	0.63	0.74	0.83
	CPI	0.12	0.22	0.27	0.36	0.43	0.49
Canada	IMP	1.34	1.29	1.23	1.00	0.88	0.73
	PPI	0.33	0.37	0.33	0.34	0.35	0.36
	CPI	0.14	0.21	0.25	0.29	0.32	0.35
Finland	IMP	0.60	0.86	0.82	0.81	0.71	0.52
	PPI	0.36	0.36	0.47	0.47	0.45	0.38
	CPI	0.24	0.24	0.35	0.38	0.36	0.36
Italy	IMP	0.55	0.82	0.67	0.75	0.87	0.84
	PPI	0.12	0.30	0.30	0.23	0.23	0.22
	CPI	0.09	0.16	0.16	0.16	0.16	0.17
Japan	IMP	0.63	0.88	0.99	0.78	0.47	0.13
	PPI	0.09	0.20	0.28	0.32	0.31	0.27
	CPI	0.09	0.08	0.14	0.16	0.19	0.19
Spain	IMP	1.23	1.38	1.16	0.91	0.76	0.72
	PPI	0.30	0.51	0.45	0.45	0.48	0.50
	CPI	0.19	0.26	0.16	0.15	0.11	0.08
Sweden	IMP	0.39	0.64	0.00	0.13	0.23	0.14
	PPI	0.30	0.45	0.16	0.21	0.30	0.26
	CPI	0.12	0.38	0.59	0.62	0.69	0.72
UK	IMP	0.26	0.30	0.32	0.24	0.25	0.25
	PPI	0.08	0.07	0.14	0.16	0.17	0.19
	CPI	0.07	0.10	0.13	0.16	0.16	0.18

Note: IMP denotes “import price index”.