DLSU Business & Economics Review 32(1) 2022 p. 1-13

RESEARCH ARTICLE

Institutions and Growth: A Macroeconomic Framework

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This paper is an attempt to meet North's (1990) challenge to macroeconomists, and to incorporate Acemoglu *et al.*'s (2005, 2012) argument about the overarching role of political and economic institutions in long-run economic performance. This is done through a formal growth model in which goods and services produced by institutions are inputs to an endogenous capital and technology (or productivity) sector, which is the main driver for robust and steady long-run economic growth. Countries with institutions that protect property and contract rights and the rule of law, promote fiscal, monetary, and financial stability, sustain efficient financial intermediation, build and maintain public infrastructure, support education, training and digital technology, and are allocated sufficient resources for their enlargement and improvement in order to reduce production and transaction costs in the productivity sector, are likely to experience high and sustained rates of economic growth in the long term. The efficiency with which such institutions contribute to robust, long-term economic performance is measured by their marginal, externality impact on the productivity sector. In the case of less developed or poor countries, these externalities are either negligible or even negative. For developed countries, they are large and positive. For countries in transition, they start from small positive magnitudes and increasingly become large in their journey to developed or advanced status. Such key externalities are correlated with the six regularly published World Bank's Worldwide Governance Indicators (WGI). The effectiveness of growth policies and the speed of adjustment to long-term growth are determined by individual country values of the six WGI. Improvements of these WGIs are results of political decisions made by government officials and the body politic in a democratic society. Following analysis and discussion of the growth model, the paper concludes with several implications for a long-term growth strategy focused on improvements in the WGI and increased investments in the institutional and productivity sectors.

Keywords: Institutions, Neoclassical Growth, Capital, Technology, Growth Policies

JEL Codes: E13, O410, O430

In my graduate courses in growth theory in the early 1960s, I liked macro better than micro. The reason had nothing to do with level of aggregation, but rather with a difference in approach. In macro at the time, we would write down plausible behavioral relations, phrased as a difference (differential) equation system, and let the adaptive dynamics play out. What would happen? What would we learn? The macro approach seemed closer to behavior and more open to novelty and imagination (word in parentheses added).

John Conlisk (2004) in a *Festschrift*
for Nobel Laureate Herbert Simon

Introduction

North (1990) makes it clear that institutional change is the underlying determinant of long-term economic performance. Acemoglu *et al*. (2005) argue that institutions are the fundamental cause of long-run growth. Underlying the formation of institutions is the costliness of transacting and the attempt of institutions to reduce it. North (1990, p. 3) defines "institutions (as) the rules of the game in a society or, more formally (as) the humanly devised constraints that shape human interaction. In consequence they structure incentives in human exchange, whether political, social, or economic."

Institutions define the opportunity set facing producers and consumers. Organizations (and their managers) emerge to take advantage of this opportunity set. Examples of organizations that reduce production and transaction costs, define the incentive structure, secure, monitor, and enforce property and contractual rights, educate and train entrepreneurial and labor forces, promote fiscal, monetary and financial stability and efficient financial intermediation, and facilitate the exchange of goods and services are:

Political (I^p): executive branch (excluding finance ministry), legislature, and judiciary–codification, execution, and enforcement of laws protecting private property and contract rights and the rule of law; and

Economic (I^e): finance ministry, central bank, banking system, insurance, money and capital markets–promotion of fiscal, exchange rate, price, and financial stability, and an efficient financial sector; and the building and maintenance of public infrastructure, i.e., ports, storage, bridges, and communication network (towers, etc.).

If the institutional framework favors consumptive rather than productive activity, organizations will be created to divert resources toward consumptive activities, and away from strengthening political and economic institutions (I^p and I^e) and from increased investments in physical, human and intellectual capital.

It is plausible to argue that high production and transaction costs have led to slower accumulation of capital (broadly defined to include physical, human, and intellectual capital). The empirical findings of Knack and Keefer (1995) suggest that countries with low scores on the "Rule of Law" and "Expropriation Risk" (used as proxies for the security of property and contract rights) are likely to experience reduced quantity and efficiency of capital investments. An institutional framework with the opposite set of incentives is exemplified by the few advanced industrial countries that have followed the British-North American tradition and by South Korea (vis-à-vis North Korea) discussed by Acemoglu *et al*. (2005).

North (1990) observes that substantial resources are devoted to the functioning of institutions. Wallis and North (1986) have estimated that the value of the institutional sector in the American economy is over two fifths of GNP. Physical, human, and intellectual investments require substantial resources, and such resources are provided by political institutions (the only ones vested with political power) and by economic institutions guided by political institutions. Economic institutions directly contribute to economic growth, but they, too, are subservient to political institutions. Thus, the quality, magnitude, and pace of long-run economic growth are ultimately determined by the quality of political institutions. The primary objective of the present paper is to meet North's (1990) and Acemoglu *et al*.'s (2005) challenge to incorporate institutions into neoclassical macroeconomic theory by exploring their implications for the productivity sector (new capital and new technology). This is done through a formal growth model in which goods and services produced by political and economic institutions are inputs to an endogenous capital and technology (or productivity) sector, which is the main driver for robust and steady long-run economic growth. The efficiency with which such institutions contribute to robust, long-term economic performance is measured by their marginal, externality impact on the productivity sector. In the case of less developed or poor countries, these externalities are either negligible or even negative. For developed countries, they are large and positive. For countries in transition, they start from small positive magnitudes and increasingly become large in their journey to developed or advanced status. Such key externalities are correlated with the six regularly published World Bank's Worldwide

Governance Indicators (WGI). The effectiveness of growth policies and the speed of adjustment to long-term growth are determined by individual country values of the six WGI. Improvements of these WGIs are results of political decisions made by government officials and the body politic in a democratic society. Countries with efficient political and economic institutions that are allocated sufficient resources for their enlargement and efficiency are likely to experience high and sustained long-run rates of economic growth. This paper derives the simple analytics of the temporary and permanent output growth effects of enlarged and efficient institutions .

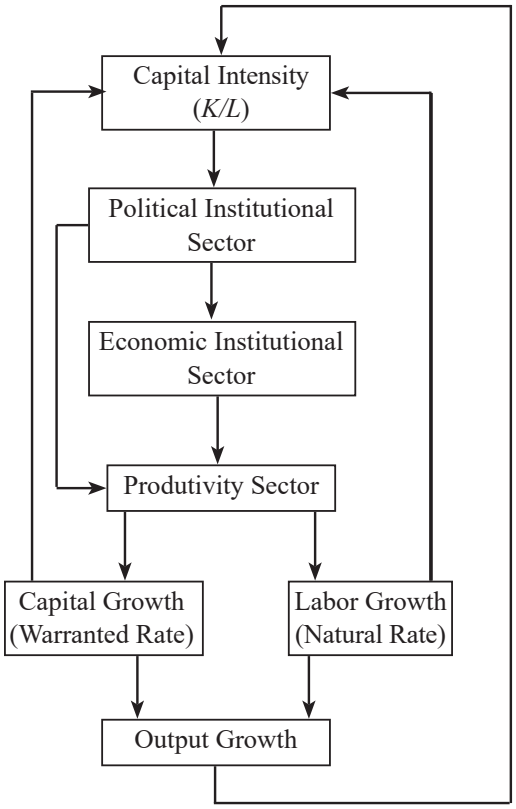
Following analysis and discussion of the formal growth model in the next two sections, the paper concludes with several implications for a long-term growth strategy focused on improvements in the WGIs and increased investments in the institutional and productivity sectors.

The Growth Model

As in the neoclassical growth model of Solow (1956)-Swan (1956) and of Villanueva in Villanueva *et al.* (2022b) , the two state variables are capital K and effective labor L. Box 1 is a schematic presentation of the model. The model economy produces five types of goods and services: consumer goods C, services from political institutions I^e, goods and services from economic institutions, new physical capital goods U, and new human and intellectual capital V.[1] All five *GDP* components use portions of K and L as inputs. Owing to the assumed unit-homogeneity of the five production functions for goods and services and of the joint output index of U and V, the growth rates of *GDP* and its components are functions of the ratio of capital to labor $k = K/L$, with feedback effects on subsequent *GDP* growth.[2]

From the top of Box 1, services (or more precisely services per unit of labor) produced by the political institutional sector are determined by the initial level of capital intensity (ratio of capital K to labor L).[3] In line with the argument of Acemoglu *et al*. (2005), additional to K and L, goods and services produced by economic institutions are also influenced by services produced by political institutions—an externality effect (positive, zero, or negative). Besides inputs of capital and labor, the productivity sector's outputs U and V are functions of the goods and services produced by

Box 1. The Workings of the Model



Political institutional sector I^p: executive branch (excluding finance ministry), legislature, and judiciary — codification, execution, and enforcement of laws protecting private property and contract rights and the rule of law. *Services under GDP.*

Economic institutional sector I^e: finance ministry, central bank, banking system, insurance, money and capital markets—promotion of fiscal, exchange rate, price, and financial stability, and of an efficient financial sector—and public infrastructure, i.e., ports, storage, bridges, and communication network (towers, etc.). *Goods and services under GDP.*

Productivity sector: G(U,V), U = physical capital goods with embodied advanced technology, including industrial equipment, V = human and intellectual capital, including education-training-experience of workers (gained at Harvard, MIT, Caltech, Silicon Valley and other colleges, universities vocational and technical schools, agricultural extension services) and blueprints, methods, and processes to efficiently produce goods and services, including IT, R&D, applied software development, Internet, Internet of Things, 5G technology, AI, Business Management Software and similar high-tech, intellectual activities. *Goods and services under GDP.*

Political and economic institutional sectors are included in *GDP* under *Services*.

economic institutions—an externality effect (positive). New capital U with embodied technology feeds into the model via addition to K or the warranted rate. Similarly, new labor-augmenting technology V enters as addition to effective L or the natural rate. The growth rate of aggregate output is a weighted average of the warranted and natural rates. The model is closed loop. There is feedback effect of output growth on the capital-labor ratio. Changes in the capital-labor ratio are triggered by discrepancies in the warranted and natural rates, whose weighted average determines the instantaneous output growth rate.

The structural model is as follows:

$$C = C[(1 - \tau^{p,k} - \tau^{e,k} - \rho^1)K, \quad (1)$$
$$(1 - \tau^{p,l} - \tau^{e,l} - \rho^2)L, I^p, I^e,]$$

$$I^p = I^p(\tau^{p,k}K, \tau^{p,l}L) \quad (2)$$

$$I^e = I^e(\tau^{e,k}K, \tau^{e,l}L, I^p) \quad (3)$$

$$G = (U, V) = F(\rho^1 K, \rho^2 L, I^p, I^e) \quad (4)$$

$$\dot{K} = U - \delta K \quad (5)$$

$$\dot{L} = V + nL \quad (6)$$

$$\frac{U}{V} = \psi(k) \quad (7)$$

$$k = \frac{K}{L} \quad (8)$$

Notation: C = output of consumer goods, K = capital stock, L = effective labor (efficiency units, in man-hours[4]), I^p = output of services in the political institutional sector, I^e = output of goods and services in the economic institutional sector, U = new capital goods (with embodied advanced technology), V = new labor-augmenting technology, k = ratio of capital to effective labor, δ = constant rate of depreciation of K, n = constant growth rate of working population L, adjusted for any exogenous labor-augmenting technical change; τ^{ij}, $i = p, e; j = k, l$; ρ^m for m = 1,2, all constant positive fractions; $\psi'(k) < 0$; $I^j(.)$, for $i = p, e$, $G(.)$; $F(.)$ = unit-homogeneous functions; and t = time (suppressed).

Discussion

The growth model is neoclassical, in the tradition of Solow (1956) and Swan (1956) and Villanueva *et al.* (2022b), with production functions having the property of diminishing returns to factor inputs separately, and constant returns jointly. Not only are the functions $I^i(.)$, $G(.)$, and $F(.)$ assumed unit-homogeneous, but the production functions $I^i(.)$ and $F(.)$ are also assumed to have well-behaved properties satisfying the Inada (1963) conditions.[5]

Equation (1) is a production function showing output of consumer goods C as a function of capital K, labor L, and goods and services provided by political I^p and economic I^e institutions. Since C appears only in Equation (1), Equations (2)-(8) stand alone and the form of the $C(.)$ function will not play a role in the rest of the paper.[6] Equations (2) and (3) are production functions of the political (p) and economic (e) institutional sectors showing output of goods and services I^i for $i = p, e$ as functions of capital K and labor L in proportions τ^{ij}, $i=p,e$ $j=k,l$ allocated to them. Equation (3) shows the output of goods and services of the economic institutional sector as a function of resources allocated to it, but importantly as a function of the services provided by the political institutional sector I^p.[7]

Besides Equations (2) and (3), Equation (4) is a key innovation of the model. It specifies the production of the joint output index $G(U, V)$ of new capital U and new labor-augmenting technology V as function of $\rho^1 K$ of capital, $\rho^2 L$ of labor, and institutional outputs of goods and services I^i. Equation (4) is the production function of the productivity sector, which is the driver of long-term economic growth. The productivity sector includes the aggregation of new capital construction, *R&D* expenditures, education, on-the-job training, and skills upgrade for a full-fledged digital economy.[8] The output U is new capital, measured in technology or productivity-augmented units, much like effective labor L. But unlike L, it is not possible to decompose K into a number of natural units and an index of their productivity. In the real world, technical progress continuously changes the basic structure of capital; therefore, a time-invariant natural unit of K is not defined. Empirical measures of K are total value figures, reflecting both productivity and quantity.[9] Even the theoretical surrogate concept of K in vintage capital models is a productivity-weighted or technology-weighted integral of past vintages. By contrast, a human being provides a time-invariant natural unit.

Equation (5) states that new capital U less depreciation δK equals the increment in K (warranted

rate). Equation (6) says that new labor-augmenting technology V plus working population growth nL (including any rate of exogenous technical change) equals the increment in L (natural rate). As defined earlier, $L = AN$[10], where A is a productivity or technology multiplier[11] and N is the population of workers. The increment in L is the sum of $\dot{A}N + A\dot{N}$. Assuming that $\dot{N} = nN$, and denoting $\dot{A}N = V$, the growth model's Equation (6) is derived. Thus, output V is new labor-augmenting technology.

Equation (7) determines the composition of outputs U and V. One reasonable assumption is that U/V is a negative function of the $k = K/L$ ratio [$\psi'(k) < 0$]. As k increases (decreases), the marginal product of K goes down (up) relative to the marginal product of L, and therefore firms tend to produce less (more) of U and more (less) of V. Finally, Equation (8) defines capital intensity k as the ratio of K to L.

The efficiency with which the institutional sectors' outputs contribute to the joint production of new capital and new technology is measured by the partial derivatives $\partial F / \partial I^p$ and $\partial F / \partial I^e$ [see Equations (9) and (10)]. [12,13]

Owing to the assumed unit-homogeneity of the production function for institutional services I^i, the following variables may be written in intensive form:

$$\frac{I^p}{K} = I^p(\tau^{p,k}, \frac{\tau^{p,l}}{k}) \quad (9)$$

$$\frac{I^e}{K} = I^e[\left(\tau^{e,k}, \frac{\tau^{e,l}}{k}\right), I^p\left(\tau^{p,k}, \frac{\tau^{p,l}}{k}\right)] \quad (10)$$

$$\frac{I^e}{L} = I^e[(\tau^{e,k}k, \tau^{e,l}, \{I^p(\tau^{p,k}k, \tau^{p,l})\}] \quad (11)$$

$$\frac{I^p}{L} = I^p(\tau^{p,k}k, \tau^{p,l}) \quad (12)$$

Thus, the ratio of capital to labor, $k = K/L$, feeds into the output of the political and economic institutional sectors. The political sector feeds into the economic institutional sector's production function [Equations (10) and (11)]. The logic behind this argument is provided by Acemoglu et al. (2005)--political power resides in political institutions that ultimately determine long-term economic performance.

Political power determines the strength of economic institutions that, in turn, determines *pari passu* with political institutions, the development and robustness of the productivity sector that shapes the time paths of productive resources K and L used in producing aggregate output. The political institutional sector wields enough political power via legislation and fiscal policy so that it influences the magnitudes of the resource allocation parameters τ^{ij}. Using $\rho^1 K$, $\rho^2 L$, and I^i, the productivity sector produces joint outputs of new capital U and new labor-augmenting technology V.[14]

Reduced Model

Owing to the unit-homogeneity of $G(U,V)$ and using Equation (7), Equation (4) can be restated as:

$$G(U,V) = UG\left(1, \frac{1}{\psi(k)}\right) = F(\rho^1 K, \rho^2 L, I^p, I^e) \quad (13)$$

Dividing by K,

$$\frac{U}{K} G\left(1, \frac{1}{\psi(k)}\right) = F\{(\rho^1, \frac{\rho^2}{k}, I^p\left(\tau^{p,k}, \frac{\tau^{p,l}}{k}\right), I^e\left[\left(\tau^{e,k}, \frac{\tau^{e,l}}{k}\right), I^p\left(\tau^{p,k}, \frac{\tau^{p,l}}{k}\right)\right]\},$$

$$\frac{U}{K} = \frac{F\{(\rho^1, \frac{\rho^2}{k}, I^p\left(\tau^{p,k}, \frac{\tau^{p,l}}{k}\right), I^e\left[\left(\tau^{e,k}, \frac{\tau^{e,l}}{k}\right), I^p\left(\tau^{p,k}, \frac{\tau^{p,l}}{k}\right)\right]\}}{G\left(1, \frac{1}{\psi(k)}\right)}. \quad (14)$$

Dividing Equation (5) by K and substituting Equation (18),

$$\frac{\dot{K}}{K} = \frac{F\{(\rho^1, \frac{\rho^2}{k}, I^p\left(\tau^{p,k}, \frac{\tau^{p,l}}{k}\right), I^e\left[\left(\tau^{e,k}, \frac{\tau^{e,l}}{k}\right), I^p\left(\tau^{p,k}, \frac{\tau^{p,l}}{k}\right)\right]\}}{G\left(1, \frac{1}{\psi(k)}\right)} - \delta \quad (15)$$

which is the warranted rate, whose slope is negative by inspection.[15]

Owing to the unit-homogeneity of $G(U,V)$ and using Equation (7), Equation (4) can be restated as:

$$G(U,V) = VG[(\psi(k), 1] = F(\rho^1 K, \rho^2 L, I^p, I^e) \quad (16)$$

Dividing by L,

$$\frac{V}{L} G[(\psi(k), 1] = F\{(\rho^1 k, \rho^2, I^p(\tau^{p,k}k, \tau^{p,l}), I^e[(\tau^{e,k}k, \tau^{e,l}, \{I^p(\tau^{p,k}k, \tau^{p,l})\}])\}, \quad (17)$$

$$\frac{V}{L} = \frac{F\{(\rho^1 k, \rho^2, I^p(\tau^{p,k}k, \tau^{p,l}), I^e[(\tau^{e,k}k, \tau^{e,l}, \{I^p(\tau^{p,k}k, \tau^{p,l})\}])\}}{G[(\psi(k), 1]}. \quad (18)$$

Dividing Equation (6) by L and substituting Equation (18),

$$\frac{\dot{L}}{L} = \frac{F\{(\rho^1 k, \rho^2, I^p(\tau^{p,k}k, \tau^{p,l}), I^e[(\tau^{e,k}k, \tau^{e,l}), I^p(\tau^{p,k}k, \tau^{p,l})]\}}{G[(\psi(k), 1]} + n, \quad (19)$$

which is the natural rate, whose slope is positive by inspection.

The proportionate rate of change of $k = K/L$ is Equation (15) minus Equation (19),

$$\frac{\dot{k}}{k} = \frac{F\{(\rho^1, \frac{\rho^2}{k}, I^p\left(\tau^{p,k}, \frac{\tau^{p,l}}{k}\right), I^e\left[\left(\tau^{e,k}, \frac{\tau^{e,l}}{k}\right), I^p\left(\tau^{p,k}, \frac{\tau^{p,l}}{k}\right)\right]\}}{G\left(1, \frac{1}{\psi(k)}\right)} -$$

$$\frac{F\{(\rho^1 k, \rho^2, I^p(\tau^{p,k}k, \tau^{p,l}), I^e[(\tau^{e,k}k, \tau^{e,l}, \{I^p(\tau^{p,k}k, \tau^{p,l})\}])}{G[(\psi(k), 1]} -$$

$$(n + \delta), \quad (20)$$

whose slope is negative, given the slopes of the first and second terms of the right hand side.

On the balanced growth path, $k^* = (K/L)^*$ is constant, and the warranted rate equals the natural rate, and by the constant returns assumption, equals the equilibrium growth rate in per capita income,

$$(Y - n)^* = (g - n)^* = \quad (21)$$

$$\frac{F\{(\rho^1 k^*, \rho^2, I^p(\tau^{p,\kappa}k^*, \tau^{p,\iota}), I^e[(\tau^{e,\kappa}k^*, \tau^{e,\iota}, \{I^p(\tau^{p,\kappa}k^*, \tau^{p,\iota})\}])}{G[(\psi(k^*), 1]}$$

where k^* = equilibrium capital intensity.
The instantaneous growth rate in income per capita is

$$(Y - n) = g - n = (g - n) * + \pi(k)(\tfrac{\dot{k}}{k}) \quad (22)$$

where $0 < \pi(k) < 1 =$ income share of capital $[\pi'(k) < 0)]$, and $\frac{\dot{k}}{k}$ is given by Equation (20).

Finally, the allocation coefficients τ's and ρ's need to be interpreted broadly. Higher values for these coefficients mean foregoing current consumption in favor of future, higher consumption—thus, they are partly saving coefficients. However, they are also production coefficients because they determine factor intensities in the institutional and capital-technology sectors.

Short-Term and Long-Term Growth Effects of Improved WGIs

The phase diagram of the model is shown in Figure 1. The vertical axis measures the warranted rate, natural rate, and equilibrium growth rate of output. The horizontal axis measures the level of capital intensity. The warranted rate [Equation (16)] is negatively sloped, while the natural rate [Equation (19)] is positively sloped. Point A (k^*_u, g^*_u) shows the equilibrium balanced growth path of an underdeveloped economy, with equilibrium capital intensity k^*_u and equilibrium income growth g^*_u. Such an equilibrium is associated with WGI_0 (weighted average of Rule of Law and other WGIs). After, say 50 years, e.g., Singapore, point B (k^*_a, g^*_a) shows the equilibrium balanced growth path of an advanced economy. Such an equilibrium is associated with WGI_1, which is much larger than WGI_0. The advanced economy shows higher equilibrium capital intensity k^*_a and equilibrium income growth g^*_a. Notice that the graduation from underdeveloped to advanced status is characterized by a larger shift of the warranted rate relative to the upward shift of the natural rate, reflecting much larger capital investment as a share of the sum of capital and technology investments.

Figure 2 shows the adjustment dynamics of the model. The vertical axis shows the per capita income growth rate and the rate of change in capital intensity. As before, capital intensity is measured along the horizontal axis. Equilibrium points D and A characterize the underdeveloped economy. At D, the $\frac{\dot{k}}{k}$ line intersects the k-axis at k^*_u. At this low level of capital intensity, the equilibrium growth rate of per capita income is g^*_u at point A. Because of the improvement in the Rule of Law and the other WGIs (measured by WGI_1), equilibrium shifts to points F and C, characteristic of the advanced economy. Both $\frac{\dot{k}}{k}$ and $\frac{\dot{Y}}{Y} - n$ lines shift upward. At F, the new $\frac{\dot{k}}{k}$ line intersects the k-axis at k^*_a. At this high level of capital intensity, the equilibrium growth rate of per capita income is g^*_a at point C (reading off the new $\frac{\dot{Y}}{Y} - n$ line). The advanced economy is more capital intensive and exhibits higher per capita income growth. What is the transitional (short-term and medium- term) dynamics from underdeveloped to advanced status?

Reading off the line $\frac{\dot{Y}}{Y} - n = g^*_a + \pi(k)(\frac{\dot{k}}{k})$, , at the starting low level of capital intensity k^*_u some 50 years earlier, the economy's per capita income growth rate

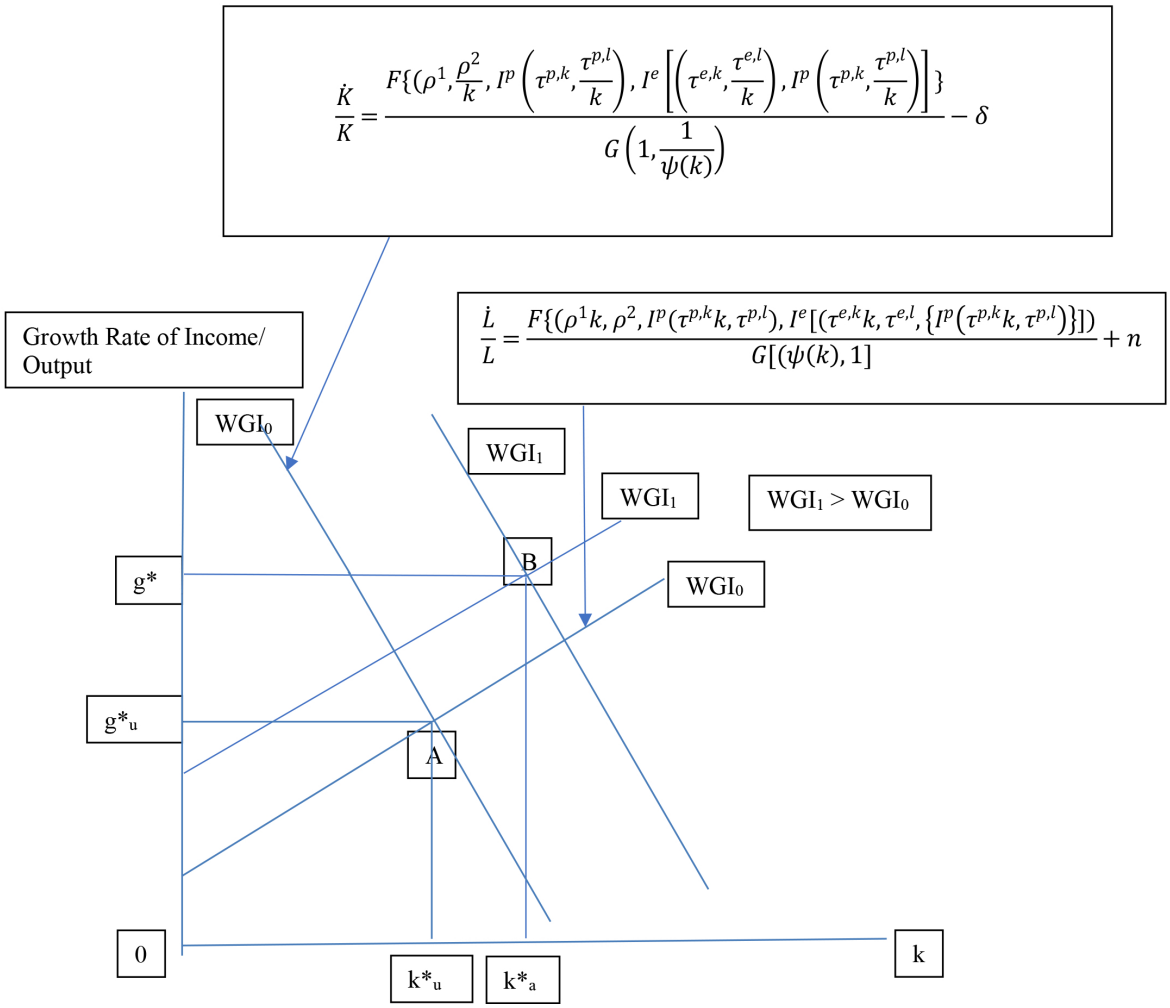


Figure 1. Long-Run Growth Effects of Improved WGI

shoots up to $g - n$, much higher than the starting low rate of g^*_u, and overshooting its advanced long-term per capita income growth at g^*_a. Also at k^*_u, and reading off the new $\frac{\dot{k}}{k}$ line (reflecting its rightward shift), $\frac{\dot{k}}{k} > 0$ at point E, thus allowing temporary overshooting in per capita income growth at point B equal to $g - n$. As capital intensity rises towards k^*_a, diminishing returns to capital begin and $\frac{\dot{k}}{k}$ becomes less and less positive until it is zero once again at point F[16]. Reflecting this, per capita income growth falls temporarily from $g - n$ to a permanently higher rate g^*_a at the (advanced economy) equilibrium point C.[17]

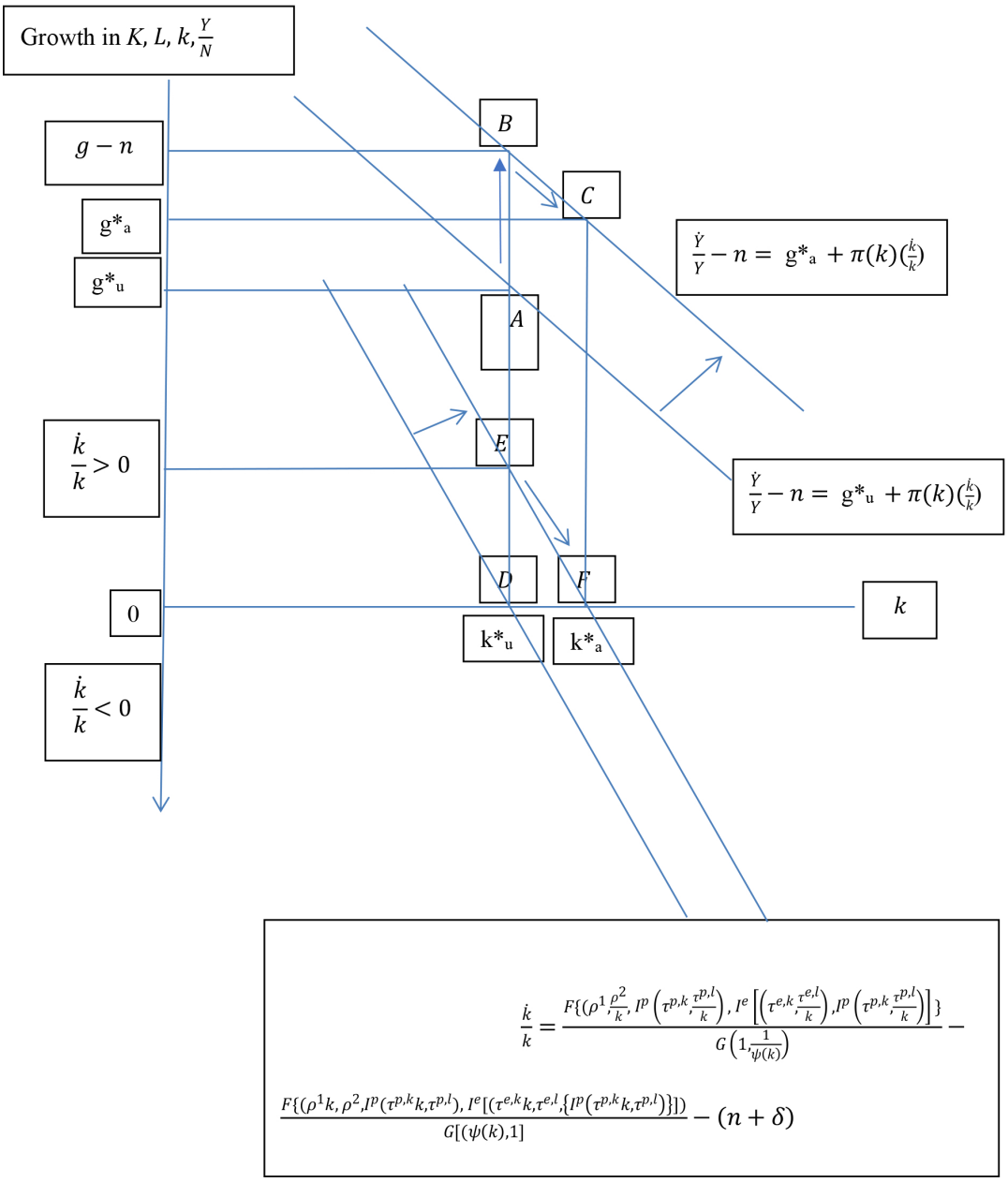


Figure 2. Equilibrium and Growth Dynamics: Effects of Improved WGI

Conclusion

This paper has made an attempt to meet North's (1990) challenge to macroeconomists, and to incorporate Acemoglu *et al.*'s (2005, 2012) argument about the overarching role of political and economic institutions in long-run economic performance. This is done through a formal growth model in which goods and services produced by institutions are inputs to an endogenous capital and technology (or productivity) sector, which is the main driver for robust and steady long-run economic growth.

The efficiency with which political and economic institutions contribute to robust, long-term economic performance is measured by the marginal, externality effects of their outputs on the productivity sector. As highlighted in the introductory section, in the case of less developed or poor countries, these externalities are either negligible or even negative. For developed countries, they are large and positive. For countries in

transition, they start from small positive magnitudes and increasingly become large in their journey to developed or advanced status. Such key externalities are correlated with the six regularly published World Bank's Worldwide Governance Indicators (WGI). The effectiveness of growth policies and the speed of adjustment to long-run growth are determined by individual country values of the six WGI. Improvements of these WGIs are results of political decisions made by government officials and the body politic in a democratic society.

The implication for a growth strategy is straightforward. Countries should establish institutions that protect property and contract rights and the rule of law, promote fiscal, monetary, and financial stability, sustain efficient financial intermediation, build and maintain public infrastructure, support education, training and digital technology, and are allocated sufficient resources for their enlargement and improvement in order to reduce production and transaction costs in the productivity sector. Such countries are likely to experience permanently high and sustained rates of growth in per capita incomes over the long run.

Notes

[1] The model of Villanueva in Villanueva et al. (2022b) is extended to include the goods and services produced by political and economic institutions that influence U and V.

[2] See Discussion for proof.

[3] Wallis and North's (1986) estimates of the U.S. transactions sector are based on employment L.

[4] If a 2022 man-hour is equivalent as an input in the production function to two man-hours in the base period, say, 2000, then the ratio K/L is the amount of capital per half-hour 2022 or per man-hour 2000.

[5] With reference to any production function $F(K,L) = Lf(k)$, where K is capital, L is labor, and k is the ratio of K to L, these conditions can be summarized as follows: $\lim \partial F/\partial K = \infty$ as $K \rightarrow 0$; $\lim \partial F/\partial K = 0$ as $K \rightarrow \infty$; $f(0) \geq 0$; $f'(k) > 0$, and $f(k) < 0$ for all $k > 0$.

[6] C is used to derive total output $Y = C + I^i$ $(i = p, e) + U + V$.

[7] I^p enters in the I^e production function because of the paramount and all-encompassing influence of the political sector in the functioning of economic institutions, as Acemoglu et al. (2005) have argued.

[8] The institutional outputs of goods and services I^i are inputs to the productivity sector because they directly increase this sector's outputs U and V. See Clarke (2001) and Acemoglu et al. (2005), who find empirical evidence that stronger government institutions that secure private property from expropriation and ensure the rule of law also encourage greater R&D expenditures included in $G(U,V)$. Likewise, goods and services produced by economic institutions raise new capital and new technology via increased financial resources and through provision of public infrastructure that lower production and transaction costs.

[9] E.g., a new computer with a faster processor selling at a fraction of the price of the old computer.

[10] Generally, the definition of L should be $L = APN$, where P is the labor participation rate, $0 < P \leq 1$. The working population is PN. When $P = 1$, $L = AN$. Whatever P is, it is usually assumed as an exogenous constant, whose rate of change is zero. For an endogenous and variable P, see Villanueva *et al*. (2022a).

[11] Or human capital, the variable *"h"* in hN of Lucas (1988).

[12] These partial derivatives are correlated with the following six Worldwide Governance Indicators (WGI) regularly published by the World Bank: (1) Voice and Accountability, (2) Political Stability and Absence of Violence/Terrorism, (3) Government Effectiveness, (4) Regulatory Quality, (5) Rule of Law, and (6) Control of Corruption. For an explanation of these indicators, read Kaufmann, et al. (2010). For regularly published data, see https://databank.worldbank.org/reports.aspx?Report_Name=WGI-Table&Id=ceea4d8b. The effectiveness of growth policies and the speed of adjustment to steady-state growth are determined by individual country values of the six WGI. Improvements in the WGI are political decisions made by government officials and the body politic in a democracy.

[13] The Appendix shows the effects of political and economic institutions on the joint outputs of U and V.

[14] The inclusion of political and economic institutions in the $F(.)$ function [North's (1990) and Acemoglu *et al.'*s (2005) arguments] signifies (positive, zero, negative) externalities of institutions on the productivity sector, which drives or drags long-term economic growth. For a similar treatment of the export sector exerting (positive) externalities on labor-augmenting technology, see Villanueva *et al.* (2022c).

[15] By assumption, all first partial derivatives of $F(.)$ with respect to all its arguments > 0 and $\psi'(k) < 0$.

[16] *D-E-F* is the trajectory of the capital intensity adjustment.

[17] *A-B-C* is the trajectory of the per capita income growth adjustment.

[18] Values assigned by the World Bank at https://databank.worldbank.org/reports.aspx?Report_Name=WGI-Table&Id=ceea4d8b.

[19] Singapore graduated from a poor, underdeveloped country to an advanced economy in a span of 50 years, the time it required to reach the steady state.

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Appendix:
Effects of Political and Economic Institutions on the Joint Outputs of *U* and *V*

Take the total differentials of main text Equation (4):

$$\partial G/\partial K = \rho^{1}(\partial F/\partial K) + (\partial F/\partial I^{p})[\tau^{p,k}(\partial I^{p}/\partial K)] \quad \text{(A1)}$$

$$+ (\partial F/\partial I^{e})[(\partial I^{e}/\partial K)\tau^{e,k} + (\partial I^{e}/\partial I^{p})\{(\partial I^{p}/\partial K)\tau^{p,k}\}]$$

$$\partial G/\partial L = \rho^{2}(\partial F/\partial L) + (\partial F/\partial I^{p})[\tau^{p,l}(\partial I^{p}/\partial L)] \quad \text{(A2)}$$

$$+ (\partial F/\partial I^{e})[(\partial I^{e}/\partial L)\tau^{e,l} + (\partial I^{e}/\partial I^{p})\{(\partial I^{p}/\partial L)\tau^{p,l}\}]$$

Resource allocation fractions ($0 < \rho$'s, τ's < 1):

ρ^{1} = proportion of K allocated to the productivity sector
ρ^{2} = proportion of L allocated to the productivity sector
$\tau^{p,k}$ = proportion of K allocated to the political institutional sector
$\tau^{p,l}$ = proportion of L allocated to the political institutional sector
$\tau^{e,k}$ = proportion of K allocated to the economic institutional sector
$\tau^{e,l}$ = proportion of L allocated to the economic institutional sector

Marginal products (> 0):

$\partial F/\partial K$ = marginal product of capital in the productivity sector
$\partial F/\partial L$ = marginal product of labor in the productivity sector
$\partial I^{p}/\partial K$ = marginal product of capital in the political institutional sector
$\partial I^{e}/\partial K$ = marginal product of capital in the economic institutional sector
$\partial I^{p}/\partial L$ = marginal product of labor in the political institutional sector
$\partial I^{e}/\partial L$ = marginal product of labor in the economic institutional sector

Externality effects (-2.5 ~ +2.5)[18]:

$\partial F/\partial I^{p}$ = externality effect of the political institutional sector on output of the productivity sector
$\partial F/\partial I^{e}$ = externality effect of the economic institutional sector on output of the productivity sector
$\partial I^{e}/\partial I^{p}$ = externality effect of the political institutional sector on the economic institutional sector.

Positive marginal products of K and L imply that the expressions (A1) and (A2) assume positive values. By assumption, $\partial F/\partial K$, $\partial F/\partial L$, $\partial I^{p}/\partial K$, $\partial I^{e}/\partial K$, $\partial I^{p}/\partial L$, $\partial I^{e}/\partial L > 0$. Depending on the effects of the WGIs , which assume negative, zero, or positive values, $\partial F/\partial I^{p} \gtreqless 0$ and $\partial I^{e}/\partial I^{p} \gtreqless 0$. $\partial F/\partial I^{e} > 0$ is a reasonable assumption, although it may be small or large positive. Thus, the resulting values for the marginal products of capital and labor in the productivity sector, Equations (9) and (10), may be small or large positive, reflecting the values for $\partial F/\partial I^{p} \gtreqless 0$ and $\partial I^{e}/\partial I^{p} \gtreqless 0$, showing the effects of political institutions on the productivity sector directly, or indirectly through their effects on the economic institutions themselves and the latter's effects on the productivity sector. The externality effects of institutions on *GDP* growth can be positive, zero, or negative. Zero or negative externality effects are a drag to economic growth, while positive externality effects are a boon. These externality effects of political and economic institutions reflect their robustness or lack thereof (for explanation, see main text Figure 1).

How can this model measure the qualities of political and economic institutions? This is a crucial question, because of the primacy of these institutions in determining the quality and durability of economic performance and long-run growth.

Take the total differentials of the production functions, Equations (2) and (3):

$$d^{I^p} = \frac{\partial I^p}{\partial K}\left(\tau^{p,k}dK + Kd\tau^{p,k}\right) + \frac{\partial I^p}{\partial L}\left(\tau^{p,l}dL + Ld\tau^{p,l}\right) \quad \text{(A3)}$$

$$d^{I^e} = \frac{\partial I^e}{\partial K}\left(\tau^{e,k}dK + Kd\tau^{e,k}\right) + \frac{\partial I^e}{\partial L}\left(\tau^{e,l}dL + Ld\tau^{e,l}\right) + \frac{\partial I^e}{\partial I^p}dI^p \quad \text{(A4)}$$

Low-quality and small-sized political and economic institutions emanate from low values of the following response coefficients, low values of resource allocation parameters, and low levels of investments in technologically-augmented K and L (18 explanatory factors below):

In the political institutional sector:

(i) $\frac{\partial I^p}{\partial K}$: low marginal product of capital in the production of political services

(ii) $\frac{\partial I^p}{\partial L}$: low marginal product of labor in the production of political services

(iii) $\tau^{p,k}$: low proportion of K allocated to the political sector

(iv) $\tau^{p,l}$: low proportion of L allocated to the political sector

(v) $d\tau^{p,k}$: small increment in the proportion of K allocated to the political sector

(vi) $d\tau^{p,l}$: small increment in the proportion of L allocated to the political sector

(vii) dK: small increment in new capital
small saving-investment in I^p

(viii) dL: small increment in new technology

In the economic institutional sector:

(ix) $\frac{\partial I^e}{\partial K}$: low marginal product of capital in the production of goods and services

(x) $\frac{\partial I^e}{\partial L}$: low marginal product of labor in the production of goods and services

(xi) $\frac{\partial I^e}{\partial I^p}$: low (or negative) externality effect of political institutions on economic institutions

(xii) $\tau^{e,k}$: low proportion of K allocated to the economic sector

(xii) $\tau^{e,l}$: low proportion of L allocated to the economic sector

(xiv) $d\tau^{e,k}$: small increment in the proportion of K allocated to the economic sector

(xv) $d\tau^{e,l}$: small increment in the proportion of L allocated to the economic sector

(xvi) dI^p: small increment in the size of the political institutional sector

(xvii) dK: small increment in new capital
small saving-investment in I^e

(xviii) dL: small increment in new technology

All the above factors are characteristics of many low-income developing countries.[19]