V Capital Accumulation, Total Factor Productivity, and Growth

Since the restoration of macroeconomic stability in 1991, the Dominican Republic has entered a period of remarkable economic growth. During the period 1991–98 annual average GDP growth was more than 6 percent (Table 18), with even higher growth rates in recent years. This positive performance came after more than a decade of low and volatile growth dating back to the late 1970s. The resumption of strong economic growth has already had a beneficial impact on poverty and recent analysis by the BCRD indicates that between 1992 and 1998, the incidence[60] of poverty declined from 31.7 percent to 25.8 percent.

With more than 2 million Dominicans still living in poverty, the sustainability of growth is a key issue. There is a dual nature to the production structure that raises questions about the sustainability of current growth rates. On the one hand, there are areas such as tourism, telecommunications, and the industrial FTZs, which operate in a highly competitive environment, are closely linked to the world economy, and are often shielded from state intervention through special administrative arrangements. On the other hand, there are the more traditional sectors of the economy, such as agriculture and some subsectors of industry (outside the FTZs), which continue to operate amidst strong state intervention, including excessive protectionism, red tape, and insecure property rights. Without continued progress in implementing structural reforms (particularly in the more traditional sectors), sustained growth could be jeopardized.

[60]Percentage of population living in conditions of poverty.

Sources of Growth in the Dominican Republic

Studying the determinants of growth has been at the core of economic research for half a century. The pioneering study of Solow (1956) on the mechanics of factor accumulation and GDP growth led to a host of applied papers designed to test the applicability of the exogenous growth model, the role of total factor productivity, and the validity of the standard neoclassical production function (for a survey see Maddison,

Table 18. Economic Structure and Growth, 1991–98

	1991 (In percent of GDP)	1998 (In percent of GDP)	1991–98 Average Annual Growth (In percent)	1991–98 Contribution to Growth (In percent)
Construction	7.5	12.1	13.8	20.7
Commerce	12.4	12.9	6.8	12.5
Hotels, bars, and restaurants	4.2	7.0	14.0	14.3
Industry	14.9	13.1	4.3	7.5
Telecommunications	2.4	4.7	16.5	9.0
Agriculture	13.9	11.7	3.5	6.8
FTZ[1]	3.3	3.4	7.2	5.3
Total economy	100.0	100.0	6.1	100.0

Source: BCRD.

[1]The national accounts methodology does not fully capture the contribution to growth of the FTZs, since it is based only on the wage bill and not on value added.

1987). Most of these studies were based on the notion that economic growth was the outcome of capital and labor accumulation and technological improvements leading to factor productivity growth. Accordingly, it was assumed that value added in each sector could be expressed as:[61]

$$\text{Log}_{Yt} = \gamma + \alpha_1 \text{Log}_{Kt} + \alpha_2 \text{Log}_{Lt} + \mu_t \qquad (1)$$

Because the variables in equation (1) are nonstationary (see unit root tests in Appendix V) parameter estimates using standard techniques (for example, ordinary least squares methods) do not have standard asymptotically normal distributions and are prone to spurious correlations (Granger and Newbold, 1974). This model is therefore best estimated by using cointegration techniques. In addition, since a lack of proper accounting of short-term fluctuations can potentially bias the estimation (Hargreaves, 1994), this basic specification was extended to capture the short-run dynamics of growth arising from the presence of transitory shocks by estimating:

$$\Delta\text{Log}_{Yt} = \alpha_0 \Delta\text{Log}_{Kt} + (1 - \alpha_0)\Delta\text{Log}_{Lt} + \beta[\text{Log}_{Yt-1} - \gamma - \alpha_1 \text{Log}_{Kt-1} - (1 - \alpha_1)\text{Log}_{Lt-1}] + \varepsilon_t \qquad (2)$$

In this specification, Δ is the first difference of the variables, and the expression in brackets corresponds to the last period's deviation of output from its long-term determinants. For example, from a condition of excess capacity the self-correcting mechanism immediately calls for a future expansion in growth. The speed of the adjustment is determined by β; the smaller the value of β, the slower is the adjustment process. The parameter α_0 captures the short-run effect of capital and labor on the growth rate, while parameter α_1 captures the long-run effect of capital and labor on output. The latter are then used to estimate the contribution of each factor of production to growth with the residual accounting for technology or productivity change.

The model from equation (2) was estimated for the 1970–98 period using annual data, with separate estimates being carried out for the FTZs to capture some of the dual nature of the Dominican economy.[62] The estimates presented in Table 19 indicate that the share of capital in the economy's production function (excluding the FTZs)—at about 63 percent—is similar to factor compensation shares in the country's national accounts of roughly 65 percent during 1992–97.[63] Surprisingly, the estimated equation for the FTZs does not reflect the conventional thought that the FTZs are more labor intensive than the rest of the economy. Finally, the parameter for the speed of adjustment in each sector, β, suggests that FTZs adjust to shocks about twice as quickly as the rest of the economy (1.5 years versus 3 years).

Sources of Growth Excluding the FTZs

The estimates of sources of growth based on the production function estimates of Table 19 indicate that for the last 25 years, the most important source of growth by far has been capital accumulation. At the same time, there has been a remarkably low contribution of total factor productivity growth to overall economic growth. This result is even stronger when considering that the estimate of labor growth does not take into account improvements in educational attainment that have undoubtedly taken place in the last three decades.[64] Consequently, it could be expected that the unmeasured improvements in human capital are being captured in the form of total factor productivity increases, which nevertheless average only 0.4 percent per year.

Such low overall improvements in productivity should obviously be a source of concern, since they raise doubts about the sustainability of strong growth. However, separating the analysis into different periods (Table 20) provides a somewhat different picture. The strong growth *since 1992* has relied both on capital accumulation and on important growth in total factor productivity. The increase in capital accumulation is attributable to a rebound in savings that has taken place since 1992. The ratio of investment to GDP, which had declined from about 23 percent in the 1970s to 20 percent during the 1982–91 period, has been consistently increasing since 1992, averaging more than 24 percent for the 1992–98 period. By the same token, total factor productivity growth since 1992 has averaged a historically high 2.3 percent per year.

Assessing the determinants of this increase in capital accumulation and total factor productivity growth is beyond the scope of this chapter. However, some important stylized facts are worth mentioning. First, there is a strong correlation between the suc-

[61]Equation (1) is derived under the assumption that the production function is Cobb-Douglas. Under constant returns to scale, the estimated parameters of inputs equation (1) are equal to the factor shares in production, while the estimated constant is a proxy (up to a scale) of the average productivity growth. Tests indicated that the null hypothesis of constant returns to scale in both the FTZs and the rest of the economy could not be rejected and the estimation of (1) was carried out under the restriction that $\alpha_1 + \alpha_2 = 1$.

[62]All results must be interpreted with caution, given that GDP data use a base year of 1970. The stock of capital was estimated using the perpetual inventory method (see Appendix V). Reasonable changes in depreciation rates (from 4 percent to 6 percent) or in the capital-to-GDP ratio (from 2½ to 3) do not affect the results qualitatively, although quantitatively, the coefficient estimates will vary slightly.

[63]These shares are similar to those found by Senhadji (1999) (ranging from 0.52 to 0.72 for Latin American countries).

[64]There are insufficient data on educational attainment to control for this variable.

cessful macroeconomic stabilization of 1991 and the initiation of structural reforms in the early 1990s with the rebound in capital accumulation and total factor productivity growth. Second, the instability associated with the debt crisis of the 1980s not only affected capital accumulation, but also productivity growth. While some of the high productivity growth in the early 1990s may have been attributable to a rebound effect, toward the end of the 1990s this was to be less of a factor. Nonetheless, the analysis would seem to indicate that sustained strong productivity growth will not be possible without continued implementation of structural reforms. Third, the experience of other developing countries shows that sustaining productivity growth rates of the kind that have been experienced recently by the Dominican Republic is difficult (Table 21). Some of the fastest-growing economies in the world, such as Chile, Ire-

Table 19. Production Function Estimates, 1970–98

Sectors	α_0	α_1	β	γ	R^2 Cointegration*	R^2 Error Correction	DW
Free-trade zones	0.301 (0.212)	0.714 (0.042)	0.907 (0.183)	–4.09 (0.184)	0.980	0.817	2.07
Rest of the economy	0.824 (0.161)	0.632 (0.168)	0.337 (0.122)	–0.355 (0.276)	0.972	0.570	1.99

Note: (*) Corresponds to the sample fit of the cointegrating vector. Standard deviations are in parentheses.

Table 20. Sources of Growth Estimates
(In percent)

Period	GDP Growth (A year)	Capital			Labor			Total Factor Productivity Growth	
		Growth (A year)	Contribution to GDP Growth	Share in GDP Growth	Growth (A year)	Contribution to GDP Growth	Share in GDP Growth	Contribution to GDP Growth	Share in GDP Growth
1973–98	4.6	4.5	2.8	62.3	3.6	1.3	29.2	0.4	8.5
1973–82	5.6	5.3	3.4	59.6	4.1	1.5	26.7	0.8	13.7
1983–91	2.2	3.6	2.3	106.1	3.9	1.4	65.8	–1.6	–71.9
1992–98	6.1	4.4	2.8	45.8	2.6	1.0	15.8	2.3	38.3

Table 21. Total Factor Productivity Growth of Other Developing Countries
(In percent)

	Korea	Taiwan Province of China	Singapore	Chile	Ireland	Morocco	Jordan
1960–70	0.60	1.40	0.10	1.40	2.50	4.60	–1.10
1970–80	0.80	1.10	0.40	0.00	1.70	–0.20	3.00
1980–86	2.50	1.80	–0.80	–1.90	1.20	–0.30	–2.60
1986–92	1.90	2.50	4.00	3.80	3.40	–1.20	–4.30

Source: Bosworth, Collins and Chen, 1995.

land, Korea, and Taiwan Province of China, have not been able to sustain average annual productivity growth rates in excess of 2 percent for more than five or six years.

Sources of Growth for the FTZs

The traditional methodology for estimating sources of growth assumes that the long-run structure of the economy is unaffected by the accumulation of capital and labor and, therefore, the underlying production function remains constant over time. In the presence of important structural reforms and a rapidly expanding sector such as the FTZs, where learning and adaptation is an important process, this may not be a reasonable assumption. Soto (1997) discusses why a model in which learning is substantial cannot be estimated using the standard, fixed-parameter model. In that case, the existence of an S-shaped learning curve would lead to substantially distorted and nonrobust results due to new information not reaching economic agents. A more sensible assumption would be to expect a learning curve, as FTZs evolve from infancy to maturity.

Taking this into consideration, the sources of growth analysis for the FTZs is carried out using a Kalman-filter specification:

$$\Delta \text{Log}_{Yt} = \alpha_0 \Delta \text{Log}_{Kt} + (1 - \alpha_0)\Delta \text{Log}_{Lt} + \beta[Log_{Yt-1} - \gamma - (\alpha_1 + SV_t)\,\text{Log}_{Kt-1} - (1 - \alpha_1 - SV_t)\text{Log}_{Lt-1}] + \mu_t \quad (3)$$

$$\text{where } SV_t = \theta SV_{t-1} + vt$$

This specification allows parameters to evolve as agents learn to be more productive with given inputs. In standard microeconomic terms, the specification allows the FTZs to be initially at an interior point in the transformation curve and move sequentially towards the efficient frontier. A graphic display of the estimated time-evolving parameter is presented in Figure 4.

An analysis of the sources of growth for the FTZs (Table 22) shows remarkable productivity growth. From 1973 to 1998, the annual average productivity growth of the FTZs has consistently been more than four times higher than that of the rest of the economy. It must be pointed out, however, that because of data constraints, in recent years the estimate of total factor productivity growth has probably been overestimated, while capital accumulation, and therefore the contribution of capital to growth, has been underestimated. This result stems from the absence of detailed data on investment in the FTZs. Consequently, the area of their physical plants and their level of utilization is used as a proxy for capital. In recent years, however, as the constraints of market access to the United States have become more binding, there has been an important process of diversification that has included increased vertical integration—and value added (VA)—in the production of garments, and also the development of other more capital-intensive products. Since these shifts can take place in the absence of expansion of the physical plants of the FTZs, total factor productivity growth is probably being overestimated.

Figure 4. Kalman-Filter Estimates of the Share of Capital in FTZ Production Function

Ultimately, however, whether because of different levels of investment and capital/labor ratios or because of differences in factor productivity growth, there is a clear difference in average productivity between the FTZs and the rest of the economy (Table 23). This important difference indicates the output gains that could be derived were the type of regulatory environment that applies to the FTZs to be extended to the economy at large.

The Role of Public Investment in Growth

The analysis in the preceding sections suggests that maintenance of strong growth in the Dominican Republic will hinge on at least three elements: maintaining macroeconomic stability; continuing to implement structural reforms that can help sustain high factor productivity growth; and increasing the rate of capital formation. In the past, the process of capital formation was reinforced by macroeconomic stability and the government's own public investment program. Since late 1996, however, there has been a significant shift in the composition of government expenditure, away from investment and toward cur-

Table 22. Estimates of Sources of Growth in the FTZs
(In percent)

Period	Value Added Growth (A year)	Capital Growth			Labor Growth			Total Factor Productivity Growth	
		Growth (A year)	Contribution to VA Growth	Share in VA Growth	Growth (A year)	Contribution to VA Growth	Share in VA Growth	Contribution to VA Growth	Share in VA Growth
1973–98	21.3	15.0	10.7	50.4	19.7	5.6	26.5	4.9	23.1
1973–82	18.9	11.7	8.4	44.4	25.0	7.1	37.9	3.3	17.8
1983–91	29.1	26.5	18.9	65.2	24.8	7.1	24.4	3.0	10.4
1992–98	14.7	4.9	3.5	23.8	5.6	1.6	10.9	9.6	65.4

Table 23. Average Productivity in the Economy and the FTZs
(In percent)

Period	Free-Trade Zones		Economy without FTZs	
	VA Growth	Growth in Average VA per Worker	GDP Growth	Growth in Average GDP per Worker
1973–98	21.3	3.28	4.6	1.12
1973–82	18.9	–2.23	5.6	2.10
1983–91	29.1	3.96	2.2	–1.56
1992–98	14.7	8.70	6.1	3.44

rent expenditure (including the wage bill) (Table 24). While some of the increase in the wage bill has been directed to finance human capital formation, this evolution raises concerns regarding its likely impact on private investment and, subsequently, on long-run growth.

To analyze the impact of the changing composition of public expenditures on growth and the ensuing policy implications, estimates were made of the *net* contribution of public investment to total investment.[65] There is a vast literature on modeling the determinants of investment based on the relation between output and the cost of capital (Jorgenson, 1971), the role of uncertainty (Abel, 1983), the response of investment to transitory output shocks (Blejer and Khan, 1984), and the role of the effect of real exchange rate changes on the profitability of investment projects and the cost of imported intermediate or capital goods (Krugman and Taylor, 1978). More recently, the role of economic stability has also been tested as a key determinant of private investment (Servén and Solimano, 1993). There is evidence that public investment may either crowd in or crowd out private investment, depending on the nature of those investments (Balassa, 1988; Khan and Reinhart, 1990; and Easterly, Rodríguez, and Schmidt-Hebbel, 1994). Estimates for the Dominican Republic are based on the following equation:

$$\frac{Priv.\ Inv_t}{GDP_t} = f\left(\hat{GDP}_t,\ Openness_t,\ \Delta Capital\ Cost_t,\ W_t,\ \pi_t,\ \frac{Publ.\ Invt_t}{GDP_t},\ \frac{Gov.\ Const_t}{GDP_t}\right) \quad (4)$$

where openness is measure by the ratio of exports to GDP,[66] π is inflation, and W is the private real wage index.

The estimates presented in Table 25 show that in the Dominican Republic, public investment has had a net crowding-out effect on private investment since the parameter for total public investment is negative and significant, suggesting that for every percentage point of increased public investment,

[65]Some public investment can crowd out private investment, reducing its net contribution.

[66]Given past exchange controls and trade restrictions, the ratio of exports to GDP was seen as a better proxy for openness than the ratio of exports plus imports to GDP.

Table 24. Dominican Republic: Composition of Public Expenditures, 1995–98
(In percent of GDP)

	1995	1996	1997	1998
Current expenditures	7.2	7.8	10.6	11.1
Current expenditures adjusted[1]	6.0	6.5	9.1	n.a.
Wages	3.5	3.6	5.1	5.2
Transfers	1.9	2.5	3.3	3.5
Capital expenditures	7.0	6.6	5.5	5.1
Investment	4.5	4.6	2.8	2.7
Capital transfers	1.7	1.3	1.6	1.3
Amortization	0.7	0.7	1.6	0.8

Source: Based on information provided by ONAPRE.
[1]Current expenditures adjusted equals total current expenditures minus wages for education.

private investment decreases by 0.2 percentage point (Equation A). This crowding-out effect is significantly lower than that recently estimated by the World Bank (1998) for Mexico, where it reached a high 50 percent. Moreover, when separating the type of public investment between basic public goods and other nonpublic goods some interesting results and policy implications are obtained (Equation B). Public investment in basic public goods has a crowding-in effect of about 30 percent, thus contributing to *increased* private investment, while public investment in nonbasic public goods has a crowding-out effect of 15 percent. This would imply that even in the context of declining public investment the reallocation of public investments towards core public goods would allow for continued strong capital formation.

Conclusion

The restoration of macroeconomic stability and the initiation of structural reforms in the early 1990s has led to strong economic growth and poverty reduction. Growth has been anchored by both a resurgence of capital formation and strong productivity growth, although the latter may be slightly overestimated given the imperfect measurement of human capital embodied in the measure of labor inputs.

With a ratio of investment to GDP of about 26 percent in 1998, high productivity growth and investment will be needed for a continuation of GDP growth rates of between 7 and 8 percent per year. The past performance of the Dominican Republic and international experience indicate that, in the absence of continued structural reforms, current rates of productivity growth will be hard to maintain. This implies that (1) the Dominican Republic should push forward with its implementation of structural reforms—recent developments are encouraging in this regard; and (2) strong capital formation needs to be maintained. To this end, increasing public investment *and* improving the focus of those investments to promote a crowding-in of private investment should be a priority.

Increases in real GDP growth rates and openness promote private investment. According to the empirical results, each extra percentage point of GDP in exports will raise private investment by 0.3 percentage point of GDP. Thus, the results are consistent with the notion that trade liberalization not only reduces price distortions and increases efficiency, but also encourages private investment and, ultimately, output growth.

Table 25. The Determinants of Private Investment, 1979–96

							Public Investment					
	Constant	Change Capital Cost	Lagged Change Wages	GDP Growth	Openness	Lagged Excess Capacity	Total	Lagged Basic Public Goods[1]	Lagged Other[2]	AR(1)	R^2	DW
Equation (A)	–2.353	–0.013	–0.234	1.481	0.279	0.069	–0.177			0.816	0.71	2.14
	(–10.47)	(–1.59)	(–1.72)	(3.70)	(2.36)	(3.09)	(–2.50)			(9.84)		
Equation (B)	–1.258	–0.019	–0.129	1.030	0.259	0.045		0.296	–0.151	0.872	0.76	1.96
	(–2.92)	(–2.37)	(–1.32)	(4.41)	(2.39)	(1.14)		(3.88)	(–2.98)	(8.51)		

Source: World Bank estimates based on public investment classification from ONAPLAN. T-statistics are shown in parentheses.
[1]Basic public goods involve investments in transport, rural roads, water, and sewerage.
[2]Other includes housing, irrigation, communications, energy, agriculture, and urban developments.

Appendix V Economy-Wide Data*

GDP is available in constant 1970 prices for the 1970–98 period.

The capital stock is estimated using the perpetual inventory method, assuming that the ratio of capital to GDP was 2½ in 1980, and the depreciation rate is 4 percent. Choosing a capital-output ratio in the range of 2½ to 3 is customary in TFP models (see for example, Pindyck, Servén, and Solimano, 1993; Sarel, 1997; and Braun and Braun, 1998). The selection of 1980 as a pivot for the estimation was based on the notion that excess capacity and macroeconomic imbalances were minimal at that time.

Employment data are not available for all periods, with a gap from 1984 to 1991. The gap was filled by estimating:

$$\text{Log Employment}_t = 6.76 + 0.035\ \text{Trend}_t + 0.458\ \text{Log Employment}_{t-1}$$
$$(139.2) \qquad (9.10) \qquad (2.69)$$
$$R^2 = 0.969$$

Breusch-Pagan Residual Correlation Test = 1.621

FTZ Data

Value added series in FTZs was obtained from the IMF for the 1983–98 period. For the 1970–82 period, total export figures were obtained from the study by Dauharje and others (1989), and it was assumed that value added was 30 percent of exports. This assumption is consistent with IMF data for the 1983–97 period, which estimates the ratio between 29 percent and 31 percent. Value added was deflated using the U.S. Producer Price Index to obtain real figures (valued in 1980 U.S. dollars).

The capital stock was proxied using data on physical investment (area of buildings) from the National Council of Free-Trade Zones. The latter is used for estimating the stock of capital with a perpetual inventory method under three assumptions: (1) the stock of capital in 1984 was US$238 million (Dauharje et al., 1989), (2) the average value of a square foot of construction and equipment in FTZs was US$80.3 in 1984, including machinery (Dauhajre et al., 1989), and (3) depreciation rates were 4 percent per year.

Employment data are obtained directly from the National Council of Free-Trade Zones.

General Data Issues

The Dominican Republic has made significant advances in the quality of its national accounts data in the 1990s. Long-term data series, such as the ones used in this paper, may, however, suffer from certain limitations. Investment data for the late 1980s, a period of relatively high inflation and changing relative prices, may be subject to measurement problems. In this paper, the ratio of investment (I) to GDP was measured in real terms. However, measuring I/GDP in nominal terms yields different results. In the latter case, I/GDP remains fairly constant throughout the 1980s and 1990s, whereas I/GDP measured in real terms falls in the mid- to late-1980s, and rises in the 1990s. Thus, factor productivity growth is much higher in the 1990s when measuring I/GDP in real terms.

Unit Root Tests for Time Series Data

The series were first tested for unit roots (Table 28) using standard augmented Dickey-Fuller and Phillips-Perron tests (see Hamilton, 1994 for a description). Since the series are rather short—27 observations—tests were supplemented with the simple first-order autocorrelation of the series to classify series as integrated or trend stationary.

Estimates of the Production Function

Before estimating equations (2) and (3) (see main text) Granger causality tests were run between valued added and GDP and inputs. The results presented in Table 29 show that for the FTZs it is unlikely that there are simultaneity biases arising from the es-

*Data sources are described in Table 26. Data are shown in Table 27.

Table 26. Data Sources

Variables	Description	Source
National accounts	Official national accounts (base year 1970)	BCRD
Private and public investment	Breakdown of private and public investment	ONAPLAN
Price of capital goods	Ratio of investment deflator to GDP deflator	BCRD
Nominal exchange rate	Year average nominal exchange rate (in RD$ per U.S. dollar)	BCRD
CPI	Consumer price index, base year 1984	BCRD
Terms of trade	Terms of trade index	1965–92 Soto (1994) 1993–97 World Bank
Wages	Real private wage index, base year 1984	1965–95 World Bank 1996–97 Secretaría de Trabajo
Real exchange rate (RER)	Proxied by eP*/CPI	P* is the U.S. CPI index (base year 1984)
Capacity utilization	Potential GDP estimated using a nonlinear, quadratic model with intercept adjustments in 1980 along Clements and Hendry's (1999) methodology	Own calculation
r*	International interest rate	U.S. 3-year t-bills, annualized
Openness	Exports in percent of GDP	BCRD
Value added in FTZ	Net exports	1970–82 Soto (1994), 1983–97 IMF
Labor in FTZ	Total employment	National Council of Free-Trade Zones
Capital in FTZ	Estimated using perpetual inventory (see text)	National Council of Free-Trade Zones

timation of the error-correction, cointegration models. Consequently, Engle-Granger estimation procedures can be undertaken without the disturbing presence of nuisance parameters. Estimates for the variables representing the non-FTZ economy show, however, that there is simultaneous causation between GDP and capital shocks. Simultaneity biases can be controlled, however, by including leads of capital shocks in the error-correction model, as discussed in Hargreaves (1994).

References

Abel, Andrew, 1983, "Optimal Investment under Uncertainty," *American Economic Review,* Vol. 73, pp. 228–33.

Balassa, Bela, 1988, "Public Finance and Economic Development," *PPR Working Paper No. 31,* The World Bank.

Blejer, Mario, and Mohsin Khan, 1984, "Government Policy and Private Investment in Developing Countries," *IMF Staff Papers,* Vol. 31.

Braun, J., and M. Braun, 1998, *El Crecimiento Potencial: El Caso de Chile,* mimeo, Pontificia Universidad Católica de Chile.

Clements, Michael P., and David F. Hendry, 1999, *Forecasting Non-Stationary Economic Time Series,* MIT Press, Boston, Mass.

Collins, Susan, Barry Bosworth, and Yu-chin Chen, 1996, "Accounting for Differences in Economic Growth," in Akira Kohsaka and Koichi Ohno (eds.). *Structural Adjustment and Economic Reform,* Tokyo, Japan: Institute of Developing Economics, 1996.

Dauharje, A., hijo, and others, 1989, *Impacto Económico de las Zonas Francas Industriales de Exportación en la República Dominicana,* Fundación Economía y Desarrollo.

Easterly, W., C.A. Rodríguez, and K. Schmidt-Hebbel, eds., 1994, *Public Sector Deficits and Macroeconomic Performance* (Oxford University Press for The World Bank).

Engle, R., and C. Granger, 1987, "Co-Integration and Error-Correction: Representation, Estimation, and Testing," *Econometrica,* Vol. 55, pp. 251–76.

Granger, C.W.J., 1969, "Investigating Causal Relations by Econometric Models and Cross-Spectral Models," *Econometrica,* Vol. 37, pp. 424–38.

———, and P. Newbold, 1974, "Spurious Regressions in Econometrics," *Journal of Econometrics,* Vol. 2, pp. 111–20.

Hamilton, J.D., 1994, *Time Series Analysis* (Princeton University Press, N.J.).

Table 27. Data Used in Estimations and Simulations

Year	Free-Trade Zones			Economy (Except FTZs)				
	Value Added (In millions of 1984 U.S. dollars)	Capital Stock (In thousands of 1984 U.S. dollars)	Employment (In thousands)	GDP (In millions of 1970 pesos)	Capital Stock (In millions of 1970 pesos)	Employment (In thousands)	Private Investment (In millions of 1970 pesos)	Public Investment (In millions of 1970 pesos)
1970	4.0	8.0	0.5	1,485.5	4,682.8	1,030.5	208.0	76.3
1971	8.0	21.0	1.0	1,647.0	4,779.4	1,080.0	227.5	105.7
1972	12.7	32.2	2.3	1,818.2	4,882.7	1,022.0	259.6	115.1
1973	12.4	55.3	3.2	2,052.8	5,046.1	1,202.0	342.8	132.7
1974	19.3	68.1	4.8	2,176.0	5,297.8	1,230.6	382.2	151.0
1975	26.5	81.1	7.0	2,288.9	5,598.2	1,234.2	426.1	186.0
1976	33.6	94.5	8.6	2,442.9	5,935.3	1,348.7	430.9	141.8
1977	42.9	98.7	10.9	2,564.5	6,242.4	1,391.0	486.9	132.0
1978	49.3	100.1	13.5	2,619.6	6,611.6	1,397.5	516.5	119.1
1979	53.6	92.5	16.1	2,738.2	6,982.8	1,434.4	553.6	133.9
1980	52.2	83.9	18.3	2,956.4	7,391.0	1,414.6	603.6	144.4
1981	62.0	81.1	20.5	3,082.9	7,843.4	1,497.6	543.7	123.8
1982	64.4	83.5	19.6	3,135.3	8,197.1	1,508.1	470.4	77.6
1983	120.5	92.7	22.3	3,280.4	8,417.2	1,601.7	495.7	99.1
1984	99.1	118.4	27.1	3,321.5	8,675.3	1,598.7	548.3	74.5
1985	85.2	156.4	35.7	3,251.0	8,951.0	1,735.5	494.0	99.5
1986	174.2	270.9	51.2	3,365.5	9,186.5	1,783.6	485.1	132.1
1987	188.2	295.7	66.0	3,706.0	9,436.2	1,834.6	653.7	291.3
1988	239.8	360.6	83.8	3,785.9	10,003.8	1,885.0	429.4	374.1
1989	336.2	424.3	122.9	3,952.5	10,407.1	1,916.5	604.2	342.3
1990	332.5	586.7	130.0	3,736.9	10,937.4	1,982.6	572.8	223.1
1991	423.0	630.8	135.5	3,773.2	11,295.8	2,116.2	525.9	200.6
1992	514.4	706.2	141.1	4,075.7	11,570.4	2,265.3	634.3	265.6
1993	665.1	725.6	164.3	4,198.6	12,005.6	2,252.4	623.9	342.1
1994	704.5	733.1	176.3	4,380.7	12,593.3	2,224.3	649.7	376.6
1995	761.9	774.2	165.6	4,591.4	13,162.1	2,235.1	847.9	300.6
1996	793.4	762.8	164.6	4,925.0	13,755.0	2,358.4	914.6	331.6
1997	974.7	780.0	182.2	5,326.4	14,430.4	2,469.8	1,055.5	244.8
1998	1,080.8	877.0	195.2	5,712.9	15,310.1	2,530.5	...	...

Hargreaves, C., 1994, "A Review of Methods of Estimating Cointegrating Relationships" in *Non Stationary Time Series Analysis and Cointegration* (Oxford University Press).

Jorgenson, Dale, 1971, "Econometric Studies of Investment Behavior: A Survey," *Journal of Economic Literature,* Vol. 9, pp. 1111–47.

Khan, Mohsin S., and C.M. Reinhart, 1990, "Private Investment and Economic Growth in Developing Countries," *World Development,* Vol. 18, No. 1.

Krugman, Paul, and Lance Taylor, 1978, "The Contractionary Effects of Devaluations," *Journal of International Economics,* Vol. 8, pp. 445–56.

Maddison, August, 1987, "Growth and Slowdowns in Advanced Capitalist Economies: Techniques of Qualitative Assessments," *Journal of Economic Literature,* Vol. 25, pp. 649–98.

Pindyck, R., 1993, "Irreversibility, Uncertainty, and Investment," *Striving for Growth After Adjustment: The Role of Capital Formation,* L. Servén and A. Solimano (eds.). The World Bank.

Sarel, Michael, 1997, "Growth and Productivity in ASEAN Countries," IMF Working Paper 97/97.

Senhadji, Abdelhak, 1999, "Sources of Economic Growth: An Extensive Growth Accounting Exercise," IMF Working Paper 99/77.

Servén, Luis, and Andrés Solimano, 1993, "Private Investment and Macroeconomic Adjustment: A Survey"; *Striving for Growth After Adjustment. The Role of Capital Formation,* L. Servén and A. Solimano (eds.). The World Bank.

Solow, Robert M., 1956, "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics,* Vol. 70, pp. 65–94.

Table 28. Unit Root Tests

	First Order Autocorrelation	Variable in Levels		ADF First Difference
		ADF*	PP*	
Value added in FTZ	0.858	–1.55	–2.08	–5.94
Capital stock in FTZ	0.831	–0.80	–2.40	–2.80
Employment in FTZ	0.855	–2.11	–3.12	–4.24
GDP rest of economy (ROE)	0.887	–2.44	–2.89	–3.90
Capital stock ROE	0.928	–2.61	–3.22	–2.84
Employment in ROE	0.916	–1.04	–1.32	–3.43
Private investment (in percent of GDP)	0.577	–3.67	–3.69	...
Public investment (in percent of GDP)	0.696	–2.87	–2.99	
Terms of trade	0.377	–3.53	–3.86	...
Real exchange rate	0.538	–2.97	–3.01	...
Real wages	0.746	–2.20	–2.16	–5.49
Alternative cost of capital	0.780	–1.34	–1.20	–4.78
Relative cost of capital goods	0.418	–4.12	–3.12	...
Inflation	0.365	–3.79	–3.81	...
TFP growth ROE	0.176	–4.12	–4.08	...
Openness	0.675	–2.11	–2.08	–5.98
Capacity utilization	0.169	–5.18	–4.68	...
Public investment in infrastructure	0.707	–2.48	–3.09	...
Public investment in social capital	0.772	–4.09**	...	...
Public investment in housing and urban development	0.863	–3.00**	...	...

Note: (*) ADF is the augmented Dickey-Fuller Test and PP is Phillips-Perron unit root test. Critical value is –2.62 at 90 percent. (**) The Perron structural break test was performed, allowing for a jump in the mean of the series in 1984.

Table 29. Causality Tests

Test	F-Test	Test	F-Test
GDP does not Granger cause employment	1.5	Value added does not Granger cause employment	1.07
Employment does not Granger cause GDP	2.92*	Employment does not Granger cause value added	3.02*
GDP does not Granger cause capital	3.25*	Value added does not Granger cause capital	0.36
Capital does not Granger cause GDP	5.23*	Capital does not Granger cause value added	0.35

Soto, R., 1994, "A Macroeconomic Assessment of the Dominican Republic: Policies and Prospects," mimeo, The World Bank.

———, 1997, "Non-Linearities in the Demand for Money: A Neural Network Approach," Working Paper Series No.107, ILADES-Georgetown University.

World Bank, 1998, Mexico: Country Economic Assessment, mimeo.