DEPARTAMENTO DE ECONOMIA
PUC-RIO

TEXTO PARA DISCUSSÃO
Nº. 423

THE PASS-THROUGH FROM DEPRECIATION TO INFLATION: A PANEL STUDY

ILAN GOLDFAJN
SERGIO R. C. WERLANG

ABRIL 2000

The Pass-through from Depreciation to Inflation: A Panel Study[1]

By

Ilan Goldfajn	and	Sergio R.C. Werlang
Pontificia Universidade Catolica		EPGE
Departamento de Economia		Fundação Getúlio Vargas
Marques de Sao Vicente, 225		Deputy Governor
Rio de Janeiro, Brazil		Banco Central do Brasil
Phone: (5521) 274-2797		Brasilia, Brazil
Fax: (5521) 294-2095		
email: goldfajn@econ.puc-rio.br		

Abstract

The paper studies the relationship between exchange rate depreciations and inflation using a sample of 71 countries in the period 1980-1998. The main determinants of the extent of inflationary pass-through of the depreciations (appreciations) are the cyclical component of output, the extent of initial overvaluation of the real exchange rate (RER), the initial rate of inflation, and the degree of openness of the economy. The paper finds that the pass-through coefficients increase the larger is the horizon measured, with its peak at 12-months. It also finds that RER misalignment is the most important determinant of inflation for emerging markets while the initial inflation is the most important variable for developed countries. Using the estimated model, the paper predicts somewhat higher inflation than actually observed in several well known large depreciation cases, even if one takes into account existing measures of exchange rate expectations. This suggests that policy makers should use caution when using past models to predict future inflation in the aftermath of large depreciations.

Keywords: Passthrough, Real Exchange Rate, Devaluations

---

[1] The authors would like to thank Gabriel Srour for excellent Research Assistance. Also, to Moriah Aurora Meyskens for editorial help.

Table of Contents

I. Introduction

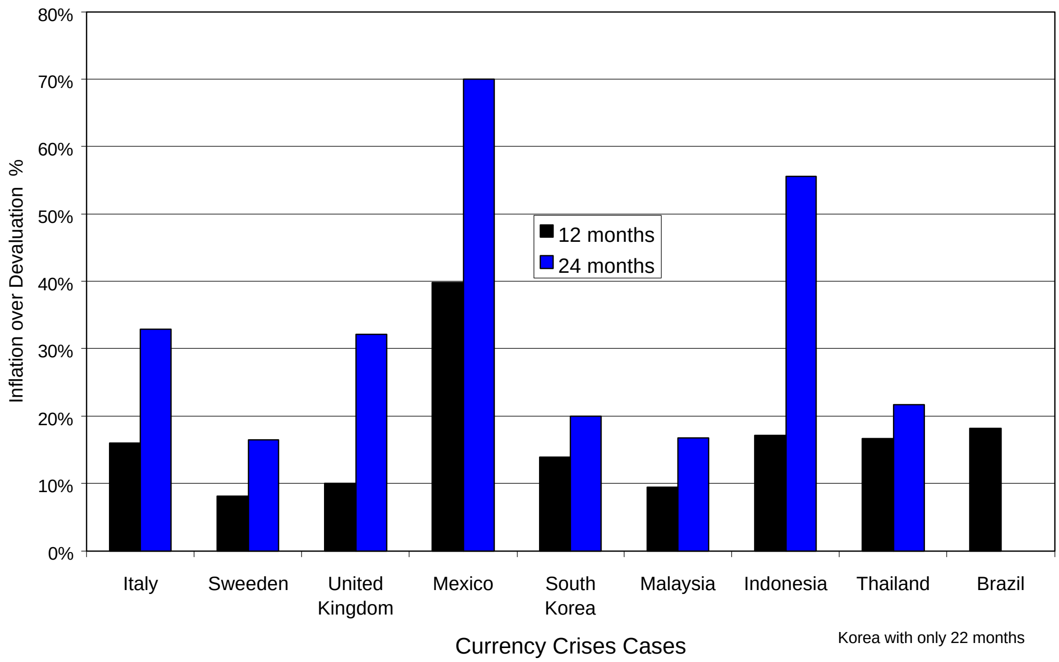
Currency crises and the resulting large depreciations often bring about a fear that an inflation-depreciation spiral has just started. Usually this fear is based on a previous history of high inflation that the exchange rate, as a useful nominal anchor, has helped change. Sometimes, this fear of the return of inflation is based on the sheer size of the depreciation of the exchange rate, so large than even if it doesn't lead to an inflation-depreciation spiral it often overshoots its long run value.

However, the resulting observed inflation has been lower than expected initially. Figure 1 below shows how small the pass-through coefficient – the extent that the large depreciation has become inflation – in several crises during the 1990's, with the notable exception of Mexico in 1994. Therefore, the conventional wisdom is either in front of a new stylized fact or unfamiliar with an old regularity. The figure also shows that the pass-through increases the longer is the horizon. Is this also a new stylized fact?

Once the initial few months of the crisis are over and the inflation behaves better than expected, policy makers often face the need to forecast inflation for monetary policy purposes in a new floating exchange regime. In this scenario, the difficulty arises because new data on the behavior of the economy is still not available and long-term data reflects partly the behavior of the economy under an old regime. In short, the past gives little help in forecasting the future. In this context, the average experience of other countries could be of help, notwithstanding the specificities of the particular country involved.

There is a vast theoretical literature on the pass-through of exchange from depreciation to inflation (Dornbusch 1987, Feenstra et al. 1994, Fisher 1989, Goldberg et al. 1997, and Klein 1990). There is also some empirical work on the pass-through for specific countries, regions (Amitrano et al 1997 and others). Few papers have investigated the pass-through in a large sample of countries over time (an exception is Borensztein and De Gregorio, 1999, that look at currency crises).

Pass-through: Effect of devaluation on inflation (%)



This paper aims at providing additional empirical evidence on the relationship between inflation and depreciation in a broad sample of country's (71) in the last 20 years. The results provided from this paper could be of help for academics and policy makers. The paper finds that the pass-through coefficient increase the larger is the horizon measured, with a maximum value at 12-month horizon, and that its most robust determinants are the RER overvaluation and the initial inflation. The GDP deviation and openness variables are significant determinants but are more sensitive to the horizon and sample chosen. The paper also concludes that using the coefficients obtained during normal times to predict inflation after currency crisis generates an upward bias, i.e., the model systematically over-predicts future inflation. This occurs even when one controls for different exchange rate expectations, using survey data. This suggests that econometricians should use caution when using past models to predict future inflation in the aftermath of large depreciations.

The paper is organized as follows. The next section presents the theoretical section that motivates the empirical exercise and sets up the methodology. Section III estimates the passthrough coefficient under different time horizons and samples. Section IV investigates the determinants of the pass-through coefficient. Section V analyzes the fit of the estimated model forecasts in a few known currency crisis cases. Section VI uses survey data to test the effect of including exchange rate expectations on the pass-through results. Section VII performs several robustness tests on the results. Section IX concludes and in the appendix we list the countries under different definitions.

II. Theoretical Motivation and Methodology

This paper estimate the pass-through from depreciation to inflation in a panel data framework. A few series for each country are constructed using monthly data (from 1980 to 1998) of 71 countries amounting to approximately 14,013 valid observations. The period examined is quite rich since it contains the large swings in the dollar-yen relationship, as well as alternate periods of tranquility and important exchange rate crises. The panel data analysis allows the paper to pool a larger amount of data that was used in previous studies.

The following series were identified as potential determinants of the pass-through from exchange rate depreciation to inflation. First, a proxy for the business cycle (GDP deviation from an estimated trend) was included to capture the notion that with increasing sales firms find it easier to pass-through increases in costs to final prices. The reverse is also true. Large depreciations sometimes do not imply large price increases because the economy is in recession and firms do not adjust their prices proportionally to their increase in costs.

Second, we identified the real exchange rate as potentially affecting the pass-through. Previous studies have shown that the real exchange rate (RER) overvaluation is an important determinant of future depreciations (Goldfajn and Valdes, 1999). These depreciations need not call for higher inflation, if they simply restore the real exchange rate to its steady state. In this case, the overvaluation would be corrected by a change in the relative price of tradables – non tradables, and the depreciation would not generate a generalized increase in prices. On the other hand, large depreciations that are not based on required adjustments in relative prices would either induce inflation or reverse itself through a future nominal appreciation (the stylized fact is that the correction of excess nominal depreciations tend to occur through higher inflation (Goldfajn and Gupta, 1998)). This effect was also identified by Borensztein and De Gregorio (1999).

Third, the inflation environment may determine the willingness of firms to increase prices in the presence of increasing costs. The pass through is determined by the perceived persistence of costs changes, that is influenced largely by the persistence of inflation. Since inflation tends to be positively correlated to the persistence of inflation, it may also be positively correlated to the pass-through, as argued recently by Taylor (1999). Inflationary countries would tend to have a greater degree of pass through, while stable countries will tend to maintain current low inflation, even in the presence of a large depreciation. Amitrano et al 1997 has shown that the latter was indeed the case after the large depreciations in Europe in 1992.

Fourth, the degree of openness of a country to the rest of the world should also affect the pass-through coefficient. The literature has concentrated on the direct effect of openness on inflation, showing how openness puts a check on inflationary finance in a Barro-Gordon type model without a commitment technology (Romer, 1993). This effect implies that one should observe a negative correlation between inflation and openness. The effect of openness on the pass-through coefficient works in the opposite direction. In a more open economy, with larger presence of imports and exports, a given depreciation has a larger effect on prices. In the appendix we develop a simple model with endogenously determined tradable and non tradable goods, where the degree of openness induces more pass through from depreciation to inflation. Note that this variable is closely linked to foreign firm participation in the domestic market, a fundamental microeconomic determinant in the pass-through literature (see Dornbusch, 1987).

In the paper, the nominal exchange rate (E) is expressed as domestic currency units per unit of foreign currency, or in other words, the price of foreign exchange in terms of domestic currency. Thus it is possible to have more than 100% devaluation in local currency. The real exchange rate (e) is the ratio of the domestic price level over foreign price level expressed in the same currency, $e = p/E\, p^*$, where p is the good's price in domestic currency, p^* is the price in foreign currency.

The pass-through coefficient is defined as the relationship between accumulated inflation in j periods, $P_{[t,t+j]}$, and the exchange rate depreciation also accumulated in i periods

$\hat{e}_{[t-1,t+j-1]}$, but allowing at least one month lag of inflation's response to a change in the exchange rate. A pass-through coefficient near 1 is equivalent to a total pass-through of exchange rate depreciation to inflation, while a coefficient near zero represents a total inelasticity of the economy's prices to a change in the nominal exchange rate.

The inflation series were built for each country from monthly data of seasonally adjusted CPI (Consumer Price Index) from the Information Notice System (INS) database of the IMF. Accumulated inflation is the difference between the CPI index at time t+12 and time t. Depreciation was calculated as changes in the effective nominal exchange rate index, defined as trade-weighted nominal exchange rate of domestic currency over foreign currency. The source is also the INS database. Accumulated inflation is the difference between the CPI index at time t+12 and time t. A proxy for "openness" was created using the sum of exports plus imports as a percentage of GDP, all from the IFS database of the IMF. A monthly series of multilateral real exchange rate (RER) was also used in the regression estimation (upward movements in the index indicate appreciation). Misalignment of the RER was constructed for each country using the percentage difference between the actual RER and a Hodrick-Prescott filter of the RER. To control for the economic cycle, a series of monthly industrial activity's level was used, or GDP at constant prices. Data from International Financial Statistics of the International Monetary Found was used. In the absence of the monthly GDP, the quarterly or the annual index was used.

Using the Hodrick-Prescott filter, the paper calculates the percentage of deviation of the actual GDP from an estimated trend. A positive variation indicates that the country was growing faster than the trend, while a negative variation represents the opposite. The same procedure was applied for the real effective exchange rate. Therefore, the equilibrium exchange rate is proxied by the estimated trend, instead of assuming a purchasing power parity equilibrium exchange rate (see Goldfajn and Valdes, 1999).

One might consider that using the initial GDP Deviation to explain the accumulated inflation in the next 12 months is not appropriate, given that the business cycle stance may change throughout the period. The alternative is to use an average GDP deviation for the 12-month period. However, this may generate endogeneity problems, in other words, the average GDP deviation may be affected by the inflation accumulated during the 12-month period. In any case, for robustness purposes, the exercise will be redone using the average GDP in chapter VII. Also, the initial inflation variable is denominated in the period t-1, in order to avoid a spurious relationship with accumulated inflation in the period t to t+12. The trade openness variable is measured at the t moment.

It is interesting to observe some stylized facts of the data. In Table 1, it is clear that there is a difference between medians and averages reflecting the fact that the distribution of inflation and depreciation across countries and time has a few extreme observations related to the hyperinflation and high inflation episodes. The average or median GDP gap is small as well as the median RER misalignment by construction of the misalignment indices. The average it is not exactly zero because we could not use in the overall regression all the data points we used to construct the misalignment series.

Table 1: Descriptive Statistics

Statistic	Inflation	Exchange Rate Depreciation	Openness	RER Misalignment	GDP Gap
Average	167.0	121.3	60.6	-11.7	-0.5
Median	61.5	5.0	53.3	-2.1	1.4
Number of Observations	14013	14013	15389	14013	14013
Number of Countries	71	71	72	71	71

Note: All data in percentage terms.
Source: INS(IMF), IFS(IMF), GDP various sources

III. The effect of depreciation on inflation

In this section, the paper estimates directly the pass-through coefficient in order to shed light on the overall effect of the exchange rate depreciation on inflation and observe its behavior over time (to establish the stylized fact observed in Figure 1 in the introduction), across regions and development status. In the next section, we will include cross terms on the depreciation coefficient to explain the specific determinants of the pass-through coefficient.

The following equation, that only include the isolated effects of the independent variables over accumulated inflation, was adopted to estimate the pass-through coefficient:

$$(1)\ P_{i,[t,t+j]} = b_0 + b_1\, \hat{e}_{i,[t-1,t+j-1]} + b_2 RER_{i,t(-1)} + b_3 GDP_{i,\, t(-1)} + b_4 P_{i,t(-1)} + b_5 OPE_{i,\, t(-1)} + u$$

where i indicates the country and t the time. The inflation rate and nominal exchange rate depreciation are accumulated during a period of time and the other control variables - real exchange rate deviation, initial inflation, GDP Deviation and trade openness - are included at time t-1.

The results of equation (1) are summarized in Table 2 where the estimated regression using fixed effects and generalized least squares results are presented. All the variables included are significant. As expected, depreciation, initial inflation and GDP above trend are positively related to inflation, while overvaluation and openness (in some cases) dampen inflation.

There are important changes as the time period expands. For a time horizon of 1 month (lower panel in Table 2) the coefficient's values are still relatively low, a 10% depreciation will only cause a 1.24% inflation in the following month. It is interesting to observe that a 10% overvaluation will dampen inflation by 1.21%. Therefore, in a hypothetical case where a 10% nominal devaluation corrects an exchange rate overvaluation of the same amount, one would not observe an increase in inflation, *ceteris paribus*. A larger coefficient in this time horizon is associated only with the initial inflation variable, where each 1% of monthly inflation will generate a 0.5% of inflation next period, evidence of inertia in the very short run.

The coefficients are larger as the time horizon of the regression is expanded. The pure pass-through coefficient jumps from 0.0124 in the first month to 0.1704 in 3 months and 0.426 after 6 months, finally reaching 0.732 after 12 months. Figure 2 allows one to observe the passthrough coefficient as a function of the time horizon. The evidence from the panel regression seems to confirm the casual observation shown in the introduction, an increasing pass-through coefficient over time. The figure also shows that the pass-through coefficient reaches a limit after 12 months, and its magnitude is smaller than 1, evidence that the risks of a spiral inflation depreciation is not overwhelming (in contrast to the average behavior of Latin America shown in Figure 3).

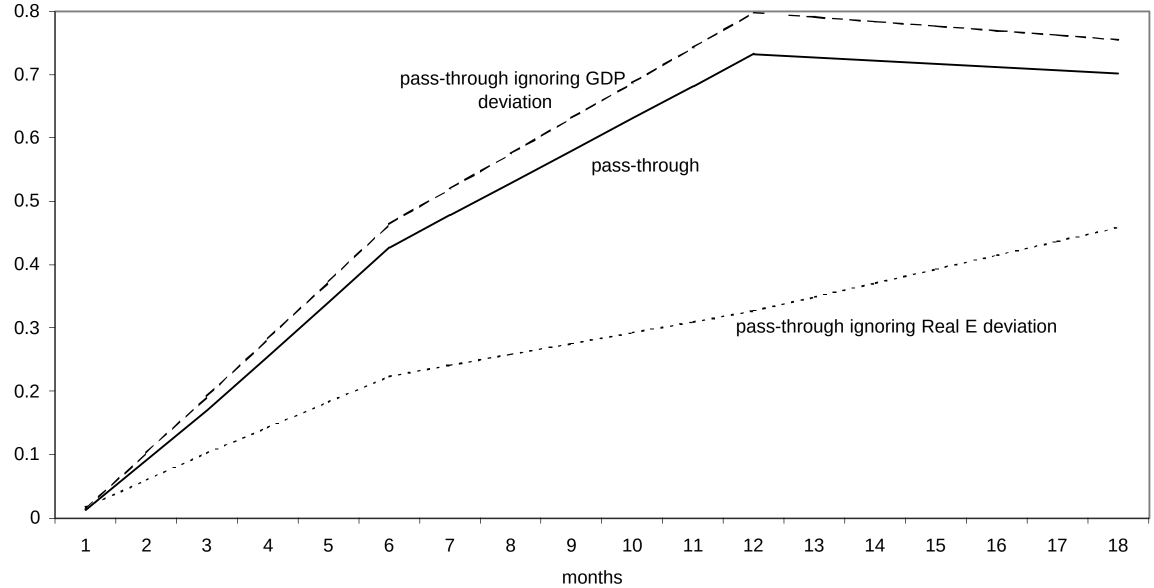
The magnitudes of the coefficients of the control variables are relevant. The real exchange rate overvaluation is important (in 12 months, a 10% of overvaluation decreases inflation by 11.8%). Therefore, a nominal devaluation that does not overshoot its required adjustment would not have severe consequences in terms of inflation. The effect of the GDP deviation is much smaller. Graphically, in Figure 2, we can track the effects of these variables on the pass-through coefficient by omitting it in the regression of equation (1). Note that the pass-through coefficient's curve that ignores the real exchange rate deviation is permanently below the pure pass-through coefficient curve, since an overvaluation significantly reduces the exchange rate depreciation's pass-through to inflation. The opposite is true for the effect of a positive GDP deviation. However, the effect is much smaller.

We can divide the sample by different criteria. One possible subdivision is by geographical criteria, into five regions. Another is to classify the countries according to their social economic condition, or in other words, into emerging, developed, and developing countries.[2] Alternatively, with the same purpose, we divide the countries between OECD members and non-members.

The results of the regional subdivision can be seen in Table 3 and Figure 3. For the first month after devaluation, the pass-through coefficient is relatively similar in all the regions. Starting in the first quarter, one can see that the American and Asian regions possess a higher degree of pass-through of the exchange rate to higher prices, than other regions. Certainly the American coefficient is strongly influenced by the South American country's inflationary tendencies. The European coefficient is very small, which in fact is the subject of a study by Amitrano, A. (1997). Oceania can be considered as the region with the smallest pass-through coefficient, where all four countries that make up this sub-sample also individually exhibit very small coefficients. Overall, the increase of the pass-through coefficient up to 12 months is evident for all regions.

[2] A World Bank Classification. See the complete list in the appendix.

Figure 2: Pass-through



Note:Estimated with fixed effects and cross section weights

The subdivision of the sample by economic development produces the results shown in Table 4. In six months, the pass-through coefficient is much larger in developing (0.34) and emerging markets (0.394) than in developed countries (0.245). In 12 months, the emerging countries have an almost complete (0.912) pass-through coefficient, while the developed and other developing countries have a pass-through coefficient equal to 0.605 and 0.506 respectively . Nevertheless, the dampening effect of the real exchange rate deviation is greater in emerging countries than in the developed countries, a 10% overvaluation reduces inflation by 15.34% versus 7.9% in developed economies. The initial inflation variable appears to be more important in developed countries due to their greater inflationary stability during the analyzed period.

The results for OECD members and non-members subdivision confirm the results above. The pass-through coefficient is in fact much lower for OECD members than non-OECD. For 6 months, for example, a 10% nominal exchange rate devaluation would lead to 1.13% inflation for OECD members and 4.71% for non-members.

Table 2: Pass-through Panel Regressions Without Cross Terms

Dependent Variable: Accumulated inflation rate (t to t+12)				
Variable	Coefficient	Expected Sign	t-Statistic	P-value
GDP deviation	0.023	+	4.449	0.000
Initial Inflation	2.429	+	1.603	0.109
Openness	0.035	-	9.074	0.000
Real E deviation	-1.185	-	-3.348	0.001
Accumulated Depreciation	0.732	+	3.458	0.001

Dependent Variable: Accumulated inflation rate (t to t+6)				
Variable	Coefficient	Expected Sign	t-Statistic	P-value
GDP deviation	0.015	+	7.194	0.000
Initial Inflation	1.729	+	6.735	0.000
Openness	0.005	-	3.264	0.001
Real E deviation	-0.447	-	-8.611	0.000
Accumulated Depreciation	0.426	+	7.293	0.000

Dependent Variable: Accumulated inflation rate (t to t+3)				
Variable	Coefficient	Expected Sign	t-Statistic	P-value
GDP deviation	0.003	+	6.900	0.000
Initial Inflation	0.812	+	8.798	0.000
Openness	-0.001	-	-2.599	0.009
Real E deviation	-0.132	-	-15.223	0.000
Accumulated Depreciation	0.170	+	8.115	0.000

Dependent Variable: Accumulated inflation rate (t to t+1)				
Variable	Coefficient	Expected Sign	t-Statistic	P-value
GDP deviation	0.001	+	5.004	0.000
Initial Inflation	0.499	+	15.777	0.000
Openness	0.000	-	-8.084	0.000
Real E deviation	-0.012	-	-13.021	0.000
Accumulated Depreciation	0.012	+	3.275	0.001

Note: Estimated with Fixed Effects and Cross Section Weights

Table 3: Pass-through coefficient by Regions

Months	Total	Europe	Africa	America	Oceania	Asia
1	0,012	0,018	0,018	0,013	0,002	0,093
3	0,169	0,116	0,159	0,199	0,051	0,166
6	0,426	0,211	0,343	0,539	0,092	0,367
12	0,732	0,360	0,643	0,692	0,158	0,712
18	0,701	0,460	0,520	1,240	0,193	0,841

Figure 3: Pass-through By Region

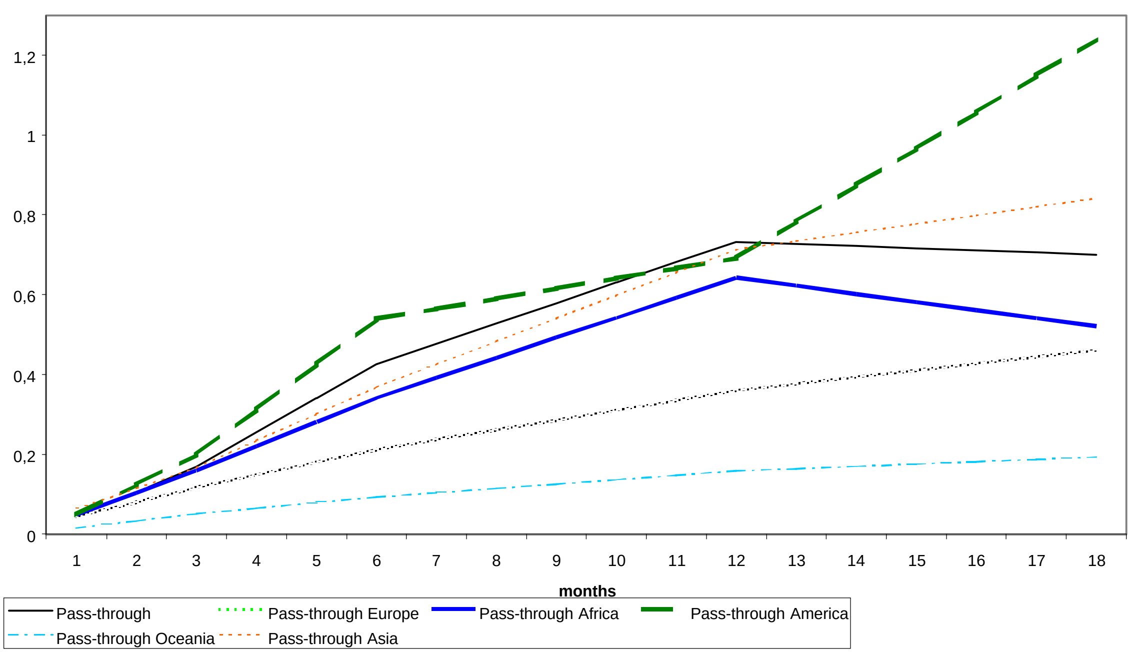


Table 4: Pass-through Regressions by Type of Country

12 Months - Dependent Variable Accumulated Inflation - Fixed Estimation	Developed		Emerging		Other Developing	
	coefficient	t-Statistic	coefficient	t-Statistic	coefficient	t-Statistic
GDP deviation	0,033	4,313	-0,002	-0,209	0,032	1,766
Initial Inflation	4,701	5,221	1,219	2,083	1,489	1,789
Openness	-0,033	-5,287	0,041	9,628	0,068	2,070
Real E deviation	-0,797	-5,855	-1,534	-7,202	-1,045	-2,638
Accumulated Depreciation	0,605	5,916	0,912	7,562	0,506	2,220

6 Months - Dependent Variable Accumulated Inflation - Fixed Estimation	Developed		Emerging		Other Developing	
	coefficient	t-Statistic	coefficient	t-Statistic	coefficient	t-Statistic
GDP deviation	0,007	2,217	0,015	3,441	0,018	1,998
Initial Inflation	3,151	6,513	1,170	3,980	1,112	4,061
Openness	-0,016	-5,290	0,012	10,178	0,016	4,482
Real E deviation	-0,215	-5,222	-0,412	-6,045	-0,470	-5,994
Accumulated Depreciation	0,245	4,539	0,394	5,152	0,340	4,393

Note1: GDP deviation and Openness are at time t. Initial Inflation, Real E deviation and Accumulated Depreciation are at time t-1. White-Corrected standard errors.
Source: List of emerging countries in appendix

12 Months - Dependent Variable Accumulated Inflation - Fixed Estimation	OECD		non-OECD	
	coefficient	t-Statistic	coefficient	t-Statistic
GDP deviation	0,029	3,326	0,014	3,886
Initial Inflation	4,336	8,156	2,087	1,298
Openness	-0,031	-6,815	0,088	6,260
Real E deviation	-0,258	-10,975	-1,314	-3,739
Accumulated Depreciation	0,188	10,512	0,754	3,841

6 Months - Dependent Variable Accumulated Inflation - Fixed Estimation	OECD		non-OECD	
	coefficient	t-Statistic	coefficient	t-Statistic
GDP deviation	0,016	3,054	0,010	3,498
Initial Inflation	2,447	9,810	1,553	5,975
Openness	-0,022	-9,234	0,027	12,380
Real E deviation	-0,119	-11,675	-0,530	-9,665
Accumulated Depreciation	0,113	8,838	0,471	8,088

Note: GDP deviation and Openness are at time t. Initial Inflation, Real E deviation and Accumulated Depreciation are at time t-1. White-Corrected standard errors.
Source: List of oecd countries in appendix

We can summarize the results obtained in this section as follows. The pass-through coefficient is increasing as the time period increases. For example, the 12-months coefficient is more than 4 times larger the 3-month coefficient. The coefficients for the control variables have the correct sign and are statistically significant. The economically relevant coefficients are the degree of exchange rate overvaluation and the initial inflation. For example, for the 12-months case, an overvaluation of 10 percent reduces subsequent inflation in 11.8 percent. The pass-through coefficient in the American region is the highest (1.24 in 12 months) reflecting the spiral inflation-depreciation in several Latin American countries. Europe, Africa and Oceania have a substantial lower pass-through coefficient than in Asia and America. The pass-through is substantially lower in OECD (or developed countries) relative to emerging market economies. In contrast, the dampening effect of the initial overvaluation is larger in emerging and other developing countries.

IV. The determinants of the passthrough coefficient

It is relevant to analyze the effect of several of the control variables directly on the pass-through coefficient. Does the passthrough coefficient depend on the initial overvaluation, GDP deviation, initial inflation or degree of openness? A direct approach would have been to calculate $PT_t = P_{[t,t+i]} \; / \; \hat{e}_{[t-1,t+i-1]}$ and regress against the independent variables. However, some countries presented depreciation rates close to zero (due for example to a fixed exchange rate) with positive inflation rates leading to very high pass-through numbers.[3] Given the large volatility of the pass-through observations and the high standard errors it produces, and to avoid arbitrary dropping of data, we have chosen instead to analyze the model including cross terms in equation (1) to avoid large standard deviations. The paper estimates a functional form that includes both the interaction terms as well as the direct effect of the proposed variables. In fact, it is expected that the real exchange rate deviation, for example, be as important in explaining directly the inflation rate, as in determining the pass-through

[3] New Zealand, for example, exhibits a pass-through coefficient of 12,188 in January of 1982. In January of 1982, the country had inflation of 1.3%, and in December of 1981 nominal depreciation was only $1{,}1 \times 10^{-4}$ %. Even though the country had a reasonable pass-through coefficient during other periods, the average of the coefficient was 55.1484 and the standard deviation was 811.175. Evidently, the median was only 0.0333.

coefficient through its' indirect effect. For simplicity, it is assumed that that pass-through coefficient is a linear function of the other variables in question:

$$P\ i_{[t,t+j]} = a + b_1\, \hat{e}_{i,\ [t-1,t+j-1]} + b_2 RER_{i,\, t(-1)} + b_3 GDP_{i,\, t} + b_4\, P_{i,\, t(-1)} + b_5 OPE_{i,\, t} + u$$

where $b_1 = b_6 + b_7 RER_{i,\, t(-1)} + b_8\, GDP_{i,\, t} + b_9 P_{i,\, t(-1)} + b_{10} OPE_{i,\, t}$

Or:

(3) $$P_{i\, ,\, [t,t+j]} = a + b_6\, \hat{e}_{i\, ,\, [t-1,t+j-1]} + b_7\, \hat{e}_{i\, ,[t-1,t+j-1]} * RER_{i,\, t(-1)} + b_8\, \hat{e}_{i\, ,\, [t-1,t+j-1]} * GDP_{i,\, t} + b_9\, \hat{e}_{i\, ,\, [t-1,t+j-1]} * P_{i,\ t(-1)} + b_{10}\, \hat{e}_{i,\, [t-1,t+j-1]} * OPE_{i,\, t} + b_2 RER_{i,\ t(-1)} + b_3 GDP_{i,\ t} + b_4\, P_{i,\ t(-1)} + b_5 OPE_{i,\ t} + u$$

The estimates are presented in Table 5, which has the results for 1, 3, 6, 12 and 18 months. For the first month after the depreciation, the interactive terms (those that make up the pass-through coefficient) are not significant, with the exception of initial inflation that shows the opposite sign to that expected. The coefficient on the isolated terms continues to show the correct sign and significance. For three months, the interactive terms results improve significantly. For each 10% of positive GDP deviation, the pass-through coefficient increases 4.65% indicating the importance of the business cycle to determine the degree of the devaluation's pass-through on inflation. The initial inflation and the exchange rate deviation variables also influence the passthrough with the expected sign and were significantly different from zero.

For the sixth month period, one observes that effect of the initial inflation or the business cycle on the pass-through coefficient reached its limit. At the same time, the exchange rate overvaluation variable continues to be important in determining the pass-through coefficient and increases in value during the months in question. An exchange rate previously 10% overvalued, decreases the pass-through coefficient by 0.09%, 1.77%, 3.48%, 6.78% e 7.06% respectively during the periods of 1, 3, 6, 12 and 18 months after the exchange rate depreciation. Finally, within a year, the trade openness variable's effect on the passthrough produces the expected sign and significance over the pass-through coefficient. Nevertheless, the isolated term's sign is different than expected.

As in the previous section, exercises were done for the interactive terms model in which the sample was divided in regions. Table 6 contains the results for 6 and 12 months for each region. For the first semester, note the interactive GDP deviation variable's importance for America and Oceania, where for each 10% of activity level below the trend, the pass-through coefficient decreases by 19.54% and 31.6% for the respective months. The initial inflation's role as a component in determining the pass-through coefficient is more relevant in Europe and in Asia, where each 10% of monthly initial inflation provokes a pass-through coefficient 20% and 48% greater, respectively. The cross effect of the real exchange rate deviation on the pass-through coefficient is important and relatively stable among the regions in question.

We could summarize the results obtained in this section as follows. In general, the RER overvaluation, initial inflation, trade openness and GDP deviation do affect the pass-through coefficient but in different degrees. The most robust determinants are the RER overvaluation and the initial inflation. RER overvaluation is particularly important for the passthrough coefficient in the American region but has influence in other regions' passthrough coefficient too. Initial inflation is a particularly important determinant for European countries. The influence of RER increases as the horizon increases while the influence of initial inflation is limited to 6-month horizon. The GDP deviation and openness variables are more sensitive to the horizon and sample chosen. The GDP gap has an important effect within a 6-month period. However, the sign reverses at a 12-month horizon. The probable reason is that the level of activity at t has little effect on the degree of pass-through close to t+12. In essence, it is possible that devaluations are counter-cyclical making the initial GDP gap negatively correlated to future pass-through of the inflation. Openness is particularly important for the pass-through coefficient in Africa and Oceania.

Table 5: Pass-through Panel Regressions With Cross Terms

months	1		3		6		12		Expected Sign
	coefficient	P-value	coefficient	P-value	coefficient	P-value	coefficient	P-value	
GDP*Ê	0.092	0.222	0.465	0.000	1.169	0.000	-0.055	0.616	+
INF*Ê	-0.109	0.000	0.678	0.000	1.357	0.000	0.770	0.000	+
OPE*Ê	0.007	0.318	0.003	0.739	-0.010	0.313	0.069	0.000	+
RER*Ê	-0.009	0.329	-0.177	0.000	-0.348	0.000	-0.678	0.000	-
GDP deviation	0.001	0.409	0.002	0.508	0.005	0.355	0.042	0.007	+
Initial Inflation	0.557	0.000	0.791	0.000	1.334	0.000	2.423	0.000	+
Openness	0.000	0.305	-0.002	0.186	-0.004	0.129	0.027	0.002	-
Real E deviation	-0.011	0.000	-0.116	0.000	-0.298	0.000	-0.694	0.000	-
Accumulated Depreciation	0.022	0.000	0.167	0.000	0.294	0.000	0.492	0.000	+

Note: Estimated with Fixed Effects and Cross Section Weights

Table 6: Pass-through Regressions Using Cross-Terms - fixed estimation

Dependent Variable: Accumulated Inflation

12 - Months Regression

	America		Africa		Europe		Asia		Oceania	
	coefficient	P-value	coefficient	P-value	coefficient	P-value	coefficient	P-value	coefficient	P-value
GDP*Ê	-0,890	0,000	-0,370	0,636	0,204	0,353	-0,139	0,425	5,219	0,000
INF*Ê	-0,204	0,001	-0,048	0,204	0,550	0,001	3,895	0,000	1,119	0,309
OPE*Ê	-1,090	0,000	0,493	0,000	-0,006	0,874	-0,065	0,002	0,292	0,000
RER*Ê	-0,927	0,000	-0,411	0,000	-0,611	0,000	0,780	0,000	0,318	0,000
GDP deviation	0,673	0,004	-0,060	0,374	0,030	0,014	0,005	0,727	0,352	0,000
Initial Inflation	3,745	0,000	0,475	0,018	3,923	0,000	0,721	0,000	2,635	0,000
Openness	0,260	0,000	0,006	0,807	-0,024	0,007	0,040	0,000	0,117	0,000
Real E deviation	-0,780	0,000	-0,867	0,000	-0,555	0,000	-0,733	0,000	-0,125	0,000
Accumulated Depreciation	1,316	0,000	0,373	0,000	0,411	0,000	0,420	0,000	-0,058	0,049

6 - Months Regression

	America		Africa		Europe		Asia		Oceania	
	coefficient	P-value	coefficient	P-value	coefficient	P-value	coefficient	P-value	coefficient	P-value
GDP*Ê	1,954	0,000	0,481	0,335	0,744	0,000	-0,366	0,003	3,160	0,001
INF*Ê	0,838	0,000	0,777	0,000	1,999	0,000	4,806	0,000	-2,885	0,014
OPE*Ê	-0,582	0,000	0,236	0,000	-0,045	0,072	-0,015	0,315	0,144	0,003
RER*Ê	-0,257	0,000	-0,274	0,000	-0,231	0,001	-0,166	0,155	0,384	0,000
GDP deviation	0,147	0,004	-0,076	0,022	0,008	0,144	0,005	0,401	0,196	0,000
Initial Inflation	1,554	0,000	0,310	0,000	2,222	0,000	0,557	0,000	1,788	0,000
Openness	-0,027	0,003	-0,007	0,456	-0,014	0,000	0,017	0,000	0,028	0,114
Real E deviation	-0,282	0,000	-0,381	0,000	-0,184	0,000	-0,262	0,000	-0,097	0,000
Accumulated Depreciation	0,586	0,000	0,215	0,000	0,222	0,000	0,185	0,000	0,016	0,548

Note1: GDP deviation and Openness are at time t. Initial Inflation, Real E deviation and Accumulated Depreciation are at time t-1.

Table 7: Pass-through Regressions by Type of Country

Including Cross-Terms

12 Months - Dependent Variable Accumulated Inflation - Fixed Estimation							
	Developed		Emerging		Other Developing		**Expected Sign**
	coefficient	P-value	coefficient	P-value	coefficient	P-value	
GDP*Ê	0.246	0.882	-1.029	0.319	-0.659	0.874	+
INF*Ê	1.983	0.190	0.740	0.300	0.218	0.431	+
OPE*Ê	0.632	0.001	-0.911	0.006	0.255	0.354	+
RER*Ê	1.342	0.333	-1.305	0.128	-0.398	0.224	-
GDP deviation	0.033	0.003	0.039	0.178	0.061	0.485	+
Initial Inflation	4.246	0.000	0.831	0.045	1.586	0.000	+
Openness	-0.031	0.000	0.107	0.000	0.090	0.000	-
Real E deviation	-0.398	0.000	-0.744	0.000	-0.724	0.000	-
Accumulated Depreciation	-0.083	0.121	1.144	0.000	0.357	0.036	+

6 Months - Dependent Variable Accumulated Inflation - Fixed Estimation							
	Developed		Emerging		Other Developing		**Expected Sign**
	coefficient	P-value	coefficient	P-value	coefficient	P-value	
GDP*Ê	0.511	0.672	1.454	0.025	0.977	0.304	+
INF*Ê	2.752	0.025	1.548	0.000	0.832	0.130	+
OPE*Ê	0.297	0.008	-0.237	0.002	0.035	0.762	+
RER*Ê	0.080	0.912	-0.230	0.647	-0.270	0.133	-
GDP deviation	0.013	0.011	-0.008	0.599	0.008	0.049	+
Initial Inflation	2.522	0.000	0.810	0.053	0.887	0.000	+
Openness	-0.024	0.000	0.018	0.000	0.014	0.000	-
Real E deviation	-0.128	0.000	-0.282	0.000	-0.365	0.000	-
Accumulated Depreciation	-0.043	0.261	0.385	0.000	0.292	0.000	+

Note: GDP deviation and Openness are at time t. Initial Inflation, Real E deviation and Accumulated Depreciation are at time t-1.

V. Forecasts

It is important to check the accuracy of the model's forecasts using known cases of large devaluations and comparing the results to their actual inflation. Most of the cases, with the exception of Brazil, are part of the sample, so the predictions below have to be interpreted as mostly in-sample prediction. First, the paper looks at the prediction for inflation in emerging markets such as Indonesia, Brazil, Korea, Mexico, Thailand, Malaysia and Phillipines. Next, the paper looks at some developed country's experience as in the U.K., Sweden, Italy, Spain and Finland. Note that all of the known cases are devaluation cases during currency crisis events. This will have a bear on the results.

Table 8a fully presents the forecasts' results and the main components that determine annual inflation in the countries that encountered exchange rate crisis beginning in 1994, according to the two equations presented in this paper.[4] The forecasts are done using the general coefficients attained by including the entire available sample, but also, alternatively, by using the specific coefficients of emerging and developed countries.

Using the model's general coefficients, it can be seen that forecasted inflation is greater, in all cases, than observed inflation. Clearly, the factor that primarily contributes to inflation is the actual exchange rate depreciation itself and the main buffer is the exchange rate overvaluation that these countries encountered before the devaluation.

Thailand, for example, has a general forecasted inflation of 18% (in contrast to observed inflation of 10%). If we consider each variable individual effect, we find that the exchange rate devaluation contributed to 34.1% to inflation while the overvaluation reduced it by 19.2%. Other countries present a similar situation. Indonesia can be considered an exception. A large local currency devaluation of 285%, made it inevitable to predict a very high inflation, although the actual inflation was "only" 82%.

Using, instead, the emerging country's coefficients, the upward bias in the forecast of inflation is magnified, since the pass-through coefficient is larger for this group of countries.

It is worth noting that part of depreciation's strong influence is counterbalanced by (a also larger) real exchange rate deviation coefficient. One could argue, therefore, that these countries behaved like "developed countries" during exchange rate crisis periods due to their lower pass-through coefficient.

The sub-sample that includes the European crisis countries in 1991-2, show low inflation in spite of large depreciations, even below the forecasted inflation (Table 8b). For example, Sweden had less than 5% annual inflation after a more than 30% decline in the nominal value of it's currency. Similar to the previous sample, the depreciation appears to strongly influence inflation, although it is countered by the initial deviation of the real exchange rate. The trade openness acts significantly, but with less intensity. One must stress that including the constant decisively affects the forecasted inflation, indicating that even if there were no depreciations, inflation would be around 4% annually from inflation inertia. When the forecast is calculated by using coefficients for the developed countries, there are no clear advantages, since even though a smaller pass-through coefficient exists, which would cause lower expected inflation, the exchange rate overvaluation coefficient is also lower, with less restraint on inflation.

Tables 8c and 8d use the interactive term model to forecasted inflation. In general, this model succeeds in attaining a better forecast than the isolated terms model. The results for emerging markets using the general coefficients gives an important role to nominal depreciation and real exchange rate overvaluation. The latter effect may be subdivided into two: the first effect, through its direct reduction of inflation (isolated coefficient) and the second, even more important, by reducing the pass-through coefficient which indirectly discourages inflation. Also, the trade openness variable appears to strongly affect inflation, through the pass-through coefficient.

The process in Indonesia serves as a good example to emphasize this point. In the forecast using only isolated terms, the model underforecasts inflation due to the very large devaluation. In the cross terms model, the real exchange rate deviation not only dampens inflation directly but also multiplies the nominal depreciation and indirectly reduces inflation

[4] This emerging group includes: Brazil (1999), Indonesia (1997), Korea (1997), Mexico (1994), Thailand (1997), Malaysia (1997) and the Philippines (1997).

by decreasing the pass-through coefficient. Therefore, the predicted inflation in the cross term model is closer to the actual inflation in Indonesia than the previous model.

The forecasts for the European countries tend to produce better results when using developed economies passthrough coefficients than the general coefficients. Once again exchange rate depreciation and the initial exchange rate deviation were the main determinants of inflation. The initial inflation, although only marginally, was influential in consolidating future price increases, contrary to its' relatively lesser contribution in determining the inflation in emerging countries.

Table 9 compares the forecasts of the two models and the results of Borensztein and De Gregorio. On average, this paper produces slightly better forecasts than these authors' forecasts. Notwithstanding, a common problem is the downward bias in the forecasts, indicating a possible structural break during crisis periods, thereby reducing the pass-through coefficient.

In sum, the estimations presented in this section seem to predict better than previous studies, in particular, Borensztein and De Gregorio, J (1999) that concentrates on crises cases. The complete model, that includes the cross terms, is a better predictor than the simplified model. The main lesson for emerging markets is that one must take into account the RER overvaluation in the country in order to better predict inflation. Equivalently, the effect of the initial inflation is fundamental to access inflation in Europe or in developed countries in general. Notwithstanding these results, we find that there is a systematic upward bias in the prediction of inflation in these crises cases. This is prevalent across all models. One possibility is that in these cases the nominal exchange rate overshot and the expectation is that it will revert partially to its mean, inducing smaller price adjustment than in normal times. We will investigate this possibility in the next section.

Table 8a: 12-Month Inflation Prediction in Selected Crises Cases

Dependent Variable	**Type of Regression**	**Contribution to Inflation in:**						
	General	Indonesia - 97	Brazil-99	Korea -97	Mexico-94	Thailand - 97	Malaysia -97	Phillipines-97
Constant		-5.1	0.0	-1.3	3.8	-0.2	-3.4	0.8
GDP deviation	0.000	0.0	-0.3	0.1	0.0	-0.1	0.2	0.0
Initial Inflation	2.430	0.0	-0.4	0.8	0.9	0.4	0.2	2.5
Openness	0.032	0.0	0.6	2.5	1.9	3.0	6.0	3.5
Real E deviation	-1.184	-23.0	-23.7	-12.3	-16.0	-19.2	-14.7	-12.4
Accumulated Depreciation	0.732	208.8	36.6	25.1	71.0	34.1	28.0	27.1
Predicted Inflation		**185.2**	**12.7**	**14.8**	**61.6**	**18.0**	**16.4**	**21.5**
Actual Inflation		**82.2**	**8.9**	**6.6**	**51.7**	**10.0**	**5.8**	**9.9**

Dependent Variable	**Type of Regression**	**Contribution to Inflation in:**						
	Emerging	Indonesia - 97	Brazil-99	Korea -97	Mexico-94	Thailand - 97	Malaysia -97	Phillipines-97
Constant		-7.3	0.0	-2.0	2.8	-0.5	-4.2	-0.1
GDP deviation	0.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Initial Inflation	1.219	1.4	-0.2	0.4	0.4	0.2	0.1	1.3
Openness	0.039	2.2	0.7	3.0	2.3	3.7	7.4	4.3
Real E deviation	-1.534	-29.8	-30.7	-16.0	-20.7	-24.9	-19.0	-16.0
Accumulated Depreciation	0.912	260.1	45.6	31.3	88.5	42.4	34.9	33.7
Predicted Inflation		226.6	15.4	16.7	73.3	21.0	19.2	23.1
Actual Inflation		**82.2**	**8.9**	**6.6**	**51.7**	**10.0**	**5.8**	**9.9**

Dependent Variable	**Type of Regression**	**Contribution to Inflation in:**						
	Developed	Indonesia - 97	Brazil-99	Korea -97	Mexico-94	Thailand - 97	Malaysia -97	Phillipines-97
GDP deviation	0.033	0.0	-0.5	0.2	0.0	-0.1	0.3	0.0
Initial Inflation	4.701	5.3	-0.8	1.5	1.7	0.8	0.4	4.9
Openness	-0.033	-1.8	-0.6	-2.5	-1.9	-3.1	-6.2	-3.5
Real E deviation	-0.797	-15.5	-15.9	-8.3	-10.8	-12.9	-9.9	-8.3
Accumulated Depreciation	0.605	172.5	30.3	20.7	58.7	28.1	23.1	22.4
Predicted Inflation		160.5	12.4	11.6	47.7	12.9	7.8	15.5
Actual Inflation		**82.2**	**8.9**	**6.6**	**51.7**	**10.0**	**5.8**	**9.9**

Table 8b: 12-Month Inflation Prediction in Selected European Crises Cases

Dependent Variable	***Type of Regression***	***Contribution to Inflation in:***				
	General	England - 92	Sweden - 92	Italy - 92	Spain - 92	Finland - 92
Constant		1.1	-0.2	2.4	2.7	0.6
GDP deviation	0.023	0.0	-0.1	0.0	-0.1	-0.1
Initial Inflation	2.430	0.6	0.5	0.6	1.5	0.6
Openness	0.032	1.6	1.7	1.2	1.2	1.7
Real E deviation	-1.184	-4.1	-13.3	-7.0	-7.8	-6.5
Accumulated Depreciation	0.732	6.6	22.3	14.6	12.2	9.1
Predicted Inflation		5.7	11.0	11.8	9.8	5.4
Actual Inflation		**1.4**	**4.6**	**4.9**	**4.7**	**1.6**

Dependent Variable	***Type of Regression***	***Contribution to Inflation in:***				
	Developed	England - 92	Sweden - 92	Italy - 92	Spain - 92	Finland - 92
Constant		3.8	3.5	4.1	4.4	3.8
GDP deviation	0.033	0.0	-0.2	0.0	-0.1	-0.1
Initial Inflation	4.701	1.1	1.0	1.1	2.8	1.2
Openness	-0.033	-1.6	-1.8	-1.2	-1.2	-1.7
Real E deviation	-0.797	-2.8	-8.9	-4.7	-5.2	-4.4
Accumulated Depreciation	0.605	5.5	18.4	12.0	10.1	7.5
Predicted Inflation		6.0	12.1	11.4	10.7	6.3
Actual Inflation		**1.4**	**4.6**	**4.9**	**4.7**	**1.6**

Table 8c: 12-Month Inflation Prediction in Selected Crises Cases - Using Cross Terms

Dependent Variable	Type of Regression	Contribution to Inflation in:						
	General	Indonesia - 97	Brazil-99	Korea -97	Mexico-94	Thailand - 97	Malaysia -97	Phillipines-97
Constant		-0.4	0.0	0.4	6.6	0.9	-1.9	3.3
GDP*Ê	-0.055	-0.5	0.4	-0.1	0.0	0.1	-0.2	0.0
INF*Ê	0.770	2.5	-0.1	0.1	0.3	0.1	0.0	0.3
OPE*Ê	0.069	11.0	0.6	1.8	3.9	3.0	5.0	2.8
RER*Ê	-0.678	-37.5	-6.8	-2.4	-8.9	-5.1	-3.2	-2.6
GDP deviation	0.042	0.1	-0.6	0.2	0.0	-0.1	0.4	0.1
Initial Inflation	2.423	2.7	-0.4	0.8	0.9	0.4	0.2	2.5
Openness	0.027	1.5	0.5	2.0	1.5	2.5	5.0	2.9
Real E deviation	-0.694	-13.5	-13.9	-7.2	-9.4	-11.2	-8.6	-7.2
Accumulated Depreciation	0.492	140.1	24.6	16.9	47.7	22.9	18.8	18.2
Predicted Inflation		106.2	4.3	12.4	42.6	13.4	15.5	20.1
Actual Inflation		**82.2**	**8.9**	**6.6**	**51.7**	**10.0**	**5.8**	**9.9**

Note: Brazil is an estimate for the first 12-Month

Dependent Variable	Type of Regression	Contribution to Inflation in:						
	Developed	Indonesia - 97	Brazil-99	Korea -97	Mexico-94	Thailand - 97	Malaysia -97	Phillipines-97
Constant		0.0	0.0	0.0	0.0	0.0	0.0	0.0
GDP*Ê	0.246	2.0	-1.7	0.4	0.0	-0.3	0.9	0.1
INF*Ê	1.983	6.4	-0.2	0.2	0.7	0.2	0.1	0.8
OPE*Ê	0.632	101.2	5.6	16.7	35.6	27.4	45.5	25.3
RER*Ê	1.342	74.3	13.4	4.8	17.6	10.1	6.4	5.2
GDP deviation	0.033	0.1	-0.5	0.2	0.0	-0.1	0.3	0.0
Initial Inflation	4.246	4.8	-0.8	1.4	1.5	0.7	0.3	4.5
Openness	-0.031	-1.7	-0.5	-2.4	-1.8	-2.9	-5.8	-3.4
Real E deviation	-0.398	-7.7	-8.0	-4.1	-5.4	-6.5	-4.9	-4.2
Accumulated Depreciation	-0.083	-23.8	-4.2	-2.9	-8.1	-3.9	-3.2	-3.1
Predicted Inflation		155.5	3.2	14.3	40.1	24.8	39.4	25.3
Actual Inflation		**82.2**	**8.9**	**6.6**	**51.7**	**10.0**	**5.8**	**9.9**

Dependent Variable	Type of Regression	Contribution to Inflation in:						
	Emerging	Indonesia - 97	Brazil-99	Korea -97	Mexico-94	Thailand - 97	Malaysia -97	Phillipines-97
Constant		-4.8	0.0	-3.7	3.1	-3.4	-10.5	-0.6
GDP*Ê	-1.029	-8.4	7.3	-1.8	0.0	1.3	-3.6	-0.5
INF*Ê	0.740	2.4	-0.1	0.1	0.3	0.1	0.0	0.3
OPE*Ê	-0.911	-145.9	-8.1	-24.0	-51.3	-39.5	-65.6	-36.5
RER*Ê	-1.305	-72.2	-13.0	-4.7	-17.1	-9.8	-6.2	-5.0
GDP deviation	0.039	0.1	-0.6	0.2	0.0	-0.1	0.4	0.1
Initial Inflation	0.831	0.9	-0.1	0.3	0.3	0.1	0.1	0.9
Openness	0.107	6.0	1.9	8.3	6.2	10.0	20.2	11.6
Real E deviation	-0.744	-14.5	-14.9	-7.8	-10.0	-12.1	-9.2	-7.8
Accumulated Depreciation	1.144	326.1	57.2	39.2	110.9	53.2	43.7	42.3
Predicted Inflation		89.9	29.6	6.1	42.4	-0.2	-30.6	4.7
Actual Inflation		**82.2**	**8.9**	**6.6**	**51.7**	**10.0**	**5.8**	**9.9**

Table 8d: 12-Month Inflation Prediction in Selected European Crises Cases - Using Cross Terms

Dependent Variable	*Type of Regression*	*Contribution to Inflation in:*				
	Developed	England - 92	Sweden - 92	Italy - 92	Spain - 92	Finland - 92
Constant		4.2	4.3	5.2	5.3	4.2
GDP*Ê	0.2464	0.0	-3.6	0.0	-0.1	0.1
INF*Ê	1.9826	0.0	0.1	0.1	0.2	0.1
OPE*Ê	0.6317	2.8	10.4	4.5	4.0	4.1
RER*Ê	1.3419	0.4	4.6	1.6	1.5	0.9
GDP deviation	0.0327	0.0	-1.6	0.0	-0.1	0.1
Initial Inflation	4.2463	1.0	0.9	1.0	2.5	1.1
Openness	-0.0310	-1.5	-1.7	-1.1	-1.2	-1.6
Real E deviation	-0.3980	-1.4	-4.5	-2.3	-2.6	-2.2
Accumulated Depreciation	-0.0833	-0.8	-2.5	-1.7	-1.4	-1.0
Predicted Inflation		4.8	6.5	7.4	8.0	5.7
Actual Inflation		**1.4**	**4.6**	**4.9**	**4.7**	**1.6**

Dependent Variable	*Type of Regression*	*Contribution to Inflation in:*				
	General	England - 92	Sweden - 92	Italy - 92	Spain - 92	Finland - 92
Constant		2.0	1.0	3.4	3.5	1.4
GDP*Ê	-0.055	0.0	0.8	0.0	0.0	0.0
INF*Ê	0.770	0.0	0.0	0.0	0.1	0.0
OPE*Ê	0.069	0.3	1.1	0.5	0.4	0.4
RER*Ê	-0.678	-0.2	-2.3	-0.8	-0.7	-0.5
GDP deviation	0.042	0.0	-2.0	0.0	-0.1	0.1
Initial Inflation	2.423	0.6	0.5	0.6	1.4	0.6
Openness	0.027	1.3	1.4	1.0	1.0	1.4
Real E deviation	-0.694	-2.4	-7.8	-4.1	-4.5	-3.8
Accumulated Depreciation	0.492	4.4	15.0	9.8	8.2	6.1
Predicted Inflation		6.0	7.9	10.4	9.3	5.8
Actual Inflation		**1.4**	**4.6**	**4.9**	**4.7**	**1.6**

Table 9: Comparing 12-Month Predictions of Different Models

	Actual		**Predictions**						
			Borensztein &	**Without Cross Terms**			**With Cross Terms**		
	Depreciation	Inflation	**De Gregorio**	General	Emerging	Developed	General	Emerging	Developed
Indonesia 97.8	285.1	82.2	111.9	**185.2**	233.9	160.5	106.2	89.9	155.5
Brazil 99.1	50.0	8.9	na	**12.7**	15.4	12.4	4.3	29.6	3.2
Korea 97.7	34.3	6.6	18.0	**14.8**	18.7	11.6	12.4	6.1	14.3
Mexico 94.12	97.0	51.7	56.0	**61.6**	70.5	47.7	42.6	42.4	40.1
Thailand 97.6	46.5	10.0	19.1	**18.0**	21.5	12.9	13.4	-0.2	24.8
Malaysia 97.6	38.2	5.8	34.8	**16.4**	23.4	7.8	15.5	-30.6	39.4
Phillipines 97.7	37.0	9.9	24.7	**21.5**	23.2	15.5	20.1	4.7	25.3

	Actual		**Predictions**			
			Without Cross Terms		**With Cross Terms**	
	Depreciation	Inflation	General	Developed	General	Developed
England-92	9.0	1.4	5.7	6.0	6.0	4.8
Sweden-92	30.5	4.6	11.0	12.1	7.9	6.5
Italy-92	19.9	4.9	11.8	11.4	10.4	7.4
Spain-92	16.7	4.7	9.8	10.7	9.3	8.0
Finland-92	12.4	1.6	5.4	6.3	5.8	5.7

VI. Using expectations

One possibility for the upward bias of the forecasts is that the specification does not capture properly the role of expectations. If expectations are taken into account one could argue that only changes in the nominal exchange rate perceived to be permanent should affect inflation. Therefore, controlling for expectations, the direct pass-through effect should be smaller.

The paper uses a survey-based measure of expectations from the *FT Currency Forecasters* magazine. The magazine collects opinions/estimates of 140 specialists for the future exchange rate for 27 countries. This is a much smaller sample than the one used in this paper (171 countries). In order to compare the effect of expectations on the results, we redid the exercise in the previous sections, using only the restricted sample.[5] The expectation variable is calculated as the expected exchange rate variation for the next 3 or 6 months. The estimation is based in the following linear form:

$$(4)\quad P_{i,[t,t+j]} = b_0 + b_1\,\hat{e}_{i,[t-1,t+j-1]} + b_2 RER_{i,t(-1)} + b_3 GDP_{i,t} + b_4 P_{i,t(-1)} + b_5 OPE_{i,t} + b_6 E(\hat{e})_{i,[t,t+j]} + u_{i\,t},$$

It is important to note the timing that the expectations variable is introduced. Initially, the expectations were introduced a one month after the beginning of the nominal exchange rate depreciation (at time t). In this way, the expectations are formed with the knowledge of the initial extent of depreciation. If the agents expect a reversal in the depreciation process in the next few months, as opposed to a permanent depreciation, one would expect a smaller adjustment in domestic prices.

The results are shown in Table 10. Using expectations for 3 and 6 months (longer horizons are not adequate since one would expect some learning during the process and the expectations at time t would not be representative of future adjustment of prices). The pass-through coefficient increases when one includes the expectation variable, but only marginally.

For 6 months, the devaluation expectation coefficient was significantly positive, confirming that the more the exchange rate is expected to depreciate the greater is the markup of prices. However, the coefficient is relatively small, suggesting that either the expected permanent depreciation is small or that the initial exchange rate expectations do not affect substantially inflation in the next 3 or 6 months.[6]

One could argue that it is important to measure expectations before the agents know the extent of depreciation (at time t-1). The rational is to check the effect of unexpected depreciation on inflation. However, in the bottom panel of Table 10, one can see that there are no significant changes in the results.

The cross terms model results may shed light on the effect of expected depreciation on inflation (Table 11). The effect of the control variables on the "passthrough" from expected depreciation to inflation is, in general, not significant (see the cross terms coefficients at the bottom of the table). This is in contrast to the significant cross term coefficients regarding the passthrough of actual depreciation to inflation. Interestingly, the pure expected devaluation coefficient is reasonably high compared to the pure devaluation coefficient, in accordance to the "permanent hypothesis." Therefore, the cross term regression allows us to conclude that exchange rate expectations work as expected directly, but not through the same channels that actual depreciation affects inflation.

This section has investigated the role of expectations on the passthrough coefficients and its determinants. We found that although statistically significant, the effect of expectations on inflation is relatively small. This result is robust to changing the timing of the expectations variable (t or t-1). One probable reason for this result is that the horizon analyzed is large enough such that agents' expectations at the beginning of the period may not represent their beliefs along the period. Therefore, price changes throughout the period may not always be correlated to expectations measured at the beginning of the period. Nevertheless, the effect of expectations becomes relevant and dominates the direct impact of depreciation once the effect of our main determinants of passthrough (RER, openness, initial inflation, GDP deviation) is factored in. In other words, it is only the direct impact of the passthrough

---

[5] In this way, any type of bias problem when comparing the model with and without expectations is avoided.
[6] The emphasis here is on the fact that expectations are measured at the beginning of the period.

coefficient (or the passthrough residual after controlling for its determinants) that is affected by the permanent/temporary distinction.

Table 10: Pass-through Regressions Using Expectations from Survey

Expected Depreciation at t

Dependent Variable Accumulated Inflation - RE Estimation									
	6 months				*3 months*				Expected Sign
	*coefficient**	*P-Value*	*coefficient*	*P-Value*	*coefficient*	*P-Value*	*coefficient*	*P-Value*	
GDP deviation	0.022	0.037	0.036	0.007	0.008	0.137	0.013	0.046	+
Initial Inflation	2.820	0.000	2.516	0.000	1.590	0.000	1.574	0.000	+
Openness	-0.012	0.006	-0.009	0.202	-0.005	0.015	-0.006	0.081	-
Real E deviation	-0.329	0.000	-0.378	0.000	-0.080	0.000	-0.095	0.000	-
Accumulated Depreciation	0.377	0.000	0.434	0.000	0.153	0.000	0.190	0.000	+
Depreciation Expectation			0.022	0.000			0.003	0.120	+

Note: GDP deviation, Depreciation Expectation and Openness are at time t. Initial Inflation, Real E deviation and Accumulated Depreciation are at time t-1.
*Calculated only for 27 countries with avaiable data from the survey.

Lagged Expected Depreciation (t-1)

Dependent Variable Accumulated Inflation - RE Estimation									
	6 months				*3 months*				Expected Sign
	*coefficient**	*P-Value*	*coefficient*	*P-Value*	*coefficient*	*P-Value*	*coefficient*	*P-Value*	
GDP deviation	0.022	0.037	0.039	0.027	0.008	0.137	0.016	0.024	+
Initial Inflation	2.820	0.000	2.517	0.000	1.590	0.000	1.575	0.000	+
Openness	-0.012	0.006	-0.010	0.261	-0.005	0.015	-0.005	0.095	-
Real E deviation	-0.329	0.000	-0.373	0.000	-0.080	0.000	-0.094	0.000	-
Accumulated Depreciation	0.377	0.000	0.437	0.000	0.153	0.000	0.190	0.000	+
Depreciation Expectation			0.015	0.023			0.004	0.053	+

Note: GDP deviation and Openness are at time t. Initial Inflation, Real E deviation, Accumulated Depreciation and Depreciation Expectation are at time t-1.
*Calculated only for 27 countries with avaiable data from the survey.

Table 11:Pass-through Regressions using Expectations with cross terms

Dependent Variable Accumulated Inflation - Fixed Estimation								
	6 months				3 months			
	coefficient*	P-value	coefficient	P-value	coefficient	P-value	coefficient	P-value
GDP*Ê	1.686	0.000	1.318	0.000	0.737	0.000	0.537	0.000
INF*Ê	1.642	0.000	2.194	0.000	1.273	0.000	1.534	0.000
OPE*Ê	-0.171	0.000	-0.244	0.000	-0.103	0.000	-0.160	0.000
RER*Ê	-0.359	0.000	-0.434	0.000	-0.026	0.559	-0.089	0.086
GDP deviation	0.004	0.622	0.460	0.000	0.001	0.782	0.573	0.000
Initial Inflation	2.140	0.000	-0.638	0.000	1.124	0.000	-0.143	0.000
Openness	0.000	0.944	-0.201	0.000	-0.001	0.679	-0.004	0.657
Real E deviation	-0.151	0.000	-0.667	0.000	-0.061	0.000	-0.072	0.309
Accumulated Depreciation	0.270	0.000	0.019	0.060	0.153	0.000	0.006	0.213
Depreciation Expectation			1.755	0.000			0.911	0.000
GDP*EXP			-0.008	0.091			-0.003	0.220
INF*EXP			-0.116	0.000			-0.055	0.000
OPE*EXP			0.276	0.000			0.177	0.000
RER*EXP			0.112	0.000			-0.002	0.786

Note: GDP deviation and Openness are at time t. Initial Inflation, Real E deviation, Accumulated Depreciation and Depreciation Expectation are at time t-1
*Calculated only for 27 countries with avaiable data from the survey.

VII. Robustness Checks

This section performs important sensitivity tests of the results to other specifications and to the sample chosen. First, it investigates the influence of both openness and GDP deviation on the pass-through coefficient, under different specifications. Second, it analyzes the results when the sample does not include any overlapping in the data and, also, when the sample is subdivided randomly.

The effect of the business cycle on the passthrough coefficient has proven to be sensitive to the time horizon chosen. For example, on Table 5, the 12-month cross term coefficient of GDP deviation and depreciation is insignificant. We have argued that the probable reason is that the level of activity at t has little effect on the degree of pass-through close to t+12. In order to confirm this important hypothesis, we run the same equation but using the GDP Deviation variable at time t+6, or in other words, in the middle of the studied period. Table 12 shows the regression results. Note that we now obtain a statistically and economically significant coefficient on the cross term GDP-depreciation variable.

Table 12: Pass-through Panel Regressions with Cross Terms

GDP T+6

12 Months	coefficient	P-value	Expected Sign
GDP*Ê	0.580	0.000	+
INF*Ê	0.755	0.000	+
OPE*Ê	0.051	0.001	+
RER*Ê	-0.678	0.000	-
GDP deviation	0.019	0.089	+
Initial Inflation	2.406	0.000	+
Openness	0.023	0.009	-
Real E deviation	-0.696	0.000	-
Accumulated Depreciation	0.513	0.000	+

The trade openness variable is also sensitive to the specification and not always behaves according to the theory. One possibility is that trade openness variable is reacting to the degree of indebtedness of the countries that compose the sample. Terra (1998) argues that openness has a stronger effect on inflation the more indebted is the country. The reason is that the public external debt repayments depend on a dual resource transfer: trade surpluses have to be generated to make debt repayments and inflation tax is needed to transfer resources from the private to the public sector. The more indebted is the country, the more inflation needs to be generated for a given degree of openness. In order to verify this hypothesis, we subdivided the sample in more or less indebted countries (see appendix for the list of countries).

The results for the cross and non-cross term's models are summarized in Table 13. The trade openness variable appears statistically insignificant in 6 and 12 months for both groups of countries, except for 12-months for the less indebted countries where the sign is significantly positive (instead of negative). Therefore, it is not the degree of indebtedness of some countries that weakens the results. It is interesting to realize that these negative results contradict findings of both Romer (1993) and Terra (1998), since we do not find a relationship between inflation and openness, even if one isolates only the highly indebted countries. One possibility to reconcile the results is that the effect is captured by our other determinants, as for example RER deviation or initial inflation.

One could argue that the large number of observations attained was only possible due to the overlapping of data. In other words, when an annual analysis uses data from January to January, and from February to February, etc, much of the information for each of these periods is repeated in subsequent periods. In order to test the result's sensibility to this effect we use only non-overlapping data, basically using annual data. The result can be seen in table 14. Almost all the variable's magnitudes and signs continued to be close to those obtained in previous sections.

Finally, it is possible to argue that there may be a sample bias problem in some of the subdivisions made in the paper. In order to test the sensitivity of the results to sample bias, two samples were constructed randomly and the results compared. Table 15 shows the results. The sign and the magnitude of the coefficients was reasonably similar between the two samples which implies that the choice of the countries participating in the sample may not have influenced the results.

This section has hinted the reasons why the GDP deviation is not significant for some specifications. The GDP deviation at time t+6 seems to more representative of the business cycle during the period than the initial GDP deviation at time t. This section has also shown that the results are robust to different sampling and to using non-overlapping data.

Table 13: Pass-through Panel Regressions Without Cross Terms

Less Indebted countries

Dependent Variable: Accumulated inflation rate (t to t+12)

Variable	Coefficient	Expected Sign	t-Statistic	P-value
GDP deviation	-0.006	+	-0.161	0.872
Initial Inflation	1.373	+	2.956	0.003
Openness	0.037	-	2.440	0.015
Real E deviation	-1.004	-	-3.604	0.000
Accumulated Depreciation	0.644	+	3.683	0.000

Dependent Variable: Accumulated inflation rate (t to t+6)

Variable	Coefficient	Expected Sign	t-Statistic	P-value
GDP deviation	0.020	+	1.085	0.278
Initial Inflation	1.125	+	5.963	0.000
Openness	0.004	-	0.648	0.517
Real E deviation	-0.448	-	-4.186	0.000
Accumulated Depreciation	0.431	+	3.431	0.001

More Indebted countries

Dependent Variable: Accumulated inflation rate (t to t+12)

Variable	Coefficient	Expected Sign	t-Statistic	P-value
GDP deviation	0.024	+	7.441	0.000
Initial Inflation	1.324	+	1.539	0.124
Openness	0.065	-	1.806	0.071
Real E deviation	-1.272	-	-3.406	0.001
Accumulated Depreciation	0.641	+	3.115	0.002

Dependent Variable: Accumulated inflation rate (t to t+6)

Variable	Coefficient	Expected Sign	t-Statistic	P-value
GDP deviation	0.016	+	5.267	0.000
Initial Inflation	0.970	+	2.269	0.023
Openness	0.006	-	1.423	0.155
Real E deviation	-0.591	-	-6.874	0.000
Accumulated Depreciation	0.431	+	5.302	0.000

Note: GDP deviation and Openness are at time t. Initial Inflation, Real E deviation and Accumulated Depreciation are at time t-1. White-Corrected standard errors.
Source: List of indebted countries in appendix

Table 14: Pass-through Panel Regressions With Cross Terms Without Overlapping

months	6		12		Expected Sign
	coefficient	P-value	coefficient	P-value	
GDP*Ê	2.149	0.000	3.128	0.000	+
INF*Ê	1.000	0.000	1.411	0.000	+
OPE*Ê	0.051	0.094	-1.303	0.000	+
RER*Ê	-0.457	0.000	-4.568	0.000	-
GDP deviation	0.022	0.145	0.043	0.813	+
Initial Inflation	1.162	0.000	-0.974	0.054	+
Openness	-0.014	0.116	0.012	0.814	-
Real E deviation	-0.392	0.000	-1.026	0.000	-
Accumulated Depreciation	0.376	0.000	1.846	0.000	+

Note: Estimated with Fixed Effects and Cross Section Weights

Table 15: Pass-through Panel Regressions Without Cross Terms

Random Sample 1

Dependent Variable: Accumulated inflation rate (t to t+12)

Variable	Coefficien	Expected Sig	t-Statistic	P-value
GDP deviation	0.023	+	4.174	0.000
Initial Inflation	2.988	+	2.242	0.025
Openness	0.067	-	12.212	0.000
Real E deviation	-0.927	-	-2.529	0.012
Accumulated Depreciation	0.581	+	2.646	0.008

Random Sample 2

Dependent Variable: Accumulated inflation rate (t to t+12)

Variable	Coefficien	Expected Sig	t-Statistic	P-value
GDP deviation	0.020	+	1.054	0.292
Initial Inflation	2.187	+	1.238	0.216
Openness	0.039	-	1.834	0.067
Real E deviation	-1.364	-	-2.111	0.035
Accumulated Depreciation	0.812	+	1.997	0.046

VIII. Conclusions

The paper reached a few results that are worth summarizing. First, with respect to the overall effect of exchange rate depreciation on inflation, we find that the pass-through coefficient increases the longer is the time horizon analyzed, the 12-months coefficient is more than 4 times larger than the 3-month coefficient. The pass-through coefficient has its maximum value at a 12-month horizon. The pass-through is substantially lower in OECD (or developed countries) relative to emerging market economies. Europe, Africa and Oceania have a substantial lower pass-through coefficient than Asia and America.

Second, regarding the determinants of the passthrough, the paper finds that, in general, the RER overvaluation, initial inflation, trade openness and GDP deviation do affect the pass-through coefficient but in different degrees. The most robust determinants are the RER overvaluation and the initial inflation. RER overvaluation is particularly important for the passthrough coefficient in the American region but has influence in other regions' passthrough coefficient too. Initial inflation is a particularly important determinant for European countries. The influence of RER increases as the horizon increases while the influence of initial inflation is limited to 6-month horizon. The GDP deviation and openness variables are more sensitive to the horizon and sample chosen. The GDP gap has an important effect within a 6-month period. However, the sign reverses at a 12-month horizon. The probable reason is that the level of activity at t has little effect on the degree of pass-through close to t+12. In essence, it is possible that devaluations are counter-cyclical making the initial GDP gap negatively correlated to future pass-through of the inflation. Openness is particularly important for the pass-through coefficient in Africa and Oceania.

Third, we used our estimations to predict passthroughs in known large depreciations cases, following currency crisis. The forecasts presented in the paper seem to predict better than previous studies, in particular, the complete model, that includes the cross terms, fares well. Notwithstanding these results we find that there is a systematic upward bias in the prediction of inflation in these crises cases. The main lesson for emerging markets is that one must take into account the RER overvaluation in the country in order to better predict inflation.

Equivalently, the effect of the initial inflation is fundamental to access inflation in Europe or in developed countries in general.

Fourth, in search of an explanation of the upward bias of our results, the paper investigated the role of expectations in influencing the passthrough coefficient. We find that although statistically significant, the effect of expectations on inflation is relatively small. This result is robust to changing the timing of the expectations variable (t or t-1). One probable reason for this result is that the horizon analyzed is large enough such that agents' expectations at the beginning of the period may not represent their beliefs along the period. Therefore, price changes throughout the period may not always be correlated to expectations measured at the beginning of the period. Nevertheless, the effect of expectations becomes relevant and dominates the direct impact of depreciation once the effect of our main determinants of passthrough (RER, openness, initial inflation, GDP deviation) is factored in. In other words, it is only the direct impact of the passthrough coefficient (or the passthrough residual after controlling for its determinants) that is affected by the permanent/temporary distinction. Finally, the results of the paper are robust to different sampling and to using non-overlapping data.

XI. References

Amitrano, A., De Grauwe, P. e Tullio,G. “Why Has Inflation Remained So Low After the Large Exchange Rate Depreciations of 1992?”. *Journal of Common Market Studies.* Vol. 35, 1997.

Borensztein, E. e De Gregorio, J. “Devaluation And Inflation After Currency Crises”. mimeo, 1999.

Campa, J. e Goldberg, L. "Investment, Pass-Through and Exchange Rates: A Cross-Country Comparison”. *National Bureau of Economic Research* n^{o} 5139, 1995.

De Grauwe, P. e Tullio, G. “The Exchange Rate Changes of 1992 and Inflation Convergence in the EMS”. Longman, 1993.

Dornbusch, R. “Exhange Rates and Prices”. *American Economic Rewiew* vol. 77, 1987.

Feenstra, R. C. e Kendal, J. D. "Pass-Through of Exchange Rates and Purchasing Power Parity". *National Bureau of Economic Research* n^{o} 4842, 1994.

Fisher, E. “A Model of Exchange Rate Pass-Through”. *Journal of International Economics* vol. 26, 1989.

Goldfajn, I. and Valdés. R. “The Aftermath of Appreciations,” Quarterly Journal of Economics, vol. 114, No. 1, 1999.

Goldfajn, I. and Gupta. P. “Does tight monetary policy stabilize the currency?” Puc-Rio Working Paper No. 396 , 1998.

Goldberg, P.K. e Knetter, M. “Goods Prices and Exchange Rates: What Have We Learned?”. *Journal of Economic Literature* vol. 35, 1997.

Klein, M. “Macroeconomic Aspects of Exchange Rate Pass-Through”. *Journal of International Money and Finance* vol 9,1990.

Romer, D. “Openness and Inflation,” Quarterly Journal of Economics, vol. 108, 1993.

Taylor, John . “Low Inflation, Pass-Through, and the Pricing Power of Firms” mimeo Stanford Universtity.

Terra, M.C. “Openness and Inflation: a comment,” Quarterly Journal of Economics, vol. 113, 1998.

Fisher, S, Dorbusch and Samuelson, P.A , "Comparative Advantage, Trade and Payments in a Ricardian Model with a Continuum of Goods" American Economic Review, vol 67, No 5. 1977

X. Appendix

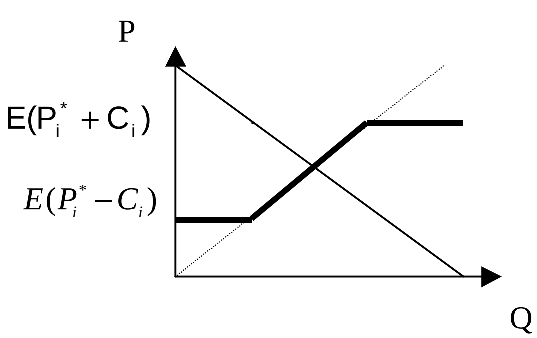
This model describes the effect of openness and other variables on the passthrough coefficient. There is an small open economy with an infinite amount of goods, as in Dorbusch, Fischer and Samuelson (1977), with a uniform transport cost proportional to each good's international price. Each good has an international price that is distributed uniformly around an average international price:

$$P_i^* = \overline{\mathrm{P}} \,.\, \tilde{\mathrm{i}}$$

where $\tilde{i} \sim \mathrm{U}(0,1)$ and

$$C_i = qP_i^*$$

The demand and supply of each good, Including imports and exports, is given by:



$$P_i^d = \mathrm{A} - \mathrm{Q}$$

$$\mathrm{P}_i^s = \begin{cases} \mathrm{E}(\mathrm{P}_i^* - C_i) \;\text{ if }\; \mathrm{Q} \leq \mathrm{E}(\mathrm{P}_i^* - C_i) \\ Q_i \;\text{ if }\; \mathrm{E}(\mathrm{P}_i^* - C_i) < \mathrm{Q} < \mathrm{E}(\mathrm{P}_i^* + C_i) \\ E(P_i^* + C_i) \;\text{ if }\; \mathrm{Q} \geq \mathrm{E}(\mathrm{P}_i^* + C_i) \end{cases}$$

The equilibrium price is:

$$P = \begin{cases} \mathrm{E}(\mathrm{P}_{\mathrm{i}}^{*} - C_i) \text{ if } \dfrac{\mathrm{A}}{2} \leq \mathrm{E}(\mathrm{P}_{\mathrm{i}}^{*} - C_i) \\ \dfrac{A}{2} \text{ if } \mathrm{E}(\mathrm{P}_{\mathrm{i}}^{*} - C_i) < \dfrac{\mathrm{A}}{2} < \mathrm{E}(\mathrm{P}_{\mathrm{i}}^{*} + C_i) \\ E(P_i^{*} + C_i) \text{ if } \dfrac{\mathrm{A}}{2} \geq \mathrm{E}(\mathrm{P}_{\mathrm{i}}^{*} + C_i) \end{cases}$$

Therefore:

$$\tilde{P}_i = \begin{cases} E(1-q)\,\overline{\mathrm{P}}\,\tilde{\mathrm{i}} \text{ if } \dfrac{\mathrm{A}}{2\mathrm{E}\overline{\mathrm{P}}(1\text{-}q)} \leq \tilde{\mathrm{i}} \\ \dfrac{\mathrm{A}}{2} \text{ if } \dfrac{\mathrm{A}}{2\mathrm{E}\overline{\mathrm{P}}(1\text{-}q)} < \tilde{\mathrm{i}} < \dfrac{\mathrm{A}}{2\mathrm{E}\overline{\mathrm{P}}(1+q)} \\ \mathrm{E}(1+q)\overline{\mathrm{P}}\,\tilde{\mathrm{i}} \text{ if } \dfrac{\mathrm{A}}{2\mathrm{E}\overline{\mathrm{P}}(1+q)} \geq \tilde{\mathrm{i}} \end{cases}$$

The domestic price level is given by:

$$E\left[\tilde{P}_i\right] = \int_0^1 \tilde{\mathrm{P}}_{\mathrm{i}}\,\mathrm{di} = \int_0^{\frac{\mathrm{A}}{2\mathrm{E}\overline{\mathrm{P}}(1+q)}} \mathrm{E}(1+q)\,\overline{\mathrm{P}}\,i\,\mathrm{di} + \int_{\frac{\mathrm{A}}{2\mathrm{E}\overline{\mathrm{P}}(1+q)}}^{\frac{\mathrm{A}}{2\mathrm{E}\overline{\mathrm{P}}(1\text{-}q)}} \frac{\mathrm{A}}{2}\,\mathrm{di} + \int_{\frac{\mathrm{A}}{2\mathrm{E}\overline{\mathrm{P}}(1\text{-}q)}}^{1} \mathrm{E}(1\text{-}q)\overline{\mathrm{P}}\,i\,\mathrm{di}$$

where we assumed that:

$$\frac{A}{2E\overline{P}(1-q)} \leq 1$$

$$\text{or} \quad \mathrm{E} \geq \underline{\mathrm{E}} \quad \text{where} \quad \underline{E} = \frac{\mathrm{A}}{2\overline{\mathrm{P}}(1\text{-}q)}$$

So that:

$$\left(E(1+q)\,\bar{P}\,\frac{i^2}{2}\right)\Bigg]_0^{\frac{A}{2E\bar{P}(1+q)}} + \frac{A}{2}\left[\frac{A}{2E\bar{P}(1-q)} - \frac{A}{2E\bar{P}(1+q)}\right] + \left(E(1-q)\,\bar{P}\,\frac{i^2}{2}\right)\Bigg]_{\frac{A}{2E\bar{P}(1-q)}}^{1} =$$

$$= \frac{E(1+q)\,\bar{P}}{2}.\left(\frac{A}{2E\bar{P}(1+q)}\right)^2 + \frac{A^2}{4E\bar{P}}.\left(\frac{(1+q)-(1-q)}{1-q^2}\right) + \frac{E(1-q)\,\bar{P}}{2}.\left[1-\left(\frac{A}{2E\bar{P}(1-q)}\right)^2\right]$$

and:

$$\frac{1}{8}.\frac{A^2}{E\bar{P}(1+q)} + \frac{A^2}{4E\bar{P}}.\frac{2q}{1-q^2} + \frac{E(1-q)\bar{P}}{2} - \frac{1}{8}.\frac{A^2}{E\bar{P}(1-q)} =$$

$$= \frac{1}{8}.\left[\frac{A^2}{E\bar{P}}\right].\left[\frac{1}{1+q} - \frac{1}{1-q}\right] + \frac{E(1-q)\bar{P}}{2} + \frac{A^2}{4E\bar{P}}.\left[.\frac{2q}{1-q^2}\right] =$$

$$= \frac{E(1-q)\bar{P}}{2} + \frac{A^2}{4E\bar{P}}.\left(\frac{q}{1-q^2}\right)$$

The domestic price level is a function of the nominal exchange rate as shown by the equation immediately above. The equation has a minimum at:

$$E_M = \frac{A}{\bar{P}}\,g^{\frac{1}{2}}$$

where $g = \dfrac{q}{2(1-q)(1-q^2)}$

It is easy to show that:

$\underline{E} \geq E_M$ if $q \in [0,1]$

Therefore, the part of interest to the function is always increasing and the pass-through coefficient is positive:

$$\frac{dP}{dE}\cdot\frac{E}{P}=\frac{1-\frac{A^2}{\overline{P}^2E^2}.g}{1+\frac{A^2}{\overline{P}^2}.g} > 0$$

In the relevant part of the equation above, one can verify that the pass –through coefficient is positively correlated to the transport cost θ. Since the latter also determines the degree of openness of the country (proportion of non tradable goods), the degree of openness is also positively correlated to the pass-through coefficient. Equivalently, one can verify that the pass-through increases with demand (parameter A in the model)

Table A6: List of Countries

Emerging	Developed	Developing
Argentina	Canada	Bolivia
Brazil	USA	Costa Rica
Chile	Austria	Ecuador
Colombia	Belgium	El Salvador
Mexico	Denmark	Guatemala
Peru	Finland	Haiti
Venezuela	France	Honduras
South Africa	Germany	Jamaica
Zimbabwe	Ireland	Paraguay
Greece	Italy	Trindad and Tobago
Hungary	Netherlands	Uruguay
Portugal	Norway	Burundi
Turkey	Spain	Burkina Faso
China	Sweden	Cameroon
India	Switzerland	Egypt
Jordania	United Kingdom	Ethiopia
Korea	New Zealand	Ghana
Malaysia	Singapore	Kenya
Nepal	Australia	Madagascar
Pakistan		Morocco
Philippines		Nicaragua
Thailand		Sierra Leone
Indonesia		Tunisia
Israel		Zambia
		Romania
		Bahrain
		Bangladesh
		Papau New Guinea

Table A7: Countries Crises Dates

Countries	Date	Countries	Date
Argentina	1980:06	Korea	1980:01
Argentina	1982:08	Peru	1987:10
Argentina	1989:04	Philippines	1983:10
Bolivia	1982:02	Spain	1992:09
Brazil	1983:02	Sweeden	1982:10
Brazil	1987:02	Sweeden	1992:09
Brazil	1990:03	Thailand	1984:11
Cameroon	1994:01	Turkey	1994:03
Chile	1982:06	United Kingdom	1992:09
Chile	1985:07	Uruguay	1982:11
Colombia	1985:02	Venezuela	1984:02
Colombia	1995:08	Venezuela	1986:12
Finlandia	1982:10	Venezuela	1989:02
Finlandia	1992:09	Venezuela	1994:05
Indonesia	1983:04	Mexico	1982:02
Indonesia	1986:09	Mexico	1994:12
Italy	1992:09		

Table A8: List of Countries

OECD	Non-OECD
Canada	Argentina
United States	Belgium
Austria	Bolivia
Finland	Brazil
France	Burkina Faso
Germany	Burundi
Greece	Cameroon
Hungary	Chile
Ireland	Colombia
Italy	Costa Rica
Netherlands	Denmark
Norway	Ecuador
Portugal	Egypt
Spain	El Salvador
Sweden	Ethiopia
Switzerland	Ghana
Turkey	Guatemala
United Kingdom	Haiti
Australia	Honduras
New Zealand	Jamaica
	Kenya
	Madagascar
	Malawi
	Mexico
	Morocco
	Nicaragua
	Paraguay
	Peru
	Sierra Leone
	South Africa
	Trinidad and Tobago
	Tunisia
	Uruguay
	Venezuela
	Zambia
	Zimbabwe

Table A9: List of Countries

Less indebted	More indebted
Argentina	Bolivia
Bangladesh	Malaysia
Brazil	Kenya
Burkina Faso	Honduras
China	Cameroon
Colombia	Ecuador
El Salvador	Jordan
Guatemala	Burundi
Haiti	Papua New Guinea
India	Tunisia
Indonesia	Ghana
Malawi	Nicaragua
Mexico	Jamaica
Nepal	Morocco
Pakistan	Ethiopia
Paraguay	Costa Rica
Romania	Philippines
South Africa	Hungary
Thailand	Chile
Trinidad and Tobago	Egypt
Turkey	Sierra Leone
Uruguay	Madagascar
Venezuela	Peru
Zimbabwe	Zambia

Table A10: List of Countries

Random Sample 1	Random Sample 2
Argentina	Jordan
Australia	Korea
Austria	Kenya
Bahrain	Madagascar
Bangladesh	Malawi
Belgium	Malaysia
Bolivia	Mexico
Brazil	Morocco
Burkina Faso	Nepal
Burundi	Netherlands
Cameroon	New Zealand
Canada	Nicaragua
Chile	Norway
China	Pakistan
Colombia	Paraguay
Costa Rica	Peru
Denmark	Philippines
Ecuador	Papua New Guinea
Egypt	Portugal
El Salvador	Romania
Ethiopia	Sierra Leone
Finland	Singapore
France	South Africa
Germany	Spain
Ghana	Sweden
Greece	Switzerland
Guatemala	Thailand
Haiti	Trinidad and Tobago
Honduras	Tunisia
Hungary	Turkey
India	United Kingdon
Indonesia	Uruguay
Ireland	United States
Israel	Venezuela
Italy	Zambia
Jamaica	Zimbabwe