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Policymakers Beware: **The Use and Misuse of Regressions in Explaining Economic Growth**[1]

By Francisco Rodríguez

In recent years a voluminous literature relying on cross-national data sets and linear-regression analysis has confidently drawn major inferences about the causes of economic growth. This literature has not been confined to purely academic debates: its results have been used widely to influence economic policies in developing countries.

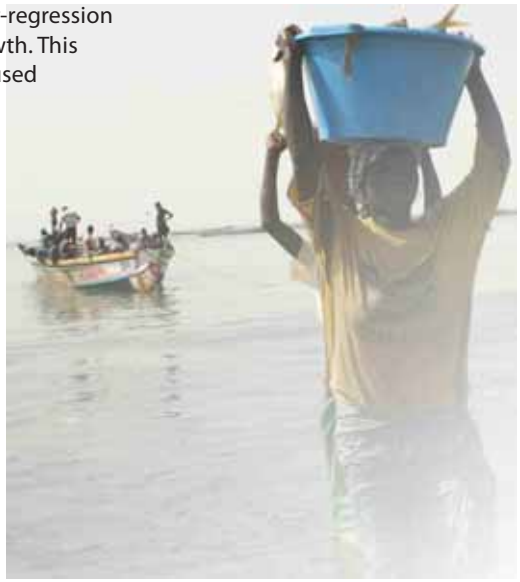


Photo: T. Hutman.

But policymakers must be cautious in interpreting the results of these exercises. They are often clouded by serious methodological problems that are seldom discussed transparently. The purpose of this Policy Research Brief is to explore the limitations of the current growth-regression approach to formulating policies in the real world and pose some promising alternatives.

I. Causality, Measurement and Robustness: The Usual Suspects

Suppose a policymaker is deciding whether to increase her country's exposure to international trade. A new report comes out filled with growth-regression exercises that attribute a significant increase in growth to trade liberalization. Prominent in the report are a set of visually impressive scatter plots on which a regression line is superimposed in order to show that more open economies have higher growth rates. How should this information affect her decision?

The first question to ask is whether the graph would not make more sense with the axes inverted. In other words, does it make at least as much sense to argue that faster growth generates more trade openness? For example, if liberalization is easier to push forward politically in the midst of an economic expansion, one would expect to see a positive association between trade and growth even if trade itself is not the cause.

But there are more subtle reasons why correlation need not imply causation. Both growth and trade could be caused by a third factor. Imagine that an economy is benefiting from the effects of educational reforms that have made its labour force more productive. The resulting increase in competitiveness implies that the economy is able to both export more and produce more, therefore experiencing higher growth and increased trade at the same time. But this coincidence does not imply that increasing trade raises growth.

A second question to ask about the regression analysis is whether the way that the variables are measured corresponds to the policy tools that the country is considering to use. For example, much of the trade-growth literature uses the trade share (the ratio of imports plus exports to GDP) as its measure of openness, even though policymakers are more interested in the effect of lowering policy barriers that they actually control—such as tariffs and non-tariff barriers.

Figure 1 (next page) shows that the choice of indicator makes a huge difference in this case: while there is a positive relationship between growth and trade shares (the upward sloping line in the left panel), there is virtually no relationship between growth and tariffs (the horizontal line in the right panel).

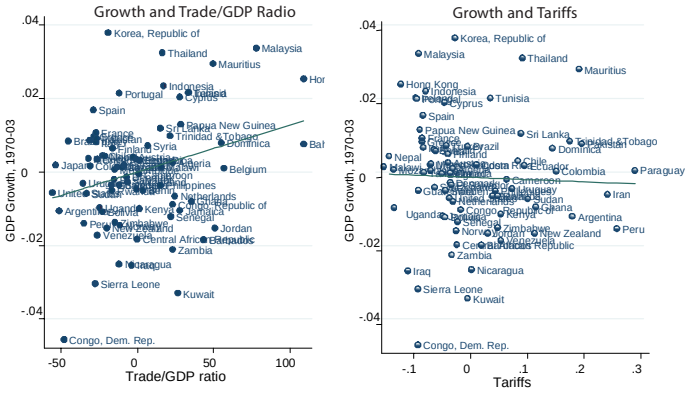
A third question to ask about regression analysis is whether the result is just a quirk of either the sample or the selection of other variables in the regression. In data sets spanning fewer than 100 countries, the decision to exclude or include a particular set of countries can make a big difference. So does including or omitting relevant variables from the analysis. In other words, the results do not remain unaltered, 'robust', in response to changing the sample or adding variables.

Suppose, for example, that countries tend to liberalize trade at the same time that they carry out macroeconomic stabilization. Then the results of a regression showing a trade-growth association might hinge on whether the regression in question includes controls for such stabilization. If they are not included, the estimated effect of trade liberalization could simply be reflecting effects due to macroeconomic reforms.

The academic growth literature has made some reasonable attempts to deal with these issues, such as using instrumental variables to eliminate the possibility of reverse causation. Nevertheless, most growth-regression exercises fail to seriously address issues of causality, measurement and robustness. This might be due, in part, to the relative ease with which very simple analyses can be carried out with ready-made data sets. It might also be due to the inherent appeal of finding 'causes' of growth that can serve as magic bullets in the development process.

Figure 1

Growth and Trade Regressions



In a world in which even well-trained academics have trouble sorting out informative results from spurious ones, policymakers are well-advised to be extremely cautious about believing overarching conclusions about development policy based on the results of current growth analyses. While problems of causation, measurement and robustness plague just about any regression exercise, they are particularly serious in linear growth regressions. Studies of economic growth rely on a small number of countries—commonly 70-100—so small clusters or even single countries can have marked effects on the results. Also, instrumental variables are very difficult to find at the national level where multiple channels of causation are likely to operate. Moreover, useful methods available to microeconomic researchers—such as designing controlled experiments—are neither feasible nor desirable at the national level.

II. What If the World Isn't Flat? Dealing with Real World Complexity

Some methodological problems are unique to studies of economic growth. The foremost problem is dealing with real world complexity. The workhorse growth regression embodies a particular vision of the world that assumes, implicitly, that the same model of growth is true for all countries.

A linear growth regression, the standard in applied research, goes even further: it assumes that a very simple *linear* model is true for all countries. But a linear relationship might not apply in many cases. An example would be a country in which moderate trade protection would increase economic growth but closing off its economy completely to international trade would spell economic disaster.

Linear growth regressions imply that the effect of increasing the value of the independent variable would be the same for all countries, regardless of the initial value of that variable or other variables. This is what it means to fit a straight line to such a data set (such as in Figure 1). Therefore, an increase of the tariff rate from 0 to 10 percent is presumed to generate the same change in the growth rate as a change from 90 to 100 percent.

Furthermore, the change from 0 to 10 percent is assumed to have the same effect in a poor country as in a rich country, in a primary-resource exporter as in a manufactures exporter, and in a country with well-developed institutions as in a country with underdeveloped institutions.

To be fair, some growth researchers have attempted to deal with these problems by slightly relaxing the linear framework. A common approach is to introduce a quadratic or multiplicative term in order to capture, respectively, nonlinearities and interactions among variables. However, this approach, while increasingly popular, is ill-suited to handling real-world complexity. Growth can have complex relationships with a number of different variables, rather than just one or two.

One might react to this criticism by noting that a regression is really no more than an approximation of the truth, and so it is necessarily less complex. Nevertheless, some approximations are better than others. And, indeed, some can be quite bad.

An extensive econometrics literature has established that a linear regression cannot generally be expected to provide a good approximation of an unknown non-linear function. In recent research, I have carried out simulations that show that the resulting bias can be quite large, often leading to gross mis-estimates of the actual effect (see Rodríguez 2007).

III. Policymaking under Radical Uncertainty

Designing a growth strategy is somewhat like getting to the peak of a mountain that is covered by clouds. You cannot see where the peak is. You might not even know the direction in which to go. All you know is that if you go up, there is some probability that you are ascending the peak.

Of course, if you have a good map and a compass, navigating can be easier. And if you have a GPS system, it would literally be just a walk in the park. Doing growth empirics is essentially a project that constructs a map. But the linear growth regression is tantamount to trying to draw the map assuming that the mountain is shaped like a pyramid.

What do you do then if you do not have a map? Or your map is not very good? The simple answer is that instead of trying to use global information on where the mountain peak is located, you will have to intensively use local information in order to make reasonable inferences about how to reach the peak. You will try to infer where you are from careful observation of the vegetation, the terrain, the flow of rivers, and just about any other observable characteristic that allows you to make progress.

Conceptually, the same principles can be applied to economic growth. Research by Ricardo Hausmann, Dani Rodrik and Andrés Velasco of Harvard University (2004) has considered the problem of designing a growth strategy in a context of 'radical uncertainty' about any generalized growth effects. They call their method 'growth diagnostics', in part because it is very similar to the approach taken by medical specialists in identifying the causes of ailments. In such a context, assuming that every country has the same problem is unlikely to be very helpful. The principal idea is to look for clues in the country's concrete environment about the specific binding constraints on growth.

The growth diagnostics exercise asks a set of basic questions that can sequentially rule out possible explanations of the problem. The answers are inherently country-specific and time-specific. The essential method is to identify the key problem that you are interested in addressing as well as the signals that the economy would provide if a particular constraint were the cause of that problem.

The method is illustrated in Figure 2 for an economy that suffers from signs of low investment and entrepreneurship. The first question to ask is whether this is due to unattractive returns on investment or very costly credit. If the latter were the cause, there should be signs of high costs of finance. If, in contrast, returns were not attractive, you need to know whether the actual rates of return are low or investors are not certain about retaining (appropriating) the returns from their activity. If there is 'low appropriability', this might be due, in turn, to either market failures or government failures.

Carrying out a complete growth diagnostics requires that you go down the appropriate branches of the tree of possible explanations illustrated in Figure 2. The process goes on until

one identifies the constraints that, when loosened, are likely to generate the highest increase in growth.

Hausmann and Rodrik (2005) provide an example of applying growth diagnostics to El Salvador. The country is a puzzling case for some analysts since it has strictly followed the recommendations of the Washington Consensus yet its growth experience has been lacklustre, at best.

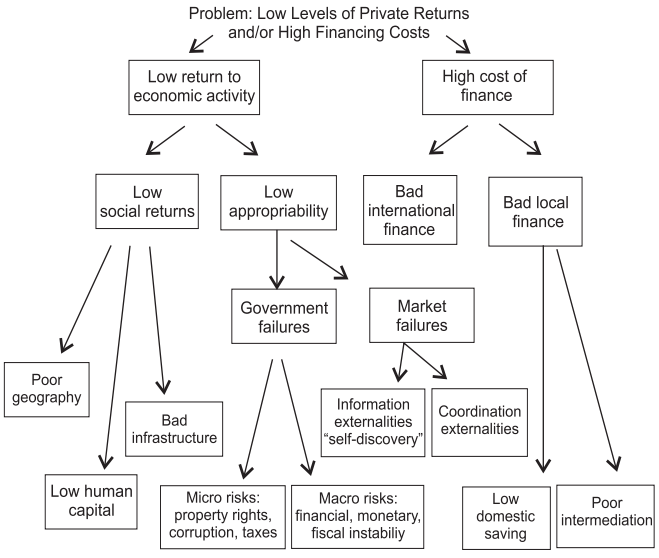
We can start out by asking whether this outcome can be explained as a result of constraints on international borrowing. If this were the case, there would be a high cost of external finance. But the country enjoys investment-grade credit rating, has an external debt to GDP ratio of less than 30 per cent and has had balance of payments deficits of less than two per cent of GDP in the last five years.

Instead, the problem appears to be due to low returns to investment. But most of the standard explanations for these low returns can be discounted in El Salvador: it does not have high taxes, costly labour restrictions or insecure property rights. Hausmann and Rodrik argue instead that El Salvador shows many signs of coordination failures in its export sectors—a problem that can be addressed through active government policies to support the development of new exportable products.

Such decision-making under 'radical uncertainty' is surely much more difficult than operating on the illusion that 'one size fits all'. But real-world experience suggests that one should be very sceptical about such a rigid approach to policymaking. The experience of the 1990s, when the overwhelming majority of developing countries followed some variant of the Washington Consensus, produced numerous examples of staggering gaps between the predicted effects and the actual results

A widely disseminated recent report by the World Bank, entitled *Economic Growth in the 1990s: Learning From a Decade of Reforms*, carries out an in-depth analysis of country experiences with market reforms and reaches the sobering conclusion that "different polices can yield the same result, and the same policy can yield different results, depending on country institutional contexts and underlying growth strategies" (World Bank 2005, p. 12).

Figure 2
The Growth Dianostics Methodology



Source: Hausmann, Rodrik. and Velasco (2004).

IV. Drawing Maps and Charts in a Complex World

Obviously, a good map would be very useful in trying to reach the peak of our mountain. Even though it could well be imprecise, it should be able to provide us with some valuable information to complement our local knowledge and experimentation. The problem is not with the idea of making a map; it is with our methods of mapmaking.

The design of growth strategies takes place in a context of uncertainty about the multiple relationships among potential causes, intermediate channels and the final outcome of economic growth. Policymakers will generally have a clear idea of their destination but vaguer notions of the appropriate levers to pull to start moving there. In the words of a former Venezuelan minister of industry,

"Inducing large-scale social changes through deliberate policy reforms is akin to walking through a constantly shifting maze filled with menacing beasts. When confronted, some of these monsters turn out to be harmless—paper tigers—while others are deadly minotaurs" (Naim 1993, p. 13).

If we want to build a map of these complex relationships, we can either recognize the uncertainty inherent in mapmaking or try to use *a priori* beliefs to give the map an illusory structure. The latter approach was taken by cartographers in the fifteenth century, and produced quite a few maps that predicted that you would fall off a cliff once you reached the edges of the known world.

How do we take full account of existing uncertainty in our attempt to understand the development process? A whole field of econometric theory is devoted to estimating relationships when we have no prior knowledge about their underlying forms. This field, known as nonparametric econometrics, has made significant advances in the past two decades. Its key idea is that instead of embracing *a priori* assumptions about the relationships among potential explanatory variables, we should "let the data speak" as much as possible about them.

A commonly mentioned drawback of nonparametric econometrics is that it requires considerable amounts of data in order to reasonably estimate the underlying functions. But, just as in mapmaking, some inferences require a lot of data while others do not. A precise map of the world requires painstaking and exhaustive surveying. But you can safely reject the general hypothesis that the world is round by circumnavigating it only once.

In a recent paper (Rodríguez 2007), I have used methods of nonparametric econometrics to understand the potential effects of different components of reform strategies on economic growth. The results, some of which are contained in Table 1 on the next page, capture only some very general features of a reality that is, in essence, very complex.

The analysis distinguishes among three types of reforms: policy, institutional and structural. Policy instruments, such as tariffs, exchange rates and the money supply, are the components of an economic strategy that tend to be under the control of the government. Institutional reforms are more complex, requiring concerted action by governments and social forces to reform key aspects of the rules of the game under which societies operate. Structural reforms are associated with the achievement of medium- to long-term transformations in the economic organization of societies.

The table presents the average growth effect of completely reforming a particular dimension of a country's policy, institutional or structural environment, and contrasts the

Table 1
Growth Effects of Reforms, Linear and Nonparametric Estimates

	Linear Regression	Nonparametric Regression
Policy Variables		
Inflation	-1.3%	-0.3%
Black Market Premium	-1.6%	-0.3%
Government Consumption	**-1.8%**	-0.7%
Tariff Rate	1.7%	-0.1%
Policy Index	**-1.8%**	0.4%
Institutional Variables		
Rule of Law	1.0%	0.6%
Political Stability	2.3%	**1.9%**
Economic Freedom Index	**3.5%**	**1.6%**
Index of Government Effectiveness	**3.5%**	**1.2%**
Institutions Index	**3.4%**	**1.0%**
Structural Variables		
Non-Primary Exports	0.3%	**1.0%**
Urbanization Rate	1.2%	**1.4%**
Life Expectancy	**4.0%**	**1.4%**
Liquid Liabilities/GDP	2.4%	**2.1%**
Economic Structure Index	**4.3%**	**1.8%**

Source: Rodríguez (2007). Bold-faced font indicates significant coefficient at 5%. Nonparametric estimate refers to the average partial derivative.

results from an ordinary linear growth regression with those from a nonparametric method. The latter approach allows for the variables in question to affect growth through an unknown function.

Several results are apparent from the table. One is that standard growth regressions often tend to exaggerate the effects of changes in explanatory variables in comparison to the more flexible nonparametric estimate. The average absolute value of the effects in Table 1 is more than twice as large for the linear regression as for the nonparametric one. But this tendency is not uniform across different types of explanatory variables.

The results show that the relative importance of different variables changes dramatically when we shift from the restrictive linear approach to the more flexible nonparametric approach. Policy variables are much less significant while structural variables are much more significant in accounting for changes in growth. Institutional variables also become somewhat more significant.

The increased relevance of structural and institutional variables and the diminished importance of policy variables are not surprising. Because linear regression tries to fit all countries into the same mould, it necessarily tends to give added weight to outliers—observations that exhibit very atypical patterns. Since the data on policies are more variable, perhaps because they are easier to change than institutions or economic structure, they are more prone to produce this distortion.

Our evidence can be read as putting forward a rationale for concentrating on deep, long-run structural and institutional reforms instead of the easier-to-change macroeconomic policies that tended to be emphasized in the Washington Consensus strategies of the 1990s. Certainly, the results suggest that a more nuanced view of economic reforms, in which long-run reforms are much more vital than policy changes, goes hand in hand with a more flexible view of how to interpret the growth evidence.

V. Concluding Remarks

Many of the results from cross-country regressions are severely limited by methodological problems, ranging from issues of causality, measurement and robustness to deeper problems inherent in a one-size-fits-all model that cannot capture the real-world complexity of the development process.

There are alternative tools for interpreting the growth evidence that can help avoid such pitfalls. One is growth diagnostics, which seeks to identify the binding constraints on growth faced by particular countries at particular points in time. Another is nonparametric econometric tools, which can be used to understand the growth evidence without imposing the straitjacket of assuming linear relationships.

The conclusions derived from such tools are considerably different from those generated by standard methods. Most importantly, these methods allow us to construct a picture of the world that is consistent with its inherent complexity. The illusion of certainty provided by conventional exercises no longer prevails. But there is not much defence of such an illusion if it leads to grossly inaccurate policy conclusions, such as assuming that you will fall off a cliff if you try to circumnavigate the world.

■

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References:

Hausmann, Ricardo, and Dani Rodrik (2005). 'Self-Discovery in a Development Strategy for El Salvador', *Economía* 6(1):43-87.

Hausmann, Ricardo, Dani Rodrik and Andrés Velasco (2004). 'Growth Diagnostics'. mimeo, Harvard University.

Naim, Moisés (1993). *Paper Tigers and Minotaurs: the Politics of Venezuela's Economic Reforms.* Washington, DC: The Carnegie Endowment.

Rodríguez, Francisco (2007). 'Cleaning Up the Kitchen Sink: Growth Empirics When the World Is Not Simple', Department of Economics, Wesleyan University.

World Bank (2005). *Economic Growth in the 1990s: Learning from a Decade of Reform*. Washington DC: The World Bank.

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