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Nature, Development and Distribution in Latin America Evidence on the Role of Geography, Climate and Natural Resources

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Introduction

When Latin America began its historic opening to the world economy in the 1980s and 1990s, most observers and participants in the process probably thought of the region as a capital scarce, labor abundant economic area, and thought that the economic effects of the opening would be conditioned by these circumstances. For example, or so simple trade theory tells us, the region's trade liberalization could be expected to raise demand for the relatively abundant factor of production, and if this factor is labor, we might have expected to see major expansions in the production and exports of labor-intensive products. Such a development would be welcome not only on efficiency grounds, but also on distributional grounds, as the consequent upward pressure on demand for unskilled workers' wages would be expected to improve the distribution of income.

However, during the 1990s it became clear that this view of the region is incomplete and in an important sense very misleading. Compared to industrial economies, Latin America does suffer from a scarcity of capital and enjoys an abundance of unskilled workers, but in the global economy of the 1990s Latin America is far from the most labor abundant and capital poor region - that honor belongs to the economies of emerging East Asia. Latin America is special because of its enormous endowment of natural resources. And the impact of this endowment was clearly felt in many countries of the region, as economic liberalization was in several countries followed by rapid growth of foreign investment and exports of natural-resource intensive products, with a much more modest growth of labor-intensive manufacturing industries.

Also during the 1990s, the economics profession was gaining a new appreciation for the impact of geography and natural resource endowments on patterns of economic development, spurred in large part by the influential paper by Sachs and Warner (1995b), which documented their finding that resource-poor economies often vastly outperform resource rich economies in economic growth, even after accounting for other determinants of economic growth. These were not, of course, the first authors to point out this inverse relationship between resource wealth and slow economic growth; arguably the most astonishing economic development of the past 30 years has been the extremely rapid growth of the resource-poor "Asian Miracle Economies", whose performance was frequently juxtaposed against slow-growing oil economies like Mexico, Nigeria, and Venezuela, and the monumental waste and costs associated with mismanaged natural resource booms were well known.[1] But Sachs and Warner's work was important because it was the first comprehensive and methodical assessment of the association between resource abundance and growth, and showed that, even after controlling for other determinants of economic growth, the quantitative significance of the relationship was very large. For example, their estimates imply that a 15 percentage point increase in the ratio of natural resource exports to GDP reduces predicted growth by over a percentage point per year.

More recently, Gallup and Sachs (1998) have extended this line of research to include other dimensions of a country's natural resource endowment, including in particular aspects of its geographical inheritance. They provide convincing evidence that tropical countries grow substantially more slowly than do countries in subtropical and temperate climates, that landlocked countries grow more slowly than do countries where most of the population is along a coastline,

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1 [1] See, for example, Gelb (1988). See Auty (1990) for a case study approach to understanding attempts to promote resource based industrialization in eight oil countries.

and that the distance of a country from major centers of economic activity hurts economic development.

This raises important questions about recent Latin American experience. What does increased reliance upon natural resource-based industries mean for development prospects, and for the distribution of income? Has trade liberalization promoted increased reliance upon had adverse consequences for economic growth, income distribution, and economic instability?

Natural Resource Endowments are Associated with Slower Economic Growth

Although our dataset was developed with the aim of exploring issues surrounding the distribution of income, we begin with some results on economic growth. This is useful to confirm that the results reported in Sachs and Warner (1995a, 1995b) and Gallup and Sachs (1998) are generally supported in our somewhat different dataset, and to explore a couple of dimensions of the story that these otherwise more comprehensive studies did not discuss.

The data set that was used for the chapter was generated from annual data from a variety of sources. (Table 1 summarizes the variables that we use in this study and provides sources of the original data.)

Because measurements of income inequality and some of the other data that were used for the study are made at infrequent and irregular intervals, we aggregated the time series into three 11-year time intervals: 1960-1970, 1971-1981, and 1972-1982 inclusive, and used the average of the available annual data for each time period. We are thus able to learn something from the time-series, as well as the cross-sectional, variation in the data, although with only three time periods and much missing data in the earlier time periods, most of the information in the data set comes from the cross-sectional variation. As we have noted, there is much missing data for several of the variables, and the panel is as a result quite unbalanced.

In Table 2 we explore the link between geography, natural resources and economic growth in a simplified version of a Barro growth regression. In the first column of the table we present the simplest specification. We see that the lagged value of per capita income enters negatively, as is common in most empirical studies of economic growth, supporting the idea of neoclassical growth 'convergence'. We also see that investment in human capital, measured as the change in the mean years of schooling of the adult population, is highly positively correlated with economic growth, as expected, and that growth in the terms of trade is positively correlated with economic growth.

Table 1 **Variable definitions and sources**	
Gini	Gini coefficient of income inequality. Source: Deininger and Squire (1996) database.
Expsurvey	Dummy variable = 1 if the measurement of income inequality is based upon a survey of household expenditure and = 0 if the measurement is based upon a survey of household income. Source: Deininger and Squire.
Latam	Dummy variable = 1 if the country was from Latin America and the

	Caribbean.
Lppp	Log of per-capita income in constant, purchasing parity adjusted dollars. Source: *World Penn Tables 1995.* Lppp{1} refers to the lagged value of Lppp.
LKapw	Log of capital stock per worker in constant US dollars. Source: *1995 World Tables* of the World Bank.
MeanSchool	Average years of schooling of the population aged 25-65. Source: Barro and Lee (1994).
StdSchool	Standard deviation of years of schooling of the population aged 25-65. Computed using Barro-Lee data.
EduProg	Change in average years of education from one (11-year) period to the next: Meanschool-Meanschool{1}
Urban	Share of the population living in urban areas. Source: World Bank *World Tables, 1995.*
Popgrow	Rate of growth of the population. Computed using data from IMF *International Financial Statistics.*
Meanage	Average age of the population. Computed using data from the World Bank *World Tables, 1995.*
Latitude	Distance of the country from the equator. Computed as the absolute value of the latitude divided by 90.
LLand	Log of arable land per capita. Source: World Bank *World Tables, 1995.*
Xpriy	Share of primary exports in GDP. Source: export data and US$ GDP from World Bank *World Tables, 1995.*
Xfuely	Share of fuel exports in GDP. Source: export data and US$ GDP from World Bank *World Tables, 1995.*
Xnfuely	Share of nonfuel primary exports in GDP. Source: export data and US$ GDP from World Bank *World Tables, 1995.*
Xmetminy	Share of metal and mineral exports in GDP. Source: export data and US$ GDP from World Bank *World Tables, 1995.*

Table 2
Natural resources are associated with lower economic growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lppp (lagged)	-.006 (-3.00)	-.010 (-3.75)	-.006 (-3.23)	-.006 (-3.28)	-.006 (-3.12)	-.009 (-4.00)	-.012 (-5.05)	-.011 (-4.26)
Eduprog	.013 (3.51)	.014 (3.62)	.011 (2.98)	.013 (3.84)	.012 (3.57)	.010 (2.85)	.006 (1.78)	.011 (3.33)
TTgrow	.072 (2.00)	.067 (1.87)	.077 (2.13)	.137 (3.61)	.086 (2.46)	.091 (2.73)	.064 (2.04)	.088 (2.69)
Latitude		.028 (2.23)				.024 (2.13)	-.0001 (-0.01)	.009 (0.74)
Lland			-.003 (-2.34)			-.005 (-4.45)	-.002 (-2.02)	-.003 (-3.01)

Xpriy				-.006 (-0.57)				
Xmetminy					-.081 (-2.98)	-.057 (-2.14)	-.051 (-2.05)	-.056 (-1.87)
Latam							-.014 (-3.03)	
Africa							-.029 (-5.04)	
GDPvol								-.118 (-1.59)
SWOpen								.010 (2.07)
Deg. of freedom Adjusted R^2	185 .085	184 .104	184 .104	154 .159	173 .141	171 .232	169 .325	154 .273
Dependent variable: Rate of growth of real, PPP-adjusted GDP. Communist countries are excluded from all regressions. T-statistics are in parentheses.								

In the next several columns we add measures summarizing different dimensions of the economy's natural inheritance. In column 2 we add "Latitude", which is the distance of the geographical center of the economy from the equator.[2] As in Gallup and Sachs, the result suggests that tropical areas are heavily disadvantaged; the point estimate suggests that being at the Unites States' latitude raises the expected growth rate by roughly 1.2 percentage points, compared with an otherwise identical country at the equator.

In column 3 we investigate the role of land intensity, using the log of agricultural land per capita as our measure. Again, we see that there is a strong negative correlation between land intensity and economic growth. In column 4 we investigate the role of natural resource endowments, using as our indicator of resource abundance the share of primary commodity exports in GDP. Unlike in Sachs and Warner (1995b), we do not find strong evidence of a negative link between primary exports and growth, a discrepancy that we have as yet been unable to explain. However, we do find that exports of nonfuel commodity exports, and especially metals and minerals, are strongly negatively associated with economic growth.

Thus, despite the fact that our dataset does not permit a comprehensive study of the determinants of economic growth, we are able to confirm existing evidence that countries in tropical regions, with a lot of agricultural land, and abundant supplies of natural resources tend to grow more slowly than do countries with fewer natural resources, located in more temperate climates. In column 6 we add all three of these indicators to the growth regression, and see that each remains statistically significant, and the explanatory power of the regression (as measured by the adjusted R-squared) rises substantially. In column 7 we perform a very simple robustness check, adding Latin America and Africa dummy variables, motivated by the knowledge that Latin America and Africa are both resource-intensive regions whose growth performance has been poor over much of the time period of the study; we want to ensure that the measures of natural endowments are doing more than merely standing in for these dummy variables. Both dummy variables are negative, as expected, but the measures of land intensity and mineral exports remain statistically significant when the dummy

[2] This is actually the absolute value of the latitude, divided by 90. Thus, it is unity at the north pole and zero at the equator. Some values are: Argentina, .38; Brazil, .11; Mexico, .26; United States, .42, Japan, .40; Germany, .57; Finland, .71.

variables are included. (Distance to the equator, on the other hand, is less robust to the inclusion of these dummy variables.)

In the last column of the table we include two variables that have been the focus of attention in some recent studies of economic growth, and which could be mechanisms through which natural resource intensity affects economic outcomes. The first is a measure of the volatility of the underlying macroeconomic environment.[3] We use as our indicator the standard deviation of percentage changes in the rate of real GDP growth. The second is a measure of the openness to international trade that has been constructed by Sachs and Warner. They constructed a measure of a country's openness to international trade that is either zero (closed) or one (open) in each year, and we use as our measure of openness the average value of the Sachs-Warner index during the years of our three sample periods. This variable has the advantage that it is intended to cover the country's policy stance, rather than outputs such as the share of trade in GDP which depends upon many things in addtion to trade policy. It has the disadvantage that it is based upon the necessarily somewhat subjective judgements of its creators.

As in previous studies, we find evidence that macroeconomic volatility is negatively associated with economic growth, though the correlation is somewhat weaker than in some previous studies, and strong evidence that open trade policies are - other things being equal - associated with more rapid growth. However, these new variables do not reverse our earlier finding that land intensity and natural resource intensity are negatively related to economic growth, although the link between latitude and economic growth is weakened when the new variables are included.

To summarize: our data suggests, as do previous studies, that economic growth tends to be slower in tropical economies, in economies that are very land intensive, and in economies that have an abundance of natural resources, especially metals and minerals. How important might these results be? If we use the point estimates in equation 6, and use as our counterfactuals the characteristics of Europe, on the one hand, and emerging East Asia on the other, we can compute an estimate of how much more rapidly Latin America's growth would be predicted to be if it had the natural characteristics of the other two regions. Surprisingly the result is the same for both regions; Latin America's growth is estimated to be about 1.3 percentage points lower than it would have been had the region possessed the other regions 'geography and natural resource endowments. Compared with Europe, Latin America suffers mainly from proximity to the equator, though its larger endowment of land is also an important factor. Compared with emerging East Asia, the striking difference is in land intensity, which explains nearly all of the difference.

This doesn't get us very far, because it doesn't tell us much about the causes that lie behind the association between slow growth and resource intensity. But before we discuss potential linkages, we turn to evidence on the relationship between geography, resource intensity and the distribution of income.

Natural Resources are Associated with a More Unequal Distribution of Income

In recent research[4] we have explored the sources of income inequality, distinguishing between factors that are associated with the process of economic and demographic development (such as, for example, the demographic transition, educational progress, urbanization, formalization of the

3[3] For studies that emphasize the role of macroeconomic volatility, see Inter-American Development Bank (1995), Ramey and Ramey (1995), Mendoza (1996) and references cited therein.

4[4] Summarized in Inter-American Development Bank (1998).

workforce, and the process of capital deepening), and factors that are more long-lasting, notably factors related to geography and natural resource endowments. In this section we summarize and extend some of this research, paying particular attention to the role of geography and natural resource endowments.

We begin, in column (1) Table 3, with an attempt to explain the Gini coefficient of income inequality using two dummy variables, per-capita income, and squared per-capita income, which together do a reasonable job of capturing the impact on development of the development-related "transitions" described above. This basic regression adjusts for the difference between expenditure and income surveys[5], and includes a Latin America dummy, reflecting the region's high and hard-to-explain income inequality. We see that, holding income constant, Latin America's Gini coefficient of income inequality is about 10 percentage points higher than that of the rest of the world. Finally, the data suggest an inverted "U-shaped" relationship between the level of development and income inequality, although in fact the upward-sloping part of the curve applies only to such low income levels as to be largely irrelevant for almost all of Latin America and the rest of the world; on balance, the data suggest that development is associated with lower income inequality.

Table 3
Natural resources are associated with greater income inequality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Expsurvey	-3.66 (-2.70)	-4.80 (-4.16)	-6.45 (-5.44)	-5.32 (-4.50)	-5.60 (-4.63)	-1.84 (-1.82)	-3.56 (-2.45)
Latam	9.93 (7.31)	5.28 (4.18)	6.26 (5.00)	6.39 (5.16)	6.17 (4.91)	3.00 (2.79)	3.23 (1.30)
Lppp	27.47 (2.52)	30.34 (3.24)	18.76 (1.91)	24.40 (2.54)	25.53 (2.63)	2.02 (0.23)	63.69 (4.17)
$Lppp^2$	-1.96 (-2.91)	-1.97 (-3.38)	-1.32 (-2.16)	-1.62 (-2.71)	-1.70 (-2.83)	-.138 (-0.26)	-3.93 (-4.08)
GDPvol		58.79 (2.99)	81.16 (3.88)	71.42 (3.57)	68.63 (3.39)	28.85 (1.70)	48.29 (1.65)
Latitude		-20.84 (-6.13)	-18.58 (-5.12)	-17.74 (-5.24)	-18.68 (-5.54)	-10.02 (-3.67)	-23.59 (-4.20)
LLand		1.12 (3.95)					2.06 (4.17)
Xpriy			-1.02 (-0.31)				
Xnfuely				7.98 (1.52)			
Xmetminy					17.33 (1.63)	16.86 (1.78)	
Gini{1}						.623 (9.21)	

[5] According to the results, household expenditure tends to vary less across the population than does household income. This is consistent with the consumption-smoothing hypothesis, if as seems plausible households are subject to large, transitory shocks to their income.

Fdep							-3.12 (-0.67)
LndGini							-7.89 (-1.25)
Degrees of freedom Adjusted R^2	166 .471	158 .625	138 .668	148 .638	145 .645	72 .885	54 .725
Dependent variable: Gini coefficient of income inequality. Communist countries are excluded from all regressions. T-statistics are in parentheses.							

In column 2 of Table 3 we begin to add some variables related to more long-lasting characteristics of the economic and physical environment. Our first finding is that macroeconomic volatility is associated with substantially more income inequality, confirming our earlier results(Inter-American Development Bank (1995)) with a much expanded dataset.

We also see a strong, negative correlation between distance to the equator and income inequality. Other things being equal, being at the United States latitude instead of the equator is predicted to lower the Gini coefficient by more than 8 percentage points! This is roughly half the difference between Latin America's and the industrial country's income inequality.

We also see that land intensity is associated with more inequality, a result that is statistically and economically highly significant. The point estimate in column 2 suggests that the difference between the typical land intensity in Latin America and that of emerging East Asia accounts for roughly 3 percentage points of the difference in the region's Gini coefficients.

In subsequent columns of Table 3 we investigate the correlation between other measures of natural resource intensity and the distribution of income. Column 3 shows that total primary exports are not correlated with income inequality, in large part because there appears to be a weak negative correlation between oil exports and income inequality. However, as we see in columns 4 and 5 of the table, nonfuel primary exports are positively correlated with income inequality, and exports of metals and minerals even more so.

There may be cause for concern that this correlation between natural resource intensity and inequality is a spurious one, driven by other unmeasured differences between regions like Latin America and Africa, both areas of high inequality that are resource rich but also differ in other potentially relevant respects from resource-poor regions like emerging East Asia. If we had a comprehensive list and the relevant information on potential, alternative explanators, we could control explicitly for them, and we have verified that the basic results in Table 3 are robust to a number of additional explanatory variables. In column 7 of Table 3 we illustrate one such result, including two variables that were emphasized in a recent, influential paper on income inequality by Li, Squire and Zou; financial depth and the Gini coefficient of land ownership. As in that paper, financial depth is measured as the ratio of banking system liabilities to GDP. Inclusion of these variables does actually increase slightly the magnitude and statistical significance of the "natural resource" variables that are included in the regression - latitude and land intensity - and the additional explanatory variables are statistically insignificant and in the case of the land Gini, of the wrong sign.[6]

[6] The negative (conditional) correlation between the land Gini and the income Gini is puzzling, if only because one might expect a high income Gini to result in a high land Gini. However, our reading of the evidence is that the land Gini is a particularly fragile explanator of income inequality. This positive correlation between the income Gini and the land Gini results almost entirely from the fact that Latin America has very high income and land inequality. A Latin America dummy is enough to wipe out the statistical

Of course, we cannot control for every possible alternative explanatory variable, because we have neither the imagination, the data, nor the time to test all possible combinations. An alternative robustness check is to include the lagged Gini coefficient as an explanatory variable. To the extent that the lagged Gini is correlated with alternative, omitted determinants of the current Gini, it should reduce the possibility of a spurious correlation between our natural resource variables and income inequality. In column 6 of Table 3 we add the lagged income Gini to our basic regression. This does reduce the magnitude and the statistical significance of income per capita. However, the variables that are our primary concern - including our measures of macroeconomic volatility, geography and resource intensity - remain statistically significant, and the estimated long-run effect of changes in those variables is roughly the same as in the previous specification, except in the case of metal and mineral exports, where it is larger in the new specification.[7]

We thus see that measures of geography and natural resources are closely associated with income inequality, and that this association is statistically significant. But is the association significant in quantitative, as well as statistical terms? Table 4 addresses that question by constructing two counterfactuals, which use the regression results reported in column 2 of Table 3 to answer the question, how would Latin America's income inequality be predicted to change if the region possessed the characteristics of Europe or emerging East Asia.

Table 4
Estimated impact on income inequality of geography and land intensity

Estimated impact of:	Counterfactual:	
	Europe	Emerging East Asia
Latitude	7.8	-0.3
Land intensity	0.6	3.3
Total	8.4	3.0
Actual difference	19.2	10.8

Source: Authors' calculations based upon regression results reported in column (2) of Table 3. Emerging East Asia includes Hong Kong, Indonesia, Korea, Malaysia, Singapore, Taiwan, and Thailand.

The results suggest that, in quantitative as well as statistical terms, the most important 'explanator' of the difference between Latin American and European income inequality is distance to the equator, which is associated with an increase of the Latin American Gini coefficient of nearly 8 percentage points, accounting for over 40 percent of the very large difference between Latin American and European Gini coefficients. Latin America's land intensity 'explains' about 0.6 percentage points of the difference between Latin American and European income inequality.

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significance of the correlation and to change its sign. For example, in a regression of the income Gini on a constant, the expenditure survey dummy and the land Gini, the coefficient on the land Gini is positive with a t-statistic of 3.52. If a Latin American dummy is added to this regression, the estimated coefficient becomes negative, with a t-statistic of -1.03. A similar pattern was observed when additional explanatory variables were included in the regression.

7 [7] If 'a' denotes the coefficent on an explanatory variable in regression (6) and 'b' denotes the coefficient on the lagged Gini coefficient, the long-run effect of a change in the explanatory variable is a/(1-b). The specification with land intensity is also robust to the inclusion of the lagged Gini coefficient.

If we compare Latin American income inequality to emerging East Asia, a different picture emerges. The distance to the equator explains very little of the difference in the regions' income inqualities, but the vast difference between Latin America's very abundant, and emerging East Asia's very scarce, endowments of land 'explains' about 3 percentage points of the 10.8 percentage point difference between Latin American and East Asian income inequality.

We conducted a similar exercise using the specification reported in column (5) of Table 3, which substitutes mining and mineral exports for land intensity. We found that the quantitative significance of mining and metals endowments was quite small for Latin America as a whole, because for most countries of the region, these exports are not large. However, for some countries the estimated impact on the Gini coefficient was large, including notably Chile, where the variable 'accounts' for roughly 2.5 percentage points of the difference between the country's Gini coefficient and that of the industrial economies.

One would not want to take these point estimates too literally. The data are rife with measurement problems, there is no really strong theory to support and provide restrictions on any particular empirical specification. Finally, there are important interactions among the explanatory variables, some of which we explore below, which complicate the interpretation of these 'comparative static' exercises. Nevertheless, the results do point toward significant effects of geography and natural resource endowments on income inequality. Distance to the equator bears an extremely strong and robust association with income inequality, even after one controls for the level of development and the regional dummy variables that are also highly correlated with income inequality. Measures of land intensity are also strongly correlated with income inequality, although the correlation is less powerful than that of latitude. Finally, there is evidence that natural resource endowments, as reflected in exports of primary commodities, are positively associated with income inequality, an association that seems to be strongest for metals and mineral exports.

What Does This Mean?

This all suggests that geography and a country's natural resource endowments matter. Countries located near the equator, with large endowments of land and natural resources tend to grow more slowly and generate more income inequality than less resource-intensive economies countries located in subtropical or temperate climates. What does this mean? We cannot discuss every possible explanation here, but focus on three stories that seem particularly plausible to us, after which we turn to some policy implications.

Hypothesis 1 - Tropical conditions reduce labor productivity and wages.

One explanation for the strong association between geography and inequality and growth emphasizes the difficulties that tropical conditions create for workers, and the impact of tropical conditions on the productivity of labor. While progress has been made in ameliorating some of these conditions, life in tropical areas remains complicated by disease, and by problems associated with climate, soil quality, pests, and water quality that hamper the productivity of labor, and particularly undermine agricultural efficiency. This has been amplified historically by the fact that many of the most important innovations in agricultural technology have been associated with agricultural products and production techniques that are well suited to temperate, but not tropical regions.

As we have noted, recent studies have begun to quantify the enormous toll that these conditions impose on progress for economic growth. This interruption of development prospects itself contributes to inequality, because as we have argued economic development tends to be good for distribution, except at quite low income levels. But there is also good reason to expect that tropical

conditions exert an independent effect on income inequality. At least in the earlier stages of development, when industrialization is taking place by drawing labor out of the rural workforce, wages and working conditions in the modern sector will be linked, at least loosely, to conditions in the rural areas.

If an independent worker without a lot of capital can, as was the case in the United States during much of its industrialization, make a good living in farming, a fairly high floor will be placed on wages that workers will accept in the industrial sector. Under these conditions, industrialization can take place with relatively high wages and low income inequality. If, on the other hand, workers in rural areas face the life of low productivity and difficult living conditions that are to be found in many tropical regions, industrialization may take place in a 'buyer's market' for labor, with low wages and high inequality. Moreover, as we have emphasized above, the resultant income inequality is likely to be amplified and perpetuated by the impact of these difficult labor market conditions - in rural and modern sectors alike - on family decisions about fertility, labor force participation, and education.

These labor market conditions may be reinforced by mechanisms that are emphasized in a complementary explanation for the association between tropical environments and inequality.[8] This explanation emphasizes the nature of the technologies appropriate for tropical crops, as compared with crops grown in temperate climates. Many of the most important tropical crops, including for example cotton, sugar, and tobacco, are efficiently produced on large-scale plantations. This is much less true of most temperate crops such as wheat, maize, or barley for which, until the relatively recent introduction of agricultural mechanization, relatively small-scale production was reasonably efficient.

It has been argued that the returns to scale associated with many tropical crops facilitated an extreme concentration of land ownership. This idea is certainly borne out by the data, which show that the ownership of land is much more concentrated in tropical than in temperate areas. In fact, the correlation between latitude and the concentration of land ownership is even more impressive that the correlation between latitude and the distribution of income, suggesting that the promotion of highly concentrated land ownership is an important mechanism through which climate and geography have influenced the distribution of income.

The concentration of land ownership that was facilitated by the increasing returns to scale in the production of tropical crops reduces competition among employers and may provide them with substantial market power over their employees, thus compounding the difficulties faced by workers in tropical areas. This most extreme manifestation of this market power was slavery, a phenomenon that developed almost exclusively in tropical and subtropical climates, these being parts of the new world where agricultural technology presumably made it most profitable. One view is that inequality in many parts of Latin America is in substantial part the inheritance of this legacy of tropical labor markets, including importantly slavery, its most extreme form.

The concentration of land ownership that typifies countries in tropical regions was facilitated in Latin America by the land, immigration, and labor policies of governments from early colonial times. But the interesting historical question is whether these policies were accidents of history, or whether they were themselves the result of the natural resource endowments, climate, and other geographical conditions of the Latin American colonies. It has been argued[9] that such policies, as

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8 [8] See Engerman and Sokoloff (1998) for a persuasive presentation of this view.

9 [9] See, for example, Engerman and Sokoloff (1998).

well as many of the institutional features that have long been invoked as explanations for Latin America's highly skewed distribution of income have their roots in the factor endowments that awaited the Spanish and Portugese colonizers of the region.

Hypothesis 2 - Natural resources are a 'capital sink'

There are other explanations for the link between natural resource endowments and inequality. It has been argued, for example, that mineral resources and certain types of land may require a lot of physical capital to exploit.[10] In developing countries, where capital is scarce, the attraction of capital to natural resource based industries may severely limit the availability of the capital that may be required to support a growing manufacturing and modern services sector, without at the same time generating a significant demand for unskilled labor. This leaves workers in a difficult situation, lowering real wages and worsening the distribution of income. And, to the extent that growth is facilitated by the development of manufacturing and nonresource-based industries more generally, natural resources may even undermine prospects for long run development, with deleterious implications for the distribution of income.[11]

Hypothesis 3 - Natural resources create macroeconomic volatility, leading to low growth and high inequality

We argued above that macroeconomic volatility undermines both prospects for growth and the distribution of income. This provides another channel through which natural resources matter, for countries that are more reliant upon natural resource based industries face much larger external shocks than do other countries. Some evidence for this is provided in Table 5, where we show the strong correlation between the volatility of terms of trade shocks and the volatility of real GDP growth.[12] Columns 1-3 of Table 5 document the fact that the volatility of real GDP growth is strongly correlated with the volatility of the terms of trade and with the ratio of primary exports to GDP. Furthermore, column 7 of the same table shows that countries that are heavily reliant upon primary commodity exports tend to experience larger terms of trade shocks.

The econometric work discussed above suggested that this macroeconomic volatility is associated with greater income inequality. We can go further and describe some of the mechanisms through which economic instability contributes to income inequality. One key channel is education. As we and other authors have argued in recent work, during bad economic times poor families may be forced into adjustments that have long-lasting implications for their earning capacity and that of their children. They may, for example, be forced to pull their children out of school, either because the out-of-pocket expenses are too high or because they need their childrens 'earnings to help support the family. However, once the adverse macroeconomic conditions subside, it is unlikely that the child will return to school. A transitory shock will have done permanent damage to this family's accumulation of human capital.

This happened in a big way during the 1995 recession in Mexico. During the recession year 1995, more than 5 percent of youths between the ages of 12 and 25 entered the labor force - most of

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10[10] See Leamer *et. al.* (1998) for a more complete articulation of some of these ideas.

11[11] A number of theoretical ideas have been floated to explain how large natural resource endowments may undermine growth prospects. These typically involve externalities, increasing returns to scale, or important learning-by-doing dynamics in industries that tend to be crowded out by the presence of natural resource wealth. See, for example, Matsuyama (1992).

12[12] In other work we have argued that volatility in the terms of trade also contributes to volatility in the real exchange rate, and that real exchange-rate volatility also undermines economic growth. See Gavin and Hausmann (1996) for evidence on the link between terms of trade shocks and real exchange rate volatility, and Inter-American Development Bank (1995) and references cited therein for evidence on the relationship between real exchange rate volatility and economic growth.

them into informal employment, and most of the remainder into unemployment - suggesting that a significant number of youths had to abandon their studies.[13] And despite the recovery that was achieved in 1996, the flow of youths into the labor force was not reversed, but rather continued.

In Table 6 we provide additional evidence that macroeconomic volatility is associated with lower educational attainment.[14] We regress the average years of education of the population aged 25-65 on the log of the physical capital stock per worker, to control for the stage of development, and on real GDP volatility. The coefficient on our measure of macroeconomic volatility is negative and highly significant in statistical terms, indicating that a volatile macroeconomic environment impedes overall educational progress. It goes almost without saying that this is bad for growth and development. It is also bad for the distribution of income, because the scarcity of human capital translates into higher skills premia and greater wage dispersion.

But there is more, for it is lower-income families who are likely to be forced into actions like these, not the relatively wealthy. Indeed, one might expect the children of wealthy parents, who face far less pressing financial constraints during bad macroeconomic times, to extend their stay in school when times are hard, since the opportunity cost of school is much less attractive than it would be during a period of good times and tight labor markets.[15] We thus expect macroeconomic volatility to be associated not only with lower educational attainment on average, but also a wider dispersion of educational attainment across the population. Columns 4-6 of Table 6 show that this expectation is also borne out by the data. After controlling for the relationship between average educational attainment and educational inequality[16], there is a strong positive relationship between real GDP volatility and educational inequality. There is also a strong positive relationship between inflation and educational inequality, which is consistent with the idea that high inflation is particularly burdensome for lower-income households.

Some Thoughts on Policy Implications

Passing from the kind of econometric evidence that we have discussed to policy implications is of course a treacherous business, complicated here because of the absence of a strong theoretical framework with which to frame and quantify the relevant tradeoffs. But the stories that we have described above do seem to us to have some implications for policy, which we now discuss.

1. Geography, development and distribution: A new 'human capital' agenda?

Among the most striking results that we have documented in this paper is the strong correlation between the physical environment, as measured here by the distance to the equator, and income inequality. This finding parallels the equally striking linkages between geography and economic growth rates that have recently been documented by Gallup and Sachs (1998), among others. To the extent that these results have to do with the physical conditions of life in the tropics that

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13[13] These figures are based upon an analysis of household survey data for Mexico. See Inter-American Development Bank (1998) for more details.

14[14] See also Flug, Spilimbergo and Wachtenheim (1996).

15[15] This is, of course, the pattern typically observed in industrial economies.

16[16] Our measure of educational inequality is the standard deviation across the population of years of schooling. The relationship between average educational attainment and educational inequality is described in more detail in Inter-American Development Bank (1998). It is approximated from aggregate data on educational attainment from the Barro-Lee database. It stems in large part from the fact that increased educational attainment is associated with a gap between the education of the young and that of the old, thus, even if intra-cohort inequality is unaffected, educational inequality across cohorts and thus in the population at large will increase.

impede labor productivity, including tropical diseases, soil and water quality, transport costs, and so on, they raise a rather different agenda for human capital accumulation, one which may place more emphasis on eradicating or mitigating the effects of these specific difficulties, in addition to promoting educational progress.[17]

For a middle-income substantially urbanized population like most of Latin America, these concerns are probably much less relevant than they may be in lower income and more agricultural regions like Africa or South Asia. However, even if they are not relevant today, they may have been relevant only a relatively few generations ago, when conditions facing agricultural workers were a more decisive influence on the distribution of income. And, while the initial causes of high inequality may have receded in importance, its influence may remain with the region through its impact on economic institutions and policies, and because highly unequal distributions of income tend to be propagated from one generation to the next, as poor families in one generation take decisions about fertility, labor force participation and their children's education that transmit poverty to the next generation. This suggests the desirability of compensatory policies designed to break the intergenerational transmission of inequality in human capital and earnings capacity, such as raising the quality and lowering the costs of education for lower income families, and policies to reduce barriers to labor force participation by women, such as restrictions on part-time work that force women into 'all or nothing' choices between participation and their family responsibilities.[18]

2. Has trade liberalization gone too far?

As we have argued, Latin America is abundantly endowed with natural resources. Theory and experience suggest that trade liberalization will therefore tend to encourage specialization in resource-based industries. We have also argued that such a specialization has tended to be associated with lower rates of economic growth and worsened income inequality, in part because it renders the economy more vulnerable to external shocks. The question naturally arises: have we overdone it with trade liberalization? Was the wholesale retreat from the import-substitution policies of the region's recent past a mistake?

In our view, the question needs to be taken seriously, but the answer is almost certainly 'no'. First, there is now substantial evidence that openness to international trade is associated with substantially more rapid economic growth. Second, even if there were adverse effects on growth, open trade policies are likely to promote greater economic efficiency and welfare, even if they result in an expansion of the resource-based industries. (How much additional growth would Venezuela require to compensate for the loss of its oil industry? One suspects that it is almost surely more than the country would obtain from closing down the industry.)

Third, the import substitution policies of the past may have promoted the development of a less specialized production structure, but it did not make the economy less reliant upon primary commodities in its international trade; indeed, as is well known, the anti-export bias of these policies discouraged the development of all but the most profitable industries, which were often those based upon abundant supplies of natural resources. This may be one reason why openness is apparently *negatively* associated with macroeconomic volatility. In column 4 of Table 5, above, we add the Sachs-Warner index of the openness of policies toward international trade to the regression

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17[17] For example, Gallup and Sachs suggest that the incidence of malaria is strongly negatively correlated with economic growth, suggesting that such tropical diseases may be an important part of the story behind the link between tropical climate and economic growth.

18[18] See Inter-American Development Bank (1998) for a more complete discussion of this point in the Latin American context.

that seeks to explain the volatility of real GDP growth. There is a strong negative association between openness and volatility - indeed, openness is estimated to reduce the volatility of real GDP growth by 1.6 percentage points, nearly 2/3 the difference between Latin America's and the industrial countries' real GDP volatility, and the t-statistic is -3.96, suggesting that the result is highly significant in statistical terms. In column 6 of Table 5 we interact this measure of openness with the ratio of primary commodity exports to GDP, to see if the openness appears to be more or less stabilizing for countries that are highly reliant upon primary commodities. The result suggests that open trade policies have a larger stabilizing effect in countries that are reliant upon primary commodity exports, which is consistent with the idea that in such economies, policies that close the economy to trade tend to promote a specialization in resource-based exports.

The evidence also appears to belie the idea that there is an equity-efficiency tradeoff in trade policy. In the first column Table 7 we add the Sachs-Warner index of openness to the regression that we used to explain the Gini coefficient of income inequality in Table 2. We see that there is essentially no correlation between the Gini and trade liberalization, which is consistent with the results of Londoño and Székely (1997), which found very small direct effects on inequality of trade liberalization and other structural reforms of the 1990s. In column 2 we interact openness with our measure of capital intensity and find that openness tends to be more unequalizing in capital-abundant economies, which is consistent with the idea that in countries with lots of capital, openness encourages specialization in capital intenstive goods and raises the return to capital, which leads to greater income inequality. In column 3 we obtain the somewhat surprising result that openness tends to be particularly *equalizing* in land intensive economies. In column 5 we include both interactive terms, and see that the results continue to hold, a pattern that is encouraging for Latin America which, as a region of relatively low capital intensity and high land intensity, is predicted to see improvements in the income distribution as a result of liberalization. In column 4, however, a more cautionary note is struck, as we obtain some (statistically very weak) evidence that the openness may worsen the distribution of income in countries with very large endowments of metals and minerals.

3. Policies toward natural resource industries.

We have argued that there is little evidence to suggest that the closed economic policies of the region's fairly recent past would promote more rapid economic growth, reduce macroeconomic volatility, or generate a more equal distribution of income. This does not mean that there are no decisions to be made with respect to the exploitation of a country's natural resource endowments, or that a completely neutral trade and industrial policy toward the sector is warranted. There are plausible arguments to suggest that taxation of the natural resource-based industries should be at least as high as that of other sectors that compete with the sector for resources. For example, under the unproven but far from implausible hypothesis that the manufacturing industry carries with it learning-based and other externalities that promote economic growth, the competition between manufacturing and natural-resource based industries for factors of production will result in an inefficiently small manufacturing sector, leading to an unnecessary sacrifice of economic growth and welfare. At the same time, the highly capital intensive nature of many resource-based activities will tend to raise returns to capital, and lower wages, as compared with an economy with a vibrant manufacturing sector. These arguments are probably too speculative at this juncture to justify an explicit industrial policy designed to discourage resource-based industries and promote others. But the evidence on the apparently adverse effects on growth and equity of large resource-based industries certainly suggests that special tax and other incentives should not be provided for resource based industries, even if they are an important part of the export base.

4. Policies to control and manage the effects of macroeconomic volatility.

Finally, the region's reliance upon natural resource exports leaves it highly vulnerable to terms of trade shocks, a vulnerability that is all too apparent now, as the region's economies are being buffeted by the enormous commodity-price shock associated with the Asian financial crisis. This vulnerability demands a policy response, to reduce the impact of shocks on the domestic economy, and ameliorate their effect on vulnerable segments of the population. An extended discussion of these issues would take us too far afield, but here we merely note that important revisions to the policy framework are warranted above all in fiscal policy and public debt management, and in the regulation and supervision of the domestic financial system. Because of the region's exposure to such disturbances, the macroeconomic stakes are higher in Latin America, and policy needs to adapt to the challenge or suffer the consequences for growth, inequality, and economic insecurity.

Table 5
Natural resources are associated with macroeconomic volatility

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	GDPvol	Gdpvol	Gdpvol	GDPvol	GDPvol	GDPvol	TTvol
TTVol	.167 (7.72)		.154 (5.83)	.107 (3.58)	.106 (3.55)	.113 (3.86)	
Xpriy		.058 (5.90)	.039 (3.36)	.043 (3.04)	.043 (3.05)	.057 (3.91)	.171 (6.56)
Oild				.004 (0.71)	.005 (0.75)	.004 (0.71)	.041 (3.22)
SWOpen				-.017 (-3.96)	-.016 (-2.79)	-.007 (-1.41)	
SWOpen*Xpriy						-.020 (-3.06)	
Lppp					-.0008 (-0.30)		
Degrees of freedom Adjusted R^2	345 .145	273 .110	259 .233	234 .250	233 .247	233 .276	268 .244

Dependent variable is indicated at the head of each column. Communist countries are excluded from all regressions. T-statistics are in parentheses.

Table 6
Volatility is associated with less, and more unequal, educational attainment

	(1)	(2)	(3)	(4)	(5)	(6)
	Mean school	Mean school	Mean school	Std school	Std school	Std school
Lkapw	1.62 (15.49)	1.56 (14.20)	1.61 (14.14)			
Gdpvol		-10.96 (5.89)	-12.21 (-2.02)		3.71 (3.56)	3.21 (2.45)
Infltax			.882 (0.62)			.753 (2.53)
Meanschool				-.348 (-8.88)	-.342 (-8.69)	-.318 (-7.59)
LMeanschool				2.63 (14.36)	2.68 (14.37)	2.55 (12.45)
Degrees of freedom Adjusted R^2	166 .589	162 .593	159 .590	303 .616	288 .623	266 .592

Dependent variable is indicated at the head of each column. Communist countries are excluded from all regressions. T-statistics are in parentheses.

Table 7

Openness and inequality: An equity-efficiency tradeoff?					
	(1)	(2)	(3)	(4)	(5)
Expsurvey	-5.10 (-4.35)	-6.54 (-4.57)	-4.78 (-4.08)	-5.69 (-4.83)	-6.13 (-4.25)
Latam	4.37 (2.99)	3.83 (2.15)	4.44 (3.07)	4.20 (2.90)	3.86 (2.18)
Lppp	33.36 (3.40)	44.16 (2.51)	34.49 (3.54)	31.45 (3.10)	43.58 (2.50)
$Lppp^2$	-2.13 (-3.49)	-2.90 (-2.66)	-2.22 (-3.67)	-1.98 (-3.17)	-2.90 (-2.69)
GDPvol	52.45 (2.41)	64.21 (2.31)	43.60 (1.99)	55.59 (2.45)	58.87 (2.12)
Latitude	-22.97 (-6.70)	-24.13 (-4.94)	-21.42 (-6.16)	-22.23 (-6.64)	-23.90 (-4.93)
LLand	1.23 (4.07)	.907 (2.55)	2.22 (3.92)	.926 (3.01)	2.21 (2.48)
SWOpen	-.50 (-0.32)	-19.58 (-1.45)	2.25 (1.11)	-2.68 (-1.43)	-19.83 (-1.48)
SWOpen*Lkapw		2.16 (1.41)			2.63 (1.70)
SWOpen*Lland			-1.47 (-2.06)		-1.65 (-1.59)
SWOpen*Xmetminy				28.87 (1.17)	
Degrees of freedom Adjusted R^2	146 .624	98 .663	145 .632	138 .652	97 .668
Dependent variable: Gini coefficient of income inequality. Communist countries are excluded from all regressions. T-statistics are in parentheses.					

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