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Why Do Resource-Abundant Economies Grow More Slowly?

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This article suggests an alternative explanation for why resource-rich economies have lower growth rates: because they are likely to be living beyond their means. It is shown that overshooting the steady state's equilibrium consumption and investment can be optimal in a Ramsey growth model with natural resources. Therefore, the economy will converge to its steady state from above, displaying negative growth rates on the transition. A dynamic general equilibrium model is calibrated to the Venezuelan economy and shown to approximate the economy's performance over the oil boom years adequately.

Keywords: natural resources, economic growth, Venezuela, computable general equilibrium models

JEL classification: O11, O41, O54, Q43

1. Introduction

Recent studies have uncovered the fact that resource-poor economies tend to outperform resource rich ones (see especially Sachs and Warner, 1995). In fact, resource abundance is an important determinant of economic failure, with differences of one standard deviation in the share of primary exports in GDP leading to growth rates on average between .7 and 1 percent lower (Sachs and Warner, 1995, p. 21). And indeed, some of the world's most tremendous development failures are among oil-exporting countries such as Algeria and Venezuela (see case studies in Gelb, 1988, 1986). These are surprising facts, which stand in stark contrast to the optimism with which countries have tended to welcome resource booms.[1] They also call for an explanation from economists, especially since simple economic intuition would lead us to expect that, if anything, an increase in the resources that a society has access to should raise its rate of growth.

Several explanations have been advanced in the literature for this phenomenon. It has been suggested that greater resource abundance can lead economies to shift away from competitive manufacturing sectors in which many externalities necessary for growth are generated (see models in Sachs and Warner, 1995, and Matsuyama, 1992). On the other hand, some authors have proposed that the root of the problem is political: resource booms tend to put large amounts of resources in the hands of the state and thus create an incentive for agents to participate in rent seeking as opposed to productive activities that spur growth (Tornell and Lane, 1994; Lane and Tornell, 1996; Karl, 1997).

In this article we explore a simple alternative hypothesis: resource-rich countries may grow more slowly because they are likely to be living beyond their means. This is because natural resource industries, which rely on exhaustible factors of production, cannot expand at the same rate as other industries. In the steady state, production of the natural resource will tend to zero. But on the transition to that steady state, the natural resource allows an economy to afford extraordinary consumption possibilities. Thus, typically, a resource-rich economy will adjust to its steady state from above, not from below. During the transition, it will display negative rates of growth on average.

If an economy can invest its resource windfalls in international assets that pay permanent annuities, then the problem we are alluding to could not occur. Any economy experiencing a resource boom will invest it and permanently consume the interest it earns on that asset. But if an economy cannot invest its resource revenues in international capital markets, whether because of internal political restrictions, lower or declining expected rates of return abroad, or a preference for holding home assets,[2] then it will have to invest them in the home country, generating temporary consumption and production booms. The fact that these booms are temporary means that these economies will sooner or later have to see consumption and production decline.

Our explanation suggests that there is an association between lower growth rates and higher levels of income. Resource-abundant economies grow more slowly precisely *because* they have an unsustainably high level of income. In traditional stories, political or economic distortions harm the growth rate and ultimately drive the resource-rich country's income below what it would have been in the absence of natural resources. Table 1 shows a simple, often unnoticed fact about the relationship between income, growth, and natural resources: resource-rich countries have higher rates of growth than resource-poor countries while at the same time having higher levels of income. Column 1 shows a typical regression from Sachs and Warner (1995) in which the effect of natural resources on economic growth is negative. Column 2 shows that if exactly the same regression is run but with income as the dependent variable, the coefficient on natural resources becomes positive.

Our key assumption is that exports of natural resources cannot expand at the same rate as other industries. We model this by specifying a sector whose output is fixed, whereas the rest of the industries in the economy can expand with further use of labor and capital. We believe this is a good characterization of many natural-resource-intensive industries with a market share that is being continuously eroded by nonnatural resource intensive substitutes as well as by pure depletion. We also show that our result holds in environments characterized by optimal depletion of the natural resource.

Let us illustrate our argument with a striking numerical example. Estimates of Venezuelan GDP per capita at the beginning of this century put it at U.S. $50 (at 1970 prices). This ranked fourteenth out of 20 Latin American countries, a meager 62 percent of the region's average and a little over 25 percent of the region's leader. By 1970, *before the first oil boom*, Venezuela's per capita GDP of U.S. $942 was the region's second highest, 184 percent of

Table 1. Effect of natural resources on growth and level of income.

Dependent Variable	Growth 1970–1990	Ln(GDP1970)
Constant	8.28	3.99
	(5.65)	(13.63)
Ln(GDP1970)	−1.76	
	(−5.75)	
Life expectancy	.086	.061
	(3.26)	(9.19)
Investment rate	.099	.010
	(3.52)	(.981)
Openness	2.03	.236
	(4.09)	(1.41)
Share of primary exports	−3.50	1.32
	(−2.58)	(4.32)
R^2	.62	.75

Note: T-statistics in parentheses. Data from Sachs and Warner (1995)

the region's average, and just a notch below the region's leader, Argentina.[3] Yet during the intervening period, Venezuela did not undergo a political or economic process radically different from that of the 12 Latin American countries it surpassed. By the early 1970s, the Venezuelan private sector was remarkably uncompetitive even by Latin American standards (see Naím, 1989), and the political situation was every bit as unstable as in any other country in the region.[4] The only difference was that by 1970 Venezuela had become one of the world's main exporters of oil.

Our argument applied to Venezuela is that the extraordinary development in the oil industry that took off with the Mene Grande discoveries in 1914 and led Venezuela to control 13 percent of the world oil market by 1970 (Ministerio de Energia y Minas, 1976, p. 151) afforded this country the opportunity to overshoot its steady state in terms of consumption and production. And, simply put, what comes up must come down. Already during the 1960s, Venezuela's oil exports in per capita terms had started to decline. As Figure 1A shows, per capita oil revenues in constant U.S. dollars fell by a third during the 1960s. And notwithstanding the magnitude of the oil booms, by the late 1980s per capita oil revenues had already fallen below their preboom levels. It is only logical then to expect, as we indeed observed, for per capita GDP in 1990 to be lower than in 1970. The oil boom of the 1970s and early 1980s was of course able to reverse this trend, but only temporarily.

Granted our explanation makes theoretical sense, does it make empirical sense? Can the simple dynamics of oil revenues account for the disappointing growth performance of a country like Venezuela? In this article, we attempt to answer this question using a dynamic general-equilibrium model of the Venezuelan economy. After testing the model's accuracy by showing that it is capable of tracking the main swings in the Venezuelan economy during the 1970s and 1980s, we use it to show that Venezuela does indeed fit the picture of an economy that is converging to its steady-state income from above. According to our

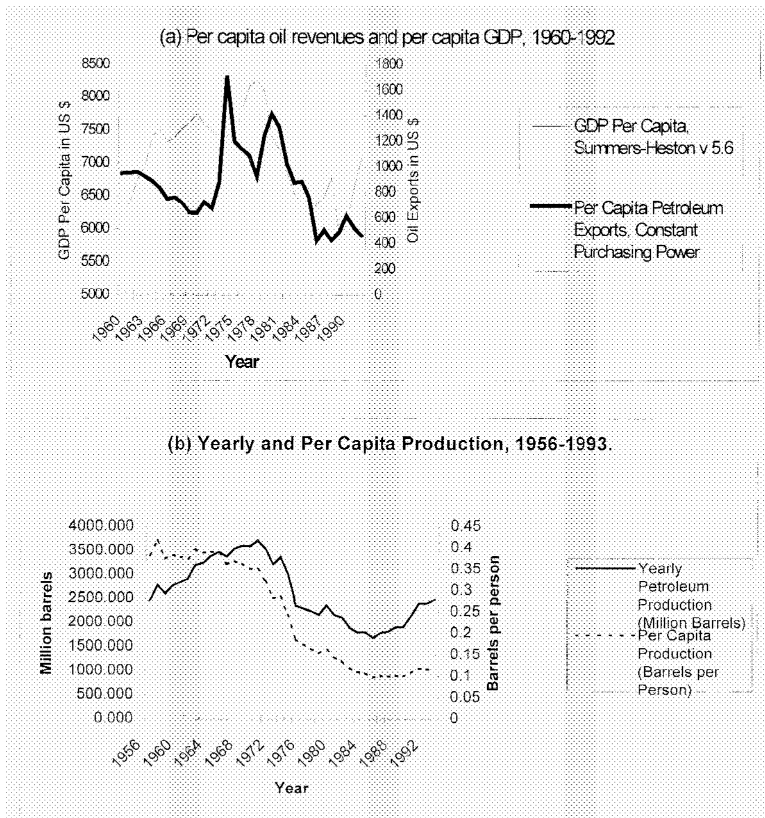

Figure 1. Oil production, oil revenues, and per capita GDP.

model's calculations, Venezuelan GDP per capita is at present about two times its steady-state level. Venezuela's slow growth performance during the 1970s and 1980s[5] is predicted by our model as a result of convergence from above to its steady state. In sum, we show that the story of natural-resource exporters as economies that have overshot their steady states makes quantitative sense in that it can account acceptably well for a typical natural-resource exporter's main growth dynamics.

We also use our model to try to gain some insights as to the process of adjustment of an oil exporter to falling oil revenues. We show that countries may experience temporary export booms as a result of the combination of slack demand and a level of the capital stock that cannot be sustained in the long run rather than due to the genuine emergence of new export industries. Furthermore, we show that the factor intensities of recently emerging export industries may be a poor guide to the economy's long-run comparative advantage. This conclusion sheds some doubt on attempts to identify the comparative advantage of a natural resource intensive economy by looking at emerging industries during an export boom.

Our article proceeds as follows. In Section 2 we sketch a simple theoretical model and use it to illustrate how we expect an economy to respond to an influx of revenues from an export of natural resources. We prove that, given a large enough natural-resource sector, one would expect the natural-resource-intensive economy to overshoot its steady state. In Section 3 we present our dynamic general-equilibrium model of the Venezuelan economy and discuss its calibration. Section 4 summarizes the main results of the simulations. Section 5 shows how we use the model to analyze temporary export booms and the evolution of an economy's comparative advantage over time. Section 6 concludes.

2. A Simple Theoretical Model

In this section we present a simple stylized theoretical model of a natural-resource intensive economy and show that overshooting of the steady state—in the precise sense that the capital stock is likely to converge to the steady state from above even if it starts out below—is likely to occur in these economies. In following sections, we establish that this is the case for more general models that lack analytical closed-form solutions, among them a computable general-equilibrium model calibrated to the Venezuelan economy.

Our model is a simple extension of the Ramsey growth model, which introduces an additional sector with an exogenous level of production (which is thus declining in per capita terms). It is a one good economy in which exports can be traded in international markets for imported investment goods. The current account is balanced so that there is no international investment. This effectively constrains the economy to invest the natural resource revenues in domestic capital, thereby generating the overshooting effect.

A representative agent maximizes the intertemporal utility function

$$Max \int_0^\infty e^{-\rho t} \log c_t dt, \tag{1}$$

with ρ being the subjective discount rate and c_t period t consumption (all variables are per capita). Production y_t is carried out using a Cobb-Douglas technology in capital k_t and labor l_t:

$$y_t = Ak_t^\alpha l_t^{1-\alpha}. \tag{2}$$

Resources can be devoted either to investment I_t^d or consumption:

$$c_t + i_t^d = y_t, \tag{3}$$

and domestic as well as imported investment goods I_t^m raise the capital stock:

$$\overset{\circ}{k} = k(l - \delta - n) + i_t^d + i_t^m. \tag{4}$$

The model is closed with a balance-of-payments constraint that specifies that natural resource exports z_t can be used to cover the cost of importing investment goods

$$z_t = i_t^m, \tag{5}$$

as well as an initial condition specifying k_0. Equation (5) embodies the restriction that international investment be set to zero (discussed above).

Assume for now that the amount of per capita natural resources available z_t falls at a linear rate μ:

$$z_t = \mathrm{Re}^{-\mu t}. \tag{6}$$

We take μ for now to be exogenous. The simplest justification of (6) is to assume that the country exports R units of the natural resource every time period, so that in per capita terms exports would be Re^{-nt}. As we show below, even absent population growth, our results can be extended to a model characterized by optimal depletion.

This is just a simple Ramsey model with an additional equation, which specifies that the economy gets a decreasing quantity of "free" investment goods. Nothing of what follows changes if consumption imports are introduced.[6]

The standard way to solve this model leads us to the following system of differential equations:

$$\overset{\circ}{c} = c(A\alpha k^{\alpha-1} - \delta - \rho), \tag{7}$$

$$\overset{\circ}{k} = Ak^{\alpha} - c - (n+\delta)k + \mathrm{Re}^{-\mu t}. \tag{8}$$

Since the system is not autonomous, usual graphical solution techniques cannot be used. But the system can be linearized around the steady state and solved analytically. This allows us to establish the following:

Proposition 1 *Given a sufficiently high R, an economy that starts out with a capital stock lower than its steady-state level will overshoot its steady state in the precise sense that there will exist a T such that for all $t > T$:*

$$c_t > c^{ss},$$

$$k_t > k^{ss},$$

where the superscript ^{ss} denotes steady-state values.

Proof: See Appendix A. ■

Panel A of Figure 2 shows the behavior of the capital stock in our model.[7] The thick line describes the time path followed by the capital stock for a level of R of roughly 5/3 that of the steady-state capital stock, while the thin line describes its evolution when $R = 0$.

The basic intuition here is that even though the natural-resource economy has the same steady state as an economy without these resources, its abundance allows it to enjoy abnormally high levels of consumption for an extended period. However, in the long run, it will not be able to sustain its capital stock on the basis of its foreign-exchange earnings, since those foreign-exchange earnings tend to zero as time advances. Thus declining output marks the process of adjusting toward the steady state.

To illustrate this phenomenon, think of two economies, A and B, identical up to period t_0, and assume A enjoys a resource discovery in that period. Since A cannot save

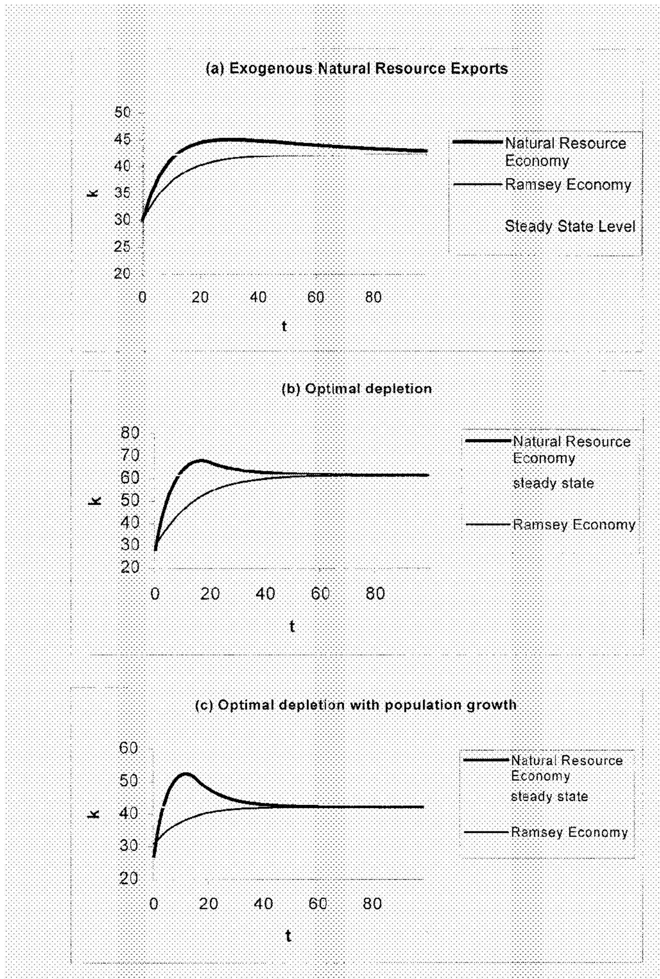

Figure 2. Transition to steady state in natural resource and Ramsey economies.

internationally, its only way of saving the resources is to invest domestically. As it starts saving, however, it pushes down its marginal product of capital and therefore raises the price of future consumption, stimulating a consumption boom. Since it is investing more than B, A can and will reach its steady-state level of the capital stock in finite time given a sufficiently large endowment of natural resources. However, A will not then be in its steady state because at that moment it will have positive foreign revenue from its natural resource exports, which allow it to invest more than it would be able to do in its steady state; therefore, A keeps investing and overshoots its steady state. As time progresses, however, *any* level of the capital stock higher than the steady-state level becomes unsustainable, so that A's production will tend to equal B's. It is easy to see that this phenomenon cannot occur if the economy has access to perfect capital markets, as in that case the marginal product of capital would not be able to fall below the international rate of return.

Proposition 1 also establishes that what is necessary to generate overshooting is that the initial stock of natural resource be large enough. In other words, if the economy is sufficiently natural-resource intensive, it is likely to overshoot its steady state.

The overshooting phenomenon will also appear in models characterized by optimal depletion of natural resources. Panels B and C of Figure 2 show results from simulations in which earnings from the export sector are not assumed to be constant over time (and thus declining in per capita terms) but where the decision to deplete the natural resource is taken optimally.[8] Panel B shows the case of optimal depletion without population growth, with the depletion function equal to $\overset{\circ}{R} = -i_t^m - \chi i_t^{m^\theta}$, with $\chi > 0, \theta > 1$, and panel C shows the case with the same depletion function but with positive population growth. The optimally chosen level of investment in imported capital goods (the only import in the model) thus determines the depletion of natural resources.[9] Other simulations, not shown for reasons of space, suggest that the overshooting result generalizes to a wide range of parameter values when there is optimal depletion.

Indeed, the key restriction generating the overshooting result is not the lack of optimal depletion; it is the lack of access to international asset markets. If the natural resource-abundant economy were able to sell its natural resource internationally and permanently consume the interest on the assets derived form that,[10] it would avoid the overshooting result. Why these economies would decide to do otherwise is an interesting question, which we discuss further below. For now, it is important to point out that many natural-resource exporters, including Venezuela, do not tend to accumulate net creditor positions during boom periods in international markets, making equation (10) an accurate characterization of their behavior.[11]

Figure 1B shows how this simple depletion of natural resources has worked in the Venezuelan case. Despite its many ups and downs, mainly related to OPEC export restrictions, Venezuelan physical production of oil has been approximately constant for the last forty years. Meanwhile, population growth has eroded almost three-fourths of this production in per capita terms. In 1956, .4 barrels of oil were produced for every Venezuelan per day. Today, that figure has gone down to .1 barrel.[12]

The above argument leaves many questions unanswered. Do these dynamics extend to more complex economies and realistic economies? Do they make quantitative sense, in the sense of enabling us to capture the main swings of the process undergone by a typical natural-resource-abundant economy? What happens when the economy has the alternative of developing other export industries?

In the next section, we explore these issues with a computable general-equilibrium model calibrated to the Venezuelan economy. We show that an extension of the model presented in this section that allows for a series of other important factors accounts remarkably well for the main swings of the Venezuelan economy during the 1972 to 1993 period. We also use that model to analyze Venezuela's recent export boom and to develop implications about the country's dynamic comparative advantages.

3. An Intertemporal General-Equilibrium Model of the Venezuelan Economy, 1972 to 1993

In this section we present a dynamic macroeconomic model and calibrate it to the Venezuelan economy. We use this model to show that Venezuela does indeed seem to fit the picture of a country that has overshot its steady state and is converging to it from above; this sole fact seems to be the main explanation behind Venezuela's poor growth performance. We also show that the oil shocks of the 1970s were able to offset this tendency only temporarily. Our model indicates that Venezuela is at the moment not very far from where it would have been without the oil shock. We furthermore use the model to gain new insights about the emergence of new export industries.

In what follows, we present the equations of the model, justify its main assumptions, and explain some salient facts about the calibration of the model. Then we show that the model is able to track reasonably well the main swings in the fundamental economic indicators of the Venezuelan economy (output, investment, share of nontradeables, and exports) over the 1972 to 1993 period. Finally, we go on to discuss the main inferences the model allows us to draw about the factors behind Venezuela's poor growth record.

3.1. Structure of the Model

The model is an intertemporal dynamic three-sector trade model. The current account is set at zero so we ignore changes in world asset holdings by Venezuelans. As in the standard Dutch disease model, we have three sectors: tradeables, nontradeables, and petroleum. There is no uncertainty. The model is presented in Tables 2 and 3. Since it describes a perfectly competitive economy with infinitely lived agents, we can find its solution in terms of a social planner's optimization problem. Otherwise, as in the case of overlapping-generations models, the competitive equilibrium may differ from the planner's optimum. The equations characterizing that problem are presented in Table 2, with variable definitions in Table 3. All variables are in per capita terms.

One of the main characteristics of the model is that it specifies in great detail the role of imported intermediates and capital goods, while it considerably simplifies the consumption side. The adoption of import substitution policies that attempted to generate a domestic final-goods industry by favoring imports of capital and investment goods indeed constrained consumption imports to a minor role in the Venezuelan economy.[13] To capture the full impact of these policies in the stylized framework of the model, we constrain consumption imports to zero during the import substitution period of the model (1972 to 1988). As Venezuelan legislation explicitly prohibits imports of oil products by anyone other than the state oil enterprise, and as these imports are typically negligible,[14] we also restrict the imports of petroleum goods to equal zero.

Another important feature of the model is the backstop technology for production of nontradeables. This kind of specification is common in many development models and tries to capture the existence of alternative labor markets that impart the economy with a great deal of wage rigidity without generating the high levels of unemployment common in

Table 2. Equations for computable general-equilibrium models.

1. Utility function	$u = \sum_{t \neq T} DISC_t \frac{c_t^{1-\sigma}}{1-\sigma} + \frac{DISC_T}{r} \frac{c_t^{1-\sigma}}{1-\sigma}$
2. Consumption bundle	$c_t = \prod_i (c_{it}^d + c_{it}^m)^{\beta_i}$
3. Production function	$x_{it} = D_i \left(B_i fa_{it}^{\rho_i} + (1 - B_i) ha_{it}^{\rho_i}\right)^{\frac{1}{\rho_i}}$
4. Value added	$fa_{it} = A_i l_{it}^{\alpha_i} k_{it}^{1-\alpha_i}$
5. Intermediate Inputs used in production of good i	$ha_{it} = G_i \left(\sum_z N_{iz} int_{izt}^{\lambda_i}\right)^{\frac{1}{\lambda_i}}$
6. Intermediate inputs of sector z used in production of good i	$int_{izt} \begin{cases} = S_{iz} \left(F_i gd_{izt}^{\eta_{iz}} + (1 - F_i) gm_{izt}^{\eta_{iz}}\right)^{\frac{1}{\rho_i}} \text{ if} \\ = gd_{izt} \text{ if } z \text{ is not importable} \end{cases}$
7. Alternative technology for production of non-tradeables	$x_i = \xi l_l$
8. Feasibility constraint	$c_{it}^d + iod_{it} + \sum_z gd_{zit} = x_{it}' - e_{it}$ with $x_{it}' = \begin{cases} x_{it} + x_l & \text{for } i = nt \\ x_{it} & \text{otherwise} \end{cases}$
9. Intertemporal linkage	$ks_{t\mid t>1} = \frac{ks_{t-1} \cdot (1 - \delta) + inv_{t-1}}{1 + n}$
10. Demand for investment goods originating in sector i	$io_{it} = \gamma_i \, inv_t$
11. Supply of investment goods originating in sector i	$io_{it} \begin{cases} = Y_i \left(H_i iod_{it}^{\theta_{iz}} + (1 - H_i)\, iom_{it}^{\theta_i}\right)^{\frac{1}{\theta_i}} \text{ if } i \text{ is importable} \\ = iod_{it} \text{ if } i \text{ is not importable} \end{cases}$
12. Current account balance	$\sum_i pe_{it} e_{it} = \sum_z \sum_i pim_{zi} gm_{izt} + \sum_i pkm_{it} iom_{it} + \sum_i pcm_{it}$
13. Factor market equilibrium	$l_t^s = \sum_i l_{it} + l_l$ $k_t^x = \sum_i k_{it}$
14. Terminal condition	$inv_T = k_T^s (n + \delta)$
15. Closure	$e_{pet,t} k_l^s$, pe_{it}, pim_{it}, pkm_{it} and pcm_{it} given

more advanced economies (Lewis, 1954; Taylor, 1983). This can be seen as a shortcut for the specification of a fuller model of the labor market along the lines recently advocated by Devarajan, Ghanem, and Thierfelder (1996).

Table 3. Variable definitions.

Variable	Definition
u	Net discounted utility
c_t	Consumption
c_{itj}	Consumption of good i (j = domestic or imported)
x_{it}	Production in formal sector of good i
fa_{it}	Value added by capital and labor to industry i
ha_{it}	Intermediate inputs used by industry i
l_{it}	Labor used in industry i
k_{it}	Capital used by industry i
int_{izt}	Intermediate inputs used by industry i originating in industry z
gd_{izt}	Domestic intermediate inputs used by industry i originating in industry z
gm_{izt}	Imported intermediate inputs used by industry i originating in industry z
x_I	Production of non-tradeables in the informal sector
l_I	Labor used in the informal sector
io_{it}	Investment originating in sector i
iod_{it}	Investment in domestic goods originating in sector i
iom_{it}	Investment in domestic goods originating in sector i
x'_{it}	Total domestic production of good i (formal and informal sector)
ks_t	Capital stock
inv_t	Investment
n	Population growth rate
δ	Rate of depreciation
e_{it}	Exports of good i
m_{it}	Consumption imports of good i
l_{t^s}	Labor supply
pe_{it}	International price of exports of sector i
pim_{it}	International price of imported intermediate goods of sector i^a
pkm_{it}	International price of imported capital goods of sector i
pcm_{it}	International price of imported consumption goods of sector i

[a] Imported intermediates are the numeraire good. Therefore, $pim_{Tt} = 1$.

3.2. *Model Calibration*

We calibrate our model to the 1984 Social Accounting Matrix for Venezuela developed by Clemente and Puente (1987).[15] This allows us to retrieve the parameters β_i, D_i, B_i, $A_i\alpha_i$, G_i, N_{iz}, S_{iz}, and F_i.[16] Our elasticity estimates for ρ_i, θ_i, λ_i, η_{zi} are taken from Hentschel (1992). Appendix B shows our Social Accounting Matrix as well as the values taken by the parameters. σ was taken from Ostry and Reinhart's (1992) estimates for Latin American economies. The discount rate r was set to .065.[17] n is taken from Venezuelan demographic statistics. ψ_i is set to equal the average wage rate for informal sector workers in the baseline year.

Our treatment of exports deserves a special comment. In the baseline year (and this is true in general for the period previous to the late 1980s) petroleum exports accounted for almost 88 percent of exports. But exports of petrochemicals, minerals, and the energy-intensive basic industries counted for another 7 percent, making Venezuela's percentage of exports that depend either directly or very closely on its comparative advantage in energy production at least 95 percent.[18] In other words, nonoil exports in the baseline year were close to nonexistent. Economically, this means that there are many potential export industries that did not find it profitable to produce any exports in the Venezuelan economy as captured by our base year data. We choose thus to modify the base year social accounting matrix so that nonoil exports are equal to zero.

This assumption implies that the export price level is not sufficiently high to induce exports of nonpetroleum goods in equilibrium. Usual calibration techniques would assign a price relative to the numeraire of 1 to these exports, which would mean that a unit of home production would be assumed to have sold for the same price in international markets as in national markets. We have chosen to model exports as having a price lower than 1 in the baseline year. Our modeling choice is driven by the belief that a 1984 price of exports equal to one would overestimate the value international markets would have put on Venezuelan goods.

By not restricting the relative price of exports in the base year to equal one, we are creating an unobservable parameter. Our admittedly questionable solution is to infer the relative price of exports in the base year on the basis of the prices at which export industries that were forced by slack domestic demand to export were able to sell their goods on international markets. A great quantity of exports is indeed countercyclical in Venezuela: goods are exported to international markets only if there is no domestic demand for them. We thus look at the price levels at which manufacturing[19] industries with very countercyclical[20] exports were selling their exports during the 1989 to 1990 recession so as to get an indicator of what price international markets were willing to pay for Venezuelan exports. The fact that the 1989 recession was particularly deep and unexpected makes it an almost natural experiment for finding out the price which international markets would have paid for Venezuelan products. This calculation gives us an export price level of .625—that is, 62.5 percent of the price of tradeables in the domestic market in the baseline year.

The model was solved using GAMS Release 2.25. A code for the model is available from the authors on request.

3.3. Overshooting Tendency and Historical Simulations

We first confirm that our model is indeed characterized by the same overshooting tendency of the simple analytical model sketched previously. We simulate the transition paths of two economies that start out from an identical capital stock of just under 60 percent of its steady-state value. One of them has no natural resource earnings, while the other one has export earnings from the natural resource industry of approximately one-third of initial year GDP. We obtain a very similar pattern to that of Figure 2, with the resource abundant economy's GDP per capita exceeding the steady state level of income after 11 years by 23 percent and the income of the nonresource-abundant economy by 50 percent.

We use our model to simulate the Venezuelan economy's performance from 1972 to 1993. Its growth performance during this time period is often cited as an example of a striking development failure by a rich oil exporter. As we are making no attempt to explain the short-run fluctuations of the economy, all time-varying exogenous variables in the model are passed through a Hodrick-Prescott filter.[21] This comes from our desire to capture the main swings in the relevant variables, and not the high-frequency fluctuations.[22]

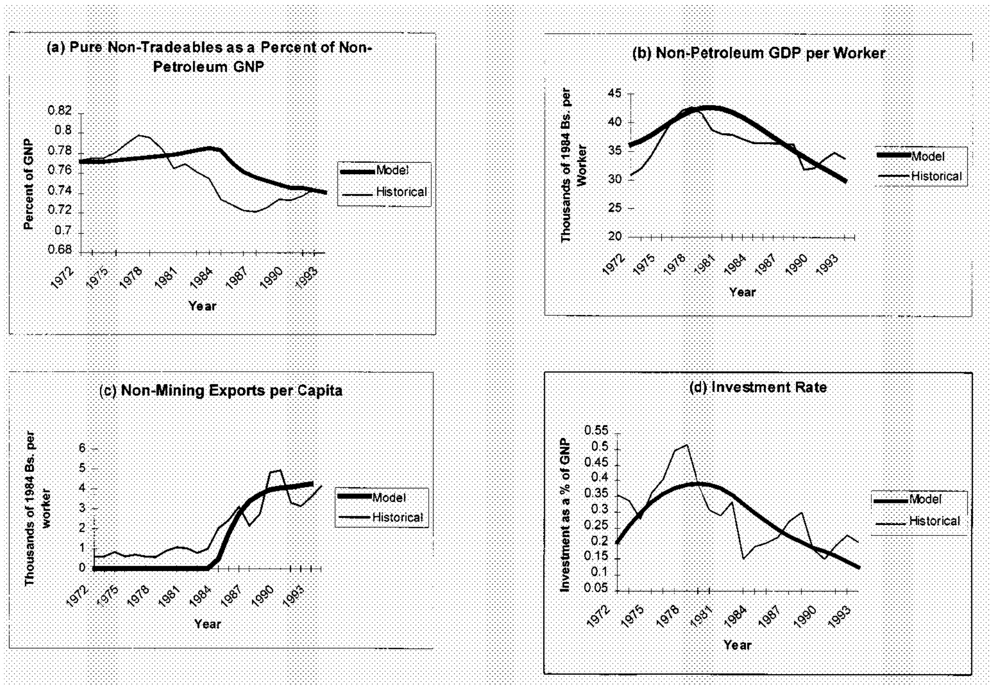

Figure 3. Comparison of historical data with model.

Figure 3 shows the model's prediction of the economy's key variables, plotted against the historical data. These figures are encouraging, since they show that the model is able to predict the main swings undergone by some key variables in the Venezuelan economy, getting the magnitude and timing of the boom right.

The model is able to predict the main swings in nontradeables production (panel A) GDP per worker (panel B), investment (panel C) and nonpetroleum exports (panel D) pretty accurately.[23] Most important, the model is able to predict Venezuela's lack of growth of output per worker from 1972 to 1993. In none of these is the fit perfect, but it does seem in all these figures that our model is capturing the main medium-run movements of the Venezuelan economy during the last two decades. On the whole, the model lends support to our thesis that the behavior of the Venezuelan economy during this period can be understood as the response of an economy that is depleting its natural resources to a temporary rise in its oil exports.

3.4. Understanding Venezuela's Growth Performance

The central contention of this article is that a typical natural-resource exporter is likely to be converging from its steady state from above and will therefore perform poorly in terms

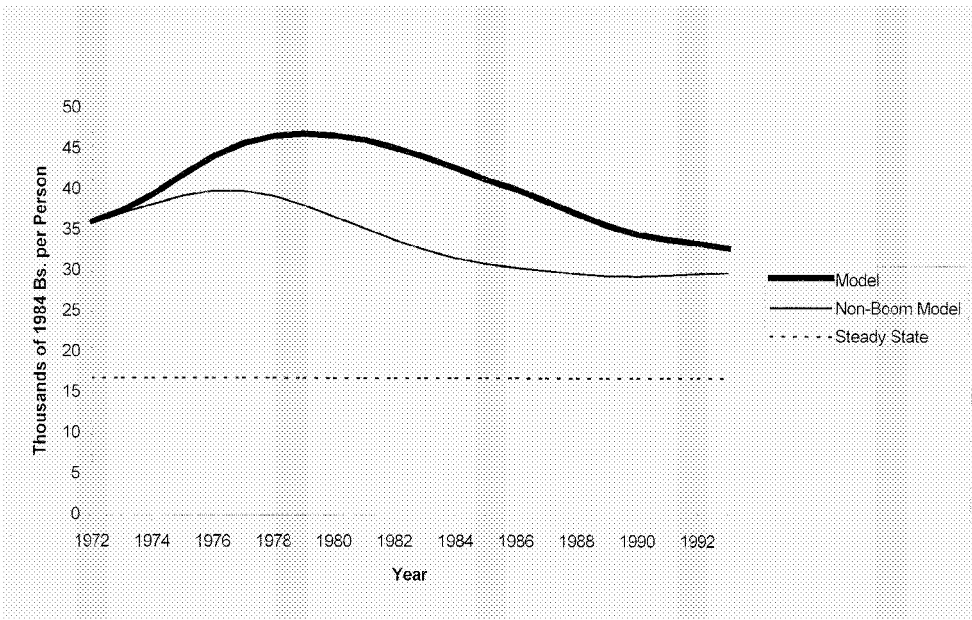

Figure 4. Per worker GDP in boom and non-boom models.

of GDP per capita growth. Figure 4 shows the level of per capita GDP achieved in the model simulation and in an alternative simulation in which oil exports, prices, and TFP are kept fixed at their 1972 levels. These figures underscore the fact that Venezuela is at this moment not very far from where it would have been without an oil shock. They also show that the country's poor growth is due to the fact that it is converging to its steady state from above. In fact, the figures suggest that per capita output in Venezuela is at the moment more than twice as high as its steady-state level.

Our simulations also suggest that the slight recovery in output toward the late 1980s and early 1990s is due to a mix of improving TFP and more favorable international prices of imported intermediates. Thus, even at constant oil prices, the model predicts a temporary halt to the fall in output at the end of the 1980s. This corresponds to an upward shift of the steady-state level of output (not shown). This recovery should not distract from the fact that the overall tendency of per capita GDP is to decline. Indeed, augmented Dickey-Fuller tests for nonstationarity of TFP and international prices faced by the Venezuelan economy did not allow us to reject the unit-root hypothesis, indicating that further improvements in these factors cannot be expected to revert the tendency of the Venezuelan economy to decline toward its steady-state levels. This point is driven home by Figure 5A, which shows that the model projects that Venezuelan GDP per capita will fall by over a quarter during the next 12 years.

In a certain sense, the Venezuelan economy's predicted decline will be due as much to depletion of natural resources as it is to Venezuela's lack of productivity growth. The

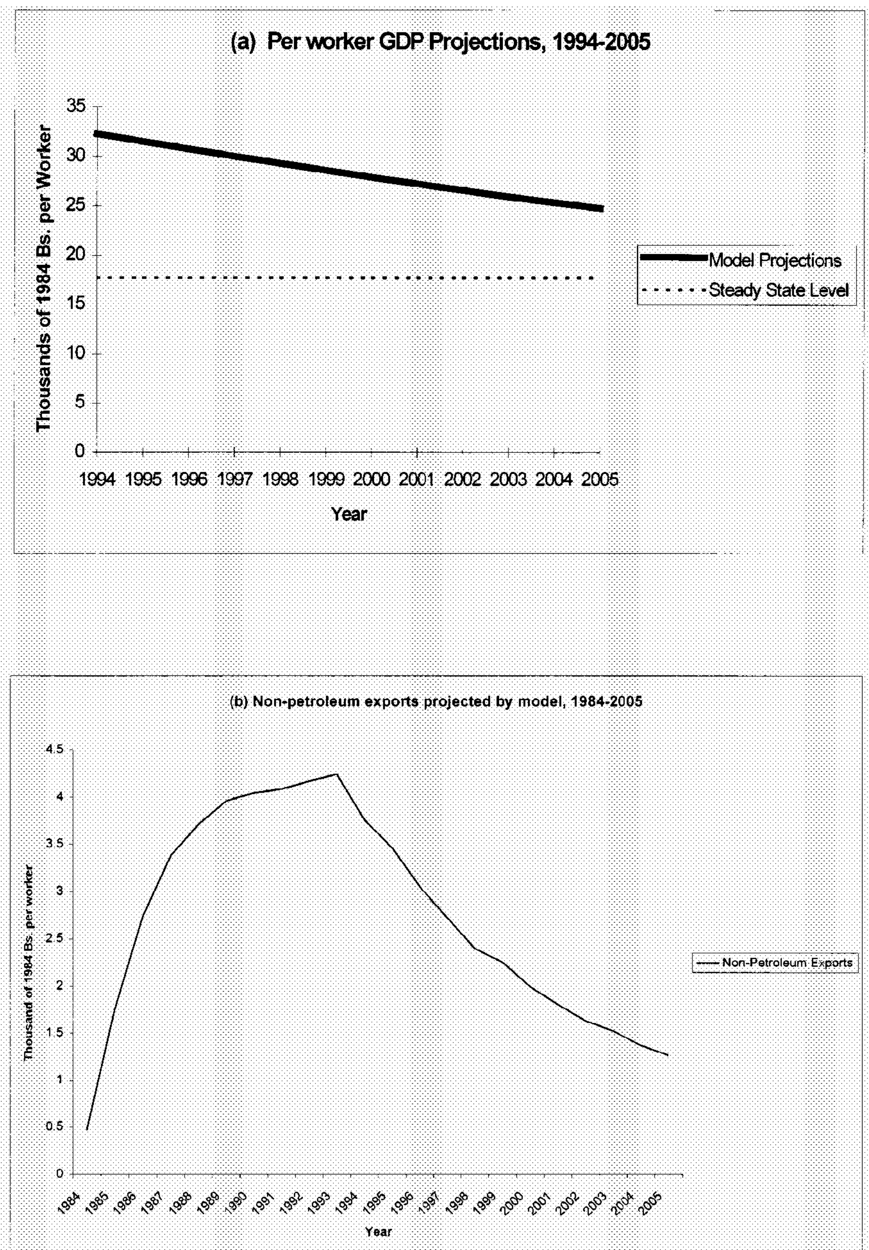

Figure 5. Exports and GDP projections.

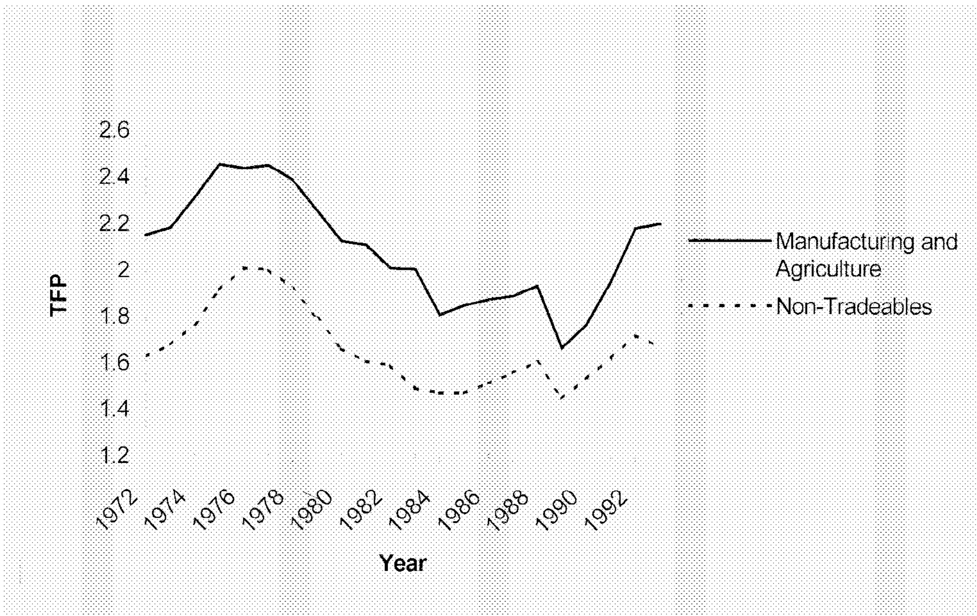

Figure 6. Total factor productivity, 1972 to 1993.

projections of Figure 5A are based on an assumption of constant TFP from 1994 to 2005. As shown in Figure 6, Venezuelan TFP has been approximately constant for the past 20 years in nontradeables as well as in tradeables.[24] This stands in contrast to the high TFP growth rates achieved by the strongest emerging economies in the same period, although it falls in line with the experience of the rest of Latin America.[25] Our simulations suggest that Venezuela would need TFP growth of approximately 1.1 percent a year simply to offset the declining tendency for output seen in Figure 5A. This productivity growth would be roughly equal to what was experienced by some of the best-performing developing economies of the world over the last 30 years. But whereas in the case of countries like South Korea such productivity growth has brought about higher living standards, in Venezuela it would simply offset the fall in oil revenues.

Table 4 shows the results of sensitivity analysis carried out with respect to our parameters. Our results do not seem sensitive to alternative parameter assumptions. The steady-state level of output is hardly changed by altering the values of the elasticities. The discount rate, the price of exports, and the productivity of the informal sector all have a moderate effect but do not take away from the main conclusion that the steady-state levels of output and the capital stock are considerably lower than their present-day levels.

Table 4. Sensitivity analysis: Nonoil GDP per capita under alternative parameter assumptions.

Elasticities of substitution		High	Baseline	Low
Domestic and imported intermediates	Parameter value	0.50	0.25	0.17
	Per worker GDP	17.75	17.71	17.71
	As % of 1993 level	*46.90*	*46.80*	*46.80*
Imported and domestic capital goods	Parameter value	0.41	0.19	0.12
	Per worker GDP	17.73	17.71	17.71
	As % of 1993 level	*6.85*	*46.80*	*46.80*
Value added and intermediates	Parameter value	0.65	0.38	0.27
	Per worker GDP	17.83	17.71	17.67
	As % of 1993 level	*47.11*	*46.80*	*46.69*
Intermediates by sector	Parameter value	0.50	0.25	0.17
	Per worker GDP	17.67	17.71	17.73
	As % of 1993 level	*46.70*	*46.80*	*46.86*
Other parameters				
Discount rate	Parameter value	0.10	0.07	0.03
	Per worker GDP	16.75	17.71	19.27
	As % of 1993 level	*44.28*	*46.80*	*50.92*
Price of exports	Parameter value	0.75	0.64	0.55
	Per worker GDP	18.54	17.71	16.68
	As % of 1993 level	*48.99*	*46.80*	*44.07*
Productivity of informal sector	Parameter value	20.00	15.68	10.00
	Per worker GDP	21.93	17.71	12.10
	As % of 1993 level	*57.97*	*46.80*	*31.98*

Note: Values refer to nonoil GDP per capita, in thousands.

3.5. Temporary Export Booms

Panel C of Figure 3 shows that Venezuelan exports expanded during the early 1990s, and the model predicts this expansion quite accurately. Indeed, this is precisely what one would expect to see on the basis of simple intuition about the Dutch disease: as export revenues from the boom industry fall, it is necessary for alternative industries to expand while the nontradeables industry contracts.

In our model, this fact is complicated by the fact that we expect the Venezuelan economy's capital stock to *decline*, not rise, toward its steady-state level. This fact is particularly important if the economy experiences a downward shock in its oil export price as the Venezuelan economy did during the second half of the 1980s. The first tendency of the economy will at that moment to export more non-oil tradeables in order to import intermediates and to keep production going given the existing capital stock. In the long run, the economy's tendency is to draw down its level of the capital stock, thus allowing for a fall in exports.

Figure 5B gives support to this view. After an initial export boom in the late 1980s, the fall in the capital stock is expected to bring down with it the export requirements of the economy. Therefore, oil and nonoil exports go down together. Our model thus casts doubt on the long-run prospects of the Venezuelan export industry. Although this industry will tend to expand as a proportion of the economy's output, it can be expected to decline in

Table 5. Intensities of emerging export industries.

% of Total Export Production	Moderate Capital Intensity	Middle Intensity	Moderate Labor Intensity	High Labor Intensity
1984–1986	0%	25%	75%	0%
1987–1989	0	10	90	0
1990–1992	0	0	100	0
1992–1995	0	0	90	10
1996–1998	0	0	62	38
1999–2001	0	0	66	34

absolute terms in line with the rest of the economy. Our model paints a pessimist picture of the prospects for Venezuela's exports.[26]

To gain insight as to the dominant factor intensities of the nascent export industries, we now use the model to attempt to discriminate between several export industries. To do this, we run simulations in which we substitute four alternative export industries for the non-oil tradeables industry.[27] These industries are characterized by the same parameters as the tradeables industry we have been using except as respects their labor intensity. Several degrees of labor intensities are selected by choosing production functions that have more convex isoquants placed along the isoquant for the baseline industry. This is equivalent to considering the baseline industry's isoquant an "outer envelope" of isoquants for many alternative export industries.[28]

Table 5 shows our results. They indicate a changing dynamic comparative advantage from more capital-intensive to more labor-intensive industries. The first export boom is characterized by production in medium and moderate labor-intensive industries, whereby our model predicts that by the late 1990s export production will have shifted to more labor-intensive industries. These results suggest that the usual strategy used in many studies of competitiveness of looking for the most efficient industries given the static general equilibrium of the economy may be a poor guide to a nation's long-run comparative advantage in the case of a natural-resource-intensive industry.[29] This fact is well known in the case of countries that are converging to their steady states from below and can be traced back to Chenery and Syrquin's (1986) description of the trends in sectoral composition of output and exports during the path of development, which suggested increasing capital intensity of export industries through time. What is less well understood is that for natural-resource-intensive economies the tendency may be for more labor-intensive industries to dominate in the long run, as their capital stock may be falling.

4. Concluding Remarks

This study shows that a story of natural-resource economies as converging to their steady states from above makes both theoretical and empirical sense. It makes theoretical sense insofar as it is a natural feature of the transition path of a neoclassical growth economy that also exports natural resources. It makes empirical sense in that a simple stylized model with this feature calibrated to a natural-resource-exporting economy is well able to track the main swings in that economy's output and its sectoral composition.

We have used this model to study Venezuelan economic performance. We find that Venezuela's growth performance during the 1972 to 1993 period, commonly viewed as a puzzling outlier in growth regression analyses, can be accounted for satisfactorily as a result of convergence from above to its steady state. We confirm that Venezuela seems to have overshot its steady state considerably and that barring high productivity growth we can expect per capita GDP to decline steadily in the future. We have also used our model to argue that countries may undergo temporary export booms more as a consequence of slack demand combined with an abnormally high level of the capital stock than of the emergence of industries that will in the long run substitute for oil exports. As a matter of fact, our model suggests that the industries that will substitute for oil will tend to be much more labor intensive than those that have emerged during the recent Venezuelan export boom. This is due to the fact that the economy's comparative advantage changes through time, a factor not always considered in studies of comparative advantage.

The decline in GDP per capita is of course a politically difficult process in which expectations of living standards must continuously adjust downward over time. It creates frustration and sparks social resentment, as Venezuelans see themselves enjoying lower living standards than previous generations. By accounting for this declining trend in living standards, our model can contribute toward explaining the severe political and social dislocations experienced by Venezuela during the past two decades.

The key restriction in our model that generates the overshooting result is the assumption of a balanced current account. As noted previously, an economy can avoid the overshooting result by selling the resource in international markets, depositing the revenues at a fixed interest rate and consuming the interest on these deposits. Although the assumption of a balanced current account is consistent with the behavior of Venezuela's current account during the 1972 to 1993 period (during which the current account surplus averaged 1.65 percent of GDP) (World Bank, 1998), a fully satisfactory account of the overshooting phenomenon should provide an account of why such a restriction seems to hold in practice.

In the Venezuelan case the answer to that question seems to bring us back to politics. The fact that the Venezuelan current account was effectively closed during the period studied masks a significant accumulation of external public liabilities and external private assets.[30] To understand the reason for which the overshooting result is generated, one must effectively understand the reasons leading the state to take actions that ultimately result in offsetting private decisions to invest resources internationally.

Two types of explanation suggest themselves. On the one hand, the state's political incentives may lead it to act in such a way as to offset private decisions. Recent research shows that in political-economy models the equilibrium response of an economy to positive terms of trade shock may not be to raise its holdings of foreign assets (Lane and Tornell, 1996; Perotti, 1996) due to the interaction of political and economic forces. Putting together our work with these models is a promising avenue for future research that may shed considerable light on the growth failures of natural-resource exporters. On the other hand, policymakers may indeed have believed that resource booms allowed them to relax the aggregate demand constraint that impedes a "big push" into development, in line with development theories in vogue at the time.[31] They may thus have genuinely deemed it necessary to use their augmented borrowing capacity to finance the investments necessary to make the economy jump to a higher-income steady state before the boom was reversed. Further research is necessary to disentangle the explanatory power of these competing explanations.

Our model presents bleak prospects for the Venezuelan economy. Most striking is the prediction that Venezuela's capital stock and capital production are bound to keep falling as it converges back to its steady-state capital stock, which according to our model is substantially lower than present-day levels. But this is due as much to Venezuela's lack of productivity growth than to its natural-resource abundance. What is really striking is that a constant rate of productivity growth is not an unreasonable assumption for Venezuela, as shown in Figure 6. If Venezuela were able to achieve rates of productivity growth similar to those undergone by the strongest performing developing countries, the downward tendency in the growth rate could be reversed.

Appendix A. Proof of Proposition 1

To establish Proposition 1 we will approximate the system of differential equations characterizing the economy's evolution near its steady-state and will prove that, given a sufficiently high resource endowment, the economy's level of the capital stock near its steady state is higher than the steady-state level despite the fact that its initial capital stock is lower.

Note first that in a steady state, $Re^{-\mu t} = 0$. But then the steady-state levels of consumption and the capital stock are the same as in the traditional case:

$$k^{ss} = \left(\frac{\delta + \rho}{A\alpha}\right)^{\frac{1}{\alpha - 1}} \tag{9}$$

$$c^{ss} = Ak^{ss^{\alpha}} - (n + \delta)k^{ss} \tag{10}$$

We can now linearize (7) and (8) around the steady states:

$$\overset{\circ}{c} = c^{ss} A\alpha(\alpha - 1)k^{ss^{\alpha-2}}(k - k^{ss}), \tag{11}$$

$$\overset{\circ}{k} = (\rho - n)(k - k^{ss}) - (c - c^{ss}) + \mathrm{Re}^{-\mu t}. \tag{12}$$

The system has the following eigenvalues:

$$\lambda_1 = \frac{(\rho - n)}{2} + \frac{\sqrt{(\rho - n)^2 - 4c^{ss} A\alpha(\alpha - 1)k^{ss^{\alpha-2}}}}{2}$$

$$\lambda_2 = \frac{(\rho - n)}{2} - \frac{\sqrt{(\rho - n)^2 - 4c^{ss} A\alpha(\alpha - 1)k^{ss^{\alpha-2}}}}{2}. \tag{13}$$

The associated matrix of eigenvectors will be

$$V = \begin{bmatrix} \lambda_2 & \lambda_1 \\ 1 & 1 \end{bmatrix}, \tag{14}$$

with inverse:

$$V^{-1} = \frac{1}{\lambda_2 - \lambda_1}\begin{bmatrix} 1 & -\lambda_1 \\ -1 & \lambda_2 \end{bmatrix} = \begin{bmatrix} V_{11}^{(-1)} & V_{12}^{(-1)} \\ V_{21}^{(-1)} & V_{22}^{(-1)} \end{bmatrix}. \tag{15}$$

The solution for the original variables satisfies:

$$\begin{bmatrix} c \\ k \end{bmatrix} = V \begin{bmatrix} z_1 \\ z_2 \end{bmatrix} = \begin{bmatrix} V_11\left(b_1 e^{\lambda_1 t} + \frac{K_1}{\lambda_1} - \frac{V_{12}^{(-1)}\,\mathrm{Re}^{-\mu t}}{\lambda_1+\mu}\right) + V_{12}\left(b_2 e^{\lambda_2 t} + \frac{K_2}{\lambda_2} - \frac{V_{22}^{(-1)}\,\mathrm{Re}^{\mu t}}{\lambda_2+\mu}\right) \\ V_{21}\left(b_1 e^{\lambda_1 t} + \frac{K_1}{\lambda_1} - \frac{V_{12}^{(-1)}\,\mathrm{Re}^{-\mu t}}{\lambda_1+\mu}\right) + V_{22}\left(b_2 e^{\lambda_2 t} + \frac{K_2}{\lambda_2} - \frac{V_{22}^{(-1)}\,\mathrm{Re}^{-\mu t}}{\lambda_2+\mu}\right) \end{bmatrix},$$

where

$$K_1 = V_{11}^{(-1)} c^{ss} A\alpha(\alpha - 1)k^{ss^{\alpha-1}} + V_{12}^{(-1)}\left((\rho - n)\,k^{ss} + c^{ss}\right), \tag{16}$$

$$K_2 = V_{21}^{(-1)} c^{ss} A\alpha(\alpha - 1)k^{ss^{\alpha-1}} + V_{22}^{(-1)}\left((\rho - n)\,k^{ss} + c^{ss}\right). \tag{17}$$

The transversality condition implies $b_1 = 0$, whereas the initial condition implies

$$b_2 = k_0 - \frac{K_1}{\lambda_1} + \frac{V_{12}^{(-1)}R}{\lambda_1 + \mu} - \frac{K_2}{\lambda_2} + \frac{V_{22}^{(-1)}R}{\lambda_2 + \mu} = k_0 - k_{ss} + \frac{R\mu}{(\lambda_1 + \mu)(\lambda_2 + \mu)}. \tag{18}$$

As we have now characterized the levels of consumption and the capital stock near the steady-state, we can now compare these with the steady-state levels. In the case of the capital stock, we can see that for it to exceed its steady-state level the following condition must hold:

$$k_t > k_{ss} \Leftrightarrow b_2 e^{\lambda_2 t} - \frac{V_{22}^{(-1)}\,\mathrm{Re}^{-\mu t}}{\lambda_2 + \mu} - \frac{V_{12}^{(-1)}\,\mathrm{Re}^{-\mu t}}{\lambda_1 + \mu} > 0. \tag{19}$$

Substituting (18) into (19) we get

$$(k_0 - k_{ss})e^{\lambda_2 t} + \frac{R\varpi}{(\lambda_1 + \mu)(\lambda_2 + \mu)}\left(e^{\lambda_2 t} - e^{-\mu t}\right) > 0. \tag{20}$$

The second term on the right-hand side of (20) will always be positive, since $\lambda_2 > -\mu$ if and only if $e^{\lambda_2 t} > e^{-\mu t}$. Therefore, for a given $(k_0 - k_{ss})$ (which we assume to be negative), R sufficiently large will ensure that the second, positive term in (20) will outweigh the first one, proving our claim. The extension to output is derived simply by inserting k in the production function.

Appendix B. Social Accounting Matrices

This appendix presents the Social Accounting Matrices from Clemente and Puente (1987) used to calibrate our model.

Table A1. Social Accounting Matrix for 1984 (unbalanced).

	Production Supply				Value Added	Investment	
	Manufacturing and Agriculture	Nontraded	Petroleum and Mining	Exports	Total Consumption	Total Investment (incl. Inventories)	Row Sum
Production demand							
Manufacturing and agriculture	42469	26390	1379	0	84414	6294	175744
Nontraded	26071	47238	5324	0	114288	34555	231973
Petroleum and mining	4558	5873	17121	85782	2894	446	116674
Imports value added							
Imports	31813	2011	3879	0	0	9306	47009
Depreciation	25327	52000	12518	0	0	0	327158
Labor rewards	30386	59823	6559	0	0	0	
Capital rent	33591	91935	78339	0	0	0	
Savings	0	0	0	0	58106	0	58106
Column sum	175744	248866	116674	105077	259702	50601	548947/ 956664

Table A2. Social Accounting Matrix for 1984 (balanced).

	Production Supply				Value Added	Investment	
	Manufacturing and Agriculture	Nontraded	Petroleum and Mining	Exports	Total Consumption	Total Investment (incl. Inventories)	Row Sum
Production on demand							
Manufacturing and agriculture	39229.1	28047.9	1545.7	0	106961	6597.4	182382
Nontraded petroleum and mining	22857.1	47985.9	5717.5	0	139445	34596.8	250602
	3893	5833.2	17999.1	85782	3465.6	436.5	117409
Imports value added							
Imports	56561.4	3855.2	7661.5	0	0	17703.9	85782
Depreciation	16971.3	42078.2	10856.4	0	0	0	69905.9
Labor rewards	20361.2	48408.5	5688.4	0	0	0	74458.1
Capital rent	22508.9	74393.5	67940.8	0	0	0	164843
Savings	0	0	0	0	59334.6	0	59334.6
Column sum	182382	250602	117409	85782	309207	59334.6	1004718

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Notes

1. Thus the widely shared view in the early 1970s was that oil-exporting countries would be able to overcome the savings constraint that kept developing countries in a poverty trap. In Venezuela, Carlos Andrés Pérez advanced the project of creating the "Great Venezuela" while in Iran Shah Reza Pahlevi spoke of building the "Great Civilization."
2. Such a preference seems well documented. See Feldstein and Horioka (1980).
3. Data are from Bulmer-Thomas (1994, Tables 9.4, A.2.1).
4. The decade of the 1960s was marked in Venezuela by repeated failed coup attempts both from the right and from the left that attempted to topple the nascent democratic system and by a prolonged Cuban-inspired guerrilla insurrection.
5. A performance that was, of course, marked by a strong expansion during the early 1970s and subsequent economic decline from 1979 to 1990.
6. In fact, if the solution is interior in the sense that $i_m^t > 0$, the problem is formally identical.
7. These results come from a simulation of a discrete-time analog of the model presented above.
8. Typically, when there is optimal depletion the stock of the natural resource will hit zero in finite time. The planners' problem becomes a dynamic optimization problem subject to binding inequality constraints on the state variables. The growth trajectory of natural-resource economies becomes a combination of a time interval in which it enjoys natural resources and a time interval during which it is identical to a Ramsey economy (overshooting occurs because it starts the latter time period with more capital stock than its steady-state level). The change in regime is characterized by jumps in the level of the multipliers (see Seierstrad and Sydsaeter, 1987, theorem 5-2), making linear approximation around the steady state (the technique used to prove Proposition 1) uninformative about the existence of overshooting and therefore making necessary the solution of the model by computational techniques.
9. The term $\chi i_t^{m^\theta}$ in the depletion function represents a convex adjustment cost that is included to rule out an infinite instantaneous rate of depletion. In its absence, the economy could use resource depletion as a substitute for flows of perfectly mobile capital and jump instantly to its steady state.
10. After investing the sum of resources necessary to augment its capital stock so as to jump to its steady-state level, assuming no adjustment costs.
11. We discuss Venezuela's net international investment position further in the conclusions.
12. Although some of the dip in production during the 1970s was due to producing below capacity, in 1993 Venezuela was producing at 87 percent of capacity (PDVSA, 1993). PDVSA's planned expansions for the end of the century promise to recover this figure to 1.4 barrels per person by 2006. However, a great part of this expansion will be achieved through profit-sharing agreements with transnationals as well as exploitation of the higher cost reserves of the Orinoco Belt, translating into a much lower surplus per barrel to be distributed among Venezuelans.

13. Capital and intermediate goods made up between 75 and 85 percent of imports and commercial policy was explicitly designed to favor intermediate and capital good imports in detriment of consumption imports, following the conventional import-substitution wisdom. Thus, although the unweighted ad valorem tariff rate was 34 percent, the average for consumer goods was 49 percent. And while a policy of exonerations reduced the effective level of these tariffs for intermediates and capital goods to less than 10 percent, even the post-exoneration tariff for consumer goods was between 20 and 30 percent. A full 81 percent of consumer goods were subject to licensing, compared with between 25 and 35 percent of intermediate and capital goods. The sources for these figures are own calculations based on OCEI (Various years) and World Bank (1987).
14. They typically do not exceed 1 percent of imports. See Antivero (1992).
15. The matrix was modified to ensure consistency with the simplifying assumptions of our model (zero consumption imports, zero base year exports of the artificial nontraded sector, as well as no government sector). Thus we estimated our Social Accounting Matrix using a method proposed by Zenios (1996) that sets the components of the matrix by minimizing the sum of squared deviations from the original observations both of the elements of the matrix as of their row and column totals. We imposed the additional restriction that exports of oil should be held at their baseline year level, since one of the elements of the closure is an exogenous series for oil exports. As this introduced certain variations in the data, all of our comparisons with historical data are actually with historical data scaled by the proportion of our estimated value of that variable in the Social Accounting Matrix used to their value in national accounts.
16. For a description of calibration techniques, see Dervis, de Melo, and Robinson (1982), Shoven and Whalley (1992), and Ginsburgh and Waelbroeck (1981).
17. Mendoza and Uribe (1996) calculate this as the equilibrium value in an endogenous discount rate calibration to the Mexican economy.
18. An important fraction of the remaining 5 percent are on transport services, of which a great proportion was probably oil-related also. Own calculations based on Antivero (1992) and Banco Central de Venezuela (Various years).
19. We exclude agriculture because the perishability of its products may indeed force it to accept a price decline much greater than the price it would be able to get in the long run if it wants to sell output that it has not been able to place in the home market.
20. We defined an industry as very countercyclical if it observes a fall in its volume of exports during the 1986 to 1988 expansion relative to both the 1984 to 1985 and 1989 to 1990 recessions.
21. These exogenous variables are price and total factor productivity levels, as well as the level of petroleum exports. As we are using annual data, the value $\lambda = 100$ was used for the Hodrick-Prescott filter (Hodrick and Prescott, 1997). This value is common in studies with annual data. Since all exogenous variables in the model are smoothed in this way, the output for the model is a set of smooth series. The only discontinuities in the slopes of the model's output series are for the year 1989, in which our model relaxes restrictions on consumption imports. This relaxation is intended to proxy for the effects of trade liberalization, which led to a contraction in the resources allocated to the import-competing industry and an expansion of the share of nontradeables in nonpetroleum GNP.
22. The only series that, after filtering, have considerable variation left are petroleum exports and petroleum export prices. Therefore, similar results are obtained when we consider only variations in petroleum exports, export prices, and TFP and hold all other price variables fixed.
23. The model does have a tendency to predict that downturns in the economy (and in the share of nontradeables) would come later than expected. The Venezuelan economy did indeed fail to be stimulated much by the second oil shock, mainly because of the contractionary policies of the Herrera administration. See Rodríguez (1986) for an account of the political economy of the Herrera contraction.
24. Our results confirm those of Paredes, who found that "in contrast with the experience of the industrialized countries and of the rapidly growing LDCs, the contribution of TPFG to overall economic growth in Venezuela has been negligible since the 1950s . . . with the exception of the early 1990s, productivity growth has been negative since the 1970s" (1993, p. 12).
25. Collins and Bosworth (1996) calculate an annual TFP growth rate of −.8 for Latin America over the 1973 to 1994 period.
26. It is too early at this time to determine whether the evidence from the 1990s supports this hypothesis. By 1996 (most recent available data at writing) nonoil or mining exports per worker were up 18 percent from their 1993 level but 7 percent lower than at their 1990 peak.

27. Technically, we set tradeable export to zero and introduce four alternative export industries.
28. See, for example, Findlay (1995) for a description of this technique.
29. An example is Enright, Francés, and Saavedra (1994) who conclude that Venezuela's most competitive industries are in skilled labor and human-capital-intensive activities.
30. Venezuelan public and publicly guaranteed external debt went from U.S. $ 1.41 billion to U.S. $ 26.9 billion (from 4 to 47 percent of GDP) from 1972 to 1993, whereas privately held external assets (excluding interest) increased by U.S. $ 38.4 billion during the same period (own calculations based on current account statistics).
31. The works of Gumersindo Rodríguez (1981, 1986), key architect of Venezuela's public investment programs during the 1970s, provide a justification for Venezuelan public borrowing precisely along these lines. For a formal model showing that a natural resource boom can lead the economy to jump to a new Pareto superior steady state, see Sachs and Warner (1997). In that paper, it is also shown that there may be conditions in which a resource boom actually leads the economy's growth rate to *decrease*.

References

Antivero, I. (1992). *Series Estadísticas de Venezuela en los Ultimos Cincuenta Años*. (vols. 1–5). Caracas: Banco Central de Venezuela.

Banco Central de Venezuela. (Various years). *Anuario de Cuentas Nacionales*. Caracas: Banco Central de Venezuela.

Bulmer-Thomas, V. (1994). *The Economic History of Latin America Since Independence*. Cambridge: Cambridge University Press.

Chenery, H. B., and M. Syrquin. (1986). "Typical Patterns of Transformation." In Hollis Chenery, Sherman Robinson, and Moshe Syrquin, eds., *Industrialization and Growth: A Comparative Study*. New York: Oxford University Press.

Clemente, L., and A. Puente. (1987). "La Matriz de Insumo Producto de Venezuela en 1984." Mimeo, Instituto de Urbanismo, Universidad Central de Venezuela.

Collins, S. M., and B. Bosworth. (1996). "Economic Growth in East Asia: Accumulation vs. Assimilation." *Brookings Papers in Economic Activity* 2, 135–191.

Devarajan, S., H. Ghanem, and K. Thierfelder (1996) "Economic Reform and Labor Unions: A General-Equilibrium Analysis Applied to Bangladesh and Indonesia." Mimeo, World Bank.

Dervis, K., J. de Melo, and S. Robinson. (1982). *General Equilibrium Models for Development Policy*. New York: Cambridge University Press.

Enright, M. J., A. Francés, and S. Saavedra. (1994). *Venezuela, el reto de la competitividad*. Caracas: Ediciones IESA.

Feldstein, M., and C. Horioka. (1980). "Domestic Saving and International Capital Flows." *Economic Journal* 90, 314–329.

Findlay, R. (1995). *Factor Proportions, Trade, and Growth*. Cambridge: MIT Press.

Gelb, A. H. (1986). "Adjustment to Windfall Gains: A Comparative Analysis of Oil-Exporting Countries." In J. Peter Neary, and Sweder van Wijnbergen, eds. *Natural Resources and the Macroeconomy*. Oxford: Basil Blackwell.

Gelb, A. H., and Associates. (1988). *Oil Windfalls: Blessing or Curse*? New York: Oxford University Press.

Ginsburgh, V., and J. L. Waelbroeck. (1981). *Activity Analysis and General Equilibrium Modeling*. Amsterdam: North-Holland.

Hentschel, J. (1992). *Imports and Growth in Highly Indebted Countries: An Empirical Study*. New York: Springer-Verlag.

Hodrick, R. J., and E. C. Prescott. (1997). "Postwar U.S. Business Cycles: An Empirical Investigation." *Journal of Money, Credit, and Banking* 29, 1–16.

Karl, T. L. (1997) *The Paradox of Plenty: Oil Booms, Venezuela, and Other Petro-States*. Berkeley: University of California Press.

Lane, P., and A. Tornell. (1996). "Power, Growth, and the Voracity Effect." *Journal of Economic Growth* 1, 213–241.

Lewis, A. (1954). "Economic Development with Unlimited Supplies of Labour." In Deepak Lal. ed., *Development Economics*. London: Elgar.

Matsuyama, K. (1992). "Agricultural Productivity, Comparative Advantage, and Economic Growth." *Journal of Economic Theory* 58, 317–334.

Mendoza, E., and Martín Uribe. (1996). "The Syndrome of Exchange-Rate-Based Stabilizations and the Uncertain Duration of Currency Pegs." Board of Governers of the Federal Reserve System, International Discussion Papers, 548.

Ministerio de Energía y Minas. (1976). *Petroleo y otros datos estadisticos*. Caracas: Divisi6n de Imprenta y Reproducci6n del MEM.

Naím, M. (1989). *Las Empresas venezolanas: su gerencia*. Caracas: Ediciones IESA.

OCEI. (Various years). *Anuario del Comercio Exterior de Venezuela*. Caracas: Oficina Central de Estadística e Informática.

Ostry, J., and C. Reinhart. (1992). "Private Saving and Terms of Trade Shocks: Evidence from Developing Countries." *IMF Staff Papers* 39, 495–517.

Paredes, C. (1993). "Productivity Growth in Venezuela: The Need to Break with the Past." Mimeo, IESA.

Perotti, R. (1996). "Redistribution and Non Consumption Smoothing in an Open Economy." *Review of Economic Studies* 63, 411–433.

PDVSA. (1993). *PDVSA Data Diskette* Caracas: Petróleos de Venezuela, S. A.

Rodríguez, G. (1981). *Economía pública, planificación y capitalismo de estado en Venezuela*. Caracas: Ediciones Corpoconsult.

Rodríguez, G. (1986). *Era Posible la Gran Venezuela*? Caracas: Editorial Ateneo de Caracas.

Sachs, J., and A. Warner. (1995). "Natural Resource Abundance and Economic Growth." NBER Working Paper 5398.

Sachs, J., and A. Warner. (1997). "The Big Push, Natural Resource Booms and Growth." Mimeo, Harvard Institute for International Development.

Seierstad, A., and K. Sydsaeter. (1987). *Optimal control theory with economic applications*. Amsterdam: North-Holland.

Shoven, J. B., and J. Whalley. (1992). *Applying General Equilibrium*. New York: Cambridge University Press.

Spraos, J. (1983). Inequalising Trade? A Study of Traditional North/South Specialisation in the Context of Terms of Trade Concepts. New York: Oxford University Press.

Taylor, L. (1983). *Structuralist Macroeconomics: Applicable Models for the Third World*. New York: Basic Books.

Tornell, A., and P. Lane. (1994). "Are Windfalls a Curse? A Non-Representative Agent Model of the Current Account and Fiscal Policy." NBER Working Paper 4839.

World Bank. (1998). *World Development Indicators 1998*. Washington, DC: World Bank.

Zenios, S. A. (1996). "Modelling Languages in Computational Economics: GAMS." In Amman, H. M., Kendrick D. A., and Rust, J., eds., *Handbook of Computational Economics* (vol. 1). Amsterdam: North-Holland.