Working Paper No. 609

Using Capabilities to Project Growth, 2010–30

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August 2010

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ABSTRACT

We forecast average annual GDP growth for 147 countries for 2010–30. We use a cross-country regression model where the long-run fundamentals are determined by countries' accumulated capabilities and the capacity to undergo structural transformation.

Keywords: Capabilities; Forecast; Growth

JEL Classifications: C53, 050

I. INTRODUCTION

We forecast growth rates for 2010–30 by estimating a cross-country reduced form conditional-convergence regression, augmented with variables that account for a country's accumulated capabilities and capacity to undergo structural transformation. We define structural transformation as the process by which countries change what they produce and how they do it. It also involves the upgrading and diversification of the production and export baskets. Structural transformation results in shifts in the output and employment structures, away from low-productivity and low-wage activities into high-productivity and high-wage activities. As a consequence, structural transformation is the key for a country to shift from low-income to high-income.

In recent research, Hidalgo et al. (2007) and Hausmann et al. (2007) argue that while growth and development are the result of structural transformation, not all kinds of activities have the same implications for a country's development prospects. Hausmann et al. (2007) show that the composition of a country's export basket has important consequences for its growth prospects and show that, after controlling for initial income, countries with more sophisticated export baskets grow faster. On these grounds, Hidalgo et al. (2007) argue that development should be understood as a process of accumulating more complex sets of capabilities and of finding paths that create incentives for those capabilities to be accumulated and used. The implication is that a sustainable growth trajectory must involve the introduction of new goods and not merely involve continual learning on a fixed set of goods.

In this paper, we use set of variables that measure a country's capabilities, which we consider to be a fundamental determinant of long-term growth, to forecast long-term growth rates. Specifically, we use: (i) the sophistication level of a country's export basket; (ii) diversification of a country's export basket; and (iii) the size of available opportunities for future growth.

The rest of the paper is organized as follows. Section 2 discusses the forecasting methodology. Section 3 presents the results from the cross-country regression models. Section 4 discusses how values for some of the key variables are projected and presents our growth projections for 147 countries. Section 5 compares our forecasts with those of other studies and discusses if China can achieve an average annual growth are of 8–10% during 2010–30. We would like to caution against using the approach adopted in this paper to project growth rates for the short- to medium-term. Likewise, we do not attempt to address the shortcomings of the cross-country growth regression approach. Our view is that one can learn from the historical cross-country growth experience, determined by the fundamentals of growth (in our case capabilities), and use the resulting relationship to project long-term growth rates based on the current state of fundamentals.

2. METHODOLOGY AND DATA

Recently, some attempts have been made at using cross-country regression models to project long-term economic growth. For example, Wilson and Stupnytska (2007), Jorgenson and Vu (2008), Carone et al. (2006), and Dadush and Stencil (2010) use a growth accounting framework.

Batista and Zalduendo (2004) use a cross-country regression framework to examine if IMF's medium-term (five-year ahead) projections can be improved by using information on macroeconomic management (such as inflation and fiscal balance), structural variables (such as openness to trade, strength of the financial sector, black market exchange rage premium, and quality of institutions) relevant for projecting medium-term growth, private choices (such as fertility rates which affect labor participation rates), and environmental variables (internal and external shocks).

Bloom et al. (2007) also use cross-country regressions to examine if the inclusion of information on the share of the working-age population can improve long-term growth projections.

In this paper, we use a cross-country growth regression to project average annual growth rates for 2010–30. Our empirical specification follows Barro's (1997) model, according to which growth is inversely related to the initial level of per capita income and positively related to the steady-state level of per capita output. The steady-state income per capita is, in turn, determined by long-run fundamentals. In this paper, we use capabilities as a measure of fundamentals. Specifically, the measures of capabilities used are: (i) the sophistication of a country's export basket; (ii) the diversification of a country's export basket. Specifically, we use the share of "core" commodities in the total number of products exported with comparative advantage, and the growth of this share. Core commodities are chemicals, machinery, and metals; and (iii) the size of available opportunities for future growth, based on the existing set of capabilities.

Our basic specification is as follows:

$$Growth\ GDPpc_{i1962-2007} = \alpha + \beta_1 Ln(GDPpc_{i1962}) + \beta_2 (landlock)_i + \beta_3 (life\ expectancy)_{i1962} +$$
$$\beta_4 (life\ expectancy)^2_{i1962} + \beta_5 Ln(EXPY_{i1962}) + \beta_6 (share\_core)_{i1962} +$$
$$\beta_7\ (Growth\ in\ share\_core)_{i1962-2007} + \beta_8 Ln(OpenForest_{i1962}) + \beta_9 (Ln(OpenForest_{i1962}))\wedge 2 +$$
$$\beta_{10} (invest\text{-}to\text{-}GDP)_{i1962} + \varepsilon_i \tag{1}$$

The dependent variable is the average annual growth rate of GDP per capita over the period 1962–2007. GDP per capita growth rates are based on 2005 PPP$ (GDP in 2005 PPP$ from World Development Indicators, measured in ‘000s). The explanatory variables on the right-hand side are as follows:

(i) $Ln(GDPpc_{1962})$: Log of GDP per capita in the initial year (1962). This variable captures the initial level of development and the coefficient captures the speed of convergence. Its expected sign is negative.

(ii) landlock: Dummy variable that takes the value 1 if the country is landlocked and 0 otherwise.

(iii) Life expectancy: Life expectancy and its square.

(iv) $Ln(EXPY_{1962})$: Log of initial sophistication (EXPY). EXPY captures the ability of a country to export products exported by the rich countries to the extent that, in general, rich-country exports embody higher productivity, wages, and income per capita. EXPY is a weighted average of the sophistication level of the products in the country’s export basket. Following Hausmann et al. (2007), we calculate the level of sophistication of a product (PRODY) as a weighted average of the GDP per capita of the countries that export that product. Algebraically:

$$PRODY_i = \sum_c \left[\frac{xval_{ci} \Big/ \sum_i xval_{ci}}{\sum_c \left(xval_{ci} \Big/ \sum_i xval_{ci} \right)} \right] \times GDPpc_c \tag{2}$$

where $xval_{ci}$ is the value of country *c*'s exports of commodity *i*, and $GDPpc_c$ is country *c*'s per capita GDP.[1] The level of sophistication of a country's export basket (EXPY) is then calculated as the weighted average of the sophistication of the products exported. Algebraically:

$$EXPY_c = \sum_i \left(\frac{xval_{ci}}{\sum_i xval_{ci}} \times PRODY_i \right) \tag{3}$$

EXPY is also measured in 2005 PPP$ and the measure used is in '000s.

(v) share_core$_{1962}$ and (Growth in share_core)$_{1962\text{-}2007}$: A key insight from Hidalgo et al. (2007) is that a significant presence in the "core" allows a country to shift to other more sophisticated products. Core products are machinery, chemicals, and metals. These are products that, on average, have a high PRODY. They represent 41% of the total number of products that we work with (a total of 779). We use the share of core products exported with comparative advantage in the total number of products exported with comparative advantage (share_core). The average annual growth rate of the share of core products over the period 1962–2007 is also included as an explanatory variable (Growth in share_core). The rationale that underlies our analysis is that technical progress and structural change evolve together (technical progress induces structural change and vice versa; they jointly lead to growth), and underlying both is the mastering of new capabilities. We expect the coefficients of both initial share_core and Growth in share_core to be positive.

[1] We use highly disaggregated (SITC-Rev.2 4-digit level) trade data for the years 1962–2007. Data from 1962–2000 is from Feenstra et al. (2005) from the United Nations Commodity Trade Database. This data is extended to 2007 using UNCOMTRADE Database. PRODY is calculated for 779 products. PRODY used is the average of the PRODY of each product in the years 2003–2005.

(vi) Ln(OpenForest$_{1962}$): The size of available opportunities, conditional on the existing capabilities, is a measure of the potential for further structural change. This measure is referred to as *Open Forest*. In a recent paper, Hausmann et al. (2008) conclude that countries with a higher open forest, that is, with a more flexible export basket (in the sense that this allows jumping into other products more easily), are better prepared to react successfully to adverse export shocks. Open Forest is calculated as the weighted average of the sophistication level of all potential export goods of a country (i.e., those goods not yet exported with comparative advantage), where the weight is the *density* or distance between each of these goods and the goods presently exported with comparative advantage. Density (distance) in this context is not a physical concept; rather, it measures how close (far) a commodity, not exported presently with comparative advantage, is to the commodities in which the country currently has a comparative advantage. It is a proxy for the probability that a country can successfully export a "new" product (i.e., that it acquires revealed comparative advantage in it). Algebraically:

$$Open\_Forest_c = \sum_j \left[\omega_{cj}(1 - x_{cj})PRODY_j \right] \tag{4}$$

where $\omega_{cj} = \frac{\sum_i \phi_{ij} x_{ci}}{\sum_i \phi_{ij}}$ is the density; $x_{ci}, x_{cj} = \begin{cases} 1 \text{ if } \mathrm{RCA}_{i,j} \geq 1 \text{ for country } c \\ 0 \text{ if } \mathrm{RCA}_{i,j} < 1 \text{ for country } c \end{cases}$; φ_{ij} denotes the proximity or probability that the country will shift resources into good *j* (not exported with comparative advantage), given that it exports good *i*; $PRODY_j$ (see equation 2) is a measure of the sophistication of product *j* (not exported with comparative advantage); and $\omega_{cj} PRODY_j$ is the expected value (in terms of the sophistication of exports) of good *j*. Open forest is measured in 2005 PPP$ and expressed in '000s.

Open forest reflects the (expected) value of the goods that a country could potentially export, i.e., the products that it currently does not export with comparative advantage. This value, therefore, depends on how far the nonexported goods are from the goods currently being exported with a comparative advantage, and on the sophistication level of these nonexported goods.

One may conclude that, because developed countries have, in general, comparative advantage in more products than developing countries, possibilities for further diversification for developed countries (and, therefore, of a high value of open forest) are limited. However, this is not exactly what matters for purposes of open forest. Developed countries have comparative advantage in sophisticated products (e.g., some types of machinery). These products are "close" to many other sophisticated products, for example, other types of machinery, or chemicals, in the sense that there is a high probability that the country can export them successfully (i.e., that it can acquire comparative advantage) because these products use capabilities similar to the ones it already possesses. On the other hand, there are products that are "far" from the current basket (i.e., greater distance and hence low probability that the country acquires comparative advantage in them) and developed countries will probably not export. These products tend to have low sophistication (e.g., natural resources, some agricultural products) and contribute little to open forest. Therefore, even though developed countries have revealed comparative advantage in the export of a large number of goods, many of the products that they still do not export with comparative advantage are highly sophisticated and the probability of exporting them is high. Hence the relatively high open forest of these countries.

The opposite is true for the developing countries. Even though they can potentially export many products (those in which they do not have a comparative advantage) and most of them are sophisticated (e.g., machinery), the probability that these countries export them is low because they do not have the capabilities to do it (i.e., they are from the current export basket). Hence the low open forest of these economies. Felipe (2010) shows, using a cross-country regression and controlling for the investment-to-GDP ratio and the number of export destinations of each country, that open forest increases with GDP per capita up to a certain level and beyond that level it declines. To take account of any possible non-linearities of GDP per capita growth with respect to open forest, the specification in equation (1) includes both the log of open forest and its square.

(vii) invest-to-GDP: Investment-to-GDP ratio.

3. EMPIRICAL RESULTS

We have estimated three variants of equation (1) and used the three models to generate growth projections. Regression results are shown in table 1. In each case we show both estimated and beta coefficients. [2]

Table 1: Cross-country Regressions of GDP Per Capita Growth on Initial Conditions (1962–2007)

	Model 1		Model 2		Model 3	
	Estimated Coeff.	Beta Coeff.	Estimated Coeff.	Beta Coeff.	Estimated Coeff.	Beta Coeff.
Ln($GDPpc_{1962}$)	-1.642***	-1.179	-1.603***	-1.129	-1.601***	-1.127
	[0.207]		[0.188]		[0.188]	
Landlock	-1.253***	-0.255	-1.063***	-0.202	-0.985***	-0.187
	[0.389]		[0.386]		[0.348]	
Life expectancy	0.416***	3.221	0.517***	3.929	0.473***	3.596
	[0.118]		[0.110]		[0.117]	
(Life expectancy)^2	-0.003**	-2.345	-0.004***	-3.17	-0.003***	-2.95
	[0.001]		[0.001]		[0.001]	
Ln($EXPY_{1962}$)	0.978***	0.403	0.968***	0.399	0.706*	0.291
	[0.273]		[0.307]		[0.354]	
($share\_core_{1962}$)	3.724**	0.331				
	[1.473]					
(Growth in $share\_core_{1962-2007}$)	25.241***	0.294	16.753**	0.191	16.641**	0.19
	[9.072]		[6.818]		[6.280]	
Ln($OpenForest_{1962}$)			-3.629*	-2.075	-3.836**	-2.193
			[1.876]		[1.760]	
(Ln($OpenForest_{1962}$))^2			0.349**	2.416	0.372**	2.568
			[0.156]		[0.147]	
Invest-to-GDP					0.033**	0.257
					[0.014]	
Constant	-13.572***		-6.294		-4.356	
	[3.433]		[6.266]		[6.048]	
Observations	69		68		68	
Degrees of freedom	61		59		58	
R-squared	0.64		0.66		0.69	
Adjusted R-squared	0.6		0.61		0.64	

Source: Authors' estimations.
Notes: Robust standard errors in brackets. ***, **, * represent statistical significance at 1%, 5%, and 10%, respectively.

[2] GDP per capita (measured in 2005 PPPs) and the investment-to-GDP ratio are taken from the World Development Indicators. Capabilities-related measures such as EXPY, diversification, and open forest are constructed using SITC 4-digit (Rev 2) data from UNCOMTRADE. Data on life expectancy is from United Nations' Population division. For initial life expectancy, we use life expectancy for the period 1960–1965.

Model 1 includes all the variables in equation (1) except Open Forest (and its square) and the investment-to-GDP ratio. Initial GDP per capita has a negative sign (statistically significant) i.e., countries with a relatively low GDP per capita in 1962 grew faster over the next 45 years. In other words, controlling for other factors, there was conditional convergence among the countries in our sample over the period under consideration. The average annual growth rate of landlocked countries was a little over one percentage point lower than that of countries with access to the sea. Countries with a higher initial life expectancy, signaling a healthier workforce, have grown faster as shown by the positive coefficient of the variable. However, increases in GDP per capita growth derived from higher life expectancy come at a decreasing rate, shown by the negative coefficient on the square of life expectancy.

Initial sophistication is positive and statistically significant. A ten percent increase in the initial level of sophistication adds 0.1 percentage points to the average annual growth rate. The second variable of interest is the initial diversification (share_core). We also use growth in diversification (share_core) to capture the effect on growth of accumulating more complex capabilities. The initial share in the core is measured by the total number of products in the core in which a country has a revealed comparative advantage normalized by the total number of commodities in which the country has a comparative advantage. Our results show that countries with a higher initial share_core, i.e., those with a greater share of acquired complex capabilities at the start of the period, grow faster. A 10 percentage point increase in the share in the core adds 0.4 percentage points to the average annual growth rate. The growth in the share of commodities in the core i.e., the pace at which more capabilities are added, is also positive and statistically significant. A one percentage point increase in the average annual growth rate of the share of commodities in the core with comparative advantage adds 0.25 percentage points to the average annual growth rate of GDP per capita.

Model 2 adds Open Forest and eliminates the Initial Share in the Core. The estimation includes both the level and the square of log Open Forest. [3] All the coefficients carry the expected sign. Our results show that the coefficient on the log of the Open Forest is negative, whereas the

[3] In unreported regressions, the initial share of commodities in the core was included but was found to be insignificant.

coefficient on the square of log of Open Forest is positive (both are statistically significant). This indicates that the relationship between Open Forest and GDP per capita is U-shaped.

Model 3 adds (on the variable in Model 2) the investment-to-GDP ratio. All coefficients carry the expected sign. Estimation results indicate that a one percentage point increase in the investment-to-GDP ratio adds 0.03 percentage points to the average annual growth rate.

4. GENERATING GROWTH PROJECTIONS

Using the estimated coefficients from models 1–3 in table 1, we project average annual GDP per capita growth rates for 2010–30. The projected GDP per capita growth rates and average annual population growth rates (the latter taken from the UN Population Division) are used to project GDP growth rates. We need initial values for all variables as well as projections for growth in diversification for 2010–30 to generate GDP per capita growth rates. Construction of the initial values for each of the variables is explained in table 2. For our key variables, we generate two different scenarios.

Table 2: Projection Assumptions

Variable	Scenario I	Scenario II
Initial GDP per capita	We use the growth rate of GDP per capita for 2007–10 from the IMF's World Economic Outlook (October 2009) and apply it to the GDP per capita levels from the WDI to project the level of GDP per capita in 2010.	Same as scenario I.
Life expectancy	Projections of life expectancy are from the United Nation's population division. Specifically, we use life expectancy for 2010–15.	Same as scenario I.
Initial EXPY	Initial EXPY for 2010 is the predicted value obtained by regressing log EXPY on a time trend. The sample period for estimation is 1962–2007.	Same as scenario I except that the sample now is 1986–2007.
Initial share in the core	The initial share in the core for 2010 is the predicted value obtained from the regression of the share in the core on a time trend. The share in the core is defined as the share of core commodities exported with revealed comparative advantage in the total number of commodities exported with comparative advantage. Thus, it is constrained to lie between 0 and 1. We impose the further constraint that for each country: (i) the upper bound on the share of commodities in the core is assumed to be that country's maximum share (max_share) for 1962–2007 plus 0.1, if the maximum share at any point in the past was less than 0.8; (ii) if the maximum share at any point during 1962–2007 was between 0.8 and 0.95, the upper bound is the maximum share plus 0.05; and (iii) if the maximum share at any point for a given country is above 0.95 we take that to be the upper bound.[4] Since the diversification measure is bound between 0 and the upper bound describe above, we first map diversification into a real line using a logit transformation before we estimate the trend growth rates for each country.[5] Since max_share varies for each country, so does the upper	Same as scenario I except that the estimation period is 1986–2007.

[4] The measure of share in the core is a ratio. Changes in the number of products exported with comparative advantage, both core and overall, observed in the historical data is on a net basis, i.e., number of commodities in which a country gains comparative advantage minus the number of commodities in which a country loses comparative advantage. For example, even if a country has a comparative advantage in the same number of products in any two years, some of these products may be different.

[5] For each country, share in the core is mapped into the real line using a logit transformation as follows: log((share_core -0)/(max_share+0.1-share_core)) if max_share<0.8, log((share_core -0)/(max_share+0.05-share_core)) if max_share>=0.8 & max_share<0.95, and log((share_core -0)/(max_share-share_core)) if max_share>=0.95.

	bound for the logit transformation for each country. For scenario 1, estimation period is 1962–2007.	
Growth in the share of commodities in the core over the period 2010–30	It is calculated using the share of commodities in the core exported with comparative advantage in 2010 and in 2030 (both are projected using the steps discussed above for initial share in the core).	Same as scenario I except that estimation is based on the period 1986–2007.
Initial open forest	Open forest for 2010 is calculated using the average annual growth rate for 1980–2007	Same as scenario I, except that the average annual growth rate is for 1994–2007.
Investment-to-GDP ratio	The investment-to-GDP ratio for 2010 is calculated as the average of the ratios in 1994 and in 2007.	Investment to GDP ratio for 2010 is calculated as the average of the ratios in 1994, 2000, and 2007.

Using the assumptions in table 2, we project annual GDP per capita growth rates for 2010–30. As discussed above, for our key variables we generate two alternative sets of initial values for 2010 (scenario I and scenario II). We use both values for each of the three models to generate GDP per capita growth rates. This gives us six projections. In general, GDP per capita from scenario II is not very different from the projections under scenario I, except in a few cases (Singapore, Korea, and Ireland). Population growth rates are then added to the GDP per capita growth rates to generate GDP growth rates.

The range of the six GDP growth rate projections is shown in table 3. It should be noted that the minimum and maximum GDP growth rates across countries need not come from the same model-scenario combination. A few projections are discussed here. Over the twenty-year period considered (2010–30), our projections show China’s GDP growth rate in the range 4.2% to 5.1%; and that of India in the range 5.8%–7.o%. There has been a lot of interest in academic and policy circles about whether China will continue to grow in the 9%–10% range, or even at 8%, which many have suggested is needed to keep unemployment from rising. Our projections show that, over the long term, a high growth such as 10% or even 8% may not be achievable. The reason is that, in the context of our models, China will not be able to continue accumulating capabilities at the same pace as in the past. This significant decline in growth should not be interpreted as a collapse or a crisis, but rather as a deceleration in the rate of accumulation of capabilities.[6] We elaborate upon this in the next section.

Our projections also show that India should be able to grow at an average annual growth rate of 5.8%–7% over the period 2010–30, a growth rate similar to that seen in the past decade. The reasons why India will be able to attain a higher average growth rate than China are as follows:

(i) China has a higher initial per capita income. Recall that countries with a lower initial income per capita grow faster. Even though China has a higher EXPY and share_core than India, the beta coefficients on these two variables are smaller (in absolute terms) than that of initial income per capita. Thus, any positive effects coming from a higher EXPY and share_core are offset by the negative effect of China's higher initial income per capita; and

(ii) Open forest and its square have the third highest (in absolute terms) beta coefficient, and the projected value of Open Forest for India in 2010 ($2,490,900) is greater than China's ($2,417,077). This difference is not offset by the effect of life expectancy and its square, which have the highest (in absolute terms) beta coefficients, because of the negative sign on the square of life expectancy.

Our projections indicate that Brazil's average annual growth rate will be in the range 3.6%–4.5%; Mexico's, 3.7%–4.6%; Thailand's, 4.1%–5%; Poland's, 1.3%–2.8%; and Russia, one of the so-called "BRIC" countries, is projected to grow at a low 1.0%–1.2%.[7] Among the industrialized countries, our projections indicate that Germany's growth rate during 2010–30 will be in the range 1.4%–1.9%; Japan's, 0.8%–2.5%; and United States', 2.1%–2.6%.

[6] See Felipe et al. (2010) on China and Felipe, Kumar, and Abdon (2010a) on India.
[7] Felipe, Kumar, and Abdon (2010b) develop an Index of Opportunities and identify China, India, Poland, Thailand, Mexico, and Brazil (in that order) as countries having the most complex and diversified capabilities among the non-high income countries.

Table 3: GDP Growth, 2010–30

Country	Growth projection, average annual growth rate 2010–30 (%)	Average annual growth rate 1990–2007 (%)	Country	Growth projection, average annual growth rate 2010–30 (%)	Average annual growth rate 1990–2007 (%)
Albania	2.75-3.25	3.94	**Kyrgyz Republic***	0.74-2.97	0.94
Algeria	3.37-4.96	2.67	**Lao PDR**	3.35-4.41	6.83
Angola	3.32-4.92	4.91	**Latvia***	1.74-3.05	5.76
Argentina	2.96-3.43	4.25	**Lebanon**	2.79-3.88	5.20
Armenia*	2.28-3.61	7.56	**Liberia**	8.48-10.14	0.51
Australia	0.79-1.27	3.20	**Libya**	1.92-4.63	2.09
Austria	0.47-0.87	2.22	**Lithuania***	1.41-2.65	3.74
Azerbaijan*	0.61-1.23	5.62	**Macedonia, FYR*****	1.09-1.3	2.21
Bangladesh	6.01-6.45	5.19	**Madagascar**	7.5-8.52	2.42
Barbados	0.49-2.58	1.38	**Malawi**	4.47-6.42	3.06
Belarus*	0.76-1.23	3.62	**Malaysia**	4.01-5.03	6.07
Belgium	1.65-2.17	1.93	**Mali**	4.26-4.58	4.22
Belize	3.54-5.43	5.15	**Malta**	0.85-2.56	3.49
Benin	6.04-7.46	4.48	**Mauritania**	4.45-5.46	3.43
Bolivia	3.49-4.01	3.70	**Mauritius**	1.45-2.36	4.78
Bosnia and Herzegovina**	2.62-4.06	14.01	**Mexico**	3.72-4.55	3.12
Brazil	3.64-4.54	2.93	**Moldova***	1.02-2.25	0.38
Bulgaria	0.72-2.71	0.85	**Mongolia**	1.49-3.19	3.33
Burkina Faso	5.23-5.74	5.82	**Morocco**	3.66-4.81	3.88
Burundi	5.59-7.06	0.55	**Mozambique**	3.49-6.79	6.93
Cambodia	4.5-5.31	8.61	**Nepal**	5.49-6.61	4.33
Cameroon	4.45-5.39	2.31	**Netherlands**	1.45-1.71	2.67
Canada	1.38-2.01	2.78	**New Zealand**	1.97-2.29	3.01
Central African Republic	4.24-4.79	1.05	**Nicaragua**	3.6-5.02	4.17
Chad	5.07-5.52	5.34	**Niger**	7.53-8.49	2.80
Chile	2.16-2.53	5.45	**Nigeria**	4.12-5.24	3.83
China	4.15-5.12	10.34	**Norway**	0.5-1.32	3.09
Colombia	4.24-4.72	3.56	**Oman**	1.25-2.63	6.26
Congo, Rep.	3.33-4.68	3.24	**Pakistan**	5.78-7.36	4.39
Costa Rica	2.96-4.42	4.88	**Panama**	3.11-3.8	5.30
Cote d'Ivoire	6.32-7	1.43	**Papua New Guinea**	5.52-5.71	3.33
Croatia*	1.83-2.49	3.57	**Paraguay**	3.39-3.98	2.93
Cyprus	2.17-2.74	3.39	**Peru**	3.31-4.03	4.65
Czech Republic	0.8-1.76	1.94	**Philippines**	5.85-7.06	3.94
Denmark	1.65-1.99	2.24	**Poland**	1.29-2.79	3.96
Djibouti	4.89-5.87	-0.25	**Portugal**	1.45-2.68	2.13
Dominican Republic	3.84-4.68	5.67	**Qatar**	-0.9-1.36	6.70
Ecuador	3.56-3.91	3.34	**Russian Federation**	1.04-1.23	0.28
Egypt, Arab Rep.	5.24-6.37	4.52	**Rwanda**	4.34-5.39	3.37
El Salvador	2.97-4.85	4.95	**Samoa**	3.72-5.19	4.06
Equatorial Guinea	1-2.35	20.46	**Saudi Arabia**	2.08-3.69	4.02

Country	Growth projection, average annual growth rate 2010–30 (%)	Average annual growth rate 1990–2007 (%)	Country	Growth projection, average annual growth rate 2010–30 (%)	Average annual growth rate 1990–2007 (%)
Estonia*	2.03-3.02	5.39	**Senegal**	6.9-8.2	3.77
Ethiopia	5.52-7.4	4.86	**Sierra Leone**	6.23-7.88	2.40
Fiji	3.04-4.42	2.35	**Singapore**	0.63-2.72	6.62
Finland	1.56-2.42	2.38	**Slovak Republic********	-0.3-0.78	4.01
France	1.98-2.26	1.95	**Slovenia***	2.08-2.28	4.26
Gabon	1.86-3.26	1.95	**South Africa**	1.98-3.05	2.34
Gambia, The	6.62-7.4	3.85	**Spain**	1.87-2.83	2.35
Georgia*	1.76-2.3	3.14	**Sri Lanka**	3.54-4.29	5.27
Germany	1.44-1.94	1.73	**Sudan**	5.66-5.97	6.49
Ghana	5.92-6.85	4.58	**Suriname**	2.45-4.09	2.25
Greece	0.92-1.76	2.89	**Sweden**	1.66-2.64	2.23
Guatemala	5.34-7.28	3.66	**Switzerland**	0.38-1.26	1.28
Guinea	5.59-6.95	3.56	**Syrian Arab Republic**	5.09-6.78	4.55
Guinea-Bissau	6.85-8.19	0.22	**Tajikistan***	2.48-3.32	0.63
Guyana	2.79-3.52	2.79	**Tanzania**	6.85-8.14	4.25
Haiti	4.54-6.85	-0.46	**Thailand**	4.14-4.99	4.70
Honduras	4.87-6.37	4.48	**Togo**	7.17-8.55	2.34
Hong Kong, China	1.11-1.47	4.37	**Trinidad and Tobago**	0.27-1.73	4.59
Hungary	0.93-1.51	1.94	**Tunisia**	3.38-4.17	4.78
Iceland	0.54-1.75	3.06	**Turkey**	3.35-4.95	4.24
India	5.78-7.07	6.47	**Turkmenistan***	1.17-1.97	5.43
Indonesia	5.11-6.49	4.69	**Uganda**	6.02-7.76	6.96
Iran, Islamic Rep.	2.76-3.15	3.88	**Ukraine**	2.66-3.52	-1.85
Ireland	1.44-2.98	6.05	**United Arab Emirates**	1.01-1.64	5.65
Israel	2.67-3.87	4.67	**United Kingdom**	1.82-2.53	2.46
Italy	1.83-2.12	1.25	**United States**	2.11-2.64	2.90
Jamaica	2.33-3.46	2.21	**Uruguay**	1.81-2.54	2.99
Japan	0.82-2.53	1.37	**Uzbekistan***	2.51-3.52	3.58
Jordan	5.1-5.92	5.92	**Venezuela, RB**	2.84-4.5	2.86
Kazakhstan*	-0.05-0.81	3.16	**Vietnam**	5.13-6.18	7.55
Kenya	6.35-8.06	2.86	**Yemen, Rep.********	6.54-7.45	5.03
Korea, Rep.	1.64-2.63	5.47	**Zambia**	4.12-5.59	2.03
Kuwait	0.22-2.53	6.31			

*, **, ***, ***** average annual GDP growth rates are for the years 1992–2002, 1994–2002, 1993–2002, and 1991–2002, respectively.

5. SOME FINAL CONSIDERATIONS

We close the paper with a brief discussion about why most likely China will not be able to achieve an average growth rate of 8–10% in the next 20 years, and with a comparison with the projections provided by other models

Can China Achieve an Average Growth Rate of 8%–10% Over the Next 20 Years?

Using our cross-country regression model, we "reverse-engineer" the initial conditions (i.e., the values of the right hand side variables, specifically sophistication, diversification, and open forest) needed for China to achieve an average annual growth rate in the range of 8%–10%. We rely on model 3 which, for China, generates the highest growth projection. To find out what it would take to generate an average growth rate of 8% over the next 20 years, we plug in different values for all the variables in the model. For initial GDP per capita, life expectancy and investment-to-GDP ratio, we assume the following values for 2010: (i) initial GDP per capita, $6,458; (ii) life expectancy, 74 years; and (iii) investment-to-GDP ratio, 32%. These values are the same as those in scenario I (see table 2). With respect to the variables measuring capabilities, we proceed as follows. The beta coefficients in table 1 show how changes in the three variables affect GDP per capita growth rates. Among the three relevant variables, Open Forest exerts the biggest influence, followed by growth in diversification and, last, initial sophistication. To be able to generate a growth rate of GDP of 8% the variables need to take on the following values:

(i) Our projections for the share_core for 2010 (36%) and 2030 (43%) in table 3 correspond to an average annual growth in share_core of 1%. This may seem small, but one has to keep in mind that this growth represents a net gain. For purpose of our reverse-engineering exercise, we now assume that the growth in share_core over 2010–30 is the same as that over 1985–2007, when share_core increased from 22% to 40%, i.e., an average annual growth rate of 2.75%. This implies that share_core increases from 36% in 2010 to 62% in 2030.

(ii) Level of initial sophistication. The initial EXPY value used in our projection in table 3 is $15,735. Now we assume a value 25% higher, i.e., $19,583.

(iii) The actual value of Open Forest for China is $2,330,289 in 2007 and the projected value for 2010 used in table 3 is $2,417,077. We now assume a value of Open Forest of $7,710,000.

The problem with these assumptions is that the values assumed for the right-hand side variables needed to generate an annual growth rate of 8% are not plausible. First, even if a 2.75% average annual growth in share_core (i.e., the share of core commodities in total commodities exported with comparative advantage) were feasible, a 25% increase in sophistication between 2007 and 2010 is rather difficult, given the already high level of EXPY. Second, the high value of Open Forest that we have assumed to achieve a growth rate of 8% is about three-times China's value today, already one of the highest in the world and at the level of the advanced countries. The implausibility of the projected values of our key variables of interest needed to generate a growth projection of 8% should not be interpreted as a failure (although it may have important consequences for China). Our analysis simply highlights that China will not be able to continue accumulating capabilities at the same rate as in the previous 50 years. This is something to be expected.

Comparison with Other Long-term Growth Projections

While there are some studies that forecast long-term GDP growth (for the years 2010–30 and even beyond), none covers the large sample of countries that we do. Table 4 presents a comparison of our growth projections with projections from the studies of Carone et al. (2006), Dadush and Stancil (2010), and Wilson and Stupnytska (2007).

In general, the top end of our growth projections is similar to that of at least one of these other studies. Our projections are slightly more optimistic for some developed countries, such as France, Germany, Italy, Japan, and the Netherlands. One possible reason for this outcome could be our focus on capabilities. These countries have acquired a very complex and varied set of capabilities, which places them very well to continue growing. In some other cases, such as Hungary, Iran, Ireland, Latvia, Lithuania, Malta, Nigeria, Russia, Saudi Arabia, the Slovak Republic, and South Africa, the top end of our growth projections is lower than the growth rate provided by other authors.

Finally, our growth projections for China are comparable to those of other studies;[8] while for India our projections are about a percentage point higher. Our projections are also slightly higher for Brazil, and are similar for Mexico and Poland.

[8] Perkins and Rawski (2008), using a conventional growth accounting framework to forecast China's growth to 2025, also reach the conclusion that it will not be able to achieve an annual growth rate of 9–10%. A more possible scenario, assuming a stable domestic and international political environment, is a growth rate of 6–8% during 2006–2015, and of 5–7% during 2016–2025. Nevertheless, the authors make the point clear that these growth rates "are not a sure thing" (Perkins and Rawski 2008: 879).

Table 4: Comparisons with Other Projections

Country	Our Projections	Dadush and Stancil (2010)		Carone et al. (2006)	Wilson and Stupnytska (2007)	
		2009-50 (low)	2009-50	2011-30	2006-30	2015-30
Argentina	2.96–3.43	2.80	4.10			
Australia	0.79–1.27	2.10	2.90			
Austria	0.47–0.87			1.63		
Bangladesh	6.01–6.45				5.23	5.37
Belgium	1.65–2.17			1.73		
Brazil	3.64–4.54	2.80	4.10		3.82	3.77
Canada	1.38–2.01	1.80	2.60		2.07	1.93
China	4.15–5.12	4.10	5.60		5.79	4.67
Cyprus	2.17–2.74			3.74		
Czech Republic	0.8–1.76			2.53		
Denmark	1.65–1.99			1.64		
Egypt	5.24–6.37				5.04	5.07
Estonia	2.03–3.02			3.01		
Ethiopia	5.52–7.4	5.10				
Finland	1.56–2.42			1.69		
France	1.98–2.26	1.40	2.10	1.79	1.74	1.70
Germany	1.44–1.94	0.80	1.40	1.38	1.14	0.80
Ghana	5.92–6.85	5.00				
Greece	0.92–1.76			1.58		
Hungary	0.93–1.51			2.54		
India	5.78–7.07	4.30	5.90		6.18	5.93
Indonesia	5.11–6.49	3.30	4.80		4.77	4.63
Iran	2.76–3.15				4.19	4.00
Ireland	1.44–2.98			3.31		
Italy	1.83–2.12	0.70	1.30	1.48	1.17	0.97

Japan	0.82–2.53	0.50	1.10		1.26	1.23
Kenya	6.35–8.06	3.90				
Korea	1.64–2.63	1.60	2.50		3.18	2.57
Latvia	1.74–3.05			3.34		
Lithuania	1.41–2.65			3.24		
Malta	0.85–2.56			2.81		
Mexico	3.72–4.55	3.10	4.30		4.27	4.20
Netherlands	1.45–1.71			1.59		
Nigeria	4.12–5.24	3.90			5.97	6.20
Pakistan	5.78–7.36				5.04	5.00
Philippines	5.85–7.06				5.20	5.13
Poland	1.29–2.79			3.22		
Portugal	1.45–2.68			2.14		
Russia	1.04–1.23	2.20	3.30		3.57	3.13
Saudi Arabia	2.08–3.69	3.60	4.80			
Slovak Republic	-0.3–0.78			3.35		
Slovenia	2.08–2.28			2.43		
South Africa	1.98–3.05	3.00	4.30			
Spain	1.87–2.83			1.97		
Sweden	1.66–2.64			2.38		
Turkey	3.35–4.95	3.10	4.40		4.05	3.83
United Kingdom	1.82–2.53	1.50	2.10	2.08	1.84	1.57
United States	2.11–2.64	2.00	2.70		2.30	2.30
Vietnam	5.13–6.18				6.96	6.47

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