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A causality test of inflation environment and lower exchange rate pass-through

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Abstract

Recent literature has argued that exchange rate pass-through (ERPT) into inflation has been declining following a dramatic change in inflation environment during the 1990s. We formally check this hypothesis for a sample of 12 emerging and developed economies, by making use of a state-space model that allows ERPT to be time-varying and dependent on the inflation environment, and testing whether inflation contains significant information about the future evolution of ERPT. The results reinforce the view of a smooth decline in the impact of exchange rates on inflation, but do not support the hypothesis that lower inflation precedes this declining ERPT.

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1. Introduction

The degree of pass-through from exchange rate changes into domestic inflation appears to have been declining in many countries in recent years (see, e.g., Campa and Goldberg, 2005; Bailliu and Fujii, 2004; Gagnon and Ihrig, 2004; Choudhri and Hakura, 2006). A common explanation for this decline is that it is a by-product of the low inflation environment of the 1990s. Taylor (2000) was the first to provide an interpretation of the declining exchange rate pass through (ERPT, hereafter) related to a lower inflation environment. He argued that with staggered prices, firms are more likely to pass-through cost changes, including those from the exchange rate, when inflation is high. A similar argument is developed in Devereux and Yetman (2010), where the degree of pass-through is a function of the stance of monetary policy as it affects the degree of price stickiness. When firms can adjust their frequency of price changes, loose monetary policy (high inflation) leads to higher ERPT. In this sense, ERPT would be endogenous to a country's inflation performance. Campa and Goldberg (2005), Gagnon and Ihrig (2004), Choudhri and Hakura (2006), among others, have analyzed this relationship, finding a positive correlation between ERPT and inflation.

Most of the existing evidence on the decline in ERPT is provided by splitting the estimation sample, as in Campa and Goldberg (2005), Gagnon and Ihrig (2004) and Choudhri and Hakura (2006), or by rolling regressions, as in Reyes (2003). Those practices do not provide a precise timing of the exchange rate parameter shift and involve a degree of arbitrary choice of the sample splitting date or the rolling window. Three exceptions to these approaches are Kim (1990) that applies the Kalman Filter to U.S. data until the mid-1980s; Amstad and Fischer (2005) whose approach is an application of event-study procedures used in empirical finance to Switzerland; and Sekine (2006), who estimates ERPT for some developed economies using a time-varying parameter with stochastic volatility model, and finds that ERPT into consumer inflation has declined over time, and is correlated to inflation.

Empirical investigations on the causes of this decline encounter the difficulty that ERPT is an unobservable variable. Moreover, the previous literature has tested Taylor's hypothesis that the inflation environment is inducing a decrease in ERPT by analyzing cross-country correlations between inflation and ERPT. The main limitation of this procedure is that correlations do not imply causality.

In order to address these issues, we model ERPT by means of a state-space model, allowing for time variation in the ERPT coefficient. The state-space model presents a flexible structure that allows testing the causal relationships postulated in the literature in terms of temporal causality. That is, we ask the question whether a decline in inflation contains significant information for the future evolution of the ERPT. The model is based on a simple backward-looking Phillips curve augmented with exchange rate and import price changes. The specification allows the ERPT to depend on lagged inflation. We then apply Wald and Likelihood ratio tests for the hypothesis that lagged inflation is a significant determinant of the ERPT coefficient.

We apply these tests to a set of 12 developed and emerging market countries. Our results show that ERPT has indeed declined for all the economies under consideration, as suggested by the previous literature. Moreover, we too observe a high correlation between ERPT and the inflation environment. However, our results do not support the hypothesis that falling inflation precedes the decline in ERPT.

The remainder of the paper is structured as follows. Section 2 presents the methodology. Section 3 presents the data used in our estimations. Section 4 shows the results. Finally, section 5 concludes.

2. Methodology

We use a state-space specification to model a time-varying ERPT. A wide variety of time-series models can be written and estimated as special cases of a state-space specification. Extensive examples of applications of state-space models can be found in Harvey (1989). One important advantage of the state-space model is that it allows unobserved variables (the state variables) to be estimated using the information contained in the the observable model. State-space models can be estimated using the Kalman Filter recursive algorithm, which is commonly employed in time-varying coefficient models. A very important feature of state equations for our purposes is their flexibility, as they may contain exogenous variables and unknown coefficients.

The state-space model consists of the measurement equations and the state equations. The Kalman filtering approach provides optimal estimates for state variables based on the information from the two sources, the measurement and the state equations. We present a simple model consisting of equations (1) and (2) below:

$$\Delta p_t = \alpha + \beta \Delta p_{t-1} + \chi \Delta p_{t-1}^{imp} + \delta \Delta y_{t-1} + \gamma_t \Delta e_{t-1} + \varepsilon_t \quad (1)$$

$$\gamma_t = \gamma_{t-1} + \phi \pi_{t-1} + \mu_t \quad (2)$$

where (1) and (2) are the measurement and state equations respectively. Δp is the quarterly rate of inflation; Δp^{imp} is the import prices inflation; Δe is the exchange rate change; Δy is the output growth; and π is the inflation environment (defined as the previous quarter year-on-year inflation). The terms ε_t and μ_t are independent normally distributed errors, with zero mean and constant variance. The parameter γ_t is our time-varying short-run ERPT, i.e. the lagged one-quarter effect of exchange rate changes on consumer prices. We only allow the ERPT coefficient to be time-varying to avoid over-parameterization given the available sample sizes. The system is estimated using the Kalman Filter technique[1]. Note that we imposed a unit root in the state equation. As discussed in Harvey (1989) and Sekine (2006) this is a standard procedure in the literature.

The measurement equation (1) follows the traditional specifications used in the literature on ERPT, and is similar to that estimated in Campa and Goldberg (2005), Choudhri and Hakura (2006) and Gagnon and Ihrig (2004). The equation represents a backward-looking Phillips curve, controlling for the exchange rate and the foreign price of imports. As shown by Campa and Goldberg (2005), empirical specifications that seek to isolate ERPT should introduce controls for the foreign costs, as without such controls the measured relationship is a statistical correlation without specific interpretation in terms of ERPT. In our specification (2) of the ERPT effect we included lags of the "inflation environment" measured as the year-on-year inflation rate. That is, ERPT is modelled as a function of its past value and of the inflation environment. This specification allows us to formally test for the information content of lagged inflation for current ERPT.

We make use of Wald and Likelihood ratio tests for the null hypothesis $H_0 : \phi = 0$. That is, whether the inflation environment causes the ERPT in the Granger-causal sense. The Wald test follows the traditional χ^2 distribution. Regarding the Likelihood ratio test λ, when the sample size is large, it also follows a χ^2 distribution with degrees of freedom equal to the

[1] To obtain time-series for the state variables we applied the Kalman Smoothing procedure. The smoothing uses all the information in the sample to provide smoothed estimates of the states and variances.

number of restrictions imposed by the null hypothesis. If the λ statistic exceeds the critical value at the chosen level of significance, the null hypothesis is rejected.

As mentioned before, the previous literature has analyzed simple correlations between ERPT and the rate of inflation for cross-sections of countries. This approach, however, is silent about whether inflation is useful to predict ERPT. In addition, cross-country regressions may suffer from problems of country heterogeneity, which is not the case in a time-series context. Our model allows the ERPT to be time-varying and simultaneously depend on lagged inflation. This also avoids standard problems involved in two-step procedures where ERPT is estimated in a first stage and then regressed on other variables in a second step[2].

3. Data

Quarterly data were collected for twelve countries that can be split in two groups: the first one comprises six developed economies (Australia, New Zealand, Norway, Denmark, Switzerland and U.K.), and the second of six emerging markets (Czech Republic, Mexico, Colombia, Turkey, Thailand and Chile). Data were obtained from the IMF's IFS database.

The inflation rate is the seasonally adjusted quarterly rate of growth of the consumer price index. CPI data for Switzerland was seasonally adjusted by the authors. Exchange rate data is the quarterly change of the national currency per unit of US dollars, so a positive variation means a depreciation of the local currency. Output data is the quarterly change of the seasonally adjusted real GDP. The GDP data was seasonally adjusted by the authors for Chile and Thailand. Because of data availability, in the cases of Norway, New Zealand, and Mexico the industrial production index was used, whereas the output control was omitted from Colombia's estimations. Import prices are defined as the change in the index of dollar price of imports. This data was not available for Mexico and Switzerland, so as a proxy we used the change in the U.S. consumer prices index. The estimation samples are in Table 1.

Table 1
Estimation periods by country

Country	Estimation period
Australia	1980:1 - 2007:4
Denmark	1980:1 - 2007:2
New Zealand	1980:1 - 2007:4
Norway	1980:1 - 2007:4
Switzerland	1980:1 - 2007:4
U.K.	1980:1 - 2007:4
Chile	1980:3 - 2007:4
Colombia	1980:1 - 2007:4
Czech Republic	1994:2 - 2007:4
Mexico	1989:2 - 2007:4
Thailand	1993:3 - 2007:4
Turkey	1989:3 - 2006:2

4. Results

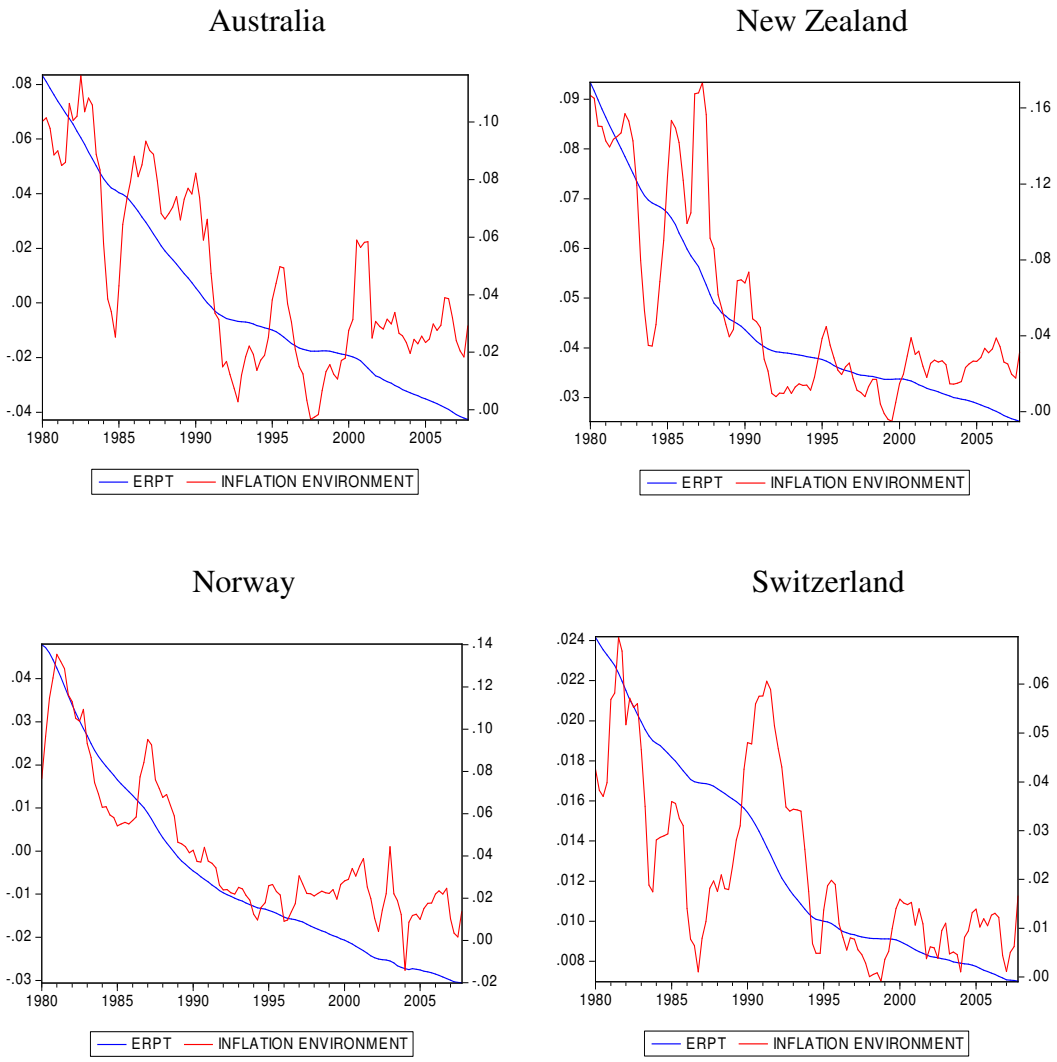
Figure 1 plots the estimated ERPT series together with the inflation environment variable. It is visually clear that there is a strong correlation between inflation and ERPT, with both

[2] Implying that the first stage may be mis-specified.

variables declining throughout the sample period[3]. Simple correlation analysis shows an average coefficient of about 0.70. These results are in line with priors from the literature.

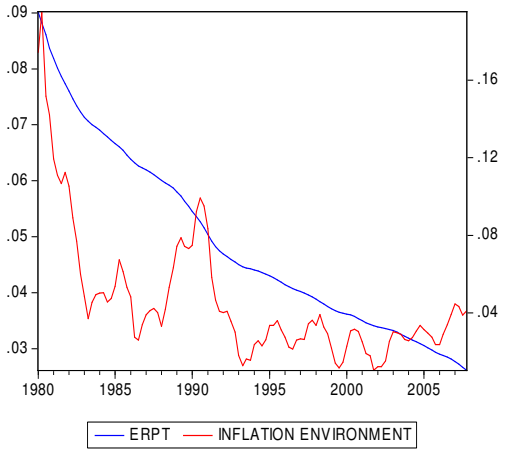
The figure also shows that, in accordance with previous literature, ERPT has indeed declined over time. Clearly, the decline in ERPT seems to have been a wide-reaching phenomenon, not restricted to the developed world. The degree of ERPT for emerging markets at the start of the sample is substantially higher than that of developed countries at the same period, and hence the decline in ERPT for these countries is faster. This finding is consistent with Ca'Zorzi, Hahn and Sanchez's (2007) results, who show that ERPT tends to be similar between developed economies and emerging markets with moderate rates of inflation. The figures also suggest that this decline took place gradually, and not in a regime-wise way. When compared to estimates obtained from rolling regression (e.g. Reyes 2003 and Sekine 2006), the results hold resemblance to those, but again the decline is smoother. Finally, it is possible to see the role of exchange rate and confidence crises for the degree of ERPT, as in the cases of Mexico and the Czech Republic[4].

Figure 1

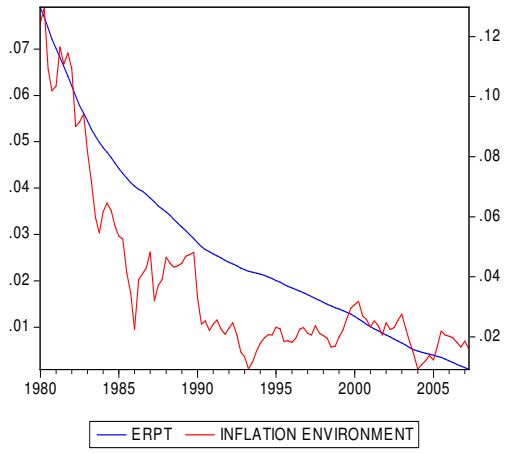


[3] ERPT coefficients with standards deviations, and some basic estimation results are available upon request.
[4] See Nogueira and Leon-Ledesma (2011) for a discussion on the role of economic instability on ERPT.

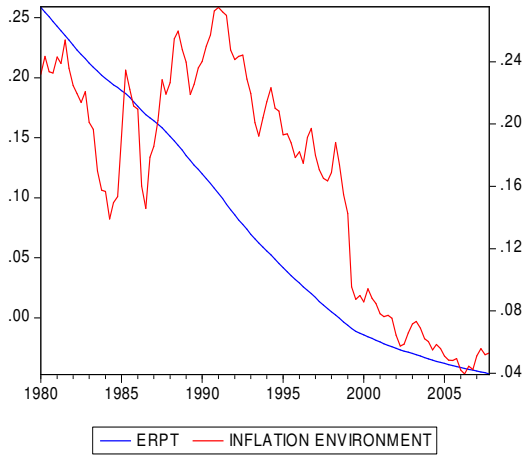
United Kingdom



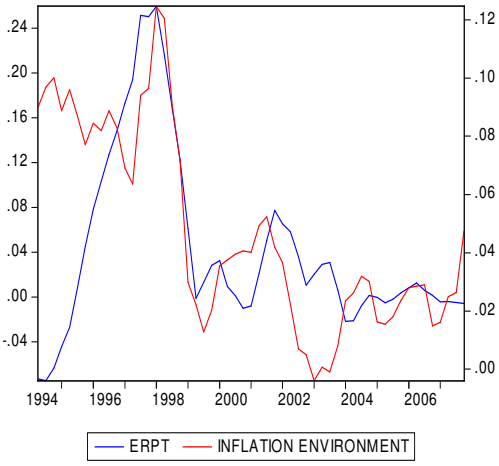
Denmark



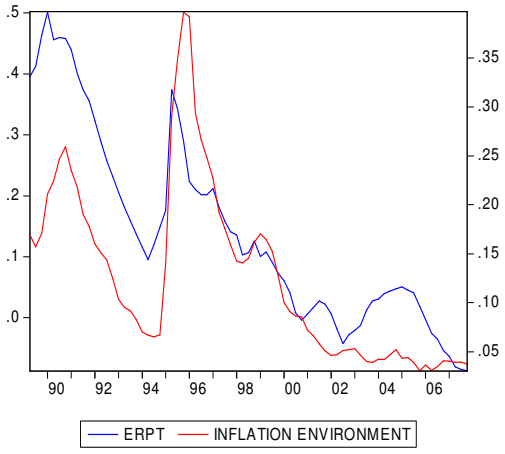
Colombia



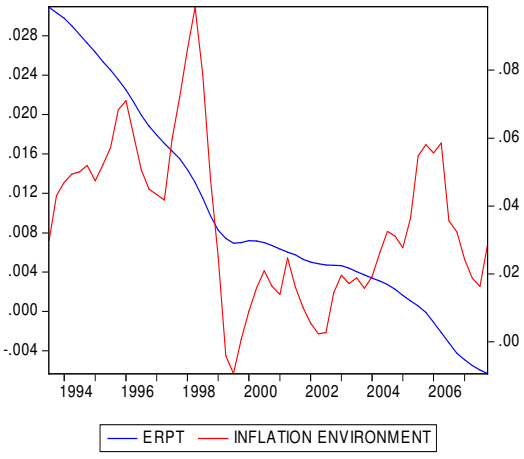
Czech Republic



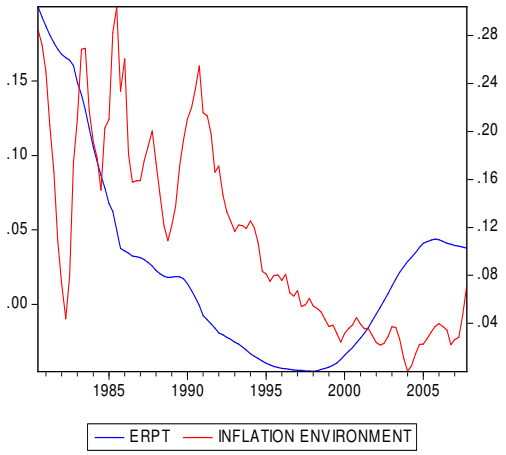
Mexico



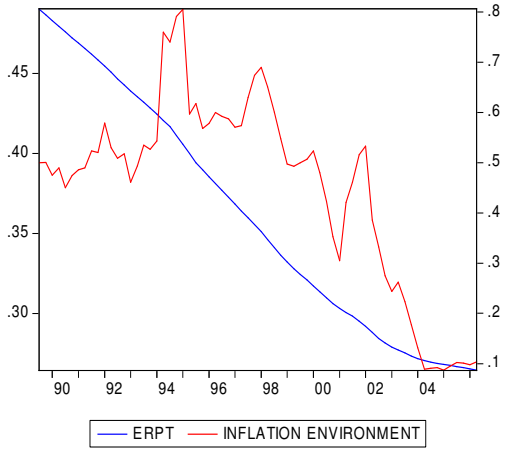
Thailand



Chile



Turkey



The results of the Wald and likelihood ratio tests are presented in Table 2.

Table 2
Causality tests between inflation and ERPT

	df	$\lambda - stat$	$\chi^2 - stat$
Australia	1	2.627	2.161
Denmark	1	2.763*	2.334
New Zealand	1	1.363	0.816
Norway	1	1.697	1.347
Switzerland	1	0.783	0.499
United Kingdom	1	0.725	0.433
Chile	1	1.151	1.155
Colombia	1	6.019**	3.278*
Czech Republic	1	0.016	0.026
Mexico	1	0.749	0.802
Thailand	1	0.091	0.093
Turkey	1	1.598	0.576

Notes: ** indicates significance at the 5% confidence level and * indicates significance at the 10% confidence level. The $\lambda - stat$ refers to the Log-likelihood ratio test statistic, and the $\chi^2 - stat$ refers to the Wald test statistic.

The results show that only in 2 (Denmark and Colombia) out of the 12 countries studied we are able to reject the null hypothesis that the inflation environment does not Granger-cause ERPT. We cannot reject the null for the other 10 countries. Moreover, for Denmark we can reject the null only for the LR test and just at the 10% confidence level. The results then show that, although there is a strong correlation between these variables, inflation does not generally help improve the in-sample forecast for ERPT. This lack of information content suggests that the positive correlation between these variables may be driven by other events that occur in parallel. These can be macroeconomic events such as the reduced volatility of macroeconomic variables during this period, or microeconomic such as changes in the degree of openness (and competition) and the structure of international trade.

5. Conclusion

We present new evidence on the role of low inflation on the observed decline of ERPT into consumer prices for a group of developed and emerging market economies. As opposed to previous literature, instead of analyzing cross-sectional correlations between ERPT and inflation, we provide evidence using time-series based on information content criteria.

We estimate a state-space model of a Phillips curve, allowing for time variation of the ERPT parameter, where it is simultaneously a function of lagged inflation. In accordance with previous literature, we observe a gradual decline in ERPT from the 1980s onwards. We then apply Wald and Likelihood Ratio tests for temporal causality (information content) running from the inflation environment to ERPT. Our results show that, out of 12 countries analyzed, evidence in favour of temporal causality can only be found for 2 of them. The close link between inflation and ERPT found in the previous literature may hence be due to other factors driving both variables down. Our findings highlight the importance of further econometric investigation on the causes of the decline in ERPT observed in the last two decades.

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