Original Paper

Inflation and Exchange Rates: An International Examination of Relative Purchasing Power Parity

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Abstract

Purchasing power parity (PPP) is an old and controversial proposition in economic literature. It is based on the law of one price, which argues that, after adjusting for the exchange rate, domestic and foreign price levels are equal. The relative version of PPP argues that exchange rate changes depend on the differential between domestic and foreign inflation rates. The absolute PPP version is based on restrictive assumptions that prevent it to hold in the short run. However, several studies support the validity of the relative PPP proposition in the long run. It is often observed that countries with persistently high inflation experience weak currencies. Our empirical testing using impulse response functions derived from a VAR model for eight countries provide mixed results. In six out of eight selected countries, relative PPP is supported by data in the long run.

Keywords

purchasing power parity, relative PPP, inflation, exchange rate, VAR model, durable and non-durable goods

1. Introduction

The Purchasing power parity (PPP) is an old proposition in economic literature. It argues that exchange rates and price levels, move in the same direction leaving the real exchange rate unchanged. PPP is based on restrictive assumptions that prevent it from holding in the short run. However, many studies that support validity of the PPP in the long run. In reality, it is observed that many countries with persistently high inflation experience weak currencies, for example, many Latin American counties with very-high inflation were faced with devaluation and depreciation of their currencies. On the other hand, several western European countries such as Germany, Switzerland and Denmark with stable prices have experienced strong currencies.

Several studies have examined international price differences by dividing goods into durables and non-durables. They argue that durable prices tend to equalize, as goods move across borders, assuming no tariffs and barriers to trade. However, non-durable goods are mainly services, which do not move internationally. As a result, international price differences are mainly due to differences in prices of non-durables. This proposition is supported in reality, where services in developed countries are far more expensive than the same services in developing countries. However, for non-durable goods without trade barriers, PPP should hold. This means that if a country's inflation is high, its exports will decline causing falling demand for its currency and depreciation.

The purpose of this paper is to select a sample of countries and investigate how inflation in those countries is related to their exchange rate. Section 1 presents a review of the literature. In section 2, some graphical time series over a long period are presented. In section 3, a theoretical model is developed. Empirical results are discussed in section 4. Summary and concluding remarks are offered in section 5.

2. Review of Literature

Krugman and Obstfeld (2003) showed that in most Latin American countries with high inflation, exchange rates tend to depreciate proportional to price changes. For example, Mexico's prices and exchange rate changes respectively were 757 and 585 precent in 1984 and 396 and 143 percent in 1985. The authors argued that in the short run prices are relatively rigid, but exchange rates fluctuate rapidly. Prices are less flexible because they are mainly based on contacts that do not change in the short run. Hence, PPP cannot be valid in the short run.

Froot and Rogoff (1994) pointed out that discussions relating to re-establishing exchange rate to equilibriums using PPP, referred exclusively to relative PPP. They further argued that real shocks can lead to changes in the relative prices of different commodities, especially so for low inflation economies. Moreover, there is not much evidence to provide support for the relative PPP proposition compared to the absolute PPP.

Frenkel (1978) showed that the PPP theory is valid for countries with hyper-inflation but was less successful for countries with a stable economy. With the unsuccessful attempts in the early days, researchers started to approach the issue by testing the null hypothesis that the real exchange is not mean-reverting, and it follows a random walk. Some statistical techniques for testing unit roots included the Dickey-Fuller and Augmented Dickey-Fuller test and Variance ratios. These techniques did not improve the probability of rejecting the null hypothesis of random walk. More recently, co-integration and error correction have entered the literature. Taylor (1988), Kim (1990) applied the co-integration technique but mainly found that the null hypothesis of non-co-integration cannot be rejected in most cases. Rogoff and Froot (1994) compared the three above-mentioned techniques for validity of the PPP and concluded that although the co-integration test had been more successful in rejecting the null hypothesis, it is still unclear whether this technique is superior to the simple PPP

hypothesis or random walk test.

Perhaps in a light-hearted vein, the Big Mac index has become a popular approach to PPP. Pakko and Pollard (2003) argued that the PPP theory states that, in the long run, currency exchange rates should move to equalize the price of a basket of goods and services in different countries. The McDonald's Big Mac—with identical ingredients in every country is the best representative of a basket of goods. For example, the 2020 index shows that a Big Mac costs £3.39 in the UK and US$5.71 in the United States – which gives a PPP exchange rate of 0.59. This is derived by dividing the price among Britain (£3.39), by the price in the US ($5.71). At the same time, the actual exchange rate at that time was 0.79 – which indicates that the British Pound is undervalued roughly about 25 percent.

Pakko and Pollard (2003) presented measures of relative PPP in U.S. dollar for selected countries, including Australia, Britain, Canada Denmark, Hong Kong, Chile Czech Republic, Hungary, Thailand, and Japan. The measures show the difference between the Big Mac inflation differential and the change in the exchange rate. The relative PPP is not expected to hold on a year-to-year basis, but probably to be observable on average over several years. The authors show that for several countries the difference between inflation differential and change in the exchange rate bounces around zero and no persistent deviations from the zero line. They note that, for example, the currencies of Australia, Britain, Canada, and Hong Kong all appear to have approximately maintained relative PPP against the dollar since 1991. On the other hand, the Japanese yen and Danish krone have shown less evidence of maintaining relative PPP against the dollar. The results were based on annual data from 1986 – 2002. As a longer-run test, relative PPP is somewhat difficult to examine for the Big Mac because data are not available in many countries. The data suggest that the absolute or the relative PPP does not generally hold in the short run. For many currencies, deviations from PPP against the U.S. dollar remain for several years.

One of the most well-known theories to explain the deviations from PPP, in the long run, is the Balassa-Samuelson model (Balassal, 1964; Samuelsonl, 1964). Their empirical results from this study show that in general, richer countries will have a higher consumer price index (CPI) than poorer countries. They argued that wealthier countries are relatively more productive in the traded good sector than the poorer countries. As they have technological superiority in the traded goods, this will result in a rise in productivity, which will, in turn, increase the level of wages for the sector. But as the price of tradable goods is restricted by the world prices, it will not increase. Contrastingly for the non-traded sector, they will have to increase their price as they could not match the productivity increase of the tradable sector. In the end with the increase in the price of non-traded goods accompanied by the constant price of tradable goods, the overall price level throughout the country will rise. But if the non-tradable goods sector can match the productivity superiority of the tradable sector, the overall price level and the real exchange rate will remain constant. Froot and Rogoff (1994) have mentioned that if the non-traded goods sector is more labour-intensive, even balanced growth in both sectors will result in an appreciation of relative tradable price. Empirical results from Rogoff (1996) also supported this claim as they found a positive relationship between income and price levels, with the richer countries having the greatest association.

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Other factors that might impact the PPP from holding include differences in the exchange rate regime, trade restrictions, transportation costs, perishable goods, and location. These will influence the price of similar goods in different countries as well as the general price level in those countries, causing the violation of the law of one price and long-run convergence to PPP.

3. Theoretical Discussion and Graphical Presentations

The PPP argues that the exchange rate is determined by the ratio of domestic prices to foreign prices. In equation 1 P, P*, and E are domestic price level, foreign price level and exchange rate respectively. The exchange rate is the price of foreign currency; upward movements show depreciation, and downward movements indicate an appreciation.

$$E = P/P^* \text{ or } EP^* = P \tag{1}$$

By taking the logarithm of both sides and differentiate with respect to time, equation 1 can be written as:

$$\dot{E} + \acute{P}^* = \acute{P} \qquad \text{or} \qquad \dot{E} = \acute{P} - \acute{P}^* \tag{2}$$

Where $\dot{E}$, $\acute{P}^*$ and $\acute{P}$ are percentage change in exchange rate, foreign inflation, and domestic inflation.

$$\dot{E} = > 0 \qquad \text{if } \acute{P} > \acute{P}^* \quad \text{and} \quad \dot{E} < 0 \text{ if } \acute{P} < \acute{P}^* \tag{3}$$

Those two inequalities in 3 indicate that the exchange rate depreciates if domestic inflation is less than foreign inflation and appreciates if the opposite is true.

Most of the evidence on an absolute version of PPP or law of one price, equation 1, show that is not valid, mainly because of barriers to trade, transportation costs and differences in quality of goods produced in different countries. Some argue that the same goods produced in two different regions of a city may sell at different prices.

However, there is sufficient evidence to support the relative version of PPP, equation 2. That is, in the long run, the exchange rate fluctuates as a result of differences in inflation rates between countries. Those with persistently high inflation experience weak currencies and those with low inflation have strong currencies.

Some graphical presentations of inflation and exchange rate fluctuations for eight selected countries are plotted in Figures 1 to 8. In all eight countries inflation rates are the annual percentage change in producer price index (PPI) and the exchange rates are domestic currency per US dollar. All of the time series data were collected from two OECD websites, references are given in the appendix.
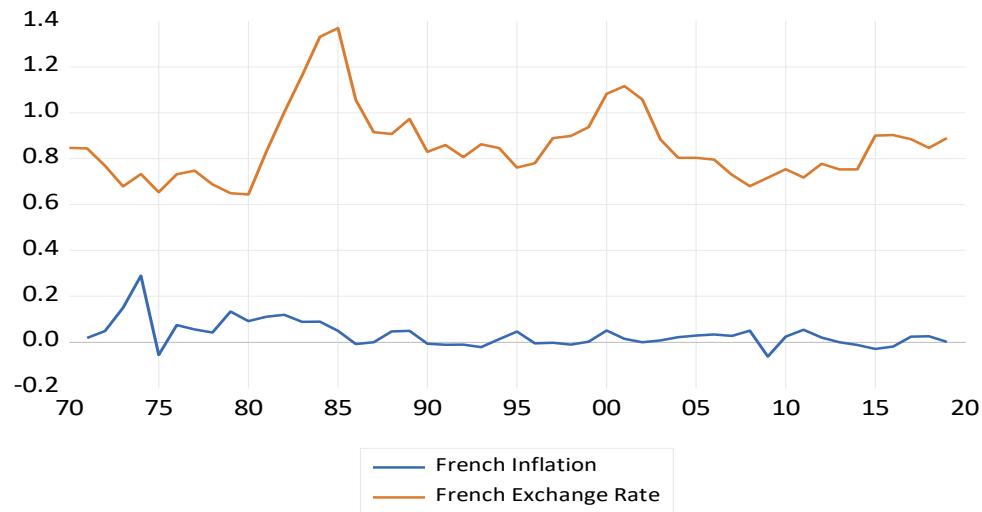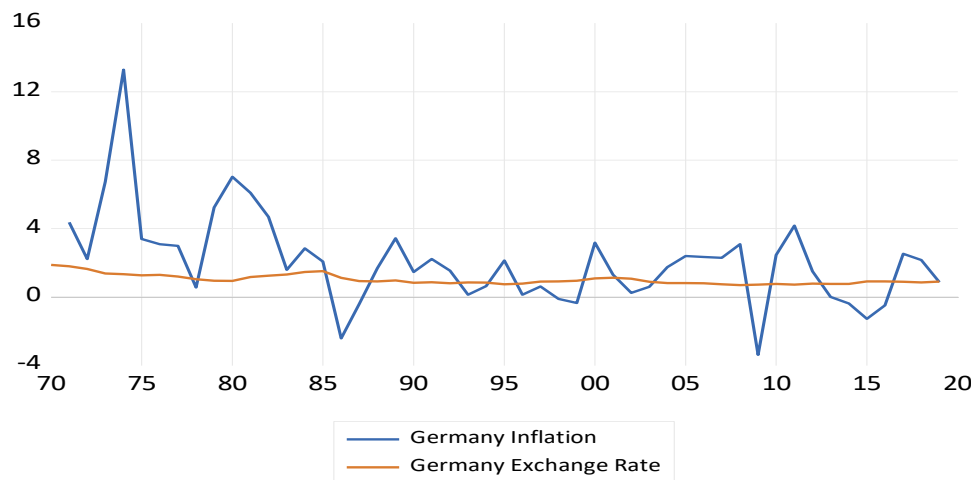
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Figure 1. French Inflation and Exchange Rate
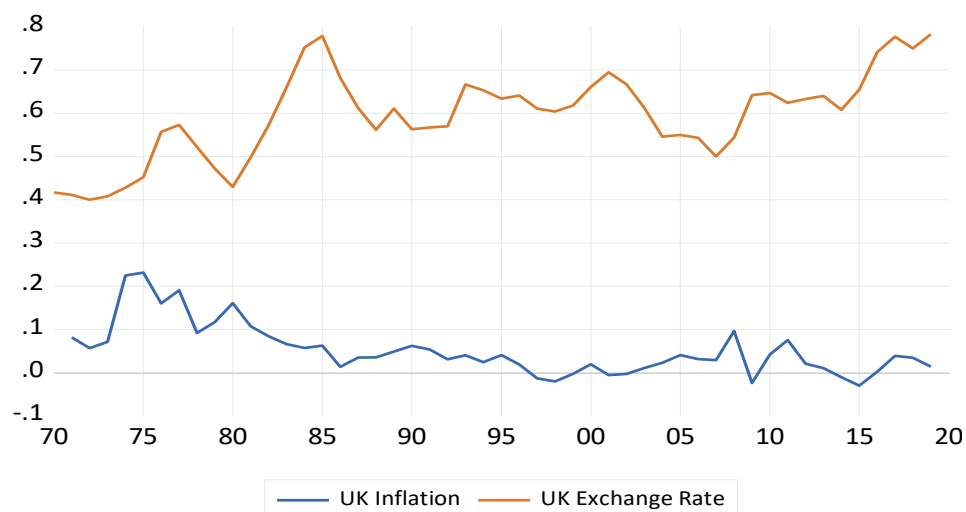
Figure 2. Germany Inflation and Exchange Rate
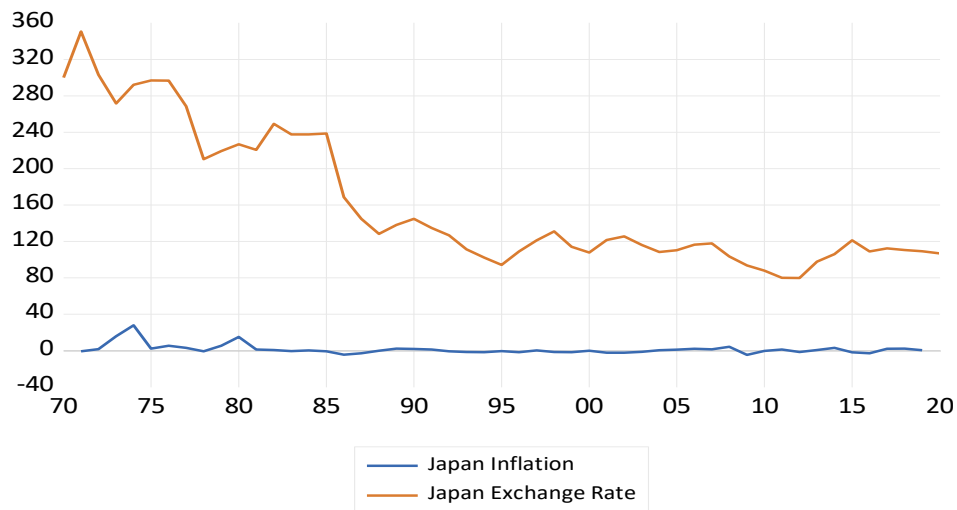
Figure 3. UK Inflation and Exchange Rate
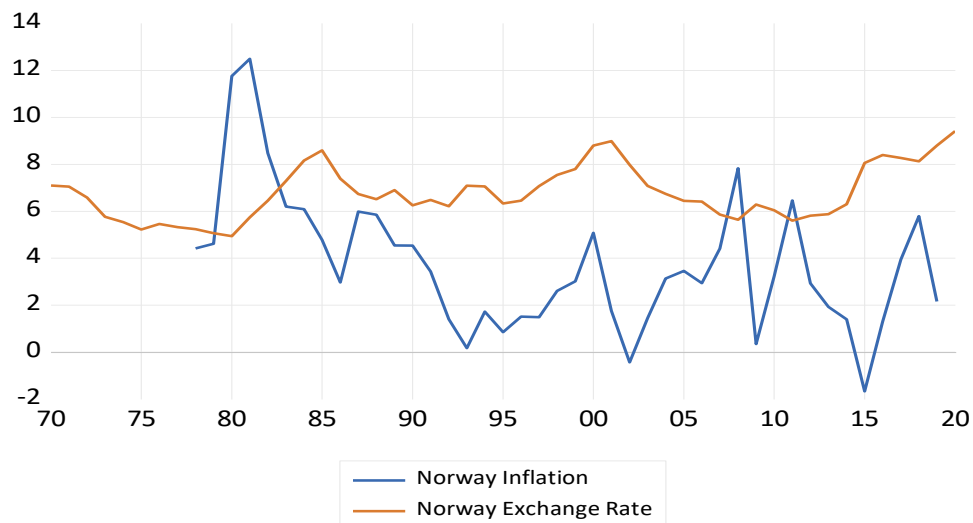
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Figure 4. Japan Inflation and Exchange Rate

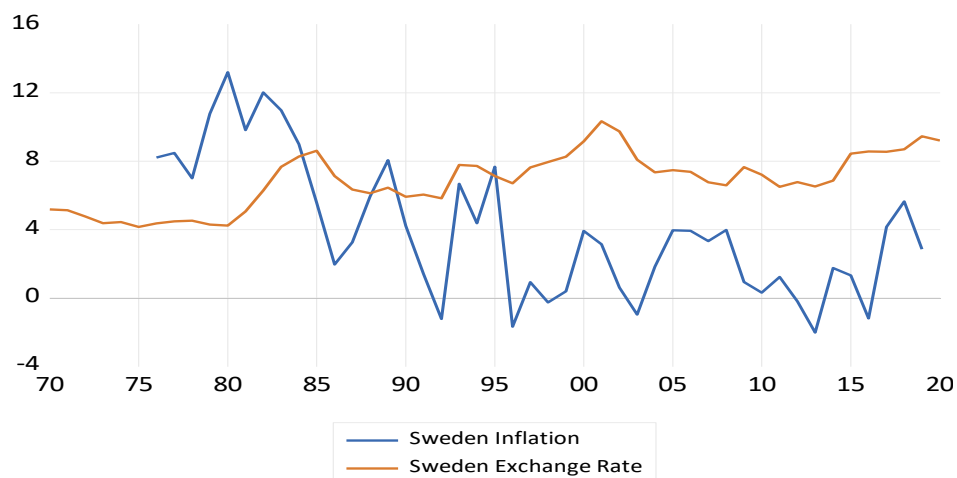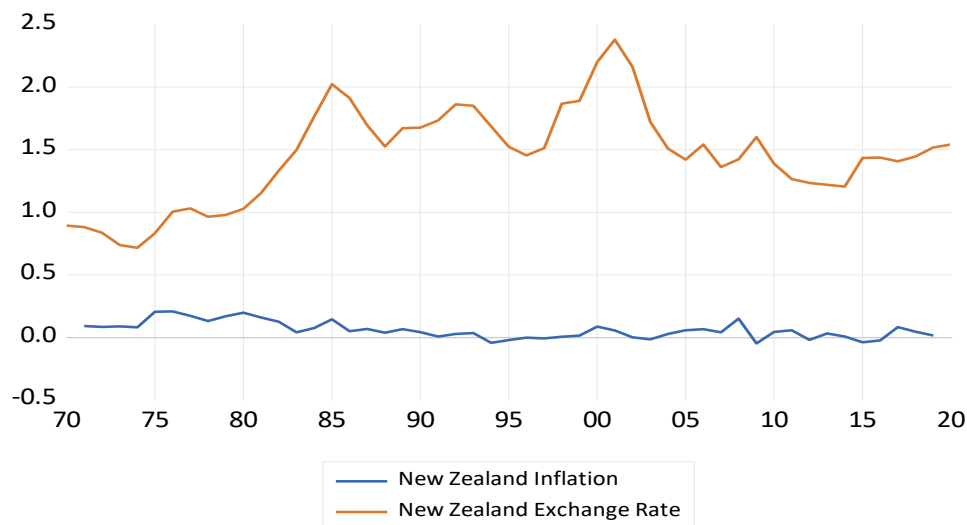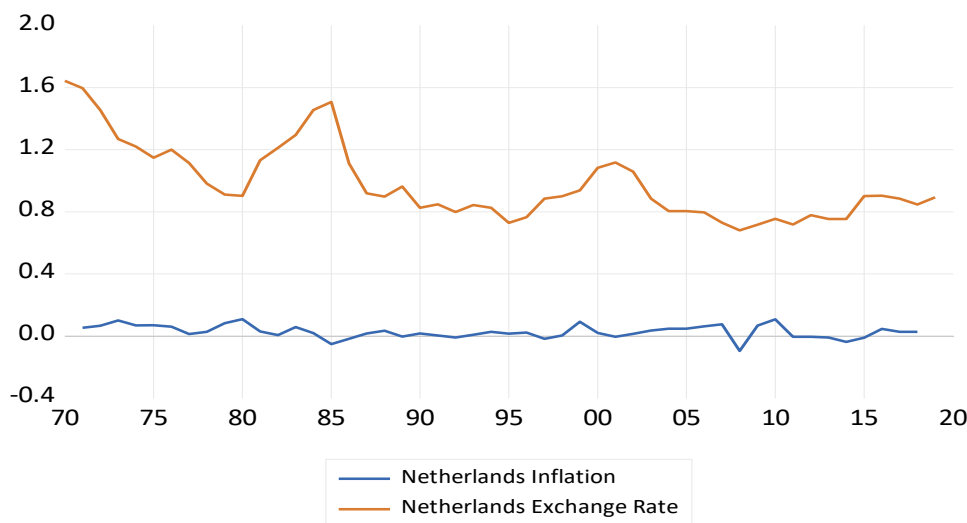**Figure 5. Norway Inflation and Exchange Rate**

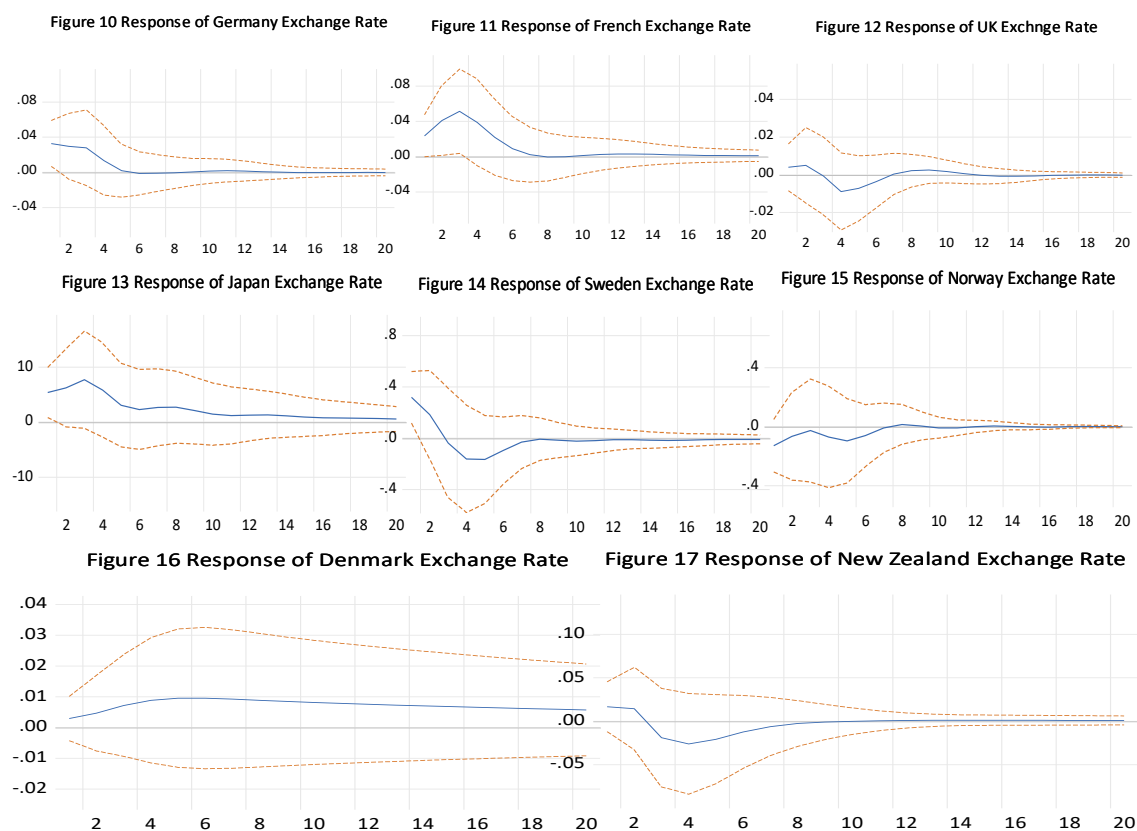**Figure 6. Sweden Inflation and Exchange Rate**

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Figure 7. New Zealand Inflation and Exchange Rate

Figure 8. Netherlands Inflation and Exchange Rate

The nine graphical presentations show relationships between each country's inflation and exchange rates but provide no support for approval or rejection of PPP. There are some occasional supports such as the UK in the decade of 1970s, France in the 1980s and Sweden in the 1980s.

The empirical results presented in the next section may provide stronger support for PPP in the long run. In the above eight cases, Germany, Japan and the Netherlands are three counties with stable inflation and appreciating currencies. Impulse response functions (IRF) derived from a vector autoregressive model show overtime response of a variable to one standard deviation shock of another variable in the model. If PPP is valid, a shock of inflation is expected to cause depreciation of the currency.

Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E.

Figure 10 Response of Germany Exchange Rate

Figure 11 Response of French Exchange Rate

Figure 12 Response of UK Exchnge Rate

Figure 13 Response of Japan Exchange Rate

Figure 14 Response of Sweden Exchange Rate

Figure 15 Response of Norway Exchange Rate

Figure 16 Response of Denmark Exchange Rate

Figure 17 Response of New Zealand Exchange Rate

In six out of eight cases, during two to four years, the exchange rates tend to rise in response to a shock of inflation. However, over a long period of 20 years, all of the exchange rate responses reach zero, implying that the PPP holds for two to four years. In the New Zealand case, the exchange rate tends to appreciate initially, but starts to depreciate in year four.

Following Kim (1988) and Taylor (1990) co-integration tests were conducted to examine the long-run stability of the real exchange rate based on relative PPP. The cointegrating variables are differentials between domestic and foreign inflation rates and the logarithm of the country's exchange rate. Germany Price level was chosen as foreign price. Results are presented in Table 1.

Table 1. Cointegration Results

Country	Trace Test	λMax	Cointegrating vectors
Denmark	16.02	10.58	None
France	37.53	21.95	2
Japan	28.19	25.2	2
Norway	24.44	19.8	2
New Zealand	20.16	16.12	2
Sweden	16.68	12.17	None
United Kingdom	25.27	22.06	2

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4. Summary and Concluding Remarks

Most of the research on PPP does not provide support for the absolute version (law of one price) PPP. However, over a long period, countries with high inflation experience weak and depreciating currencies. Examples are most of the Latin American countries. On the other hand, countries like Switzerland, Germany, Japan and the Netherlands with historically low inflation have maintained strong currencies. This observation is supportive of the relative version of PPP, which argues that in the long run, exchange rate changes are depended on inflation differential. The empirical results from this study based on eight countries are mixed but mostly supportive of the relative PPP. Furthermore, five out of seven cases showed co-integration of inflation differential and exchange rate, supporting the long-run stability of the real exchange rate.

While this article has focused on PPP in terms of the relationship between inflation and exchange rates, the concept of Purchasing power parity has also been used extensively in the context of comparative income measures. While aware of the conceptual problems in PPP comparisons, as typical consumption baskets can vary considerably from country to country, the use of PPP is a vast improvement on exchange rate conversions. It is a real eye-opener to see the difference in results from using PPP and exchange rate conversions. The orders of magnitude involve differences in ratios of 66:1 compared to 16:1 or 120:1 compared to 40:1. Average incomes in poor countries were three or four times higher using PPP converters (Lodewijks, 2017). Using exchange rate converters exaggerated global inequality. Our focus in this article was a more modest one and we do not wish to underestimate the broader utility of the purchase power parity concept.

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