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An examination of the purchasing power parity hypothesis in a low inflation environment

I. INTRODUCTION

The relationship between relative prices and the exchange rate has been an area of intensive research. Most studies focus on the empirical validity of the purchasing power parity hypothesis (PPP) as investigators attempt to establish whether there is co-movement of exchange rates and relative prices in the long run. The PPP hypothesis can be traced to the work of classical economist including Alfred Marshall, John Stuart Mill and Viscount Goschen, however the modern interpretation is associated with the work of Cassel (1921, 1920).[1] Apart from being considered, as a theory of exchange rate determination by modern scholar's, the

[1] Cassel's ideas were very influential in informing the debate over Britain attempts to restore its pre-war mint parity with the dollar after 1925.

Paper prepared by R. Darius and O. Williams, economists of the Research and Information Department, of the Eastern Caribbean Central Bank (ECCB) and presented, at the IV Meeting of the Network of America Central Bank Researchers, organized by the Banco Central de Chile, in Santiago, in October 20 and 21, 1999. The views expressed in this paper are those of the authors and do not necessarily reflect policy positions of the ECCB. All errors and omissions accrue entirely to the authors.

interest in the hypothesis partly reflects its importance as a fundamental building block of modern exchange rate theories.[2] In addition the theory has been utilized, in determining the most relevant exchange rate for a newly independent country and forecasting medium to long term exchange rates.

The growth in research in this particular area reflects the changes that occurred in the global monetary system in the mid-1970's, along with developments in econometrics and in particular co-integration theory. The majority of researchers have not found evidence in support of the hypothesis. For instance Corbae and Oulieries (1988), Park (1991) and Arderi and Lubin (1991) and Dornbusch (1988) using cointegration analysis all report evidence in favor of the rejection of PPP as a long run hypothesis, using cointegration techniques. However it must be noted that the majority of studies conducted to date have been on developed countries and a limited number on high inflation developing countries.

The main motivation for this paper is to examine the relevance of the PPP hypothesis in a sample of developing countries. The countries selected are those, which form part of the Eastern Caribbean unified monetary area.[3] The sample was chosen for two reasons, because of the low inflation environment and the existence of a fixed nominal exchange rate for the group of countries. This is of particular importance as studies conducted in high inflation countries are more supportive of the hypothesis than under conditions of general price stability.

The structure of the paper is of the following order: In section II, the basic PPP theory will be examined and possible reasons for short term and long term deviation from the theory will be discussed. Section III examines econometric technique and in particular co-integration theory and its general applicability to the

[2] The popular flexible, fixed and sticky price monetary model of the exchange rate, which evolved in the 1970's to explain exchange rate behavior, uses the PPP hypothesis as an essential building block. See Dornbusch (1976) and Frenkel (1970).

[3] The Eastern Caribbean Central Bank is the monetary authority for the six independent islands of the Eastern Caribbean, namely St Lucia, Dominica, Grenada, St Kitts and Nevis, Antigua and Barbuda and St Vincent, in addition too the British dependent territories of Montserrat and Anguilla. To our Knowledge only one such study has been conducted using data from this area. However the study was based on low frequency data and tested the relationship for data on the entire group. See Rambarran (1995).

study being undertaken. Section IV discusses the results obtained and related issues, which emerged.

II. PURCHASING POWER PARITY

The purchasing power parity theory is used to determine prices and the exchange rate. If one assumes zero transaction cost or other impediments to trade, given that all goods are tradable effective arbitrage would result in the strongest version of PPP, namely absolute PPP which is stated as follows:

$$E = P/P^* \tag{1}$$

Where E is the exchange rate and represents the number of units of domestic currency required for purchasing one unit of foreign currency. P and P* are the domestic and the foreign price indices respectively. This version of the PPP is premised on the law of one price, which states that once converted into a common currency, national price levels should be equal.

In reality the equilibrium price of a good may not be the same when converted into a common currency. The reasons for this include the wedge created because of transport cost, Quota's, tariff's and informational asymmetry, which reduces the effectiveness of arbitrators. In addition the presence of non-traded goods can prevent arbitrators from responding to profitable investment opportunities. Furthermore the non-nuetrality of money can generate price differences in similar goods across countries.

To account for the shortcomings of the absolute version of PPP an alternative referred to as relative PPP is often specified. According to this version the change in the exchange rate is equivalent to the difference in inflation rates and is given by the following:

$$\Delta E = \Delta P - \Delta P^* \tag{2}$$

Where ΔE is the percentage change in the exchange rate, while ΔP and ΔP^* represents the rate of change of the domestic and foreign price level. The above equation states that the rate of change of the exchange rate approximates the domestic rate of inflation minus the foreign rate of inflation. Due to the fact that the PPP hypothesis is regarded as a theory of exchange rate determination one may erroneously conclude that the validity of the

theory maybe dependent on the degree of flexibility of the exchange rate. However despite the fact that most developing countries has shown preference for the maintenance of a fixed peg to a major currency, it is however impossible to avoid fluctuations in the effective exchange rate as long as major currencies are allowed to float against each other.

Deviations from Purchasing Power Parity

An obvious reason for deviations of the exchange rate from its PPP value in the long is if a substantial amount of the goods cannot be traded. Thus with the existence of non-traded goods, arbitrage condition is not satisfied for all internationally produced goods but only for tradable goods. Deviations from PPP caused by the existence of non-tradable goods is likely to be more acute in developing countries where the typical consumption basket usually consist of more non-tradable items. There are two possible methods, which could be utilized to address this issue. Rogers and Jenkins (1995) disaggregated the data and tested for a long run relationship between relative prices of certain commodities across different countries. Kim (1990) used wholesale prices rather than the consumer price indices based on the assumption that wholesale prices is a better indicator of the general price of tradable goods.

Over the last two decades the debate on PPP has resulted in a number of theories which seek to explain deviations from PPP whether transitory or permanent. A factor, which is commonly identified, is the role of 'news' and in particular the response of exchange rates to new developments. The reaction of exchange rates to news formed the basis of the Dornbusch (1976) model of overshooting exchange rates. Daniel (1986) contends that the response of exchange rates to news is a crucial determinant of short-term deviations from PPP. The basis of the theory is that news is processed faster in exchange rates than in prices. The rationale has been that prices are determined in the commodity markets, where signals tend to be digested very slowly. This is compared to exchange rates, which are determined in the auction markets where news is quickly assimilated.

Based on the above hypothesis deviations from PPP are largely the result of Price stickiness. Hence it is logical to conclude that such deviations should disappear overtime as prices adjust to a new equilibrium given nominal disturbances. In the case where a real disturbance occur and the price indices contain different

goods and weights in various countries, the PPP deviations may decline but might not disappear altogether. The role of news as a source of deviation from PPP is likely to be more relevant in the developed countries. This is related to the fact that in developed countries with sophisticated financial markets, exchange rate movements are usually influenced by developments in the asset markets.

Another explanation for deviations from PPP, which is gaining increasing popularity, is the idea of partial pass-through of exchange rates. This hypothesis has been analyzed and developed by a number of theorist including Froot and Rogoff (1995) and Freenstra and Kendall (1997). The basic tenet of the proposition is that under conditions of imperfect competition, firms involved in the export of goods and services may adjust prices by less than the complete change in the exchange rate. A firm, which wants to maintain market share, may decrease profit margins in order to absorb some of the price increases associated with a currency appreciation. Hence, only a certain percentage of the price increase associated with the currency change is passed through to the importer price.

Freenstra and Kendall (1997) argue that the change in price relative to domestic substitutes, due to the pass through behavior, should be taken into account when measuring parity between prices in the exporting and importing countries. To account for the pass through effect a weighted average of import relative to domestic prices and export prices relative to the cost of production is recommended.

The above discussion mainly highlights the explanations for short-term deviations from PPP, however in the long run such deviations should diminish significantly. In contrast empirical studies indicate that in a number of cases this deviation persist in the long run and are likely to be accounted for by real factors. Balassa (1964) and Samuelson (1964) provided the first possible explanation for these occurrences, they stated that when prices are converted into a common currency at prevailing exchange rates, prices in richer countries will be higher than that of poor countries. A closely related theory is associated with the work of Kravis and Lipsey (1983) and Bhagwati (1984). They argue that the existence of higher capital-labor ratios in developed countries results in higher wages. Given the assumptions of (a) low labor cost in developing countries and (b) non-traded goods are labor intensive, when measured in common currency price levels are higher in rich countries. Other factors that may account for per-

sistent deviations from PPP include developments with relation to the current account balance and government behavior.[4]

Co-integration and PPP

Co-integration theory is especially useful when there is need to determine whether two or more time series have a stationary relationship over the long run. This theory is particularly useful in testing the PPP hypothesis, which is essentially a long run relationship. Many earlier empirical studies of PPP indicate a high level of short run violations from the theory. Although most studies allude to the poor performance of the theory in the short run,[5] many economist still hold the view that over the long run, relative price may move in proportion to the change in the nominal exchange rate, so that the real exchange rate will revert to parity. As indicated in section II, the relative PPP version can be expressed in the following form:

$$\text{Ln } E_t = \eta + \gamma (Pt/P_t^*) + \varepsilon_t$$

If E_t changes over time but is a stationary ARIMA (p, q) process, then deviations from parity is largely temporary and is expected to disappear through time. Previous studies have tested for long run PPP via two methods. The first approach is to test for a unit root in the real exchange rate, while the second involves a test for cointegration between the nominal exchange rate and relative prices. For the existence of long run PPP, ε_t should be stationary or the variables in equation (6) should be co-integrated. Rejection of the existence of a cointegrating vector implies that the PP hypothesis is not relevant. The use of cointegration technique when linked with the Error Correction Framework allows for the separation of long run relationships and produces superconsistent estimates. Following Engle and Granger (1987) given the presence of a co-integrating relationship amongst the variables in equation (7) an error correction representation which caters for flexibility in the short run dynamic process while the model is constrained to return to the long run equilibrium can be specified.

Data and empirical findings

The data utilized in this paper were obtained from the interna-

[4] For further exposition of these arguments, see Rogoff (1986).
[5] See Lehmann (1983), Frenkel(1981).

tional financial statistics of the international monetary fund. The preferred price index is the Wholesale Price Index (WPI), however the countries under investigation do not calculate this index; thus the Consumer Price Index (CPI) was utilized. The exchange rate was the end of period effective real and nominal rate measured in terms of units of domestic currency per US dollar. The estimates are performed using both quarterly and monthly data extending from 1980-1997, although the nominal exchange rate for the countries under investigation has remained pegged to the US dollar for the entire period at a fixed rate there is considerable variability in the effective exchange rate index.

TABLE 1. UNIT ROOT TEST FOR REAL EXCHANGE RATE, IN LEVELS AND FIRST DIFFERENCES FOR QUARTERLY AND ANNUAL DATA

	ADF(q)	1st diff.	P-P(q)		ADF(m)		P-P(m)	
Antigua	-1.704	-4.307	-1.935	-7.263	-1.991	-7.131	-2.125	-9.153
Dominica	-2.443	-3.566	-2.657	-6.646	-2.336	-6.283	-2.473	-17.549
Grenada	-2.020	-3.779	-2.416	-5.919	-2.095	-5.423	-2.376	-12.384
St Kitts/Nevis	-1.161	-3.230	-1.330	-6.482	-1.258	-6.262	-2.167	-12.092
St Lucia	-1.620	-4.345	-2.137	5.815	-2.153	-6.986	-2.256	-10.321
St Vincent	-1.659	-3.734	-1.603	-6.310	-1.514	-6.072	-1.489	-13.089

NOTE: 95% critical value -2.904 for quarterly series and -2.875 for annual data.

The first method of testing for PPP was based on testing for stationarity in the real effective exchange rate. The results of the unit root test for both quarterly and monthly data are reported in Table 1. The results indicate that both the augmented Dickey-Fuller and Phillips- Peron test statistics fail to reject, the null hypothesis of a unit root for the monthly and quarterly series of the six countries at the 5 per cent confidence level.

However the null hypothesis is rejected when the first differences of the series are taken, that is, all series of the six countries are I (1) as is shown in table 1. Thus based on the non-stationarity of the real exchange rate variable in levels it can be deduced that the PPP relationship is invalid in the sample of countries over the time period under consideration.

The next step in evaluating the relevance of the PPP theory in this sample of countries involves testing for the existence of a cointegrating vector between relative prices and the nominal effective exchange rate (see eqn.6). The first step in this process is to test for the presence of a unit root in the two series under con-

TABLE 2. UNIT ROOT TEST FOR NOMINAL EXCHANGE RATE IN LEVELS AND FIRST DIFFERENCES OF QUARTERLY AND MONTHLY SERIES

	ADF(q)		P-P(q)		ADF(m)		P-P(m)	
Antigua	-2.787	-4.194*	-2.205	-6.794*	-2.582	-6.829*	-2.407	-9.711*
Dominica	-2.112	-3.055*	-1.562	-5.832*	-0.281	-4.108*	-0.908	-7.273*
Grenada	-0.638	-2.807*	-0.183	-5.949*	-0.182	-5.778*	-0.039	-10.07*
St Kitts/Nevis	-1.454	-3.281*	-1.500	-5.892*	-1.287	-5.842*	-1.326	-10.43*
St Lucia	-1.566	-4.021*	-1.175	-6.580*	-1.195	-6.517*	-1.106	-9.957*
St Vincent	-1.876	-3.563*	-1.528	-6.033*	-1.795	-5.892*	-1.655	-10.48*

NOTE: The symbols * and ** denotes rejection of the null-hypothesis of non-stationarity at the 1% and 5% significance levels.

sideration, namely the nominal effective exchange rate and relative prices for monthly data and quarterly data. The results test for unit roots in the variables using the augmented Dickey-Fuller test and the Peron-Phillips test are presented in table 4 and 5. The results indicate that for monthly and quarterly data the nominal effective exchange rate and the price level are both I (1), meaning that they are first difference stationary. Since both of the variables, which would enter the PPP formulation, are integrated of the same order, then it is possible to test for the presence of a cointegrating vector.

TABLE 3. UNIT ROOT TEST FOR RELATIVE PRICES IN LEVELS AND FIRST DIFFERENCES BASED ON QUARTERLY AND MONTHLY DATA

	ADF(q)		P-P(q)		ADF(m)		P-P(m)	
Antigua	-2.492	-3.629*	-2.045	-15.917*	-5.278	-11.01*	-6.017	-79.41*
Dominica	-0.809	-4.693*	-0.024	-6.824*	-0.279	-6.860*	-0.155	-17.549*
Grenada	-0.027	-3.031**	-0.600	-3.215**	-1.165	-3.546**	1.048	-11.740*
St Kitts\Nevis	-2.016	-1.168	-1.694	-7.285*	-2.252	-5.576*	-1.673	-14.369*
St Lucia	-1.308	-7.849*	-3.456	-41.78*	-2.720	-11.00*	-1.869	-238.51*
St Vincent	-0.308	-4.359*	-0.083	-7.528*	-0.070	-6.048*	-0.237	-17.137*

NOTE: The symbol * and ** denotes rejection of the null hypothesis of non-stationarity at the 1% and 5% level respectively.

The test for the presence of a cointegrating vector is performed using the Johansen method. The Johansen test is performed in the VAR framework and different values of the lag length K=1 to 8 was considered. In most cases a lag of K=4 is required to remove serial correlation in the residuals, so statistical results based on a VAR (4) model are reported. The results of the cointegrat-

ing test are reported in Table 4 for the monthly and quarterly time series data. The test results indicate that for both the quarterly and monthly series a cointegrating vector was identified in St Lucia and St Kitts and Nevis, while the presence of a cointegrating vector was confirmed in the case of Dominica based on the quarterly data set.

TABLE 4. RESULTS OF THE JOHANSEN TEST FOR COINTEGRATION FOR THE MONTHLY AND QUARTERLY SERIES

	Monthly Ho: r ≤ 2	Quarterly	Monthly At most one	Quarterly	Monthly None	Quarterly
Antigua			1.203	0.458	7.621	8.152
Dominica			0.007	7.425	6.739	8.236
Grenada			0.060	0.067	7.350	8.859
St Kitts\Nevis			7.505	9.268	19.442	26.173
St Lucia			4.521	4.528	10.21	28.260
St Vincent			0.098	0.0416	7.296	7.675

NOTES: Critical values for monthly and quarterly data are as follows: At most one vector at 5 % and 1%, 3.76 and 6.65 respectively, no vectors at 5% and 1% 15.41 and 20.04. * Indicates significance at the 5% level.

The lack of cointegration or evidence of PPP in a number of countries can be said to deviate from apriori expectations. Indeed the dominant convention is that the more significant the share of non-tradable in GDP, the greater the possibility of the exchange rate diverging from its PPP value. In general when price parity is calculated from a general price this may induce systematic bias for countries where the non-traded sector is dominant. The countries, which form part of the Eastern Caribbean Monetary area posses weak domestic production, thus by extension non-tradable share of income, is relatively low. A crude measure of the contribution of the traded sector to GDP is the share of external trade to GDP, which is relatively high across the sample of countries in this study.

The literature on the PPP suggest that trade restrictions and specifically, asymmetric restrictions on import compared to exports is a probable cause of deviations from PPP especially among developing countries. However there is limited conclusive evidence to support this view in the OECS as trade restrictions have been gradually reduced over the past two decades. Furthermore where restrictions have been imposed it is usually as a revenue generating measure and has not being prohibitive. In addition

the large import content of consumption and production limits the degree to which imports can be discriminated against.

McNown and Wallace (1989) illustrated that the exchange rate in high inflation countries tended to follow PPP more closely than low inflation countries. In a high inflation environment monetary growth is likely to overshadow real factors, hence the exchange rate is likely to converge to its PPP value. Thus it is quite plausible that the reason for the very weak evidence in support of PPP in this sample of countries is due to the generally low inflation environment which obtains. The nature of the monetary arrangement in the sample of countries restricts the ability of the governments to engineer bouts of inflation via excessive monetary accommodation of fiscal expansions. Prices in the countries are largely determined by developments in the main trading partner countries. The rate of inflation in the group of countries is on average approximately 5.0 per cent.

Another probable cause of the weak evidence of PP in this group of developing countries relates to the use of the effective exchange rate in this study. This rate of exchange depends heavily on the structure of commodity trade as the weights applied to the prices are based mainly on trade data. The deficiency of this approach is that service trade and financial flows tend to exert a strong influence on the exchange rate in developing countries.

Short run impact of inflation on exchange rates

For the countries where the null hypothesis of non-cointegration is rejected, an error correction model can be estimated, utilizing the residuals of the equilibrium regression. The theory underlying the estimation of such a model is that a proportion of the deviation from PPP in the initial period is corrected in the following period. Thus an error correction model of the following form can be specified:

$$\Delta \ln E_t = \sum_{i=1}^{n} \pi_i \Delta \ln E_{t-i} + \sum_{i=1}^{n} \beta_i \Delta \ln(p^d_{t-i} p^f_{t-i} + Z\{\ln E_{t-1} - \mu - \chi \ln(p^d_{t-1} / p^f_{t-1})\} + \varsigma_t$$

Where Z_t is the error correction term, which shows the departure of the exchange rate from its PPP value, that is corrected in the subsequent periods. The coefficient ς measures the single period response of the exchange rate shock. If the coefficient is significantly different from zero and is negative this implies that the exchange rate will adjust to the long run PPP relationship. Therefore an increase in the relative domestic inflation rate

compared with the foreign country would reduce the value of domestic currency but the currency would eventually converge to its long run equilibrium.

The results of the Vector Error Correction Model for the countries in which the presence of a cointegrating vector was confirmed are reported in table 6. The VEC model is estimated for both quarterly and annual data series. The modeling approach is based on the general to specific approach associated with the work

TABLE 5. ERROR CORRECTION MODELS (VARIABLES IN FIRST DIFFERENCES)

	Monthly data		Quarterly data		
Variables	St Lucia	St Kitts	St Lucia	St Kitts	Dominica
E_{t-1}	0.408 + (0.069)	0.3177+ (0.063)			
E_{t-2}	-0.159* (0.074)				
E_{t-3}	0.114** (0.069)		0.327* (0.120)		
E_{t-4}				0.236** (0.120)	
RP_{t-1}	0.005 (0.005)		0.246* (0.122)	-0.187 (0.588)	0.439+ (0.138)
RP_{t-2}	0.0096** (0.005)		0.240** (0.123)		
RP_{t-3}	0.010** (0.005)			1.201** (0.683)	
RP_{t-4}	0.008** (0.004)			1.086 (0.659)	
ECR_{t-1}	-0.016** (0.009)	-0.0005+ (0.0001)	-0.042* (0.018)	-0.071+ (0.019)	-0.050* (0.019)
R^2	.17	.15	.191	.214	.172
DW	1.97	1.96	1.6	1.55	1.48
SER	0.010	0.026	0.007	0.018	0.009
LM	0.555	1.431	1.289	1.204	0.7119

NOTES: A constant was estimated but is not reported. * And ** denotes significance at the 5% and 10% confidence interval, while + denotes significance at the 1% confidence level. DW is the Durbin Watson Statistic, SER is the Standard error of the regression and LM is the test statistic for the Breusch-Godfrey Serial Correlation LM test for higher order correlation. ECR is the error correction term, RP is relative prices and E is the nominal effective exchange rate.

of Hendry (1987). The procedure involves the estimation of a VAR with all the variables entering the model being I(1). The equation is initially estimated with dependent variables with lags of four quarters for quarterly data and twelve lags for monthly data. Variable deletion test was performed to determine the joint significance of the lagged variables. The final parsimonious equation for the various countries are presented, these equations were subjected to a battery of diagnostic test.

In general although the models pass the battery of diagnostic test, the ability of the ECM to explain exchange rate movements was limited as can be interpreted via the adjusted R2 statistic. Based on the results obtained, the estimated coefficients of the error correction term was significant and correctly signed in all the countries and suggest a relatively quick reaction to correct deviations from PPP. However the adjustment of the exchange rate to inflation difference between the United States and the respective countries was under 10%, which can be regarded as relatively small.

Is there an Alternative?

In general the results of this study is consistent with other studies on the relevance of the PPP hypothesis. The rejection of the theory is generally invariant to the type of test conducted or the data frequency utilized. One major difficulty is that an investigator cannot easily determine whether the failure to reject the unit root hypothesis is reflective of the limited power of unit root test especially in small samples. In search of increased power a number of researchers have attempted to evaluate the theory using longer spans. Another method, which is becoming increasing popular, is the use of panel data in trying to confirm the PPP hypothesis. The use of this method to test for PPP was motivated by the work of Levin and Lin (1992).[6] However although the results of such test are more conclusive it is not overwhelming, in addition a few investigators have questioned the efficiency of unit root test in panel data.[7]

[6] It must be noted that critical values for unit roots in panel data based on this framework do not incorporate serial correlation in the disturbances.

[7] Frenkel and Rose (1996) finds evidence of mean reversion using panel data, Papell (1997) finds considerable though not conclusive evidence against the unit root hypothesis. In contrast Abauf and Jorion (1990) can only find weak evi-

The advantage of panel data based unit root test is that it compensates for insufficient time series variation by introducing cross section variation, thus resulting in an increase in the power of the test. This quality renders this test particularly useful in the Eastern Caribbean Central Bank area, indeed many previous studies on these economies have utilized the panel data approach to allow for increase degrees of freedom when the time series data span is relatively short.[8] However new research has questioned the efficacy of panel data based unit root test to prove the hypothesis? O' Connell (1996) argues that wide sample panel studies are inaccurate as their fail to account for cross-sectional dependence in the real exchange rate. The underlying reasoning is that the real exchange rates of two closely linked countries are generally correlated. For example a shock to the countries of the Eastern Caribbean which affects prices or exchange rates will cause them to deviate together. If such cross sectional dependence is ignored the power and size of panel data unit root test is significantly reduced.[9] Thus the acceptance of the PPP hypothesis by some theorist using panel data is largely due to the fact that the cross sectional dependence is not controlled. O'Connell (1996) in his study illustrates that once this is controlled by using GLS to increase the efficiency of the test, the evidence in support of the PPP hypothesis in panel data is no more favorable than when time series data is used.

IV. CONCLUSION

The main purpose of this study was to examine the relevance of the PPP hypothesis in a relatively stable and low inflation environment. The test procedure drew extensively from the recent developments in econometric theory and in particular the advances made in the area of cointegration. The PPP hypothesis was examined using two standard approaches: testing for unit roots in the real exchange rate and testing for a cointegrating vector amongst the nominal exchange rate and relative prices. These tests were conducted using both quarterly and monthly data.

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dence in support of PPP using panel data in a sample of ten industrialized countries.

[8] Example of studies which has used panel data series include Watson (1993) and Williams and Darius (1997).

[9] For further elaboration See O'Connell (1996) pp. 4-6.

From this study the evidence in support of the PPP hypothesis was generally weak. The null hypothesis of a unit root in the real exchange rate could not be rejected in any of the countries irrespective of the data frequency. Meanwhile a cointegrating vector was confirmed for only two countries when monthly data was used and three countries in the case of quarterly data.

The result of the study is consistent with other studies, which indicates that the theory is less likely to be relevant in countries experiencing relatively low rates of inflation. In addition the method of calculating the effective exchange rate along with the level of trade restrictions in these countries may have impacted on the results. The failure to find conclusive evidence in support of the hypothesis may also be due to the shortness of the time series utilised. To counter this problem a number of investigators have resorted to the use of panel, this method was not utilised in this paper partially because of the fact that if cross section independence is not accounted for the results using that method is likely to be inefficient. The general results of this study indicates the need to search for models with greater explanatory power to model exchange rate behavior, thus the need to develop and test models which incorporates the role of real factors in explaining exchange rate movements.

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Anston Rambarran

Bank competition and contestability in Trinidad and Tobago: a case for further commitments under the GATS

1. INTRODUCTION

The Caribbean Community (Caricom) trading bloc has only participated marginally in the multilateral process of liberalization of financial services under the General Agreement on Trade in Services (GATS). Whereas many regional states made offers on reinsurance at the conclusion of the Uruguay Round in 1994 they did not participate in the renewed negotiations of 1995 when further liberalization measures were announced by most of the major developed, developing and transition countries. At the new round of negotiations in 1997 only Jamaica went further and made offers with respect to life and non-life insurance, selected aspects of banking and one narrow area of securities-related financial services. Additionally, in 1998 the regional negotiating arm of the Caricom Secretariat recommended a mixed strategy of liberal

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and protectionist elements for devising an appropriate schedule of commitments under the GATS.

This limited participation can be traced to the notion that imperfect competition is deeply rooted in Caribbean financial markets. Studies such as Peart (1995), Craig et al. (1996), Danns (1996), Forde (1996) and McFarlane (1997) all attest to a highly concentrated regional financial system based on the traditional structure-conduct-performance (SCP) paradigm. Although the SCP framework has a strong theoretical foundation, alternate explanations of industry structure pose serious challenges. One such alternative is contestability theory under which openness in services has been analyzed in the recent literature. Markets are considered contestable, that is, open to foreign competition when barriers to entry are low (Graham and Lawrence, 1996). For such Caricom member states as Guyana, Jamaica and Trinidad and Tobago that are already so far advanced along the road of liberalization it is probably more appropriate to interpret their pre-GATS financial sectors as contestable markets. Moreover, since there is no universally applicable liberalization strategy one should take into consideration the specific circumstances of each country when devising an appropriate schedule of commitments.

Accordingly, the purpose of this study is to assess whether Trinidad and Tobago, which has engaged in significant financial system restructuring since the early 1990s, has the potential for undertaking further multilateral commitments than actually made. The analysis is confined to the banking sector, since data on insurance and securities are more difficult to obtain. The rest of the paper is organized as follows. Section 2 discusses the applicability of contestability theory to the structure and regulation of banking in Trinidad and Tobago. Section 3 presents an empirical analysis of bank competitive conditions using two widely accepted non-structural measures, the conjectural variation and Rosse-Panzar models. Some conclusions are offered in Section 4.

2. BANK MARKET STRUCTURE, REGULATION AND CONTESTABILITY THEORY

Although the benefits of open and market-based financial markets are widely recognized, the speed and sequencing of financial sector reform demand careful consideration. Indeed, the Asian financial crisis has demonstrated the adverse effect of imprudent financial opening and the high systemic costs of banking crises.

For this reason, Galbis (1994), Johnston (1994), and Lindgren, Garcia and Saal (1996) all recommend a pragmatic case-by-case approach to financial opening that tends to succeed if preceded by macroeconomic stabilization and supported by evolving prudential measures. Since the early 1990s Trinidad and Tobago has been restructuring its domestic financial system to create a more competitive environment broadly in line with the path suggested by Villanueva and Mirakhor (1990). The authorities first eliminated selective credit and interest rate controls, then strengthened the supervisory and regulatory framework for financial institutions, and have now begun the transition towards indirect monetary management through open market operations. Restrictions on cross-border capital flows were also eliminated and a flexible exchange rate regime adopted against the backdrop of macroeconomic stabilization.

The financial system in Trinidad and Tobago is relatively well diversified but banks remain the dominant financial intermediaries. The broad money indicator (M2*/GDP) measured about 45 percent at the end of 1998, broadly in line with the OECD country average and indicating a heavy reliance on the formal banking system compared to other forms of financial intermediation such as bonds and equities. A similar pattern is evident in the other indicator of financial depth – private credit to GDP. Presently six commercial banks operate in the country with just over 20 branches per bank. Foreign ownership has resurfaced and is currently a major feature of the banking system. Two banks are foreign owned and a third retains a minority foreign shareholding. Banking assets and the network of bank branches are highly concentrated suggesting a predisposition to an undesirable exercise of market power; the three largest banks account for almost two-thirds of bank assets and have no less than 70 percent of the branch network.

Banks are regulated under the Financial Institutions Act (FIA) of 1993, which is based on the guidelines of the Basle Committee on Banking Regulation and Supervisory Practices. Capital adequacy ratios generally exceed the minimum requirement of 8 percent. Standards for loan classification and provisioning compare favorably to many OECD and developing countries. Provisioning rules for securities holdings and accounting standards are also in line with international best practice. Banks are restricted from having large exposures to a single borrower or to a single borrower group. Similar restrictions apply with respect to unsecured loans to insiders and to related parties. In addition, bank

problems are usually remedied when detected by bank supervision.

While the issue of bank competitiveness has always been controversial it has assumed signal importance in light of the global commitment to a more liberal multilateral financial services regime. Strategic alliances between banks and insurance companies and the resulting creation of hybrid financial products have tended to circumvent the controls of existing legislation. Banks now market mutual funds on an in-house basis and have begun to offer annuity products previously sold almost exclusively by insurance companies. Some of the larger banks have diversified into the provision of security and educational services. Perhaps the most notable competitive features of the financial landscape are the varying modes of bank mergers and bank-insurance strategic alliances as well as the cross-border emergence of banks onto the Caribbean region and beyond. Although these developments are testing the current regulatory framework they also appear to be major factors towards enhancing the capacity of local banks to meet and sustain the challenges of international competition.

Alongside this form of competitive behavior exist high interest rate spreads and the generation of supernormal profits, which has led to the suggestion that banks may be engaged in collusive behavior in some segments of the market. It is far easier to dismiss the claim of collusion based on the level of profits than on interest rate spreads that are too high for a low inflation country and too wide to simply reflect competitive adjustments for risk. The average return on assets (ROA) of the banking system is in line with that of viable banks operating in a competitive environment, averaging a little above 1 percent over 1994-1996. Moderate profitability also indicates that domestic banks could meet the challenge of liberalization. On the other hand, the implicit bank interest rate spread between 1989 and 1996 was about 9 percentage points higher than the implicit spread for US banks (Rambaran, 1998). This suggests the potential for improving the efficiency of financial intermediation. Not surprisingly there have been calls for anti-trust legislation to counter opportunistic behavior on the part of banks. Such fears of consolidation and the potential for the abuse of market power tend to stem from the dynamics of the traditional SCP paradigm, but may be invalid if the banking market is at least partially contestable.

Contestability theory as developed by Baumol et al. (1982) is best considered a generalization of the theory of perfect competi-

tion. Price-taking behavior is the critical assumption in perfect competition; entry is the equivalent assumption in contestability theory. Entry is free in the sense that potential entrants face no entry and exit barriers, either economic or legal. Potential competitors also possess the same cost functions as the incumbents that already serve the market, and can therefore rapidly enter and exit any market without losing their capital. This implies that production involves no sunk costs, although there may be fully reversible fixed costs. In light of these conditions, if an excess profit opportunity is presented, an entrant may hit and run with no risk of oligopolistic interaction. These features and highly price-elastic demands for industry outputs mean that, in a perfectly contestable market the threat of competition by potential entrants can serve to discipline incumbent firms. In particular, firms will have to price their products in a socially efficient manner that would yield normal returns.[1]

Notwithstanding the challenge to the conventional theory of industrial organization and the implications for competitive strategy, reservations have been raised about the power and wide applicability of contestable markets. Spence (1983) notes that the theory of contestability neglects the dimensions of strategic interaction associated with entry deterrence such as preempting market positions by first making irreversible moves. Cairns and Mahabir (1987) argue that based on the advantages conferred by sunk costs in other products, it is more likely that existing rather than new firms would be potential entrants. They also suggest a refinement of the theory to engender wider applicability by paying attention to research and development, product differentiation, excess capacity, entry barriers, the anticipation of post-entry games, and endogenous product sets.

The theory's entry assumptions may be partially satisfied in Trinidad and Tobago's banking market, because apart from the legal entry requirements[2] there are few barriers to setting up a fi-

[1] Baumol et al. (1982) demonstrate that a contestable market produces several desirable results including Ramsey optimal prices, efficient production and market structure, innovation and an avoidance of cross subsidies in pricing. Also contestability theory focuses on cost structures while demand considerations are not centrally important.

[2] The entry provisions of the FIA (1993) require any person intending to carry on the business of banking to apply for a license from the Central Bank and to meet six minimum criteria for licensing. These include the following: - that directors, controlling shareholders and mangers be fit and proper persons;

nancial intermediary. For example, a commercial bank and a merchant bank were established in 1998 and there have been expressions of interests by several international banks, including those associated with Islamic financial intermediation. On the other hand, there may be economic barriers and possible sources of market power at different levels of banking business. Investment in physical and human capital and the building up of a clientele and reputation for solvency may in principle give a bank an absolute cost or product differentiation advantage in a particular market segment. So would strategic alliances with insurance companies and the creation of hybrid financial products.

The second crucial aspect of contestability theory is the ability to recover sunk costs, which is difficult to assess in a banking or financial market. Exit implies that a bank either leaves the industry entirely or withdraws from particular lines of business, although the latter may be less costly as sunk costs can be more quickly recovered. Nonetheless, a bank may assess its ability to recover sunk entry costs under the *ex ante* assumption that the business would be well managed even while recognizing that it might turn out to be unprofitable *ex post*. Analysts usually proffer bank failures as evidence that recovering sunk costs is difficult (Nathan and Neaves, 1989). Demirgűç-Kunt and Detragiache (1998) define a banking crisis if at least one of the following four conditions hold:

i) non-performing loans exceed 10 percent of the total assets of the banking system;

ii) the cost of the rescue operation is at least 2 percent of GDP;

iii)banking sector problems result in large scale nationalization of banks; and

iv)extensive bank runs take place or the government enacts emergency measures.

None of these conditions have ever been in place in Trinidad and Tobago. What come closest are the suspension of five non-bank financial institutions (NFIs) in 1986 and the merger of the three indigenous banks in 1993 (Forde, 1996). It is quite possible therefore that banking failures in Trinidad and Tobago more likely reflect unsound banking practices and provide little infor-

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that the business be conducted in a prudent manner; and that the institution have minimum net assets of TT$15 million at any time.

mation about normal exit costs. Moreover, as indicated above banks have entered rather than exited financial markets over the last decade. An avenue for further empirical research relates, therefore, to the malleability of capital and the time needed to recover capital costs in the banking industry.

The foregoing brief sketch of financial sector development raises rather than settles any issues, but it does not negate the possibility that the banking system may exhibit some characteristics of contestability. The structural indicators suggest that foreign bank participation could bring benefits of higher competition, reduce high interest margins and provide a broader range of financial services. Relatively sound capital adequacy ratios also speak for more opening. Nonetheless, one should be cautious in using these performance indicators as specific targets of negotiations to liberalize sectors, as they can vary across countries for reasons such as perception of risk and size of market with little relation to competition and openness of the financial sector (Sorsa, 1997). In this regard, Nathan and Neaves (1989) state that while theoretical work proceeds, empirical analysis can usefully address the actual performance of market structures, particularly if tests of contestability are not closely related to the theory's more controversial aspects.

3. TESTING TWO NON-STRUCTURAL MODELS OF BANKING CONDUCT

In this section, two non-structural models are used to test openness in the banking market of Trinidad and Tobago. Although both models rely on the comparative statics of a profit-maximizing firm, Worthington (1990) demonstrates that such tests provide a valid empirical analysis of dynamic equilibrium. In addition, both methods rely on the intermediation model of the banking firm developed by Klein (1971) and Sealey and Lindley (1977). This model assumes that banks use labor to obtain deposits and in conjunction with deposits, to originate loans.

The first approach to testing for market power is a parameterization of the extent to which firms perceive a distinction between marginal revenue and price. That parameter is known as the conjectural variation and is denoted by λ, where $-1 \leq \lambda \leq +1$. The test relies on the idea that profit-maximizing firms set marginal cost equal to their perceived marginal revenue, which corresponds with the demand price in classical competitive equilib-

rium, but corresponds to the industry's marginal revenue in the collusive extreme (Bresnahan, 1982). The application of the conjectural variation model by Iwata (1974), Gollop and Roberts (1979), Alexander (1988) and Shaffer (1989, 1993) across banking structures were generally consistent with perfect competition and often rejected the hypothesis of joint monopoly.

The second approach uses the Rosse-Panzar 'H-statistic' [Rosse and Panzar (1977) and Panzar and Rosse (1982, 1987)] to determine the competitive nature of banking markets. The H-statistic is calculated from reduced form revenue equations and measures the sum of elasticities of total revenue with respect to input prices. Studies of the Canadian banking industry by Nathan and Neave (1989) and Shaffer (1993) using the H-statistic found evidence of competitive conduct. Molyneux et al. (1994) found that banks in Germany, the United Kingdom, France and Spain earned revenues as if under conditions of monopolistic competition. This underlined the importance of completing a single market in financial services in the European Community (EC) banking market.

3. 1. The conjectural variation model

Formally, the demand function for commercial bank services is represented as:

$$Q = D(P, Y, \alpha) + \varepsilon \tag{1}$$

where Q is aggregate output, P is industry price, Y a vector of exogenous variables, α a vector of demand system parameters to be estimated, and ε is a random error term. The firm's perceived marginal revenue function MR^p can be expressed as:

$$MR^p = P + \lambda h\,(Q, Y, \alpha) \tag{2}$$

where h (.) is the semi-elasticity of market demand and λ denotes the conjectural variation. The value of $\lambda = 0$ implies that banks act as price takers in perfectly competitive behavior and do not perceive a difference between their marginal revenue functions and the demand function. For $\lambda = 1$, banks act in joint monopoly or perfect collusion choosing output or prices according to the industry marginal revenue curve. Intermediate values of λ correspond to various degrees of imperfect competition or collusion. The special case of $\lambda = 1/n$ when there are n banks in the industry suggests a Cournot equilibrium with each bank independently maximizing its own profit and not the industry (joint) profit.

Shaffer (1993) indicates that in addition to being an index of market power, $-\lambda$ constitutes a local estimate of the percentage deviation of aggregate output from competitive equilibrium.[3] As long as the data spans at least one complete market, estimates of λ are unbiased. In cases where the industry comprises multiple markets, λ signifies the average degree of market power over the separate markets.

Estimation of λ requires an inverse demand function and a supply relation. The demand function is specified as:

$$Q = \alpha_0 + \alpha_1 P + \alpha_2 Y + \alpha_3 PZ + \alpha_4 Z + \alpha_5 PY + \alpha_6 YZ + \varepsilon \quad (3)$$

where Q is the output quantity of banking services proxied by the total value of assets. The price of bank services P is measured as the ratio of operating income to total assets and α_1 is hypothesized to be negative, corresponding to a downward-sloping demand curve. Y is an exogenous variable representing aggregate demand and α_2 is expected to be positive. Z is another exogenous variable such as the price of a substitute for bank services measured as the average discount rate on treasury bills; if this rate is a good proxy then α_4 should be positive. The interaction terms, the products PZ, PY, and YZ are necessary to permit rotation of the demand curve in order to identify λ. Lau (1982) shows that $\alpha_3 + \alpha_5 > 0$ is a necessary and sufficient condition for identification of λ in the system. In addition, a downward sloping industry demand curve requires that $\alpha_1 + \alpha_3 Z < 0$.

The translog cost function employed in many studies of depository institutions is given by:

$$\begin{aligned} \ln C = {} & \gamma_0 + \gamma_1 \ln Q + \gamma_2 (\ln Q)^2 + \gamma_3 \ln W_1 + \\ & + \gamma_4 \ln W_2 + \gamma_5 (\ln W_1)^2/2 + \gamma_6 (\ln W_2)^2/2 + \\ & + \gamma_7 \ln W_1 \ln W_2 + \gamma_8 \ln Q \ln W_1 + \gamma_9 \ln Q \ln W_2 \end{aligned} \quad (4)$$

where C is the total cost of bank services, and W_1 and W_2 represent exogenous input prices whose estimated coefficients should be positive. W_1 is the input price of funds measured as the ratio of interest expenses to total deposits and W_2 the unit price of labor proxied by wages and salaries per employee. Physical capital is often viewed as a third input in the banking production function

[3] Since actual price deviates from the competitive price by $-\lambda Q/(\partial Q/\partial P)$, and actual quantity deviates from the competitive quantity by $\partial Q/\partial P$ times this price deviation or $-\lambda Q$, then the percentage deviation in output is $-\lambda Q/Q = -\lambda$.

but is omitted in this specification as it constitutes less than 5 percent of operating expenses during the estimation period.

The translog cost function gives rise to a marginal cost function of the form:

$$MC = (C/Q)(\beta_1 + \beta_2 \ln Q + \beta_3 \ln W_1 + \beta_4 \ln W_2) \qquad (5)$$

The conditions of concavity and symmetry do not pertain to any of the coefficients in (5) above. Monotonicity involves but does not constrain β_3 and β_4. Linear homogeneity in input prices implies that $\beta_3 + \beta_4 = 0$; homotheticity implies $\beta_3 = \beta_4 = 0$.

The supply function derived from the marginal cost function under the assumptions that banks are input price-takers and seek to maximize profits is therefore:

$$P = - \lambda Q/(\alpha_1 + \alpha_3 Z + \alpha_5 Y) + (C/Q)(\beta_1 + \beta_2 \ln Q + \\ + \beta_3 \ln W_1 + \beta_4 \ln W_2) - \beta_5 DQ/(\alpha_1 + \alpha_3 Z + \alpha_5 Y) \qquad (6)$$

where D is an iterative time dummy to measure whether the degree of competition was different on average after the liberalization of the financial system in 1988. D is set equal to 0 for the period 1969-1988 and equal to 1 for 1989-1997. There is no a priori hypothesis on the sign of its coefficient β_5.

The system {(3), (6)} was estimated simultaneously using Three-Stage Least Squares (3SLS) and reported in Table 1. In the specification with an interactive shift term, eight coefficients are significant, three of these at the one percent level. In the specification without a shift term, seven parameter estimates are significant (three at the one percent level). With the exception of the sign of the coefficients on the price of bank assets and the price of funds, a priori expectations on all other coefficients are generally confirmed by the results. Both α_3 and α_5 are significantly different from zero, ensuring that λ is identified within the system. Indeed, the index of competition λ is estimated fairly precisely, having a standard error of less than 0.5 in the regressions. Even so the null hypothesis that $\lambda = 0$ could not be rejected at a reasonable level of significance for any of the estimations, implying that the bank behavior is consistent with competitiveness. In addition, the upper bound of the 95 percent confidence interval is 1.28, quite different from the symmetric collusive level of 1.

These results are weakly inconsistent with joint monopoly or symmetric Cournot behavior and suggest a degree of competitive

TABLE 1. CONJECTURAL VARIATION MODEL, EQUATIONS (3) AND (6)

Parameter Estimate	No Shift	Shift
α_0	-3381.42[b] *(-2.37)*	-3632.27[b] *(-2.53)*
α_1	1633.68[b] *(2.96)*	1601.95[b] *(2.83)*
α_2	2.20[a] *(3.49)*	2.22[a] *(3.46)*
α_3	-50.52[b] *(-2.56)*	-59.17[b] *(-2.71)*
α_4	374.19 *(1.55)*	417.24[c] *(1.73)*
α_5	-0.86[b] *(-2.82)*	-0.81[b] *(-2.59)*
α_6	-0.12 *(-1.40)*	-0.13 *(-1.49)*
β_1	15.76[a] *(4.09)*	18.87[a] *(3.24)*
β_2	-1.95[a] *(-3.82)*	-2.22[a] *(-3.16)*
β_3	-0.31 *(-0.42)*	0.09 *(0.09)*
β_4	-0.70 *(-1.13)*	-1.18 *(-1.18)*
β_5	------	0.22 *(0.76)*
λ	0.42 *(1.05)*	0.20 *(0.40)*
$R^2(3)$	0.77	0.76
$R^2(6)$	0.99	0.83
$\sigma(3)$	215.47	220.3
$\sigma(6)$	0.73	1.01
D.W. (3)	1.45	1.39
D.W. (6)	3.25	3.35

Notes: *t*-statistics are in parentheses. Data calculated from various issues of *Operating Results of the Banking System, 1969-1982*, and *Operating Ratios of the Financial System, 1983-1997*, Central Bank of Trinidad and Tobago.

[a] Denotes significance at 1 percent level; [b] significance at 5 percent level; and, [c] significance at 10 percent level.

conduct on the part of banks somewhat greater than Cournot. Banks simultaneously decide what quantity to produce, forecasting the output of other banks in order to make strategic decisions. Nonetheless, the interactive shift term shows no increase in the degree of competition in the banking system after 1989, perhaps because the industry is yet to converge to a new long-run equilibrium following the regulatory and structural changes of the 1990s. The impact of the various regulatory proposals on the systematic risk of banks' portfolios remains to be assessed. The value of $(-\lambda + \beta_5)$ gives a local estimate of the percentage deviation of aggregate output from competitive equilibrium level in the post-1989 period. The estimate suggests that the aggregate amount of bank assets is lower than competitive equilibrium (or static optimum) by 40 percent or about $10 billion based on 1997 figures. In effect, the results are consistent with temporary disequilibrium and simultaneous insufficient capacity levels, implying that the system is not over-banked as the entry of at least two more average-sized banks would tend to engender an optimal market size.

3. 2. The Rosse-Panzar Model

Rosse and Panzar (1977) apply Shephard's lemma to a firm's profit-maximizing first-order conditions to show that the H statistic is negative when the structure is a monopoly, a perfectly colluding oligopoly, or a conjectural variation short-run oligopoly. Under these conditions an increase in input prices increases marginal costs, reduces equilibrium output and subsequently reduces total revenues. In contrast, the H-statistic is positive but not greater than unity under perfect competition, as any increase in input prices increases both marginal and average costs without altering the optimal output of any individual firm. Shaffer (1983) shows that H is unity for a natural monopoly operating in a perfectly contestable market and also for a sales-maximizing firm subject to break-even constraints.

The parameter H thus constitutes a one-tail test in the sense that a positive value rejects any form of imperfect competition, but a negative value is consistent with a variety of possibilities, including short-run competition. A critical feature of the H-statistic is that the tests must be undertaken on observations that are in long-run equilibrium. The empirical tests for equilibrium is suggested by the fact that competitive capital markets will equalize risk-adjusted rates of return across banks, such that in equilib-

rium, rates of return should not be correlated statistically with input prices. Table 2 summarizes these different interpretations of the Rosse-Panzar H-statistic.

TABLE 2. INTERPRETING THE ROSSE-PANZAR H-STATISTIC

Competitive environment test	Equilibrium test
H < 0 Monopoly or conjectural variations short-run oligopoly	H < 0 Disequilibrium
0 > H <1 Monopolistic competition	H = 0 Equilibrium
H =1 Perfect competition, or	
H =1 Natural monopoly in a perfectly contestable market, or	
H =1 Sales maximizing firm subject to a breakeven constraint	

SOURCE: Molyneux et al. (1994)

Since output quantity is endogenous to the firm and reflects aggregate demand characteristics as well as inter-firm and technological considerations, 3SLS is used to estimate a two-equation system for the commercial banking industry between 1969 and 1997. The system comprises the demand equation:

$$\ln Q = \phi_0 + \phi_1 \ln P + \phi_2 \ln Y + \phi_3 \ln Z + \phi_4 D \qquad (7)$$

plus the revenue equation:

$$\ln P = \psi_0 + \psi_1 \ln Q + \psi_2 \ln PR + \psi_3 \ln W_1 + \psi_4 \ln W_2 \qquad (8)$$

where PR is ratio of provisions for loan losses to total loans, employed to account for firm-specific risk and hypothesized to have a negative sign. In this model, the H-statistic is calculated as H = $= \psi_3 + \psi_4$. The equilibrium test of the H-statistic is based on return on assets (ROA) as the endogenous variable in equation (8). A finding that H <0 would indicate disequilibrium whereas H = = 0 would indicate equilibrium. Table 3 gives the estimated coefficients. The overall fit is good and most of the parameters are significant across the banking system. In particular, the coefficients for the price of labor and the price of funds are statistically significant. In the case of the other independent variables, the sign on the asset size coefficient is negative, indicating that size-induced differences between banks may lead to lower operating income per dollar of assets. The positive sign on the risk-adjustment parameter is contrary to expectations, while the interactive shift parameter is not significantly different from zero.

TABLE 3. ROSSE-PANZAR MODEL ESTIMATES, EQUATIONS (7) AND (8)

Parameter Estimate	Competitive Stance	Equilibrium Test
ϕ_0	-0.05	-4.53[a]
	(-0.005)	*(-3.63)*
ϕ_1	-0.49[b]	0.19[c]
	(-2.28)	*(1.92)*
ϕ_2	0.77	1.52[a]
	(0.73)	*(9.50)*
ϕ_3	0.95	-0.06
	(1.31)	*(-1.11)*
ϕ_4	-0.67	0.93
	(-1.005)	*(0.48)*
ψ_0	5.02[a]	0.47
	(8.15)	*(0.28)*
ψ_1	-0.69[a]	2.08[a]
	(-7.57)	*(9.84)*
ψ_2	0.01	-0.36[a]
	(0.53)	*(-18.43)*
ψ_3	0.43[a]	0.37[b]
	(2.73)	*(2.14)*
ψ_4	0.22[c]	-0.86[b]
	(1.89)	*(2.18)*
H	0.68	-0.49
$R^2(7)$	0.76	0.94
$R^2(8)$	0.96	0.99
$\sigma(7)$	0.21	0.03
$\sigma(8)$	0.13	0.09
D.W. (7)	1.09	1.69
D.W. (8)	0.81	3.31

NOTES: *t*-statistics in parentheses. Data calculated from various issues of Operating Results of the Banking System, 1969-1982, and Operating Ratios of the Financial System, 1983-1997, Central Bank of Trinidad and Tobago.

[a] denotes significance at 1 percent level; [b] significance at 5 percent level; and, [c] significance at 10 percent level.

Like the conjectural variation model, the interactive shift term in the Rosse-Panzar model shows little change in the degree of competition exhibited by banks after 1989. The calculated H-statistic is equal to 0.65 and significantly different from zero and

unity but does not represent long-run equilibrium. Thus, the results of the Rosse-Panzar model reject the monopoly, conjectural variation short-run oligopoly and perfect competition hypotheses for the banking system. Rather, banks appear to earn revenues as if under monopolistic competition. This suggests that contestability theory may have some validity in describing bank behavior, as do theories of monopoly or oligopoly. However, for such a result to be strongly consistent with a contestable banking market potential competition must guarantee perfectly competitive pricing by incumbent firms, otherwise a monopolistically competitive outcome could reflect the threat of hit-and-run entry. This is another potentially fruitful area for further empirical research. Nonetheless, the results broadly suggest that the Rosse-Panzar model may not fit the sample data as well as the conjectural variation model in the previous section and should be treated with more caution.

4. CONCLUSION

Trinidad and Tobago is already so far advanced along the road of liberalization that it is probably more appropriate to interpret its pre-GATS financial sector as a contestable market, that is, open to foreign competition, when barriers to entry are low. Structural indicators suggest that foreign bank participation could bring benefits of higher competition, reduce high interest margins and provide a broader range of financial services. Relatively sound capital adequacy ratios also speak for more opening. Non-structural measures based on the conjectural variation and Rosse-Panzar models find a partially contestable banking market. Bank conduct is consistent with a degree of competitiveness somewhat greater than Cournot behavior and banks appear to earn revenues as if under monopolistic competition. The threat of potential entry seems to constrain banks to price their products competitively. Concerns about the potential for the abuse of market power on the part of banks may therefore not be warranted. Additionally, it appears that the banking industry is yet to converge to a new long-run equilibrium following the regulatory and structural changes of the 1990s. Banking system assets are lower than competitive equilibrium (or static optimum) by 40 percent or about $10 billion based on 1997 figures, implying that the system is not over-banked as the entry of at least two more average-sized banks would tend to engender an optimal market size.

The above would suggest further commitments in the various modes of supply under the GATS agreement in financial services.[4] Actual liberalization has so far been modest. Apart from specific commitments on reinsurance services, Trinidad and Tobago made horizontal commitments to the acquisition of property and shares in domestic companies and the movement of labor at the conclusion of the Uruguay Round in 1994. On the basis of the preceding analysis and in contrast to the recommended strategy of the Caricom Secretariat/Regional Negotiating Machinery Report there is a case for Trinidad and Tobago to give further commitments under the GATS. Binding financial sector reform in GATS Mode 3 (commercial presence) would make sense given that Trinidad and Tobago has already allowed the establishment of foreign banks in its territory. Under the commercial presence mode of supply, all entry authorization would still be subject to prudential criteria under the relevant laws and regulation. Commitment under the more demanding Mode 1 (cross-border) liberalization is also possible in the context of an already open capital account. Such a commitment can take the form of an unbound position with respect to market access and national treatment for both cross-border supply and consumption abroad and for both acceptance of deposits and lending of all types. In light of the new dimensions in trade relations, Trinidad and Tobago needs to make a strategic decision as to whether and how it will participate in the multilateral liberalization process.

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Orlando C. de Matos

Volatility of rates of return and capital adequacy in the Brazilian banking sector: an analysis of the 1993/97 period

1. INTRODUCTION

Up to 1988, the Brazilian banking system was composed of isolated and independent conglomerates and institutions. These conglomerates were composed of juridically distinct companies normally led by a commercial bank. Most if not all of the companies included in these conglomerates were investments banks, finance companies, leasing companies, insurance companies, brokerage firms, investment companies and capitalization companies, private social security firms and stock and security distribution companies.

Each company included in the conglomerate had its own management and services, though their strategies were defined by a

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single command structure. Relations among the different companies were based on complex systems of overlapping ownership of voting capital. Within the conglomerates themselves, the same individuals could often be found on the boards of several different companies. At the same time, in practical terms, commercial bank branches acted as sales outlets for the products and services of the entire conglomerate.

The merely legal independence of the component companies generated situations in which identical services were performed in many different segments of the same conglomerate. The result was that it was practically impossible or, at least, very difficult to achieve the degree of centralization required to optimize utilization of available resources. The obvious consequence was inefficiency in the allocation of resources.

These institutions came on the scene in the early 1950s when commercial banks recognized that the conglomerate structure could be utilized as an instrument for regaining market positions they had lost when they were legally prohibited from paying adequate earnings on investment inflows. With the worsening of inflation, interest rates on deposits became negative, and investors were literally driven into the securities and real estate markets in order to obtain positive rates of earnings (Perdigão, 1983:193).

In light of this situation, the National Monetary Council decided to give legal form to a de facto situation and began encouraging formation of multiple banks (Resolution no. 1,524, dated 9.22.98). According to the terms of this instrument, these institutions were to include commercial, investment, consumer credit and real estate credit portfolios and had to have at least a commercial or investment portfolio. Inclusion of brokerage and distribution companies was not permitted.

Aside from enhanced efficiency, the central objective of the new organizational model of the Brazilian banking system, which is quite similar to the universal banks found in the German system, was to create a more flexible and agile banking structure in which institutions would be able to operate on a multiplicity of financial markets through the same legal-administrative structure.

With adoption of this structure, the diversification potential of a multiple bank is greater than that of a commercial bank. Here, it should be noted that, even if an institution is classified as a single portfolio bank according to the National Monetary Council concept, it will always have potential for diversification since the process of financial innovation makes it possible to differentiate its services on a constantly changing basis. By way of example, a

commercial bank classified as a single portfolio institution according to the new definition is in no way impeded from diversifying the nature of its asset operations through interfinancial liquidity investments, stocks and securities, loans, discounting of invoices, rural and housing financing, consumer credit, marketing, investment and infrastructure financing operations, development financing, and so forth. Each one of these operations has its own specific characteristics in terms of revenue generation, risk, terms, geographic location of the client, economic sector, etc. On the liability side, considerable leeway is available for contracting funding in varied market segments.

Many different diversification possibilities exist. The difference in relation to the multiple banks is that the latter are authorized to operate in other market segments aside from those in which commercial banks are active. With this, the diversification capacity of these institutions increases and they are able to reduce their costs.

In the ten years that have passed since this experiment began, there are signs that multiple banks in general have been able to obtain higher rates of return than single portfolio institutions (Matos, 1998). However, going further into an evaluation of the model introduced as of 1988, one can question whether the rates of return obtained by banks with multiple portfolios have been more stable and less volatile than in the case of commercial banks. In more general terms, one must try to identify the factors that determine the differences in volatility in the rates of return obtained by Brazilian Banks. Following the same line of thought, one must ask what are the factors that determine capital adequacy levels (the institution's capital/liabilities) among banking institutions in Brazil. In other words, what are signs to be sought in these institutions that reflect degrees of vulnerability and could indicate a bankruptcy risk.

The emphasis given to vulnerability is justified since it is an indication of risk or instability, both of which are themes much in vogue today. The vulnerability of an institution is rooted in the fact that a bank's profits depend on a varied array of factors, many of which are not subject to direct management control: performance of the economy as a whole, interest rates, exchange rates, stock prices, and so forth. Obviously, adverse movements under these variables will have an unfavorable impact on the individual financial results of banks and on the banking industry as a whole. Since banking institutions are generally exposed to the impact of adverse external factors, Jorion (1997:4) stresses that

risk management has become a fundamental instrument in guarantying the survival of any business, no matter what the nature of its affairs.

In pursuing these objectives, the theoretical hypotheses found in pertinent literature were analyzed and the factors that condition the volatility of rates of return were identified. The following step is an analysis of the evolution of the national banking system, coupled with a description of the volatility that existed in the period 1993.1/97.2. Based on categories common to Brazilian banks, one should emphasize the magnitude of these indicators, together with the impact of the Real Plan on risk behavior. In the third place, an analytical-explanatory model is formulated on the basis of the theoretical hypotheses already discussed and the specific characteristics of the Brazilian banking sector.

Aside from the introduction, this study is composed of four sections. The second contains a discussion of the theoretical hypotheses found in literature. The third reveals a characterization of volatility in terms of magnitude and behavior among the different categories of banks. The fourth chapter formulates an analytical-explanatory model and analyzes the estimated results. Finally, we present the conclusions drawn from development of this analysis.

2. THEORETICAL DETERMINANTS OF RISK

According to Jorion's definition (1997:3-4), viewed in generic terms, risk can be defined as the volatility of unexpected results, generally in terms of the value of assets or liabilities. More specifically, financial risk refers to possible financial market losses and can be classified as market risk, credit risk, liquidity risk and operating risk.

Market risk refers to variations in basic asset and liability positions and business results, caused by changes in the prices of market variables, such as interest rates, exchange rates, stock prices, commodity prices, and so forth. Credit risk arises when borrowers are unwilling or unable to honor their contractual obligations, generating costs for the lender who must then restore his interrupted cash flow. In more generic terms, credit risk could generate losses when debtor ratings are lowered by risk rating agencies, since the market value of the institution's liabilities will decline. Liquidity risk refers principally to losses generated by the lack or reduction of funding for purposes of immediate

payment. Finally, operating risk corresponds to the potential for losses that can result from inadequate operating systems, administrative failings, imperfect controls, fraud or human error (Jorion, 1997:14).

Consequently, the phenomenon upon which we are going to concentrate in this study is, in summarized form, the instability of the results obtained by banking institutions caused by unforeseen changes in factors that impact those results, such as the performance levels of the economy in general, unemployment, interest rates, exchange rates, commodity prices, regulatory measures, etc. When these changes occur, they are reflected in rates of return. If the changes are adverse, the impact will generate losses or, in other words, results that are below expectations. The extent to which these movements impact the results of a business or any investment is termed volatility or, in other words, the empirical counterpart of risk. Since all these movements impact rates of return, the volatility of such rates incorporates all types of risk, including those not included in Jorion's classification.

The risk or volatility to which a business is exposed has been measured by the variance or, more commonly, by the standard deviation of that business's rates of return on assets or invested capital (Leite, 1994:257). In this case, the higher the standard deviation (or variance) of the rates of return, the greater will be the possibility of dispersion of the expected values in the future and, consequently, the greater will be the risk (Fabozzi and Modigliani, 1996:170). Therefore, risk and volatility of rates of return are closely related concepts, even though one is theoretical and the other empirical.

Keeping the nature of these two concepts in mind, the question that remains concerns identification of the determinants underlying risk or volatility differentials among banks. In other words, one must ask what are the characteristics associated to banks or their operating environments that affect the volatility of their rates of return and the capacity of their own capital positions to absorb losses generated by adverse conditions.

2. 1. Diversification, Size and Risk

Starting with a pioneering study published by Harry Markowitz in 1952, specialized literature points to portfolio diversification as a practice capable of attenuating risk. In the case of the stock market, if the prices of two stocks have an absolutely negative correlation, they will move in opposite directions and, conse-

quently, make it possible to form an optimum portfolio. In this way, it will be possible to obtain a rate of return that is higher than the pure rate of interest (free of risk), without simultaneously registering lesser risk (Leite, 1994:257). On a broader level, one can argue that an adverse result in a market, sector or type of client can be offset by a more positive result in another market, sector or clientele. Thus, by operating in various markets, a bank will depend to a lesser extent on the demand variations of a specific product and, in this way, will reduce its exposure to risk (Perdigão, 1983:201). Obviously, the extreme situations of no correlation or of an absolute correlation are far from realistic. However, the existence of some degree of correlation is plausible and is consistent with Marcowitz's original hypothesis. In this regard, Fabozzi and Modigliani (1996:172) note that the risk of a given portfolio can be sharply reduced through diversification but cannot be totally eliminated.

More recently, in an analysis of the competitiveness of large scale conglomerates, Clifton (1977:137-151) observed the intense capital mobility that occurs in this type of company as a result of the varied strategies adopted to ensure competitive advantages. Consequently, capital tends to shift from sectors with low profitability levels to more favorable sectors. The result is withdrawal of older products and introduction of new products and services. Thus, new markets must be continuously sought in order to absorb the new products. Based on this phenomenon, expectations are that the large conglomerates will be able to obtain uniform rates of return as a consequence of their diversification strategies.

A third approach involves arguments in favor of an inverse relation between diversification and risk and is designated the modern theory of intermediation. According to those who formulated this theory [Diamond (1984), Ramakrishnan and Thakor (1984), Boyd and Prescott (1986), Williamson (1986) and Allen (1990)], the foundation of this theoretical approach is the asymmetry of information between borrowers and lenders. In this environment, financial intermediaries obtain economies of scale and scope in the gathering, processing and analyzing of information and, therefore, are able to appropriate advantages by formalizing operating contracts with a large number of borrowers and lenders. Thus, to the extent that the number of borrowers and lenders increases, the possibilities of diversification increase and are further driven by cost reductions in contracting operations among asymmetrically informed agents. On the other hand, if a

large number of investments is made by a single financial intermediary, the resulting risk of this combination is either reduced or eliminated and becomes similar to a situation in which the contract is formalized directly between each borrower (agent in deficit position) and lender (agent in surplus position). Aside from this, diversification reduces the expected cost of the asymmetry of information accumulated in financial intermediaries (Boyd and Runkle, 1993:50-51).

Aside from the advantages they obtain in terms of information (characteristics of the borrower or lender, choice of projects and monitoring of operations, etc.), financial intermediaries can have "...well defined preferences on the part of savers and the holders of wealth with respect to the risk/return combination for the resources saved" (Bender, 1997:665). Thus, the activity of financial intermediation through investment of resources with the objective of obtaining more and better information and, in this way, reducing the asymmetry of information and minimizing the costs of financial transactions makes it possible "...to alter risks and returns related to the various assets of the economy" (Bender, 1997:666).

A forecast of an inverse relation between size and risk also emerges from the previous argument. However, it should be stressed that Boyd and Runkle are referring to the risk of bankruptcy or, in other words, to the loss of a bank's capacity to absorb losses as a consequence of the volatility of its rates of return and capital adequacy (the institution's capital/assets).

The bargaining power enjoyed by large scale banks is also a factor that contributes to the stability of rates of return, independently of their greater or lesser capacity to cope with adversities. In this sense, Myers (1977:52) affirms that the theory points to lower risk levels for large companies since size reflects the degree of diversification of the institution's activities, though the author admits that this is not an unbending principle.

Therefore, taking these considerations into account, one must conclude that the larger and more diversified banks[1] tend to obtain more stable and less volatile rates of return, since they are more able to offset adverse results than their highly specialized competitors and/or obtain economies of scale and scope or bring together and utilize the voluminous information they gather.

[1] See Ferrier, et al. (1993) with regard to diversification in the banking industry.

2. 2. Capital Ownership, Organization, Nationality and Risk

Abstracting from the degree of diversification and viewed under an intertemporal prism, situational conditions – gross domestic product (GDP) growth rates, interest rates, exchange rates, etc. – can generate fluctuations in the rates of return of financial intermediaries. This means that, even if all the banks were equally diversified at a specific moment in time, their rates of return could vary positively, if situational conditions are favorable, or negatively in the case of adverse conditions.

In this way, situational conditions can result in levels of volatility in rates of return that vary among different categories of banks as a result of the organizational characteristics of each of them. In the case of public sector banks, one can go so far as to accept the hypothesis that their rates of return are more unstable than those of their private sector counterparts, since their adjustment capacity (closing of deficit branches, layoffs, pressure on clients in default, etc.) is relatively limited as a consequence of social commitments or political favoritism. In the case of private banks, the adjustment process is much more rapid since they are practically free of these restrictions and even certain legal restraints.

Thus, efforts to avoid reductions in rates of return are more successful at private banks. One can argue that, even with more favorable conditions, public sector banks experience greater difficulty in achieving positive growth in rates of return, since these institutions come under pressure to pay extra bonuses to employees and directors, increase stockholder dividends, particularly to the controller, and to respond favorably to a broad array of requests. At the same time, considering that public banks generally have more stable sources of funding since they are the financing agents of their controllers, one could expect that this would, in some way, reduce the volatility of their results. Therefore, it is not a priori clear whether the relation between stock capital ownership (public x private) and volatility is direct or inverse.

Insofar as systems of organization are concerned (commercial banks x multiple banks), the commercial banks would seem to be subject to greater volatility than the multiple banks since the latter are in a better position to diversify their operations.

As regards nationality, one can normally expect foreign banks to have more stable rates of return than national banks since they generally adopt risk management practices more frequently and

implement more effective management instruments. Naturally, we are dealing here exclusively with externally controlled foreign banks from developed countries.

2. 3. Leverage and Risk

Myers (1977:52) postulates a direct relation between leverage and risk, though he does not present clear arguments in favor of this position. In any case, an indebted company's exposure to fluctuations of market variables, such as interest rates, exchange rates, etc., is relatively higher in comparison to companies with lower levels of indebtedness. At the same time, in the case of financial intermediaries, one should note that in those cases in which there is a high proportion of assets in the form of credits, the probability of losses (credit risk) increases and the capacity of the institution's own capital to absorb them declines, if this capital is not maintained at levels compatible with the structure of the assets subject to risk.

Consequently, expectations are that the degree of leverage (liabilities/institution's own capital) directly conditions the volatility of banks' rates of return.

2. 4. Hedge Operations and Risk Control

Hedging can be understood as an operation that makes it possible to reduce or eliminate risk of losses or less than expected returns. Thus, aside from the diversification strategies that make it possible to reduce the volatility levels of rates of returns, both banks and other companies are able to protect themselves at least partially against financial risk through hedge operations. This type of protection is similar to purchasing insurance against the adverse effects of variables over which companies have no control (Jorion, 1997:7-8).

As Gilbert affirms, one should stress that banks are encouraged to assume higher risks when deposit insurance exists, since this can operate as a hedge. Deposit insurance was introduced into Brazil relatively recently and, consequently, the protection it offers to the liability operations of banks is still not significant. There are innumerable systems of hedging available, since just about any operation targeted to reducing risk can be classified as a hedging operation. For example, when a bank that has obtained short-term funds seeks to invest these funds with maturity terms that are shorter or equal to those of its liabilities, it is per-

forming a hedging operation to the extent that it reduces its liquidity risk. Protection of these funds will be even greater if the bank performs asset operations covered by guaranties. However, what we are going to deal with here are hedging operations in the form of derivatives.

In this way, independently of the traditional practice of seeking to protect their operations from risk exposure by diversifying or aligning maturity terms among funding sources and investments, banks can also do this through operations on the derivatives market. However, participation in these markets can be aimed at controlling own risk or even speculating or performing arbitrage operations. However, the most common use of derivatives is risk management.

On using derivative operations as hedges, the banks are able to isolate and/or transfer specific risks to third parties. As a matter of fact, companies – and particularly financial institutions – that have considerable exposure to such market factors as commodity prices, interest rates, exchange rates, etc. can reduce their net exposure to these factors by acquiring compensatory exposures and this can be done on the derivatives market.

By way of illustration, consider that a bank's exposure to long-term interest rates indicates that its market value can decline as a result of interest rate increases. Such a situation could arise as a result of a policy on long-term loans that are funded with resources contracted in short-term deposits. In this case, the bank would become insolvent if interest rates were to pass the mark, let's say, of 200 base points. However, if the bank offsets its exposure to risk with an interest rate swap operation, its net exposure to long-term interest rate will decline. In this case, the hedge operation transferred the risk to the counterpart of the swap. However, this does not imply that the counterpart is obligated to speculate with interest rates. The counterpart may have exposure that is opposite that of the bank. This situation exists when, for example, the counterpart is an insurance company that has short-term assets for liquidity purposes, but long-term commitments, such as life insurance and/or property insurance indemnities. In this case, it should be noted that, if the short-term interest rate increase, the bank will suffer losses since it will have to pay more to its depositors, but the insurance company will gain since it will earn higher returns on its short-term assets (Hentschel & Smith Jr., 1997:313-315).

These authors conclude that the risk of default that can arise out of derivative operations has three fundamental implications

for banks. In the first place, a bank will face a lower default rate if its counterparts are also using derivatives has their hedge instead of simply speculating. Secondly, when banks use derivatives to reduce their risk exposure, they also reduce the probability of default of all their liabilities, including deposits. Thirdly, even when the banks use derivatives to speculate and, therefore, can increase their risk (for example, because of asymmetrical payments), the default arising out of derivatives is always less than the probability of default on fixed liabilities like uninsured deposits (Hentschel & Smith Jr., 1997: 320).

In summary, expectations are that the banks that utilize derivative operations as hedges tend to obtain more stable and less volatile rates of return in comparison to those that do not use them or that use them on a lesser scale.

3. EVOLUTION OF THE BANKING SYSTEM AND ANALYSIS OF THE VOLATILITY OF RATES OF RETURN

3. 1. Evolution of the Brazilian Banking System

When the National Monetary Council began authorizing formation of multiple banks, two movements were noted as of 1988. In the first place, most commercial banks became multiple banks and, with the exception of brokerage and distribution companies that are formally excluded by the new rules (Resolution nº 1,524/88), these institutions simply incorporated the financial institutions already encompassed by informal conglomerates into a single legal entity. The other reaction to the new system of organization was constitution of new banks with multiple portfolios. Generally, this process involved transformation of distribution companies into banking institutions.

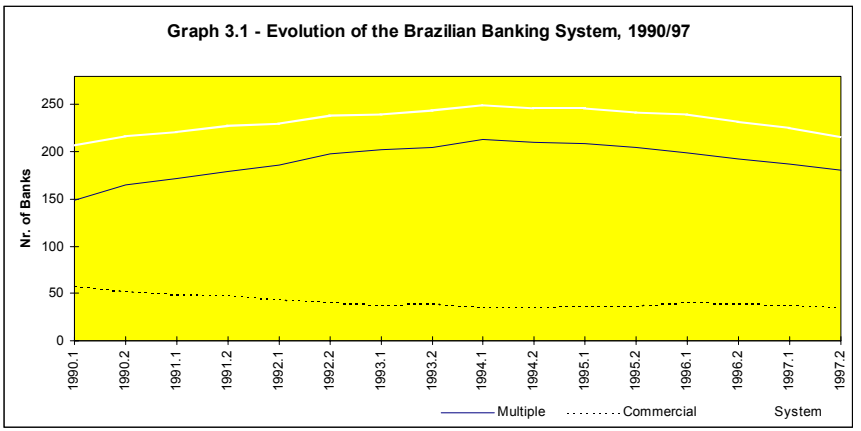
The evolution of the Brazilian banking system since the first half of 1990 is shown in Table 3.1 and in Graph 3.1. It should be stressed that the reaction of the banking system to the new organizational rules was significant. As a matter of fact, 72% of all Brazilian banks were multiple banks by 6.30.90 and, by the end of 1997, this figure had already climbed to 83%. At the same time, one should note that the number of banks has decreased as a result of mergers, incorporations and acquisitions that have marked the structural adjustment process that followed introduction of the Real Plan (June 1994).

TABLE 3. 1. BRAZILIAN BANKING SYSTEM – EVOLUTION IN THE NUMBER OF BANKS ACCORDING TO ORGANIZATIONAL STRUCTURE AND CAPITAL OWNERSHIP, 1990.1./97.2

	Multiple banks				*Commercial banks*				*Banking system*	
Year/half-year	*Private*	*Public*	*Total*	*Growth (%)*	*Private*	*Public*[1]	*Total*	*Growth (%)*	*General total*	*Growth (%)*
1990:1	140	9	149	-	34	24	58	-	207	-
1990:2	155	10	165	10.7	33	19	52	-10.3	217	4.8
1991:1	161	11	172	4.2	32	17	49	-5.8	221	1.8
1991:2	166	13	179	4.1	32	16	48	-2.0	227	2.7
1992:1	169	17	186	3.9	32	12	44	-8.3	230	1.3
1992:2	176	22	198	6.5	32	8	40	-9.1	238	3.5
1993:1	179	23	202	2.0	31	7	38	-5.0	240	0.8
1993:2	182	23	205	1.5	32	7	39	2.6	244	1.7
1994:1	187	26	213	3.9	30	6	36	-7.7	249	2.0
1994:2	184	26	210	-1.4	30	6	36	0.0	246	-1.2
1995:1	183	26	209	-0.5	31	6	37	2.8	246	0.0
1995:2	179	26	205	-1.9	31	6	37	0.0	242	-1.6
1996:1	173	26	199	-2.9	34	6	40	8.1	239	-1.2
1996:2	166	27	193	-3.0	33	6	39	-2.5	232	-2.9
1997:1	161	26	187	-3.1	32	6	38	-2.6	225	-3.0
1997:2	159	21	180	-3.7	30	6	36	-5.3	216	-4.0

SOURCE: BACEN (Gross Data).

[a] Banco do Brasil and Savings Banks included.



3. 2. Analysis of the Volatility of Rates of Return and Capital Adequacy

Before going on to an analysis of the volatility of rates of return and capital adequacy according to different groupings of banking institutions and/or periods of time, one should present a more precise definition of the risk measurement systems adopted in this paper, since no single mechanism has been universally adopted for this purpose.

3. 2. 1. Methodological Observations

Specialized literature points to four major systems for measuring risk at the company level, each of which has advantages and disadvantages. These are: (a) beta coefficient; b) variance (standard deviation) of rates of return; c) capital adequacy; and d) bankruptcy risk.

With regard to the beta coefficient as a system of risk measurement, initially one considers the model that relates the return of a specific asset to the market return of the portfolio, as proposed by Sharpe (1964) and later perfected by other authors [apud Sanvicente and Mellagi Filho (1988) and Leite (1994)]. Thus, one comes to $R = \alpha + \beta R_m + u$, in which R is the rate of return of the asset and R_m is the rate of market return of the portfolio and the beta coefficient to R_m is the associated parameter.

Based on this model, it should be noted that $Var(R) = \beta^2 Var(R_m) + Var(u)$, in which the first term refers to the systemic risk

and the second to nonsystemic or diversifiable risk. While the systemic risk is inevitable and never nil, the diversifiable risk can be nil, since the investor or company can, through a process of diversification, combine assets or liabilities in such a way that "...the effects of specific events mutually cancel one another out" (Sanvicente and Mellagi, 1988:47).

Consequently, once data on market returns on assets and on portfolios are obtained, it becomes possible to identify the systemic risk, the diversifiable risk and total risk. The latter corresponds to the variance of the rates of return.

Since this has the property of encompassing risks, the variance of the rates of return on assets is utilized as a measurement of risk or volatility and can be interpreted as the deviation of rates of return in relation to the expected result, and this deviation occurs as a result of the company's incapacity to forecast future events (Campello and Moreno, 1996).

With regard to business results, the most common measurement of risk or volatility has in fact been the standard deviation of rates of return since, aside from incorporating the systemic and diversifiable risk, as the variance system does, it also expresses volatility in the same unit of the rate of return and it is precisely this that the variance measurement does not do.

Leahy and Whited (1996:68) criticize the utilization of dispersion measurements as risk indicators. The authors argue that, since companies face varied forms of uncertainty in terms of price variations and changes in technologies and since it is difficult to measure them as a consequence of the scarcity of high quality data in the first case and a lack of perception in the latter, variance as a risk measurement instrument has the disadvantage of incorporating variations in the rate of return, even though it is able to perceive movement related to multiple aspects of the environment in which companies operate, and these variations do not reflect only changes that generate uncertainties, but also translate situational "bubbles", unexpected happenings and manipulations.

A third measurement of risk is capital adequacy, defined by the ratio of the institution's own capital to assets (Boyd and Runkle, 1993; Campello and Moreno, 1996). This is an indicator of the risk of bankruptcy, since the company's capacity to absorb losses generated by risk will depend directly on the level of that company's own capital. If capital adequacy is low, this capacity is jeopardized and the company becomes relatively more vulnerable. Should the contrary occur, the company is strengthened and distances itself from the threat of bankruptcy.

Finally, one can utilize a combination of capital adequacy and the standard deviation of rate of return as a measurement of risk. As defined by Boyd and Runkle, this combination corresponds to the ratio [(L + K)/A]/S, in which L is the financial result (profit or loss), K is the institution's own capital, A is assets and S refers to the standard deviation of the rates of return on assets. In this case, the risk measurement can be interpreted as the number of standard deviations needed for a loss to absorb all of a company's own capital. Consequently, a high level in this score indicates lesser probability of bankruptcy. This measurement defines what is designated in specialized literature as the risk of bankruptcy. In this regard, one should note that low volatility (S) is a condition that favors reductions in the threat of bankruptcy. However, its effect can be reduced or neutralized by a still lower capital adequacy [(L + K)/A] or, in other words, a high degree of leverage.

One can also perceive the risk of bankruptcy based on the ratio of the variance of the rates of return to capital adequacy (institution's own capital/assets) [Gilbert(1990)]. Thus, high values in the measurement of the risk of bankruptcy would indicate strong erosion in the company's own capital as a result of losses generated by risk.

In this study, volatility measured in terms of the standard deviation of the rates of return and the risk of bankruptcy[2] that results from the combination of capital adequacy and volatility, as suggested by Boyd and Runkle (1993), were adopted as risk indicators. In the case of volatility, the standard deviation of three rate of return indicators was utilized: a) operating result to profitable assets (RO); b) adjusted operating result to the opportunity cost of the company's own capital; and c) net result of the half-year period to profitable assets (RS).

Profitable Assets (or Total Adjusted Assets) are defined by Current and Long-Term Assets, after deduction of Available Funding, Interfinancial Relations and Interbranch Relations, based on the Accounting Plan of National Financial System Institutions (Cosif). The Adjusted Operating Result refers to the accounting heading Operating Result less the opportunity cost of the institution's own capital (Net Worth + Results of future years). This measurement of results had the objective of estimating the accounting results of the economic profit concept. The opportunity

[2] Since the risk of bankruptcy corresponds to the capital adequacy/volatility ratio, the concept of capital adequacy will henceforward be used to facilitate interpretation instead of the risk of bankruptcy.

cost corresponds to earnings on the institution's own capital, in which case the rate applied was defined by the average of the ten lowest ratios between income on interfinancial liquidity investments and financial liquidity Investments in the 10 half-year periods of the analysis: 0.3083 (1993:1); 0.1728 (93.2); 0.2408 (94.1); 0.0849 (94.2); 0.0404 (95.1); 0.0274 (95.2); 0.0174 (96.1); 0.0129 (96.2); 0.0184 (97.1); and 0.0126 (97.2). It should be stressed that estimates were made on the basis of the average rates of the over-Selic. However, the figures obtained did not make it possible to draw meaningful conclusions.[3]

With respect to capital adequacy, as a component of the definition of the risk of bankruptcy, the ratio of the institution's own capital/liabilities is utilized, in which the institution's own capital corresponds to Net Worth, while liabilities refer to Total Adjusted Assets. Thus, if volatility is high and capital adequacy is low, this would be a sign of a high risk of bankruptcy. Should volatility be high, one can conclude that there is a high degree of erosion in the institution's own capital caused by losses generated by that risk. Consequently, it should be underscored that this definition of risk of bankruptcy can be understood as a refined measurement of capital adequacy.

It should be emphasized that, to some extent, variations in the rates of company returns can be generated by mere situational fluctuations or even by certain unforeseen happenings or manipulations as is noted by Leahy and Whited. Obviously, Brazil is no exception. However, since standard deviation of rates of return over the course of time is used here instead of utilizing distinct dates for different banks, it is expected that this problem will be attenuated or even eliminated. With respect to possible manipulation of data, one can accept that such manipulations are systematic and rooted in identical causes. Therefore, if errors occur in the same directions, comparisons among banks are not meaningfully affected, even over the course of time, as will be noted further on. In any case, the informative content of these data can be evaluated by comparing them with the theoretical framework utilized, given that the logic in this comparison has no relation with possible informational errors and that the consistency obtained in this comparison can certainly not be ascribed to mere coincidence. Beyond that, any indicator that is used is subject to measurement errors.

[3] A more elaborate form of explaining the opportunity costs of a company is denominated added economic value and can be found in Grant (1997).

In this regard, one should note that standard deviations were calculated for each bank over the course of 1993.1/97.2. However, in order to verify as to whether there exist differences in volatility as a result of the changes introduced by the Real Plan in terms of inflation, the period 1993.1/97.2 was subdivided into three subperiods, as follows: a) period of high inflation (1993.1/94.1); b) period immediately following the Real Plan (1994.2/95.2); and c) period of low inflation (1996.1/97.2).

For the period of 1993.1/97.2, the number of observations taken into account involved 247 banks. However, it should be noted that, in order to eliminate problems of interpretation of the measurements utilized and biases in the results, those institutions that, following calculation of the average of their half-year values, continued registering negative net worth or other discrepancies were simply eliminated. However, this problem occurred only in the case of leverage, defined by the ratio Total Adjusted Assets/Net Worth, as a result of a negative or excessively low average level of net worth, resulting in situations in which this ratio was either lower than zero or very high. Consequently, it was decided that six banks would be eliminated from the sampling since they had registered leverage factors that were negative or greater than 50. With this, the units considered in the study totaled 241. However, this was not considered in the tabular analysis that follows since it did not involve direct considerations on this variable.

3. 2. 2. Analysis of Volatility

Among the measurements discussed above, the standard deviation of rates of return was adopted in order to analyze the behavior of volatility on the basis of selected groups of banks. Emphasis was given to the system of organization (multiple banks x commercial banks) and size categories. In the latter case, it was possible to control such variables as capital sources, system of organization and nationality of the proprietors of the stock capital.

It was also possible to perceive to what point variability in rates of return was altered as a consequence of hedging based on derivative operations. At the same time, the differences in volatility provoked by the changes introduced by the Real Plan also became evident.

3. 2. 2. 1. System of Organization and Volatility

Average volatility measured according to the system of organi-

zation of the bank and period selected is shown in Table 3.2. It should be noted that commercial banks registered volatility scores that were considerably higher than those registered by the multiple banks, no matter what rate of return definition was adopted and independently of the period under consideration.

TABLE 3. 2. BRAZILIAN BANKING SYSTEM – AVERAGE VOLATILITY OF ASSET RETURN RATE ACCORDING TO THE ORGANIZATIONAL STRUCTURE OF THE BANK DURING SELECTED PERIODS

Return rate indicator	Sample period	Commercial banks	Multiple banks	Banking system
Operating result/profitable assets	1993:1-94:1	0.1251	0.0494	0.0622
	1994:2-95:2	0.1769	0.0639	0.0829
	1996:1-97:2	0.0685	0.0562	0.0582
	1993:1-97:2	0.2095	0.0997	0.1193
Adjusted operating result/ profitable assets	1993:1-94:1	0.1242	0.0682	0.0777
	1994:2-95:2	0.1782	0.0596	0.0796
	1996:1-97:2	0.0688	0.0496	0.0527
	1993:1-97:2	0.1856	0.0973	0.1130
Half year result/profitable assets	1993:1-94:1	0.0727	0.0242	0.0324
	1994:2-95:2	0.1815	0.0555	0.0767
	1996:1-97:2	0.0667	0.0493	0.0521
	1993:1-97:2	0.1493	0.0654	0.0803

SOURCE: BACEN (Gross Data).

With regard to volatility over the course of the period 1993.1/97.2, higher values were generally registered in the three half-year periods that followed introduction of the Real Plan (1994.2/95.2). This suggests that to the extent in which the changes that occurred in the economic-financial environment of the country with implementation of the stabilization plan had not been foreseen, uncertainties were generated and these, in turn, resulted in increased volatility of the rates of return of banking institutions in general.

This result provides empirical backing to the hypothesis that diversification reduces the volatility of rates of return. However, changes in the economic environment contribute to increased volatility and, consequently, make financial institutions more vulnerable.

3.2.2.2. Size and Volatility

Broken down by size categories, the average volatility of the rates of return for the period 1993.1/97.2 is presented in Table 3.3. Initially, one should note that size categories were defined on the basis of average total assets (in logarithm). This means that volatility decreases as the size of the bank increases, and the rates of variation are decreasing. It is important to stress that there is a clear inverse relationship between volatility and size. As a matter of fact, in the case of the operating result over assets, one notes that volatility moved from an average of 0.3801 for the 18 smallest banks to just 0.0267 for the seven largest. In the other rate of return indicators, the result followed a similar pattern.

TABLE 3. 3. BRAZILIAN BANKING SYSTEM – AVERAGE VOLATILITY OF RETURN RATE ACCORDING TO SIZE CATEGORIES, 1993.1/97.2

Asset categories (in logarithm)	Nº of banks	Operating result/ assets	Adjusted. operating result/assets	Half-year result/asset
0.00 ---| 9.65	18	0.3801	0.3057	0.2124
9.65 ---| 11.76	90	0.1633	0.1619	0.1180
11.76 ---| 13.88	78	0.0752	0.0748	0.0549
13.88 ---| 15.99	54	0.0346	0.0329	0.0192
15.99 ---| 18.10	7	0.0267	0.0321	0.0112
Banking system	247	0.1193	0.1130	0.0803

SOURCE: BACEN (Gross Data).

This result indicates a significant inverse relationship between volatility and size. One should now verify whether this relation is maintained when other variables are controlled. Thus, the average volatility by selected categories of banks and size for the period 1993.1/97.2 is shown in Table 3.4. As is shown, the behavior of volatility was analyzed according to proprietorship of stock capital (state banks x private banks), systems of organization (multiple banks x commercial banks) and nationality (national banks x foreign banks).

The most important result to be drawn is the maintenance of the inverse relation between volatility and size in all categories of banks, no matter what the rate of return indicator utilized. This reinforces the indication of the strong influence that the size of the institution exerts on stabilizing its rates of return.

Analysis of volatility according to capital proprietorship shows

that the differences between state and private banks did not follow a clear standard of behavior. As a matter of fact, the private banks only registered volatility indices that are lower than those of the state banks when the return is measured in terms of the operating result and the net result of the half-year period (Table 3.4).

With respect to the differences between commercial and multiple banks, as already stated (Table 3.2), the latter grouping is characterized by significantly lesser volatility. However, it should be noted that, contrary to expectations, by controlling size, the medium and large commercial banks registered lesser average volatility levels than the multiple banks of the same size categories. Consequently, the lesser volatility in the case of multiple banks occurred only in the case of small institutions (Table 3.4). This leads to the conclusion that, in terms of risk, small commercial banks are generally more vulnerable.

In terms of nationality, the results obtained indicate significant volatility differentials between national and foreign banks, with greater magnitudes for the latter institutions. However, this difference occurs as a result of high levels of instability in the rate of return of six small foreign banks. In the case of the medium and large foreign banks, average volatility levels are much lower than those registered in the same categories of private national banks.

The reason for this difference is doubtlessly found in the fact that, among the six foreign banks classified as small, there are banks that originate in Latin American countries and are characterized by relatively restricted diversification capacity and low levels of protection for their asset and liability exposure positions, together with various institutions from developed countries that have gone through a series of merger-generated transformations.

The results obtained in the tabular analysis are useful for verifying the magnitude of the volatility indices. However, a relation between volatility and these bank categories only becomes clear when it is strong, as occurred in the case of volatility-size and volatility-system of organization (multiple banks x commercial banks). If this association is not strong, the relation is not clear even when other variables are controlled. Thus, a clearer relation between volatility and the characteristics observed at the level of the bank will only appear when all of the explanatory variables of interest are utilized simultaneously. This will be seen in the next topic when the econometric model will be used.

TABLE 3. 4. BRAZILIAN BANKING SYSTEM – AVERAGE VOLATILITY OF RETURN RATE OF ASSETS ACCORDING TO SELECTED CATEGORIES AND SIZES,[a] 1993.1/97.2

Categories/size of bank	Nº of banks	Operating result/assets	Adjusted operating result/assets	Half-year result/assets
		Capital ownership		
State owned	33	0.1299	0.1130	0.0991
Small	4	0.3004	0.2347	0.2153
Medium	17	0.1530	0.1356	0.1312
Large	12	0.0402	0.0403	0.0147
Private	214	0.1176	0.1130	0.0774
Small	73	0.2260	0.1927	0.1397
Medium	112	0.0682	0.0809	0.0508
Large	29	0.0354	0.0365	0.0234
		Form of organization		
Commercial	44	0.2095	0.1856	0.1493
Small	19	0.4211	0.3710	0.2991
Medium	17	0.0611	0.0552	0.0439
Large	8	0.0224	0.0225	0.0179
Multiple	203	0.0997	0.0973	0.0654
Small	58	0.1673	0.1371	0.0927
Medium	112	0.0822	0.0931	0.0641
Large	33	0.0403	0.0413	0.0216
		Nationality		
National	210	0.1147	0.1104	0.0781
Small	71	0.1947	0.1637	0.1208
Medium	108	0.0830	0.0947	0.0655
Large	31	0.0423	0.0433	0.0243
Foreign	37	0.1449	0.1278	0.0927
Small	6	0.6458	0.5638	0.4139
Medium	21	0.0612	0.0545	0.0402
Large	10	0.0200	0.0201	0.0104
Banking system	247	0.1193	0.1130	0.0803

SOURCE: BACEN (Gross Data).

[a] Small banks are those having an average total assets lower than R$ 70 million. Medium banks are placed tetween R$70 million and R$2.000 million. Large banks have average total assets above R$2.000 million.

3. 2. 2. 3. Hedge Operations and Volatility

Derivative operations – forward, futures, option and swap contracts – are fundamentally designed to provide hedge or, in other words, wholly or partially protect the asset and liability operations of financial institutions against losses generated by risks of any nature. In this sense, the hedge has the objective of stabilizing rates of return. Since these reflect all types of losses motivated by adverse conditions faced by the banks in their daily operations, expectations are that the institutions that utilize hedge operations more frequently would have relatively lower volatility levels in their rates of return. However, derivative operations are frequently used for speculative purposes aimed at generating profit and, contrary to expectations, this type of operation transforms hedging into additional risk instead of protection.

Based on the supposition that derivative operations are primarily for purposes of hedging and as such have the potential for reducing the volatility of rates of return and given that these operations synthesize all of the possible losses consequent upon the risks assumed by the financial institution, independently of the nature of those risks, we have sought to verify to what extent those operations provide effective protection and, therefore, contribute to reducing the volatility level of the institution's rates of return.

The procedure followed to perform this test initially consists of the definition of an index of hedging or protection through derivative operations (IH), corresponding to the ratio of the reference value of the specific derivative operation[4] over adjusted total assets, since this heading – aside from encompassing all of the primary profitable investments exposed to risk – provides an approximate dimension of the volume of liability operations subject to the volatility of market variables. Thus, a bank that does not involve itself in derivative operations will have a hedge or protection index that is nil and, in this case, expectations are that the volatility of its rates of return will be higher in relation to those of

[4] The accounting record of the face value of the specific derivative operation at financial institutions in Brazil can be made in the asset accounts when there is a physical transfer of the commodity or financial asset (accounts 1.3.3.30.00-4 Forward Acquisition Receivable and 1.8.4.50.00-6 Forward Sales Receivable) or in the clearance accounts when there is no transfer of commodities or financial assets (account 3.0.6.10.00-6 Stock, Financial Assets and Commodity Contracts, subheadings 3.0.6.1040-8 of the Institution, 3.06.10.60-4 Swap and 3.0.6.10.70-7 Swap with Guaranty) (COSIF 1-4-2-1/16).

a bank that performs derivative operations for hedging purposes.

The hedge indices for each bank are calculated on the basis of half-yearly data, generating an average for the period 1993.1/97.2. In the sequence, five categories of banks were defined according to the magnitude of the calculated hedge index. The result of this was the average volatility of the rates of return within each one of these categories. The results obtained are presented in Table 3.5.

TABLE 3. 5. BRAZILIAN BANKING SYSTEM – AVERAGE VOLATILITY BY HEDGE INDEX CATEGORIES IN THE FORM OF DERIVATIVES, 1993.1/97.2

				Average volatility (standard deviation of the return rates)		
Hedhe index categories (IH)	Average (IH)	Correlation between IH and LT	Nº of banks	Operating results/ assets	Adjusted operating result/assets	Half-year result/ assets
Banking system	1.206	0.0336	247	0.1193	0.1130	0.0803
0.0000 |----- 0.0001	0.000	0.0000	39	0.3040	0.2587	0.2021
0.0001 |----- 0.5000	0.129	-0.1059	121	0.0994	0.0999	0.0673
0.5000 |----- 2.0000	1.138	-0.0415	48	0.0622	0.0761	0.0460
2.0000 |----- 5.0000	3.114	-0.3257	21	0.0455	0.0480	0.0291
5.0000 |---- 26.5000	9.012	0.1404	18	0.0912	0.0759	0.0553
Private banking system	*1.385*	*0.0853*	*214*	*0.1176*	*0.1130*	*0.0774*
0.0000 |----- 0.0001	0.000	0.0000	29	0.3074	0.2603	0.1860
0.0001 |----- 0.5000	0.153	0.0888	100	0.1077	0.1099	0.0742
0.5000 |----- 2.0000	1.165	0.0619	46	0.0628	0.0711	0.0466
2.0000 |----- 5.0000	3.114	-0.3257	21	0.0455	0.0480	0.0291
5.0000 |---- 26.5000	9.012	0.1404	18	0.0912	0.0759	0.0553

SOURCE: BACEN (Gross Data).

NOTE: Hedge Index = Notional value of own operations of derivatives/Adjusted Assets and LT = Adjusted assets logarithm.

Taking the banking system as a whole (247 banks), examination of these results makes it possible to visualize an inverse relation between the hedge index and volatility, with a notable difference between the banks that do not use derivatives (IH=0) in relation to those that do (IH>0). Aside from this, among the banks that do utilize derivatives, it was seen that – with the exception of those classified as IH>5 - those that have the higher hedge indices also have the lowest volatility levels in their rates of return, independently of being expressed as operating results or as re-

sults of the half-year period (which includes the non-operating results and deducts income tax, social security contributions, profit participation and contributions to employees). The reason that banks with a higher proportion of derivative operations in relation to adjusted assets (IH>5) have higher average volatility indices may possibly be related to utilization of this type of operation for speculative purposes also. In this case, the contracting of derivative operations may well create increased risk in light of the losses that could be generated.

In any case, this result is consistent with the hypothesis that derivative operations have effectively contributed to banks' need to protect themselves from risks of any nature and, consequently, have been an important element in stabilizing their rates of return, even though these same operations can be utilized with the objective of speculating or even carrying out arbitrage operations.

Nonetheless, it is a given fact that the derivative operations of state banks are relatively insignificant (average IH of 0.043 as against 1.385 for private banks). The protection-volatility index ratio was also calculated for both national and foreign private banks (214 institutions). These results are also presented in Table 3.5. The conclusion is that the behavior pattern of volatility among the different categories of the hedge index does not change significantly or, in other words, volatility declines with the relative increase in derivative operations up to the level of IH=5.

An additional precaution concerns the possibility of the hedge index being correlated to the size of the bank. Considering that there was a significant inverse relation between size and volatility, the influence of the hedge effected through derivative operations on volatility could be attributed to the common effect of the size of the bank, provided that this also be correlated to the protection index (IH). Despite being relatively low (0.0336 for the banking system as a whole), the correlation calculated indicates a certain degree of dependence between these two variables, principally with regard to the private banking system (correlation coefficient of 0.0853). This could signify that the inverse relation between volatility and the calculated hedge index would be attributed to the variable of size, given that a correlation does exist between these last two variables.

There are significant variations between the average values of the IH and the volatility index. Looking at the banking system as a whole and considering the volatility measured on the basis of the operating result, one can perceive, for instance, that while the average IH moves from 0.129 to 3.114 (growth of 2,314.0%),

volatility declines by only 54.2%. In the case of volatility in terms of the half-year results, the reduction in the same IH class came to 56.8%. In the fourth class, growth of the average index came to about 189.4% - considerably below that registered in the previous class, but sharply greater than the increases of 100.4% and 90.0%

TABLE 3. 6. BRAZILIAN BANKING SYSTEM – AVERAGE VOLATILITY OF RETURN RATE, ACCORDING TO SIZE AND ABILITY TO OPERATE IN THE DERIVATIVES MARKETS, 1993.1/97.2

			Average volatility (standard deviation of the return rates)		
Types of banks/ categories assets	Nº of banks	Hedge index categories (IH)	Operating result/assets	Adjusted operating result/assets	Half-year result/ assets
All banks	39	0.0000|---0.0001	0.3040	0.2587	0.2021
	208	0.0001|--26.5000	0.0846	0.0857	0.0575
	169	0.0001|---2.0000	0.0888	0.0914	0.0612
	39	2.0000|--26.5000	0.0666	0.0609	0.0412
AT < 95 million	31	0.0000|---0.0001	0.3063	0.2524	0.1809
	62	0.0001|--26.5000	0.1673	0.1717	0.1200
	51	0.0001|---2.0000	0.1794	0.1858	0.1307
	11	2.0000|--26.5000	0.1112	0.1064	0.0704
AT > 95 million	8	0.0000|---0.0001	0.2948	0.2828	0.2843
	146	0.0001|--26.5000	0.0495	0.0492	0.0309
	118	0.0001|---2.0000	0.0497	0.0506	0.0312
	28	2.0000|--26.5000	0.0490	0.0431	0.0297
Private banks	29	0.0000|---0.0001	0.3074	0.2603	0.1860
	185	0.0001|--26.5000	0.0879	0.0899	0.0604
	146	0.0001|---2.0000	0.0936	0.0977	0.0655
	39	2.0000|--26.5000	0.0666	0.0609	0.0412
AT < 95 million	26	0.0000|---0.0001	0.3137	0.2616	0.1796
	62	0.0001|--26.5000	0.1673	0.1717	0.1200
	51	0.0001|---2.0000	0.1794	0.1858	0.1307
	11	2.0000|--26.5000	0.1112	0.1064	0.0704
AT > 95 million	3	0.0000|---0.0001	0.2530	0.2487	0.2413
	123	0.0001|--26.5000	0.0478	0.0487	0.0304
	95	0.0001|---2.0000	0.0475	0.0504	0.0306
	28	2.0000|--26.50000	0.0490	0.0431	0.0297

SOURCE: BACEN (Gross Data).

registered in volatility levels in terms of operating results and results of the half-year, respectively.

In light of this result, one should question as to the reasons behind these accentuated differences in variations. This suggests that banks do not have to increase their protection levels significantly through derivatives in order to reduce the volatility of their rates of return. Thus, banks with relatively high levels of derivative operations would, in fact, be speculating or, in other words, trying to generate returns through these operations. This could well neutralize or reduce the effect of that share of the derivative operations designed to provide protection to exposures to adverse market factor variations.

Taking the analysis to a deeper level, the volatility of the rates of return was calculated according to the category of the hedge index and size of the bank. The results are presented in Table 3.6. The general conclusion is that, in the two size classes utilized, the pattern of behavior of volatility does not change significantly. In other words, the banks that used derivative operations obtained more stable rates of return (lesser volatility) than those that did not utilize these operations. On the other hand, backing up this result, it was noted that, among banks that utilized derivative operations, those that did so with greatest intensity (higher hedge index (IH) level) generally obtained better results. In other words, their rates of return were more stable and less volatile when compared to like institutions that did not use hedging (IH=0) or used these operations on a lesser scale.

However, it is important that a test be performed to check on the significance of the hedge index variable, when one controls the effect of the size of the institution and the other explanatory variables. This will be done under the next topic. The tabular analysis was targeted more at presenting the magnitude of the volatility indices observed than at testing the statistical significance of the hypotheses formulated on the behavior of this variable.

In any case, in summarized form, one can conclude that the inverse empirical relation observed is consistent with the hypothesis that hedge operations contribute to lessening the volatility levels to which banks are exposed. Furthermore, one can also infer that, aside from strategies aimed at diversifying operations, markets, clients, regions and so forth, banks have also made use of derivative operations as a means of coping with risk. However, one should highlight the fact that this result is limited since, among the different derivative operations registered, it was not

possible to identify those that were utilized exclusively for hedging and not for speculation or arbitrage purposes.

3. 2. 2. 4. Impact of the Real Plan on Volatility

The economic policy measures included in the Real Plan generated significant changes in the prices of goods and services, interest rates, exchange rates, etc. Since bank profits depend on these variations, one could foresee that, following introduction of the Real Plan in July 1994, the volatility levels of rates of return would undergo changes. Table 3.7 presents the volatility indices for the subperiod prior to the Real Plan (1993.1/94.1), as well as for selected subperiods after June 1994 or, in other words, for the low inflation period.

TABLE 3. 7. BRAZILIAN BANKING SYSTEM – AVERAGE VOLATILITY IN SELECTED PERIODS, 1993.1/97.2

		Average of volatility (standard deviation of return rates)		
Period	Nº of banks	Operating result/assets	Adjusted operating result/assets	Half-year result/assets
1993:1-94:1	218	0.0622	0.0777	0.0324
1994:2-95:2	220	0.0829	0.0796	0.0767
1996:1-97:2	210	0.0582	0.0527	0.0521
1994:2-97:2	232	0.0939	0.0863	0.0844
1993:1-97:2	247	0.1193	0.1130	0.0803

SOURCE: BACEN (Gross Data).

Comparing the indices calculated for the period 1993.1/97.2 with those observed for the subperiods, these results demonstrate that, just as expected, volatility rates were higher in the wake of the Real Plan. However, when one subdivides the post-Real Plan period into two subperiods the volatility rates are higher only in the three half-year periods immediately following adoption of the Plan in the month of June 1994. This was particularly true in the case of the Operating Result and the Net Result of the Half-Year Period.

There is no doubt that the reason for this is to be found in the climate of uncertainty found among financial intermediaries when the rate of inflation literally plunged to unprecedented low levels. In the following subperiod when the new rules governing the economy had already become relatively well-known and the

banking system had begun adjusting to the new situation, rates of return became more stable or, in other words, volatility indices dropped in relation to the initial stage of the Real Plan. In the case of rates of return measured in terms of the Net Result of the Half-Year Period (which incorporates the non-operating result and excludes taxes and legal participations), despite being lower than the levels registered in the subperiod 1994.2/95.2, volatility rates continued higher than in relation to the numbers registered in the high inflation period (Table 3.7).

3. 2. 3. Analysis of Capital Adequacy

Capital adequacy was defined by the (net worth/liabilities)/volatility ratio. Consequently, it is an indicator of the risk of bankruptcy. However, defined in this way, capital adequacy expresses the risk of bankruptcy when its respective values are low and this could well reflect a high level of leverage. The contrary situation, high levels of capital adequacy, indicates the possibility of erosion of the institution's own capital as a result of losses generated by financial risks. In this case, the leverage or, in other words, the degree of the bank's indebtedness is relatively less.

In order to verify to what extent organizational characteristics, such as size, capital ownership, system of organization and nationality, condition or are conditioned by capital adequacy and, consequently, by the risk of bankruptcy, an analysis was made at the same time focusing on the behavior of capital adequacy indices in different inflationary contexts over the course of the 1993/97 period.

3. 2. 3. 1. Organizational Characteristics of the Banks and Capital Adequacy

Based on the organizational characteristics of the banks, the average levels of capital adequacy are presented in Table 3.8. With this, one can indicate the possible differences between the groupings used in this study.

Insofar as capital proprietorship is concerned, one can observe that capital adequacy is systematically higher at the private banks than in like government controlled institutions. This would indicate that there is greater probability of a bankruptcy risk among the state institutions than among the private institutions. However, when these results are controlled by size categories, it is only in the case of state banks that capital adequacy increases with size,

TABLE 3. 8. BRAZILIAN BANKING SYSTEM – AVERAGE CAPITAL ADEQUACY BY SELECTED CATEGORIES AND BANK SIZES,[a] 1993.1/97.2 1993:1-97:2

Category/size	Nº of banks	Capital adecuacy in terms of volatility of:		
		Operating result/assets	Adjusted operating result/assets	Half-year result/assets
		Capital ownership		
State owned	33	2 000	2 689	7 869
Small	4	1 127	1 505	1 750
Medium	17	1 756	2 597	5 555
Large	12	2 670	3 254	13 461
Private	214	4 226	4 979	10 971
Small	73	3 631	5 638	11 618
Medium	112	4 108	4 599	9 563
Large	29	6 231	4 741	14 768
		Form of organization		
Commercial	44	3 986	4 272	9 968
Small	19	2 286	2 557	5 284
Medium	17	4 085	4 929	12 331
Large	8	7 811	6 950	16 073
Multiple	203	3 835	4 676	10 426
Small	58	3 900	6 362	13 012
Medium	112	3 663	4 167	8 287
Large	33	4 305	3 442	13 143
		Nationality		
National	210	3 734	4 541	10 026
Small	71	3 691	5 749	11 546
Medium	108	3 622	4 101	8 082
Large	31	4 224	3 305	13 322
Foreign	37	4 586	4 965	10 150
Small	6	1 256	1 567	5 895
Medium	21	4 218	5 122	12 613
Large	10	7 359	6 672	14 931
Banking system	247	3 862	4 604	10 345

SOURCE: BACEN (Gross Data).

[a] Banks were considered small when their average total assets were inferior to R$ 70 million. Medium size banks have average total assets between R$ 70 and R$ 2,000 million and large banks have average total assets above R$ 2,000 million.

as was originally expected. In the case of private banks, this direct relation does not occur. The truth of the matter is that, only when volatility is measured in terms of the Operating Result does one note that capital adequacy levels increase with the size of the bank. If volatility is expressed in terms of the Adjusted Operating Result, the relation capital adequacy-size is inverse or, in other words, the small banks have higher levels of capital adequacy in comparison to large and medium institutions. In the case of volatility measured in terms of the Half-Year Result (which incorporates the non-operating result), no behavior pattern is sufficiently clear.

With regard to the form of organization, in cases involving volatility in terms of the Adjusted Operating Result and the Half-Year Result, the multiple banks – as expected – registered higher average capital adequacy than the commercial banks. When the results based on size categories are controlled, capital adequacy was seen to increase as size increases, though this occurs exclusively in the commercial banks. Among the multiple banks, this result occurs only when the volatility implicit in capital adequacy is measured in terms of the Operating Result. In terms of the Adjusted Operating Result, the relation is contrary to what can be expected in the case of capital adequacy, suggesting that the bankruptcy risk would increase with size if the multiple banks were to effectively disburse the opportunity costs of their own capital. The relation is not clear when one utilizes volatility in terms of the Half-Year Result. One should take particular note of the fact that the pattern observed here for multiple banks is quite similar to what was seen in the case of private banks. This is explained by the fact that most private banks are multiple banks.

With regard to the question of nationality, the differences in capital adequacy levels are most favorable to the foreign banks in general, particularly as regards the possibility of failure. When size categories are controlled, it becomes clear that there is a direct relation – as is to be expected – between capital adequacy and the size of the bank. However, this occurs only in the case of the foreign banks. In the case of national banks, just as occurred with private and multiple banks, levels of capital adequacy decline with the growing size of the institution. There is no clear relation when volatility in terms of the Half-Year Result is utilized.

In summary, it is noted that despite some degree of inconsistency between what is perceived and what is expected, it is possible to affirm that, in general, the large banks have higher levels of capital adequacy and, therefore, their probability of bankruptcy is

smaller in comparison to the smaller institutions. However, it is still possible to perform a more rigorous test that controls the other variables and this will be done later on in this study (Section 4.2.2).

3. 2. 3. 2. The Real Plan and Capital Adequacy in the Banking System

One should question to what extent the changes provoked by the Real Plan have contributed to significant alterations in the capital adequacy levels of Brazilian banks and, therefore, to their bankruptcy risk levels. The capital adequacy indices for periods of high inflation (1993.1/94.1) and low inflation (1994.2/97.2) are presented in Table 3.9.

TABLE 3. 9. BRAZILIAN BANKING SYSTEM – AVERAGE CAPITAL ADEQUACY IN SELECTED PERIODS, 1993.1/97.2

Period	Nº of banks considered	Capital adecuacy in terms of volatility of:		
		Operating result/assets	Adjusted operating result/assets	Half-year result/assets
1993:1-94:1	218	9 528	7 225	37 450
1994:2-95:2	220	10 250	11 148	20 194
1996:1-97:2	210	12 542	12 850	20 661

SOURCE: BACEN (Gross Data).

In periods of high inflation, capital adequacy levels are higher. However, this only occurs when volatility is measured in terms of the Half-Year Result (which incorporates non-operating results). In the period subsequent to the Real Plan, capital adequacy levels were higher in the subperiod 1996.1/97.2. This indicates a lesser risk of bankruptcy in comparison to the period immediately following implementation of the stabilization program (1994.2/95.2). In the light of the problems faced by Brazilian banks as a result of the rapid decline in inflation, this result was only to be expected.

4. ANALYTICAL-EXPLANATORY MODEL OF BANKING RISK IN BRAZIL

4. 1. Formulation of Analytical Model

The theoretical hypotheses discussed above, coupled with the elements that are characteristic of the volatility of the rates of re-

turn of Brazilian banks, make it possible to formulate the following analytical-explanatory model, formally expressed as below:

$$V = b_0 + b_1L + b_2D + b_3F + b_4H + b_5N + b_6P + b_7T + u \quad (4.1)$$

in which:

V = Volatility, measured by the standard deviation of the rates of returns on assets over the course of time.
L = Leverage, measured by the ratio total adjusted assets/net worth.
D= Diversification of activity, measured by the Herfindahl index or, in other word, $D = (1-\Sigma p^2)$, in which p is the relative participation of each modality of the bank's asset investments.[5]
F = Dummy variable that indicates the bank's system of organization. It corresponds to 1 in the case of multiple banks and 0 in that of commercial banks.
H = The bank's hedge index, measured by the reference value relation of derivative operations/ total adjusted assets.
N = Dummy variable that indicates the nationality of the bank. It corresponds to 1 for foreign banks and 0 for national banks.
P = Dummy variable that indicates capital proprietorship. Corresponds to 1 for private banks and 0 for public institutions.
T = Size of the bank, measured by the logarithm of the real value of total adjusted assets.
u = Random term.

As is normal, there is a possibility that not all the explanatory variables will be included in the estimated equations, since there will be some with significant statistical coefficients.

With regard to the signs of the parameters, expectations are that the diversification, system of organization, hedge index, nationality and size of the institution have a negative impact on volatility or, in other words, it is expected that b_2, b_3,b_4,b_5 and b_7 will be less than zero, while the effect of the leverage value is expected to be positive ($b_1 > 0$). In the capital ownership variable, its impact on volatility was not a priori defined and b_6 is simply expected to be different from zero.

In order to analyze the behavior of bankruptcy risk, the same analytical structure found in Model 4.1 was utilized. With regard to the sign of the parameters, it is expected that they will be the opposite of those postulated for the volatility model due to the way in which the bankruptcy risk was defined: capital ade-

[5] In this regard, see Matos (1983), pp. 65-67 and Perdigão (1983), pg. 199.

quacy/standard deviation of the rates of return. In this way, the risk of bankruptcy is defined by capital adequacy in terms of units of the volatility indicator. Therefore, the higher the capital required to absorb possible losses generated by adverse fluctuations in the rates of return (volatility), less probable will be the risk of bankruptcy. The contrary case of low capital adequacy implies a more probable risk of bankruptcy. Therefore, it is expected that the variables that condition volatility act in a direction contrary to capital adequacy. Understanding this is important to interpreting the results of estimation of the analytical model.

4. 2. Analysis of the Results of Estimation of the Models Formulated

Utilizing data drawn from 241 banks[6] corresponding to the averages of the variables in the period 1993.1/1997.2, the analytical-explanatory model of the behavior of the volatility of the rates of return on assets and of capital adequacy was estimated. The estimates were obtained for each one of the three risk indicators adopted, utilizing leverage, diversification, system of organization, the hedge index, nationality, capital ownership, size and a special variable denominated outlier as the explanatory variables.

This variable was incorporated into the original volatility and capital adequacy models with the objective of perceiving possible impacts of special bank characteristics that would result in divergent values and relatively higher dependent variables (outliers). This would suggest the existence of relevant characteristics in the banks that are not perceived by the theoretically justified explanatory variables. One can affirm that, in the period analyzed, the banks went through situations that generated strong fluctuations in their rates of return, including financial and administrative turmoil, changes in majority stock ownership, external interventions, etc. Consequently, it was decided that this variable should be included and it was given the value of 1 when the value of the dependent variable (volatility or capital adequacy) is greater than its average plus three times its standard deviation (average + 3 x standard deviation), and zero when this does not occur. Thus, it is expected that the estimated parameter associated to the outlier variable will be positive in the case of the vola-

[6] As noted in item 3.2.1 – Methodological Observations – six banks out of a total of 247 were eliminated since they had negative (two) or excessively low net worth, thus generating meaningless leverage indices.

tility model and negative when dealing with the capital adequacy model.

Two general observations should be made with regard to estimating these models. In the first place, the coefficients of determination (R^2) and the F statistics obtained in the estimation of the models with the use of data observed at the level of the companies themselves are relatively low, precisely due to the outliers. This indicates the omission of variables as a result of identification difficulties. Secondly, despite possible problems of heteroscedasticity (non-constant variance of residuals), no procedure was adopted to correct them. This can be justified to the extent that a correction would, at most, increase the magnitude of the t statistics associated to each regressor and does not imply a risk of rejection of the hypothesis of the nil effect when it should be accepted. This, of course, is the principal difficulty when residuals are not constant over the entire sampling.

4. 2. 1. Results of the Estimation of the Analytical Model of Volatility

The results obtained in the estimation of the model formulated for analysis of volatility on the basis of its three indicators are shown in Table 4.1. In general, one can affirm that these results were satisfactory. However, judging by the evaluation statistics, not all the explanatory variables registered the expected sign or a level of statistical significance within the generally accepted maximum limit of 10% of probability of error.

Those variables that registered coefficients that were consistent with the theoretical expectation in all the estimated equations were diversification (D), system of organization (F), hedge index (H), size (T) and capital ownership (P). However, the hypothesis of a statistically nil effect was rejected at the level of 10% or less, only in the case of diversification for volatility indicators VO and VA, form of organization, size and capital ownership for the three indicators (VO, VA and VS). The high significance of the effect of the variables of size and capital ownership deserve emphasis. In the case of the variable of size, this result provides backing to the hypothesis that large banks obtain more stable or less volatile rates of return than their smaller counterparts. Insofar as capital ownership is concerned, the hypothesis that private banks have lesser volatility indices than state banks prevailed. Here, it was considered that the state banks have a harder time adjusting in adverse situations due to social commitments and/or political concerns. At the same time, the variables of diversification and system

of organization (multiple banks x commercial banks) as factors that inhibit volatility were seen to be relevant. They are complementary variables that express the banks' strategies of diversification as a instrument for reducing risk. Taken together with the variables of size and capital ownership, these variables are responsible for explaining the behavior of volatility, particularly when this is measured in terms of the Operating Result (VO and VA).

Despite the fact that its estimated coefficients are theoretically correct, the hedge index (H) variable did not register a statistically significant effect when it appears in the complete model (Equations 1, 4 and 7). This may be a consequence of multicolinearity problems or, in other words, this variable has a relatively high correlation with other variables (see Table A.1 of the Appendix). As a matter of fact, it was seen that the relatively high correlation (for the standards of studies of this type) between the hedge index and the variables of size (4.2%) and capital ownership (16.8%) may have made it more difficult to isolate its effect on volatility. In this sense, one notes that, when the variables of capital ownership (Equations 6 and 9) and outlier (Equations 3, 6 and 9) are excluded, the hypothesis of nil effect of the hedge index variable is rejected with the probability of error of 10%. One further observes that the contribution of this variable in explaining the behavior of the volatility indicators is maintained as the variables of system of organization and size are introduced (Equations 3, 6 and 9). This means that, independently of the size and the fact that they are multiple or commercial institutions, banks have obtained favorable results by utilizing derivative operations for hedge purposes even though operations with speculative purposes are included among them.

The leverage variable registers parameters with signs that are contrary to those expected. In terms of the significance of the negative effect, it should be noted that the hypothesis of nil effect in the case of volatility in terms of the Operating Result (VO) is rejected. In the other indicators, the nil hypothesis is accepted with a high probability of being correct. Once again, the problem is found in multicolinearity, since the correlation among the variables of leverage and size (45.9%) is very high and masks the effects of that variable. Since the variable of size was considered more relevant because it expresses various characteristics of the bank (diversification, leverage, etc.), it was decided to maintain it in all the estimated equations in detriment to others that, in given circumstances, have not been shown to be statistically independent of size.

TABLE 4. 1. BRAZILIAN BANKING SYSTEM – VOLATILITY[a] OF RETURN RATE OF ASSETS - ESTIMATED EQUATIONS FOR THE PERIOD 1993.1/97.2

Specification	*Symbol*	*Expected sign*	*VO*			*VA*			*VS*		
			1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Regressors											
Constant	-		0.6118	0.6377	0.8486	0.4736	0.4767	0.6525	0.3553	0.3538	0.4992
			(10.31)	(10.87)	(10.07)	(7.35)	(7.63)	(7.50)	(8.15)	(8.54)	(7.59)
Leverage	L	(+)	-0.0024	-	-	-0.0003	-	-	-0.0006	-	-
			(-2.08)	-	-	(-0.21)	-	-	(-0.66)	-	-
Diversification	D	(-)	-0.1919	-0.1419	-0.1604	-0.1534	-0.1441	-0.1875	-0.0382	-	-
			(-3.26)	(-2.58)	(-2.14)	(-2.38)	(-2.45)	(-2.02)	(-0.89)	-	-
Form of organization	F	(-)	-0.0295	-0.0283	-0.0867	-0.0054	-	-0.0624	-0.0227	-0.027	-0.0729
			(-1.35)	(-1.29)	(-3.10)	(-0.23)	-	(-1.77)	(-1.42)	(-1.95)	(-2.87)
Hedge index	H	(-)	-0.0035	-	-0.0055	-0.0028	-	-0.0074	-0.0002	-	-0.0047
			(-1.30)	-	(-1.38)	(-0.94)	-	(-1.50)	(-0.09)	-	(-1.31)
Size	T	(-)	-0.0234	-0.0299	-0.039	-0.0203	-0.0216	-0.03	-0.0165	-0.0185	-0.0269
			(-4.56)	(-6.98)	(-6.58)	(-3.64)	(-4.71)	(-4.09)	(-4.38)	(-6.77)	(-5.51)

Nationality	N	(-)	0.0461	0.0496	-	0.0415	0.0455	-	0.0067	-	-
			(1.96)	(2.10)	-	(1.62)	(2.05)	-	(0.39)	-	-
Capital ownership	P	(+/-)	-0.0787	-0.0813	-0.0882	-0.0528	-0.057	-	-0.0574	-0.0533	-
			(-3.36)	(-3.49)	(-2.67)	(-2.07)	(-2.28)	-	(-3.35)	(-3.32)	-
Outlier[b]	O	(+)	0.8160	0.8123	-	1.0317	1.0351	-	0.7398	0.7392	-
			(17.25)	(17.11)	-	(21.63)	(21.92)	-	(24.31)	(24.76)	-
Appraisal statistics		-									
R^2 corrected	-	-	0.6713	0.6663	0.2520	0.7131	0.7156	0.1343	0.7613	0.7643	0.1416
DW statistics	-	-	1.5910	1.5871	1.7688	1.7182	1.7206	1.4890	1.8765	1.8798	1.6932
F statistics	-	-	62.2706	80.8670	17.5774	75.5520	121.7622	10.5371	96.6838	195.5341	14.5285
Nº of observations	-	-	241	241	247	241	241	247	241	241	247

[a] Volatility was measured by the standard deviation of the return rate of assets. VO refers to the volatility when the return rate of the the profitable assets in terms of operating result is used. Va is used if the operating result has been adjusted to the oportunity costs of the equity capital. RS refers to volatility when the return rate is measured in the half-year result (see Section 3.2.1 for details). [b] Those values of the dependent variable higher than its average plus 3 times the standard deviation were considered outlier.

The variable of the bank's nationality (N) registered estimated coefficients that were not consistent with the theoretical formulation or, in other words, the results indicated that the foreign banks had more volatile rates of return than similar national institutions. Aside from this, this inconsistent effect was statistically significant within the probability limit of the generally accepted maximum error limit of 10% in the case of equations that utilize volatility in terms of the Operating Result (VO and VA). Two reasons can be given to explain the inconsistency of this result. In the first place, the category of banks classified as foreign in this study includes those originating in Latin American countries that simply do not have the instruments of a financial nature or otherwise needed to control the volatility of their rates of return, at the same time in which their home offices are located in institutionally and economically unstable environments. In the second place, the classification of foreign banks also includes several that were recently involved in mergers. When we exclude the six foreign banks classified as small institutions according to the definition in item 3.2.2.1 (Table 3.4), the results improve in terms of volatility in the context of the Operating Result. The estimated coefficient for the nationality variable indicated the expected direction of the variation and the hypothesis of the nil effect was rejected at the significant level of 10%. This means that the rates of return of the foreign banks are considerably more stable.

One should also note the high statistical significance of the effect of the outlier variable (O) on changes in levels of volatility. The fact is that the hypothesis of nil effect is rejected with a probability of error very close to zero. This result has two implications. In the first place, there is evidence that other characteristics that are determining factors of changes in the volatility of rates of return were not identified and could supposedly be financial and/or administrative lack of control, external interventions, recording errors or accounting manipulation, etc. Therefore, complementary studies are required to better understand this phenomenon that is only indirectly evident. The second implication refers to improvement in estimates when dealing with the divergent values of the explanatory variables. One notes that the determining coefficients and F statistics are sharply higher when the outlier variable is introduced into estimation of the model (Equations 1, 2, 4, 5, 7 and 8) when compared to those estimated without taking account of the outliers (Equations 3, 6 and 9).

Finally, one perceives that, taken together, the explanatory variables exert a statistically significant impact on the levels of

volatility. This hypothesis was accepted at the level of maximum significance of 1% in all the estimated equations.

4. 2. 2. Results of the Estimation of the Analytical Model of Capital Adequacy

The results obtained with estimation of the capital adequacy/volatility model are shown in Table 4.2. One must note that, in general, these results are also satisfactory, since the determining characteristics (R^2) and the F statistics are relatively higher for cross-section studies. Aside from this, it was shown that a major part of the explanatory variables registers parameters that are consistent with theoretical expectations and are statistically significant within the limits of 10% maximum error.

More specifically, one notes the relevance of variables like leverage (L), diversification (D), size (T) and capital ownership (P). In the case of leverage, the consistent result is not surprising in face of the, to some degree, tautological character between this variable and the definition of the capital adequacy variable (close to the inverse of the leverage definition). In any case, one should stress that an increase in the levels of leverage necessarily implies reduction in the adequacy of the institution's own capital, thus making the risk of bankruptcy more probable. In terms of diversification (Equations 1,2 and 6) and size (Equations 1, 2, 4, 5 and 6), the tested empirical relation indicates that the largest and most diversified banks have higher levels of adequacy of their own capital and, therefore, less probable bankruptcy risks.[7] In the case of the capital ownership variable, the relevant statistically direct relation suggests that the private banks hold higher capital adequacy levels than the state banks, thus indicating a more improbable risk of bankruptcy at those institutions. However, one should also note that the fact that, in the Brazilian case, bankruptcies have occurred (in the sense of economic-financial failures) more frequently among private banks does not invalidate this result, since effective bank failure (though not formal bankruptcies) are more common among government banks.

The variables organizational structure (F) and nationality (N)

[7] Campello and Moreno (1996:221-22) tested the hypothesis of capital adequacy-size for 10 national banks. However, the significance of this relationship was rejected. It should be noted that the definition of capital adequacy, the sampling and the control variables used in this study were substantially different from those adopted by the aforementioned authors.

TABLE 4. 2. BRAZILIAN BANKING SYSTEM – CAPITAL ADEQUACY[a] – ESTIMATED EQUATIONS FOR THE PERIOD 1993.1/97.2 – NUMBER OF OBSERVATIONS: 241

			ACO		*ACA*		*ACS*	
Specification	*Symbol*	*Expected sing*	*1*	*2*	*3*	*4*	*5*	*6*
Regressors								
Constant	-		-3.8683	-3.5432	-0.4647	0.5751	-8.9255	-6.7160
			(-2.66)	(-2.49)	(-0.24)	(0.30)	(-2.11)	(-1.61)
Leverage	L	(-)	-0.1039	-0.1005	-0.1004	-0.1168	-0.2993	-
			(-3.61)	(-3.51)	(-2.57)	(-3.21)	(-3.55)	-
Diversification	D	(+)	3.0301	3.1571	2.4368	-	1.5937	7.4225
			(2.05)	(2.18)	(1.22)	-	(0.37)	(1.82)
Form of organization	F	(+)	-0.1241	-	0.5210	-	0.8234	-
			(-0.23)	-	(0.70)	-	(0.52)	-
Hedge index	H	(+)	-0.0511	-	-0.0795	-	-0.5655	-0.5119
			(-0.75)	-	(-0.86)	-	(-2.84)	(-2.52)
Size	T	(+)	0.3701	0.3289	0.1570	0.2511	1.3471	0.6952
			(2.89)	(2.65)	(0.91)	(1.78)	(3.61)	(2.22)
Nationality	N	(+)	-0.7046	-	-0.4873	-	1.8506	-
			(-1.19)	-	(-0.61)	-	(1.07)	-

Capital ownership	P	(+/-)	2.7751 (4.71)	2.5547 (4.52)	2.2806 (2.86)	1.8404 (2.45)	4.0445 (2.35)	4.7843 (2.79)
Outliers[b]	O	(+)	16.6808 (11.63)	16.5867 (11.70)	37.3847 (16.97)	37.2352 (16.92)	41.7527 (11.24)	41.6417 (11.00)
Appraisal statistics	-	-						
R^2 corrected	-	-	0.4457	0.448	0.5579	0.557	0.4051	0.3768
DW statistics	-	-	1.8588	1.8649	2.1024	2.1036	1.9898	1.9425
F statistics	-	-	25.1267	39.9490	38.8576	76.4284	21.4299	30.0192

[a] Capital adequacy refers to the ratio net worth/liabilities divided by volatility. The latter. in its turn. is equivalent to the standard deviation of the return rates of the profitable assets. ACO refers to capital adequacy when the return rate in terms of operating result is used. ACA is used if the return rate is defined by the adjusted operating result. and ACS is used in the case when the half-year result is utilized (see Section 3.2.1 for details). [b] Those values of the dependent variable higher than its average plus 3 times the standard deviation were considered outlier.

did not generate statistically significant effects in any of the estimated equation. This suggests the absence of significant differences in capital adequacy levels among multiple and commercial banks and among national and foreign banks. When one utilizes capital adequacy in terms of the volatility of the Half-Year Result and the six foreign institutions considered small are excluded (item 3.2.2.1), there are indications that the foreign banks have a lesser probability of bankruptcy than similar national institutions. In the case of the hedge index variable, statistically significant differences were registered only in the equations in which volatility is measured in terms of the Half-Year Result (which includes the non-operating result but excludes taxes and legal participation in profit).

However, the estimated coefficient is not consistent with the theoretical formulation, indicating that the banks with higher hedge indices have lower levels of adequacy for their own capital and, consequently, higher probability of bankruptcy. However, this is an isolated result and cannot be classified as systematic.

Finally, one notes the high statistical significance of the parameters associated to the outlier variable (O), suggesting that specific events connected to some banks benefit them in terms of the adequacy of their own capital (more effective financial and administrative controls, high profits, lower volatility of their rates of return, etc.), and this, in turn, implies a lower probability of bankruptcy.

Also in relation to capital adequacy, it is important to examine the behavior of this variable after implementation of the Real Plan (June 1994) in light of the problems faced by banks as a result of the sharp drop in inflation. As already stated, it was with this in mind that period 1993.1/97.2 was divided into three stages: a) high inflation period (1993.1/94.1), b) period immediately following adoption of the Real Plan (1994.2/95/2) and c) low inflation period (1996.1/97.2). Following that, the data for the three stages were brought together for purposes of comparison.

In this way, a dummy variable (R) was incorporated into the basic model (4.1) with value 1 in the period immediately subsequent to adoption of the Real Plan and 0 in the other subperiods. The results obtained are presented in Table 4.3. It should be noted that, with the exception of the hedge index (H) and nationality (N) which registered parameters with signs that were opposite those expected, the other variables generally confirm the effects observed in Table 4.2, which shows the estimated equations of capital adequacy for the average data of the general

period (1993.1/97.2). With regard to the dummy variable (R), it was seen that, when it is measured in terms of Operating Result (ACO) and Net Result of the Half-Year period (ACS), capital adequacy declined in the period immediately following adoption of the Real Plan (1994.2/95.2). This reflects a higher probability of bankruptcy in that period when compared to the situation prior to June/94 and after 1996, when the banks began to adjust to the nation's new economic reality, though this was done with government assistance.

TABLE 4. 3. BRAZILIAN BANKING SYSTEM – CAPITAL ADEQUACY[a] – ESTIMATED EQUATIONS FOR THE COMBINATION OF PERIODS 1993.1/94.1, 1994.2/95.2 AND 1996.1/97.2 – RESULTING NUMBER OF OBSERVATIONS: 626

Specification	Symbol	Expected sign	ACO	ACA	ACS
			1	2	3
Regressors					
Constant	-		-4.4288 (-1.52)	-1.1523 (-0.41)	-10.1034 (-1.20)
Leverage	L	(-)	-0.3194 (-4.44)	-0.2712 (-3.98)	-0.8519 (-3.53)
Diversification	D	(+)	5.0179 (1.77)	4.0698 (1.50)	- -
Form of organization	F	(+)	- -	2.1135 (1.95)	- -
Hedge index	H	(+)	-0.4286 (-2.96)	-0.3476 (-2.53)	-1.4937 (-3.04)
Size	T	(+)	0.9671 (3.75)	0.4840 (1.97)	3.4284 (4.54)
Nationality	N	(+)	1.7416 (1.62)	1.8126 (1.58)	- -
Capital ownership	P	(+/-)	3.1811 (2.70)	3.1393 (2.78)	- -
Real Plan	R	(-)	-1.7402 (-2.18)	0.2948 (0.39)	-5.1897 (-1.87)
Outliers[b]	O	(+)	62.3501 (22.84)	52.1057 (21.69)	351.3340 (32.23)
Appraisal statistics					
R^2 corrected	-	-	0.4904	0.4534	0.6399
DW statistics	-	-	1.9304	1.8620	1.8108
F statistics	-	-	76.1756	58.6132	223.1383

[a] See the definition for capital adequacy in Table 4.2 [b] See the definition for outlier in Table 4.2.

5. CONCLUSIONS

The major objective of this study is to identify the characteristics associated to Brazilian banks that condition the volatility of their rates of return on assets, as well as capital adequacy/volatility. With this in mind, a sampling of 241 banks was utilized, which includes practically all of the 249 banks that existed in the 1993/97 period.[8] Volatility was measured by the standard deviation of the rates of return over time and, in their turn, these were defined in three ways: a) operating result on total adjusted assets; b) adjusted operating result on total adjusted assets, and c) half-year result on total adjusted assets. The adjustment in the rate of return in terms of the operating result had the objective of making the opportunity costs of the banks' own capital explicit, which is a definition much closer to the economic concept of profitability. Capital adequacy was defined by the relation (Net Worth/Total Adjusted Assets)/volatility, involving the three indicators that are functions of the three definitions of volatility. Each variable utilized referred to the 1993/97 period or specific subperiods, based on the average values in each half-year period. The original data were drawn from the financial statements and half-year balance sheets of the banking institutions.

With regard to the volatility of rates of return, the analysis for the 1993/97 period made it possible to infer the following results that, in general, are consistent with theoretical expectations:

a) the diversification of activities contributed to reducing the volatility of rates of return when these were measured in terms of the Operating Result or Operating Result Adjusted to the opportunity costs of the institution's own capital;

b) the multiple banks registered more stable rates of return than their commercial counterparts (single portfolio), no matter what the indicator used and this strengthens the empirical foundation of the hypothesis that diversification is a relevant strategy for reducing risk;

c) there is evidence that the derivative operations of banks have provided a hedge and, in this way, contributed to reducing risk measured in terms of the volatility of rates of return;

[8] As a matter of fact, not all of these banks existed during the entire period. However, an effort was made to use the available data even though it did not cover all of the half-year periods considered. The maximum number of banks (249) was reached on 06.30.94.

d) there is strong evidence that the volatility of rates of return declines with growth in the size of the bank;

e) it was seen that private banks attained rates of return with higher volatility than their state counterparts;

f) in general, volatility indices were higher in the period following adoption of the Real Plan but this increase occurred basically in the period immediately following the plan (1994.2/95.2) due to the turbulence through which banks passed in the climate of uncertainty that gripped them in the wake of the rapid decline in the situation of chronic inflation that had made it possible for them to register substantial gains in the past.

Contrary to theoretical expectations, it was also noted that:

a) there is no evidence that the degree of a bank's leverage directly conditions the volatility of its rates of return on assets;

b) foreign banks registered more volatile rates of return than national banks when the small banks from Latin American countries or banks that had recently gone through transformations involving mergers are included. When one analyzes only medium and large institutions, rates of return measured in terms of the Operating Result of the foreign banks were more stable than in the case of the national banks.

The reason for the absence of a significant relation between leverage and volatility of rates of return is more empirical than theoretical. The high correlation between leverage and size (coefficient of 0.458) may have contributed to this result.

With regard to the results obtained on the behavior of capital adequacy, the following conclusions can be drawn:

a) the increase in leverage implies reductions in the adequacy of the institution's own capital for purposes of absorbing possible losses (risk) generated by adverse changes in market variables. As expected, this leads to growth in the possibility of failure on the part of banks (bankruptcy or financial difficulties);

b) diversification of activities, in the case of volatility in terms of the Operating Result and Half-Year Result (which includes the non-operating result), produced increased adequacy of the bank's own capital and aided in inhibiting growth in the possibilities of financial failure;

c) it was seen that capital adequacy increases with the size of the

bank, indicating – as expected – a less probable situation in terms of the difficulties that can lead to bankruptcy or failure;

d) the private banks registered higher capital adequacy levels than state banks, with less probability in terms of the difficulties that can lead to bankruptcy or failure;

e) the risk of bankruptcy on the part of banking institutions as a result of reduced levels of capital adequacy was more intense in the period of low inflation immediately subsequent to the Real Plan (1994.2/95.2).

By way of contrast, one perceives that:

a) there are no significant capital adequacy differences between multiple and commercial banks and this is no surprise given the relevant impact of diversification of activities on the process of inhibiting the possibility of bank failure and the institutions with the highest levels of diversification are precisely those that have multiple portfolios;

b) in the case of the hedge in the form of derivative operations and the possibility of bank failure, the relation is the opposite of that expected, notwithstanding the fact that it was significant when the adequacy of the institution's own capital was weighted by the volatility of the rates of return in terms of the Half-Year Result (which incorporates the non-operating result);

c) significant differences in the indicators of capital adequacy between national and foreign banks were not registered, except when the Half-Year Result was used in the definition of that variable.

One should stress that the analysis made it possible to demonstrate that the risk indicators, such as volatility of rates of return and capital adequacy, make it possible to perform a careful evaluation of the performance of the Brazilian banking system in terms of solidity, at a level of each bank and by segment, with due consideration to the historical aspects of the different financial institutions. These considerations are important since the positive and negative events that influence the trajectory of a company have strong intertemporal characteristics.

Finally, one notes that the variables used in this study – just as in the case of the proverbial iceberg – indicate only a small part of the story or, in other words, that share of risk to which banks were exposed during the specific period considered. This was

evident in the conclusion that many values in the risk indicators (volatility and capital adequacy) deviated considerably from the general standard. In this sense, despite obtaining satisfactory results in terms of theoretical consistency and the statistical significance of the estimated coefficients, some risk factors could not be fully identified due either to difficulties in measuring them or simply the fact that their nature could not be adequately identified.

Annex

TABLE A. 1. DESCRIPTIVE STATISTICS OF THE VARIABLES USED IN THE APPRAISAL OF VOLATILITY MODELS-NUMBER OF OBSERVATIONS USED: 241[a]

Symbol[b]	*Average*	*Standard deviation*	*Minimum*	*Maximum*	*Explanatory principal variables*						
					AL	*DV*	*FO*	*IH*	*LT*	*NC*	*OC*
Dependent variables											
VO	0.120	0.194	0.002	1.803	-0.177	-0.317	-0.225	-0.110	-0.437	0.054	-0.028
VA	0.114	0.226	0.002	2.106	-0.105	-0.282	-0.155	-0.090	-0.333	0.026	-0.004
VS	0.081	0.167	0.001	0.959	-0.064	-0.227	-0.200	-0.091	-0.342	0.031	-0.048
ACO	3.939	3.744	0.061	25.585	-0.119	0.193	-0.017	-0.011	0.157	0.074	0.199
ACA	4.685	5.684	0.039	70.828	-0.121	0.048	0.026	-0.038	-0.013	0.021	0.135
ACS	10.572	10.566	0.061	58.838	-0.121	0.137	0.017	-0.145	0.129	0.064	0.098
Explanatory principal variables											
AL	9.059	7.560	1.007	45.948	1.000	-0.050	-0.006	-0.017	0.458	0.032	-0.108
DV	0.580	0.155	0.000	0.818	-	1.000	0.161	-0.103	0.484	0.032	-0.281
FO	0.822	0.384	0.000	1.000	-	-	1.000	0.004	0.088	-0.463	-0.050
IH	1.236	2.724	0.000	26.057	-	-	-	1.000	0.042	-	0.168
LT	12.348	1.999	7.565	18.048	-	-	-	-	1.000	0.135	-0.244
NC	0.154	0.361	0.000	1.000	-	-	-	-	-	1.000	0.164
OC	0.871	0.336	0.000	1.000	-	-	-	-	-	-	1.000

SOURCE: BACEN (Gross Data).

[a] Six banks were rejected for showing either a negative net worth (2) or leverage (AL) higher than 50 (4). [a] Conventions: ACA = Capital adequacy in terms of adjusted operating result/assets (RA). ACO = Capital adequacy in terms of operating result/assets (RO). ACS = Capital adequacy in terms of half-year result/assets (RS). AL = Lererage. DV = Diversification. FO = Form of organization. IH = Hedge index. LT = Size. NC = Nationality. OC = Capital ownership. VA = Volatility in terms of adjusted operating result/assets (RA). VO = Volatility in terms of operating result/assets (RO). RS = Volatility in terms of half-year result/asstes (RS).

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Business cycles in emerging market economies

1. INTRODUCTION

This paper compares the sources of economic fluctuations across different groups of emerging market economies, investigating in particular on the role of external factors. The groups we focus on are (1) the ASEAN countries, consisting of Indonesia, Malaysia, the Philippines, and Thailand, (2) the newly industrialized Asian economies (NIEs), in which we include Hong Kong, Korea, Singapore, and Taiwan, and (3) selected Latin American countries, namely Argentina, Brazil, and Chile.[1] More specifically, our goal

[1] We did not include Mexico in our Latin American sample as we are considering, among other things, the effects of the relative price of oil in a panel setting and did not want the average results to be driven by the behavior of a *major oil exporter*.

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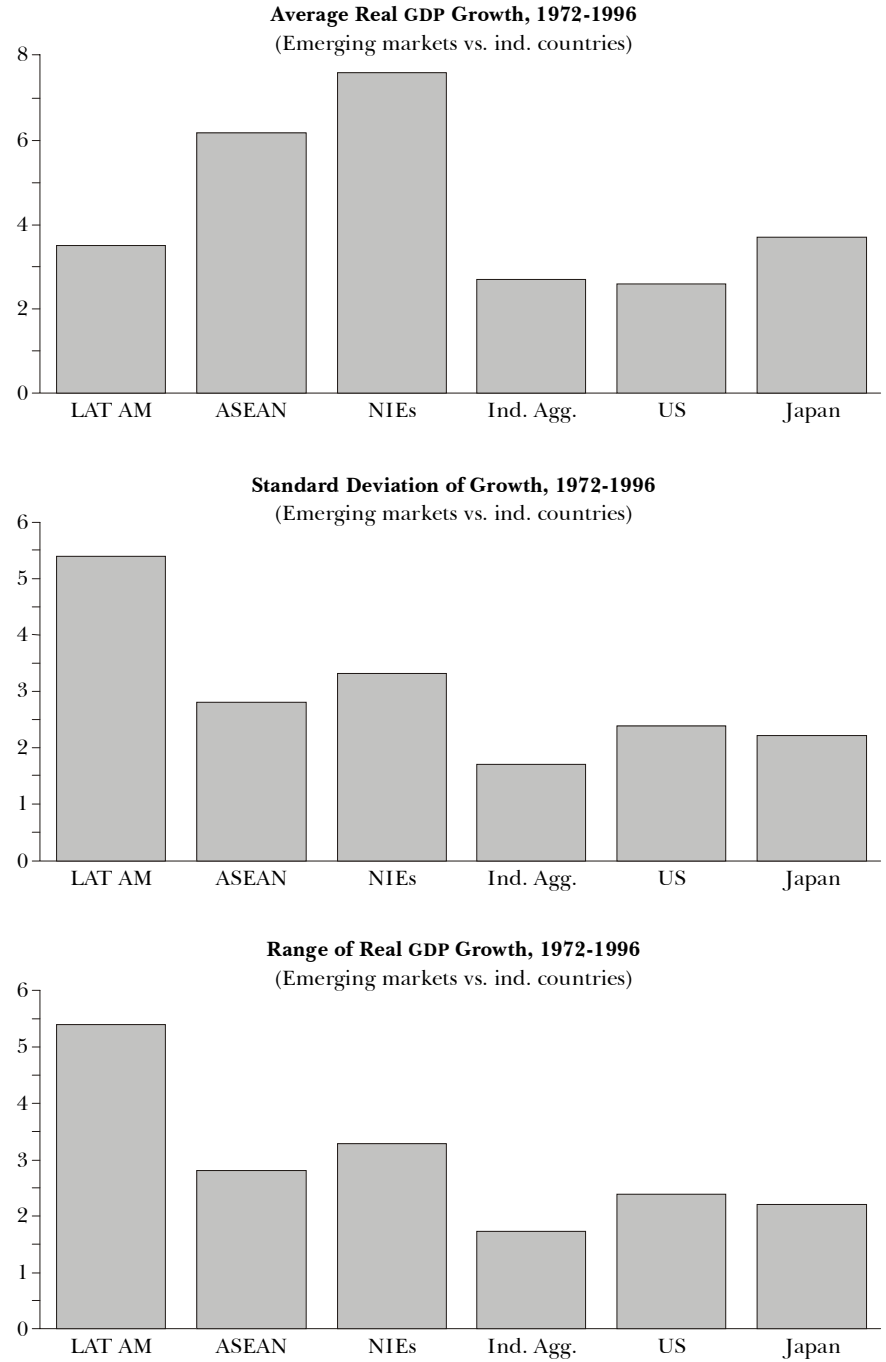
FIGURE 1


Average Real GDP Growth, 1972-1996
(Emerging markets vs. ind. countries)
8
6
4
2
0
LAT AM
ASEAN
NIEs
Ind. Agg.
US
Japan
Standard Deviation of Growth, 1972-1996
(Emerging markets vs. ind. countries)
6
5
4
3
2
1
0
LAT AM
ASEAN
NIEs
Ind. Agg.
US
Japan
Range of Real GDP Growth, 1972-1996
(Emerging markets vs. ind. countries)
6
5
4
3
2
1
0
LAT AM
ASEAN
NIEs
Ind. Agg.
US
Japan

is to determine the extent to which short-term fluctuations in output, inflation, and real exchange rates in these economies are driven by "external factors." The "external factors" we consider are changes in foreign output, the relative price of oil, and the terms of trade.

Since the early 1970s, the Latin American and Asian economies have had very varied experiences, as illustrated in figure 1. The top panel of the figure shows that, compared with the United States, Japan, and an industrial country average, the ASEAN and NIEs countries have experienced much higher average real GDP growth rate over the 1972-1996 period. By contrast, in the Latin American countries we focus on, the mean growth rate has been only very marginally higher than the industrial countries. At the same time, as is evident from the second and third panels, developing countries, particularly those in Latin America, have also been characterized by a higher range and a greater variability of growth than the industrialized countries. Our paper seeks to explain how much of the considerable variability in growth rates over time that exists in these economies can be explained by factors external to these countries; also we investigate whether the differences across groups within emerging market economies can be explained by their varied reaction to these external factors. For the purposes of this study, we view business cycles as all short-term fluctuations in economic variables, without attempting to distinguish between fluctuations due to changes in the trend component and fluctuations due to changes in the cyclical component.

The importance of emerging market countries in the world economy has increased dramatically in recent years. Moreover, these countries are being increasingly scrutinized for possible clues about the causes of their extreme experiences that seem to occur from time to time, such as the 1994-95 Mexican crisis and the 1997-98 Asian crisis. Yet, there is relatively little empirical work on what drives even normal business cycles in these countries, which motivates our paper. More specifically, the results of our paper should be relevant for answers to such questions as: How much contraction in economic activity and pass-through to inflation is induced in these economies as a result of a rise in the world price of oil? If these emerging market economies experience a shift in the world price of one of their key exports, what effect does this have on their growth and international competitiveness? If the U.S. monetary authority, say, takes measures to cool down the economy to combat potential inflation, how much

would economic activity in these developing countries get depressed? Our paper is an attempt to provide a *quantitative assesment,* which could potentially be used as a starting point for evaluating the *magnitudes* of the effects of key global factors on these economies.

The relative contribution of external factors in explaining business fluctuations in these economies also has implications for the relative merits of alternative models of open economies as well as the design and selection of appropriate macroeconomic policies in these countries. The policy implications would certainly differ depending on whether business fluctuations in these countries are driven primarily by domestic shocks or primarily by external shocks.

The empirical methodology we employ is to estimate a structural dynamic model--specifically, a vector error-correction model (VECM)--using panel data and then obtain impulse responses and variance decompositions from the estimates. A contemporaneous causal ordering of the externally determined variables, together with the assumption of the pre-determinedness of these with respect to the domestic variables (the small open economy assumption) identify the individual shocks originating in the rest of the world. The long run behavior embedded in our VECM is motivated by economic theory considerations.

The balance of the paper is organized as follows. After doing a somewhat selective literature review in section 2, we lay out the structural dynamic model that we estimate in section 3. Section 4 describes the data and presents and interprets the empirical results, and section 5 concludes.

2. SELECTIVE LITERATURE REVIEW

Some other papers have also empirically studied cyclical fluctuations in developing countries. We highlight three studies here that are particularly relevant for our work and only briefly mention some of the others. Perhaps the most relevant paper for our study is Hoffmaister and Roldos (1997). Like our paper, it uses panel data to consider the effects of various shocks on output growth, inflation, and real exchange rates in developing countries. It is comprehensive in its coverage of countries, comparing business cycles in Asia with business cycles in Latin America, and also quite comprehensive in its coverage of shocks, including world real interest rate, terms of trade, domestic fiscal, and do-

mestic supply shocks. Using long-run identification restrictions, the authors conclude that by far the main source of output fluctuations in these countries are *domestic country-specific aggregate supply* shocks, although for Latin America the real interest rate and terms of trade shocks are also somewhat important. This conclusion depends crucially on the strong assumptions that underlie the long-run identification restrictions in their theoretical model. In particular they do *not* have a foreign output shock in their model, thereby not allowing for a global productivity disturbance that can affect domestic output. This means that they do not fully distinguish external from domestic shocks and their domestic supply shock, which they find to be by far the most important shock driving fluctuations, could be representing factors that are changing world outputs in general.

We allow for such factors, which is a crucial difference. Other differences are that we use an error-correction framework, thus admitting cointegration, and use the long-run model to derive the nature of the cointegration only and not for identification of the shocks. On the other hand, their paper provides a more comprehensive breakdown of domestic shocks.

Another recent study that distinguishes between external and domestic shocks for developing countries is Edwards and Vegh (1997). They demonstrate how, in a small open economy setting, the effects of both these kinds of shocks get magnified through the bank credit channel, and support their theoretical results with empirical evidence. The only external disturbance that is relevant for making their point, though, is a world real interest rate shock, and their analysis is also limited to two Latin American countries, Chile and Mexico.

The importance of analyzing terms of trade changes is underscored in Mendoza (1995). Using simulation results from a calibrated model, he argues that about half of real GDP changes can be accounted for by terms of trade shocks. Therefore, it would be interesting to see if this result holds up in an *estimated* model, such as ours, where terms of trade shocks are econometrically identified from an empirical model.

In other work --such as Agenor, McDermott, and Prasad (1999) and Larsen and Aziz (1997)-- researchers have compared stylized facts of business cycles in emerging markets with those in industrial countries, with the latter paper focusing on the ASEAN economies. Montiel (1997) and Reinhart (1995) examine the effects of external factors such as world inflation and the relative price of exports and imports on developing countries, but the

former paper limits the analysis to focus on real exchange rate effects and the latter to trade flows. Another strand of literature -- surveyed in Edwards (1993)-- highlights the role of openness and trade liberalization in determining output growth.[2] Fackler and Rogers (1995) analyze the role of fiscal, real, monetary, exchange rate, and asset disturbances on output and inflation in two Latin American economies, namely Bolivia and Brazil, but they do not explicitly consider the role played by external shocks relative to domestic shocks in driving business cycles.

The main respect in which our work is distinguished from much of the above literature is that we are attempting to carefully identify the effects of external shocks in a manner in which they do not become confounded with the effects of domestic shocks, in a model which allows for a rich enough classification of external shocks.[3]

3. EMPIRICAL MODEL

The dynamic model we consider consists of two types of variables: those that are given by the rest of the world conditions -- labelled "external variables"-- and those that are influenced by internal factors *in addition to* external conditions-- labelled "domestic variables". The external variables are: foreign output, the relative price of oil, and the terms of trade. Our “foreign” output is an *export-weighted* aggregate of real GDP of trading partners. Given this, it is important to distinguish between between oil and non-oil terms of trade, as rise in the world price of oil will entail a deterioration of the terms of trade of both the domestic and “foreign” countries, whereas an improvement of the *non-oil* terms of trade of the domestic country is, necessarily, simultaneously a terms-of-trade deterioration of the foreign country aggregate.

The external variables behave according to:

[2] An interesting extension of the literature discussed in Edward's paper that would be related to our approach would be to consider whether the relative role played by external factors has changed over time with changes in the degree of openness and liberalization. In this paper, we do not attempt to answer this question.

[3] Ahmed and Park (1994) analyze similar issues for seven OECD small open economies; this paper borrows somewhat from the empirical methodology employed in that paper.

$$(1) \qquad (I - B)\Delta X_t = A(L)\Delta X_{t-1} + \beta_1 \alpha_1' X_{t-1} + \varepsilon_t$$

where:

$$(2) \qquad X_t = \begin{pmatrix} rpo_t \\ fy_t \\ tot_t \end{pmatrix}, \quad I\text{-}B = \begin{pmatrix} 1 & 0 & 0 \\ b_{21} & 1 & 0 \\ b_{31} & b_{32} & 1 \end{pmatrix}, \quad \varepsilon_t = \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{pmatrix}$$

and *rpo, fy, tot* represent the relative price of oil, foreign output, and the terms of trade (all in logs), respectively, A(L) is a matrix of lag polynomials, β_1 and α_1 are matrices of fixed parameters, ε is a vector of i.i.d. structural errors (the external shocks), and I is the identity matrix. $\alpha_1'X$ represents the long-term (cointegration) relationships among the externally determined variables; empirically, we did not find any evidence of cointegration among the three external variables we consider, and the results reported here are with $\beta_1 = 0$ imposed. The lower triangularity of *I-B* reflects a contemporaneous causal ordering running from the price of oil to foreign output to the terms of trade. This causal ordering allows us to achieve identification of the fundamental disturbances to the external variables, using the familiar Choleski (recursive) decomposition. Note that unit roots are allowed in *rpo, fy,* and *tot*, which is not inconsistent with the data.

The domestic variables behave according to:

$$(3) \qquad (I - C)\Delta Z_t = B_1(L)\Delta Z_{t-1} + B_2(L)\Delta X_t + \beta_2 \alpha_2' W_{t-1} + \eta_t$$

where:

$$(4) \qquad Z_t = \begin{pmatrix} y_t \\ rer_t \\ \Pi_t \end{pmatrix}, \quad W_t = \begin{pmatrix} X_t \\ Z_t \end{pmatrix}, \quad I - C = \begin{pmatrix} 1 & c_{12} & c_{13} \\ c_{21} & 1 & c_{23} \\ c_{31} & c_{32} & 1 \end{pmatrix}, \quad \eta_t = \begin{pmatrix} \eta_{1t} \\ \eta_{2t} \\ \eta_{3t} \end{pmatrix}$$

and *y, rer,* π represent domestic output, the real exchange rate (both in logs), and inflation, respectively. $B_1(L)$ and $B_2(L)$ are lag-polynomial matrices, β_2 and α_2 are matrices of fixed parameters, and η is a vector of i.i.d. structural errors representing the domestic disturbances.

Several features of equation (3) are noteworthy: First, the contemporaneous values of X are allowed to enter the right hand side of (3), which contrasts with the fact that contemporaneous values of Z are not allowed to enter the right hand side of (1). This just reflects the causal priority of the external variables, im-

plied by the small open economy setting.[4] The pre-determinedness of the external variables also implies that the fundamental domestic disturbances, η, are independent of the fundamental external disturbances, ε.

Second, except for the unity terms on the diagnol which are normalizations, the *I-C* matrix is unrestricted. Thus, there is no particular contemporaneous causal ordering of the domestic variables so that the domestic fundamental disturbances are not individually identified.

Third, $\alpha_2'W$ represents the long-term (cointegrating) relationships that might exist between the variables. Economic theory suggests the presence of cointegration. In particular, the long-run behavior of the real exchange rate can be expected to be influenced by domestic and foreign output, in line with the Balassa-Samuelson effect which links the long-run real exchange rate to productivity differentials between countries. Additionally, in theoretical models with more than a singly traded good, the terms of trade and the relative price of oil is also directly affect the real exchange rate.[5] With this in mind, we include the once-lagged levels of the real exchange rate, domestic output, foreign output, the terms of trade and the relative price of oil as error-correction terms in (3); these are en-

[4] Actually, the small open economy assumption is the reason for *lags* of Z also not appearing in (1), as opposed to *just* contemporaneous *Z*. However, since the zero restrictions on the lagged *Z*'s in (1) are testable restrictions that are not needed for identification (i.e. over-identification restrictions), we did not impose them in the empirical work.

[5] The point that oil prices should be included in real exchange rate equations has recently been made by Chinn (1997). There are several studies that analyze the long-term relationship between terms of trade and real exchange rates, both theoretically and empirically, e.g. De Gregorio and Wolf (1994) and Montiel (1997). Montiel finds that terms of trade movements are empirically relevant for explaining long-term movements of the real exchange rate for some ASEAN economies at least. There are also many studies that consider the empirical validity of the Balassa-Samuelson effect. For example, Ito, Isard, and Symansky (1997) argue in favor of the Balassa-Samuelson effect in some of the APEC countries, but their analysis considers the relationship between real exchange rates and *domestic* productivity only. Among studies for the industrial countries, Canzoneri, Cumby, and Diba (1996) investigate separately the two component hypotheses that together give the Balassa-Samuelson effect, namely relative price of non-traded goods being related to productivity in each country and PPP for traded goods prices holding. Their results are sensitive to the choice of the numeraire currency.

tered in an unrestricted manner, rather than entering a particular cointegrating vector, so that α_1 is not separately estimated. Finally, since we have domestic output responding to the output movements of the foreign country aggregate, we allow for the possibility of global ("world") output shocks that can affect outputs in all countries simultaneously, unlike Hoffmaister and Roldos.

In the empirical work, we first estimate dynamic model given by equations (1) and (3) above, but including lagged values of Z on the right hand side of (1) as indicated in footnote 4; then we retrieve the impulse responses to the individual external shocks. Variance decompositions for the contribution of the individual external shocks and the domestic shocks as a group are also provided.

4. RESULTS

Data

The data consist of annual observations from 1973-1996, although the starting date varies across countries depending on data availability. Domestic output is real GDP, the price of exports (imports) is an export (import) price index, the price level is the GDP deflator for the Asian countries and the consumer price index for the Latin American countries. The real exchange rate is a trade-weighted index expressed in units of the foreign good per unit of the domestic good, so that a rise represents an appreciation. Domestic indices for export and import prices were not readily available for the Latin American countries. For these countries, we computed our own export and import price indices by taking a weighted average of export-weighted and import-weighted price levels of major trading partners converted to domestic currency units.

The relative price of oil is obtained by taking the price of oil in domestic currency units and dividing by the export price index. The terms of trade is the ratio of the export price index to the import price index. Foreign output is an export-weighted aggregate of real GDP of eight major trading partners.

Estimates of the dynamic model

Initial experimenting indicated that the dynamic interactions between our macroeconomic variables are likely different in the

ASEAN countries, Latin America, and the NIEs. Therefore, we have estimated different panel models for each of these three groups of countries.

The impulse responses of growth rates and levels of external and domestic variables to shocks to the relative price of oil, foreign output, and terms of trade are plotted in figures 2A-2C for the ASEAN economies, figures 3A-3C for the NIEs, and figures 4A-4C for the Latin American (LAT AM) economies, along with their two standard error bands. (Standard errors were computed using Monte Carlo simulations with 1000 replications.) Figure 2A illustrates that a 15 percentage point increase in the rate of change of the relative price of oil (which is roughly a one-standard deviation shock) shaves off, on impact, about a third of a percentage point from domestic growth in the ASEAN countries and about a fifth of a percentage point from foreign growth. One year later, the effect peaks, taking close to two-thirds of a percentage point off both domestic and foreign growth. As depicted in figure 3A, the negative impact on domestic growth of the oil price increase are greater in the NIEs, taking half a percentage point off growth on impact and two-thirds of a percentage point one year later. For the Latin countries (figure 4A), there is a negative peak effect on domestic output growth about a year later of about half a percentage point but it is not statistically significant. Note that Argentina is an oil exporter and may be accounting for a lower negative effect of oil on the LAT AM group of countries, compared with the others. Overall, oil price increases do appear to have a reasonably large and statistically significant cumulative negative impact on outputs in the emerging market countries we study here. The impact effect of an oil shock on the rate of change of the real exchange rate and inflation are positive and significant, for the ASEAN and NIEs group, indicating that, initially at least, rising oil prices cause inflation and hurt the international competitiveness of these countries. By contrast the effects on the real exchange rate and inflation in Latin America are insignificant.

The variance decompositions in tables 1A, 2A, and 3A indicate that oil shocks account for less than 10 percent of the variation in domestic output growth at the 0-2 year horizon in the ASEAN countries, just under 15 percent in the NIEs, and 5 percent or lower in the LAT AM countries.

Next, consider the effect of a one-standard deviation shock to foreign output, which roughly translates into a 1 percentage point increase in the growth rate. Figure 2B and 3B show that, in response to this shock, domestic output growth moves in line with

FIGURE 2A. ASEAN MODEL: RESPONSE TO SHOCK TO OIL

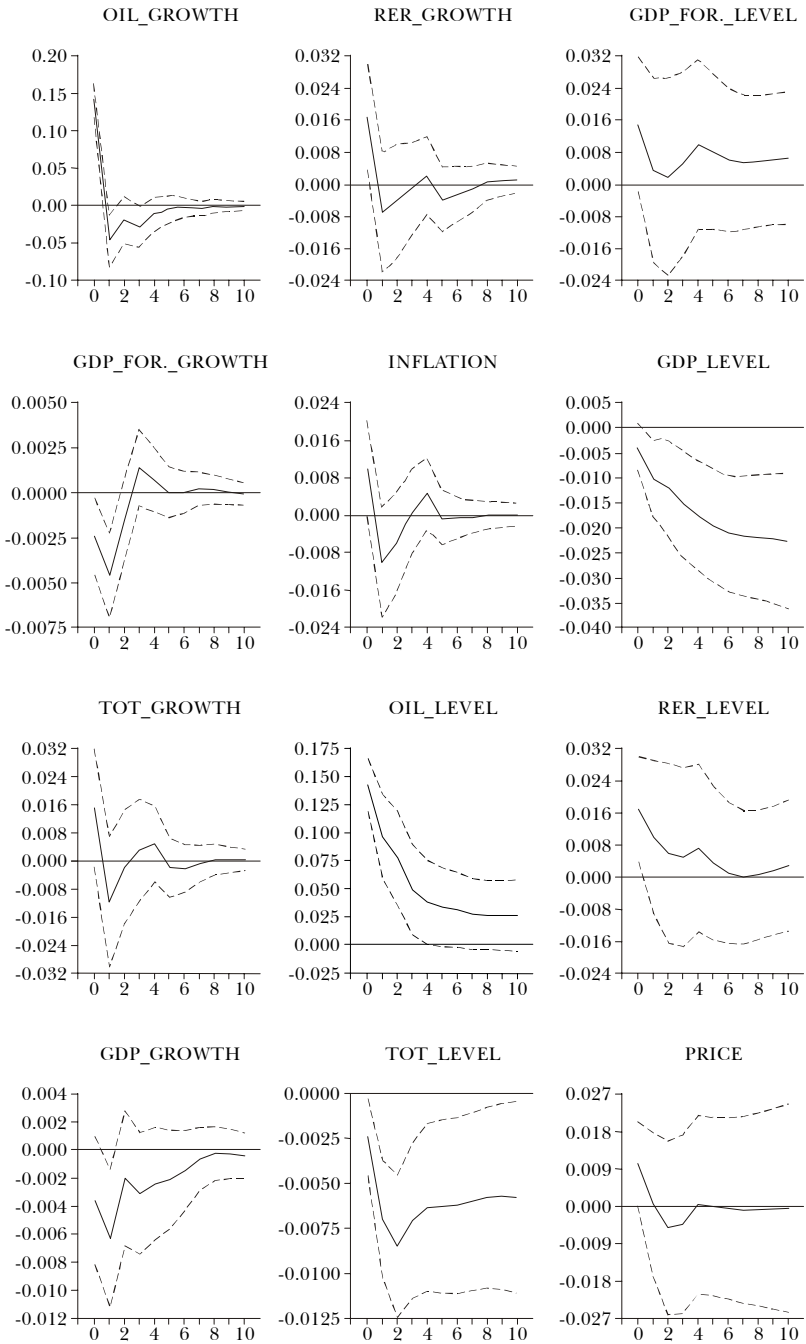


FIGURE 2B. ASEAN MODEL: RESPONSE TO SHOCK TO GDP FOREIGN

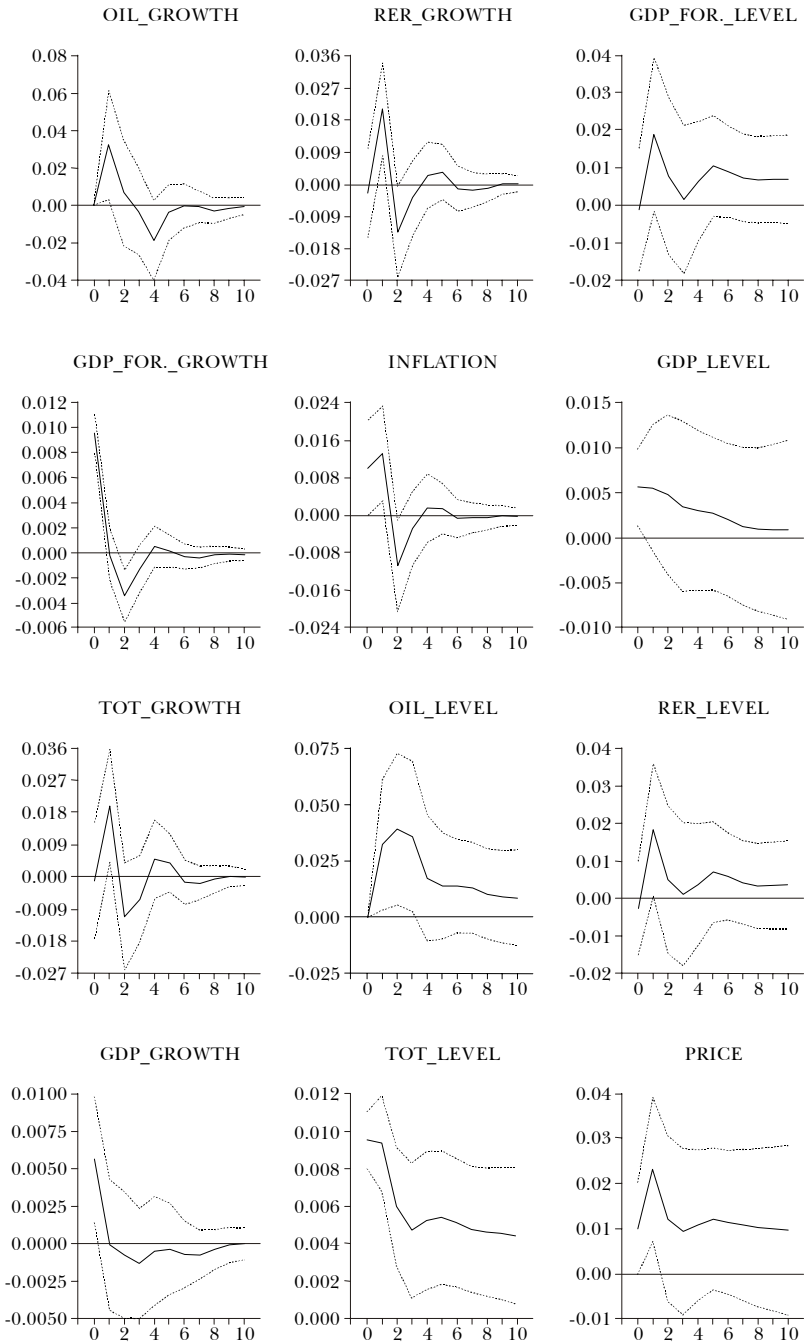


FIGURE 2C. ASEAN MODEL: RESPONSE TO SHOCK TO TOT

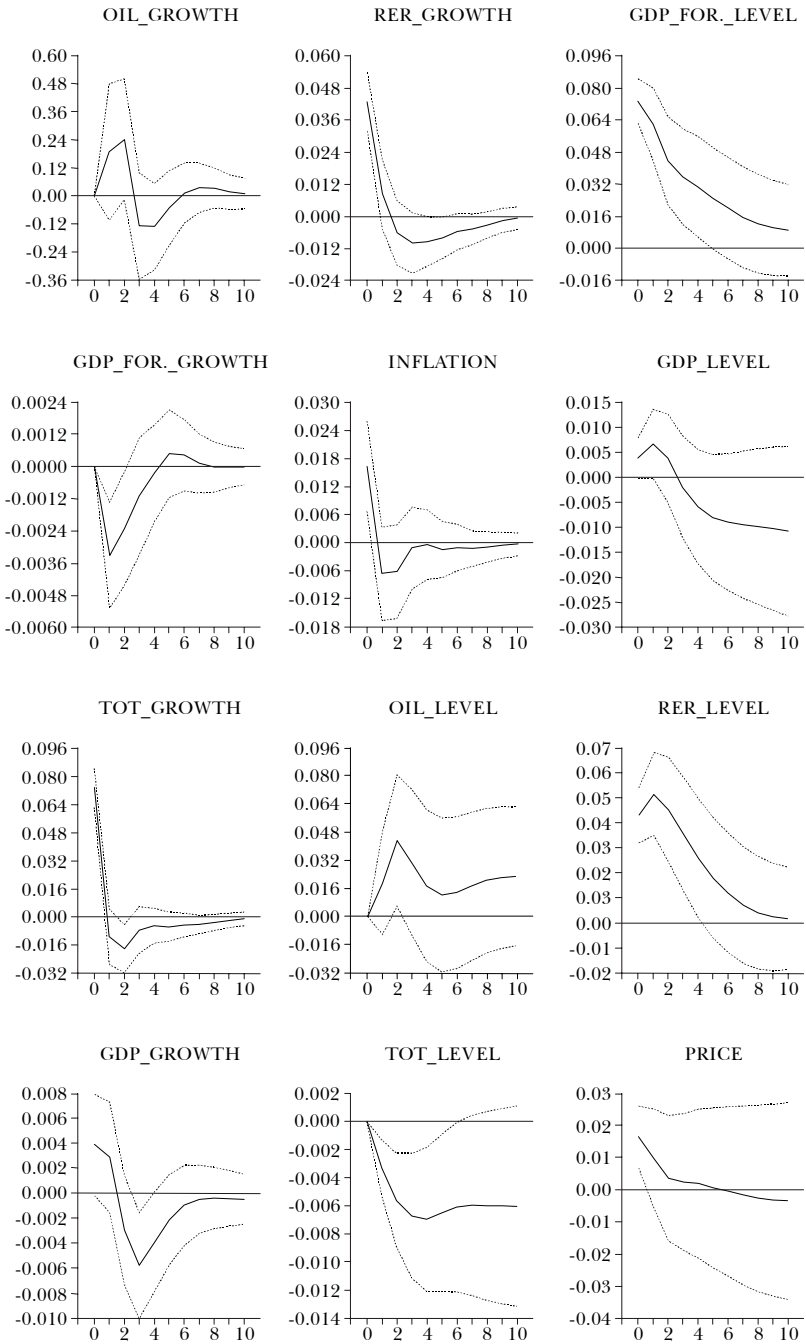


FIGURE 3A. NIES MODEL: RESPONSE TO SHOCK TO OIL

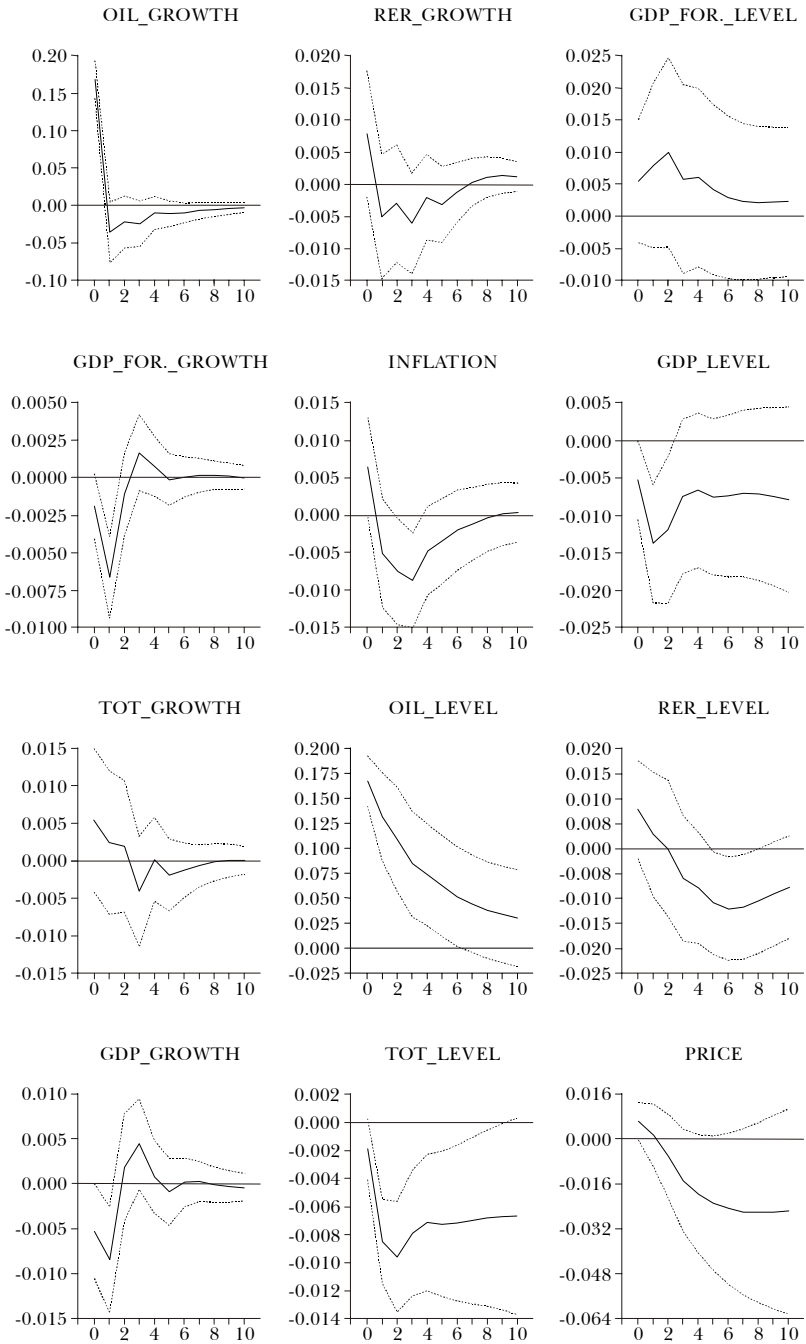


FIGURE 3B. NIES MODEL: RESPONSE TO SHOCK TO GDP FOREIGN

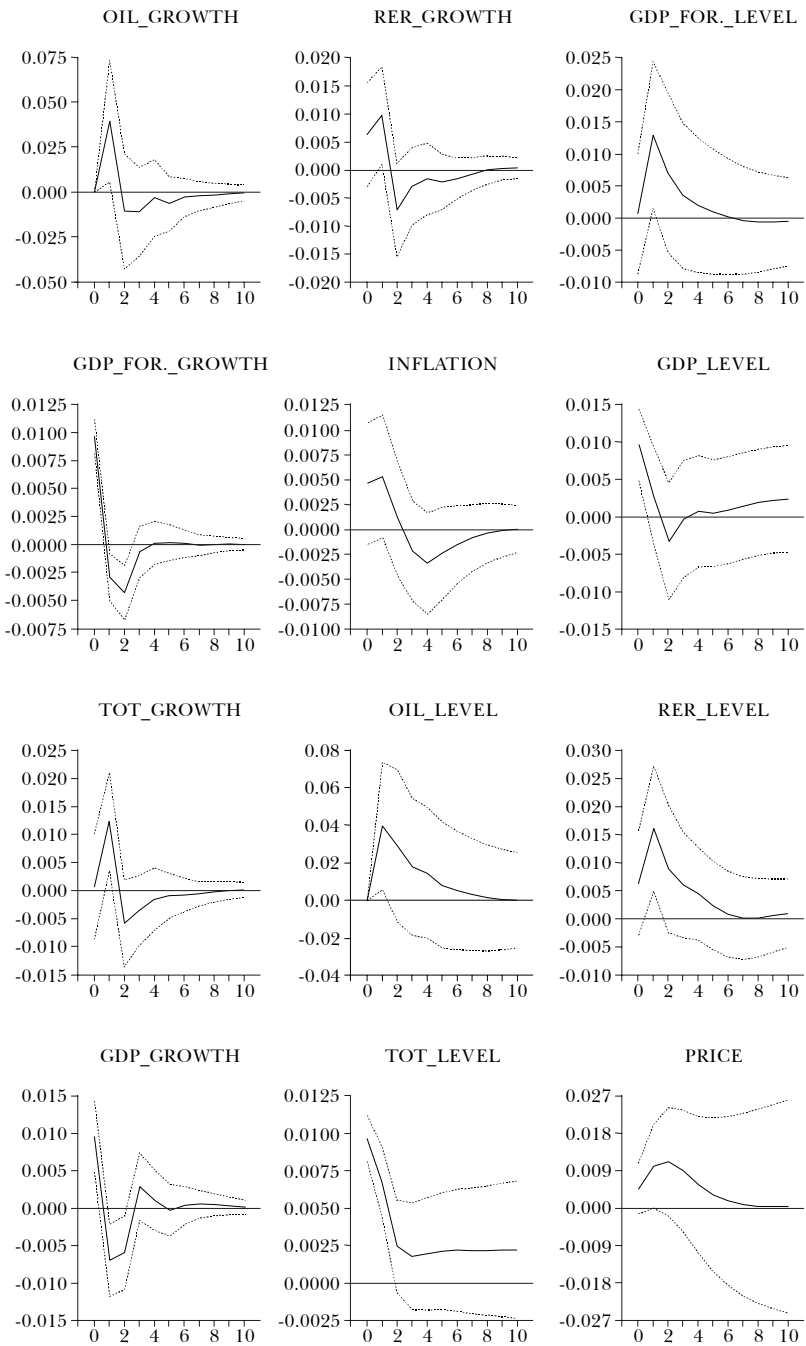


FIGURE 3C. NIES MODEL: RESPONSE TO SHOCK TO TOT

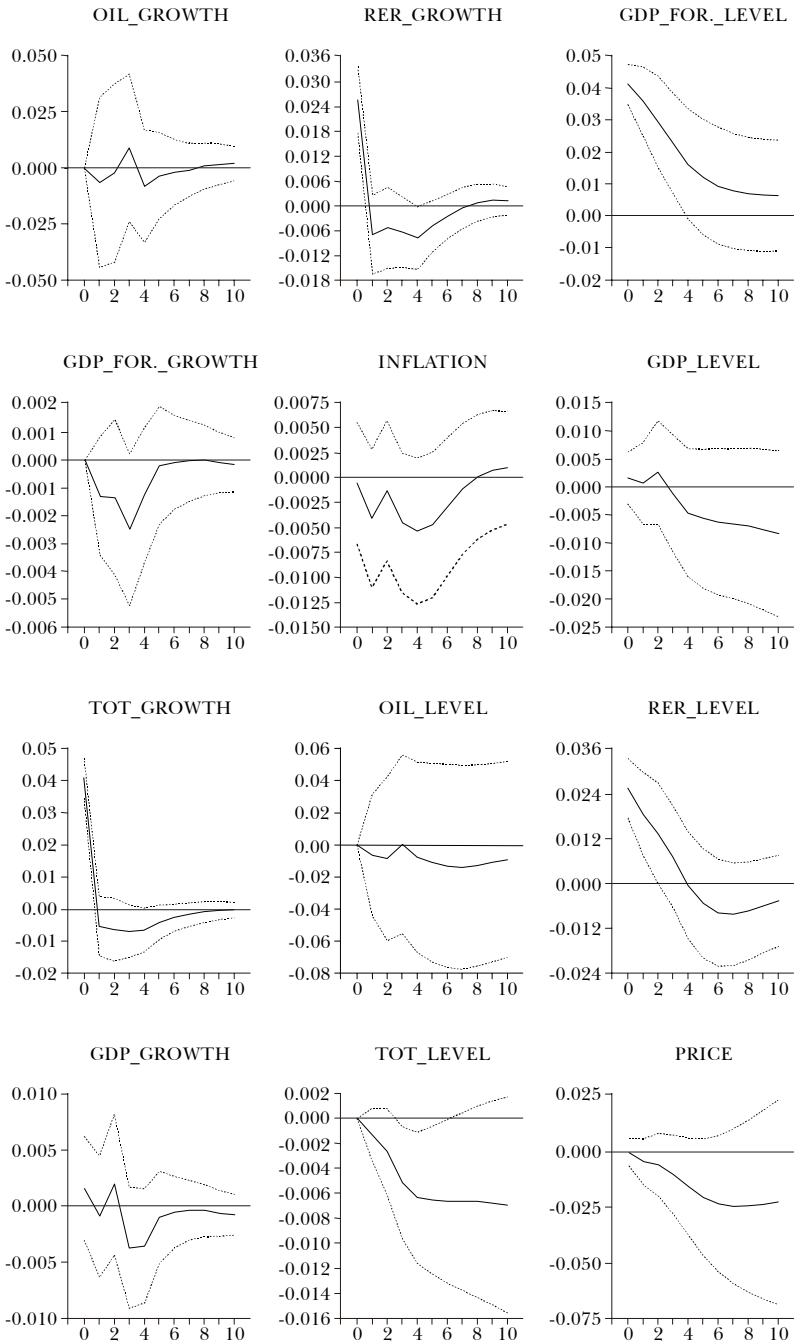


FIGURE 4A. LAT. AM. MODEL: RESPONSE TO SHOCK TO OIL

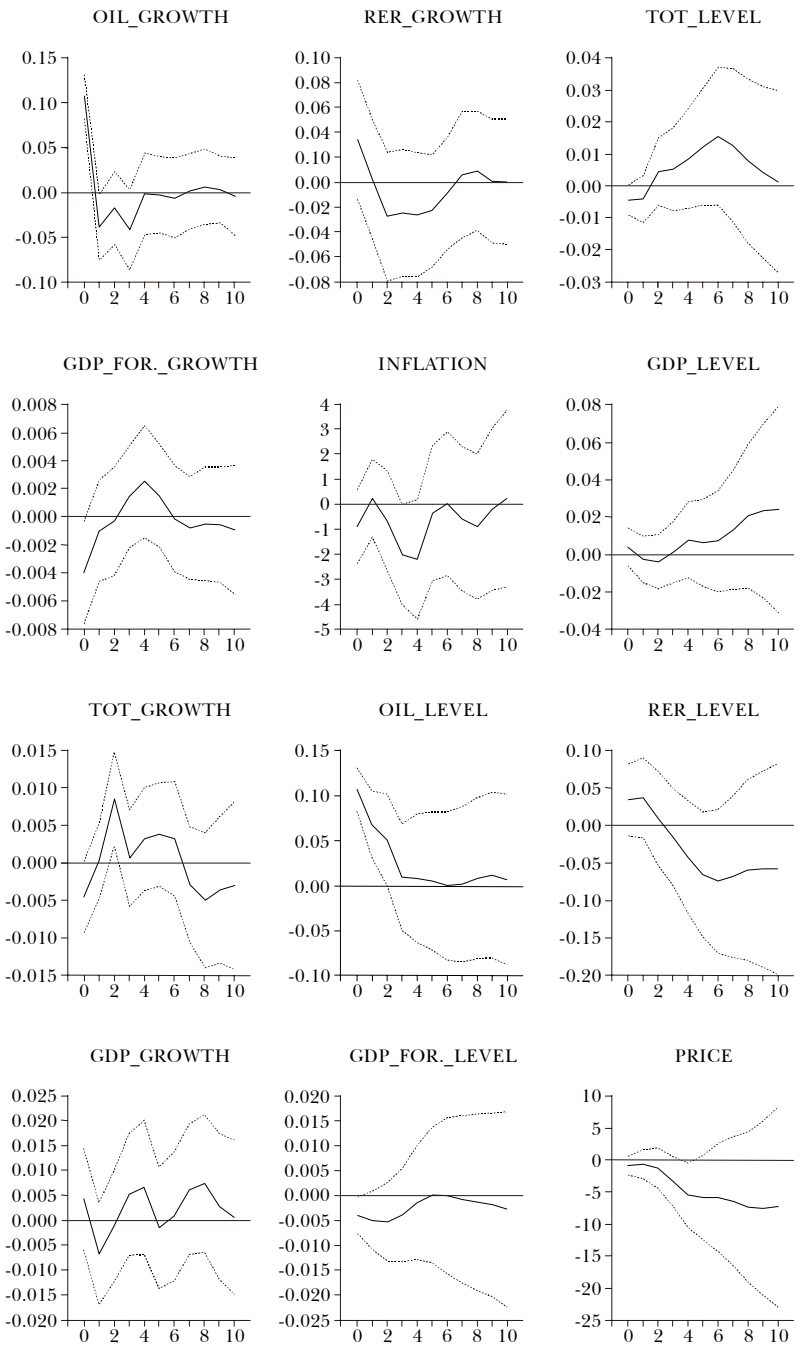


FIGURE 4B. LAT. AM. MODEL: RESPONSE TO SHOCK TO GDP_FOR

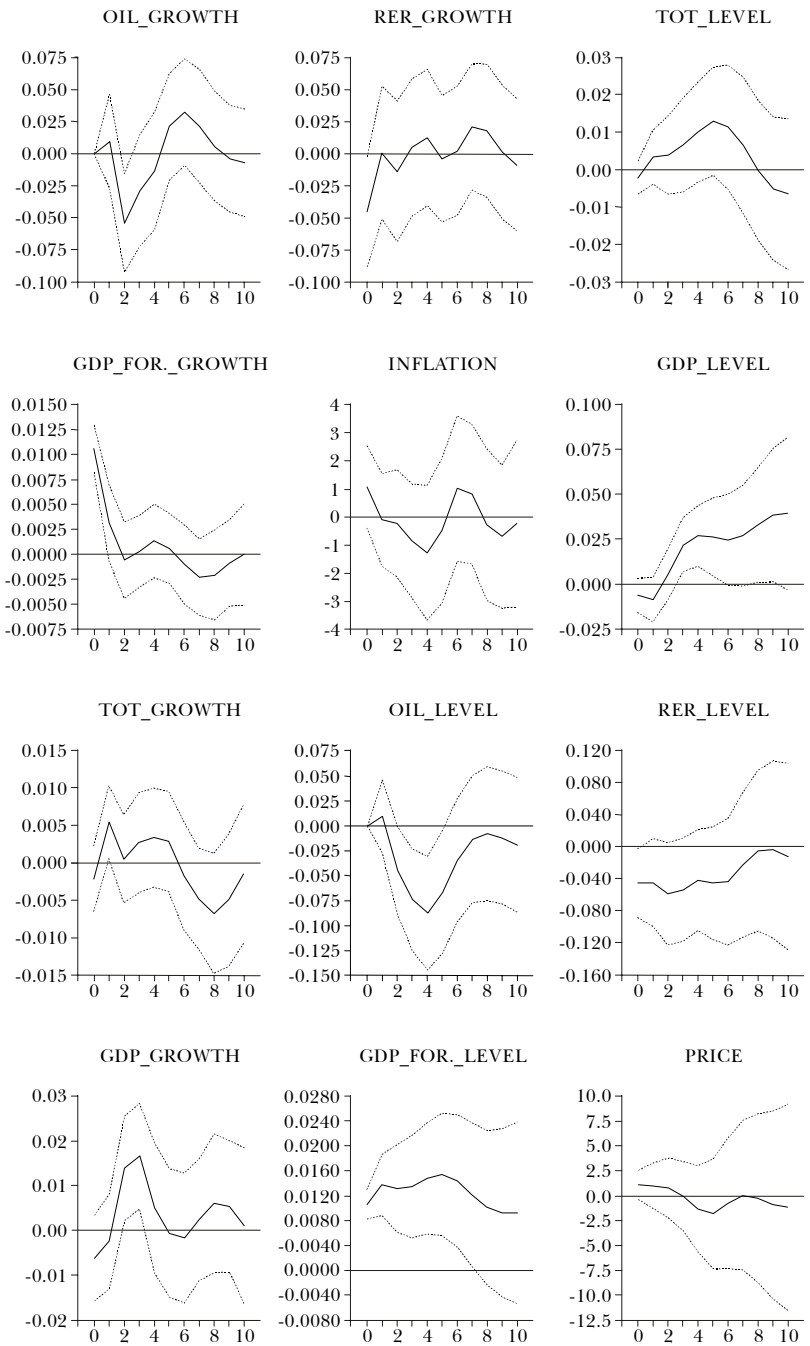
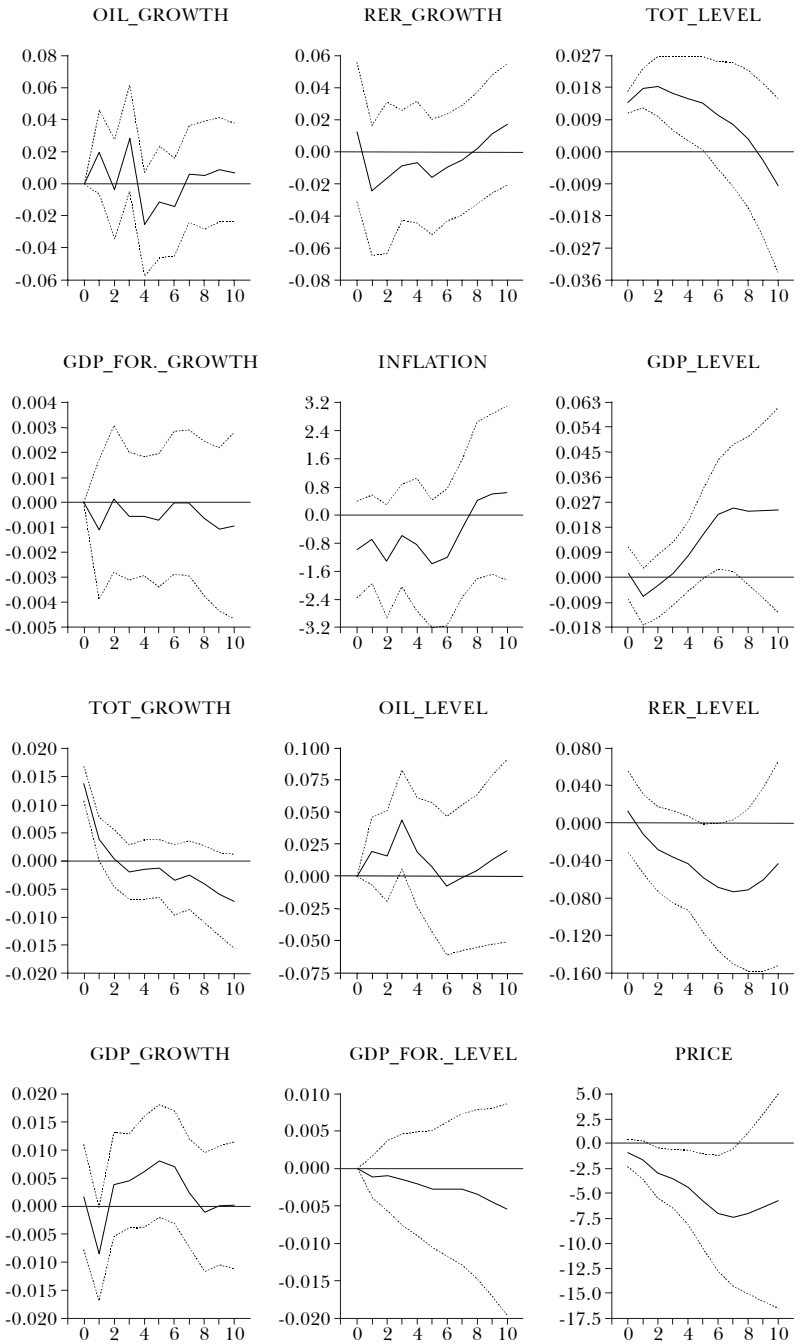


FIGURE 4C. LAT. AM. MODEL: RESPONSE TO SHOCK TO TOT



foreign output growth in the ASEAN and NIEs groups. The impact effect on domestic output growth is roughly one-to-one in the NIEs (figure 3B) and about two-thirds that in the ASEAN economies (figure 2B). However, in Latin America even though the effect of foreign output growth on domestic growth is strong it takes place about two years later, with a peak effect that is one-and-a-half times the original shock to foreign output growth. The differences between Latin America and Asia in this respect appear to indicate that different mechanisms might be at work in the two regions in generating spillover effects. In any case, the results are consistent with the notion that there are fairly strong spillover effects of global output shocks on real GDP in developing countries, which is sharply in contrast to the results of Hoffmaister and Roldos (1997). The variance decompositions in table 2A and 3A also lend some support to this notion, indicating that in the NIEs and LAT AM groups up to about a fifth of the forecast error variance of domestic output growth can be explained by foreign output shocks. However, the contribution of foreign output shocks in explaining domestic output movements in the ASEAN countries is much smaller at around 5-8 percent (table 1A).

TABLE 1. VARIANCE DECOMPOSITIONS OF THE ASEAN VARIABLES

	Percentage of the k-step ahead forecast error varianceof domestic output growth explained by				
k (in years)	*oil price shock*	*foreign output shock*	*terms of trade shock*	*all external shocks*	*all domestic shocks*
A. Variance decomposition of domestic output growth					
0	3	8	4	15	85
1	9	6	4	19	81
2	9	6	6	21	79
10	10	5	12	27	73
B. Variance decomposition of rate of change of real exchange rate					
0	8	0	51	59	41
1	7	9	40	56	44
2	7	12	37	56	44
10	6	11	38	55	45
C. Variance decomposition of domestic inflation					
0	4	4	12	20	80
1	6	9	11	26	73
2	7	12	11	30	70
10	7	12	11	30	70

TABLE 2. VARIANCE DECOMPOSITIONS OF THE NIES VARIABLES

	Percentage of the k-step ahead forecast error varianceof domestic output growth explained by				
k (in years)	*oil price shock*	*foreign output shock*	*terms of trade shock*	*all external shocks*	*all domestic shocks*
A. Variance decomposition of domestic output growth					
0	5	16	0	21	79
1	14	19	0	33	67
2	12	21	1	34	66
10	13	20	4	37	63
B. Variance decomposition of rate of change of real exchange rate					
0	3	2	38	43	57
1	4	6	35	45	55
2	4	8	34	46	54
10	5	8	34	47	53
C. Variance decomposition of domestic inflation					
0	5	3	0	8	92
1	6	5	1	11	89
2	11	4	1	16	84
10	15	5	6	26	74

The positive foreign output growth shock also increases domestic inflation and causes a real appreciation of the domestic currency in general, although for the Latin American countries the effect on real exchange rate growth is initially negative and insignificant. This is consistent with the foreign output shocks generally raising domestic demand in these countries and raising the relative price of non-traded goods.[6] However the variance decompositions in the bottom two panels of tables 1-3 indicate a generally small to modest contribution of foreign output shocks in explaining domestic inflation and real exchange rate movements, ranging from 0-12 percent.

The effects of a terms of trade shock are shown in figure 2C, 3C, and 4C. For the ASEAN countries, an improvement in the terms of trade of the domestic country--which, since the relative price of oil is accounted for, can be interpreted as an improvement in the *non-oil* terms of trade--increases domestic output and

[6] This result does not necessarily go against the Balassa-Samuelson effect as the foreign output shock also has an impact on domestic output. Moreover, the Balassa-Samuelson effect is a long-run property.

decreases foreign output, as expected. The effects of the terms of trade shock on the outputs of the NIEs and LAT AM groups are less clear-cut and not statistically significant (figures 3C and 4C). The variance decompositions also indicate a small contribution of the terms of trade shock to fluctuations in domestic output growth, specifically about 5 percent of the growth rate of domestic output over the short run for the ASEAN countries (table 1A), virtually nothing for the NIEs (table 2A), and slightly higher than 5 percent for the Latin American countries (table 3A).

TABLE 3. VARIANCE DECOMPOSITIONS OF THE LAT. AM. VARIABLES

	Percentage of the k-step ahead forecast error varianceof domestic output growth explained by				
k (in years)	*oil price shock*	*foreign output shock*	*terms of trade shock*	*all external shocks*	*all domestic shocks*
A. Variance decomposition of domestic output growth					
0	2	4	0	6	94
1	5	4	7	16	84
2	4	15	6	25	75
10	8	23	10	41	39
B. Variance decomposition of rate of change of real exchange rate					
0	5	9	0	14	86
1	4	8	3	15	85
2	6	6	3	15	85
10	10	8	5	23	77
C. Variance decomposition of domestic inflation					
0	3	5	4	12	88
1	3	4	5	12	88
2	3	3	8	14	86
10	13	8	11	32	68

However, terms of trade shocks have much bigger effects on the real exchange rate for both the ASEAN countries and the NIEs, although virtually no effect in Latin America. A one-standard deviation shock to the terms of trade--roughly a 7 percentage point increase in the rate of change for the ASEAN countries and about a 4 percentage point increase for the NIEs--increases the rate of appreciation of the real exchange rate on

impact by about 5 percentage points for the ASEAN countries and about half that for the NIEs. The variance decompositions in tables 1B and 2B indicate that terms of trade shocks account for 40-50 percent of the movements in real exchange rates for the ASEAN countries, about a third for the NIEs, but under 5 percent for the Latin countries (table 3B).

While the results on the output effects of terms of trade shocks are contrary to the importance of this variable found in the simulation results of Mendoza (1995), the effects on real exchange rates in the ASEAN and NIEs economies underscore the need to allow such shocks when analyzing macroeconomic developments in the Asian developing countries. By contrast, the very limited effect of terms of trade shocks on real exchange rates in Latin America suggest the pre-dominance of domestic fiscal and monetary policies in driving real exchange rate behavior in those countries.

5. CONCLUSIONS

There are three main points we wish to make based on the above analysis. First, external shocks make a statistically significant and substantial overall contribution in explaining output fluctuations in the developing countries we have considered. As a group, external shocks explain up to about 35 percent of the variations in domestic output growth in the Asian NIEs, about 25 percent in Latin America, and about 20 percent in the ASEAN economies. The contribution of external factors comes mainly from foreign output shocks and somewhat from oil price shocks in the case of Asia, rather than terms of trade shocks. These results lead us to the conclusion that while domestic factors--such as the health of the banking system and domestic fiscal and monetary policies--are likely the pre-dominant forces driving economic fluctuations in these countries, developments in the rest of the world nevertheless also influence them to a considerable degree. Thus, the external environment is not irrelevant to these countries and is likely to influence the speed of recovery of these economies even from crises brought about perhaps by domestic factors, such as the 1997-98 turmoil in Asia. This is reinforced by the historical decompositions which indicate that there are periods when external factors have been significantly more important than the overall variance decompositions would seem to suggest.

Second, external shocks play a quite a big role (explaining about half to two-thirds of the fluctuations) in explaining real exchange rate fluctuations, both over the full sample as well as in particular time periods for the Asian countries. In sharp contrast, domestic shocks explain about 85 percent of unanticipated fluctuations in real exchange rates in the three Latin countries we look at. In general, the above results indicate that, when modeling the behavior of real exchange rates, it is important to allow for more than a single traded good, contrary to much of the practice in empirical work in this area. On the other hand, in the case of Latin America it would be more important to focus on domestic fiscal and monetary policies in modeling at least historical real exchange rate behavior.

Third, more work needs to be done to examine the robustness of our results. Extensions to identify specific domestic shocks and shocks affecting financial markets in particular would also be desirable in light of the importance of the domestic shocks as a group.

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Bank van de Nederlandse Antillen
Banco Central de Nicaragua
Banco Central del Paraguay
Banco Central de Reserva del Perú
Banco Central de la República Dominicana
Centrale Bank van Suriname
Central Bank of Trinidad and Tobago
Banco Central del Uruguay
Banco Central de Venezuela

COLLABORATORS

Central Banks

Bank of Canada
Banco de España
Banque de France
Deutsche Bundesbank (Germany)
Banca d'Italia
Bank of Japan
Bangko Sentral ng Pilipinas
Banco de Portugal
Federal Reserve System (United States)

Other Institutions

Superintendencia de Bancos y Entidades Financieras (Bolivia)
Superintendencia de Bancos (Dominican Republic)
Superintendencia del Sistema Financiero (El Salvador)
Comisión Nacional de Bancos y Seguros (Honduras)
Superintendencia de Bancos (Panama)
Banco Centroamericano de Integración Económica
Banco Latinoamericano de Exportaciones, S. A.
Fondo Latinoamericano de Reservas