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CONSUMER PRICE INFLATION AND EXCHANGE RATE PASS-THROUGH IN JAMAICA

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Abstract

The exchange rate has long been viewed as the nominal anchor in the design of monetary policy. However, recent trends in exchange rate movements and prices have raised questions about the nature of the pass-through. Against this background this paper analyses the relationship between exchange rate and prices in Jamaica and how this has evolved over the past twelve years. The results indicate that, in the long run, the exchange rate pass-through is 'complete'. However the extent of the pass-through has slowed in recent years due in part to the shift to a tighter monetary policy regime and increased competition. Despite this however, exchange rate movements still have a significant influence on prices and inflationary expectations.

JEL Classification: C52, E31, F31
Keywords: pass-through, inflation, exchange rate

[1] The views expressed are those of the author and do not necessarily reflect those of the Bank of Jamaica

CONTENTS

1.0 Introduction

The conduct of monetary policy and the ability of a central bank to respond adequately to different shocks, require an understanding of the transmission mechanism of monetary policy. In a small open economy such as Jamaica, the exchange rate provides an important transmission channel for monetary policy, in addition to the standard aggregate demand channel. The objective of this paper therefore is to understand the exchange rate pass-through, that is, the extent to which exchange rate changes alter relative prices.

The expression 'exchange rate pass-through' is generally used to refer to the effect of exchange rate changes on one of the following: (1) import and export prices[1], (2) consumer prices, (3) investments and (4) trade volumes. The primary focus of this paper is on the effects of exchange rate changes on consumer prices. This interest stems from the fact that changes in the exchange rate pass-through to consumer prices is integral to the design of monetary and exchange rate policies and an important indicator for the private sector. Additionally, a low exchange rate pass-through is thought to provide greater freedom for pursuing an independent monetary policy and facilitates inflation targeting.

Previous studies on Jamaica have found that the exchange rate pass-through to prices and wages is significant[2]. However, those analyses were conducted during a period of expansionary monetary policy. In contrast, over the past five years, money supply growth has been curtailed, inflation has fallen significantly and the economy has become more competitive. Consequently, the degree and pattern of exchange rate pass-through may have shifted.

In this context, this paper develops and tests an exchange rate pass-through model, similar to those used for Australia and New Zealand, concentrating primarily on the post 1995 period. The study hypothesizes that consequent on shifts in policy and other structural changes, the degree of exchange rate pass-through is less. Further, given barriers to entry and the role of imported goods, particularly food commodities, this pass-through varies across

[1] Data availability precludes an analysis of import and export prices.

[2] See Robinson, 1996.

commodities. To the extent that agriculture prices are influenced by seasonal factors, excluding them may indicate a 'true' picture of the pass-through process. On the other hand, it could be argued that because of the weight of agriculture prices in the CPI, excluding them may in fact bias the results. As such, the paper studies the effects on the All Jamaica Consumer Price Index (CPI), and the CPI excluding agriculture.

The paper finds that prior to 1996, a 1.0 per cent shock to the nominal exchange rate resulted in a 0.167 per cent increase in the consumer price level one month after the initial shock. The effect of the pass-through becomes zero after ten months. In the post 1995 period a 1.0 per cent depreciation of the nominal exchange rate leads to an increase of 0.11 per cent in the consumer price level after one month. The effect of the pass-through becomes zero after about eleven months. Additionally, excluding agriculture prices from the CPI, showed different results. Prior to 1996, a 1.0 per cent shock to the nominal exchange rate resulted in an increase in the CPI - excluding agriculture prices (CPIAG) increasing by 0.142 per cent one month after the initial shock. While in the post 1995 period, a 1.0 per cent shock to the nominal exchange rate resulted in a 0.134 per cent increase in the CPIAG, one month after the initial shock. While the pass through has lessened however, the influence of exchange rate movements on prices and expectations are still significant. Further, with the recovery in income and demand, suppliers will become more willing to pass on imported costs.

The remainder of the paper is organized as follows. Section 2 gives a brief discussion on the empirical and theoretical literature on exchange rate pass-through, which is followed by an overview of inflation and exchange rate trends in Jamaica, in Section 3. The data and empirical methodology are discussed in Section 4. The results are discussed in Section 5. Section 6 highlights and evaluates the effect of an unanticipated devaluation of the Jamaican currency. The conclusion is presented in Section 7.

2.0 Literature Review

According to Goldberg and Knetter (1997) exchange rate pass-through is defined as "the percentage change in local currency import prices resulting from a one percent change in the exchange rate between the exporting and importing countries." Two channels of exchange rate pass-through are identified in the literature: a direct channel and an indirect channel [3]. Both channels are equally important in an open economy. Taylor (2000) suggests another channel via expectations. According to this view, pass-through is highest when exchange rate changes are perceived to be persistent and prices adjust because of the expectations of the public. The transmission mechanism is demonstrated in the chart below.

The *direct* channel arises mainly because of the "law of one price"[4]and the purchasing power parity (PPP) in its aggregation. The paper alludes to the relative version of PPP, which claims that starting from a base of an equilibrium exchange rate between two currencies, the future of the exchange rate between the two currencies will be determined by the relative movements in the price levels in the two countries. For a given import price, changes in the exchange rate will translate directly into higher domestic prices.

$$P = E \bullet P^*$$

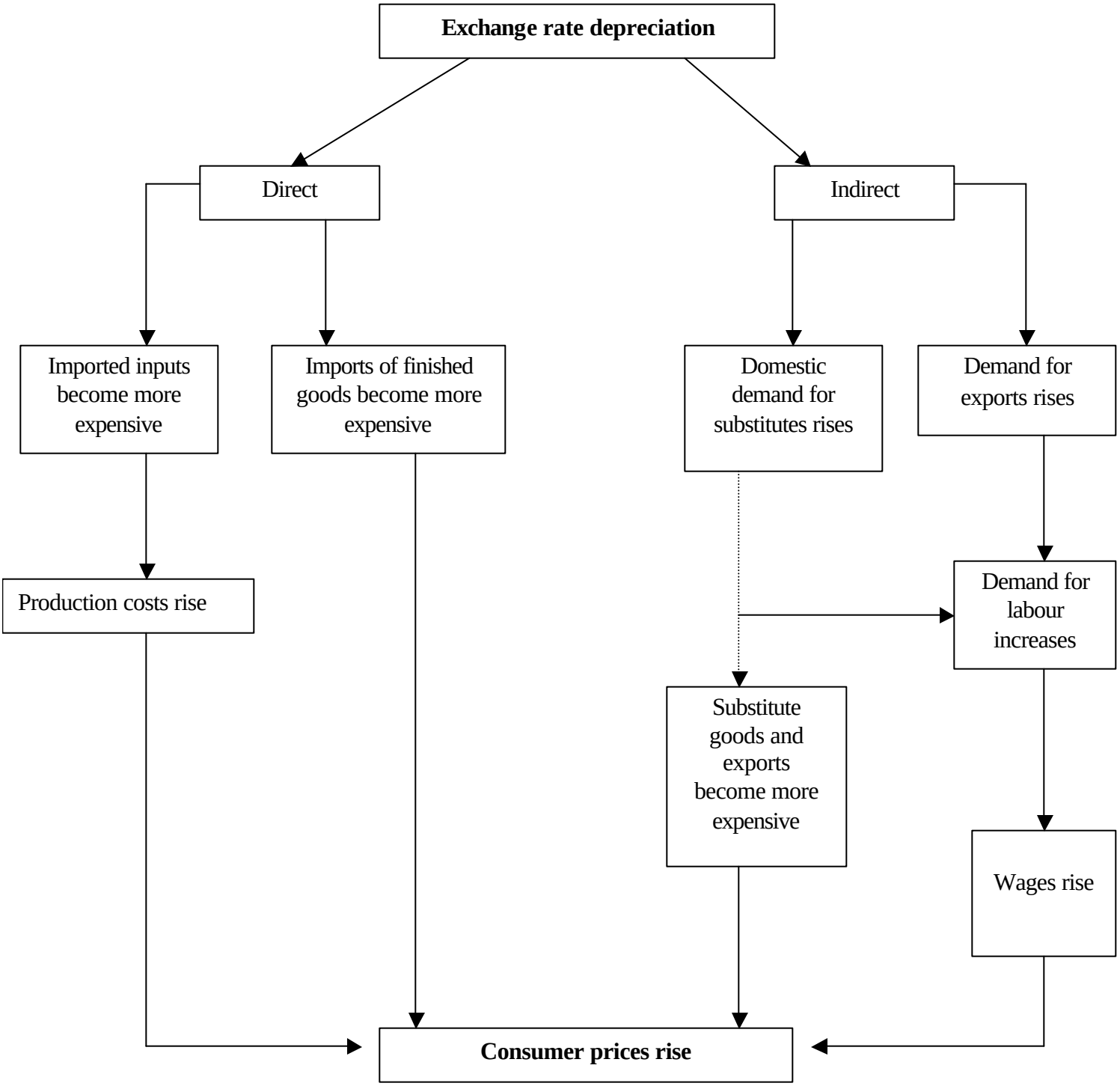
Where E is the exchange rate in terms of domestic currency per unit of foreign currency; P^* represents the foreign currency price of the imported good and P is the domestic currency price of the imported good. The pass-through is only complete (=100 percent) if (a) markups of prices over costs are constant and (b) marginal costs are constant [5].

[3] See Kahn, 1987, Menon, 1995 and Goldberg and Knetter, 1997 for an exhaustive discussion of exchange rate pass-through.

[4] See Menon (1991a) for a comprehensive discussion of the relationship between the law of one price and exchange rate pass-through.

[5] See Goldberg and Knetter, 1997:1248

CHART 1. Transmission Mechanism of Exchange Rate Pass-through



The *indirect* channel of exchange rate pass-through arises because of the impact on aggregate demand. A depreciation of the exchange rate makes domestic products relatively cheaper for foreign consumers, and as a consequence exports and aggregate demand will rise relative to potential output, inducing an increase in the domestic price level. Since nominal wage contracts are fixed in the short run, real wages will decrease and output will eventually increase. However, when real wages return to their original level over time, production costs then increases, the overall price level increases and output falls. Thus, in the end the exchange rate depreciation leaves a permanent increase in the price level with only a temporary increase in output [6].

The main factors that were found to influence the degree of pass-through are the openness and size of the economy. Other factors included relative elasticities of demand and supply for traded goods, macroeconomic conditions and the microeconomic environment. Kent (1995) argues that in the absence of other shocks, for exports, the degree of pass-through will increase the greater the elasticity of demand and the smaller the elasticity of supply. Conversely, for imports, the degree of pass-through will increase the lower the elasticity of demand and the greater the elasticity of supply. From this, Kent (1995) concludes that pass-through will be complete in the case of a small open economy, where exporters are assumed to face perfect elasticity of demand, while importers face perfect elasticity of supply, so that the country is a price taker in world markets.

Macroeconomic shocks may operate either to reinforce or counteract the influence of demand and supply elasticities. For instance, when domestic demand is buoyant or capacity is constrained, the extent of exchange rate pass-through for imports is likely to be high irrespective of the relative elasticities of demand and supply[7]. In fact, firms may face a macroeconomic shock of sufficient magnitude to generate a permanent change in the volume of goods traded and the degree of pass-through[8].

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[6] See Khan, 1987

[7] See Piggot and Reinhart, 1985 and Phillips, 1988

[8] This possibility is most often considered with respect to large changes in the exchange rate. However, such shocks may also include domestic demand.

There are a number of explanations for a low pass-through. Dornbusch (1987) and Krugman (1987) show that a less than one-to-one transmission can be explained by imperfect competition, and "pricing-to-market". When homogenous products are traded in an integrated world market, arbitrage eliminates differentials in the common currency price of goods. However, when markets are imperfectly competitive and segmented, a wide range of pricing responses is possible[9]. For example, if agents seek to maximize market share rather than profit, pass-through may be incomplete. Furthermore, if opportunities exist to discriminate between markets, "pricing-to-market" may occur, yielding different degrees of pass-through across a range of segmented markets.

Menon (1995) presents an overview of 43 empirical studies of exchange rate pass-through for both developed and developing countries. He found that the degree of pass-through was quite different across countries. This, he argued, resulted from the use of different methodology, model specification and variable selection, rather than from the different time periods studied. Although the degree of pass-through varies across countries and over time, a number of studies have found that the pass-through to consumer prices is generally weak or incomplete[10]. An implication of these results is that, a change in the nominal exchange rate might not lead to much substitution between domestically produced goods and internationally-produced goods, because the relative prices of those goods faced by the final consumer do not change much.

Following on Menon (1995), there has been some empirical work that attempted to improve on the methodological deficiencies of earlier studies. McCarthy (2000) investigated the exchange rate pass-through on the aggregate level for selected industrialized economies. He estimated a VAR model for the period 1976 – 1998 over the whole distribution chain [11] and finds that pass-through of exchange rate changes to consumer prices is modest in most of the analyzed countries. The import share of a country and the persistence of exchange rate

[9] Phillips, 1988 explores the microeconomic aspects of pass-through.

[10] See also Engel (1993) and Parsley and Wei (2001).

[11] Import, producer and consumer prices

changes were found to be positively correlated with the extent of pass-through to consumer prices, while exchange rate volatility was found to be negatively correlated. McCarthy (2000) found that the pass-through appears to be larger in countries with a higher import share of domestic demand, as well as in countries with more persistent exchange rate and import prices. He argued that if a country's import share can be assumed to be a good proxy for the import penetration faced by firms, then a country with a larger import share should have greater pass-through of exchange rate and import price fluctuations to domestic prices. In addition, both because of a direct effect as well as through a greater pass-through, exchange rates and import prices should be more important in explaining domestic price fluctuations as the import share increases.

Kim (1998) estimates the exchange rate pass-through for the USA using cointegration analysis and a vector error correction model (VECM). His paper relates producer price inflation in the USA to the trade weighted effective exchange rate, money supply, aggregate income and interest rates. In contrast to other studies, he finds that fluctuations in the exchange rate have a significant negative effect on the USA producer price inflation rate, which is supported by subsequent Granger causality tests. Kim posits that this outcome is due to the fact that inflation is caused by many other factors that also influence the demand for, and supply of, imports and exports. For instance, Kim (1998) argues that if an appreciation of the dollar is accompanied by reduced foreign supply, or by an increased demand for imports caused by a rapid growth in the money supply or income, the impact of the exchange rate change on the inflation would likely be neutralized or prices may even rise. Moreover, the exchange rate effects can be mitigated or even nullified by foreign suppliers adjusting their profit margin to absorb some or all of the impact of the price changes.

3.0 Exchange Rates and Inflation in Jamaica

With annual inflation rates averaging 23.94 per cent between 1990 and 2001, Jamaica may be considered a 'moderate' inflation economy. However, Figure 1 – Appendix shows that inflation has been trending downwards over the period, with monthly inflation averaging 2.72 per cent over the 1990 to 1995 period and 0.73 per cent over the 1996 to 2001 period. Much of the deviations from the average long run trend, which occurred primarily in 1991, corresponded to shocks from the exchange rate, money stock and structural shocks such as import prices and domestic costs[12].

Figure 1 - Appendix shows that the variation in the exchange rate is correlated with the trends in the inflation rate. Since 1990 the exchange rate has been market determined. With the introduction of this exchange rate regime, the Jamaican currency depreciated sharply against the U.S. dollar between late 1991 and early 1992. Against this background, the inflation rate increased significantly in the immediate period following the sharp depreciation in the Jamaican currency. In the 1990 to 1995 period, the movements in the exchange rate initially reflected the overvaluation, which previously existed and subsequently the looser monetary conditions. Beginning 1992, the Bank of Jamaica tightened monetary policy through higher reserve requirements. Since 1995, the Bank has focused monetary policy on inflation reduction through base money management.

Relatively low inflation rates have been recorded in the post 1995 period, with annual inflation rates averaging approximately 9.0 per cent. The monthly rates of inflation during the period fluctuated from a high of 3.3 per cent in February 1996 to a low of –1.1 per cent in February 1999. In this period, the Jamaican economy experienced increased trade liberalization as globalization became more predominant. Additionally, there has been increased competition in the domestic economy; this coupled with the fall in output following the financial crises of the mid to late 1990's would have had an impact on per

[12] See Robinson, 1996

capita income and hence aggregate demand. By 1997, inflation was 9.2 per cent, reflecting macroeconomic stability (See Figure 1 - Appendix)[13], and has fallen steadily each year.

[13] Figure 1 plot consumer price inflation and exchange rate changes, quarterly data. The exchange rate measure shown in the figure is calculated against a weighted average.

4.0 DATA and METHODOLOGY

4.1 Data

The empirical analysis is conducted using monthly data, which provides a reasonable sample size to study the exchange rate/inflation dynamics in the post 1995 period. The time span covered is January 1990 to December 2001. Inflation is measured by the change in the log of the headline consumer price index (CPI) and an adjusted CPI, which excludes *starchy foods* and *vegetables and fruits* (CPIAG). Exchange rate data are weighted average nominal exchange rates (NEXR) of the Jamaican currency vis-à-vis the U.S. currency. The U.S. currency was used since it is the currency of Jamaica's major trading partner. The Treasury Bill rates (average discount rates on 3-month instruments) (INTRATE) and base money (BM) are used to reflect changes in the Central Bank's behaviour. The variables were adjusted to capture the seasonal influences in the data. To get an indication of pass-through post 1995, the sample was split into two time periods 1990:01 to 1995:12 and 1996:01 to 2001:12.

4.2 Methodology

Given the absence of monthly output data, the analysis is restricted to focusing on the influence of the *direct* channel of pass-through. In this context the pass-through relation can be expressed most simply by the PPP relation in logs i.e.

$$p = bp^{*} + le \qquad (1)$$

The "law of one price" implies that $\beta=\lambda=1$ in which case changes in the exchange rate completely pass through to the domestic price of the traded good. If foreign prices are set as a markup over costs then (1) can be expressed as

$$p = b(1+m)c^{*} + le \qquad (2)$$

Where c^{*} symbolizes the cost of producing the goods and m represents foreign mark-up. This simple expression forms the basis of analyzing the long run pattern of exchange rate pass through. If the goods and factor markets in the foreign country are competitive and output shocks are temporary then the first term should be relatively stable over time.

Similar to Parsely and Popper (1998), the paper extends this expression to take account of the Central Bank's behaviour, by including base money and interest rates

$$p = b(1+m)c^{*} + l_1 e_t + l_2 b_t + l_3 i_t \qquad (3)$$

Central banks that target consumer price inflation will try to insulate prices from exchange rate movements. Neglecting the behaviour of policy variables may distort the true consequences of exchange rate variations on consumer prices. By including policy variables, the observed relationship between prices and exchange rates would take into account the central bank's behaviour rather than the direct influence of exchange rates on prices [14]. Traditional economic theory has been applied on the assumption that economic series have a constant mean and finite variance. That is, the variables are stationary[15]. In practice, however, most economic series are not stationary and consequently OLS estimation will lead to spurious results. Recent developments, however, have shown that standard regression analysis can be applied if a linear combination of non-stationary variables is a stationary process, that is, if a cointegrating relationship exists[16].

Based on this, the relation in (3) is estimated in a vector error correction form

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + f \Delta c_t^{*} + v_t ,$$

where $Y = [e, b, i]'$ and c_t^{*} enters exogenously since the domestic economy is a price taker. The time series properties of the data are analyzed using the Dickey-Fuller and KPSS tests for unit roots. The Johansen (1991) full information maximum likelihood procedure is used to estimate the VECM and to test cointegrating rank of Π.

[14] Both Parsley and Popper, 1998, and McCarthy, 2000 include a monetary aggregate in their system of variables. Bernanke and Mihov, 1997 included interest rates instead, they showed that monetary targets were not significant in the Bundesbank reaction function. Further, most central banks in the world by now target short-term interest rates. Gerlach and Svensson, 2000 provide further evidence for the euro area that the relationship between money-growth and future inflation is weak at best. We follow a combination of these models, to include both interest rates and monetary aggregates.

[15] A non-stationary series on the other hand is characterized by a time-varying mean or variance.

[16] See Engle and Granger, 1987.

The dynamic interaction among the variables and hence the pass-through is analyzed using impulse responses and variance decomposition. Whereas impulse response functions trace the effects of a shock to one endogenous variable on to the other variables in the VECM, variance decomposition separates the variation in an endogenous variable into the component shocks to the VECM. Thus, the variance decomposition provides information about the relative importance of each innovation.

Innovations are generally correlated, implying that their components are common among shocks. It was therefore necessary to impose some structure on the system in order to properly identify the innovations. The paper, adopts the common approach in which the covariance matrix is transformed (i.e. diagonalized) using a Cholesky decomposition such that all the common components of the innovations are attributed to the variable that comes first in the system. In this regard, the following ordering was used:

Base Money → interest rate → exchange rate → CPI

This is based on an a priori notion that in the transmission process, liquidity conditions influences the interest rates, which through induced portfolio adjustments affects the exchange rate. The exchange rate in turn influences the CPI via the *direct* channel. Alternative orderings did not change the results significantly. Additionally, an intervention dummy was modeled exogenously to account for instances when exchange rate influenced interest rates. In the post 1995 period where the policy of the Central Bank has been to maintain a low inflation stance, increases in interest rates tend to result from pressures in the foreign exchange market. Further, the Granger Causality tests reported in Table 1a - Appendix support this ordering.

In McCarthy (2000) interest rates entered last, as he assumed a reactive behaviour of the central bank. However, it is argued that the position of the interest rate might also be prior to consumer prices. Given the variable lags of monetary policy, central banks usually react to expected inflation rather than realized inflation (forward-looking behaviour).[17] In this respect

[17] See Clarida et. al. (1999).

it would be appropriate to position the interest rate variable prior to the consumer price index, that is, allowing prices to react to the central bank's policy.

5.0 RESULTS

The complete test statistics for the unit root tests[18], are given in Table 2 in the Appendix, and Table A below gives a summary of the results.

Table A. Summary Unit Root Test Results – with Constant and Trend

	CPI	CPIAG	BM	INTRATE	NEXR
Dickey-Fuller[1]	-1.608	-1.714	-1.227	-3.039	-3.223
KPSS[2]	0.333	0.329	0.352	0.277	0.161

[1] D-F 5% level of significance: -3.442

[2] KPSS 5% level of significance: 0.146

All variables, with the exception of the interest rate[19] are clearly non-stationary as the KPSS test rejects the null hypothesis of "stationarity" in both test versions at the 5 per cent and one per cent significance levels. Both the Dickey-Fuller and the KPSS tests indicate that all variables are trend stationary. The KPSS tests the null hypothesis of "stationarity", or stationarity around a deterministic trend, against a unit root alternative. Several recent studies have argued that the standard unit root tests, such as Dickey-Fuller tests have low power against stable autoregressive alternatives with roots near unity and also against fractionally integrated alternatives.[20] These findings exist in a context where most economic time series are not very informative about whether or not there is a unit root, or equivalently, that standard unit root tests are not very powerful against relevant alternatives. Kwiatkowski et al (1992) suggests that in using classical methods to determine whether economic data are stationary or integrated, it would be useful to perform tests of the null hypothesis of stationarity as well as tests of the null of a unit root.

[18] (a) Only with a constant and (b) with constant and trend

[19] KPSS test rejects the null hypothesis with a constant, but does not reject the null hypothesis with a constant and trend.

[20] See DeJong et al. (1989) and Diebold and Rudebusch (1991).

The Schwarz information criterion suggested a VECM with two lags. Additionally, the AR root lag structure indicates that no root lies outside the unit circle, hence the VAR satisfies the stability condition. Table 2 - Appendix reports the results of the Johansen tests. The hypothesis r = 0 is rejected at the 5% and 1% levels in favour of a unique cointegrating relation across the samples. Further evidence for r = 1 can be obtained from the estimated adjustment coefficients α, which indicate significant adjustment (in the sense of error correction) only in the first cointegrating vector.

Tables 4a to 4c - Appendix give the normalized values of the long run matrix, β, and the adjustment coefficient α. All coefficients are significant and have their anticipated (or at least plausible) signs. The consumer price index responds positively to the exchange rate, i.e. depreciation in the exchange rate results in an increase in the consumer price index. The coefficient to NEXR could be interpreted as the long-run pass-through coefficient, indicating that a 1 per cent devaluation results in a 0.996 and a 0.982 per cent rise in the consumer price level, a 'complete' pass-through for the full sample and the post 1995 period, respectively.

5.1 Impulse Response and Variance Decomposition

Figures 2a – Appendix shows the response of the CPI to a 1.0 per cent shock to the exchange rate for the full sample. The exchange rate shock feeds through to the CPI gradually, with the rate of increase slowing over the sample period 1990:01 to 2001:12, indicating that pass-through has slowed in recent years. Figure A[21] below reveals that for the period 1990:01 to 1995:12, a 1.0 per cent shock to the exchange rate does not have an immediate effect on the CPI, with the pass-through being approximately 80.0 per cent complete six months after the initial shock to the nominal exchange rate. On the other hand, Figure B indicates that in the last five years, a 1.0 per cent shock to the exchange rate results in the pass through being approximately 45.0 per cent complete six months after the initial shock to the nominal exchange rate.

[21] Solid line shows the accumulated responses *t* periods after the shock. The dotted line shows the discrete responses in period *t*.

Figure A. Response of CPI to a 1% depreciation
1990 - 1995

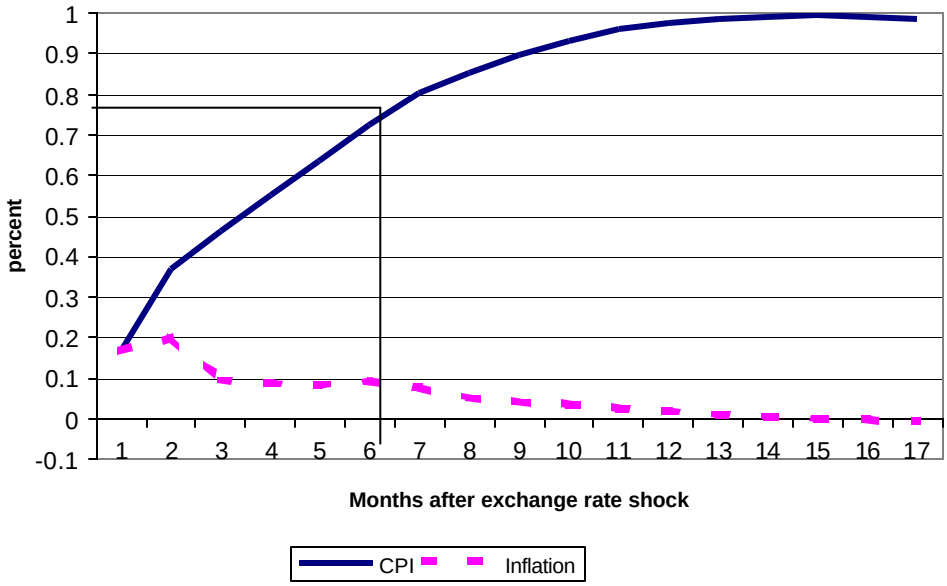


Figure B. Response of CPI to a 1% depreciation
1996 - 2001

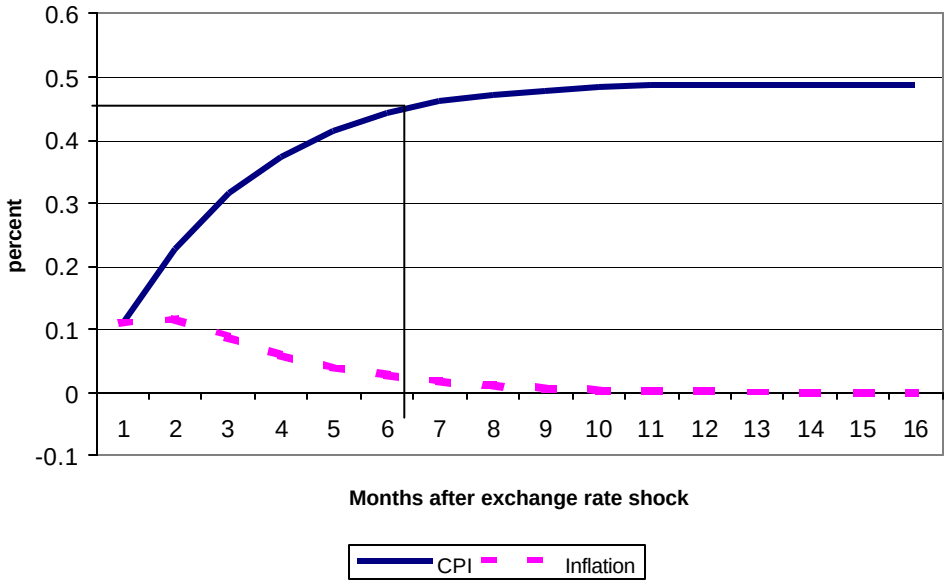


Table B below summarizes the responses of the CPI to a 1.0 per cent shock in the nominal exchange rate[22] after 3, 6, 9 and 12 months. The extent and speed of pass-through differ across time. The sample period 1990:01 to 1995:12 indicates that the pass through is 98.8 per cent complete one year after an initial shock of 1.0 per cent in the nominal exchange rate. In contrast, in the sample period 1996:01 to 2001:12, the effect of a 1.0 per cent shock in the nominal exchange rate to inflation is much smaller, that is, the pass through is 48.8 per cent complete one year after an initial shock to the nominal exchange rate. In essence, Table B and the graphs above are indicating that the degree of pass-through is lower and has slowed in the last five years.

Table B. Effects of CPI to a 1%-exchange rate shock

Sample	After 3 months	After 6 months	After 9 months	After 12 months
1990:01 - 2001:12	0.482	0.620	0.836	1.001
1990:01 - 1995:12	0.464	0.728	0.898	0.988
1996:01 - 2001:12	0.316	0.442	0.479	0.488

As indicated earlier, the literature highlights several factors that influence the degree of pass-through. These included openness, the relative size of the economy, the relative elasticities of demand and supply and macroeconomic conditions. In Jamaica, there have not been significant changes in the openness[23] and size of the economy across the sub-periods studied. Hence, the change in the pass-through cannot be significantly attributed to these factors. One plausible explanation for a reduction in the degree of the pass-through over the two sub-samples is the influence of the macroeconomic environment. Relatively low and stable inflation observed in the post 1995 period, would tend to be associated with lower pass-through than the high inflation economy that characterized 1990 to 1995. A low

[22] An increase corresponds to a depreciation

[23] Ratio of imports to GDP used as a proxy to measure openness.

inflation regime would tend to lower the pass-through by weakening the expected future effect of the shocks. Additionally, low inflation economies could be subjected to less variable monetary shocks, particularly in a context where tight monetary policy is being exercised. The lower variability of monetary shocks would decrease the information content of the exchange rates in predicting monetary shocks and this effect suggests another reason for the pass-through to be smaller under a low inflation regime. On the other hand, a higher degree of pass-through in the pre 1995 period could be reflecting the initial impact of a liberalized foreign exchange market.

Although the impulse responses indicate the extent of pass-through to domestic prices, they do not indicate how important these shocks have been in domestic price fluctuations. To investigate the importance of the variables in the model to domestic inflation, the variance decompositions were examined. Table C below summarizes the variance decomposition for the sample periods six month after an initial shock to the nominal exchange rate. Tables 5a to 5c - Appendix displays a more detailed variance decomposition of the CPI to a 1.0 per cent shock in the nominal exchange rate after 6, 12 and 24 months. CPI variance is affected by exchange rate fluctuations to a large degree, prior to 1996. The results in Table 5b – Appendix shows that exchange rate fluctuations explains on average 36 per cent of the fluctuations in the CPI. However, post 1995 this ratio has been significantly reduced. Table 5c – Appendix indicates that on average, approximately 10.5 per cent of the variations in the CPI are explained by variations in the exchange rate. Variations in the CPI are largely explained by shocks to itself, suggesting that the inflation process in Jamaica has significant inertia.

Table C. Variance Decomposition of CPI[1]

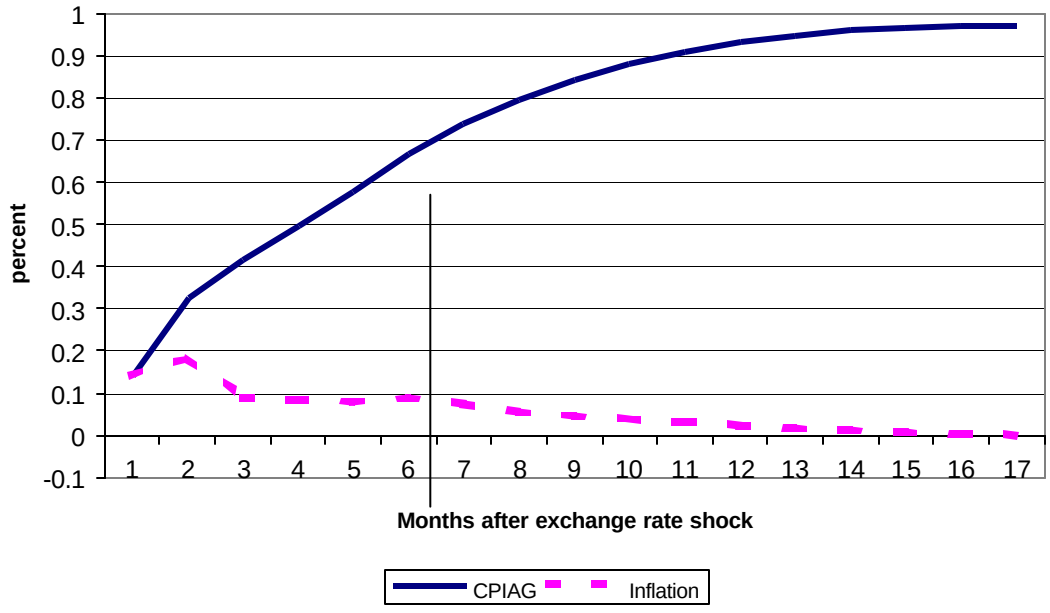
Sample	NEXR	INTRATE	BM	CPI	Standard Error
1990:01 - 2001:12	34.85	3.03	9.40	52.72	0.019
1990:01 - 1995:12	33.69	2.23	8.94	55.13	0.025
1996:01 - 2001:12	9.58	1.83	6.71	81.87	0.012

[1] six months after an initial shock to the nominal exchange rate.

5.2 Responses of CPI excluding Agriculture

By excluding agriculture prices, the behaviour of the pass-through changed when compared to the original CPI. The impact of a shock to the exchange rate was smaller, but the pass-through much faster and of a higher degree than in the post 1995 period. This may be reflecting the fact that the import component of the sub-categories in the CPI, excluding agriculture prices was significant[24]. This import component becomes a larger weight in the CPI, when agriculture prices are excluded, since the residue components are tradable goods, which are mainly imported. Additionally, the CPI excluding agriculture prices contains items that have a direct foreign exchange component, such as fuel rate. Therefore, there is a more direct pass-through when agriculture prices are excluded from the CPI. The results of the cointegrating relationship show that the long run pass-through dynamics are smaller when agriculture prices are excluded. Figures C and D below show the extent of the pass-through. Table D below summarizes the responses of the CPIAG to a 1.0 per cent shock to the nominal exchange rate after 3, 6, 9 and 12 months for the two sub-samples. Tables 6 to 7 – Appendix report the detailed results of the cointegration tests and impulse responses.

Figure C. Response of CPIAG to a 1% depreciation
1990 - 1995



[24] Data availability precludes an analysis of the import component.

Figure D. Response of CPIAG to a 1% depreciation
1996 - 2001

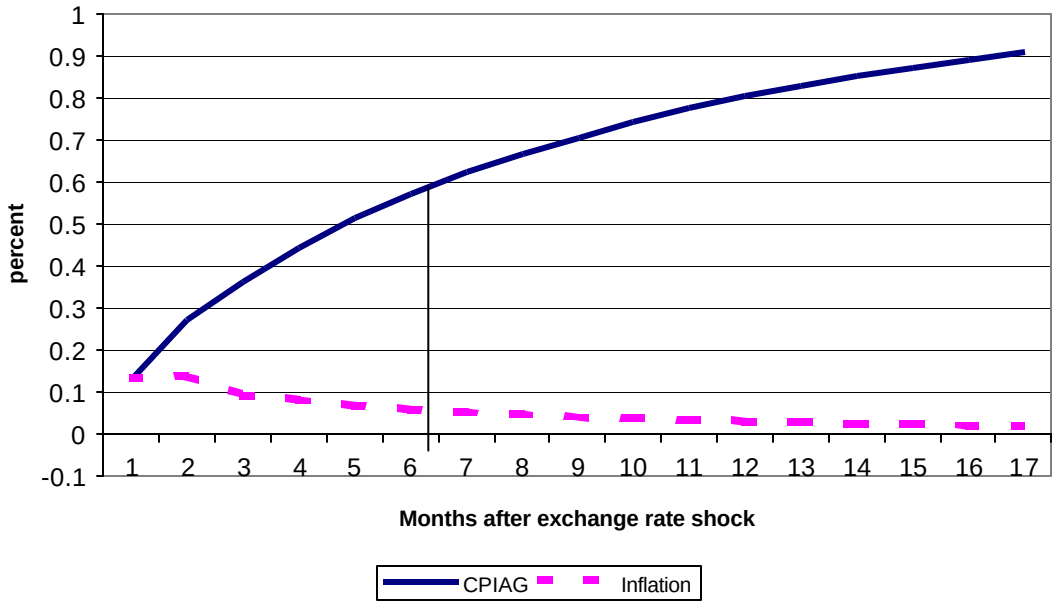


Table D. Effects of CPIAG to a 1%-exchange rate shock - VEC

Sample	After 3 months	After 6 months	After 9 months	After 12 months
1990:01 - 1995:12	0.414	0.666	0.839	0.933
1996:01 - 2001:12	0.363	0.570	0.706	0.802

6.0 CONCLUSION

The exchange rate in Jamaica is one of the most important determinants of inflation and a key element in the monetary transmission mechanism. This paper analyzed the effects of exchange rate fluctuations on the consumer price index. The evidence presented indicates that the inflationary impact of exchange rate depreciation in Jamaica has declined in recent years. Pass-through to the CPI is approximately 80.0 per cent complete six months after an initial shock to the nominal exchange rate for the 1990 to 1995 period. Conversely, the pass-through is less complete at approximately 45.0 per cent in the 1996 to 2001 period, six months after an initial shock to the nominal exchange rate. In addition, the pass-through to the CPI excluding *starchy food* and *vegetables and fruits* had similar trends to the CPI over the two sub-samples. In the period 1990 to 1995, pass-through is approximately 70.0 per cent complete six months after an initial shock to the nominal exchange rate, while in the 1996 to 2001 period, pass-through is approximately 60.0 per cent complete six months after an initial shock to the nominal exchange rate. The results indicate that the speed of the pass-through has slowed significantly in the last five years. This trend reflects the combined influence of monetary policy, lower private demand and structural transformations in the Jamaican economy. The dependence of the pass-through on the economic environment arises essentially because the pass-through reflects the expected effect of monetary shocks on current and future costs.

The literature indicates that the exchange rate policy might affect pass-through. It is possible that the exchange rate regime itself may not be the critical factor but the volatility of the exchange rate matters. Additionally, the literature has indicated that there is an inverse relationship between volatility and pass-through, that is, if volatility were lower then pass-through would be higher. The results in this paper indicate that exchange rate volatility is high in the post 1995 period, and the pass-through has declined.

It should be noted however, that despite the moderation in the pass through, the results suggest that the influence of exchange rate movements is still significant for inflation. While the lower degree of pass-through allows for some flexibility in policy, continued emphasis has to be placed on reducing volatility and moderating the pace of adjustments. In an open economy that is highly import dependent, such as Jamaica, the moderation in the pass-

through implies that producers and retailers absorbed a greater proportion of the imported inflation. This was necessitated by a lower aggregate demand over the post 1995 period. However, there is a limit to the amount of absorption and in a context where income and demand have recovered, suppliers will more readily pass on any increase in imported costs in the future. More importantly, because the exchange rate is an important nominal anchor for expectations, rapid movements in the rate can precipitate an expectation driven wage/inflation spiral.

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APPENDIX

TABLES

Table 1. Pairwise Granger Causality Tests

Sample 1990:01 2001:12
Lags: 2

Null Hypothesis:	Obs.	F-Statistic	Probability[1]
CPI does not Granger Cause BM	142	4.49	0.0129
BM does not Granger Cause CPI		1.92	0.1502
NEXR does not Granger Cause BM	142	9.10	0.0002
BM does not Granger Cause NEXR		0.50	0.6075
INTRATE does not Granger Cause BM	139	3.26	0.0413
BM does not Granger Cause INTRATE		1.78	0.1727
NEXR does not Granger Cause CPI	142	40.63	1.40E-14
CPI does not Granger Cause NEXR		4.03	0.2000
INTRATE does not Granger Cause CPI	139	1.05	0.3537
CPI does not Granger Cause INTRATE		11.57	2.30E-05
INTRATE does not Granger Cause NEXR	139	3.41	0.036
NEXR does not Granger Cause INTRATE		1.64	0.1978

[1]This denotes the probability that one variable does not granger cause the other. The hypothesis of no causation from one variable to another is rejected if a probability of 0.05 or less is obtained.

Results of the Unit Root Tests

Table 2a. Results of the Augmented Dickey-Fuller (All Variables in Logs)

1990:01 - 2001:12	Optimal Lag[1]	D-F with Constant[2]	D-F with Trend[2]	Degree of Integration[3]
CPI[4]	2	-3.07*	1.68*	I(2)
M_0 [5]	10	-3.09*	-1.27**	I(1)
Exchange Rate[6]	9	-3.69*	-2.50**	I(1)
Interest Rate[7]	1	2.32*	3.39*	I(1)?

[1]Optimal lag according to the automatic lag selection procedure developed in Schwartz Info. Criterion.
[2]D-F test statistic and significance level: * = 1%, ** = 5%
[3]I(0) = alternative hypothesis, I(1) = null hypothesis. The result is I(0) if both test reject the null
[4]Consumer Price Index.
[5]The base money supply
[6]Nominal exchange rate
[7]Treasury bill rate

Results of the Unit Root Tests

Table 2b. Results of the KPSS-Test (All Variables in Logs)

1990:01 - 2001:12	Optimal Lag[1]	KPSS with Constant[2]	KPSS with Trend[2]	Degree of Integration[3]
CPI[4]	10	1.23*	0.35*	I(1)
M_0 [5]	10	1.23*	0.35**	I(1)
Exchange Rate[6]	9	1.06*	0.29**	I(1)
Interest Rate[7]	9	0.89*	0.33*	I(0)?

[1]Optimal lag according to the automatic lag selection procedure developed in Newey/West (1994)
[2]KPSS-test statistic and significance level: * = 1%, ** = 5%
[3]I(1) = alternative hypothesis, I(0) = null hypothesis. The result is I(1) if both test reject the null
[4]Consumer Price Index.
[5]The base money supply
[6]Nominal exchange rate
[7]Treasury bill rate – I(1) with trend

Results of Cointegration Tests on Headline Inflation

Results of the Cointegration Tests (Johansen Test)

Table 3a. Test for the Cointegrating Rank

1990:01 – 2001:12

H_0	l_i	Trace	Trace95	Trace99
r = 0	0.241	66.69	47.21	54.46
r < 1	0.119	28.84	29.68	35.65

Note: The hypothesis r = 0 is strongly rejected, while the second hypothesis is not. (calculated > critical)

Results of the Cointegration Tests (Johansen Test)

Table 3b. Test for the Cointegrating Rank

1990:01 – 1995:12

H_0	l_i	Trace	Trace95	Trace99
r = 0	0.473	68.69	47.21	54.46
r < 1	0.218	24.53	29.68	35.65

Note: The hypothesis r = 0 is strongly rejected, while the second hypothesis is not. (calculated > critical)

Results of the Cointegration Tests (Johansen Test)

Table 3c. Test for the Cointegrating Rank

1996:01 – 2001:12

H_0	l_i	Trace	Trace95	Trace99
r = 0	0.332	53.30	39.89	45.58
r < 1	0.189	24.21	24.31	29.75

Note: The hypothesis r = 0 is strongly rejected, while the second hypothesis is not.

Table 4a. Normalized Estimates[1]
1990:01 – 2001:12

Variable	b	a
CPIJ	1	0.0018 (0.0015)
NEXR	-0.996	-0.0229 (0.0068)
INTRATE	1.485	-0.0364 (0.0152)
BM	1.919	0.0349 (0.0063)

[1]Standard errors for the adjustment coefficients are in parenthesis.

Table 4b. Normalized Estimates[1]
1990:01 – 1995:12

Variable	b	a
CPIJ	1	-0.0865 (0.0428)
NEXR	-0.404	-0.0253 (0.2331)
INTRATE	0.025	-0.3688 (0.4516)
BM	0.566	0.9358 (0.1469)

[1]Standard errors for the adjustment coefficients are in parenthesis.

Table 4c. Normalized Estimates[1]
1996:01 – 2001:12

Variable	b	a
CPIJ	1	0.0276 (0.0065)
NEXR	-0.982	0.0472 (0.0208)
INTRATE	0.019	-0.0102 (0.0873)
BM	0.633	0.0230 (0.0353)

[1]Standard errors for the adjustment coefficients are in parenthesis.

Table 5a. Variance Decomposition of Inflation
1990:01 - 2001:12

Horizon (months)	Variance Due to (%)				Standard Error
	NEXR	INTRATE	BM	CPI	
6	34.85	3.03	9.40	52.72	0.019
12	36.32	2.99	9.67	51.01	0.025
18	36.79	2.93	9.69	50.59	0.029
24	37.05	2.89	9.69	50.37	0.033

Table 5b. Variance Decomposition of Inflation
1990:01 - 1995:12

Horizon (months)	Variance Due to (%)				Standard Error
	NEXR	INTRATE	BM	CPI	
6	33.69	2.23	8.94	55.13	0.025
12	34.38	2.09	8.88	54.65	0.033
18	34.53	1.97	8.79	54.71	0.039
24	34.62	1.90	8.74	54.74	0.045

Table 5c. Variance Decomposition of Inflation
1996:01 - 2001:12

Horizon (months)	Variance Due to (%)				Standard Error
	NEXR	INTRATE	BM	CPI	
6	9.58	1.83	6.71	81.87	0.012
12	10.74	1.74	6.56	80.96	0.016
18	11.08	1.67	6.39	80.86	0.019
24	11.23	1.63	6.29	80.86	0.022

Results of Cointegration Tests on Headline Inflation excluding Agriculture

Results of the Cointegration Tests (Johansen Test)
Table 6a. Test for the Cointegrating Rank

1990:01 – 2001:12

H_0	l_i	Trace	Trace95	Trace99
r = 0	0.293	84.48	39.89	45.58
r < 1	0.151	35.57	24.31	29.75

Note: The hypothesis r = 0 is strongly rejected, while the second hypothesis is not. (calculated > critical)

Results of the Cointegration Tests (Johansen Test)
Table 6b. Test for the Cointegrating Rank
1990:01 – 1995:12

H_0	l_i	Trace	Trace95	Trace99
r = 0	0.466	68.40	47.21	54.46
r < 1	0.218	25.13	29.68	35.65

Note: The hypothesis r = 0 is strongly rejected, while the second hypothesis is not. (calculated > critical)

Results of the Cointegration Tests (Johansen Test)

Table 6c. Test for the Cointegrating Rank

1996:01 – 2001:12

H_0	l_i	Trace	Trace95	Trace99
r = 0	0.335	51.80	39.89	45.58
r < 1	0.192	22.40	24.31	29.75

Note: The hypothesis r = 0 is strongly rejected, while the second hypothesis is not.

Table 7a. Normalized Estimates[1]

1990:01 – 2001:12

Variable	b	a
CPIAG	1	0.0022 (0.00079)
NEXR	-0.464	-0.0145 (0.00425)
INTRATE	2.685	-0.0282 (0.0094)
BM	-1.409	0.0211 (0.00404)

[1]Standard errors for the adjustment coefficients are in parenthesis.

Table 7b. Normalized Estimates[1]

1990:01 – 1995:12

Variable	b	a
CPIAG	1	-0.0892 (0.0434)
NEXR	-0.412	-0.0179 (0.2708)
INTRATE	0.037	-0.4555 (0.5237)
BM	-0.451	1.0468 (0.1734)

[1]Standard errors for the adjustment coefficients are in parenthesis.

Table 7c. Normalized Estimates[1]
1996:01 – 2001:12

Variable	b	a
CPIAG	1	-0.0513 (0.0115)
NEXR	-0.897	0.0903 (0.0486)
INTRATE	0.0724	0.0797 (0.0873)
BM	-0.179	-0.1236 (0.0353)

[1]Standard errors for the adjustment coefficients are in parenthesis.

Table 8. Consumer Price Index (CPI) and Consumer Price Index less Agriculture (CPIAG)

	CPI	CPIAG
Jan-90	129.6	27.9
Feb-90	131.2	27.9
Mar-90	134.8	28.8
Apr-90	137.0	29.2
May-90	137.7	29.6
Jun-90	139.0	29.9
Jul-90	141.9	30.4
Aug-90	146.1	31.0
Sep-90	147.4	31.3
Oct-90	154.5	32.6
Nov-90	161.8	33.8
Dec-90	166.1	34.6
Jan-91	168.3	35.2
Feb-91	170.6	35.8
Mar-91	172.9	36.3
Apr-91	180.9	37.7
May-91	188.8	39.3
Jun-91	208.1	42.6
Jul-91	219.2	44.6
Aug-91	228.3	46.1
Sep-91	236.8	47.5
Oct-91	257.5	51.3
Nov-91	278.9	55.4
Dec-91	299.3	59.7
Jan-92	315.3	62.7
Feb-92	339.6	67.3
Mar-92	355.7	69.9
Apr-92	376.1	73.3
May-92	387.0	75.1
Jun-92	389.9	75.6
Jul-92	399.7	77.2
Aug-92	403.6	77.6
Sep-92	410.2	78.8
Oct-92	412.2	79.2
Nov-92	417.3	80.0
Dec-92	419.6	80.4
Jan-93	423.2	81.1
Feb-93	425.2	81.6
Mar-93	430.7	82.6
Apr-93	435.5	83.6
May-93	442.8	85.3
Jun-93	447.8	85.9
Jul-93	466.0	88.3
Aug-93	481.9	90.4
Sep-93	502.3	93.2
Oct-93	514.6	94.9
Nov-93	531.2	97.4
Dec-93	546.0	**100.0**

	CPI	CPIAG
Jan-94	558.9	102.5
Feb-94	578.0	106.1
Mar-94	590.4	108.3
Apr-94	601.6	110.0
May-94	616.1	112.3
Jun-94	629.8	114.9
Jul-94	650.5	116.8
Aug-94	666.4	119.5
Sep-94	673.5	120.4
Oct-94	682.5	121.4
Nov-94	687.3	121.7
Dec-94	692.3	122.8
Jan-95	701.1	124.1
Feb-95	709.2	125.4
Mar-95	715.8	126.7
Apr-95	723.5	128.2
May-95	733.7	129.9
Jun-95	740.9	130.8
Jul-95	753.5	132.2
Aug-95	766.4	133.6
Sep-95	789.2	137.4
Oct-95	810.3	140.6
Nov-95	832.8	143.6
Dec-95	869.2	150.0
Jan-96	892.1	153.9
Feb-96	921.6	159.3
Mar-96	936.4	161.8
Apr-96	948.8	164.2
May-96	960.0	166.9
Jun-96	963.6	167.9
Jul-96	970.4	168.8
Aug-96	978.4	169.5
Sep-96	989.4	170.6
Oct-96	994.7	171.0
Nov-96	999.0	171.9
Dec-96	1006.9	173.0
Jan-97	1012.8	174.7
Feb-97	1022.0	176.0
Mar-97	1025.5	176.7
Apr-97	1032.1	177.7
May-97	1039.5	178.3
Jun-97	1043.4	178.9
Jul-97	1055.0	179.7
Aug-97	1069.3	180.5
Sep-97	1084.5	181.8
Oct-97	1094.0	182.6
Nov-97	1100.2	183.3
Dec-97	1099.2	184.4

	CPI	CPIAG
Jan-98	1106.8	185.6
Feb-98	1107.5	186.4
Mar-98	1115.9	187.8
Apr-98	1119.8	188.9
May-98	1129.0	190.1
Jun-98	1149.2	193.5
Jul-98	1162.4	194.4
Aug-98	1174.5	194.8
Sep-98	1175.8	196.0
Oct-98	1172.1	196.4
Nov-98	1173.2	197.2
Dec-98	1185.5	199.0
Jan-99	1189.9	199.7
Feb-99	1176.8	199.0
Mar-99	1182.5	201.2
Apr-99	1179.9	201.7
May-99	1190.6	202.6
Jun-99	1205.9	203.4
Jul-99	1220.4	204.8
Aug-99	1234.3	207.2
Sep-99	1237.6	208.2
Oct-99	1247.5	208.7
Nov-99	1259.9	209.9
Dec-99	1265.9	210.6
Jan-00	1268.1	211.1
Feb-00	1273.1	212.4
Mar-00	1281.7	213.1
Apr-00	1294.4	214.3
May-00	1300.0	215.1
Jun-00	1311.4	216.0
Jul-00	1324.0	216.6
Aug-00	1335.9	217.8
Sep-00	1349.3	219.0
Oct-00	1351.1	220.4
Nov-00	1352.4	221.3
Dec-00	1342.6	221.9
Jan-01	1342.9	222.7
Feb-01	1358.6	225.0
Mar-01	1365.0	226.9
Apr-01	1370.8	227.8
May-01	1381.1	229.2
Jun-01	1405.0	232.9
Jul-01	1418.7	234.4
Aug-01	1431.1	235.3
Sep-01	1442.9	235.8
Oct-01	1454.9	236.4
Nov-01	1456.2	236.9
Dec-01	1460.2	237.1

FIGURES

Figure 1: Inflation and Exchange Rate Changes, Q1 1980 - Q4 2001

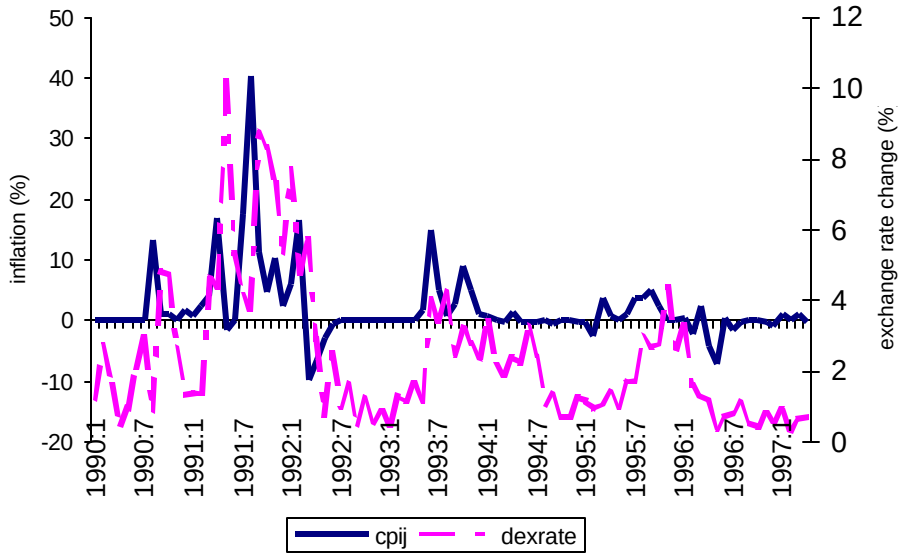

Figure 2a. Response of CPI to a 1% depreciation
1990 - 2001

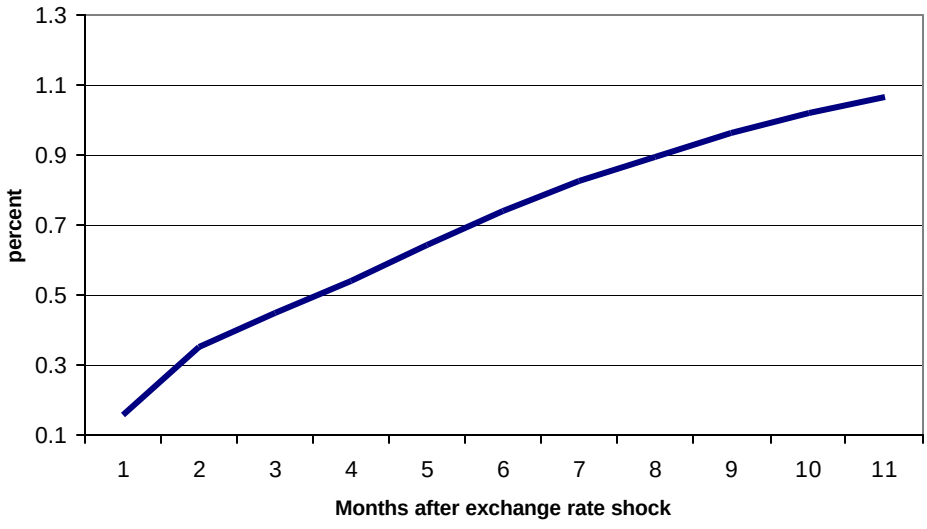

Figure 2b. Response of Inflation to a 1% depreciation
1990 - 1995

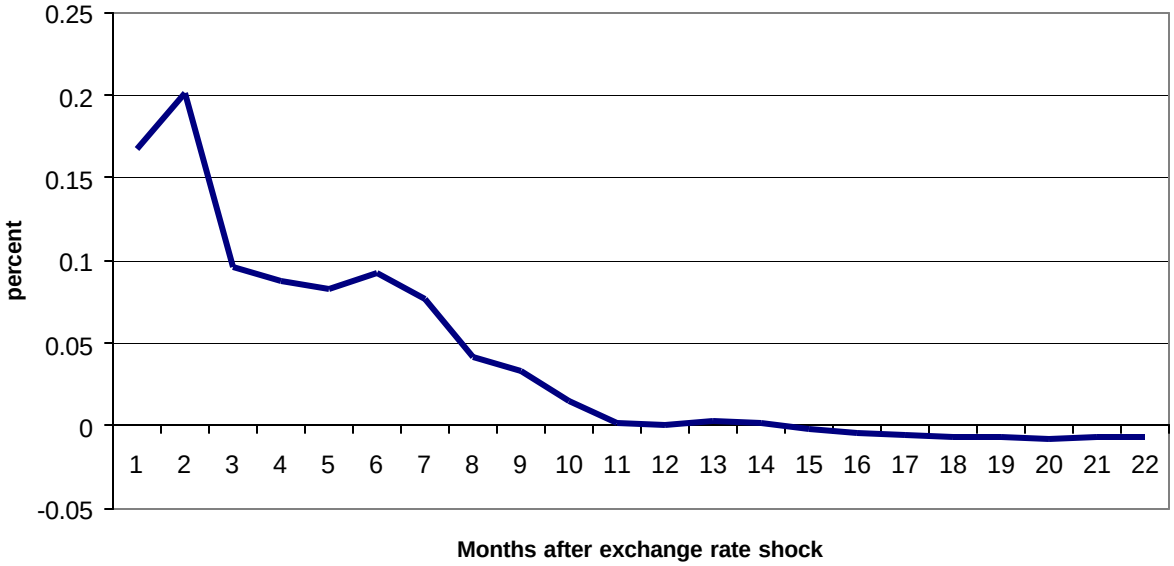

Figure 2c. Response of Inflation to a 1% depreciation
1996 - 2001

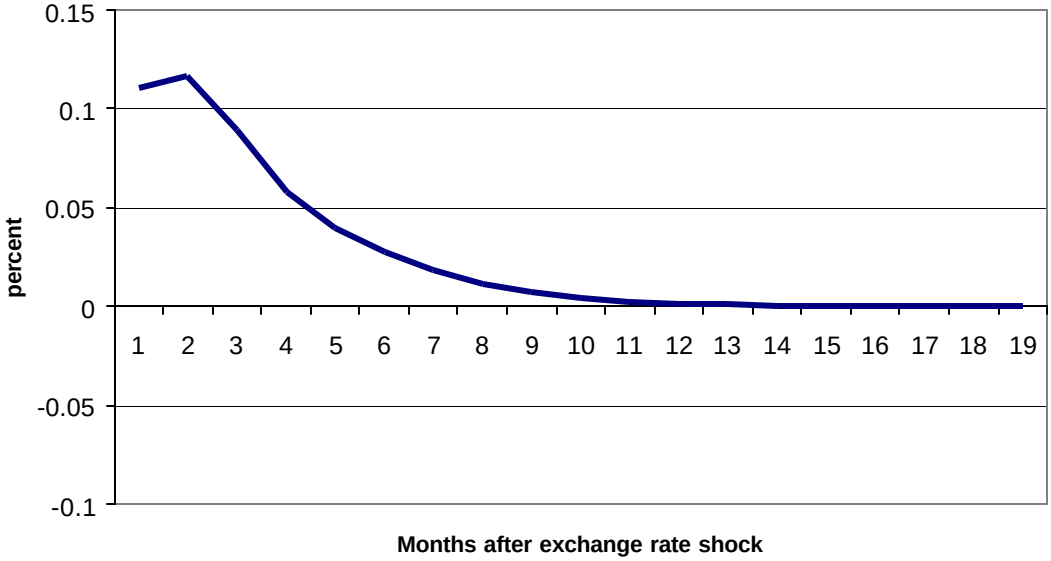

Figure 3a. Response of CPI excluding agriculture to a 1% depreciation 1990 - 2001

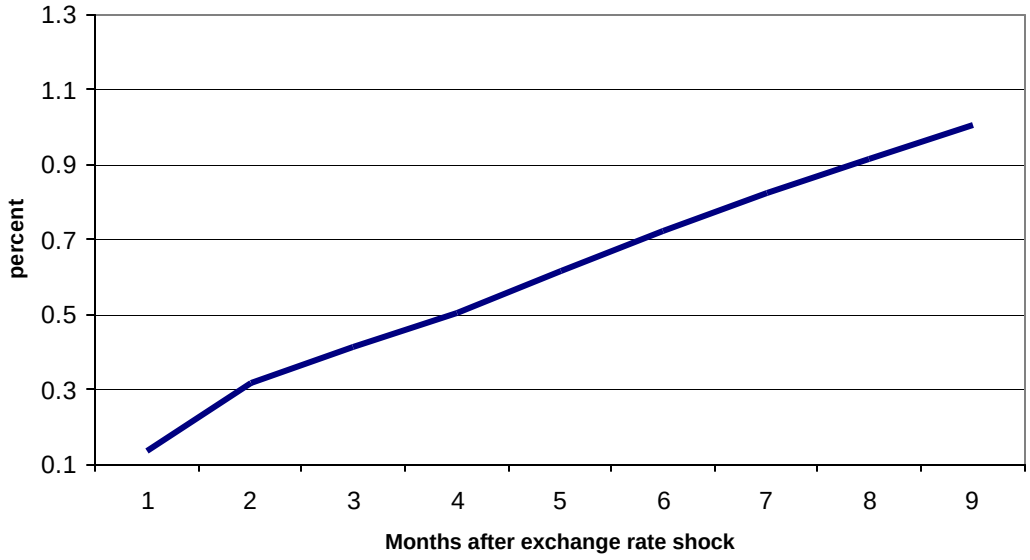

Figure 3b. Response of Inflation excluding agriculture to a 1% depreciation 1990 - 1995

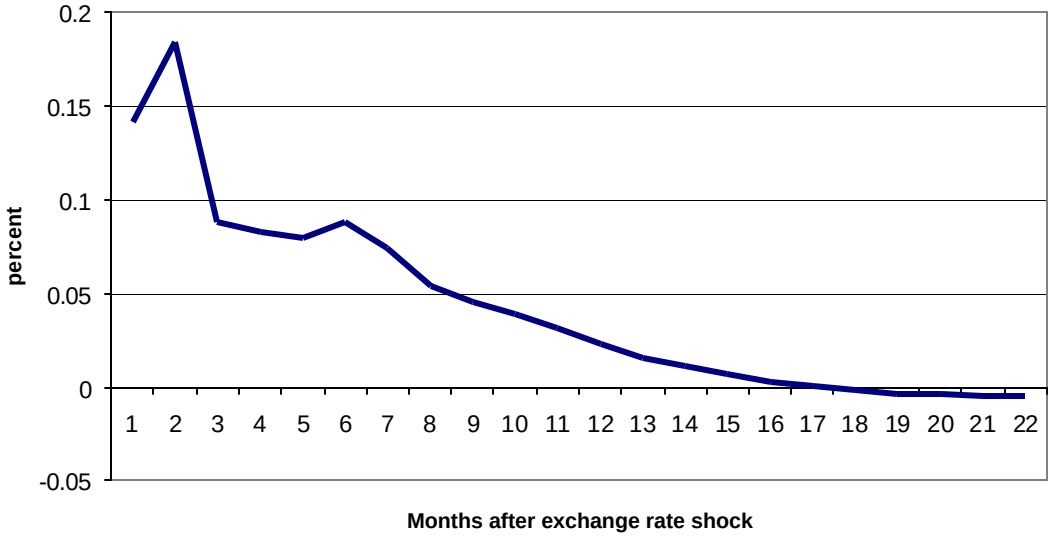

Figure 3c. Response of Inflation excluding agricultureto a 1% depreciation 1996 - 2001