Exchange Rate Pass-Through:

Experience from Selected OECD Countries

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Abstract

The paper estimates the exchange rate pass-through for a set of OECD countries. It examines the effects of the inflation rate, inflation volatility, exchange rate volatility, and the degree of openness of an economy, on the degree of exchange rate pass-through. Different measures of price levels and volatilities are used to assess the robustness of the findings to these measures. Furthermore, the paper explores the argument that the exchange rate pass-through has declined over time for countries with a low and stable inflation environment. Evidence of a positive relationship between the inflation volatility and the exchange rate pass-through is also found. Finally, the paper concludes that the degree of exchange rate pass-through may be endogenous to an economy's monetary policy. Therefore, monetary authorities and policy makers may wish to consider taking the degree of pass-through into account when designing the optimal monetary policy or exchange rate regime.

1. Introduction

The influence of exchange rate movements on domestic prices is one of the major concerns when considering monetary and exchange rate policies. It is thought that low-exchange rate pass-through provides freedom for pursuing an independent monetary policy and helps to set the correct environment for inflation-targeting.[1] It is also debated that the exchange rate pass-through has decreased over time, more specifically, for countries that were able to maintain a relatively low-inflation environment. Exchange rate pass-through influences forecasts of inflation, the effect of monetary policy and the ability of exchange rate changes to alleviate trade imbalances. The degree of exchange rate pass-through and its determinants are, therefore, important for the effectiveness of macroeconomic policy. Though exchange rate pass-through has been a matter of interest, the focus of this interest has grown significantly over time. More recently, pass-through issues have started playing a central role in heated debates over appropriate monetary policies and exchange rate regime optimality in general equilibrium models.[2] The central issues of these debates are the presence of producer-currency pricing (PCP) versus local-currency pricing (LCP) of imports, and whether the exchange rate pass-through is essentially determined by microeconomic factors that are exogenous to monetary policy or the exchange rate pass-through rates that are endogenous to a country's monetary performance.

In the 1970s, many industrialized countries adopted more flexible exchange rate regimes. The period witnessed very high inflation rates. This combination created an interest among central banks regarding the effects of movements in their currencies on inflation. These

[1]Choudhri and Hakura (2001),

[2]Campa and Goldberg (2005).

countries successfully began to stabilize and reduce their inflation rates. Many factors could have played a role in this process; however the literature agrees that it was a result of a movement towards more credible monetary policy regimes, especially in countries that adopted inflation targeting. The concern about exchange rate movements and their effects on domestic prices dwindled. The movement to a low inflation environment in industrialized countries also witnessed large depreciations in their currencies. More interestingly, these large depreciations had a significantly smaller effect on inflation rates than anticipated based on their past experiences. This had led to the common belief that exchange rate pass-through has decreased over time due to more credible monetary policy regimes.

Whether the behaviour of exchange rate pass-through is attributed to the microeconomic or macroeconomic factors, the issue of exchange rate pass-through is particularly important because of its policy implications. The current study estimates the exchange rate pass-through for a set of OECD countries. Using the data obtained from the International Monetary Fund (IMF) *International Financial Statistics* and the World Bank's *World Development Indicators* for the period from 1960 to 2006 and, following the footsteps of Choudhri and Hakura (2001), the exchange rate pass-through is estimated for 29 OECD countries. The study also attempts to explore the key macroeconomic variables which are believed to be influencing the exchange rate pass-through. Using the estimated pass-through for the sample of 29 OECD countries, the current study examines the impact of exchange rate volatility, inflation volatility, average inflation rate, and openness, which is measured as the import to GDP ratio, on pass-through. The argument that exchange rate pass-through has declined over time, especially in countries that were able to maintain a low and stable inflation environment, is also examined. Among the sample OECD countries, fourteen nations have, so far, adopted inflation targeting. To explore the change, if any, in the degree of exchange rate

pass-through in those inflation targeting countries, the pass-through coefficients are estimated for pre-and-post adoption period. In addition, different measures of price levels are used to assess the robustness of the findings to these measures.

The next section reviews some existing literature on exchange rate pass-through. Section 3 states the objectives of the present study while section 4 describes the data used in this study as well as the empirical strategies and econometric models used in this study. Section 5 presents the empirical results. Section 6 provides the major limitations of the study. Finally, section 7 adds some concluding remarks.

2. Literature Review

A large number of studies on exchange rate pass-through have been conducted so far and several determinants of the degree of exchange rate pass-through have been proposed while numerous studies have provided empirical estimates for different countries and commodities traded. Exchange rate pass-through has mainly been analyzed on two grounds. A group of studies focuses on the transmission of exchange rate changes into import and export prices, referred to as the 'first stage pass-through'.[3] The first stage pass-through deals with exchange rate pass-through at both the aggregate level (for aggregate exports and imports) and at disaggregated levels (using industry or product specific import/export price data). The second group of studies deal with the 'second stage pass-through' which examines pass-through into aggregate domestic prices as measured by consumer, producer or wholesale-price indices. It is found that the second stage pass-through is lower than the first stage one. This normally happens because the aggregate price index includes some non-tradable goods and also because non-tradable goods may be affected, for instance, by domestic taxation policies. It is also believed that the importers and wholesalers may absorb some of the exchange rate change. The literature has also been interested in the causes of low exchange rate pass-through.[4] A group of studies argue that the exchange rate pass-through is determined by microeconomic factors, whereas for others low exchange rate pass-through is due to macroeconomic factors. Key macroeconomic factors used in the literature are average inflation rate, exchange rate volatility, trade imputed elasticity, real GDP, exchange rate volatility etc., whereas key microeconomic factors considered are demand elasticity, market power, product quality and mark-up, product group characteristics. Theoretical works argue that the volatility

[3] Ghosh and Ramkishen (2007)
[4] Devereux and Yetman (2002)

in monetary aggregates and exchange rate of countries should influence the choice of invoice currencies in trade.[5]

Choudhri and Hakura (2001) test a hypothesis that a low inflationary environment leads to a low exchange rate pass-through to domestic prices. To test this hypothesis, they derive a pass-through relation based on a new open economy macroeconomic model developed in the paper, and they undertake an extensive empirical analysis based on a large data set. The paper estimates the pass-through to consumer prices. The study finds a strong evidence of a positive and significant association between the pass-through and the average inflation rate across countries and periods. They conclude by suggesting a policy implication that the dependence of the exchange rate pass-through on the inflation regime should be taken into account in designing monetary policy rules.

McCarthy (2000) tests the impact of exchange rates and import prices on the domestic producer price index (PPI) and consumer price index (CPI) in a group of industrialized countries. The study uses a vector autoregressive (VAR) model that incorporates a distribution chain. The model is estimated over the post Bretton Woods era. The study finds that exchange rates have a modest impact and import prices have a stronger impact on domestic price inflation. Furthermore, the paper suggests that pass through is larger in countries with a larger import share, more persistent exchange rates and import prices.

[5]Campa and Goldberg (2005).

Gagnon and Ihrig (2001) test whether the exchange rate pass-through in many countries has declined since 1980s. The study uses a theoretical model that attributes the changes in pass-through to increased emphasis on inflation stabilization by many central banks. The model tests this hypothesis on eleven industrial countries between 1971 and 2000. It is found that there is a widespread evidence of both a decline in pass-through and a decline in the variability of inflation in 1990s. The study also finds that there is a statistically significant link between pass-through and inflation measurability. However, the paper is unable to illustrate a direct relationship between the pass-through and measures of monetary behaviour.

Devereux and Yetman (2002) develop a framework within which they investigate the importance of slow price adjustment in explaining exchange rate pass-through in an open economy. They estimate simple aggregate pass-through coefficients for 122 countries and then show a non-linear relationship between estimated pass-through coefficients and average inflation rates. Based on the theoretical model and the empirical evidence, the study argues that sticky prices play an important role in cross-country variations in exchange rate pass-through. Finally, the study points out that the endogenous nature of exchange rate pass-through should be taken into account in designing monetary policy for a small open economy.

Leigh and Rossi (2002) test the impact of exchange rate on domestic prices in Turkey. The study uses a recursive vector autoregressive model to estimate the effect of exchange rate. The paper finds that the impact of exchange rate on domestic prices is over after a year and it is felt significantly during the first four months after the change. It is also found that the impact of exchange rate changes on wholesale prices is higher than the impact

of exchange rates on domestic prices. Furthermore, the study suggests that the estimated pass-through is complete in a shorter period of time and it is larger than the one estimated for other emerging countries.

Campa and Goldberg (2005) provide cross-country and time series evidence on the extent of exchange rate pass-through on the import prices of 23 OECD countries. The study finds a strong evidence of partial pass-through in the short run, especially within manufacturing industries. The study suggests that countries with higher rates of exchange rate volatility have higher pass-through elasticities. However, the study reports a minor role for macroeconomic variables in the evolution of pass-through elasticities over time and attributed greater importance on the shifts in the composition of country import bundles.

Barhoumi (2006) investigates the exchange rate pass-through on import prices in a sample of 24 developing countries over the period from 1980 to 2003. The study estimates a pass-through equation determined by a combination of the nominal exchange rate, the price of the competing products, the exporter's costs and demand conditions. Non-stationary panel estimation techniques and tests for cointegration are used for the analysis. Moreover, the study shows that most of these differences in exchange rate pass-through into import prices are due to three macroeconomic determinants: exchange rate regimes, trade barriers and inflation regimes.

Malin (2007) investigates the performance of various monetary policy rules in an open economy with incomplete exchange rate pass-through. The study argues that

implementing monetary policy through an exchange rate augmented policy rule does not improve social welfare compared to using an optimized Taylor rule, irrespective of the degree of pass-through. A direct exchange rate response improves welfare only if the other reaction coefficients, on inflation and output, are sub-optimal. The study concludes that the result is independent of whether society values domestic or CPI inflation stabilization.

Marazzi and Sheets (2007) document a decline in exchange rate pass-through to U.S. import prices, from well above 0.5 during the 1970s and 1980s to around 0.2 over the last decade. The study attributes this decline to the rising prominence of competition from China, a shift in import pricing behavior since the Asian financial crisis, and the reduced share of material-intensive goods in U.S. imports. It finds evidence that foreign exporters are increasingly setting their prices with an eye on U.S. prices. These results, in turn, suggest a new and more general hypothesis linking the decline in pass-through to the evolving nature of competition in global markets and structural changes in international production patterns.

Ca'Zorzi, Hahn and Sanchez (2007) test the degree of exchange rate pass-through to prices in 12 emerging countries in Asia, Latin America and Central and Eastern Europe. The study is based on three alternative vector autoregressive models. The paper finds a positive relationship between the degree of exchange rate pass through and inflation for the sample countries (excluding Argentina and Turkey). Furthermore, the paper finds a weak empirical support for the relationship between import openness and exchange rate pass-through.

Junior (2007) examines the exchange rate pass-through for a set of emerging and developed economies before and after the adoption of Inflation Targeting. The paper uses Autoregressive Distributed Lag Modelling approach. The study shows that exchange rate pass-through is higher for emerging countries than for developed countries. The paper also suggests that exchange rate pass-through decreased after the adoption of inflation targeting. However, it does not suggest that exchange rate pass-through is no longer significant for developed and emerging countries, especially in the long run.

Bailliu and Fuji (2004) investigate whether the transition to a low inflation environment led to a decline in exchange rate pass through in industrialized countries. The paper uses the data for 11 industrialized countries over the period of 1977 and 2001. The authors use a panel data approach and analyzes exchange rate pass through to consumer, producer and import prices. Furthermore, the study considers multiple shifts in inflation in 11 industrialized countries. The paper finds evidence that a low inflation environment caused by a change in monetary policy regime leads to a decline in exchange rate pass-through.

Schönerwald and Vernengo (2008) argue that there has been a decline in exchange rate pass through in Brazil. This decline has been seen in the period with a low inflation. The paper uses the data over the period of 1953-2007. The study examines the low and high inflation periods individually. The exchange rate pass through is found to be around 1 in the high inflation period but 0.2 in low inflation periods. Furthermore, the Brazilian central bank has kept the interest rates high even though there has been a decline in the effects of exchange rate. The paper suggests that this move which is called "fear of floating" is a result of "fear of inflation."

Ito and Sato (2006) examine the effect of exchange rate pass-through on domestic prices in crisis hit countries in East Asia and Latin America. The analysis also includes Turkey. The authors analyze monthly series of data from the early 1990s to 2005 or 2006. The paper uses the structural vector auto-regression to test the exchange rate pass-through. The study finds that exchange rate pass-through is higher in the Latin American countries and Turkey than in East Asian countries, with the exception of Indonesia. It is also found that the exchange rate pass-through in import prices is high in the countries affected by currency crises in the 1990s. The exchange rate pass-through to CPI is found to be high only in Indonesia.

Coulibaly and Kempf (2010) test the effect of inflation targeting on the exchange rate pass-through to prices in emerging countries. The model uses a panel VAR, which allows the authors to use a larger data set on the sample of emerging countries. The sample includes 15 inflation-targeting and 12 non inflation-targeting countries. The study concludes that the inflation-targeting countries in the sample have been able to reduce the pass-through to import prices, producer prices and consumer prices. The paper also indicates that the variance decomposition shows that exchange rate shocks to price fluctuations are more significant for the inflation-targeting countries in the sample.

Shintani, Hagiwara and Yabu (2012) examine the relationship between the exchange rate pass-through and inflation by using a non-linear time series model. The paper illustrates that the dynamics of exchange rate pass-through can be well approximated by a class of smooth transition autoregressive models using the past inflation rate as a variable.

Moreover, the paper uses several U-shaped transition functions to estimate time varying exchange rate pass-through to US domestic prices. The study concludes that the declines in the exchange rate during 1980s and 1990s are associated with low inflation rates during those periods.

3. Objectives of the Study

The primary objective of the present study is to estimate the exchange rate pass-through for a set of OECD countries and explore the influence of some selected macroeconomic variables on the pass-through. The macroeconomic variables are:

- Average Inflation
- Exchange Rate Volatility, defined as the coefficient of variation (CV) of the exchange rate.
- Inflation Volatility, defined as the coefficient of variation (CV) of the inflation rate.
- A Measure of Openness, namely the Import to GDP Ratio.

Specifically the objectives are:

- To estimate the exchange rate pass-through to Consumer Price Index (CPI).
- To find out the changing pattern of pass-through by using different measures of price level, namely, Producer Price Index (PPI).
- To assess the influence of the selected macroeconomic variables on the pass-through.
- To test the plausible argument that the exchange rate pass-through has declined over time in countries with a low and stable inflation environment.

4. Data and Methodology

To estimate the exchange rate pass-through, it is extremely important to define it. According to Goldberg and Knetter (1997), exchange rate pass-through is the percentage change in the local currency import prices resulting from a one percent change in the exchange rate between the exporting and importing countries. Ghosh and Ramkishen (2007) defines exchange rate pass-through as the transmission of exchange rate changes into import (export) prices of goods in the destination-market currency as well as into aggregate domestic prices.[6]

Thus the exchange rate pass-through is defined as the influence of exchange rate movements on domestic prices. In this study the exchange rate pass-through is estimated by using a regression of the following form:

$$\Delta \log P_{tj} = \beta_{oj} + \beta_{1j} \Delta \log S_{tj} + \beta_{2j} \Delta \log P_t^* + \beta_{3j} \Delta \log P_{t-1j} + \varepsilon_{tj} \qquad (1)$$

where, P_{tj} is the Consumer Price Index (CPI) of country j at time t, S_{tj} is the U.S. dollar exchange rate of country j at time t and P_t* the U.S. CPI at time t.

The coefficient β_1 is a measure of the short-term exchange rate pass-through as it captures the impact of movements in the nominal exchange rates on domestic prices. Another objective of the present study is to explore the changing pattern of the degree of pass-through

[6]Ghosh and Ramkishen (2007).

by using different measures of the price levels. Thus the estimation of the exchange rate pass-through was repeated using Producer Price Index (PPI) rather than CPI to assess and explore any changes in the degree of pass-through. This part of the estimation is expected to reveal the picture whether the producers or the consumers are taking the major part of the heat as a result of the exchange rate movement.

In the second stage, the study attempted to examine the effect of the average inflation rate on the pass-through and assess the influence of some selected macroeconomic variables. This step closely follows Choudhri and Hakura (2001). The macroeconomic variables considered here are exchange rate volatility, inflation volatility, and a measure of openness, namely import to GDP ratio. To estimate the impact of those variables on exchange rate pass-through, the following equation is used in this study:

$$PASS_j = \alpha_0 + \alpha_1 INFA_j + \alpha_2 INFV_j + \alpha_3 EXRV_j + \alpha_4 OPEN_j + \varepsilon_j \qquad (2)$$

where $PASS_j$ is the estimated pass-through for country j, $INFA_j$ is the average inflation rate of country j, $INFV_J$ is inflation volatility defined as the coefficient of variation (CV) in the CPI for country j, $EXRV_j$ is the exchange rate volatility defined as the coefficient of variation (CV) in exchange rates for country j, $OPEN_j$ is the level of openness of the economy j, measured as the average of import/GDP ratio over the sample period, and ε_j is the error term. The coefficient of variation (CV) is defined as the ratio of the standard deviation, s, to the mean, $\overline{X}$.

Finally, the plausible argument that the exchange rate pass-through has declined over time in countries with a low and stable inflation environment is tested. Regarding this, countries which have adopted inflation targeting are considered in this study. The sample period for those countries are divided into two periods; one period starts from the beginning until the time of the adoption of inflation targeting, and a second period starting from the time of the adoption until the end of the sample period. It is expected that this step would help to further examine and possibly explain the decline in exchange rate pass-through in some countries.

A large database that includes time series data from 1960-2006 for 29 OECD countries is used in this study. The data are obtained from the IMF *International Financial Statistics* except for Openness. The data on Openness are obtained from the World Bank's *World Development Indicators*. Fourteen of the twenty-nine OECD sample countries adopted inflation targeting.

Even though the model used in this study to estimate exchange rate pass-through and explore the influence of selected macroeconomic variables on pass-through follows Choudhri and Hakura (2001) closely, it is noteworthy to state the major differences. In the equation for estimating exchange rate pass-through Choudhri and Hakura (2001) use P_t^* which is the foreign CPI and it is used in lagged form. A monthly series for foreign CPI is obtained from the Relative Price Index (RPI) reported by the Information Notice System (INS) and then converted to quarterly series by taking simple average. The RPI is a ratio of domestic CPI of the country to trade weighted averages of the CPI's of trading partner countries. On the other hand the present study uses Pt^* which is defined as the U.S. CPI at time t and the current

form is used. By using U.S. CPI as an independent variable while estimating pass-through for the sample countries, the study assumes that United States is the major trading partner for the sample countries. Moreover, this also means that the U.S. CPI influences the domestic price levels of the sample countries. This is clearly a pretty strong assumption, but hardly would be completely untenable as an assumption, since the U.S. has become the major trading partner of a growing number of exporting countries internationally over the last half century. While Choudhri and Hakura use data from 1979 to 2001 for 71 countries obtained from the INS database of the IMF the present study uses data from 1960 to 2006 and for 29 OECD countries. While Choudhri and Hakura use quarterly data, the current study uses annual data.

5. Empirical Results

This section presents summary statistics for some key variables used in this study as well as the results of the estimations. Results from the regressions are summarized in Table 2, Table 4, Table 5 and Table 6, whereas the summary statistics are presented in Table 1 and Table 3.

Table 1: Inflation experience of Selected OECD Countries (1960-2006)

Country	Average	Maximum	Minimum	Std. Deviation
Australia	5.47	15.11	-0.28	4.03
Austria	3.67	9.52	0.56	2.06
Belgium	3.98	12.77	0.95	2.88
Canada	4.38	12.46	0.19	3.16
Chile	50.79	504.73	1.05	103.81
Denmark	5.43	15.28	1.16	3.53
Finland	5.58	17.81	0.19	4.46
France	4.98	13.65	0.50	3.82
Germany	2.00	5.08	0.57	1.23
Greece	10.23	26.90	-0.38	8.00
Hungary	11.37	34.23	1.80	8.60
Iceland	18.83	84.22	1.55	18.98
Ireland	6.75	20.88	1.40	5.56
Israel	39.08	373.82	-0.41	74.38
Italy	7.13	21.28	1.66	5.64
Japan	3.82	23.18	-0.90	4.43
Korea	8.72	28.70	0.81	7.06
Luxembourg	3.77	10.75	-0.13	2.69
Mexico	23.94	131.83	0.59	30.85
Netherlands	3.93	10.21	-0.71	2.60
New Zealand	6.61	17.09	-0.11	5.34
Norway	5.22	13.64	0.47	3.32
Poland	39.52	555.38	-0.10	98.71
Portugal	10.12	28.78	1.55	8.37
Spain	8.00	24.53	1.83	5.49
Sweden	5.24	13.70	-0.27	3.70
Switzerland	3.10	9.77	0.02	2.31
Turkey	38.21	110.17	0.40	30.95
U.K.	6.31	24.24	1.56	5.08

Table 1 exhibits the inflation experience of the selected OECD countries. In this case, the behaviour of annual CPI inflation across countries is examined. The countries exhibit a wide range of inflation experiences. The lowest mean inflation was for Germany (2 per cent) while the highest was for Chile (50.79 per cent). Based on the average inflation over the sample period, the OECD countries are divided into three categories, namely, high inflation countries for which the average inflation rate was higher than 20 per cent per year, moderate inflation countries with average inflation rate of less than 20 per cent but higher than 10 per cent, per year, and finally the low inflation countries with less than 10 per cent average annual inflation rate. Out of the 29 sample countries, only four countries, Portugal, Greece, Hungary and Iceland, fall in the moderate inflation category. Mexico, Turkey, Israel, Poland and Chile are the high inflation countries while the rest of the countries fall into the low inflation category. There is also considerable cross-country variation in the range and the standard deviation of the inflation rate. The maximum ever inflation rate experienced by a country in the sample was Poland with inflation rate 555.38 per cent, whereas the minimum ever, -0.9 per cent, was experienced by Japan. With regard to inflation volatility, Chile experienced the highest turbulence, whereas Germany experienced the lowest.

Results from the estimation of equation 1 are summarized in Table 2. I tested for unit root in the exchange rate and price level series. Augmented Dickey-Fuller tests did not reject the null hypothesis of a unit root. However the first difference did not contain any unit root according to the same hypothesis test and I proceeded using the first difference and the estimates of the exchange rate pass-through are reported. The exchange rate pass-through is defined in the present study as the influence of exchange rate movements on domestic prices. The explanatory variables in the regression for estimating pass-through are domestic annual CPI in the lagged form, U.S. annual CPI in the lagged form and the domestic exchange rate

(domestic currency per US$, market rate, period average). The second column reports the estimates of exchange rage pass-through to CPI of the sample countries. Estimates were statistically significant at the 5% level with the exceptions of a few countries[7]. It can be seen in the table that high inflation countries appear to have a higher exchange rate pass-through estimate, with the exception of Israel. Exchange rate pass-through was found to be small or insignificant for the low inflation countries. Exchange rate pass-through was found significantly higher in Mexico, Chile and Poland compared to other OECD nations. For example, a 1 per cent change in the exchange rate causes a 0.78 per cent change in consumer prices in Poland, a 0.76 per cent change in Chile, and a 0.51 per cent change in Mexico. On the other hand, a 1 per cent change in exchange rate causes a 0.002 per cent change in consumer prices in Belgium, a 0.04 per cent change in Japan, and a 0.01 per cent change in Switzerland.

[7] Australia, Canada, Finland, Greece, Norway, Spain, and the United Kingdom.

Table 2: Results from Estimating Exchange Rate Pass-Through for Selected OECD Countries

Country	Pass-Through (CPI)	Pass-Through (PPI)
Australia*	-0.0339	-0.0998
Austria	0.0039	0.0115
Belgium	0.0015	0.0038
Canada*	-0.0011	0.3035
Chile*	0.7619	0.8076
Denmark	0.3592	-0.0062
Finland	0.0180	0.0412
France	0.0253	-
Germany	0.0305	0.0884
Greece	0.0134	-
Hungary*	0.1203	1.4236
Iceland*	0.3186	-
Ireland	-0.0530	-
Israel*	0.0000	-
Italy	0.0331	0.0954
Japan	0.0413	-
Korea*	0.1355	0.3775
Luxembourg	0.0564	0.2228
Mexico*	0.5084	0.6593
Netherlands	0.0215	0.3300
New Zealand*	-0.0370	0.2287
Norway*	-0.0096	0.0256
Poland*	0.7804	0.9055
Portugal	0.1783	-
Spain	0.0110	0.1241
Sweden*	0.0287	-0.0298
Switzerland*	0.0123	0.0538
Turkey*	0.1981	-
United Kingdom*	0.0163	-0.0524

*Inflation Targeting Country.

The estimation was repeated using the producer price index (PPI) rather than consumer price index (CPI) for the sample countries. The third column of Table 2 reports the estimates of exchange rate pass-through using the PPI. The exchange rate pass-through was significantly larger when the PPI, rather than the CPI was used in the estimation. This implies that the producer prices are more affected by the exchange rate movements than consumer prices. For example, in Canada, a 1 per cent change in the exchange rates causes a -0.001 per cent change in consumer prices whereas the same change causes a 0.304 per cent change in producer prices; on the other hand, for the Netherlands the estimate with the CPI is 0.02 and with the PPI it is 0.33. A similar result was found in most countries.

The next step was to examine the effect of the selected macroeconomic variables, namely, average inflation rate, inflation volatility, exchange rate volatility, and the degree of openness, on the exchange rate pass-through. Summary statistics of these variables are presented in Table 3.

Table 3: Summary Statistics of the Selected Macroeconomic Variables for Relevant OECD Countries

Country	Average Inflation Rate	Inflation Volatility	Exchange Rate Volatility	Openness
Australia	5.47	0.74	0.27	16.64
Austria	3.67	0.56	0.57	33.37
Belgium	3.98	0.72	0.51	59.68
Canada	4.38	0.72	0.14	26.45
Chile	50.79	2.04	0.96	23.20
Denmark	5.43	0.65	1.26	34.13
Finland	5.59	0.80	0.16	26.69
France	4.98	0.77	0.20	20.04
Germany	2.00	0.62	0.31	24.99
Greece	10.23	0.78	0.88	23.81
Hungary	11.37	0.76	0.77	46.52
Iceland	18.83	1.01	1.35	37.17
Ireland	6.76	0.82	0.28	53.88
Israel	39.08	1.90	0.77	46.91
Italy	7.13	0.79	0.41	19.36
Japan	3.83	1.16	0.46	10.03
Korea	8.72	0.81	0.40	29.51
Luxembourg	3.77	0.71	0.20	88.06
Mexico	23.94	1.29	1.35	17.00
Netherlands	3.93	0.66	0.27	51.33
New Zeland	6.61	0.81	0.39	28.64
Norway	5.22	0.64	0.14	34.83
Poland	39.52	2.5	0.82	29.20
Portugal	10.13	0.83	0.71	31.38
Spain	8.00	0.69	0.37	18.54
Sweden	5.24	0.71	0.26	29.36
Switzerland	3.10	0.75	0.70	32.12
Turkey	38.21	0.81	1.25	18.32
U.K.	6.31	0.80	0.24	25.54

The expectation was to find a significant impact of the variables on the estimated pass-through coefficients. The estimated results from equation 1 reveal that high inflation countries have higher pass-through coefficients than the countries with low inflation and the expectation for the coefficient of average inflation rate was positive and significant. The same expectation was held for rest of the variables. Results are summarized in Table 4.

Table 4: Results from Estimation of the Impact of Selected Macroeconomic Variables on Exchange Rate Pass-Through

Variables	Pass-Through (CPI)	Pass-Through (PPI)
Average Inflation Rate	-0.001 (0.004)	0.024 (0.018)
Inflation Volatility	0.291* (0.102)	-0.149* (.004)
Exchange Rate Volatility	0.251* (0.083)	0.175** (0.238)
Openness	-.001 (0.001)	0.006** (0.004)
Constant	-0.265* (0.097)	-0.127** (0.083)
R-Squared	0.71	0.61

*Significant at the 5% level. **Significant at the 10% level.

The model is estimated including all the independent variables, on each variable separately, and with and without a constant. However, results are reported from the estimation with all the independent variables. The second column of Table 4 reports the effect of the independent variables on the pass-through coefficients calculated using the CPI, whereas the third column shows that on the pass-through coefficients using PPI. In case of affecting pass-through inflation volatility, which is defined as the coefficient of variation of inflation rate, the latter dominates all the other independent variables. It is significant at the 5 per cent level. The only other variable which is significantly affecting the pass-through coefficients is exchange

rate volatility. The coefficient is also significant at the 5 percent level. There is no evidence of the impact of openness on exchange rate pass-though. The same cross sectional regression was repeated using PPI. As expected, all of the independent variables, except for the average inflation rate, are significantly affecting the pass-through estimates, with the exchange rate volatility being the most significant. In both cases, contrary to the expectation, there is no evidence of any significant impact of the average inflation rate on exchange rate pass-through.

In the next step the possibility of shifts in inflation regimes is considered. To explore this, I examined the inflation behaviour of the inflation targeting countries. Out of the 29 sample OECD countries, 14 countries adopted inflation targeting. The assumption behind this is that the countries with inflation targeting are more likely to experience major changes in their inflation environment. For these countries, the entire pre-and-post adoptions of inflation targeting periods are treated as separate regimes. Exchange rate pass-though was estimated again in countries with two inflation regimes. Results are summarized in Table 5.

Table 5: Results from Estimating Exchange Rate Pass-Through for the Inflation Targeting Countries in OECD

Country	Year of Adoption	Pass-Through (CPI)		Pass-Through (PPI)	
		Before	After	Before	After
Australia	1993	-0.0328	-0.0167	-0.1023	-0.1016
Canada	1991	0.0671	-0.0574	0.2168	0.3697
Chile	1991	0.7894	0.0402	0.8246	0.2610
Hungary	2001	0.1494	0.0020	2.4786	0.2434
Iceland	2001	0.3571	0.0887	-	-
Israel	1992	0.0000	0.0000	-	-
Korea	1998	0.1361	0.0973	0.1361	0.2527
Mexico	1999	0.5143	0.0907	0.6669	0.3809
New Zealand	1990	-0.0554	0.0157	-	-
Norway	2001	-0.0240	0.7567	0.0886	-0.9477
Poland	1998	0.7987	0.1605	0.9213	0.2442
Sweden	1993	0.0516	0.0532	-0.0466	0.0272
Switzerland	2000	0.0118	0.0310	0.0591	0.0358
U.K.	1992	-0.0095	0.0726	-0.0604	-0.0215

It can be seen from the table that the pass-through coefficients are smaller for the after-adoption period than the pre-adoption period for most of the cases. This also holds for the pass-through coefficients using PPI. Notable reductions can be seen in the case of Mexico, Poland and Chile. The only exception is the case of Canada while using PPI. So the adoption of inflation targeting has a significant impact on the estimates of pass-through coefficients

even though it is not clear whether the average inflation rate or the inflation volatility is the major factor behind this reduction.

Finally, to test whether the adoption of inflation targeting has a significant impact on the estimates of pass-through coefficients a dummy variable is included with the other selected macroeconomic variables in the model. The dummy variable, inflation target, takes a value of 1 for the inflation targeting countries whereas it takes a value of 0 for non-inflation targeting countries. Results are summarized in Table 6.

Table 6: Results from Estimation of the Impact of Selected Macroeconomic Variables on Exchange Rate Pass-Through with Inflation Targeting Dummy

Variables	Pass-Through (CPI)	Pass-Through (PPI)
Average Inflation Rate	-0.001 (0.004)	0.022 (0.018)
Inflation Volatility	0.291* (0.102)	-0.187* (.004)
Exchange Rate Volatility	0.252* (0.083)	0.212** (0.238)
Openness	-0.000 (0.001)	0.007** (0.004)
Inflation Target	-0.007** (0.073)	0.207 (0.151)
Constant	-0.261* (0.083)	-0.269 (0.317)
R-Squared	0.74	0.65

*Significant at the 5% level. **Significant at the 10% level.

Results from the estimation suggest that inflation targeting has a significant effect on the pass-through (CPI) coefficients whereas it does not have any significant effect on the pass-through (PPI) coefficients. This may be due to the fact that the retail sector is more competitive than the wholesale sector. Hence when there is a change in the exchange rate, one finds that the latter shifts the cost forward to those who use the imported good as

an input, but, eventually, the user of the input, for instance, a retail firm may end up absorbing the cost rather than passing it on to the consumers.

6. Limitations

As mentioned earlier, the literature on exchange rate pass-through is very rich and has been gaining importance in the past few decades. Generally research studies on this topic develop theoretical frameworks and test these models empirically. The model used in this study is not developed based on any theoretical framework. It was built by the author, but was based on the formulations developed by Choudhri and Hakura (2001), and Devereaux and Yetman (2002). Recently, many researchers have been developing models that divide the impact of the movements in exchange rates on domestic prices into two stages, first stage pass-through, which is the impact of the fluctuations on import prices. The second stage pass-through is from import prices into consumer prices.[8] These models could possibly capture more effects and provide a more dynamic estimation of the exchange rate pass-through.

The price level of the United States is used as a benchmark in the present study. This creates a strong assumption; since the price levels of all countries in the sample are regressed on the United States CPI, it is assumed that the United States price level affects all price levels. This implies that the United States in the major trading partner of all the countries in the sample, which may not be true for all countries. This, in turn, creates a second problem in estimating the exchange rate pass-through for the United States. Since the United States price level cannot be regressed on its own price level, the pass-through coefficient is not estimated for the United States. A better alternative for the foreign CPI would be the CPI extracted from the relative price index (RPI), which was used by Choudhri and Hakura (2001).

[8]Toshikata (2006)

It is always very crucial to understand and be aware of any limitations or assumptions in the model used in this study when reporting, reading, or analyzing results. Therefore it is important to keep all the reported limitations in mind throughout the analysis and implications.

7. Conclusions

The current study examines the behaviour of exchange rate pass-through for OECD countries. Exchange rate pass-through is estimated for 29 OECD countries. In the second stage the effects of some selected macroeconomic variables on the degree of pass-through was estimated. It is argued by Taylor (2000) that a low inflation environment is associated with a low degree of exchange rate pass-through. Many countries were able to lower and stabilize their inflation rates. A plausible explanation for that is the shift to a more credible monetary policy regime. Taylor argued that the exchange rate pass-through is a function of the persistence of price and exchange rate shocks, which tend to be smaller in more stable inflation environments and in economies with credible monetary policy. This argument was tested for the OECD countries which adopted inflation targeting. The study found a significant impact of the adoption of inflation targeting on pass-through coefficients. The study concludes that the degree of pass-through depends negatively on the inflation environment. The economic intuition of this phenomenon is that inflation is determined by the behaviour of price adjusting firms of the current period. When firms adjust prices, their adjustment depends on expected future costs and prices. Therefore the higher the expected costs and prices, the higher the prices firms set this period. A low inflation environment leads to lower expected inflation, thus inducing firms to adjust less frequently, or to keep prices constant. This is likely to decrease the exchange rate pass-through. However, the study does not find any significant effect of inflation targeting on the pass-through (PPI) coefficients. This suggests a more competitive retail sector than the wholesale sector where the retail sector firms absorb the cost passed by the wholesale sector rather than passing on to the consumers.

Evidence was also found that the degree of pass-through is higher on production prices than on consumer prices. The important policy implication of these findings is that the dependence of the exchange rate pass-through on the inflation regime should be taken into account in designing effective monetary policy rules.

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