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An integrated *macro-model for the* Caribbean subregion

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The objective of this paper is to calculate a simple integrated macro-model for the Caribbean subregion. Using a homogeneous data set that runs from 1980 to 1991 for a sample of 12 countries in the subregion and a fairly simple model with non-controversial specifications for the structural relationships, we generate a representative and consistent group of estimates for a given set of parameters in pooled and individual country estimations.

I

Introduction

The research area of macroeconomic modelling¹ for developing countries, in spite of all the recent developments, still lacks harmony and consistency, both at the methodological and the empirical levels. On the methodological side, the assumptions used vary widely, even regarding some basic elements like the determination of aggregate supply and demand, the features of the trade and exchange rate regimes, the degree of capital and labour mobility and real wage flexibility, plus some of the more traditional controversies in macro modelling, like the adequate modelling of the agents' expectations. On the empirical side, dissent rages about the general specification of models and the representative values of parameters.

In the Caribbean subregion, these general problems are compounded by the scarcity both of available data and of modelling attempts, not just for the subregion as a whole, but even for its individual countries. Only some of the major countries have

made any meaningful efforts in the area of macro modelling.²

The objective of this paper is to begin to fill this gap. Using a homogeneous data set for a sample of countries in the subregion and a fairly simple model with non-controversial specifications for the structural relationships (Haque, Lahiri and Montiel, 1990), we will try to generate a representative and consistent group of simultaneous estimates for a given set of joint parameters for the sample of countries as a whole and forecast the short-term values of these parameters.

A fairly simple model could provide both national governments and national and regional agencies with a powerful tool for reliably forecasting the short-term values of some key macroeconomic variables, therefore providing an essential information set that facilitates basic policy decisions, such as the choice of suitable economic policies for the short term.

II

The data set and the model

1. The data set

The 12 countries selected for the pooled model were: Bahamas, Barbados*, Belize*, Dominica**, Dominican Republic, Grenada**, Guyana*, Jamaica*, St. Kitts and Nevis**, St. Vincent and the Grenadines**, Suriname* and Trinidad and Tobago*.³

¹ A comprehensive description of the state of the art in the economic growth modelling area may be found in Barro and Sala-i-Martin (1995), while a very good discussion of the most recent controversies is to be found in Clements and Hendry (1995).

² See Hilaire, Nicholls and Henry; 1990; Ganga, 1990; Worrel and Holder, 1987; Boamah, 1982; ECLAC, 1991, and Joefield-Napier, 1979. Special mention should be made of some recent attempts by the World Bank (see World Bank, 1994a and 1994b), because of their scope and dimension, and of the book by Nicholls, Leon and Watson, 1996, which was published after the completion of this work and provides a very updated and comprehensive description of the subject.

³ Countries marked * are CARICOM (Caribbean Common Market) member countries, while those marked ** are members of the OECS (Organization of Eastern Caribbean Countries).

2. The model⁴

The model used is a variant of the classical Mundell-Fleming formulation, with one domestically produced good consumed both at home and abroad and one exported commodity.⁵ The home country is a price-taker in terms of its demand for imports, which takes place under external constraints, but it holds a degree of monopoly power on its export output. Investment, domestic interest rates and the current account position are set endogenously in the model. Dynamics are generated by partial adjustment processes and by forward-looking expectations. The set of reduced behavioural log-linear equations used in our estimations were:

$$(1) \log C_t = \alpha_0 + \alpha_1 r_t + \alpha_2 \log C_{t-1} + \alpha_3 \log Y_t^d + \alpha_4 \log Y_{t-1}^d$$

$$(2) \log (Y/L) = \theta_0 + \theta_1 (K_t^I - \log L_t) + \theta_2 t + \theta_3 (Y/L)_{t-1}$$

$$(3) I_t = \kappa_1 (r_t - r_{t-1}) + \kappa_2 (Y_t - Y_{t-1}) + \kappa_3 I_{t-1}$$

$$(4) \log X_t = \iota_0 + \iota_1 \log \varepsilon_t P_t^*/P_t + \iota_2 \log Y_t^* + \iota_3 \log X_{t-1}$$

$$(5) \log Z_t = \delta_0 + \delta_1 \log \varepsilon_t P_t^*/P_t + \delta_2 \log Y_t + \delta_3 \log R_{t-1}/P_{t-1}^* Z_{t-1} + \delta_4 \log Z_{t-1}$$

$$(6) \log (M_t/P_t) = \beta_0 + \beta_1 i_t + \beta_2 \log Y_t + \beta_3 \log Y_{t-1} + \beta_4 \log (M_{t-1}/P_{t-1})$$

The first equation represents the aggregate consumption function⁶, where C_t is real private consumption expenditure, r_t represents the real domestic interest rates⁷ and Y_t^d is the real disposable income (defined as GDP plus earnings on net assets held abroad, minus interest paid on domestic debt and taxes). Coefficient α_1 is a test for the short-run interest elasticity of consumption, coefficient α_2 is a test for the permanent income hypotheses with no liquidity constraints, coefficient α_3 is a test for the hypothe-

ses of liquidity constraints among some households in a developing subregion like the Caribbean, and coefficient α_4 is a test for the length of the time horizons of non-liquidity-constrained households.

The second equation represents the aggregate supply function, and is based on a classical Cobb-Douglas specification with complete wage-price flexibility.⁸ Data on capital stock are extremely scarce in the Caribbean –indeed, they are virtually non-existent for most countries– so the capital stock series $-K_t^I-$ is actually a proxy based on gross investment flows (gross fixed capital formation) according to the following equation:

$$K_t^I = \log 2 + 1/2 \sum_{i=0}^{t-1} (1-\rho)^i I_{t-i} + t/2 \log (1-\rho)$$

ρ , which represents the rate of depreciation, was set at 0.1 (10%). Imposing constant returns to scale, we get

$$\log (Y/L) = \theta_0 + \theta_1 (K_t^I - \log L_t)$$

The other two terms in this equation represent technological progress (expressed by the time trend gt) and a lagged adjustment process.

The third function is a standard investment equation, first differentiated to eliminate the capital stock variable. The remaining terms are the real interest rate and the real output.

The fourth function is the exports equation, also with a standard specification:⁹ the first term represents the real exchange rate, the second the external demand (an index of world output) and the last one a lagged adjustment process.

Similarly, the fifth function is the imports equation (Goldstein and Khan, 1985), also with a standard specification: the first term represents the real exchange rate, the second the real domestic demand, the third represents the external constraint faced by many developing economies –expressed as a reserves/imports ratio– and the last one a lagged adjustment process.

The sixth and last function represents the real money demand equation, with a variable for real domestic demand and a lagged adjustment process and with i_t –the domestic interest rate– set exogenously to the model.¹⁰

⁴ This section follows closely Haque, Lahiri and Montiel, 1990.

⁵ Data limitations prevent the use of a more disaggregated specification.

⁶ This specification was based on Blinder and Deaton, 1985.

⁷ Forecasts had to be made for Suriname and the Dominican Republic for part of this series, based on the following specification: $i_t = \alpha_1 + \alpha_2 Y_t + \alpha_3 P_t + \alpha_4 i_{t-1}$, where Y is the GDP, P is the consumer price index and i is the lagged domestic interest rate.

⁸ See Solow, 1957.

⁹ See Goldstein and Khan, 1985.

¹⁰ This formulation deliberately avoids the modelling of the essential question concerning the degree and role of capital mobility in the Caribbean economies. This decision was taken due to data difficulties –the absence of series on future values of exchange rates– and theoretical questions –the lack of consensus on the right assumptions about the parameters– and aims to simplify the structure of the model.

III

Estimation of the model

1. Method of estimation

The use of a pooled estimation model always implies the question of country heterogeneity. The approach used to deal with this question was to estimate three different types of pooled estimations:

- a pooled one, which assumes that the sample has a single intercept and a single set of slopes, given by $(\gamma_{it} = \chi_{it} \beta + \alpha + \mu_{it})$;
- a fixed effects one, which assumes that the sample has a single set of slopes but that each data unit has its own intercept, i.e., the intercept captures the country heterogeneity, given by $(\gamma_{it} = \chi_{it} \beta + \alpha_i + \mu_{it})$. This is the usual approach in most estimations of this kind, either through the use of the intercept or through the use of a country dummy;
- a random effects one, which assumes that the sample has a single set of slopes and that each data unit has its intercept drawn from a common distribution with a mean α and a variance σ^2_{α} . In this estimation, the intercept captures part of the country heterogeneity, and the remainder is expressed in the error term, which has the specification: $\mu_{it} = \alpha_i + \mu_t + n_{it}$, where α_i is the individual effect, μ_t is the time effect and n_{it} is the purely random effect. The estimates for this GLS (Generalized Least Squares) model are consistent and asymptotically efficient, if the individual intercept of each data unit is not correlated with its independent variables.

We also estimated a model in which both intercepts and slopes vary among data units, which amounts to a single individual estimation for every country, given by $\gamma_{it} = \chi_{it} \beta_i + \alpha_i + \mu_{it}$, and then used the results of this estimation in an F-test of restriction of equality of coefficients (slopes and intercepts) of this model against the pooled and the fixed effects models' coefficients. We also estimated the same F-test between the fixed and random effects models.¹¹

¹¹ This amounted to the testing of a set of J linear restrictions upon the coefficients, given by $g' = (R\beta' - r)' (RCR')^{-1} (R\beta' - r)' \rightarrow \chi^2_{(J)}$, that has as null and alternative hypotheses, respectively, $H_0: R\beta = r$; $H_1: R\beta \neq 0$, with the null hypotheses being rejected for values of g greater than the critical value of the distribution $\chi^2_{(J)}$ for a pre-chosen significance level (0.05%).

List of Variables

Aggregate demand equation

C	Constant
IR	Real domestic interest rate
LTCL	Real private consumption expenditure
LYD	Real disposable income
LYDL	Real disposable income lagged

Aggregate supply equation

KS	Capital stock
TIME	Time trend
LYLL	Aggregate supply lagged

Investment equation

IRD	Real domestic interest rate
GDPD	Real output lagged
IL	Investment lagged

Exports equation

LXR	Real exchange rate
LYX	External demand
LXL	Exports lagged

Imports equation,

LXR	Real exchange rate
LGDP	Real domestic demand
LRL	Reserves level
LML	Imports lagged

Money demand

IR	Domestic interest rate
LGDP	Real domestic demand
LGDPD	Real domestic demand lagged
LMOL	Money supply lagged

2. Results of estimations

As we may see from the results of our estimations (table 1), all the equations have high R^2 and most of the variables are significant and have the expected signs.

In the case of the Aggregated Consumption Equation, the variable for the interest rate elasticity of consumption is significant but positive in all the models, albeit with a small coefficient, except for the fixed effects model. This may be explained by an interest rate administratively set and negative in real terms, as was the rule in most of the subregion during the period in question. The variable for the perma-

TABLE 1

Results of estimations

Aggregate Demand Equation					Exports Equation				
Variable	Expected sign	Pooled estimation	Fixed effects	Random effects	Variable	Expected sign	Pooled estimation	Fixed effects	Random effects
R ²		0.99	0.9	0.99	R ²		0.98	0.79	0.97
C		.005		-.07	C		1.21		1.25
		0.09		-.93			1.3		1.4
IR	-	.002	24	.003	LXR	+	.23	.3	.23
		2.2*	2*	2.9*			6.72*	5.8*	6.2*
LTCL	+	.96	.85	.95	LYX	+	-.26	-.35	-.26
		102*	14.7*	65.4*			-1.3	-1.7	-1.3
LYD	+	.36	.43	.37	LXL	+	.96	.79	1
		5.9*	7*	6.5*			80.8*	13.7*	64.6*
LYDL	+	-.31	-.12	-.31					
		-4.9	-1.6	-5.1					
Aggregate Supply Equation					Imports Equation				
R ²		0.99	0.86	0.98	R ²		0.98	0.86	0.94
C		.064		-.02	C		-.11		-.08
		.9		-.17			-1.3		-.5
KS	+	.3	.07	.04	LXR	-	.2	.12	.19
		1.8*	.75	1.14			5.7*	2.5*	5.5*
TIME	+	-.0003	.015	.0001	LGDP	+	.01	1	.13
		-.69	2.95*	.1			.28	5.7*	2.1*
LYLL	+	.98	1.13	.99	LRL	+	-.02	.004	-.01
		167.9*	21.2*	86.7*			-1	.17	-.3
					LML	+	1	.7	.9
							57.2*	12*	-.5
Investment Equation					Money Demand				
R ²		0.99	0.98	0.99	R ²		0.99	0.88	0.99
C		-.9		-6.1	C		.06		.08
		-.05		-.27			1		.8
IRD	-	3.78	4.3	3.9	IR	-	-.003	.00001	.002
		2.54*	2.82*	2.8*			-2.4	.07	-1.3
GDPD	+	.32	.29	.32	LGDP	+	1.9	1.9	1.7
		34.7*	18*	30.9*			7.5*	4.6*	6*
IL	+	1	1.1	1	LGDPD	+	-1.9	-1.6	-1.7
		41.9*	20*	35*			-7.3	-3.4	-5.8
					LMOL	+	1	.8	1
							119.2*	14.3*	84.8*

* = significant at the 5% level.

nent income hypotheses is strongly significant and has the right sign for all models, as is the variable for disposable income. The variable for lagged disposable income is not significant and has the wrong sign in all models. This also supports the hypotheses that the average household in the subregion is liquidity-constrained and has a very short time horizon in financial terms.

In the aggregate supply function, the proxy for capital stock –KS– was significant only for the pooled

estimation. The others –albeit of the right sign– are non-significant and have very small coefficients. The proxy for technological progress is significant only in the fixed effects model, and with a relatively small coefficient, although it has the right sign in all of them. This indicates the lack of a clear, sustained trend of technological upgrading in the subregion. The only variable systematically significant was the lagged investment variable. That indicates that this specific endogenous variable could probably be ade-

quately forecast in the short run by a simple ARIMA specification.

As reasons for these results, we may consider the fact that most of the countries in the subregion rely heavily on foreign direct investment and official flows for their gross capital formation—in some cases, by over 50% (Vinhas de Souza, 1996)—and that the majority have their productive structures dominated by sectors (the primary and tertiary sectors) which are not particularly capital-intensive.

In the case of the investment equation, the variable for the interest rate is significant for all of the models, but has the wrong sign and its coefficient is suspiciously high. The “investment lagged” and “real output” variables are also generally strongly significant, and have the right sign.

Some of the possible explanations for these features have been already listed for the aggregate supply and demand equations. Investment in the subregion is heavily dependent on external flows, both private and official, which are not affected by the domestic interest rate. We may add that most of the Caribbean economies were until recently almost textbook cases of financial repression:¹² several of their domestic financial systems allocated credit on an administrative basis and at heavily negative real interest rates, while the ownership structure in their economies—especially in the primary and tertiary sectors—is a mix of “traditional” and “modern” firms, in which the access of the “traditional” companies to market financing is limited, leading them to rely heavily on non-market forms of financing, which is another indication of financial repression.

In the case of the exports equation, the variable for the exchange rate is significant and has the right sign in all the models, but the estimated coefficient for the world demand proxy is not significant in all the models, and all have the wrong sign. The variable for lagged exports is significant in all the models and has the right sign. These results may be due to the fact that the subregion’s exports are dominated by preferential trade schemes such as the Lomé Agreement, the Caribbean Basin Initiative, or the U.S. Sugar Quotas, and specific quotas are actually administratively set for some major primary products (sugar, bananas).

The results for the imports equation show that the exchange rate variable is significant in all the models, but has the wrong sign in all of them; the variable for real domestic demand has the right sign in all the models but is not significant for the pooled estimation model; none of the models have a significant reserve constraints variable and two of them have the wrong sign; and the lagged imports variable is significant for two of the models, but has the right sign for all of them.

Some of the reasons for these results are the same as for the previous equation. The existence of preferential trade flows, which allows for a certain degree of stability of the hard currency flows generated by exports, especially with the help of the Lomé Agreement stabilization funds (STABEX and STAMIN), plus the importance of foreign inflows, both private and official, have reduced the importance of the reserves constraints for these economies. Also, administratively set and differentiated exchange rates, which existed in some countries in the subregion during the period, may partially explain the results for the exchange rate.

In the case of the money demand equation, the previous results for the domestic real interest rate reappear, which indicates the need for complete financial liberalization: the variable for the domestic interest rate is not significant in all the models and has the wrong sign in two of them, and the coefficients are very small. The variable for current real domestic demand has the right sign in all of the models and is significant in all of them, but the variable for lagged real domestic demand is not significant and has the wrong sign in all the models, which again lends support to the notion of liquidity-constrained households. The lagged money demand variable is strongly significant and has the expected sign for all the models.

Generally speaking, the results were very satisfactory. The models generated a set of consistent, asymptotically efficient and representative estimates. Most of the coefficients were significant, had the expected signs, and the explanatory power of the regressions—the R^2 —was very high.

Nevertheless, we must also note that all the F tests indicate the rejection of the null hypotheses, i.e., of the equality of the coefficients between the individual estimations and the pooled and fixed models, and between the fixed and random effects models. These results may indicate that the random effects

¹² For a definition of financial repression, see Gurley and Shawn, 1983.

model is the one that most adequately represents the results of individual country estimations, which is in accordance with the theory. To verify this, a Hausman test¹³ of random versus fixed effects on panel

data was made. The results of this test indicate, once again, that the random effects model is probably the most suitable aggregate modelling alternative for the individual country regressions.¹⁴

IV

Conclusions

The general results of our estimations were mostly satisfactory, and we may assume that the estimators thus generated are representative for the countries in our sample. The reliability of the model was tested by "backward forecasting", which generated values for the endogenous variables within ± 0.01 and ± 0.02 from the real variables, as indicated by the R^2 of the equations. Nevertheless, some specific features of the Caribbean economies are not adequately represented in the standard specifications of growth models,¹⁵ which is compounded by the usual problem of lack of reliable and updated data. The modelling of the specific regulatory hindrances, especially financial, still present in most Caribbean economies and of the preferential trade and investment schemes prevalent among these countries is essential for an adequate representation of their economic structures.

On the other hand, some of the previous results may also indicate that, not surprisingly, the natural diversity of the countries of the subregion –oil ex-

porters and oil importers, relatively large continental countries and small island States, colonies and independent countries, mainly industrial economies alongside primary and tertiary ones, different degrees of financial, trade and investment liberalization, and different types of institutional relationships with different sets of developed countries– means that a joint modelling effort of the Caribbean as a single economic area not only has its limitations, but may even be a completely inappropriate assumption. Specific country modelling, or the modelling of more homogeneous groupings –for example, the OECS members, but not the CARICOM member countries– would naturally provide a more precise picture.¹⁶ Nevertheless, it must be acknowledged that this fairly simple model provides both national and regional agencies with a powerful tool for reliably forecasting the short-term values of some key macroeconomic variables, thus making available an essential information set that will facilitate basic policy decisions.

(Original: English)

¹³ A Hausman test verifies the equality of two sets of estimations, β_1^* and β_2^* , in which β_1^* , the most efficient estimator, is compared with the less efficient one β_2^* . If the model specification is correct, $\beta_1^* - \beta_2^*$ will tend to zero.

¹⁴ The only exception was the investment equation, which was also the only equation that failed to reject the null hypothesis of equality between the pooled and fixed effects estimations. In this case, a specification with common slopes could be an adequate modelling alternative, perhaps because of the subregion's reliance on external capital flows and the possibly similar perceptions and constraints of investors toward this fact.

¹⁵ It should be noted that most of these "specificities" actually represent temporary deviations from market allocation, such as regulated banking and exchange rate systems, preferential trade schemes, etc., and are a measure of the amount of liberalization still needed.

¹⁶ An initial attempt at country-specific modelling gave results which were much less satisfactory than those for the joint estimation, but they nevertheless give a very interesting idea of the importance of country specificities. Also, it should be noted that Watson (1995) even rejects the use of a perceived homogeneous group such as the OECS for modelling attempts, on the grounds that such a group does not justify a meaningful joint estimation. This means that he also rejects them as true economic regions.

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