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The (non) effect of natural resource dependence on capital accumulation in Latin America

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Abstract

In a simultaneous model of human and physical capital accumulation for 17 Latin American countries from 1975 to 2004, we show that overall resource dependence is not significantly related to physical and human capital. Disaggregating the natural resource variable into sub-categories, we find that petroleum export dependence is associated with higher physical capital and lower human capital, while agricultural export dependence is often associated with lower levels of physical capital. All of these effects are quantitatively small, however, casting doubt on the idea that natural resource dependence has stifled the accumulation of capital in the region.

JEL Categories: O13, O15, O16

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I. INTRODUCTION

The resource curse, where an abundance of natural wealth ends up being a curse rather than a blessing to a country, is a well-known paradox in the development literature. It is a paradox because resource abundance was once considered a key to economic growth and development. The industrial revolution in England was thought to have been driven by the country's large deposits of coal, while the rise of the US economy was at least partly based on its abundance of natural resources. Modern day examples of the curse abound, however. The Democratic Republic of the Congo, Equatorial Guinea, and Nigeria are just a few developing countries that are rich in sub-soil wealth and poor in almost every other development indicator.

In fact, if we were to construct a matrix of natural resources and wealth, we would find that no box would be empty of examples. While there are plenty of resource-rich countries which grew quickly, there are also countries like Japan, which grew extremely quickly in the post-WWII period with few natural resources. There are also countries like Somalia, which is resource poor and has had little economic growth. Thus, the anecdotal evidence suggests that the relationship between resources and development is far from clear-cut.

While most of the research on the resource curse has focused on economic growth, there are an increasing number of papers that study the effect of resource dependence on factor accumulation. Since capital is a determinant of economic growth, lower capital accumulation would also mean lower average growth rates. In this paper, we investigate the effect of natural resource dependence on human and physical capital accumulation in a panel of 17 Latin American countries between 1975-2004, a region known for its resource abundance as well as its resource dependence.[1] Even after more than 50 years of diversification away from primary

[1] The World Bank (2006) classifies Latin America and the Caribbean as having the second highest per-capita natural capital levels in the world, where natural capital is defined as the sum of all sub-soil assets, timber and non-timber

goods, 68% of Latin America's total merchandise exports in 2000-2004 still consisted of natural resources.[2]

Our work contributes to the literature on the natural resource curse in five ways. First, we focus on resource dependence (or more specifically, export-dependence on resources) rather than resource abundance.[3] Some resource-rich countries (like Australia or the United States) do not rely much on primary commodity exports, while other resource-rich countries (especially oil-exporters) depend heavily on primary commodity exports.

Second, we disaggregate the data on natural resources to determine if different resource types have different effects on capital accumulation. Mining and petroleum extraction, for example, are often very capital-intensive processes, which means that countries that rely heavily on these activities may have higher than average levels of physical capital. On the other hand, agricultural production tends to be not as capital intensive as other sectors, such as manufacturing. We find that while overall total primary commodity exports (as a percentage of GDP) are not significantly related to the accumulation of human and physical capital, petroleum exports are associated with higher levels of physical capital and lower levels of human capital. We also show that Latin American countries that export a large percentage of agricultural goods typically have lower levels of physical capital on average.[4] Mining exports are never significantly related to either physical or human capital accumulation in our sample.

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resources, pasture and crop land, and protected areas. The region has less natural per-capita natural capital than Europe and Central Asia ($11,031) but more than the Middle East and North Africa ($7,989).

[2] See Table 1 for a ranking of the countries in our sample by the percentage of primary products exported as a percentage of total merchandise exports. Exports from Ecuador, Nicaragua and Venezuela are the most resource-intensive in Latin America, with primary products making up almost 90 percent of total exports.

[3] See Brunnschweiler (2008) and Gylfason (2008) for more on this topic.

[4] By the term primary commodities, we refer to those commodities that Leamer (1984) argues are particularly resource-intensive, such as petroleum, forest products, animal products, tropical agricultural products, and cereals. In Table 2 we discuss which commodities are considered resource intensive.

Third, while much of the literature has either focused on individual countries or large-N cross-sections or panels, we concentrate on a single region. In any empirical estimation, we ideally would like a sample where (1) all the observations come from the same data generating process, and (2) there is sufficient variation in the explanatory variables that we are able to accurately estimate their effects. Limiting the sample to a single region, and one that has shared a common colonial background (or similar background in the case of Brazil) increases the possibility that the observations come from the same data generating process.[5] While large samples increase the risk of inappropriately pooling data from heterogeneous countries, focusing on a small sample of countries brings its own risks; namely, that there is no interesting variation to investigate. Fortunately, Latin America has enough variability in resource dependence to make the region an appropriate laboratory for our purposes.[6] Besides overall variation in natural resources, there is also variation in the different types of resources.[7]

Fourth, as noted above, we investigate the relationship between natural resources and physical and human capital accumulation and not on economic growth per se. Growth regressions that include education, investment, and natural resources as right hand side variables imply that resources do not affect growth via human or physical capital accumulation. In these specifications, resource intensity only raises growth through its effect on total factor productivity. There is both theory and empirical evidence that resources affect human and

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[5] Grier and Tullock (1989) show that countries from Latin America, Asia, Africa, and Western Europe do not share a common set of coefficients in growth regressions.

[6] For instance, for the years 1975-2004, natural resource exports made up an average of 12% of GDP in the region. Venezuela, Ecuador, Honduras, and Chile, however, exported more than one standard deviation above this average during this time period. Venezuela's natural resource exports were around 23% of GDP, Ecuador's was 21%, and Honduras and Chile followed closely behind with resource exports accounting for approximately 19% of GDP. On the low end of the range were Mexico and Brazil, both of which had natural resource exports equal to around 5-6% of their national income. All of the numbers cited in this paragraph were calculated by the authors using data from UN COMTRADE and the WDI.

[7] For instance, while 84% of Venezuela's exports consist of petroleum, most of the region does not export a lot of oil. There are 6 countries in our sample where oil exports make up less than 1% of total exports (Nicaragua, Chile, Costa Rica, Uruguay, Honduras, and Paraguay). Similar variation can be found in the region in agricultural exports as well as non-petroleum mineral exports. Table 1 provides more information on this topic.

physical capital, however, which means that augmented Solow regressions that include resource dependence as an independent variable are unlikely to fully capture the effect of resources.

Lastly, Grier (2002) shows that there are important spillover effects between human and physical capital accumulation in Latin America. Investigating the effect of resource dependence on human or physical capital by itself will not reveal the true overall effect because we are not controlling for these spillovers. For that reason, we study resource dependence in a simultaneous model of physical and human capital.

Section II discusses the effect of resource abundance on physical and human capital, while Section III discusses our methodology and data. Section VI discusses the results, and Section V concludes.

II. NATURAL RESOURCES AND CAPITAL ACCUMULATION

Most of the empirical work on natural resources emphasizes the link between resources and economic growth.[8] While it is important to study the relationship between resources and overall growth, we still need to identify the channels through which the resource curse works. That is, natural resource dependence can affect growth through its impact on factor accumulation or by its effect on productivity. In this paper we focus on the former.

[8] There is extensive work on the relationship between resource abundance and economic growth. While some argue that it is possible that resource wealth can stimulate economic growth (Lewis, 1989; Brunnschweiler, 2008), much of the literature emphasize the drawbacks to resource abundance (Auty, 2001; Corden, 1984; Gelb, 1988; Neary and van Wijnbergen, 1986; Prebisch, 1950; Sachs and Warner, 1999 and 2001; Tornell and Lane, 1999, Arezki and van der Ploeg, 2010; Coxhead, 2007; and Bulte and Damania, 2008). See Lederman and Maloney (2008) for a good literature review on the impact of resource abundance on growth and Wick and Bulte (2009) for an overview of the literature on the resource curse.

Sachs and Warner (1997), Gylfason (2008), and Gylfason and Zoega (2006) identify several ways in which resources could negatively affect the accumulation of physical capital.[9] First, natural resource wealth may shorten the time horizons of policymakers. They may consume more today, and invest less carefully and productively, than policymakers without access to resource wealth.[10] Second, resource dependence may also result in the Dutch disease, where the exports of a profitable primary commodity cause the real exchange rate to appreciate, thus making manufacturing sectors less remunerative.[11] If the manufacturing sector is more capital intensive than the commodity sector, then the real exchange rate appreciation would lead to less overall capital in the economy.[12]

Gylfason (2008, p. 17) also makes the argument that natural capital, in the form of resources, can "crowd out" financial and physical capital: "When a substantial part of national wealth is stored in a natural resource, there may be correspondingly less need for financial intermediation to conduct day- to-day transactions…[because]… consumption can be financed through more rapid depletion of the natural resource and saving can take place through less rapid

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[9] On the other hand, the effect of resource dependence on physical capital may depend on what type of commodity is being considered. Mining, for example, is often a very technological complex process requiring a large amount of investment in human and physical capital. See Wright and Czelusta (2004) for more on this topic.

[10] Sachs and Warner (1997, p. 10) argue that, "governments that controlled natural resource rents tended to waste the rents through profligate or inappropriate consumption."

[11] Matsuyama (1994) constructed a formal model of the idea that manufacturing promotes economic development through learning by doing, while primary commodity sectors do not. Frankel (2010, p. 14) notes that "the implication (of Matsuyama's model) would be that deliberate policy-induced diversification out of primary products into manufacturing could help bring about economic development, and that a permanent commodity boom that crowds out manufacturing could indeed retard it." He goes on to note that "public monopoly ownership and prohibition on importing foreign expertise or capital has often stunted development of the mineral sector" in Latin America. Pegg (2010), on the other hand, uses the case of Botswana to show just how difficult it is for a resource-abundant country to diversify away from the primary-commodity sector. Auty (2001b) also discusses the issue of the Dutch disease in Botswana, arguing that Botswana has been more successful in dealing with this problem than a country like Saudi Arabia. According to Auty (2001a), non-mineral exports are around one-third of total exports in Botswana, while in Saudi Arabia they are only one-fifth of total exports.

[12] Mikesell (1997) provides a good review of the different ways in which the resource curse can hamper economic development. He argues that an export boom may move resources into the primary commodity sector and out of manufacturing. Given that the tradeable sector is likely to be the more capital intensive of the two, the boom would thus be associated with less overall capital accumulation in the economy.

depletion (or of more rapid renewal if the resource is renewable)." The problem is magnified when most of the resource rents are deposited outside of the country, leaving the domestic banking sector under-capitalized. Entrepreneurs outside of the profitable resource sector may have trouble securing credit, thus reducing the amount of investment available for manufacturing activities.[13]

Resource dependence may also affect human capital. Gylfason (2001a) argues that primary commodity sectors tend to use less skilled labor (and possibly less high-quality capital) and have few linkages to other sectors of the economy. Workers in the natural resource sector would have little to offer manufacturing firms looking for a highly skilled labor force, and a government that emphasizes primary commodities would have less need to push for educational investments. Stijns (2006), on the other hand, argues that natural resource wealth (at least in the form of minerals) should be positively related to education levels. He argues (2005, p. 1061) that, "it would be surprising that while mineral states tend to lavishly spend their revenues on numerous development projects and programs, education would be the only exception."[14] Cabrales and Hauk (2011) argue that the relationship between human capital and natural resources might be different across countries. They construct a theoretical model where the abundance of natural resources has a positive effect on education in countries with good institutions, and a negative effect in countries with bad ones.

Empirically, the relationship between natural resources and capital accumulation is somewhat mixed. Sachs and Warner (1997), in a cross section of 90 countries from 1970-1990, find no statistically significant relationship between resource wealth and savings, education, and

[13] See Yuxiang and Zhongchang (2011) for an excellent articulation of the many ways in which resource abundance may crowd out financial development. They investigate a sample of Chinese provinces between the years 1996 to 2006 and find a negative and significant correlation between resources and financial development.
[14] Gylfason (2008) acknowledges this point, noting that Botswana, a country with enormous diamond wealth, spends more on education (relative to income) than any other nation in the world.

investment. Papyrakisa and Gerlagh (2006), however, find in a cross-section of 82 countries in 1994 that there is a strong, negative relationship between a country's investment in physical capital and its endowment of natural capital. Atkinson and Hamilton (2003) show that the countries most affected by the resource curse are the ones that react to export booms by ramping up government consumption instead of investment.[15]

Gylfason (2001b), in a cross section of 162 countries from 1965 to 1998, also shows a negative correlation between the share of the labor force in the primary sector and investment rates and secondary education.[16] Gylfason (2008) shows the importance of distinguishing between resource wealth and resource dependence. In a cross section of 108 countries from 1960-2000, he shows that school life expectancy is negatively related to resource dependence but positively correlated with resource wealth.[17] Stijns (2006), in a cross-section of 70 countries from 1971 to 1995, however, shows that the correlation between education and natural resources also depends on how resources are measured. More specifically, he shows that mineral exports are positively correlated with education levels, while agricultural wealth is negatively correlated with education.[18] Stijns (2009) builds on these findings in a recent paper, where he shows that subsoil wealth is positively and significantly related to a wide array of human capital indicators in a cross section of between 69 to 77 countries. Cabrales and Hauk (2011), in a cross-sectional study of 59 countries in 2000, find that the relationship between human capital and natural resources depends on a country's institutions.

[15] Lange (2004) uses the cautionary tale of Namibia to provide support for the argument that the resource curse mostly afflicts countries that do not invest sufficiently after export booms.
[16] The education sample is shortened to 1980-1998 and includes 166 countries.
[17] The UN defines school life expectancy as "the total number of years of schooling which a child can expect to receive, assuming that the probability of his or her being enrolled in school at any particular future age is equal to the current enrolment ratio at that age." (http://unstats.un.org/unsd/Demographic/products/socind/education.htm)
[18] Maloney (2002) and Bravo-Ortega and de Gregorio (2006) show how higher levels of human capital can eliminate the negative impact that resource wealth can have on economic development.

There has been also an increasing body of literature that argues that the resource curse is non-existent. For instance, Lederman and Maloney (2007) refer to it as a "missing resource curse." Several empirical analyses, such as Brunnschweiler and Bulte's (2008), have found that there is no evidence of a resource curse and that the idea of a curse is a "red herring" that tempts policymakers into blaming economic problems on resource abundance.[19] Furthermore, Boyce and Emery (2011) argue that resource abundance can even be a blessing in the long term.[20]

Our paper departs from previous papers in that we investigate the role of resource dependence on physical and human capital accumulation in a well-specified simultaneous system. Most of the earlier papers on the topic calculate correlation coefficients between measures of natural resources and either investment or education. We want to study the effect of resource dependence on factor accumulation while (1) controlling for other relevant variables that could affect human and physical capital, and (2) controlling for the fact that the two types of capital are jointly determined. Furthermore, investigating the impact of natural resource dependence on capital accumulation in Latin America is important since human and physical capital are key determinants of economic growth. The next section describes our methodology and the data used to test our hypotheses.

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[19] Brunnschweiler and Bulte (2008) find that while natural resource dependence has no effect on growth, resource abundance has a positive effect on growth and institutions. Van der Ploeg and Poelhedke (2010), however, argue that natural resource dependence leads to high macroeconomic instability in some countries, which in turn diminishes the prospects of growth. When addressing some econometric issues they argue are present in Brunscheweiler and Bulte's (2008) analysis, they find no evidence that resources are either a curse or a blessing. Mainguy (2011) also argues that resource abundance has been neither a curse nor a blessing for Mali, a country that depends heavily on gold exports.

[20] Boyce and Emery (2011), using data for US states during the period 1970-2001, show that resource abundance is negatively correlated with growth but positively correlated with income levels.

III. METHODOLOGY AND DATA

We investigate the effect of resource dependence on factor accumulation in a panel of 17 Latin American countries from 1975 to 2004.[21] The sample includes Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, the Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Paraguay, Peru, Uruguay, and Venezuela. We average the data into 5 year intervals when possible, allowing us to capture information from fluctuations over time and average cross-country differences.[22]

We model human and physical capital in a simultaneous system because Grier (2002) finds that the two forms of capital are jointly endogenous in Latin America. That is, increases in the stock of physical capital raise average education levels, while increases in average education positively influence the physical capital stock. To construct the physical capital stock per worker variable, we follow the perpetual inventory method of Caselli and Feyrer (2007).[23] We measure the stock of human capital as the average years of primary schooling in the population aged 15 and over. Although secondary schooling is commonly used as a measure of human capital (Mankiw et al., 1992), primary schooling may be a better measure of human capital in developing countries, where overall levels are lower on average.[24] Unlike in wealthy countries, where primary school attainment levels near 100%, there is a lot of variation in primary

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[21] It is possible that resource dependence is a result, at least in part, of public policy and not merely natural endowments. For our purposes, however, it does not matter why a country is dependent on natural resources (whether it is caused by geography or policy), but rather the effect of export dependence on the accumulation of human and physical capital.

[22] Brunnschweiler (2008) notes that the exports of commodities are notoriously volatile and that measuring natural resource intensity with a single year of exports may produce misleading results. Using 5-year intervals will help to alleviate such problems.

[23] While definitely not perfect, the perpetual inventory is the most commonly used method to calculate the stock of physical capital. After constructing our measure of per-worker stocks of physical capital, we rank the countries in our sample and the results seem intuitively plausible. In our initial period, for example, Venezuela and Argentina have the highest calculated per worker stocks of physical capital, while Paraguay and Honduras have the lowest.

[24] Sachs and Warner (1999). For instance, Lin (2006) studies Taiwanese growth from 1964 to 2000 and finds that primary schooling was the level of education most important for Taiwan's rapid economic development. All of the countries in our sample are classified as less developed countries by World Bank standards. As a robustness, test, we re-estimated our regressions in the paper using total education and the results were virtually identical.

schooling rates in our sample. Even as late as 2000-04, Argentina and Chile averaged more than five years of primary schooling, while Nicaragua, Colombia, and Guatemala averaged less than three years.[25]

Our principal measure of resource dependence is the total exports of primary commodities divided by GDP.[26] We use an alternative measure of resource dependence: total exports of primary commodities divided by total exports.[27] Total exports of primary commodities as a share of total exports is a popular indicator of resource dependence in the literature and it is valuable to test whether our results hold when using this alternative measure.[28]

Estimating any simultaneous system is challenging, but it is especially difficult in a model where the two dependent variables both represent forms of capital. Identification of the system requires that we find variables that are correlated with the accumulation of one type of capital but not the accumulation of the other. In the physical capital equation, we include government spending as a share of GDP, land distribution, trade openness, the standard deviation of the inflation rate, the number of coups, and the number of years in which a country experienced a civil war in the previous period.[29] All of right hand side variables in both equations are lagged one period (i.e. 5 years) to help reduce potential endogeneity problems.

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[25] Indeed, for our sample, the standard deviation of primary education is almost double that for secondary education.
[26] Data on primary commodities is from the UNCOMTRADE, SITC, Revision 1.
[27] Lujala et al. (2005) argue that natural resources as a percentage of GDP may be an endogenous regressor in income and growth equations. Countries that have high levels of political instability and low levels of income growth may appear to be more dependent on primary commodities than they really are because the denominator (GDP) is falling faster than the numerator. We believe this problem is most applicable to resource-rich Sub-Saharan African countries. While Latin America has experienced its fair share of political instability, for the most part the instability has not been as severe or as prolonged as it has in countries like Angola or the Congo. In addition, we are not studying the effect of resource intensity on income or income growth, which should lessen the problem of endogeneity. Lastly, we use alternative measures, such as per-worker terms and share of total exports, which should not suffer from the same endogeneity issue.
[28] We also explore as an alternative indicator of resource dependence total primary commodities per worker in the robustness section. More discussion of this alternative indicator is provided in the robustness section.
[29] Unlike Grier (2002), we measure inequality in terms of resources instead of income. Specifically, we follow Easterly (2007) and use the percentage of the total area of land holdings held as family farms. The advantage of

To help identify this equation, we assume that the lag of trade openness, the standard deviation of inflation, coups, and civil war directly affect the accumulation of physical capital, but not human capital. There are several theoretical and empirical reasons to support these assumptions. First, several papers test for an empirical relationship between education levels and trade openness and do not find strong support for the idea that the two are statistically related.[30] Second, the theoretical literature on economic and political instability has not established a clear link between education rates and instability, and the empirical literature has focused almost entirely on the effect of instability on investment or income growth.[31]

In the human capital equation, we include the level and square of the ethno-linguistic fractionalization index, the lag of the number of years in which the country was considered a democracy, the lag of government spending as a share of GDP, and the lag of land distribution. Ethno-linguistic diversity is entered in the model non-linearly because previous research casts doubt on the idea that diversity has a monotonic effect on education levels. High levels of diversity may mean that it is impossible for any particular group to impose their decisions on others. Because of the disagreement on educational policy in a diverse society, we expect to find a negative correlation between human capital and diversity (Alesina et al., 1999; Easterly and Levine, 1997).

For over identification purposes, we assume that democracy and ethno-linguistic fractionalization directly affect the stock of human, but not physical, capital. The literature has not focused on the relationship between physical capital and democracy, per se, but it has

using this indicator as a proxy for inequality is that it is consistently available over time for the countries included in the sample.

[30] Sachs and Warner (1995) and Harrison (1996). It is possible that the trade openness variable is highly correlated with the natural resource exports variable, thus giving misleading results about the impact of natural resources on capital accumulation. However, in our sample, trade openness and natural resource exports are not significantly correlated (the correlation coefficient is only 0.11) and we use the lag of trade openness in the physical capital equation.

[31] See, for example, Fedderke and Klitgaard (1998).

explored the relationship between democracy and income. Much of the empirical literature has failed to find a robust positive link between democracy and income growth. Acemoglu et al. (2008) show in a large sample of countries from 1960 to 2000 that any significant relationship between democracy and per-capita income disappears once fixed effects are included in the model specification.[32]

The theoretical and empirical links between education and democracy seems to be stronger. Barro (1996) argues that democracy brings about lower fertility rates, which in turn leads to increasing education among women. Saint-Paul and Verdier (1993) find that democracy is associated with more spending on education, a result supported recently by Gallego (2010).[33] Gallego (2010) notes that there are several ways in which democracy may promote the accumulation of human capital. First, democracies may be better at "overcoming such market failures as credit constraints in financing education." (Gallego, 2010; p. 229) Second, higher levels of suffrage tend to be associated with higher levels of spending on education. He tests this theory in a sample of more than 50 ex-colonies and finds a positive and significant relationship between democracy and primary education.[34]

Like democracy, the effect of ethno-linguistic diversity on education seems clearer than its effect on physical capital. The literature has focused on diversity and income growth rather

[32] See Brunetti (1997) for a good survey of this literature.
[33] On the other hand, Mulligan et al. (2004) find no evidence that educational spending is significantly different between democracies and dictatorships in a sample of 142 countries from 1960 to 1990. Acemoglu et al. (2005) show in a sample of 108 countries from 1965 to 2000 that changes in average education levels are not significantly related to changes in democracy. More recently, however, Bobba et al. (2007) argue that these results are due to the fact that Acemoglu et al. use a weak instrument in their estimation. When they correct for this, they find that education and democracy are significantly related.
[34] In an interesting historical comparison, Lindert (2002) studies democracy and education in India and Sri Lanka. British colonial authorities awarded Sri Lanka with universal suffrage in 1931, while only giving Indians very narrow suffrage rights in 1919. Lindert notes that enrollment in primary schooling was greater than 50% in Sri Lanka during the period 1935-40, while it still had not reached even 15% in India.

than investment per se and the results are decidedly mixed.[35] As we are already controlling for the uncertainty that arises from economic and political instability in the physical capital equation, we believe that ethno-linguistic fractionalization should only directly impact education.

In sum, our identifying assumptions are that trade openness, inflation variability, and political instability directly affect physical capital and not human capital, while democracy and ethno-linguistic diversity directly affects human, but not physical, capital. As a preliminary test of these assumptions, we estimated our system including one control variable at a time in the equation in which we assume it should be excluded. We find that these excluded variables are not statistically significant at any conventional level. Thus, as an initial pass, our identifying assumptions seem appropriate.[36] Table 2 provides a detailed explanation of all the variables used in the analysis and their sources, and Table 3 provides summary statistics.

We estimate the system of equations with a General Method of Moments (GMM) estimator, which accounts for the contemporaneous correlation of the error terms in the two equations and uses a weighting matrix that is robust to heteroskedasticity.[37] As mentioned above, identification of the system requires that we find variables that affect human capital but not physical capital (and vice versa). In our case, the number of independent variables that are unique (that is, appear in one equation but not the other) is greater than the number of equations in the system. This means that our system is over identified. GMM minimizes a criterion function that is itself a function of the correlation between the instruments and errors terms,

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[35] See, for example, Lian and Oneal (1997) and Nettle (2000).

[36] We find that when we included the excluded variables into each equation, one at the time, they are not statistically significant and our previous results are robust to the inclusion of these variables. These estimations are not included for purpose of space, but are available upon request.

[37] See Wooldridge (2002) for more on system GMM estimation. The weighting matrix used in our estimation is a White covariance matrix, which is robust to heteroskedasticity of unknown form. We use simultaneous updating, which continuously updates the coefficients and weighting matrix, iterating until the coefficients and weighting matrix converge. We also estimated the system using 3SLS and the results were virtually identical. The system methods are preferred over 2SLS because there is significant correlation between the error terms in our models.

which allows us to test the null hypothesis that these over identifying restrictions are valid.[38] The minimum value of the GMM criterion function multiplied by the sample size is distributed as a χ^2 with the degrees of freedom equal to the number of over identifying restrictions in the model.[39] We calculate and report this statistic for all of our estimations below.

IV. RESULTS

A. The Effect of Natural Resource Dependency on Human and Physical Capital

System 1 of Table 4 presents the results of our model using total exports of natural resources as a fraction of GDP as our measure of resource dependence. The calculated J-test statistic (reported below the results) indicates that we cannot reject the null hypothesis that our identifying restrictions are valid at even the 0.50 level.[40]

We find that that physical and human capital are jointly endogenenous, where an increase in the stock of one type of capital has a positive and significant effect on the stock of the other. In addition, we find that inflation variability, civil war, and trade openness are all negatively related to the accumulation of physical capital. We expected the first two variables to be negatively related to physical capital accumulation, and we hypothesized that the coefficient on trade openness could theoretically be either positive or negative. If a country is more open to trade, it is also better able to import technology to help make its domestic manufacturing sector more competitive and efficient. However, if a country is exporting primary goods in return for imported manufactured goods, it is possible that these imports could deter the development of a

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[38] This test assumes a valid identification and only tests for whether the system is properly overidentified.
[39] The critical value for all systems estimated is 8.12 at the 15 percent level with five degrees of freedom.
[40] The high p-values for all of our estimated models indicate that we are probably not committing Type II error when we fail to reject this null.

strong manufacturing base. While we do not know that this is the case in Latin America, the negative coefficient is at least consistent with that story.

Government expenditures are positively related to physical capital at the .05 level. The coefficient on land distribution (our proxy for inequality) is insignificantly different from zero. In the human capital equation, ethno-linguistic diversity has a non-linear effect on human capital. Both the level and the square of logged diversity levels are negative and significant at the .01 level. The effect of ethno-linguistic fractionalization (ELF) is positive up until ELF reaches the value .24, after which any further increases reduce the stock of human capital.[41] All countries but Argentina, Bolivia, Ecuador, Guatemala, Mexico, and Peru have diversity levels below the turning point. Neither government spending, democracy, nor land distribution has a statistically significant effect on the accumulation of human capital.

Turning to our main variables of interest, we find that natural resource dependence is not statistically related to physical capital accumulation. This is consistent with the findings of Sachs & Warner (1999), who show that investment and natural resources are not significantly correlated with one another.

We re-estimate the system using an alternative measure of resource dependence: primary commodity exports divided by total commodity exports. System 2 of Table 4 reports the results. The sign and significance of the control variables in both systems are similar to those reported in Table 4. We find some evidence of a negative, but statistically weak, relationship between natural resource dependence and physical capital. The net effect of an increase in natural resource dependence of one percent would be a drop in physical capital by .14%.

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[41] This finding may seem counter intuitive as the coefficients on ELF and ELF squared are negative. The reason the effect of diversity is positive, however, is due to the fact that we are using the natural logarithm of the data. Since the ELF index ranges between 0 and 1, logging the data results in negative numbers.

Given the fact that the natural resource variable is insignificant in System 1, and only weakly significant at the 10 percent level in System 2, we conclude that resource dependence does not seem to be having a strong dampening effect on factor accumulation in Latin America.[42] However, our measure of resource dependence consists of a wide range of commodities from different categories. The impact of natural resource dependence on capital accumulation may be dependent on the type of resource in question. For example, the production of minerals requires different levels of physical and human capital than the production of agricultural goods. In the next section, we explore whether the effect of resource dependence on physical and human capital differs depending on the type of commodity that is being exported.

B. The Effect of Different Commodity Types on Capital Accumulation

Aggregate measures of resource dependence may mask differences among various categories of commodities. Isham et al. (2005), for example, find that countries which have highly localized resources (called point source resources), like minerals and plantation crops, grow slower and have worse institutions on average than countries with more widespread, or diffuse, natural resources.[43] In this section, we disaggregate our resource variable into three categories of export dependence: mineral, petroleum, and agricultural.[44] We first discuss the reasons why each of these categories may affect the accumulation of capital differently, and then re-estimate our system with disaggregated measures of resource dependence.

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[42] The term resource curse usually refers to the effect of natural resources on economic development or growth. While we are studying factor accumulation and not income, the two are positively related. The correlation between real per-capita income and our measure of physical capital from 2000-04 is 0.82, indicating that countries in the region that have more physical capital per worker also tend to have higher average per-capita incomes.

[43] On the other hand, Mavrotas et al. (2011), in a sample of 56 developing countries from 1970 to 2000, find that resource dependence, whether it be of the point source or diffuse variety, has a negative effect on institutions, which in turn dampens overall economic growth.

[44] We consider as mineral commodities the commodities from SITC codes 32, 34, 35, and 68. Petroleum is specified by the SITC code 33. Agricultural commodities include 1-9, 11, 12, 41-43, and 94 SITC codes.

B.1 Mineral Exports

Mineral resources, such as diamonds and oil, may make countries particularly vulnerable to a resource curse, while other commodities, such as pasture land and forests, may actually be favourable for development. Sala-i-Martin and Subramanian (2003) make this point for the case of Nigeria, arguing that sub-soil assets like minerals and petroleum have been bad for growth, while agriculture has not.[45] The World Bank (2006, p. 27) calculates that Latin America has the third highest percentage of its natural resources in mineral form. Table 1 shows that mineral exports made up 20% of total merchandise exports on average in 2000-04. While many of the countries in the sample are large mineral exporters, there is a lot of variation in the sample. For instance, more than 30% of the merchandise exports from Ecuador, Venezuela, Chile, Bolivia, Peru, and Colombia consist of mineral exports, while less than two percent in Nicaragua, Paraguay, Honduras, Uruguay, and Costa Rica.[46]

The empirical literature on minerals and growth has produced mixed results, and the relationship between mineral export dependence and factor accumulation is similarly unclear.[47] Mining is typically a very capital-intensive process, but one that may not have a lot of forward and backward linkages to the rest of the economy.[48] It is possible that developing countries that rely heavily on mining exports could have widespread poverty combined with high per-capita levels of physical capital. Auty (2001a), however, shows that fast-growing resource-poor countries had average gross fixed investment rates greater than 25% of GDP. He compares that

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[45] On the other hand, Stijns (2005) makes almost the opposite claim, arguing that land abundance may negatively affect growth while minerals may have either a positive or negative effect.

[46] Chile, for example, has "one of the largest and most-developed mining industries in the world" and is the "world's leading supplier of copper, copper ores and concentrates" (WTO, Chile, p. 68).

[47] Papyrakis and Gerlagh (2004) find in a large cross section of countries any negative effect of minerals on growth is caused by the indirect effects that these resources have on corruption, terms of trade, investment, and education. Davis (1995) reports a positive link between minerals and growth, while Stijns (2005) finds that the empirical relationship is mixed.

[48] Auty (2001, p. 30) writes that "the mining sector usually employs much foreign capital but only a small, albeit well-paid workforce, so that final demand linkage (i.e. domestic spending by capital and labor) is modest."

to resource-rich Latin America, where Edwards (1997) found that investment levels averaged only 20% of GDP between 1960 and 1980. Mikesell (1997) argues that there are many mineral exporters that "do not save and invest enough to compensate for the depletion of their reserves." As evidence of this, he shows that gross investment as a percentage of GDP fell in the majority of the mineral-exporting countries from 1970 to 1993.[49]

With respect to mineral export dependence and the accumulation of human capital, Gylfason (2001) and Birdsall et al. (2001) find evidence that the two are negatively related, while Davis (1995) and Stijns (2006) report a positive and significant relationship.[50] Lagos and Blanco (2010), in a study of a region of Chile (Antofagasta) that relies heavily on copper production, find that the impact of resource abundance on education is complex. Specifically, they show that average overall schooling is higher in this region, but that there are some areas where illiteracy rates are very high in comparison to the national average. They also find that the quality of education has decreased in this region since 1998, and that it differs across cities.

One reason the results are so mixed in relation to the impact of minerals on human capital accumulation may be that mineral resources should be divided into petroleum and non-petroleum categories.[51] We explore the possibility in the next section that petroleum exports may have a separate effect on factor accumulation.

B.2 Petroleum Exports

While petroleum is also a sub-soil resource and is often categorized as such, it may be worth disaggregating the data further to test whether petroleum exports have a separate effect on factor accumulation. Some countries in our sample export a lot of oil (either as a share of GDP

[49] Papyrakisa and Gerlagh (2006) develop a model of overlapping generations to demonstrate why mineral exporting countries do not incentive to save and invest as much as they should after an export boom.
[50] Mainardi (1995) develops a theoretical model in which investment in the minerals sector must provide a certain level of economic rents for the development of human capital and technology.
[51] In a study that focuses on a major copper production area of Chile, Antofagasta, Lagos and Blanco (2010) study

or of total exports), while others export little to nothing. Venezuela is the top petroleum exporter in the region, with oil revenues making up 84% of its total exports and around 21% of its GDP. Ecuador and Mexico are the next two largest oil exporters. Ecuador's oil exports make up almost one-half of all of its exports and 11% of its GDP. Mexico is more diversified, with oil exports making up 29% of total exports but only 3.6% of GDP. Countries such as Nicaragua, Chile, Costa Rica, Uruguay, Honduras, and Paraguay, on the other hand, have oil exports that make up less than one percent of their total exports.

Karl (2007, p. 7) argues that petroleum exports are even more prone to the resource curse than other minerals, arguing that, "petroleum may be one of the hardest resources to utilize well…[and that]…countries dependent on oil exports seem particularly susceptible to policy failure." On the other hand, the effect of petroleum exports on capital accumulation is likely to be similar to that of minerals in general in the sense that the oil industry is highly capital intensive with very few linkages to the rest of the domestic economy.

Most of the literature on oil and development investigate the relationship between petroleum exports and economic growth. Sachs and Warner (1999) show that countries that are dependent on oil exports have slower economic growth on average than other countries. Sala-i-Martin and Subramanian (2003) find support for this idea in the case of Nigeria. Maloney (2002) argues that petroleum exports are not necessarily associated with lower levels of development. More recently, Alexeev and Conrad (2009) show that countries rich in oil and minerals have higher per-capita GDP levels than ones without such resources.

As for oil's effect on human capital, Karl (2007, p. 11) finds that educational attainment and spending on education are both lower on average in oil exporting countries. She writes that, "in the OPEC countries, for example, 57% of all children go to secondary school compared with

64% for the world as a whole…[and that]…OPEC spends less than four percent of the GNP on education compared with almost five percent for the world as a whole." The reason why education lags in these countries is not obvious, but Karl (2007) reasons that perhaps governments are less concerned with educating the citizenry because they feel they can import the skilled personnel to work in the oil sector.

B.3 Agricultural Exports

Manufacturing is typically more capital intensive, both in terms of skills and equipment, than agricultural production. So in this sense it would not be surprising to find a negative relationship between agricultural export dependence and physical and human capital. This would be especially true if countries are experiencing real exchange rate appreciation due to the Dutch disease, where the primary good sector is pushing out the more technologically advanced manufacturing sector. It is also possible that large plantation crops, such as sugar or tobacco, may be similar to mineral sectors in that they are capital-intensive enclaves with few linkages to the rest of the economy. Auty (2001a) argues that if commercial plantation owners dominate the economy, they may see little reason to expand educational opportunities or promote economic diversification. They would be interested in infrastructure development only to the extent that it facilitated the exporting of their crops.

Nicaragua and Honduras rely more on agricultural exports than any other countries in the sample, with agricultural goods making up more than 65% of both countries' natural resource exports. In addition, despite many years of export diversification attempts, total agricultural exports for most of the countries in our sample are concentrated in a few products. For example, five commodities (soybeans, beef, maize, soybean cake, and soybean oil) make up 83% of Paraguay's agricultural exports.[52]

Unlike the case of mineral resources, Stijns (2006) finds that agricultural export intensity is negatively related to human capital. Isham et al. (2005) argue that only 2 of the 17 Latin American countries in their sample are diffuse resource exporters (Argentina and Honduras). The fact that so few of Latin American countries export diffuse commodities may mean that agricultural export dependence negatively affects factor accumulation.

B.4 Results

We disaggregate our original resource variable into mineral, petroleum, and agricultural categories.[53] System 1 of Table 5 reports the results of using mineral, petroleum, and agricultural exports as a fraction of GDP, while System 2 re-estimates the results using our alternative measure of resource intensity (resource exports as a share of total exports). In both cases, it is clear that the disaggregated measures of resource intensity better explain the variability of capital accumulation in the region. The R^2 of the physical capital equation has increased from .521 to .691, while the R^2 of the human capital equation increased from .492 to .556.

The results from both systems also show that the different types of commodities have very different effects on factor accumulation. System 1 of Table 5 demonstrates that mineral resource dependence (as a share of GDP) has no statistically significant effect on either human or

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[52] Likewise, the top five agricultural exports of Honduras (coffee, bananas, palm oil, melons, and sugar) make up 77 percent of its total agricultural exports, while the top five in Bolivia (soybean cake, soybean oil, nuts, sunflower oil, and oilseed flower) and Ecuador (bananas, organic materials, cocoa beans, fruit, and sugar confectionery) make up 74 percent and 76 percent, respectively, of their total agricultural exports.

[53] Note that commodities with the SITC codes 21-29, 63, and 64, which were all included in our aggregate measure of resource dependence, are not included in either the mineral or agricultural classification. These commodities do not fit in either category and are better classified as materials. When we add a materials variable to our model, we find that the coefficient is statistically insignificant and that its inclusion does not affect the sign or magnitude of the coefficients on the other commodity types. These results are not included but are available upon request.

physical capital accumulation.[54] Petroleum export dependence, however, is a different story. Oil exports as a share of GDP is positive and significant in the physical capital equation and negative and significant in the human capital equation (both at the one percent level). Agricultural export dependence as a share of GDP is negatively related to physical capital, while insignificantly related to human capital accumulation.[55] As can be seen in System 2 of Table 5, these results are robust to using mineral, oil, and agricultural exports as share of total exports.

We calculate the direct and equilibrium effects of petroleum and agricultural resource dependence on capital accumulation using the coefficients from System 1. The direct effect of a one percent increase in petroleum exports is reflected in an increase in physical capital of 0.05% and a decrease in human capital of 0.02%. An increase of agricultural exports as a share of GDP of one percent, however, is associated with a decrease in physical capital of 0.15%.

Since the two forms of capital are jointly determined, there are spillover effects between them and we need to calculate the long-run equilibrium effect of each commodity group on capital. The equilibrium effect of a one percent increase in petroleum exports is an increase in physical capital by 0.04%, but a decrease in human capital by .01%. The magnitude of both effects is very small, meaning that petroleum export dependence does not have much of an overall impact on capital accumulation in Latin America.

The equilibrium effect of an increase of agricultural exports as a share of GDP by one percent is reflected in the long run as a decrease in physical capital by 0.19% and a decrease in human capital by 0.04%. From this result, we conclude that the effect of agricultural export

[54] Our measure of mineral export dependence consists of commodities classified as minerals and metals. Since the natural log cannot be taken of a zero value, we adjusted 4 observations for Paraguay to a number very close to zero (we imputed 1E-13 for these observations).

[55] The signs and significance of the control variables are similar to those reported in Tables 4, except that land distribution is now negative and significant in the physical capital equation at the 5% level. Thus, countries that have more agricultural land held as family farms (representing higher equality) also tend to have lower levels of overall physical capital.

dependence on capital accumulation is negative on physical capital and close to zero on human capital.

In sum, our results demonstrate that not all resources affect factor accumulation in the same way and that studies of the impact of resource dependence on development should disaggregate resources into categories. Specifically, we find that petroleum and agricultural exports have a statistically significant effect on capital accumulation. While the equilibrium effect of petroleum dependence on physical capital is mostly positive, the effect of agricultural export intensity is negative. In addition, both have a very small negative effect on the accumulation of human capital. The magnitude of all of these effects are relatively small, leading us to conclude that there does not seem to be strong evidence of a resource curse in the region, at least in terms of factor accumulation. In the next section, we test the robustness of our results by using alternative indicators for human capital and natural resource dependence and controlling for several institutional variables.

C. Robustness

In this section, we explore whether our results are robust to several different scenarios. First, we estimate our model using alternative indicators for human capital and natural resource dependence. While the average years of primary schooling is commonly used as an indicator of human capital in developing countries, we test whether our results are robust to using a more general indicator of education that takes into consideration all levels of education. We do so by estimating our model using the average years of schooling of the population. We also re-estimate the model using an alternative measure of resource dependence: per-worker resource exports. Lederman and Maloney (2009) argue that commodity exports in per-worker terms are a better alternative to the common practice of measuring resource dependence as a percentage of GDP.

They claim that such measures overstate true resource abundance, are endogenous in growth equations, and that per worker measures are a better proxy of relative endowments across countries.[56] While we are not estimating the effect of natural resource dependence on growth, capital accumulation is closely related to GDP, and it is worthwhile to test whether our results are robust to their proposed indicator.[57] Second, we discuss in more detail the potential relationship between natural resources and institutions, and test whether our results are robust to the inclusion of variables that account for alternative institutional structures. Specifically, we include measures of civil liberties and control of corruption.

C1. Alternative Indicators for Human Capital and Natural Resource Dependence

Table 6 presents the results of using total average years of schooling as our measure of human capital (System 1) and commodity exports per worker as a proxy for natural resource dependence (System 2).[58] For the most part, our previous results are robust to using these alternative indicators. Human and physical capital are jointly endogenous and statistically significant in System 1. The magnitude and significance of the coefficients for the agricultural, petroleum and mineral exports are similar to the results of Table 5.

In System 2, we find that petroleum exports continue to have a significant positive effect on physical capital and a significant negative effect on human capital. In this estimation, the size of the coefficients for petroleum exports in both equations is very similar to the one shown in the baseline model (System 1 of Table 5). The effect of agricultural exports has changed slightly.

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[56] Lederman and Maloney (2007) re-estimate Sachs and Warner (1999) using net exports of resources per worker and show that the negative relationship between resource abundance and growth no longer holds.

[57] Lederman and Maloney (2008) argue that using total exports overstates resource abundance in countries with export processing zones where commodities are re-exported. While this may be true for countries like Singapore, we find no evidence that re-export zones of commodities are an important factor in our sample. Data from the UNCOMTRADE shows that only 5 countries re-exported commodities during the period of analysis, but this re-exporting was scattered over time and not significant in magnitude when compared with total exports.

[58] In System 2 we use all the variables specified in our baseline model, where the only difference is on the indicators of natural resource dependence.

We now find no evidence that agricultural export dependence negatively affects physical capital, and has a positive, but statistically weak, effect on human capital.

From these robustness checks, where we use alternative indicators of human capital and natural resource dependence, we can conclude that the petroleum exports shows a robust positive (negative) effect on physical (human) capital, but the effect on capital accumulation is very small. For agricultural exports we can conclude there is no evidence of a robust negative effect on capital accumulation, since in System 2, the only significant effect it has on capital accumulation is a positive (but weak) one on human capital.

C2. Institutions and Resource Dependence

The literature on the resource curse has increasingly emphasized the important role of institutions in determining whether resource abundance positively or negatively affects economic growth. One strand of the literature argues that natural resource abundance has a negative effect on institutions. For instance, resource abundance may lead to worse government performance and corruption, especially in countries that have point resources such as minerals (Bulte et al., 2005; Isham et al., 2004; Vicente, 2010). Further, resource abundance can lead to weaker democratic institutions because resource rents promote less political turnover, and in some cases, more authoritarian regimes (Cabrales and Hauk, 2011).[59]

A second strand of the literature argues that the impact of natural resources on economic growth is dependent on the type of institutions. According to Mehlum et al. (2006), whether a country has grabber friendly or producer friendly institutions determines a country's ability to

[59] See also Bhattacharyya and Hodler (2010), Boschini et al. (2003), Brollo et al. (2010), Bulte et al. (2005), Collier and Hoeffler (2010), Isham et al. (2005), Norman (2009), Ross (2001), Baland and Francois (2000), Tornell and Lane (1999), Torvik (2002), and Vicente (2010).

reap benefits from the natural resource sector in terms of higher aggregate income.[60] If institutions are grabber friendly and there is significant rent-seeking, then natural resource abundance will reduce income because it drains resources away from other productive activities. Robinson et al. (2006) also develop a theoretical model where they show that countries with more government accountability and competence are more likely to benefit from a boom in the natural resource sector.[61]

We have been less concerned about the role of institutions in this paper because our main purpose was to determine whether Latin American countries did in fact suffer from a resource curse, in the sense that they had lower capital accumulation as a result of their dependence on natural resources. We find no evidence of an overall curse in Latin America, in that primary commodity export dependence is not significantly related to either human or physical capital accumulation. However, there is some evidence that agricultural export dependence negatively affects the stock of physical capital, while oil exports negatively affects human capital. In this section, we test whether these relationships remain significant once we control for institutional factors.

We already have one institutional variable in our system of equations—democratic rule—but in this section we add several additional measures of institutional quality. Table 7 presents the results of including civil liberties and control of corruption into our baseline model. [62] We

[60] The authors define "grabber-friendly" states as ones where "rent-seeking and production are competing activities" (p. 3).

[61] Several empirical analyses have shown that good institutions, such as openness, democratic institutions, and government checks and balances, allow natural resource abundant countries to achieve higher economic growth. See, for example, Andersen and Aslaksen (2008), Arezki and van der Ploeg (2010), Boschini et al., (2007), Cabrales and Hauk (2011), Collier and Hoeffler (2009), and Kolstad (2009). On the other hand, Brunnschweiler (2008) and Yang and Lam (2008) find that institutions are not relevant for determining the impact of natural resource on economic growth.

[62] We take the natural log of these variables and also lag them to deal for endogeneity. We also estimate the model including the constraints on the executive in the system, but found that this indicator had no significant effect on either equation. We omit these results for purpose of space, but they are available upon request.

find that our previous results are robust to the inclusion of these institutional variables. In Table 7, System 1 reports the results of including an indicator of civil liberties and System 2 reports the results of including a measure of the control of corruption. We find that civil liberties have a positive and significant effect on human capital, while the control of corruption variable has a positive and significant effect on physical capital. The sign, significance level, and magnitude of the coefficients for petroleum and agricultural variables remain virtually unchanged from the results shown in Table 5. Thus, we can conclude that there is evidence of a small direct effect of petroleum and agricultural export dependence on capital accumulation even when we control for several institutional measures common in the literature.

V. CONCLUSION

We find novel results about the impact of natural resource wealth on factor accumulation in a sample of Latin American countries. Using as our measure of resource dependence total commodity exports as a % of GDP, we find no evidence of a statistically significant relationship between dependence and capital.[63] In addition, we demonstrate that not all resources affect capital in the same way. We find that it is petroleum, and not mineral, exports that have a significant effect on capital accumulation. This is an important distinction since several of the countries in the region are large petroleum exporters. Further, we find that the effect of agricultural dependence on capital accumulation is very different than the effect of petroleum dependence.

While the effect of agricultural exports on capital accumulation is not always robust, we find some evidence that countries that rely heavily on agricultural exports have less physical

[63] When we measure dependence as total primary exports divided by overall commodity exports, we find a negative, but statistically weak (and quantitatively small) effect of dependence on physical capital.

capital accumulation than other countries. We believe that this finding deserves further research. The effect of agricultural production on capital might be partly determined by the degree of land concentration, where the impact of plantation agriculture on capital accumulation may differ from the effect of smallholder agriculture. The type of technology used in agricultural production and the geographic characteristics of the land might also explain the impact of agricultural dependence on capital accumulation.

In addition, while our results illuminate the relationship between natural resources and capital accumulation for the Latin American area, further work could extend these results by investigating the relationship in other regions. The results here may not be easily generalized, as the effect of natural resources on economic development is likely to vary across regions.

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TABLE 1

Commodity exports as a percentage of total merchandise exports (2000-2004 average)

	Mineral Exports	Agriculture Exports	Material Exports	Total Commodity Exports
Ecuador	45	38	7	91
Nicaragua	2	77	10	89
Venezuela	86	1	1	89
Paraguay	0	35	52	86
Chile	30	26	30	85
Bolivia	31	27	22	81
Honduras	1	65	14	81
Peru	30	28	21	79
Colombia	39	18	8	65
Guatemala	8	51	7	65
Uruguay	2	47	16	65
Dominican Rep.	16	41	4	61
El Salvador	7	35	10	52
Brazil	7	22	19	47
Costa Rica	1	31	5	38
Mexico	11	5	2	18
Regional Average	*20*	*35*	*14*	*68*

Source: Authors' construction using UNCOMTRADE dataset. Mineral commodities include the commodities from SITC codes 32-35, and 68. Agricultural commodities include 1-9, 11, 12, 41-43, and 94 SITC codes. The materials category include commodities with the SITC codes 21-29, 63, and 64

TABLE 2
Variable Description and Sources

Variable	Description
Physical capital stock	The initial stock of capital is estimated as $I_0/(g+\delta)$, where I_0 is the level of investment in the earliest year available (1950 or 1951), g is the average geometric growth rate of the level of investment between the first year available and 1970, and δ is the depreciation rate equal to 6%. The level of investment in a specific year (I_t) is calculated as the product of the real GDP per capita (Laspeyres constant prices), population, and investment share. Source: Authors' calculation using data from the PWT (2006).
Human capital stock	The average years of primary schooling of the population aged 15 and over. Data available in 5-year frequency. Source: Barro and Lee (2001).
Natural resources GDP share	Total exports of primary commodities divided by GDP (in current USD), where primary commodities include those with SITC codes 0, 1, 2, 3, 4, 63, 64, 68, and 94. Source: Authors' calculation using data from UN COMTRADE and WDI.
Natural resources export share	Total exports of primary commodities divided by total commodity exports. Source: Authors' calculation using data from UN COMTRADE.
Natural resources per worker	Total exports of primary goods divided by the labor force. Source: Authors' calculation using data from UN COMTRADE and WDI.
Land distribution	The share of land holdings considered family farms. Data is available in 10-year frequency (1978, 1988, etc) and is averaged to have two 5-year observations every decade. Source: Vanhanen (2003).
Government share	Government share of real GDP per capita. Source: PWT (2006).
Trade openness	Exports plus imports as a share of real GDP per capita (Laspeyres constant prices). Source: PWT (Heston et al., 2006).
Ethno-linguistic fractionalization	The probability in 1960 that two randomly selected people from a given country will not belong to the same ethno-linguistic group. Source: Easterly and Levine (1997).
Democracy	Number of years in a 5-year period a country was considered a democracy (democracy score > 7). Source: Marshall and Jaggers (2007).
Constraints on the executive	5-year average of the indicator of constraints on the executive. Source: Marshall and Jaggers (2007).
Civil liberties	5-year average of the indicator of civil liberties. Source: Skaaning (2006).
Control of Corruption	Period average of the corruption index, using observations from 1984 through 2004. Source: Political Risk Service Group (2007).

5-year averages are constructed for 1970-74, 1975-79, etc. unless otherwise noted. Linear interpolation used to calculate the Dominican Republic's total exports in the 1990s due to data unavailability.

TABLE 3. Summary Statistics, 1975-2004 (5 year average periods)

	Mean	Max.	Min.	Std. Dev.
Physical capital stock $_t$	32057.650	85727.730	8780.554	19306.940
Human capital stock (primary)$_t$	3.715	6.128	1.586	0.936
Human capital stock (total) $_t$	5.165	8.830	1.910	1.471
Natural resources exports/GDP $_{t-1}$	0.129	0.275	0.025	0.065
Natural resources exports/total exports $_{t-1}$	0.787	0.985	0.143	0.170
Natural resources exports/labor force $_{t-1}$	344.184	1802.170	46.177	314.402
Agricultural exports/GDP $_{t-1}$	0.068	0.208	0.001	0.053
Mineral exports/GDP $_{t-1}$	0.013	0.114	0.000	0.027
Oil exports/GDP $_{t-1}$	0.024	0.233	0.000	0.055
Agricultural exports/total exports $_{t-1}$	0.423	0.853	0.006	0.236
Mineral exports/total exports $_{t-1t}$	0.079	0.723	0.000	0.157
Oil exports/total exports $_{t-1}$	0.118	0.939	0.000	0.230
Agricultural exports/labor force $_{t-1t}$	155.526	837.733	6.026	142.333
Mineral exports/labor force $_{t-1}$	33.347	495.720	0.000	76.830
Oil exports/labor force $_{t-1}$	96.579	1727.824	0.000	280.275
Government share $_{t-1}$	19.404	48.863	10.766	6.561
Land distribution $_{t-1}$	24.490	54.000	5.000	10.841
Trade openness $_{t-1}$	40.763	121.112	7.245	22.863
Std dev of inflation $_{t-1}$	241.777	6008.391	0.940	911.626
Coups $_{t-1}$	0.206	2.000	0.000	0.514
Civil war $_{t-1}$	0.333	5.000	0.000	1.075
Democracy $_{t-1}$	1.902	5.000	0.000	2.241
Ethno-linguistic fractionalization	0.258	0.680	0.040	0.211
Constraints on the executive $_{t-1}$	4.409	7.000	1.000	2.075
Civil liberties	15.839	19.440	13.850	1.281
Corruption	2.926	4.641	1.325	0.749

All variables have 102 observations.

TABLE 4. The Effect of Natural Resource Export Intensity on Human and Physical Capital

	System 1		*System 2*	
Variable	Physical Capital	Human Capital	Physical Capital	Human Capital
Constant	9.300	-1.129	7.775	-1.229
	(1.040)	(0.597)	(0.718)	(0.644)
ln(Human capital)	1.819***		2.223***	
	(0.371)		(0.413)	
ln(Physical capital)		0.229***		0.243***
		(0.053)		(0.055)
ln(Natural resources) $_{t-1}$	0.162	-0.002	-0.221*	0.070
	(0.119)	(0.036)	(0.133)	(0.053)
ln(Government share) $_{t-1}$	0.345**	-0.037	0.358*	-0.051
	(0.157)	(0.072)	(0.186)	(0.067)
ln(Land distribution) $_{t-1}$	-0.047	-0.018	-0.085	-0.004
	(0.100)	(0.040)	(0.118)	(0.047)
ln(Trade openness) $_{t-1}$	-0.518***		-0.305***	
	(0.140)		(0.116)	
Std. dev. inflation $_{t-1}$	-0.0001**		-0.0001*	
	(0.00003)		(0.00003)	
Coups $_{t-1}$	-0.059		-0.041	
	(0.047)		(0.038)	
Civil war$_{t-1}$	-0.091***		-0.073***	
	(0.027)		(0.029)	
Democracy $_{t-1}$		0.009		0.009
		(0.006)		(0.006)
ln(Ethno-ling. frac.)		-0.214***		-0.171**
		(0.082)		(0.087)
ln(Ethno-ling. frac.)^2		-0.071***		-0.056**
		(0.026)		(0.029)
J-test (p-value)	2.81(0.72)		2.36(0.80)	
R^2	0.521	0.492	0.429	0.492

The numbers in parentheses are robust standard errors. ***, **, and * represent statistical significance at the one, five, and ten percent level. Time dummies were estimated but not reported for reasons of space. System 1 uses the total exports of primary commodities divided by GDP, while System 2 uses the total exports of primary commodities divided by total commodity exports. Both estimations have 102 observations.

TABLE 5. Effect of Mineral, Petroleum, and Agricultural Exports on Human and Physical Capital

	System 1		*System 2*	
Variable	Physical Capital	Human Capital	Physical Capital	Human Capital
Constant	8.705	-1.636	8.834	-1.645
	(0.718)	(0.653)	(0.550)	(0.602)
ln(Human capital)	1.276***		1.286***	
	(0.218)		(0.206)	
ln(Physical capital)		0.256***		0.267***
		(0.064)		(0.052)
ln(Agricultural exports) $_{t-1}$	-0.151***	0.014	-0.188***	0.026
	(0.052)	(0.026)	(0.048)	(0.022)
ln(Mineral exports) $_{t-1}$	-0.004	-0.001	-0.006	-0.001
	(0.007)	(0.003)	(0.007)	(0.003)
ln(Petroleum exports) $_{t-1}$	0.050***	-0.020***	0.042***	-0.018***
	(0.009)	(0.005)	(0.009)	(0.005)
ln(Government share) $_{t-1}$	0.422***	-0.018	0.452***	-0.033
	(0.123)	(0.075)	(0.122)	(0.071)
ln(Land distribution) $_{t-1}$	-0.060	0.004	-0.023	-0.002
	(0.082)	(0.038)	(0.079)	(0.036)
ln(Trade openness) $_{t-1}$	-0.340***		-0.400***	
	(0.053)		(0.049)	
Std. dev. inflation $_{t-1}$	0.0001***		-0.0001***	
	(0.00003)		(0.00003)	
Coups $_{t-1}$	-0.077		-0.066	
	(0.072)		(0.071)	
Civil war $_{t-1}$	-0.080***		-0.078***	
	(0.025)		(0.022)	
Democracy $_{t-1}$		0.016**		0.013**
		(0.006)		(0.006)
ln(Ethno-ling. frac.)		-0.233***		-0.226***
		(0.079)		(0.074)
ln(Ethno-ling. frac.)^2		-0.082***		-0.080***
		(0.023)		(0.022)
J-test (p-value)	5.61(0.35)		4.42(0.49)	
R^2	0.691	0.556	0.683	0.550

The numbers in parentheses are robust standard errors. ***, **, and * represent statistical significance at the one, five, and ten percent level. Time dummies were estimated but not reported for reasons of space. Systems 1 and 2 use commodity exports as a percentage of GDP and of total exports, respectively. Both estimations have 102 obs.

TABLE 6. Alternative indicators for Human Capital and Natural Resource Dependence

Variable	System 1 Physical Capital	System 1 Human Capital	System 2 Physical Capital	System 2 Human Capital
Constant	7.782	-2.140	9.549	-1.758
	(0.711)	(0.749)	(0.586)	(0.688)
ln(Human capital)	1.431***		1.436***	
	(0.247)		(0.232)	
ln(Physical capital)		0.354***		0.274***
		(0.072)		(0.053)
ln(Agricultural exports) $_{t-1}$	-0.166***	0.038	-0.050	0.039*
	(0.051)	(0.030)	(0.059)	(0.024)
ln(Mineral exports) $_{t-1}$	0.001	-0.002	0.002	-0.001
	(0.006)	(0.003)	(0.005)	(0.002)
ln(Petroleum exports) $_{t-1}$	0.042***	-0.018***	0.048***	-0.014***
	(0.008)	(0.005)	(0.011)	(0.005)
ln(Government share) $_{t-1}$	0.363***	-0.041	0.305**	-0.034
	(0.135)	(0.080)	(0.126)	(0.074)
ln(Land distribution) $_{t-1}$	-0.0002	-0.017	-0.147	-0.018
	(0.078)	(0.042)	(0.104)	(0.046)
ln(Trade openness) $_{t-1}$	-0.249***		-0.375***	
	(0.064)		(0.060)	
Std. dev. inflation $_{t-1}$	-0.0001**		0.0001***	
	(0.00003)		(0.00003)	
Coups $_{t-1}$	-0.029		-0.079	
	(0.054)		(0.050)	
Civil war $_{t-1}$	-0.054**		-0.088***	
	(0.023)		(0.021)	
Democracy $_{t-1}$		0.014**		0.011*
		(0.006)		(0.006)
ln(Ethno-ling. frac.)		-0.153*		-0.221***
		(0.085)		(0.074)
ln(Ethno-ling. frac.)^2		-0.053**		-0.076***
		(0.026)		(0.022)
J-test (p-value)	5.60(0.35)		5.56(0.35)	
R^2	0.666	0.573	0.675	0.534

The numbers in parentheses are robust standard errors. ***, **, and * represent statistical significance at the one, five, and ten percent level. Time dummies were estimated but not reported for reasons of space. Differences in systems from baseline model: Systems 1 uses average years of schooling for human capital and System 2 uses commodity exports per worker. Both estimations have 102 obs.

TABLE 7. Other Indicators for Institutions

	System 1		System 2	
Variable	Physical Capital	Human Capital	Physical Capital	Human Capital
Constant	8.096	-2.826	7.702	-1.908
	(1.344)	(0.800)	(0.714)	(0.749)
ln(Human capital)	1.172***		1.623***	
	(0.176)		(0.231)	
ln(Physical capital)		0.272***		0.298***
		(0.063)		(0.080)
ln(Agricultural exports) $_{t-1}$	-0.175***	0.028	-0.192***	0.035
	(0.048)	(0.026)	(0.047)	(0.032)
ln(Mineral exports) $_{t-1}$	-0.006	0.0003	-0.010	0.002
	(0.008)	(0.003)	(0.008)	(0.004)
ln(Petroleum exports) $_{t-1}$	0.052***	-0.021***	0.044***	-0.020***
	(0.010)	(0.006)	(0.011)	(0.005)
ln(Government share) $_{t-1}$	0.437***	-0.063	0.170	0.002
	(0.110)	(0.074)	(0.138)	(0.078)
ln(Land distribution) $_{t-1}$	-0.054	-0.039	-0.077	0.012
	(0.077)	(0.040)	(0.068)	(0.036)
ln(Trade openness) $_{t-1}$	-0.330***		-0.180***	
	(0.052)		(0.071)	
Std. dev. inflation $_{t-1}$	-0.0001**		-0.0001**	
	(0.00003)		(0.00003)	
Coups $_{t-1}$	-0.079		-0.058	
	(0.071)		(0.048)	
Civil war $_{t-1}$	-0.071***		-0.073***	
	(0.025)		(0.024)	
Democracy $_{t-1}$		0.007		0.008*
		(0.007)		(0.005)
ln(Ethno-ling. frac.)		-0.233***		-0.188**
		(0.079)		(0.090)
ln(Ethno-ling. frac.)^2		-0.088***		-0.067**
		(0.023)		(0.029)
Institutions	0.207	0.487**	0.586***	-0.116
	(0.413)	(0.246)	(0.175)	(0.135)
J-test (p-value)	5.56(0.35)		4.69(0.45)	
R^2	0.695	0.563	0.715	0.567

The numbers in parentheses are robust standard errors. ***, **, and * represent statistical significance at the one, five, and ten percent level. Time dummies were estimated but not reported for reasons of space. Differences in systems from baseline model: Systems 1 includes civil liberties and System 2 includes control of corruption. Both estimations have 102 obs.