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Does natural resource abundance increase Latin American income inequality? [1]

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Abstract

Why is income inequality higher in Latin America than in East Asia? Is this phenomenon related to the region's natural resource abundance? Is it a contributor to Latin America's slow and narrowly focused human capital accumulation? If so, can anything be done to reverse the Latin American trends, or should we think of the region's fate as unalterable? To help answer these questions, this paper draws upon standard trade theory and cross-sectional empirical analysis to demonstrate that natural-resource-intensive sectors, particularly permanent agriculture, absorb capital that might otherwise flow to manufacturing. This depresses workers' incentive to accumulate skill and delays industrialization.

JEL classification: F11; O15

Keywords: Income inequality; Heckscher–Ohlin; International trade; Natural resource abundance

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[1] This paper explores in detail one of the main themes of our larger and ongoing inquiry into the factors affecting Latin American income inequality. The dataset used throughout this paper is available at http://www.personal.anderson.ucla.edu/ ~ peter.schott/.

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1. Introduction

Arguments abound for the relatively poor economic performance of Latin America over the past 30 years. Many of these explanations attribute the region's troubles, including low growth and high income inequality, to a particular set of political choices made by governmental leaders. Fairly representative of this view is the following abstract of a paper entitled 'Are Resource-Abundant Economies Disadvantaged' authored by Kym Anderson, University of Adelaide, CIES:

> Empirical evidence suggests that economies well endowed with natural resources relative to other factors of production have grown slower than other economies over the long term. This paper explores why that might be so and whether their fortunes might be changing with the increasing demand for environmental regulations. Proposed explanations for their relatively poor growth record, such as declining terms of trade and rising restrictions to primary product markets abroad, on closer inspection are unconvincing. The most likely reason is their own distortionary policy regimes, whose recent reforms in some resource-rich economies are already yielding growth dividends. Why it should be that their policy regimes had been more distortionary than those of other economies, and why they are currently being reformed in some but not other resource-rich economies, are moot points which have been addressed only in a cursory way to date (Anderson, 1997).

These words were written in March of 1997 prior to the Asian exchange crises, which has precipitated a new look at governments and financial systems in Asia. Today, writers might be inclined to say that governments everywhere are pretty poor. In this manuscript, we take a different tack and revisit the old structuralist arguments with a new theoretical framework—the multi-factor, multi-good Heckscher–Ohlin model. Leamer (1987) has shown using the three-factor, *n*-good model that countries rich in natural resources can have a path of development that is very unlike the paths taken by resource-poor countries. Our goal in this manuscript is to explore the idea that permanent agriculture and mineral extraction absorb a natural-resource-rich country's scarce savings, delaying the emergence of manufacturing. When manufacturing does emerge it concentrates on moderate- to high-capital-intensive products. This path is beneficial because competition with China, India and other labor-abundant countries is avoided. But the cost is the much greater income inequality associated with the production of permanent crops and ores, and the delay in the greater equality engendered by manufacturing and the accumulation of human capital it requires.

In the multi-cone Heckscher–Ohlin model, zero profit conditions link the external prices of tradeables with internal prices of factors, determining what is known as the Stolper–Samuelson mapping of product prices into factor rewards. The logic of the Stolper–Samuelson mapping is pretty straightforward. With

constant returns to scale and mobility of factors between sectors, a deterioration of the price of a tradeable must be offset by suitable reductions in some factor price in order to maintain the zero profit in the affected sector. This reduction in one factor price must be offset by increases in others in order to maintain zero profits in tradeables sectors with stable product prices. And so on. If there are 'enough' zero profit conditions in the tradeables sectors, then factor prices are completely determined by these external competitiveness conditions. If not, the external competitiveness conditions determine some linear combinations of factor rewards (via the zero profit conditions) while local demand and supply conditions complete the system.

Thus, the key idea upon which our analysis rests is that factor rewards depend upon product mix which depends upon endowments. Asian countries producing apparel and footwear have one kind of mapping while Latin American economies growing coffee and bananas have another. Income inequality and returns to skill are linked to endowments via production: some endowments attract sectors promoting equality and education and others do not.

After providing some additional background on the connection between endowments and inequality, the remainder of this paper will proceed as follows: Section 2 will summarize pertinent facts regarding income inequality, endowments and trade for a large sample of countries; Section 3 will elaborate the theory of development paths; Section 4 will employ more formal econometric analysis to seek evidence of the above hypotheses; and Section 5 will conclude.

1.1. Background: endowments and inequality

The connection between endowments and inequality is certainly very important and has inspired a long history of research in both economics and political science. Perhaps the most widely known arguments, originally put forth by Raul Prebish and reasserted by others during the oil shocks of the 1970s, relate to the impoverishing effect of natural resources (Fishlow et al., 1978). This impoverishment has two sources. First, natural resource abundant countries face declining terms of trade due to a logic similar to Engel's law: as the industrialized world accumulates wealth, its demand for raw resources (e.g., food, materials) declines relative to the demand for sophisticated manufactures and services. Second, resource abundant countries' efforts to combat this trend through industrialization may actually exacerbate it: in the drive to purchase the machinery and other durable goods necessary to produce manufactures, resource-rich countries must sell ever-increasing quantities of exports, further driving down their price. Both of these trends can encourage persistent income inequality, particularly if land ownership is also more concentrated in resource abundant countries.

Engerman and Sokoloff (1997), on the other hand, highlight the importance of endowments in the evolution of political institutions, research which complements both that of Prebisch and ours because it highlights an additional channel through

which endowments impact inequality. In their study of New World development, they argue that abundance of tropical cropland engendered unequal land ownership because the scale economies associated with raising permanent crops such as sugar and coffee fueled the acquisition of ever greater plantations.[2] Furthermore, because plantations encouraged the use of slaves (either native inhabitants or African), the dominant economic class, land-owning whites, remained a small minority of the population in tropical colonies. As a result, these colonies were marked by great disparities in wealth and politics of exclusion.

This experience contrasts sharply with more temperate colonies such as those in the northeastern United States and Canada, where agriculture with little or no scale economies encouraged the emergence of family, or small-holder farms. Because of this small-holder class, a relatively small native population to begin with, and the fact that slaves were not viable in production, the population in the temperate colonies was more homogenous, both racially and economically. It is this homogeneity, the authors argue, that gave rise to political institutions that stressed a voice for all. These institutions, in turn, mediated inequality and fostered growth.

To the extent that such forces provide a legacy to today's developing nations and influence their choice of trade and development policies, it is understandable that analysts such as Kim Anderson focus on distortionary government. Rather than concentrate on this *symptom* of endowments, however, we seek to explore the influence of *fundamental* endowments directly.

2. Pertinent facts

Which countries have extreme Gini coefficients, per capita GDP, education rates, natural resource abundance and exports per capita of natural resource products? Are there any apparent associations among these data? Do countries concentrated in natural resource intense sectors have small manufacturing sectors? Are the high-growth countries rich or poor in natural resources? Our goal in this section is to collect as much data relevant to these questions as possible. Special attention is paid to various resource-rich comparison countries including, for example, Canada, New Zealand, Argentina and Malaysia, as well as to the resource-poor high-growth countries of Asia including Japan, Taiwan and Korea. A description of the dataset and countries included in the analysis used throughout the paper is provided in Appendix A.

[2] In addition, many tropical colonies were administered by Spain, which both tightly restricted the flow of white Europeans to the New World and tended to grant very large blocs of land to worthy subjects. In addition to encouraging extreme concentration of ownership, grant recipients also gained title to the natives inhabiting it, fostering feudalism and institutionalizing inequality.

2.1. Latin American income inequality

Fig. 1, which plots Gini coefficients for 1990 vs. those for 1980 for all of the countries in our sample, highlights the two fundamental questions motivating this research. The first is why measured income inequality is so much higher in Latin American countries in both time periods than the rest of the world. The second is why it appears to be growing faster in Latin America than elsewhere. An interesting and suggestive feature of this figure is the presence of three of the more natural resource abundant countries of East Asia—Malaysia, the Philippines and Thailand—within the field of Latin American countries.

It is wise to pause a moment here to choose the right adjectives to describe income inequality. We fall too easily into using the value-laden words ‘bad’ and ‘good’ to describe the Gini coefficients rather than the neutral words ‘high’ and ‘low.’ When we notice that the countries with the lowest Gini coefficients and the most equal distributions of household income are the former communist countries of Eastern Europe, we should remind ourselves that equal incomes may arise from

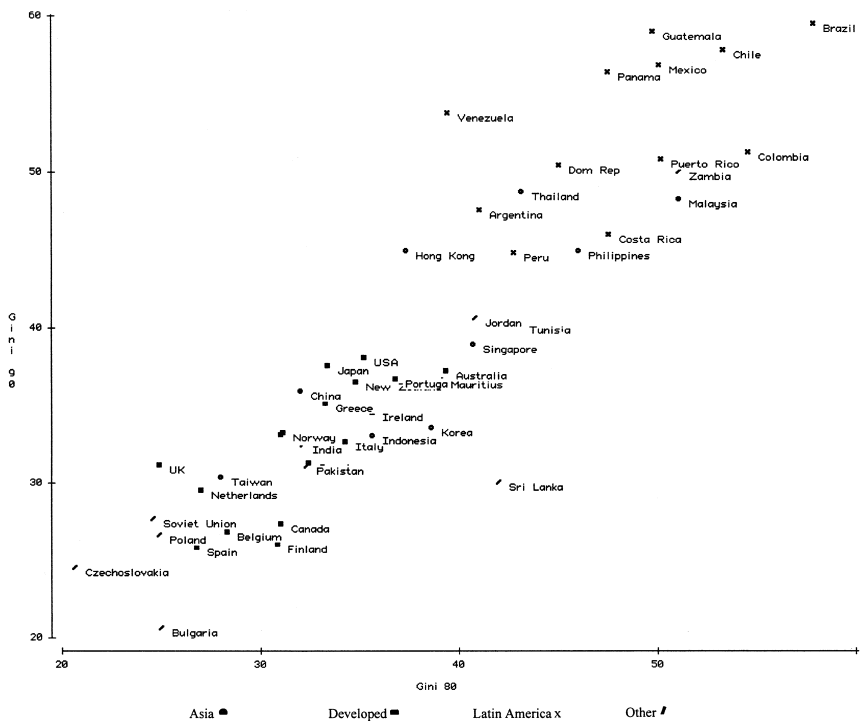


Fig. 1. Gini coefficients, 1990 vs. 1980 (Deininger and Squire, 1996).

a poverty of opportunity. Indeed, from a policy perspective it is equality of access to a wealth of opportunity and not equal incomes that is the relevant target. The traditionally high Gini coefficients in Latin America might come from very unequal access to rather limited opportunities, which seems undesirable. But the rise in the Gini coefficients following economic liberalizations in Eastern Europe and Latin America may come from an enormous increase in opportunities that integration with the advanced developed countries affords. With that said, the reader is asked to forgive us if we fall back into the habit of using the adjective 'bad' in place of 'high' and 'good' in place of 'low' to describe the Gini coefficients.

2.2. Latin American factor endowments

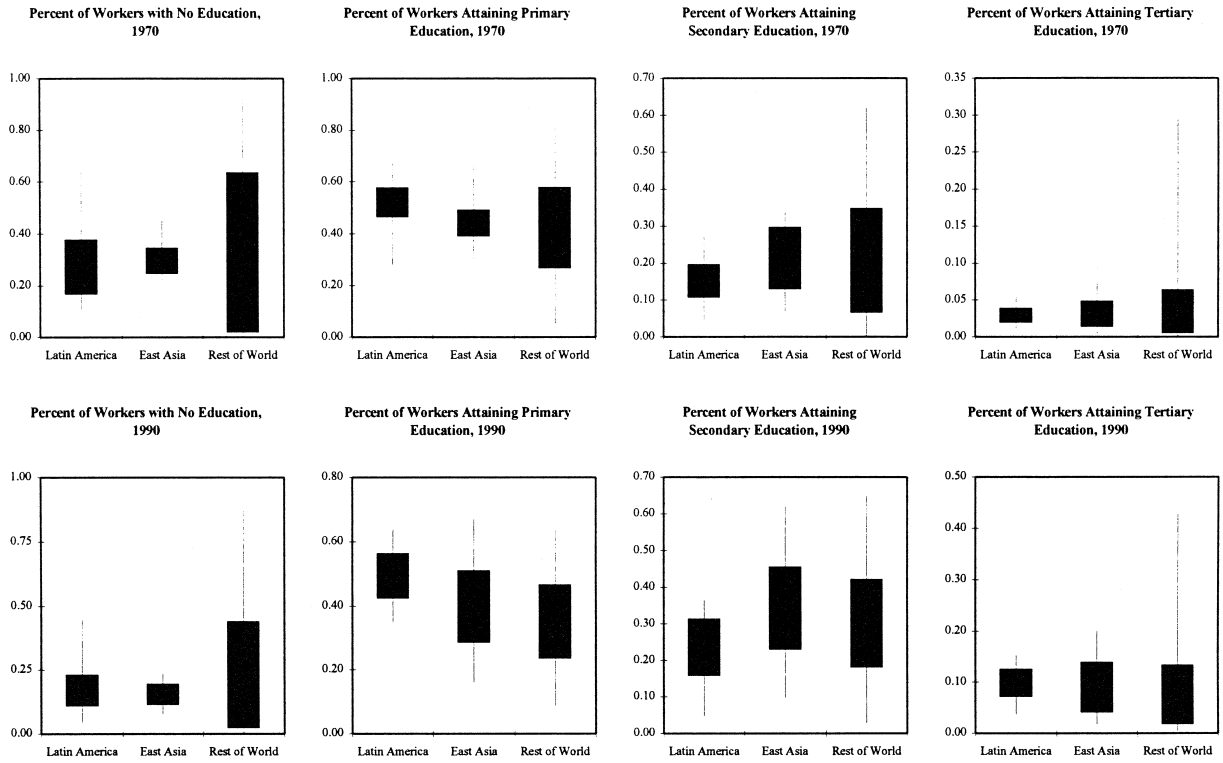
Latin American economies are characterized by an abundance of land, natural resources and uneducated workers, and a scarcity of physical capital. This relative position is clear from Figs. 2 and 3 which provide a comparison of Latin American, East Asian [3] and the rest of world endowments for 1970 and 1990. Each boxplot in the figures indicates the range of observations in each region, with the shaded box denoting the interquartile range (i.e., 25th through 75th percentiles). The relatively small boxes in land endowments signal outlying observations: Canada and Australia exhibit far higher per worker forestland and cropland (arable land), respectively, than the remaining countries in the sample.

A more quantitative measure of Latin America's position is provided in Table 1, which indicates which percentile of the rest of world endowment distribution corresponds to the median of the Latin American and Asian distributions for 1970 and 1990. This table reveals Latin America's capital scarcity by indicating that its median capital per worker ratio was at the 34th percentile of the rest of the world's distribution in 1970 and at the 37th percentile in 1990. Land abundance, on the other hand, is indicated by medians well into the right tail of the rest of world's distribution in both time periods. Note also that Latin America's experience with respect to capital contrasts sharply with that of Asia: during the same time period, its median per worker capital jumped from the 28th to the 52nd percentile.

With respect to education, Fig. 3 reveals that Latin America has become both relatively more tertiary educated abundant *and* remained at the same level of no education abundance over time. [4] This combination suggests that only a small

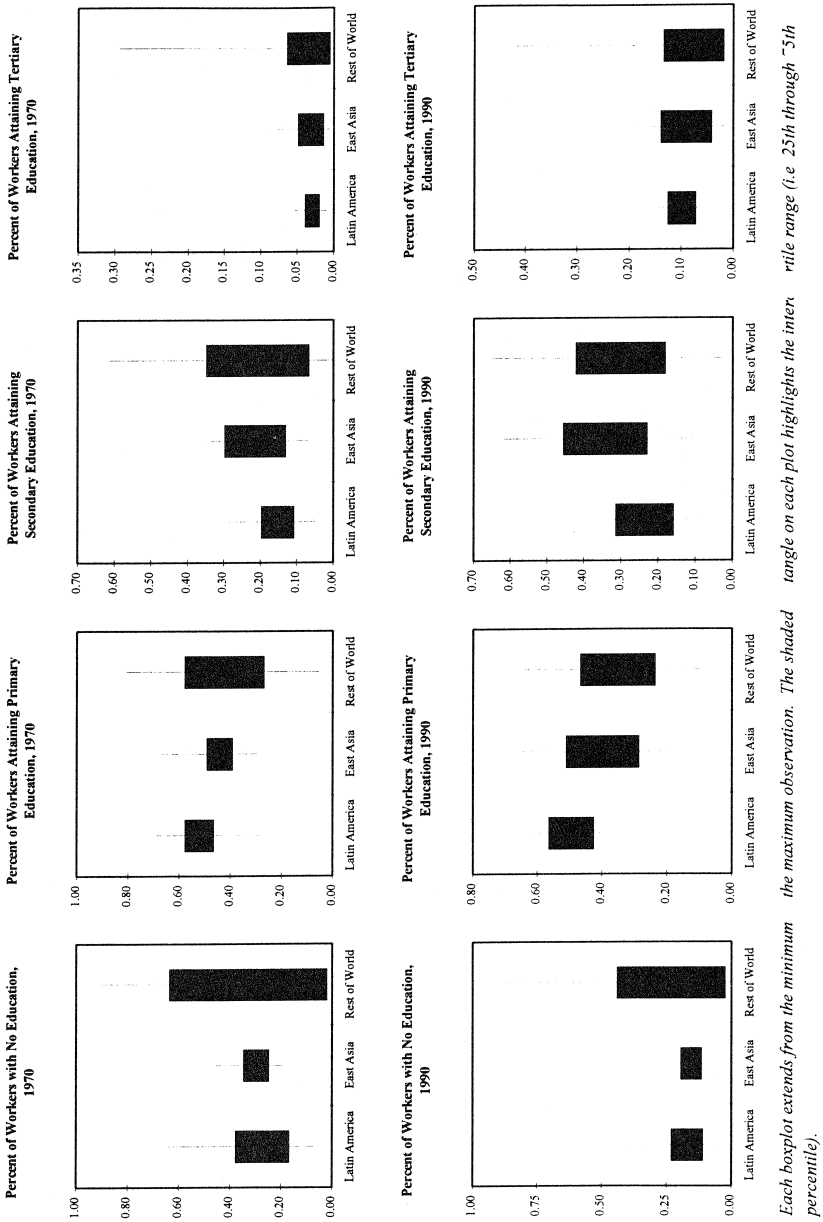
[3] Depending upon data availability, East Asia can comprise Thailand, Malaysia, Singapore, Indonesia, the Philippines, China, Korea, Taiwan and Hong Kong.

[4] Primary education denotes up to 6 years of education, secondary up to 12 years, and tertiary greater than 12.



Each boxplot extends from the minimum to the maximum observation. The shaded rectangle on each plot highlights the interquartile range (i.e 25th through ˜5th percentile).

Fig. 2. Boxplots of world capital, cropland and forestland endowments, 1970–1990 (Maskus, 1991).



Each boxplot extends from the minimum percentile). the maximum observation. The shaded tangle on each plot highlights the inter rile range (i.e 25th through 75th

Fig. 3. Boxplots of world education endowments (Barro and Lee, 1994).

Table 1
Percentile of rest of world endowment distribution occupied by Latin American and Asian medians

	Latin America		East Asia	
	1970	1990	1970	1990
Capital/worker	34	37	28	52
Cropland/worker	75	69	17	21
Forestland/worker	84	82	55	48
Proportion of workers with no education	54	54	54	52
Proportion of workers attaining primary education	69	80	54	58
Proportion of workers attaining secondary education	41	32	52	54
Proportion of workers attaining tertiary education	54	60	50	60

Education categories do not sum to unity for a given country. Proportion of workers attaining primary education, for example, includes all those who have attained secondary and tertiary, as well.

subset of Latin American workers is becoming more intensively educated over time. To be evocative, but to overstate the case, we will call this 'dumbbell' education, meaning that it produces relatively large numbers of workers in the extreme educational groups, and relatively few between these extremes. For reasons discussed theoretically below, a dumbbell educational system may be a symptom resource intensity: because resource intense sectors absorb national savings but create few skilled jobs, resource-rich countries may have little economic incentive to educate their citizens broadly until very late in the development process. [5]

Table 1 reinforces the impression that Asian education is more broad-based. Note in particular Latin America's increasing relative abundance in primary educated workers and Asia's relative decline in uneducated workers. To the extent that Asia is relatively resource-poor vis-a-vis Latin America, these Asian educational outcomes are consistent with the idea, discussed below, which has resource-poor countries investing national savings initially in labor-intensive manufactures which do require workers with modest educational attainments.

2.3. Latin American product mix

Fig. 4, which provides a breakdown of 1995 Latin American, Asian and OECD net exports, suggests a relatively simple world: Latin America exchanges natural resources and food for manufactures; Asia trades labor-intensive products for capital-intensive machinery and chemicals, and the OECD provides sophisticated

[5] Of course, it may also be evidence that the uneducated are prevented from attaining education due to credit constraints or other distortions.

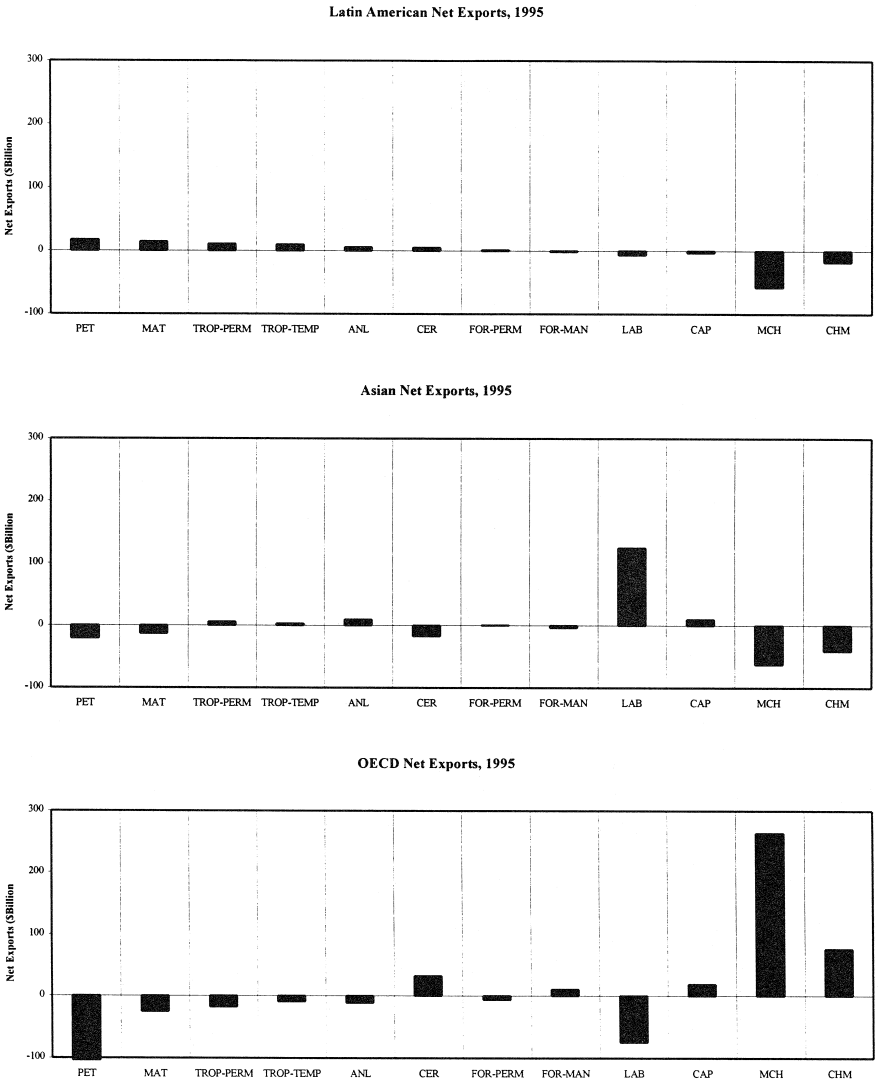


Fig. 4. Net exports by region, 1995.

manufactures and chemicals in exchange for materials, clothing and toys. This figure breaks total net exports into 10 major aggregates according to their propensity to be traded together (Leamer, 1984). For example, countries that export apparel also export footwear and toys. These goods are combined into a single aggregate: labor-intensive manufactures (LAB). The 10 major categories, and indicative products contained within them, are summarized in Table 2.

Table 2
Net export categories

Abbreviation	Category	Representative goods
PET	Petroleum products	Oil
MAT	Raw materials	Fertilizers, coal, natural gas, metals
TRP-PERM	Tropical permanent	Fruit, sugar, coffee
TRP-ANNUAL	Tropical annual	Vegetables, grains
ANL	Animal products	Live animals, meat, dairy, eggs, fish, hides, fats
CER	Cereals and grains	Cereals, feeding stuff, tobacco, oil seeds, fibers
FOR-PERM	Forest permanent	Wood, lumber
FOR-MANUF	Forest manufactures	Pulp, paper
LAB	Labor-intensive manufactures	Furniture, clothing, footwear, coins
CAP	Capital-intensive manufactures	Leather, rubber, textiles, iron, steel, fixtures
MCH	Machinery	Electrical machinery, transportation, professional goods
CHM	Chemicals	Chemicals, pharmaceuticals, fertilizers, plastics

In both the figure and the table, tropical agriculture has been split into two sub-categories according to whether the underlying crop is permanent (e.g., fruit, coffee, rubber, nuts) or temporary (e.g., vegetables, grains). [6] These special groups were constructed to help explore one of our central ideas—that permanent crops such as coffee and bananas embody large amounts of capital per worker because of the time needed to grow them from seeds to fruit-producing plants. For this reason, countries abundant in land suited to permanents can invest profitably in trees and plants, while countries not so endowed choose machinery instead. As a result, one might imagine that there are three different kinds of development paths —one for countries that are resource-poor, another for countries that are permanent cropland-rich, and another for countries that are temporary cropland abundant. (A fourth path might apply to a country with a natural resource like oil that can be 'tapped' for a continuing flow of earnings without using much capital or labor.)

How strong is the relationship between net export mix and income inequality? Fig. 5 provides an initial indication via scatterplots of the 1990 Gini vs. 1995 net export shares for four of the aggregates—Tropical Permanent, Tropical Temporary, Labor and Machinery—illustrated in the previous figure. Net export shares

[6] For the purposes of this paper, we use permanent and temporary to distinguish between different periods of gestation: by permanent we mean crops that require several years of growing before yielding fruit; by temporary we mean crops that can be harvested in the same year they are planted. Splitting countries' net exports in this manner is not possible for all countries because the trade data they report to the United Nations is insufficiently disaggregated.

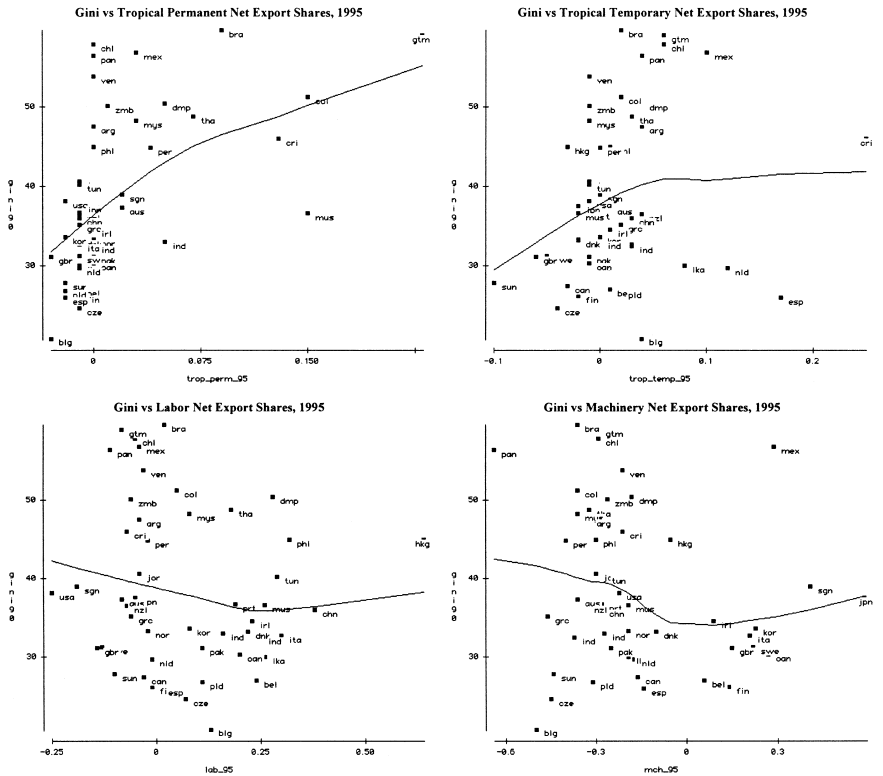


Fig. 5. 1990 Ginis vs. select 1995 net export shares (each plot is fitted with a non-parametric Lowess smoother).

for aggregate i and country c are calculated according to the formula

$$s_{ic} = \frac{nx_{ic}}{\sum_i |nx_{ic}|},$$

where nx_{ic} represents exports less imports of commodity i in country c.

The scatters are generally consistent with the idea that tropical agriculture exacerbates income inequality while manufacturing alleviates it, but they do reveal a substantial amount of noise. One means of filtering it out is to fit each plot with a non-parametric Lowess smoother. The lines resulting from this technique affirm the suspicion that Latin American income inequality may be exacerbated by its natural resource intense product mix. In Section 4 below, we will examine this relationship much more rigorously. For now, however, note that forest products and cereals (not shown) appear to be negatively associated with income inequality.

Given the correlation between tropical-permanent and income inequality we ask the question: Is it permanent crops that explain Latin American inequality? An

affirmative answer to that question needs to be prepared for a follow-up question: Why are softwood forests different from banana plantations? Why have Sweden, Finland and Canada developed sophisticated manufacturing sectors, but Guatemala has not?

One simple explanation might be that the existence of immense softwood forests in these countries is itself an endowment/final good (at least until they are cut down and need to be replanted) in a way that permanent crops are not. To the extent that these forests are there for the taking, they do not require the level of capital needed to domesticate, plant and harvest permanent crops.

Another idea we explore is that softwood forests offer a sequence of small steps toward sophisticated manufacturing, beginning with cutting down trees, then planing logs, then building furniture, then making pulp, then manufacturing 'commodity grade' paper and finally marketing specialized fine paper products. These small steps involve incremental increases in both the capital intensity and also the human capital intensity of the operations. By the time a community has progressed to the last of these stages it has the human capital (know-how as well as book-learning) to make Volvos and cell phones. Thus, further capital accumulation beyond the needs in pulp and paper can be diverted easily into non-resource based sophisticated manufacturing.

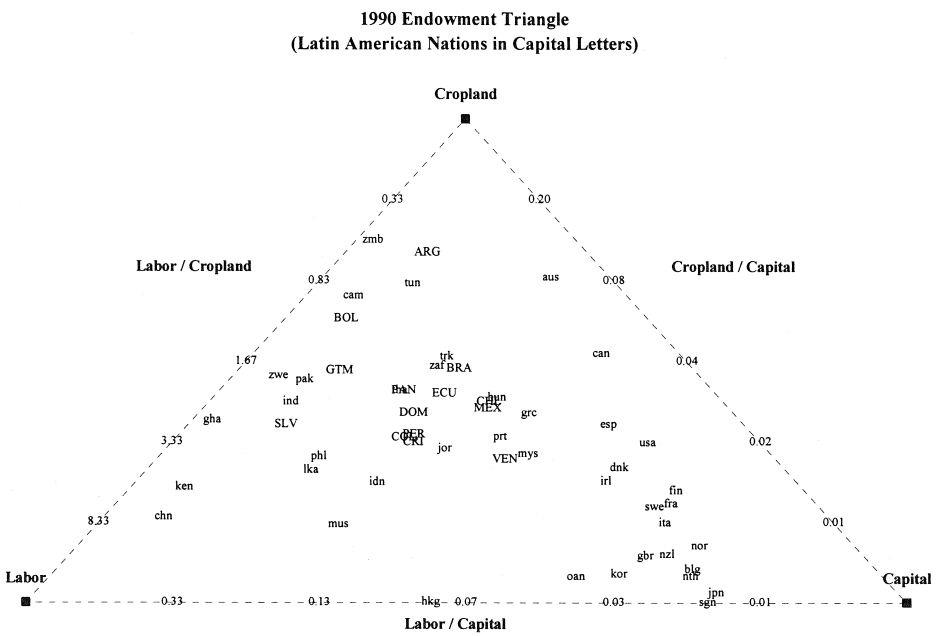
Permanent crops are very different—offering linkages into food processing, but nothing beyond that. Mangoes and dry-farmed rice are perhaps the worst crops in this sense, consuming large amounts of the community's capital but offering very little return for the accumulation of human capital, either book knowledge or manufacturing know-how. [7] A community with fully developed banana plantations may find no place at home to invest additional savings, and either capital accumulation will slow or savings will be invested in foreign assets. If it is human capital, then this takes the form of a brain drain with the most talented and most educated workers opting not to work on the plantations but choosing instead to seek better opportunities elsewhere. [8]

[7] For estimates of the capital intensity of various agricultural crops, see Leamer et al. (1998).

[8] Another idea which we do not explore in this manuscript is that the capital invested in permanent crops is highly specific and completely non-transferable. This is true also of sewing machines and sewing skills, but not hammers and not general human skills like literacy. Sector specificity of the capital can affect very much the short-run response of a community to changes in external competition whether those changes come from within through local liberalizations or from without from liberalizations in China or Eastern Europe or from global crop failures. Other things constant, investments in sector-specific assets require an especially high expected rate of return because they suffer especially high market risk. We will not be exploring this aspect of risk that is applicable in the short run, but in Leamer et al. (1998) we explore a different long-term risk issue. Namely, countries with diversified manufacturing in addition to crops can experience variability in the price of the crop without it affecting the return to capital, since it is land, not capital or labor that absorbs the risk. But countries without manufacturing, or with concentrated manufacturing have a capital stock whose returns are affected by the price risk of the crop.

Thus, while tropical exports seem ‘bad’ in Fig. 5, cereals is ‘mixed’ and forest products appear ‘good’. Canada, Finland and Sweden, all of which have relatively large forest net exports have relatively low income inequality. However, a feature of these countries’ aggregate forest net exports is that they encompass a substantial amount of forest manufactures such as pulp and paper in addition to raw forest products such as lumber. Such forest manufactures are largely absent in the aggregate forest net exports of southern cone countries, as indicated in Fig. 4. This disparity is consistent with the idea that the softwood forests of the northern hemisphere are linked to industrial staples that facilitate further industrialization in a way that the hardwood forests of the southern hemisphere are not.

Materials net exports also arise in some advanced developed countries with relatively low Ginis, namely the Netherlands. But this country also has net exports of our most advanced human-capital-intensive manufacture: chemicals. An idea that we will develop theoretically below is that natural-resource-rich countries have a development path that delays the emergence of manufacturing, but when manufacturing does emerge it is chemicals and machinery not apparel and footwear that are produced. This emergence marks the golden age of natural resource abundant countries when they achieve high levels of per capita incomes and a relatively equal income distribution. A symptom of this golden age is the



Units: Labor/Cropland is workers per hectare; Labor/Capital is workers per ($000); and Cropland/Capital is hectare per ($000).

Fig. 6. 1990 Endowment triangle (Latin America in capital letters).

coincidence of natural-resource-intensive exports with capital/human-capital-intensive manufactures.

To facilitate comparison of net export profiles with resource endowments, Fig. 6 provides a view of how countries compare in terms of physical capital, labor and cropland. These endowments are plotted within an endowment simplex (Leamer, 1987), which is formed by intersecting the positive orthant of a three-dimensional factor space with a plane so that the coordinate axes are represented by the corners of the simplex. More detail on the construction and intuition of these triangles is provided in Section 3.1 below, but for now it is sufficient to note that countries relatively abundant in factor f are located near vertex f. The most notable feature of these endowment triangles is the clustering of capital abundant, resource-poor countries along the bottom of the triangle near the capital vertex, and the rather varied capital per resource ratios among resource-intense countries.

Such clustering should be evident also in production and employment data. Fig. 7 has the correlation matrix of employment in manufacturing. In the figure, correlations at 0.8 and higher are shaded gray, with darker shading representing higher correlations (a correlation of 1.0 is black). Countries have been sorted to place the shaded, higher correlation cells as close to the diagonal as possible, thus making countries with similar employment structures close together on the list.

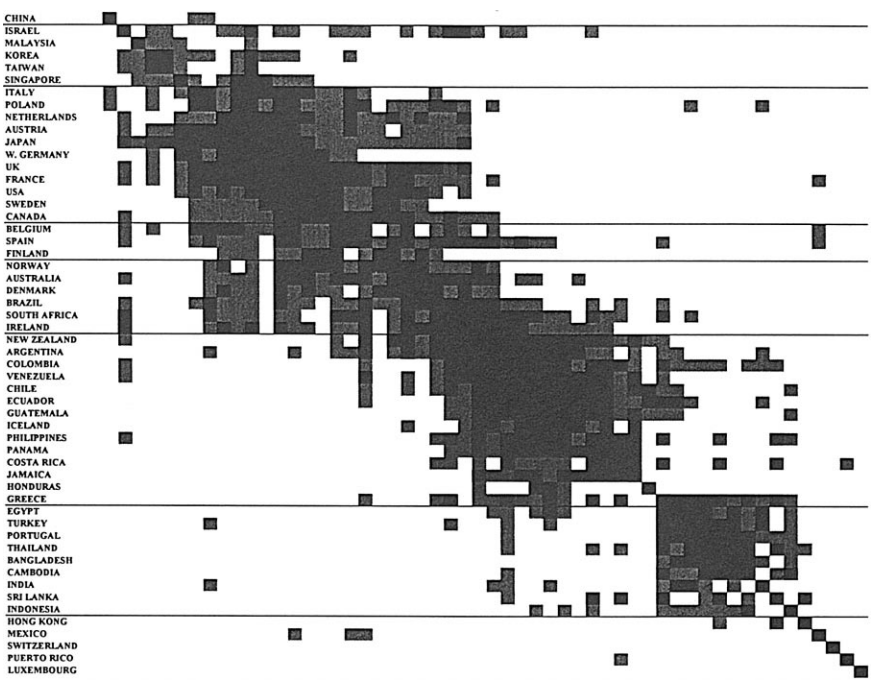


Fig. 7. Country sectoral employment correlations (darker shading represents higher correlation).

What emerges are three distinct sets of countries. There is a cluster of developed countries including Austria, Japan, Germany, the United Kingdom, France and the US. There is a cluster of what might be resource-rich developing countries including many Latin American representatives: Argentina, Colombia, Venezuela, Chile, Philippines, Panama, etc. There is a cluster of moderately resource intense developing countries including Turkey, Portugal, Thailand, Bangladesh, Cambodia, India, Sri Lanka and Indonesia. There is also a weaker cluster of mostly advanced countries that are probably resource abundant—Norway, Australia, Denmark, Ireland and Brazil as well. This display does not prove that there are multiple cones of diversification, but it certainly is suggestive. For a more in-depth search for evidence of cones, see Schott (1998).

3. Theory: development paths of natural-resource-rich countries

This section discusses in words and in diagrams how natural resource intensity might affect the tradeables product mix and factor rewards. The basic theory is laid out in Section 3.1 with two-dimensional triangles of Leamer (1987) that allow a fruitful discussion of the three-factor case. In the simple three-factor graphical setting, it is clear that the path of development can depend upon the supply of natural resources since countries abundant in natural resources choose to produce a relatively natural-resource-rich mix of tradeables. This dependence affords them special factor prices and special Stolper–Samuelson mappings of external shocks into internal factor prices.

3.1. Natural-resource-abundant countries have special development paths

Fig. 8 is the type of triangular display suggested by Leamer (1987) for studying alternative paths development. The corners of this triangle represent three factors

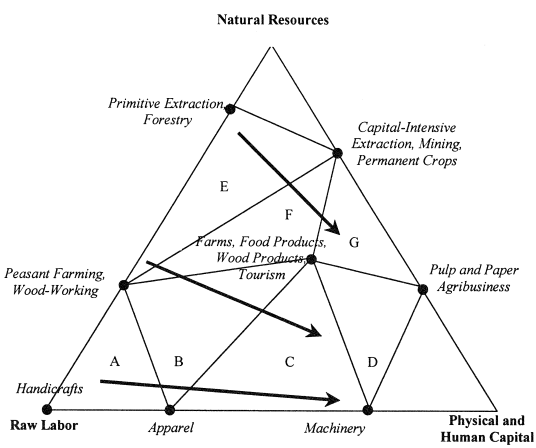


Fig. 8. Natural resource development paths.

of production: raw labor, natural resources (broadly defined) and capital (both human and physical). Both the factor endowments of countries and also the input intensities of various productive sectors are depicted by points in this triangle. The most important feature to keep in mind is that increasing the amount of one factor, say capital, while holding fixed the supplies of the other two factors swings a country's endowment point directly toward the capital vertex. Thus, on a line going through the capital vertex, the ratio of land to raw labor is constant. This allows one to put the three ratio scales on the edges of the triangle, land per labor on the left edge, capital per natural resources on the right edge and capital per worker on the bottom. You will have understood this point if you can see from the diagram that we are assuming the capital per worker in food processing is between the capital per worker in apparel and in machinery. We are also assuming that the land intensity of food processing is between the land intensity of peasant agriculture and primitive extraction.

Another feature of Fig. 8 to keep in mind is that the compensation of a factor stays the same or declines as one gets closer to the vertex representing the factor. Within a 'cone of diversification' in which the product mix is fixed, changes in factor supplies have no effect on factor prices—the so-called factor price equalization theorem, better called factor price insensitivity, meaning that factor prices are insensitive to factor supplies. However, a movement between cones in the direction of, for example, the capital vertex, is accompanied by a decline in the price of that factor. The three arrows in the figure represent three different development paths taken as countries accumulate capital holding fixed the relative supplies of land and labor. As capital accumulates and the endowment point shifts from cone A to cone B to cone C to cone D, the rate of return to capital declines and the wage rate of raw labor increases. That is the development path of a resource-poor country.

The triangle in Fig. 8 has good news and bad news for land-abundant countries. The good news is that land-abundant countries have a preferred path of development which avoids the intense competition in the labor-intensive manufactures. The bad news is that the early stages of that preferred path may not prepare a land-abundant country for the human-capital needs at later stages, causing development to stall. The bad news is also that income inequality is likely to be very high until late in the development process.

The land scarce countries follow the path A–B–C–D. At the very first stage, these land scarce countries have some peasant agriculture but depend upon exports of handicrafts to pay for imports of simple consumer items like footwear and cloth as well as machinery and chemicals. As these countries develop, they begin to produce and to export labor-intensive manufactures such as footwear and apparel. This is accomplished not so much by moving workers off the peasant farms but primarily by transferring handicraft work to the formal manufacturing sector. When most of the handicraft work is moved into the formal manufacturing sector, additional capital accumulation requires that workers are moved from peasant

agriculture to the manufacturing sector which begins to become more sophisticated and capital-intensive. The peasant farms are consolidated and more land-intensive, capital-intensive methods are used to produce crops. Further capital accumulation supports a more capital-intensive mix of manufactures and more capital-intensive methods for exploiting the meager natural resources that are available. This process is accompanied by increasing wages for raw labor, a slowly elevating need for more educated workforce and a consequent natural rise in educational attainment. Per capita income rises and income becomes more equally distributed. The greater equality comes from both the rise in the compensation for unskilled labor and also the broadening of the ownership of the country's assets that is a result of the shift from land and capital into human capital as the most important form of wealth.

The resource-rich countries have a very different development path, E–F–G–D. The most undeveloped of the land abundant countries have peasant agriculture and primitive 'harvesting' of natural resources including such things as cutting down trees, gathering natural crops and simple labor-intensive mining. Initial capital accumulation supports the shift toward capital-intensive extraction and permanent crops. Further capital accumulation moves workers out of peasant agriculture, consolidating land into farms for growing crops—grains, fruits and vegetables. This shift from peasant agriculture in natural-resource-rich countries comes with declining wages for raw labor power. Absent the capital, the abundance of natural resources supports high wages, but capital accumulation is designed to economize on the labor input and allow growers of fruits and vegetables to compete against countries that have fewer natural resources and very cheap labor (cone B). With further capital accumulation comes more capital-intensive ways of utilizing the natural resources: pulp manufacturing, paper and agribusiness (cone G). Finally, when capital accumulation has been very substantial, the resource-rich countries produce sophisticated and capital-intensive manufactures such as machinery and chemicals (cone D).

This path has one very important appealing feature—it never involves the production of apparel. The Asian success stories written by Japan, Taiwan and Korea are rapid A–B–C tales involving substantial exports of labor-intensive manufactures primarily to the United States, a market so huge that those exports could be absorbed with no terms of trade loss. But the greatly increased competition in apparel and other labor-intensive manufactures is causing new entrants like China, Indonesia, India and Bangladesh some considerable deterioration in their terms of trade. This makes it difficult for the emerging Asian countries to get from A to B, and C may now be completely unattainable and the exclusive domain of Japan, Korea and to a lesser extent Taiwan.

Although E–F–G–D may seem to offer a better future than A–B–C–D, there is another problem with E–F–G–D. In E and F, it is capital and unskilled labor that create wealth. In G and D, skilled labor is essential. The A–B–C–D sequence gradually raises the skill requirements and we can expect and we did see above the

land-scarce Asian countries gradually responding by increasing investments in human capital. But the early natural resource cones E and F do not require human capital and it is quite possible that countries get to the F–G border, with mines and food processing, but cannot make the next step because the human capital that could support the movement into cones G and D does not exist. Thus, absent the book-learning and the know-how, the development of the natural-resource-rich country comes to an end. This argument is a bit slippery because the development process stops at the very point at which the rate of return to human capital is very high, and, you may ask, why are the investments not forthcoming? There are two possible answers. There may be a social coordination problem. My education and know-how do not do me any good without equivalent investment by you, and we need to coordinate our training or not do it at all. It is easiest for me not to worry about this coordination problem but just to go elsewhere where the complementary human inputs already reside.

Another answer why development stops is a combination of capital market imperfections interacting with income inequality. Wealth embodied in natural resources and the physical capital needed to process them can be and often are owned by a very few. Human capital generally cannot be greatly accumulated unless wealth is broadly owned since it is typically self-financed or family-financed. Loans that might be used to finance human capital accumulation cannot be collateralized and indentured servitude is often an illegal and unenforceable contract. Moving from natural resource dependence to capital-intensive manufacturing requires a substantial upgrading of the human capital, but when most of the savings are generated by a few land-owners, it may be difficult for the financial system to transfer those savings into new human assets.

What about Canada and Sweden and Finland? How did they escape this dilemma? It is possible that these countries for social reasons made early investments in education and once the educational capital and infrastructure was in place then came Volvo, Ericson and Nokia. If this is somehow backed up with hard evidence, the policy advice is very clear: Governments in countries that are in cone F but close to cone G should be making major improvements in their educational systems, in particular eliminating the dumbbell educational systems that were economically efficient in cone F but inappropriate in cone G.

The paths of development of resource-rich and resource-poor countries are very different in terms of product mix but also very different in terms of income inequality. The E cone where natural-resource-rich countries begin is far from the raw labor vertex which means that these natural resource abundant countries have high wages when capital is scarce. The movement from E to F comes with lower wages, but wages rise again in G but fall in D. The highest Ginis may occur in cone F where raw labor has a lower price than cone E and the assets that generate wealth are physical capital and land which are usually unequally owned. Cone G is a lower Gini partly because of the high wages of raw labor and partly because the human-capital-intensive sectors of pulp and paper and agribusiness have emerged

and the wealth of the economy is more broadly owned. But, as we have argued, moving from F to G requires investments in human capital which may be hampered by the income inequality which is a characteristic of cone F.

The Ginis for the resource-poor countries behave very differently. The near-redundancy of labor in cone A means very low wages and probably unequal incomes, but cone B comes with higher wages for raw labor power and also greater need for human capital, both of which tend to lower the Ginis. More of the same two forces apply to the movements from B to C and finally to D. Thus, these resource-poor countries experience a steady march upward of wages for unskilled labor and a steady march downward of income inequality.

3.2. What's the difference between ores, cropland and softwood forests?

The general discussion up to this point can be specialized to deal with three somewhat different resources: ores, cropland and forestland. Paths of development for countries rich in ores and oil are illustrated in Fig. 9, for countries with cropland in Fig. 10 and for countries with softwood forests in Fig. 11.

Fig. 9 that depicts countries with ores and oil has three different development paths representing the effect of capital accumulation on countries with different initial supplies of natural resources relative to labor. Two of the countries begin in the A cone with handicrafts, primitive extraction and mechanized extraction. If enough capital accumulates, these countries move into cones B and C which involve an increasingly capital-intensive mix of manufactures. The third country has more labor and chooses apparel production not primitive extraction (cone B) at the beginning of its development path. An additional line is drawn through the

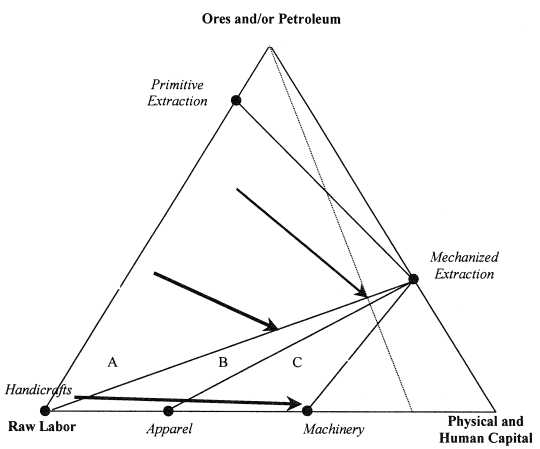


Fig. 9. Development paths for countries with ores and petroleum.

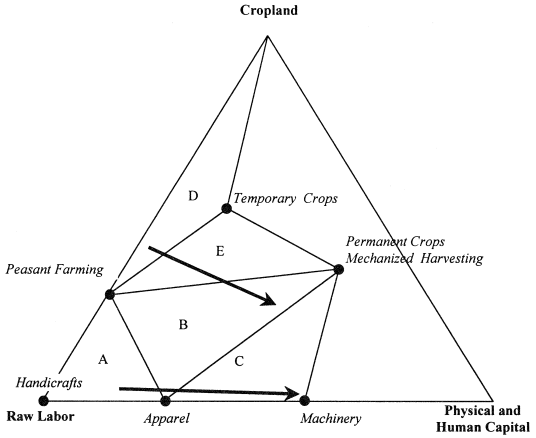


Fig. 10. Development paths for countries with cropland.

natural resource vertex and the point where the resource-rich country starts to develop a manufacturing sector. Here the capital–labor ratio is higher even than the capital intensity of machinery, which means that the emergence of manufacturing occurs at much greater levels of capital abundance for resource-rich countries than resource-poor countries. Thus, the first message of this figure is that capital-intensive methods of extraction can absorb a country's capital and slow the development process. This is what is commonly known as the Dutch disease.

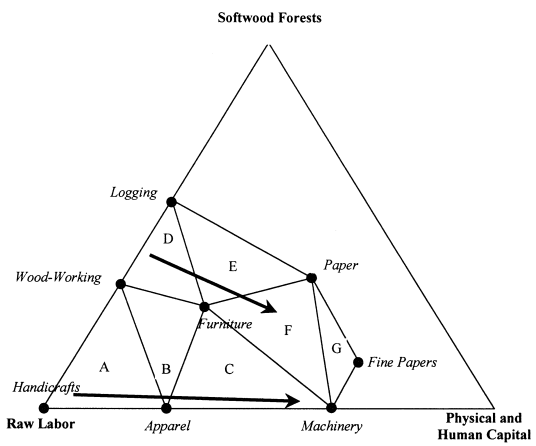


Fig. 11. Softwood forests.

It is impossible to tell from this diagram (since it depends on product prices [9]) whether wages are higher in cone A or cone B, but they are surely higher in cone C than in cone B. It is possible for some kinds of natural resources to be associated with very low wages and to have the emergence of manufacturing and the increasing capital intensity of the mix of manufactures bring increases in wages. It is also possible for unskilled workers in natural resources to have high wages and to suffer wage reductions as the country accumulates capital and starts to compete in manufacturing.

Another point that needs to be made is that capital in cones B and C is protected from price variability of natural resources, but capital bears partly the burden of price uncertainty in cone A (see Leamer et al., 1998 for more details). Although the mean return to capital is lower in cones B and C than in A, it is possible for uncertainty in the return to be great enough in cone A that there is no economic incentive for the global capital markets to transfer capital to countries in A. Not only do these countries have to go farther to get to the same point, but there are forces that make them stall along the way.

Cropland, depicted in Fig. 10, is different from ores and oil because it supports three distinctively different methods of production, rather than just two for ores. Peasant agriculture uses little capital and large amounts of labor compared with land. Temporary crops grown on farms and picked by hand require more land per worker and an amount of capital per worker that is at the low end of manufacturing capital intensities. Permanent crops and crops picked by machines use fewer workers per hectare and a capital per worker that is comparable to the capital intensities at the higher end of manufacturing.

Fig. 10 suggests three different development paths. Countries without any cropland choose manufactures all along the way, with capital accumulation leading to an increasingly capital-intensive mix of products and higher wages. The most land abundant countries begin in cone D with free land deployed partly in peasant agriculture and partly in temporary crops. Capital accumulation leads to a shift away from temporary crops in favor of permanents, and then into cone B with the beginning phases of a manufacturing sector. The first phase of this process may be associated with either rising or falling wages of unskilled workers. Countries with moderate amounts of cropland begin in cone A with land used in peasant agriculture. Capital accumulation brings workers out of peasant agriculture and into labor-intensive manufacturing. When that process has exhausted itself the country moves to cone B, using capital accumulation to upgrade agriculture by shifting to permanent crops and mechanized farming. Only at very high levels of

[9] The manner in which industry-input points are connected to form cones of diversification depends upon product prices: in general, the more expensive a commodity, the larger its region of production (Leamer, 1987).

capital abundance does the country move into cone C and shift to more capital-intensive manufactures.

The availability of cropland thus delays the emergence of a manufacturing sector, delays the upgrading of manufacturing into the more sophisticated capital-intensive sectors and delays the rise in wages that normally come with accumulating capital. In addition, cone B is a high-risk cone for capital since variation in the price of the crop affects the return to capital. This contrasts with cones A and C in which it is land that bears the risk. All else equal, global investors will try to avoid cone B, trapping communities with cropland in one of two cones. They may produce labor-intensive manufactures and use the cropland in peasant agriculture and temporary crops. Or they may have no manufactures at all, and deploy their resources in peasant agriculture, temporary and permanent crops.

Fig. 11 depicts development paths for countries abundant in softwood forests. This figure has much in common with Fig. 8 with three distinct paths of development. Very forest rich areas start with logging and wood-working and use capital accumulation to finance expansion of furniture building. Then wood-working gives way to manufacturing pulp, then commodity paper and customized furniture and finally fine paper. The point that we try to emphasize with this diagram is that forest products may allow a development 'corridor' with parallel and incremental increases on one side in capital intensity of very wood-intensive operations (compared with labor) such as logging, pulp, paper and fine papers and also on the other side of the corridor in the more labor-intensive operations like primitive wood-working, furniture and crafted furniture. This D–E–F–G corridor allows development in forest-rich communities to proceed more-or-less unaffected by events in the other corridor A–B–C. The news for these forest-abundant countries of the liberalization of China and other labor-abundant countries is only good: improved terms of trade and higher rewards for all factors of production.

The D–E–F–G path is also likely to offer relatively equal income distribution at every stage of development. Since every point on this path is 'far' from the raw labor vertex, wages of unskilled workers will be high regardless of the stage of development. Capital accumulation that takes the country from cone D to cone E which is a potential source of further income inequality is accompanied by a rise in the wages of the unskilled which would tend to hold down the Gini. This path also allows a gradual accumulation of human capital that is naturally self-financed by the high earnings of unskilled workers.

The message of this discussion is that it is possible to tell both a very optimistic story and a very pessimistic story for natural-resource-rich countries. We need to turn to the data to decide which story applies to which countries, if any.

4. Evidence

Income inequality is tied to endowments via the economic structure they engender. This section accumulates and organizes evidence regarding the particu-

lar role endowments play in each of our two main hypotheses. Our data analysis is guided by the assumption that Gini is a function of economic structure, where economic structure can be characterized either in terms of fundamentals or symptoms of these fundamentals. For the purpose of this exercise, fundamentals are resource endowments, including capital, labor, land and climate, closeness to markets and government interventions, including both the erection of trade barriers and the provision of infrastructure. However, since fundamentals are difficult to measure at the most desired level of detail, we also investigate the connection between Ginis and symptoms. For example, in addition to exploring the link between income inequality and endowments, we explore the link between income inequality and the structure of employment and trade, under the assumption that employment structure and net exports are symptoms of endowments.

4.1. Gini as a function of fundamental factor endowments

At its core, our story is that income inequality is connected to endowments via production: some endowments attract sectors promoting inequality while others are appropriate for sectors serving to combat it. Within our theoretical framework, we expect a world anchored by labor, land and capital, to have high income inequality in the land abundant region and low income inequality in the capital abundant region, with the labor abundant region somewhere in between. Three implications of this relationship are noteworthy. First, inequality always declines with rising capital intensity. Second, income inequality always rises with land intensity. Third, the effect of increased labor depends upon the land–capital ratio: for high ratios, more labor means lower inequality, and for low ratios, more labor means higher inequality.

In Table 3, these implications are addressed formally by regressing Gini coefficients in 1980 and 1990 on per worker capital, cropland and the interaction of cropland and climate. [10] (Climate, from Jones and Hall (1997), is a variable between zero and unity which measures latitudinal distance from the equator, where zero means at the equator and unity means at either the North or South Pole.) As indicated in the table, Ginis fall with capital intensity and rise with land abundance in both time periods, just as expected. The interactions with climate reveal that tropical cropland increases inequality in both periods, consistent with our story that more tropical agriculture soaks up capital and deters industrialization. 1990 results suggest, for example, that providing Panama (9° latitude, 0.75 ha cropland per worker) with Korea's (37° latitude, 0.12 ha cropland per worker) land and climate endowments would lower Panama's measured income inequality by 5.5 points, to 50, all else equal. Endowing Panama with Korea's capital (US$8943

[10] Forestland and its interaction with climate, as well as capital interactions with economic distance, are excluded from the regression due to their insignificance.

Table 3
Response of Gini to fundamentals and controls

Independent variable	Coefficient	*t*-Value
Dependent variable: 1980 Gini		
Constant	38.8	24.39
Capital/worker 1980	−0.3	−2.53
Cropland/worker 1980	7.5	3.56
Cropland/worker 1980×Climate	−17.2	−3.16
Latin America dummy	7.3	4.17
Adjusted R^2	0.68	
Observations	44	
Dependent variable: 1990 Gini		
Constant	41.0	18.37
Capital/worker 1990	−0.1	−2.09
Cropland/worker 1990	7.4	1.69
Cropland/worker 1990×Climate	−17.5	−1.58
Latin America dummy	8.9	3.15
Adjusted R^2	0.49	
Observations	49	

Capital measured in US$000; land measured in hectares; climate (between 0 and 1) measures latitudinal distance from the equator.

to US$32,360 per worker), on the other hand, would reduce its Gini by 3.26 points. [11]

Regarding the effect of adding labor on Ginis, the third implication noted above, inspection of the estimated derivative of Gini with respect to labor indicates the effect is indeed positive for low levels of land and negative for high levels, as expected. Finally, note that the importance of the Latin American dummy variable in both time periods provides an indication both that our endowment measures are imperfect and that other forces, including government policy, culture and history are important influences.

4.2. Ginis and symptoms: correlation of Gini with manufacturing employment shares

In addition to examining the relationship between Ginis and fundamental endowments, we can inspect the correlation of Ginis with symptoms of endowments. In this section, we will inspect the breakdown of *manufacturing* employment at the three digit ISIC level. [12]

[11] Regression coefficients are based on per worker capital measured in thousands of US dollars.

[12] Similar results were obtained when manufacturing employment was expressed as a proportion of total labor force. In addition, results did not change when output or value added composition was used instead of employment. Also, the main conclusions remain when we controlled by Latin American or African regional effects (i.e., regional dummies).

Table 4
Simple and partial correlations of employment shares with Gini and GDP/worker (significant correlations are in bold)

	Simple correlations of empirical share and:		Partial correlations of Gini and:			Simple correlations of empirical share and:		Partial correlations of Gini and:	
	Gini	GDP	Empirical[a] share	GDP per worker[b]		Gini	GDP per worker	Empirical share[a]	GDP per worker[b]
1980					*1990*				
Total manufactures	−0.52	0.69	−0.21	−0.34	Total manufactures	−0.44	0.69	−0.14	−0.40
Chemicals	−0.63	0.75	**−0.40**	−0.14	Tobacco	−0.29	0.01	**−0.47**	**−0.64**
Transport	−0.60	0.80	**−0.35**	−0.13	Pottery	−0.35	0.43	−0.27	**−0.52**
Tobacco	−0.27	0.01	**−0.35**	**−0.57**	Chemicals	−0.48	0.75	−0.20	**−0.37**
Machinery	−0.58	0.76	**−0.34**	−0.19	Transport	−0.54	0.80	−0.20	−0.24
Printing	−0.57	0.79	**−0.31**	−0.18	Glass	−0.42	0.68	−0.19	**−0.48**
Pottery	−0.42	0.43	−0.28	**−0.44**	Textiles	−0.16	0.10	−0.14	**−0.55**
Iron and steel	−0.56	0.75	−0.27	−0.23	Leather	−0.15	0.41	−0.14	**−0.55**
Textiles	−0.25	0.10	−0.27	**−0.54**	Paper	−0.44	0.62	−0.12	**−0.39**
Paper	−0.49	0.62	−0.24	**−0.35**	Rubber	−0.15	0.33	−0.12	**−0.55**
Metallic	−0.50	0.71	−0.23	**−0.30**	Furniture	−0.44	0.80	−0.10	**−0.39**
Furniture	−0.52	0.80	−0.23	−0.24	Machinery	−0.41	0.76	−0.10	**−0.42**
Glass	−0.50	0.68	−0.19	**−0.33**	Apparel	−0.06	0.05	−0.09	**−0.56**

Coal	−0.40	0.50	−0.16	**−0.44**	Iron and steel	−0.37	0.75	−0.07	**−0.45**
Non-ferrous	−0.49	0.77	−0.16	**−0.29**	Non-metallic	−0.31	0.54	−0.07	**−0.49**
Electrical machinery	−0.29	0.37	−0.13	**−0.49**	Food	−0.26	0.58	−0.07	**−0.51**
Other manufactures	−0.24	0.33	−0.12	**−0.50**	Printing	−0.48	0.79	−0.06	**−0.33**
Other chemicals	−0.47	0.81	−0.11	**−0.29**	Other manufactures	−0.19	0.33	−0.06	**−0.53**
Leather	−0.26	0.41	−0.10	**−0.49**	Wood	−0.30	0.49	−0.04	**−0.49**
Scientific eq.	−0.20	0.24	−0.10	**−0.52**	Scientific eq.	−0.26	0.24	−0.02	**−0.51**
Non-metallic	−0.32	0.54	−0.10	**−0.45**	Electrical machinery	−0.25	0.37	−0.02	**−0.51**
Apparel	−0.09	0.05	−0.09	**−0.54**	Non-ferrous	−0.36	0.77	−0.01	**−0.45**
Plastic	−0.18	0.25	−0.08	**−0.52**	Petroleum	−0.14	0.44	0.00	**−0.54**
Food	−0.33	0.58	−0.07	**−0.44**	Metallic	−0.42	0.71	0.03	**−0.40**
Wood	−0.26	0.49	−0.03	**−0.48**	Coal	−0.25	0.50	0.05	**−0.51**
Rubber	−0.18	0.33	−0.03	**−0.52**	Other chemicals	−0.34	0.81	0.06	**−0.47**
Petroleum	−0.20	0.44	0.01	**−0.51**	Beverages	0.00	0.41	0.10	**−0.56**
Beverages	−0.20	0.41	0.06	**−0.52**	Footwear	0.10	0.42	0.11	**−0.56**
Footwear	−0.13	0.42	0.06	**−0.53**	Plastic	−0.19	0.25	0.16	**−0.55**
Observations	41		42		Observations	45		42	

[a] Partial correlation between Gini and employment shares, given GDP per worker.
[b] Partial correlation between Gini and GDP per worker, given the employment share.

Ideally, we should seek to associate Ginis with mixes of employment shares that connote cones of diversification: countries with different mixes of products and employment shares should have different Ginis. Looking for such 'cones' of diversification in employment shares, however, is a very difficult task because real data do not exhibit, for example, the extreme form of behavior in which only a subset of the three-digit categories in each country have positive employment. We think of this as partly an aggregation problem and partly a non-traded goods problem. Every community has a tailor or two but the presence of the tailors does not mean that the labor market is linked with global apparel competition. The proper indicator of external competition is probably some *significant* share of employment in apparel rather than its mere existence, but determining such significance is also quite difficult. Thus, rather than attempt to find correlations between Ginis and employment share mixes, we inspect instead their relationship to individual employment shares.

With this caveat in mind, we present Table 4, which contains two sets of correlations for 1980 and 1990. The first two columns of each panel are simple correlations between employment shares and both Gini coefficients and per worker GDP. The other columns show partial correlations between Gini coefficients and employment shares controlling for GDP per worker (third column) and Gini coefficients vs. GDP per worker, controlling for employment share (fourth column). Sectors in each panel are sorted according to the Gini–employment share partial correlations, and statistically significant partial correlations (at the 95% level) are in bold.

The fact that all of the simple employment share–Gini correlations in 1980 and all but two in 1990 are negative indicates that countries with employment in manufacturing, irrespective of sector, tend to have lower Gini coefficients. Indeed, the total manufacturing employment share–Gini correlation is -0.44 in 1990, and human-capital-intensive sectors like transportation, chemicals, printing and paper are the ones that seem to promote equality the most: they have simple correlations in 1990 of -0.54, -0.48, -0.48 and -0.44, respectively. On the other hand, some sectors, such as footwear and beverages, which often employ less skilled workers, seem to encourage inequality. [13]

The message derived from simple correlations, however, may be insufficient given the important relationship between stage of development and income inequality. Fig. 12, for example, contains scatterplots of Gini coefficients vs. per worker GDP and per worker physical capital for each of the countries in our sample in 1990. Both exhibit a clear negative relationship: as countries develop

[13] Particularly interesting is the evidence for tobacco, pottery and plastic. Tobacco, similar in several ways to a perennial crop, is associated negatively with the Gini coefficient. A closer examination of the underlying data, however, reveals that this result is due to an outlier, Bulgaria. Similarly, Portugal pulls down the pottery correlation. Hong Kong and Singapore, on the other hand, drive down the simple correlation for plastic.

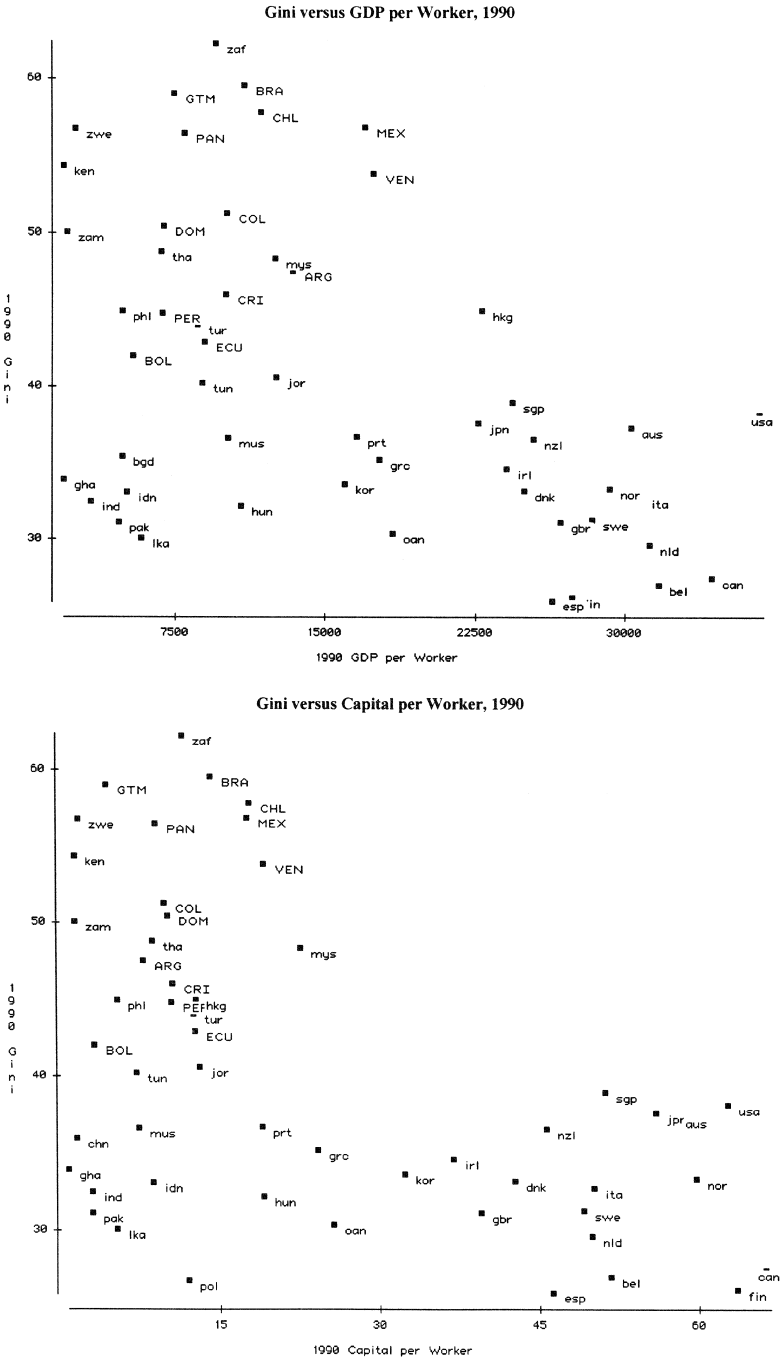


Fig. 12. Gini coefficients vs. GDP/worker and capital/worker.

and their per worker GDP and capital stock grow, their income inequality tends to decline.

Thus, a more accurate method of gauging the influence of sectoral employment is to inspect the partial correlations of Gini with employment shares controlling for per worker GDP, which appear in the third column of each panel of Table 7. As indicated in the table, these numbers are somewhat disappointing: only one sector in 1990—tobacco—and five sectors in 1980—chemicals, transportation, tobacco, machinery and printing—are statistically significant. Nevertheless, the ordering of the partial correlations seems to make sense: sophisticated manufactures like transportation and chemicals are 'better' than more resource-intense sectors such as beverages and coal.

4.3. Ginis and symptoms: finding cones in manufacturing employment shares

The structure of employment and its changes over time should tell us something about countries' movements along development paths. To that end, this section examines the structure of employment in 1990 and its changes over time, controlling for land abundance. Table 9 in Appendix A lists the countries in the sample, classified according to land abundance.[14] Land abundant countries are those with two square miles of land per worker or more, whereas land scarce countries have less than 1 square mile per worker. Note that each category includes a geographically diverse group of countries. Land scarce countries, for example, are predominantly East Asian but include the Dominican Republic, El Salvador and Jamaica. The majority of land abundant countries, on the other hand, are Latin American and Northern European, but Malaysia also qualifies. Finally, the land moderate category is primarily composed of European nations but Indonesia, Thailand and Uruguay are also included (see Table 5).

Fig. 13 illustrates the distribution of employment shares for different country groups and economic sectors in 1990 via boxplots. The breakdown of these cones suggests the types of cones of diversification that vary with land abundance described in Section 3. The employment shares used in the production of food, beverages and wood products, for example, increase with land abundance and a similar pattern emerges in sectors like paper and printing. In those cases, the median share increases and the distribution of shares shifts up with land abundance. For example, the median share for food products is close to 18% in land abundant countries but just 12% in land scarce countries. The opposite message, although less clear, emerges when we compare the employment structure of sectors in which land is not an important input, such as apparel, textiles and machinery. In this case, the median share falls and the distribution of employment shares shifts down with land abundance. The median employment share in the

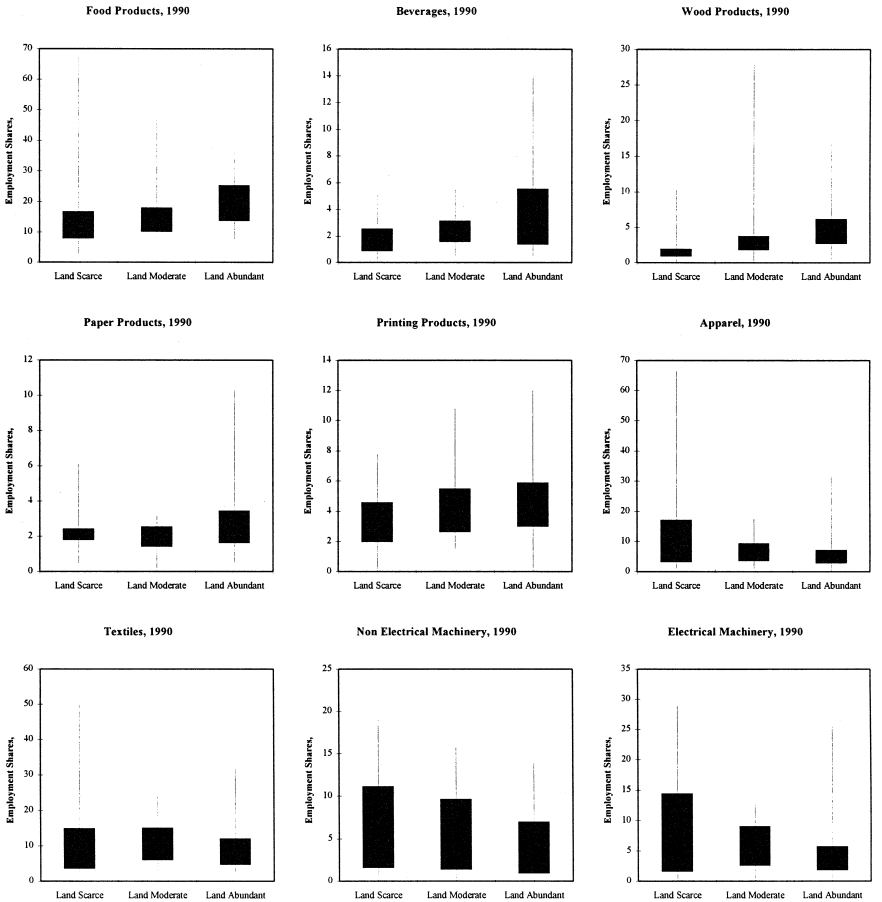
[14] The measure of land abundance was computed by adding up crop and forest land and dividing the total by the number of workers.

Table 5
Land scarce, land moderate and land abundant countries

Land scarce		Land moderate		Land abundant	
Region	Country	Region	Country	Region	Country
Africa	Egypt	Africa	Ghana	Africa	Cameroon
Africa	Kenya	Africa	Malawi	Africa	Mali
Africa	Mauritius	Africa	South Africa	Africa	Tunisia
East Asia	Bangladesh	East Asia	Indonesia	Africa	Zambia
East Asia	China	East Asia	Thailand	Africa	Zimbabwe
East Asia	Hong Kong	Europe	Austria	East Asia	Malaysia
East Asia	India	Europe	Denmark	Europe	Australia
East Asia	Japan	Europe	France	North America	Canada
East Asia	Korea	Europe	Greece	Europe	Finland
East Asia	Pakistan	Europe	Iceland	Europe	New Zealand
East Asia	Philippines	Europe	Ireland	Europe	Norway
East Asia	Singapore	Europe	Portugal	Europe	Spain
East Asia	Sri Lanka	Former Comm	Hungary	Europe	Sweden
East Asia	Taiwan	Former Comm	Yugoslavia	Latin America	Argentina
Europe	Belgium	Latin America	Uruguay	Latin America	Bolivia
Europe	Italy			Latin America	Brazil
Europe	Malta			Latin America	Chile
Europe	Netherlands			Latin America	Colombia
Europe	Switzerland			Latin America	Costa Rica
Europe	United Kingdom			Latin America	Ecuador
Europe	West Germany			Latin America	Guatemala
Latin America	Dom. Rep.			Latin America	Honduras
Latin America	El Salvador			Latin America	Mexico
Latin America	Jamaica			Latin America	Nicaragua
Other	Cyprus			Latin America	Panama
Other	Israel			Latin America	Paraguay
Other	Jordan			Latin America	Peru
Other	Turkey			Latin America	Venezuela
				Other Asian	Afghanistan
				Other	Benin
				Other	Syria
				North America	USA

Land abundant countries are those with 2 square miles per worker or more.
Land scarce countries have less than 1 square mile per worker.

non-electrical machinery sector may help to illustrate this point: the median share is 5.2% in the land scarce countries, falling to 3.2% when we move to land abundant countries. Thus, the way in which the distribution of employment shares varies with land abundance is indicative, or at least suggestive, that countries with different land abundance are positioned in different cones and produce different output mixes.



Each boxplot extends from the minimum to the maximum observation. The shaded rectangle on each plot highlights the interquartile range (i.e 25th through ˜5th percentile).

Fig. 13. Manufacturing employment share boxplots by land abundance, 1990.

We turn now to an examination of a link between income inequality and employment share changes over time. [15] In this respect, land abundant countries display development patterns consistent with the stories described in Section 3. The employment share of beverages, for instance, has been relatively stable and small in low-Gini countries, but growing and high in high-Gini nations. This sector has remained relatively constant in Sweden, Finland, New Zealand and

[15] The change in employment shares is measured by the difference between the employment share observed in 1990 and the corresponding share in 1970. Due to lack of data, for some countries the information used in 1970 corresponds to data available in the early 1970s or late 1960s.

Australia, but has expanded in countries like Ecuador, Guatemala, Honduras, Bolivia and Mexico. Referring to Fig. 8, we could interpret these findings as if the high Gini countries are moving across region E–F, whereas the low Gini representatives are already located in G–D zones. A similar story could be recovered from the food products sector: countries like Argentina, Panama and Chile, together with Norway and New Zealand, are moving into the sector. Their difference in income distribution seems to be explained by the cone in which they are located. While the Latin countries are still struggling in region F, the Nordic representatives are enjoying the amenities of region D.

A similar pattern appears when we look at the employment shares used in the production of paper, printing and other chemical products, as well as in the case of transport equipment and machinery. In the case of paper and printing, the highest and growing shares correspond to the Nordic countries, which also have smaller income inequality. The high Gini representatives have rising shares in other chemicals. These facts suggest that Nordic countries, which are more advanced in the development process, generate a product mix relatively intensive in the use of capital (human and physical), which favors income equality. Land abundant developing countries, on the contrary, face a much more adverse situation. They still produce an important amount of products pro income inequality (for instance, food and beverages); however, as the countries struggle to move out of these sectors they start producing chemical products and machinery, which are relatively more human-capital-intensive. Unfortunately, this product mix accentuates the dumbbell educational systems, promoting greater income inequality. Thus, as the land abundant developing countries move from region E to F in Fig. 8, they are expected to have high, and probably, growing income inequality.

In the case of land scarce countries, the employment shares used in the production of machinery (electric and non-electric) and transport equipment have evolved as expected. Almost all the land scarce countries in the sample observed either constant or growing shares in the sectors mentioned, indicative of movements along the development path ABCD in Fig. 8. The link to income distribution also emerges: for instance, the low Gini countries (The Netherlands, Taiwan, United Kingdom and Korea), probably located in triangle D, have some of the highest shares in machinery. The high Gini representatives (Singapore and Philippines) have the biggest changes in employment shares, which may be a signal that these countries are trying to leave triangle B. [16]

[16] In the case of sectors linked to natural resources, like food products and beverages, there is no clear pattern. This outcome is probably attributable to the characteristics of this sectors: whereas in land abundant countries is ‘natural’ the development of edible products, in land scarce countries the presence of these sectors may obey to a variety of aspects specific to each country. The same unclear pattern appears in sectors like paper and chemical products, precisely sectors that are important in land abundant countries.

The sector of textiles is becoming smaller independently of income distribution, probably reflecting that land scarce countries are accumulating capital and moving into the production of more capital-intensive goods, moving along the ABCD path already described. [17] Apparel offers a different picture. The high Gini countries have observed an expansion of the sector, whereas the low Gini countries have a falling share. In particular, the countries that have observed a contraction in these sectors are Netherlands, Germany, Taiwan and Belgium; however, these countries observed an expansion in the machinery and transport equipment sectors. Again, this pattern of development is compatible with the trajectory ABCD described earlier: as the economy accumulates capital and the output mix produced is upgraded income distribution improves.

Finally, land moderate countries offer a less clear picture with respect to development paths and income distribution. This may reflect that these countries share characteristics of both land abundant and land scarce countries and/or the sample size is relatively small to obtain some conclusions (only Thailand and South Africa may be considered as high Gini countries). Probably the most interesting development patterns identified correspond to Indonesia and Thailand: Indonesia is moving away from food products and textiles and increasing its presence in apparel and wood products, whereas Thailand is moving away from food and wood products and into textiles and apparel.

4.4. Ginis and symptoms: net export shares

We can complement the analysis of Section 4.3 by examining another signal of cones: trade data. Though not as pure as production data, trade data is available for more countries on a more consistent and disaggregate basis. In this section, we use the same 10 category aggregation scheme used in Section 2.3 above.

In the same spirit as in Section 4.3, we will examine simple and partial correlations between Gini coefficients and net export shares, and the possible existence of different development paths. Also, we will show some evidence on the two controls that will be used for the partial correlations, GDP per worker and secondary education per worker, both of which are endogenous to and highly correlated with development. Theory suggests that some sectors are better at alleviating income inequality than others: tropical agriculture makes it worse, capital-intensive manufacturing makes it better.

The simple correlation between net export structure and Gini coefficient, GDP per worker, secondary education per worker and economic distance for 1980 and 1990 are presented in Table 6. Economic distance, from Leamer (1997), is a measure of a country's distance from global GDP, in miles. Sectors are sorted by

[17] Note that the contraction in this sector may reflect the contraction of the sector in the world economy, but we do not intend to give an explanation of this phenomenon.

Table 6
Simple correlations between net export shares and various measures, 1980–1990

	Gini coefficient	GDP per worker	Secondary education per worker	Economic distance
1980				
Machinery	**−0.48**	**0.38**	**0.46**	−0.30
Chemicals	**−0.48**	**0.63**	0.21	**−0.56**
Capital-intensive manufacturing	**−0.39**	0.22	**0.52**	−0.18
Forest manufacturing	−0.20	0.27	0.03	−0.13
Labor-intensive manufacturing	−0.18	−0.24	0.26	0.30
Animal products	−0.14	0.24	0.16	0.07
Cereals	0.11	0.22	−0.19	0.22
Petroleum	0.19	−0.05	−0.25	0.09
Forest permanent	0.19	−0.07	−0.17	0.24
Tropical temporary	0.24	**−0.38**	−0.10	0.18
Raw materials	**0.34**	−0.17	**−0.32**	0.27
Tropical permanent	**0.54**	**−0.44**	−0.22	0.24
1990				
Machinery	**−0.36**	**0.42**	**0.42**	−0.18
Chemicals	**−0.33**	**0.62**	**0.54**	**−0.46**
Forest manufacturing	−0.22	0.22	0.15	−0.07
Labor-intensive manufacturing	−0.16	**−0.31**	−0.17	0.28
Animal products	−0.08	0.16	0.10	0.02
Capital-intensive manufacturing	−0.02	0.04	0.00	−0.05
Forest permanent	0.02	−0.04	0.07	0.21
Petroleum	0.21	−0.01	−0.11	0.06
Cereals	0.22	0.05	0.07	0.21
Tropical temporary	0.25	**−0.43**	**−0.35**	0.15
Raw materials	**0.34**	−0.26	−0.13	**0.33**
Tropical permanent	**0.47**	**−0.39**	**−0.42**	0.20

Bold figures indicate significance at the 95% level.

their correlation with income inequality, and figures in boldface represents statistical significance at the 95% level. Consistent with our theoretical framework, this table illustrates that Ginis are related negatively to manufacturing and positively to basic extraction and tropical agriculture. In addition, note that manufacturing categories utilizing greater levels of education (e.g., chemicals and machinery) have a larger effect on income inequality than manufacturing aggregates with lower demand for skill (e.g., labor and forest manufacturing). The relationship between per worker secondary education and net export shares reported in the third column of the table supports the view that manufacturing sectors are positively correlated with secondary education, though this effect is more pronounced in 1980 than in 1990. This difference may be due to changes in technology over time. In both periods, basic extraction and tropical agriculture are

negatively correlated with secondary education. A similar pattern is found regarding GDP per worker.

Correlations of net export shares with the economic distance indicator reveal that the closer to the global market an economy is, the more oriented toward capital-intensive products it will be, a result that is likely due to transportation costs. For raw materials, tropical agriculture and labor-intensive products the story is the opposite: the closer to the global market an economy is, the less it will produce these goods. This relationship suggests that global capital will reach out far to find natural resources but will not reach too far to find cheap raw labor (the US will prefer Mexico to China).

The main message from this table is that promoters of income equality include sectors with low land per worker, low natural resources per capital and middle to high capital per labor (i.e., capital-intensive manufacturing, chemicals and machinery). Non-promoters of income equality are characterized by the intensive use of

Table 7
Partial correlation of Gini coefficient and net export shares, controlling for GDP per worker, 1980–1990 (sectors are sorted according to partial correlations)

	Partial correlation	Net export *t*-value	GDP *t*-value
1980			
Tropical permanent	0.44	3.21	−2.77
Cereals	0.31	2.17	−4.78
Materials	0.30	2.10	−3.98
Forest permanent	0.20	1.35	−4.01
Petroleum	0.19	1.31	−4.03
Tropical temporary	0.08	0.51	−3.78
Animal	−0.03	−0.21	−3.94
Forest manufacturing	−0.08	−0.54	−3.89
Chemicals	−0.20	−1.32	−2.24
Labor-intensive manufacturing	−0.32	−2.23	−4.69
Machinery	−0.32	−2.25	−3.07
Capital-intensive manufacturing	−0.34	−2.37	−3.94
1990			
Tropical permanent	0.35	2.62	−2.94
Cereals	0.28	2.05	−4.27
Materials	0.26	1.90	−3.53
Petroleum	0.25	1.84	−4.14
Forest permanent	0.02	0.15	−4.01
Tropical temporary	−0.01	−0.06	−3.64
Chemicals	−0.03	−0.22	−3.09
Capital-intensive manufacturing	−0.05	−0.33	−4.01
Animal	−0.08	−0.59	−3.95
Forest manufacturing	−0.12	−0.82	−3.78
Machinery	−0.20	−1.43	−3.11
Labor-intensive manufacturing	−0.29	−2.11	−4.54

Table 8
Partial correlation of Gini coefficient and net export shares, controlling for economic distance, 1980–1990 (sectors are sorted according to partial correlations)

	Partial correlation	Net export *t*-value	Economic distance *t*-value
1980			
Tropical permanent	0.53	4.10	1.91
Materials	0.25	1.70	1.83
Petroleum	0.18	1.21	2.19
Tropical temporary	0.17	1.15	2.17
Forest permanent	0.15	1.01	2.04
Cereals	0.05	0.31	2.29
Forest manufacturing	−0.17	−1.14	2.28
Animal	−0.18	−1.17	2.41
Labor-intensive manufacturing	−0.30	−2.06	2.94
Capital-intensive manufacturing	−0.37	−2.56	2.11
Chemicals	−0.37	−2.61	0.77
Machinery	−0.40	−2.81	1.56
1990			
Tropical permanent	0.43	3.27	1.58
Materials	0.27	1.88	1.39
Tropical temporary	0.22	1.52	1.85
Petroleum	0.20	1.40	2.01
Cereals	0.17	1.16	1.79
Capital-intensive manufacturing	−0.01	−0.07	2.05
Forest permanent	−0.04	−0.27	2.07
Animal	−0.09	−0.62	2.08
Forest manufacturing	−0.21	−1.43	2.00
Chemicals	−0.23	−1.58	1.14
Labor-intensive manufacturing	−0.26	−1.83	2.56
Machinery	−0.33	−2.39	1.73

natural resources: tropical perennial crops, raw materials, tropical annual crops, raw forest production and petroleum extraction. Note that tropical perennial crops and raw forest products are both intensive users of waiting capital, the physical capital absorbed while perennials grow from seeds to fruit producing plants. [18]

To rule out the possibility that these simple relationships are due to the link between Gini coefficients and stage of development, highlighted above, we now turn to the inspection of partial correlations. Table 7 shows the partial correlation of Gini coefficients and net exports, controlling for effects of per worker GDP. Here, too, sectors are sorted by their correlation with income inequality. As indicated in the table, though the partial correlations are generally lower than the simple correlations, they nevertheless survive, albeit with some changes in order-

[18] Recall the discussion in Section 2.3.

ing. The positive relationship between income inequality and cereals, for example, increases. This is because controlling for GDP removes the effect of high-income, low Gini cereal exporters like the US. In addition, controlling for GDP causes labor-intensive manufacturing to join machinery as a strong promoter of income equality. This result is consistent with the story that movements into manufacturing improves inequality.

Table 8, which has the same partial correlations but controlling for economic distance rather than GDP per worker, contains the same message. The *t*-values for economic distance indicate a positive and significant relationship with income inequality. After controlling for it, tropical perennial net exports still stand out as the strongest impediment to equality. Manufacturing, on the other hand, continues to promote it.

5. Conclusion

We have provided in this article a conceptual framework for thinking about how natural resources affect development paths. In the multi-cone Heckscher–Ohlin model that we describe, it is the product mix that determines the behavior of the economy. Countries that are rich in natural resources have one kind of product mix; countries that are scarce in natural resources have another mix. The availability of natural resources, by absorbing scarce capital, delays the emergence of manufacturing, but when manufacturing does emerge, it is the relatively capital-intensive products that are selected. This is good news for Latin America because it offers a development path that avoids ruinous competition in the apparel and footwear marketplaces that are dominated by resource-scarce, low-wage Asian economies. This is bad news since natural resource exploitation requires physical capital but not human capital. This scenario may leave the educational system unprepared for the emergence of human-capital-intensive manufacturing that might otherwise be expected once the natural resources are fully developed. Coffee plantations, for example, embody large amounts of capital in the plants but require only minimal human capital inputs. Communities with coffee plantations may have large numbers of illiterate workers who are poorly prepared for jobs in textiles or transportation. As a result, such communities may experience higher income inequality for longer periods than communities producing labor-intensive manufactures, where skills are updated gradually.

The evidence in support of this idea is substantial but fuzzy. Our empirical analysis demonstrates that land abundant countries do indeed have lower capital stocks, fewer secondary educated workers and higher measured income inequality. In addition, we also show that the respective product mixes of land abundant vs. land scarce countries vary in the manner consistent with our story.

Our view in this paper is descriptive, but not prescriptive. Given equality of opportunity, the suggestion that natural-resource-rich countries may experience

Table 9
Countries included in dataset

Country	Abbreviation	Land abundance	Country	Abbreviation	Land abundance	Country	Abbreviation	Land abundance
Afghanistan	afg	Abundant	Guatemala	gtm	Abundant	Panama	pan	Abundant
Argentina	arg	Abundant	Honduras	hnd	Abundant	Paraguay	pry	Abundant
Australia	aus	Abundant	Hong Kong	hkg	Scarce	Peru	per	Abundant
Austria	aut	Moderate	Hungary	hun	Moderate	Philippines	phl	Scarce
Bangladesh	bgd	Scarce	Iceland	isl	Moderate	Poland	pol	NA
Belgium	bel	Scarce	India	ind	Scarce	Portugal	prt	Moderate
Benin	ben	Abundant	Indonesia	idn	Moderate	Sierra Leone	sle	NA
Bolivia	bol	Abundant	Ireland	irl	Moderate	Singapore	sgp	Scarce
Brazil	bra	Abundant	Israel	isr	Scarce	South Africa	zad	Moderate
Bulgaria	blg	NA	Italy	ita	Scarce	Soviet Union	sun	NA
Cameroon	cmr	Abundant	Jamaica	jam	Scarce	Spain	esp	Abundant
Canada	can	Abundant	Japan	jpn	Scarce	Sri Lanka	lka	Scarce
Chile	chil	Abundant	Jordan	jor	Scarce	Sweden	swe	Abundant
China	chn	Scarce	Kenya	ken	Scarce	Switzerland	che	Scarce
Colombia	col	Abundant	Korea	kor	Scarce	Syria	syr	Abundant
Costa Rica	cri	Abundant	Liberia	lbr	NA	Taiwan	oan	Scarce
Cyprus	cypr	Scarce	Malawi	mwi	Moderate	Thailand	tha	Moderate
Czech Republic	cze	NA	Malaysia	mys	Abundant	Tunisia	tun	Abundant
Denmark	den	Moderate	Mali	mli	Abundant	Turkey	tur	Scarce
Dominican Republic	dom	Scarce	Malta	mlt	Scarce	Uganda	uga	NA
Ecuador	ecu	Abundant	Mauritius	mus	Scarce	United Kingdom	gbr	Scarce
Egypt	egy	Scarce	Mexico	mex	Abundant	United States	usa	Abundant
El Salvador	slv	Scarce	Myanmar	bur	NA	Uruguay	urg	Moderate
Finland	fin	Abundant	Netherlands	nld	Scarce	Venezuela	ben	Abundant
France	fra	Moderate	New Zealand	nzl	Abundant	Yugoslavia	yug	Moderate
Germany	deu	Scarce	Nicaragua	nic	Abundant	Zaire	zar	NA
Ghana	gha	Moderate	Norway	nor	Abundant	Zambia	zmb	Abundant
Greece	grc	Moderate	Pakistan	pak	Scarce	Zimbabwe	zwe	Abundant

All information not available for all countries. See Section 4.2 for definition of land abundance.

relatively high income inequality during part of their development path should not in itself be troubling. What may be cause for concern, and perhaps subject to amelioration by government intervention, is the inability of resource-rich economies to make the jump from resource exploitation to skill- and capital-intensive manufacturing. A close examination of the Scandinavian economies, which have a history of both promoting education and attracting successful capital-intensive industries, may be highly beneficial in this regard.

Appendix A

Table 9 lists the countries classified according to land abundance.

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