Inflation Impact of an Exchange Rate Adjustment: The Case of Zimbabwe 1990 - 2006

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Abstract

The author aims to econometrically estimate the impact of an exchange rate adjustment on consumer price inflation using Zimbabwe's quarterly data from 1990-2006. The first round impact of devaluation on consumer prices is found to be low. The elasticity is 0.05. This means that, in the short-run, 100 percent devaluation would increase inflation by only 5 percent. The long term elasticity is estimated at 0.51. That is, about half of an exchange rate adjustment would be passed on to domestic inflation and about 51 percent real devaluation would be achieved. This is consistent with the earlier studies on exchange rate pass-through to consumer prices. The author also reports that excess demand exerts strong pressure on domestic prices. Therefore, prudent fiscal and monetary policies are essential to moderate the impact of an exchange rate adjustment on domestic prices.

Keywords: Exchange rate, devaluation, Inflation, Pass-through effect, speed of adjustment, elasticity.

Problem Statement, Objectives and Research Questions

Zimbabwe is generally an agricultural based economy with GDP per capita income of US432 in real terms and a population of 12 million people, (United Nations 1998; 2007). The agricultural sector significantly contributes to foreign earnings, with tobacco, cotton and horticulture being

the main contributors. The other sectors important in terms of foreign earnings are mining, manufacturing and tourism. In the post-independence period the government of Zimbabwe has followed import-substitution and export-oriented policies. Despite, these policies the country has experienced balance of payment problems and a critical shortage of foreign exchange. The macroeconomic imbalances led to problems of high inflation and instability of the exchange rate (CSO 2004; 2007). Thus, chronic high inflation characterized the Zimbabwe's economy throughout the 1990s through to 2006 (a point stressed by Makuyana *et al.* 2011).

Although inflation was steadily rising over the period 1990Q1 to 1997Q3, the end of the last quarter of 1997Q4 experienced a crash of the Zimbabwe dollar and this led to a surge in inflation. The crash in Zimbabwe dollar was to a large extent due to increases in government expenditure requirements in the third quarter of 1997Q3 through to 2006Q4. The increase in government expenditure requirements eroded confidence in both domestic and foreign exchange rate markets; subsequently putting more pressure on the exchange rate, thereby inflation. Despite the disequilibrium in the exchange rate market, the authorities were reluctant to devalue in that devaluation implies increased inflation, and thereby paying more for debt servicing in local currency. Yet, exporters became less competitive if currency is overvalued or misaligned from its equilibrium level. In an effort to curtail inflation programmes such as the Economic Structural Adjustment Programme (ESAP), (1991-1995) and Zimbabwe Programme for Economic and Social Transformation (1996-2000) were implemented, but failed to achieve the desired level of inflation (GOZ 1991; 1996)[1].

The problem statement simply stated is that exchange rate adjustments exerted adverse pressure on Zimbabwe's consumer price inflation in the period 1990Q1 to 2006Q4.

The objectives of the study are to explain the determinants of inflation in Zimbabwe, with particular emphasis on the inflation impact of an exchange rate adjustment. In addition, the author discusses the monetary, fiscal policies and point out the underlying dynamics of inflation in 1990s through to 2000s.

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[1] The Government of Zimbabwe (GOZ).

The author attempts to answer three questions: What is the responsiveness of prices to an adjustment of nominal exchange rate, it is how much of the devaluation pass-through to inflation? What are the speed of adjustment and the long run elasticity of inflation with respect to real devaluation of an exchange rate?

The layout of the article is as follows: section one gives the problem statement, objectives, and research questions section two is the literature survey, section three presents the methodology, section four briefly deals with data collection, section five presents data analysis, section six gives answers to research questions and section seven is the conclusion.

Literature Survey

Most of studies on devaluation of the nominal exchange rate and pass-through to consumer price inflation have been carried out in developed economies (Neiman 2010; Gust *et al.* 2010; Burstein *et al.* 2007), among others. However, there is still a dearth of knowledge with regard to similar work in less developing economies. The question often asked is what causes an incomplete or low exchange rate pass-through to import and thereby to consumer prices (Gust *et al.* 2010; Neiman 2010; Burstein *et al.* 2007; Marazzi & Sheets 2007; Taylor 2000).

Several studies using different methods and data to explain the exchange rate impact on inflation agree that in recent years the pass-through has declined implying that a depreciation of the nominal exchange rate led to less than 100 percent increase in consumer price inflation (Gust *et al.* 2010; Neiman 2010; Burstein *et al.* 2007; Marazzi & Sheets 2007; Taylor 2000; Mishkin 2008; Reyes 2007). But they differ in the explanation of the causes of the incomplete pass-through. As a consequence, various hypotheses have been put forward explaining reasons for low pass-through to imports or consumer price inflation. The general hypothesis reported by most studies is that the decline in the pass-through was due to competition in production of products, and trade integration particularly with China (Gust *et al.* 2010; Marazzi & Sheets 2007)

The author notes that several studies on exchange rate pass-through to inflation deal with import prices using aggregate, industry or firm data (Bodnar *et al.* 2002; Heghi 2003; Gust *et al.* 2010; Devereux & Engel 2002;

Neiman 2010; Burstein *et al.* 2007; Marazzi & Sheets 2007). However, other studies examine the broad effect of exchange rate pass-through to consumer price inflation (Taylor 2002; Corsetti *et al.* 2008; Mishkin 2008; Gust *et al.* 2009). In addition, same studies have focused on export prices 'price to market' the exporter set prices using the currency of the country which goods are being exported (Vigfusson *et al.* 2009; Miljkovic *et al.* 2003).

Study by Taylor (2000) show evidence that low inflation and prudent monetary policy led to incomplete or low exchange rate pass-through, which in turn, led to a positive effect on persistent price and cost increases. Gust *et al.* (2010) using 1980s data reported a pass-through coefficient of 55 percent for United States. Marazzi and Sheets (2007) observed that pass-through for the United States declined from 0.5 in the 70s and 80s to 0.2 in the last 10 years. These studies show that with improved trade integration and monetary policy the correlation between exchange rate pass-through and inflation is weak (Mishkin 2008; Taylor 2000).

Although causes of inflation differ from country to country, Lim and Papi (1997) argue that studies have shown that inflation is influenced in three ways. First, the monetary way, this is through growth of money stock. Second, it is argued that inflation originates from high government spending that exceeds revenues at a given time. The increase in debt and short fall of revenues lead governments to borrow from Central Banks, subsequently, increasing the money stock, and thereby inflation. Third, as previously mentioned, it is argued in the literature that inflation is as a result of devaluation of exchange rate. Furthermore, the oligopolistic markets through price wars and collusions lead to inflation (Hegji 2003). In addition, labour unions create price-wage spiral, which lead to high inflation.

Lim and papi (1997) carried out an empirical study for Turkey and examined the monetary, public finance and structural causes of inflation. Their results showed that the public finance variables had more influence on inflation process than other approaches. Moreover recent studies have emphasized the use of structural models to explain inflation and exchange rate pass-through (Corsetti *et al.* 2008) used structural equations to examine both short run and long run exchange rate pass-through using the United States data and concluded that the pass-through were incomplete.

Rittenberg (1973) using the Granger causality tests showed that the causality is from price change to the exchange rate, rather than from the

exchange rate to price level. Thus, the effect of devaluation on prices is inconclusive. They also assert that the expectations are largely due to inflation inertia. The current high level of inflation is expected to lead to further inflation in future.

Studies have shown that one of the causes of inflation is increased government spending that lead to budget deficit (Rodriguez, 1978). The increase in the budget deficit, and its subsequent monetization by the Central Bank fuelled inflation. However, it is believed that devaluation leads and/or triggers inflation process, and subsequent high interest rates, through contraction in monetary policies.

Rodriguez (1978) argues that albeit that devaluation leads to expensive imported goods in domestic prices, the balance of payments experiences a transitory improvement following devaluation. But this improvement could be eroded if government continues to spend on imports. Rodriguez, further argues that countries are not keen in cutting spending for political reasons and resort to small devaluations, which lead to devaluation-inflation spiral.

In spite of these analyses it is often argued that devaluation leads to high input costs, particularly when a country depends on imported intermediate goods for both domestic consumption and exports (Taylor 2002). Rodriguez (1998) noted that the main factors that are responsible for inflation in many less developed countries are the monetization of the fiscal deficit and devaluation of the domestic currency. He argues that in a country that is experiencing shortage of foreign exchange, that is expected to offset the deficit caused by high government spending, the way out would be to devalue the domestic currency, and trigger thereby inflation.

The underlying problem that leads to devaluation and inflation is the macroeconomic imbalances that stem from high government spending and subsequent fiscal deficit. The real government deficit financed through domestic credit creation by Central Bank's accommodation of government debt leads to increases in the monetary base or broad money and thereby inflation. Rodriguez concluded that an assertion that inflation is entirely caused by external factors is inappropriate, however, devaluation, in part, affects inflation, while the other part is attributed to various variables such as import prices or terms of trade.

Ghi and Hinkle (1999: 539-549) assert that if a country needs to im-

prove its competitiveness and require a devaluation of its real exchange rate, it is necessary to devalue the nominal exchange rate, in order to effect changes in the relative prices. However, devaluation could be eroded by inflation if the accompanying fiscal and monetary policies are not adjusted simultaneously to achieve the desire goal. Ghei and Hinkle, further assert that before devaluation of the nominal exchange rate, it is necessary to know the degree of misalignment between the real exchange rate and its equilibrium level. Otherwise if they are already aligned devaluation could lead to undesirable adjustment in the real exchange rate, they further assert that empirical studies have shown that devaluation often leads to inflationary pressure. But, only part of devaluation is transmitted (pass-through) to increases in consumer price inflation (Gust, Leduc & Vigfusson 2010, Neiman 2010; Burstein, Eichenbaum & Rebelo 2007; Marazzi & Sheets 2007) the other part affects the real exchange rate (Edwards 1989)[2].

Research Methodology

In the literature inflation is defined in many different ways. For the purpose of this study the author defines inflation as a persistent rise in general price level. The model the author adopts is a variant of Lim and Papi (1997) model of the determinants of inflation in Turkey and more recently studies by Taylor (2000); Mishkin (2008). However, the specification, of an eclectic model adopted in this study differs, in that it takes into account factors that have significantly influenced inflation process in Zimbabwe. Despite the focus on inflationary impact of an exchange rate adjustment, the author includes other variables that influence inflation.

The model the author uses for Zimbabwe is based on demand and supply of traded and non-traded goods.[3] A convenient starting point in the analysis of inflation process would be to discuss the determinants of aggregate demand (Qd) and aggregate supply (Qs) functions. Any changes in the composition of (Qd) and (Qs) are expected to influence price level. For

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[2] Edwards 1989 'pass through coefficient' and an 'effectiveness index' of a devaluation respectively.

[3] The production function is assumed to be homogenous of degree one and exhibit constant returns to scale.

example, borrowing from the Central Bank, an increase in government expenditures, monetary expansion and reduction in investment leads to shifts in aggregate demand, thereby increasing price level. Implicitly the resources do not adjust smoothly to changes in variables mentioned above. To encompass factors that influence demand, it is assumed that (Qd) depends on the real money balances and real income. The aggregate demand function is given as:

$$Q^d = Q^d\left(M/P, GNP/P, \mu_d\right) \tag{1}$$

where M is broad money, P, is the domestic price level, GNP is the output, and μ_d the demand random shocks.

On the other hand the price level could be affected by the factors that influence the aggregate supply (Q^s). For example, an increase in energy cost, food prices and devaluation/depreciation of the local currency are expected to shift the aggregate supply. Hence, the encompassing supply function is given as

$$Q^s = Q^s\left(NER, \pi^e, \mu_s\right) \tag{2}$$

where: NER is nominal exchange rate, π^e is expected inflation, and μ_s is the supply random shocks. The goods market is cleared when it is at equilibrium price given by

$$Q^d\left(M/P, GNP/P, \mu_d\right) = Q^s\left(NER, \pi^e, \mu_s\right) \tag{3}$$

Solving equation (3) for 'P' The author obtains the (reduced form) long run equilibrium price equation.

$$P = M + NER + GNP + \pi^e + \mu \tag{4}$$

Equation (4) is the long run price equation that states that in the long run the price level in the goods market is influenced by broad money, nominal exchange rate, Gross National Product and expected inflation.

Equation (4) is estimated and residuals are used to test for co-integration[4] and in the estimation of the short-ran equation (6) below.

The Short-run Inflation Equation

The short run model is expected to encompass cyclical movements, seasonal fluctuation, and irregular variations such as drought, elections and strikes. It is assumed in the model that change in the logarithm of inflation is a function of the logarithm of: a change in nominal exchange rate lagged two quarters, the change in money supply lagged two quarters, the change in Gross National Product (electricity consumption is used as a proxy for GNP) and change in expected inflation. The inflation equation is presented as:

$$\Delta \log \pi_t = \Phi\left(\ \Delta \log\left(NER_{t-2}, M_{2t-2}, GNP_t, \pi_t^{\ e}\right), Uhat_{t-1}, \mu_t\right) \tag{5}$$

where Δ is the change,[5] π is the inflation the dependent variable, Φ denotes a function and the logarithm of[6]: ΔNER, change in nominal exchange rate, ΔM_2 change in money supply, ΔGNP, change in gross national product, $\Delta \pi^e$, change in expected inflation, that the error correction term are independent variables μ the random disturbance whose average value is expected to be zero, and 't' is the time[7].

The lags included in the inflation equation, strongly influence the dynamics and character of inflation process. For example, in the case of unionized labour force the assumed lags are not unreasonable in that collective bargain in most industries in Zimbabwe takes place once a year. In some cases negotiations drag on for a long time. This is the case with government workers. The lags are also justified in that the process of transforming price change such as exchange adjustment into cost takes months. However, administered prices such as those of electricity, fuel and water, perhaps, are insensitive to changes in demand, thereby inflation. But if they are frequently adjusted as the situation under the study period, they

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[4] $\Delta\mu_t = - \delta\mu_t + \xi_t$

[5] $\Delta\phi(t) = \phi(t) - \phi(t-1)$

[6] π, implies changes in price level

[7] $\pi^e = \phi(\pi_{t-1}, \pi_{t-2}, \pi_{t-3}, \pi_{t-4})$

impact adversely on inflation. Taking the log transformation of equation (5) the log-linear equation is given as:

$$\Delta Log\,\pi = a_o + \beta_1 \Delta \log \mathrm{NER}_{t\text{-}2} + \beta_2 \Delta \log M_{2t-2} + \beta_3 \Delta \log GNP_t + ..$$
$$\underset{(+)}{} \quad \underset{(+)}{} \quad \underset{(-)}{}$$

$$.. + \beta_4 \Delta \log \pi^e_{\,t} + \beta_5 Uhat(t-1) + \mu_t$$
$$\underset{(+)}{} \quad \underset{(-)}{} \qquad\qquad\qquad (6)$$

where: β_i are the parameters that give elasticities of respective variables with respect to inflation and 'i' equal to 1, 2, 3...n. The signs below the variable parameter indicate a priori sign of the variable. Equation (6) is the log linear inflation equation estimated using the OLS method for the period 1990Q1-2006Q4.

Data Collection

Having discussed the variable relations the author now turn to quantitative analysis of the inflation model. The quarterly time series data for 1990Q1 - 2006Q4 is used to estimate an eclectic long run and short-run equations (4) and (6). The data is obtained from Central Statistical Office (CSO). The quarterly data is expected to track inflation process better than annual data. The consumer price index (CPI or P) is used to compute change in prices and it includes administrative prices. The author uses the geometric mean to average the monthly (CPI) in order to obtain the quarterly (CPI). The consumer price index was measured with1990 as base year.

The choice of the sample series is determined by the date in which economic reforms were adopted and the fact that more recent developments are expected to have a bearing on the future policy management of the price level and the economy. The quarterly data used is measured in millions of Zimbabwe dollars. The exchange rate used, is the nominal official effective exchange rate.

Data Analysis

Before carrying out the ordinary Least Squares estimates for the long run model a test for stationarity of the variable series was carried out. The unit root test is employed to ascertain whether the series is stationary. For the

stationarity to be achieved the author tests the null hypothesis that the variables are non-stationary (Engle & Granger 1987; Dickey & Fuller 1979).

The time series properties of the data indicate that all the variables exhibit unit roots, and implies that they are of I(1) series. The long-run price equation is estimated using quarterly data over the period 1990Q1 to 2006Q4. A test for co-integration revealed that the residuals of the long run price equation are of I(0) series[8]. In other words, inflation is co-integrated with money, exchange rate, GNP, and expected inflation. The results of the long run price equation suggest that in the long run there is not much significance difference in the effects of money and exchange rate adjustment on inflation; output (GNP) has a negative effect, while expected inflation has a positive effect on inflation.

Having established the stationarity and co-integration of the series, the author estimates the short-run Error Correction Model (ECM) (equation 6). Table 1 below reports the results.

Table 1: An Error Correction Model of Inflation
Dependent Variable $\Delta\log(\pi_t)$

Variable	Coefficient	SE	t- ratio
Constant	0.0030	0.0049	- 0.58
$\Delta\log(NER_t$	0.0475	0.0189	2.51
$\Delta\log(M_{2t-2})$	0.0746	0.0532	1.40
$\Delta\log(GNP_t)$	- 0.0379	0.0157	- 2.41
$\Delta\log(\pi^e_t)$	0.0215	0.0083	2.57
Uht_{t-1}	- 0.1315	0.0216	- 6.07

$R^2 = .71$, $R^2 \to$ adj. $= .663$, S.E of regression $= .00944$
F- stat. F (5, 35) = 16.7552 (.000), DW – stat. = 1.67
RSS = 0.003124 for 6 variables and 41
Observations, Akaike info, Criteria = 130.2
Schwarz Bayesian criteria = 125.06
S.E of Regression = 0.0094

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[8] $\Delta\mu_t = -\delta\mu_{t-1} + \xi_t$

Table 2: The Long Run Price Equation[9]

Dependent Variable Log (P_t)

Variable	Coefficient	SE	t-ratio
Constant	0.18116	0.13112	1.13112
Log(NER_t)	0.51088	0.14270	3.42300
Log(M_{2t})	0.55215	0.12330	4.47500
Log(GNP_t)	-0.2028	0.07465	-2.71700
Log($EINF_t$)	0.12028	0.06204	1.939

The estimated long run Coefficient of an Auto Regressive Distributed Lag model (ARDL) chosen by the Schwarz Bayesian Criterion is given in table 2 above. As previously mentioned, the residuals of the long run model is found to be I(0), which supported co-integration.

Key to Variables
INF = Inflation
EINF= Expected Inflation
NER = Nominal Exchange Rate
M_2 = Money Supply
GNP = Electricity Consumption (Proxy for GNP)
CPI = P: Consumer Price Index
Q_i = Quarterly

Answer to Research Questions

The results given in table 1 above indicate that the nominal exchange rate, Gross National Product, expected inflation are clearly significantly different from zero at the 5 percent level of significance in absolute terms. Their t-ratios are 2.51, -2.41, and 2.57 respectively. In the case of the money supply, there is no evidence of a significant relationship from the short run data as applied to the model. However, in the long run the relationship between the money supply and price level is strong. The error correction term Uhat (-1) is significant, and indicates a 13 percent speed of adjustment into the short run process from the previous period. The inflation elasticity with respect to

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[9] $EINF_t = \pi^e_t$.

exchange rate results is a less than proportionate change in inflation. The R-Bar-squared of 66.3 percent presents a good fit and variables have the correct signs. The results indicate an exchange rate pass-through of 0.05 in the short run and an inflation elasticity of 0.51 for long run. Implying that in the short run 100 percent devaluation would lead to a 5 percent increase in inflation, while only 51 percent pass-through to inflation is reported in the long run.

The finding does not support a view that following a devaluation prices would rise by the same magnitude of devaluation. Governments are often opposed to devaluation or exchange rate adjustment in that devaluation implies increase in prices and paying more for debts servicing in local currencies. However, the exporters became less competitive if the currency is overvalued or misaligned from its equilibrium level. The results suggest that policies that favour exchange rate adjustment that achieve alignment are advantageous to the economy.

The demand-pull factors are strong in the case of Zimbabwe. The significant Gross National Product variable is evidence of an excess demand in the economy. As output declines prices of goods and services increase. This evidence is supported by poor economic growth rates that Zimbabwe has experienced in the period 1990Q1 to 2006Q4. The result suggests that a decline in output is, in part, responsible for surge in prices in the early to mid 2000's. The expected inflation influenced the supply side through high wages. Workers real wage variable was found to be inconsistent and thereby dropped in the estimated model. The results indicate that the exchange rate adjustment leads to a less than proportionate change in prices. Thus, our analysis suggests that only a proportion of devaluation impacts on consumer price inflation (Table 1). The long-term elasticity of inflation is approximately 0.51 with respect to nominal devaluation (Table 2).

The findings in the present study have thrown some light on the effects of an exchange rate adjustment on prices. By contrast the findings and evidence obtained in this paper though different in approach and data used they are in line with other similar studies that have been undertaken in Developed and Less Developing Countries.

Summary and Conclusion

The author examines the inflation impact of an exchange rate adjustment,

and has shown that the exchange rate pass-through to domestic price for Zimbabwe is incomplete and the findings and evidence obtained in this paper complement previous literature on the pass-through discourse. The aim of the author is to explain the determinants of inflation in Zimbabwe, with particular emphasis on the inflation impact of an exchange rate adjustment on prices. An attempt is made to analyze the effects of devaluation/revaluation of an exchange rate on Zimbabwe's inflation. The model employed is based on the aggregate demand and supply of goods and services. The co-integration regression equation is estimated using the quarterly data over the period 1990Q1-2006Q4. The residuals from the long run equation are included as a variable in the estimation of the short run error correction model. The findings in this paper indicate an incomplete exchange rate pass-through to consumer price inflation.

The author notes that demand-pull inflation is strong in the case of Zimbabwe's economy. The results have shown that as output declines prices of goods and services increase. The results obtained in this study have shade some light on the effects of an exchange rate adjustment on consumer prices. By explaining the potential consequences of an exchange rate adjustment on inflation it is hoped that the findings might be useful to policy makers and other researchers. It is recommended that a simultaneous devaluation of an exchange rate and tax cuts should reduce the inflation impact of an exchange rate adjustment. The results in this paper are conclusive, though they depend on the specification of the model and quality of data used. Finally, further investigation on the subject of inflation and exchange rate adjustments, could deal with causes of incomplete exchange rate pass-through to consumer prices and remedies of demand pull inflation in Zimbabwe.

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