EXCHANGE-RATE CHANGE IN A DISTRIBUTED-LAGS MODEL OF INFLATION DETERMINATION

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INTRODUCTION

A considerable amount of interest surrounds the issue of inflation in Caribbean countries at the present time. This interest is linked partly with the high preoccupation with overall instability and the effects of measures aimed at combatting the instability. Among the arsenal of measures increasingly resorted to is exchange-rate change targeted to arrest balance-of-payments deterioration. Over the last two decades, Jamaica, Guyana and, to a lesser extent, Trinidad and Tobago, have all used the exchange-rate instrument to combat economic instability in the form of balance-of-payments problems. Indeed, Guyana and Jamaica have moved to regimes of fluctuating exchange rates making exchange rate change a day-to-day feature of their economic management.

One effect of exchange rate depreciation is to stimulate inflation and this raises a number of questions, which are a matter of practical importance, about the nature of the stabilisation process. Firstly, it is useful to have an estimate of the magnitude of the inflationary response. A large inflationary impact implies that the improvement in price competitiveness that is often expected to accompany depreciation is commensurately diminished. In addition, the austerity of devaluation and the social tensions associated with it are accordingly increased.

Secondly, it is useful to have a good idea of the length of time that can be expected to elapse before the inflationary effect of a depreciation can take its full

course. For purposes of policy implementation, it is important to have an idea of the time horizon involved in order to predict the sustainability of a stabilisation programme.

This paper will attempt to estimate the impact of exchange-rate change in terms of the magnitude and duration of the long-term inflationary response. It will employ a single-equation regression approach aimed specifically at assessing the relationship of exchange-rate change and inflation. Consequently, our approach is essentially partial. A more complete analysis would attempt, for example, to account for the factors which explain inflation. The question may also arise as to the respective roles of external shocks, on one hand, and domestic monetary shifts, on the other, in stimulating inflation. The analysis of these questions would call for a simultaneous-equations model because of the inter-relationship of a number of relevant variables. Although these questions have been extensively researched, they remain largely unresolved when it is small countries such as those of the Caribbean that are involved.

The approach to be followed by this paper will be essentially empirical and the analysis will be applied to the case of Jamaica between 1978 and 1989. Jamaica presents a useful case because of its experience of sustained stabilisation efforts since the 1970s and, in particular, its repeated use of the exchange rate instrument during that period. In addition, the data needed to carry out the analysis were found to be available at the monthly level, presented in consistent series over a long period from the 1950s to the beginning of the 1990s. The study employs distributed lags in an attempt to capture some dynamic features of the process of inflationary response to exchange-rate change.

The paper will be structured in the following way. Section II will outline the salient features of the exchange-rate regimes and policies followed by Jamaica since the mid-1970s. Section III will touch on the underlying intuitions behind the model

and the theoretical questions that arise. Section IV will briefly address the question of the data,, i.e., its sources and likely accuracy. The econometric methodology is the subject of Section V and the results of the estimation procedures are reported and discussed in section VI.

II THE EXCHANGE-RATE EXPERIENCE OF JAMAICA SINCE THE MID-1970S

The period from April 1977 to the present has been one of continuous change in Jamaica in terms both of the absolute value of the exchange rate and the exchange-rate policies and regimes in operation. This experience of fluctuation was interrupted by one period of fixed official exchange-rates in 1979 to 1983. Devaluation has been a principal instrument used by the Jamaican Government to combat external economic instability which reached crisis proportions in the mid-1970s and has held a grip on the economy ever since. The severity of the external imbalance has been reflected in a sustained situation of negative net foreign assets for the country. Devaluation has never been a popular policy in Jamaica and has been resorted to reluctantly under pressure from international multilateral institutions and against the background of declining economic performance and acute balance-of-payments problems.

Not only has Jamaica experienced much exchange-rate change but also the policy framework has been in constant flux. A wide variety of exchange rate regimes have been tried including multiple exchange rates, fixed and flexible exchange rates, crawling peg, regimes administered by the central Bank and, at the

present time, an inter-bank system where the exchange rate is determined by sales and demand for foreign exchange at the commercial banks. There have been several versions of the multiple exchange rate system with up to three rates prevailing at the same time, i.e., the official rate, the parallel rate and the CARICOM rate (during 1983). For most of the time, instability has been reflected in the presence of a thriving blackmarket in currency which has served as a useful indicator of whether the official rate was consistent with conditions in the foreign exchange market. In addition, the era of exchange-rate instability has been marked by an experience of high inflation as prices have adjusted to changes in the external situation.

The varied experience and the multiplicity of rates poses a problem in terms of arriving at a single average measure of the exchange rate for a given month. Different rates applied to different baskets of goods and the calculation of the average would depend on the application of appropriate weights. The blackmarket should also be considered because the business conducted in this sector has been substantial. However, by its nature, the blackmarket is not readily susceptible to measurement by the official agencies. A second implication of the sustained experience of exchange rate change in Jamaica is that individuals have undoubtedly undergone a learning experience in terms of their expectations and responses to devaluation. Consequently, one should expect that by the late 1980s, people could anticipate the coming of depreciation and would incorporate this expectation into their economic decisions. This would introduce an element of structural change in the behavioural responses to economic instability.

III INTUITIONS BEHIND THE MODEL

Our basic intuition is that exchange-rate change in Jamaica should have a large impact on domestic price levels. There may be a certain element of asymmetry in that appreciation may not have as strong an effect on prices as depreciation. This is largely an academic observation as the experience of Jamaica has been dominated by changes in the downward direction and so we are mainly looking at inflationary effects.

Devaluation is expected to have a large inflationary stimulus in Jamaica firstly because of the openness of the economy. This openness is reflected in a high penetration of imports, amounting to between 50 and 60 percent of GDP in the 1980s. The high proportion of imports represents an immediate channel for exchange rate changes to affect the domestic price level.

The second consideration explaining the inflationary effect is the smallness of the economy within the world economy. Given this smallness, it is natural to expect that Jamaica would behave like a price-taker in the international market with respect to the setting of prices for all of its tradable produce. The principle that the law of one price applies to tradable goods is widely accepted following the analyses of Isard (1977) among others. In the context of the Commonwealth Caribbean, the notion that domestic produce is likely to experience inflation following devaluation has had to compete with the widely held notion of improving price competitiveness as a result to devaluation. However, Thomas (1963) gave an early expression of the small-country situation, pointing out that

> the economy is likely to be largely a price-taker and hence domestic/cost ratios are not likely for long to be out of line with the rest of the world. Export prices are determined largely by international demand and supply, the same holding true for imports.

Thomas (1989) went further in suggesting the virtual absence of a non-tradable sector in Caribbean countries and therefore arguing that the level of domestic price changes should be expected to match that of the exchange rate.

The empirical evidence with respect to the Caribbean is very sketchy on this point. However, attention may be drawn to a study cited by Francis (1986) which found that Bahamian prices adjusted to changes in the US wholesale price index almost 100 percent with a 15-month lag. Although this study did not include the exchange rate explicitly, it bears relevance to the extent that the US wholesale prices could be said to reflect the price levels in the international market facing the Bahamas. The domestic response to a change in the international price scenario should be the same irrespective of whether it originates in a change in the exchange rate or in the international price level. In general, there is the expectation that depreciation will give a large stimulus to inflation. However, it is also assumed that the inflationary impact peters out gradually over a period of time. Hence, this is not a study of the overall desirability or effectiveness of devaluation which depend on wider considerations.

IV DATA

The model employs two items of data, namely, the consumer price index (CPI) and the exchange rate. Lists of these variables are presented in Appendix I. It is a rare stroke of luck that data exist on a monthly basis and up-to-date series could be found going from as early as the late 1940s and stretching up to the early 1990s. These data are available in publications of the IMF but no doubt reflect the statistical output of the relevant statistical agencies in Jamaica. One advantage of using the IMF source is that the data are reconciled over long periods

but it is possible that some accuracy may be lost in the search for consistency.

The difficulties involved in arriving at accurate measures of the monthly exchange rate have already been commented on. It is worth noting that price data may also be subject to serious shortcomings. Familiarity with the situation in Jamaica has bred the impression that official publications of domestic price indices and inflation have a tendency to be underestimated. Moreover, it is clear that a period of instability characterised by shortages of some goods will be marked by significant changes in the composition of expenditure and this will make it harder to maintain an appropriate basket of goods and to apply the correct weights consistently. However, bearing these reservations in mind, the data were judged to be adequate for the purposes of this study, there being no better alternatives available.

V METHODOLOGY

This study employs a single-equation regression model to determine the magnitude and time profile of the inflationary impact of depreciation. The underlying thinking is that the effect will gradually diminish over a period of time and so there is interest in the lag pattern of the process. Consequently it was decided to employ a distributed lag model and for this purpose the geometric lag (also referred to as the Koyck lag) was chosen. The geometric lag was considered appropriate because it seemed reasonable to expect that the pattern would involve a monotonic diminishing of the effects as one moved further into the past in relation to an exchange rate shock. The geometric lag procedure imposes such a pattern on the model. A visual analogy to this process is to think of the disappearing ripples in a stream after a pebble has been tossed into it.

The possibility of regressing changes in the CPI on lagged values of the

exchange rate was investigated. However, this was found to be unworkable because the statistical properties of the estimates obtained were not acceptable. The problem could be attributed to the presence of multicollinearity as a result of the lagged explanatory variables (see Pindyck and Rubinfeld, 1976, p. 212). The geometric lag model presented a much better prospect with more robust statistical indicators.

It is argued that the geometric lag may introduce serial correlation but the transformation may eliminate serial correlation that was originally present. The OLS estimator may become biased but it remains consistent and the achievement of consistency is considered to be more important than the lack of bias where such a choice has to be made (see Pindyck and Rubinfeld, 1976, p. 24). In the end, the statistical indicators obtained by this procedure proved to be satisfactory.

The structural model hypothesised is as follows:

$$P_t = C + b(E_t + xE_{t-1} + x^2E_{t-2} + x^3E_{t-3} + ...) + e_t \quad (1)$$

Where P_t is the change in the CPI in period t

E_t is the change in the exchange rate in period t

x is the weight attached to exchange rate changes at different lag positions.

C is a constant and b is a parameter.

Lagging the model one period, we obtain:

$$P_{t-1} = C + b(E_{t-1} + xE_{t-2} + x^2E_{t-3} + ...) + e_{t-1} \quad (2)$$

Multiplying equation (2) by x and subtracting from equation (1), we obtain:

$$P_t - xP_{t-1} = C(1-x) + bE_t + u_t \quad (3)$$

where $u_t = e_t - xe_{t-1}$.

Equation (3) may be re-expressed as:

$$P_t = C(1-x) + bE_t + xP_{t-1} + u_t \quad (4)$$

This is a convenient specification of the lag model, not only because of the small number of explanatory variables but also because it stands a good chance of meeting the requirements for robust OLS estimators. In addition, we are able to obtain some further summary indicators which can help in the interpretation of the results. In the first place, there is the mean lag which is a time-weighted average of the individual lag weights and is found to be equal to x/(1-x). A second indicator is the long-run response of the dependent variable which is equal to b times the summation of the xs or b/(1-x). The long run response is usually associated with a permanent change in the explanatory variable. However, in this case, it is envisaged that exchange-rate change is once-and-for-all. Ultimately, our main interest in this study was to estimate the values of b and x and obtain from them the values of the coefficients of the lagged exchange-rate variables.

VI RESULTS

We present the results of OLS regressions run for two periods, namely, January, 1978 - December, 1980 and January, 1984 -December, 1989. The period of 1980-83 was excluded because for most of this period, the exchange rate remained fixed. Consequently, the exchange rate change recorded is zero and this gave rise to a perverse negative sign for the coefficient.

The results obtained were as follows:

1978-80

$P_t =$	0.34 +	$2.5E_t +$	$0.5P_{t-1}$	(5)
t:	(2.2)	(2.2)	(3.4)	

$R^2 = 0.3$

D.W.: 2.09

1984-89

$P_t = 1.18 + 0.055E_t + 0.27P_{t-1}$ (6)

t: (5.0) (0.05) (2.3)

$R^2 = 0.07$

D.W.: 1.97

It is interesting to compare the results of the two estimations. In addition, attention is drawn to Appendix II which presents lists of estimated coefficients for the lagged exchange-rate variables of the original model shown in equation 1. It can be observed that the intercepts and the coefficients on the lagged price variables are significant in both equations. However, the exchange rate change coefficient is significant only in the 1978-80 period. In addition the actual estimates of the coefficients of the lagged variables, reported in Appendix II, are higher for the earlier period.

In general, the results suggest that the impact of exchange-rate change was stronger in the earlier period. This is seen in the significance of the explanatory variables and in the values of the coefficients. Moreover, the value of the long-run response is 5 for 1978-80 compared to .08 for the later period. The long-run response has to be interpreted in this case as the temporary impact of the exchange-rate shock, inflation eventually returning to its original level after the once-and-for-all shock. The mean lags which are obtained are 1 and 0.4 for 1978-80 and 1984-89, respectively. This reinforces the result shown above because the larger long-run response would be expected to take a longer time to have its full effect.

It is interesting to observe that the effects of devaluation on inflation are temporary. Devaluation gives an immediate boost to inflation but this is quickly dissipated and the economy returns to its original rate of inflation. From this point of view, the instinctive aversion to devaluation may be overdone. If external

adjustment is called for, it may be a relatively easy option to take if done in a timely fashion and backed by policies to promote long-term development and help vulnerable groups.

It must be stressed that once fundamental imbalances present themselves, some form of economic adjustment is inevitable, sooner or later, either in the form of exchange-rate change or declining economic performance and national chaos. In this context we have to qualify the view of the exchange rate as an exogenous policy variable. Ultimately, policy can determine the exchange regime rather than the real exchange rate.

The issue of the impact of devaluation on price competitiveness in Jamaica is not conclusively resolved. The 1978-80 sample suggests that domestic price changes overtake the exchange-rate change that provided the initial stimulus. In this light, any improvement in the competitiveness of prices is short-lived. The second sample, however, suggests that inflationary response is lower than the impact of the exchange-rate change. This suggests a significant structural change in the behaviour and expectations of the public. It could be that having become accustomed to exchange-rate changes, the public anticipates them and so there is a persistent trend of inflation that is not explicitly linked to devaluation. This interpretation would perhaps explain the low significance of the parameter estimates for exchange-rate changes.

Further work is indicated to achieve conclusive results. This will involve the incorporation of more variables which help to determine the inflation rate most likely in a simultaneous-equations framework. One drawback to be expected is the relative unavailability of some of the data required for such and enterprise at the monthly level.

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I wish to acknowledge the assistance of Mr. Dillon Alleyne in computing the econometric manipulations and in discussions on the study. Final responsibility for all errors and omissions remain with me.

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APPENDIX I

DATA

Month	CPI	Absolute Change	Exchange Rate	Absolute Change
78.01	22.54		1.05	
78.02	23.20	0.66	1.05	0.00
78.03	23.55	0.35	1.05	0.00
78.04	23.65	0.10	1.05	0.00
78.05	25.39	1.74	1.55	0.50
78.06	28.78	3.39	1.57	0.02
78.07	30.72	1.94	1.60	0.02
78.08	31.54	0.82	1.62	0.02
78.09	31.94	0.40	1.65	0.02
78.10	32.28	0.34	1.66	0.02
78.11	32.45	0.17	1.68	0.02
78.12	33.16	0.71	1.70	0.02
79.01	33.15	-0.01	1.71	0.02
79.02	34.22	1.07	1.73	0.02
79.03	34.61	0.39	1.75	0.02
79.04	34.98	0.37	1.76	0.02
79.05	35.38	0.40	1.78	0.02
79.06	36.01	0.63	1.78	0.00
79.07	36.59	0.58	1.78	0.00
79.08	37.35	0.76	1.78	0.00
79.09	37.85	0.50	1.78	0.00
79.10	38.80	0.95	1.78	0.00
79.11	39.17	0.37	1.78	0.00
79.12	39.71	0.54	1.78	0.00
80.01	41.32	1.61	1.78	0.00
80.02	42.27	0.95	1.78	0.00
80.03	42.61	0.34	1.78	0.00
80.04	43.08	0.47	1.78	0.00
80.05	44.82	1.74	1.78	0.00
80.06	46.46	1.64	1.78	0.00
80.07	47.52	1.06	1.78	0.00
80.08	48.33	0.81	1.78	0.00
80.09	48.97	0.64	1.78	0.00
80.10	50.05	1.08	1.78	0.00
80.11	50.84	0.79	1.78	0.00
80.12	51.11	0.27	1.78	0.00
81.01	51.53	0.42	1.78	0.00
81.02	51.14	-0.39	1.78	0.00
81.03	50.97	-0.17	1.78	0.00
81.04	51.56	0.59	1.78	0.00
81.05	51.71	0.15	1.78	0.00
81.06	51.82	0.11	1.78	0.00
81.07	52.72	0.90	1.78	0.00
81.08	53.12	0.40	1.78	0.00
81.09	53.27	0.15	1.78	0.00
81.10	53.49	0.22	1.78	0.00
81.11	53.49	0.00	1.78	0.00
81.12	53.56	0.07	1.78	0.00
82.01	53.88	0.32	1.78	0.00

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Month	CPI	Absolute Change	Exchange Rate	Absolute Change
82.02	54.15	0.27	1.78	0.00
82.03	54.38	0.23	1.78	0.00
82.04	54.96	0.58	1.78	0.00
82.05	55.17	0.21	1.78	0.00
82.06	55.51	0.34	1.78	0.00
82.07	55.88	0.37	1.78	0.00
82.08	56.60	0.72	1.78	0.00
82.09	56.97	0.37	1.78	0.00
82.10	57.37	0.40	1.78	0.00
82.11	57.34	-0.03	1.78	0.00
82.12	57.31	-0.03	1.78	0.00
83.01	57.76	0.45	1.78	0.00
83.02	58.34	0.58	1.78	0.00
83.03	59.13	0.79	1.78	0.00
83.04	59.53	0.40	1.78	0.00
83.05	60.30	0.77	1.78	0.00
83.06	61.14	0.84	1.78	0.00
83.07	62.69	1.55	1.78	0.00
83.08	64.38	1.69	1.78	0.00
83.09	65.07	0.69	1.78	0.00
83.10	65.76	0.69	1.78	0.00
83.11	66.11	0.35	3.13	1.34
83.12	66.86	0.75	3.28	0.15
84.01	69.17	2.31	3.25	-0.03
84.02	70.49	1.32	3.28	0.02
84.03	71.60	1.11	3.68	0.41
84.04	72.99	1.39	3.98	0.30
84.05	75.98	2.99	3.87	-0.11
84.06	80.28	4.30	3.87	0.00
84.07	83.31	3.03	3.98	0.11
84.08	84.29	0.98	4.13	0.15
84.09	85.53	1.24	4.28	0.15
84.10	86.37	0.84	4.58	0.30
84.11	87.16	0.79	4.84	0.26
84.12	87.69	0.53	4.93	0.09
85.01	88.41	0.72	5.13	0.20
85.02	90.65	2.24	5.04	-0.09
85.03	92.87	2.22	5.48	0.44
85.04	94.80	1.93	5.48	0.00
85.05	97.46	2.66	5.50	0.02
85.06	100.66	3.20	5.62	0.12
85.07	102.71	2.05	5.76	0.14
85.08	104.64	1.93	5.76	0.00
85.09	106.05	1.41	5.93	0.17
85.10	106.65	0.60	5.99	0.06
85.11	107.15	0.50	5.48	-0.51
85.12	107.95	0.80	5.48	0.00
86.01	110.96	3.01	5.48	0.00
86.02	111.17	0.21	5.48	0.00

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DATA

Month	CPI	Absolute Change	Exchange Rate	Absolute Change
86.03	111.24	0.07	5.46	-0.02
86.04	112.67	1.43	5.48	0.02
86.05	113.04	0.37	5.47	-0.01
86.06	114.01	0.97	5.48	0.01
86.07	115.46	1.45	5.48	0.00
86.08	116.92	1.46	5.46	-0.02
86.09	118.08	1.16	5.47	0.01
86.10	119.46	1.38	5.49	0.02
86.11	118.72	-0.74	5.48	-0.01
86.12	119.53	0.81	5.48	0.00
87.01	118.69	-0.84	5.48	0.00
87.02	119.03	0.34	5.49	0.01
87.03	119.71	0.68	5.48	-0.01
87.04	119.91	0.20	5.49	0.01
87.05	120.90	0.99	5.49	0.00
87.06	122.02	1.12	5.49	0.00
87.07	123.04	1.02	5.48	-0.01
87.08	123.71	0.67	5.48	0.00
87.09	124.52	0.81	5.48	0.00
87.10	125.47	0.95	5.49	0.01
87.11	126.63	1.16	5.49	0.00
87.12	129.53	2.90	5.50	0.01
88.01	128.76	-0.77	5.48	-0.02
88.02	134.04	5.28	5.51	0.03
88.03	137.90	3.86	5.48	-0.03
88.04	139.83	1.93	5.49	0.01
88.05	140.60	0.77	5.50	0.01
88.06	143.31	2.71	5.48	-0.02
88.07	143.44	0.13	5.49	0.01
88.08	144.21	0.77	5.49	0.00
88.09	145.50	1.29	5.48	-0.01
88.10	149.62	4.12	5.50	0.02
88.11	151.55	1.93	5.50	0.00
88.12	152.97	1.42	5.48	-0.02
89.01	154.12	1.15	5.48	0.00
89.02	156.44	2.32	5.48	0.00
89.03	157.47	1.03	5.49	0.01
89.04	160.05	2.58	5.50	0.01
89.05	164.81	4.76	5.48	-0.02
89.06	166.87	2.06	5.48	0.00
89.07	168.93	2.06	5.50	0.02
89.08	173.57	4.64	5.68	0.18
89.09	176.40	2.83	5.91	0.23
89.10	177.43	1.03	6.19	0.28
89.11	178.97	1.54	6.48	0.29
89.12	182.71	3.74	6.48	0.00

APPENDIX II

Coefficient Estimates of

Lagged Exchange-rate Variable

1978-80		1984-89
b = 2.5		0.055
x = 0.5		0.27
s	bx^s	
0	2.5	.055
1	1.25	.015
2	.63	.004
3	.31	.001
4	.16	.0003
5	.08	
6	.05	
7	.02	
8	.01	
9	.005	
10	.003	
11	.001	
12	.0005	