Strategic Factors In Economic Development Revisited

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Abstract

Using data on 128 modern economies, we update Kaldor's (1967) observed correlation between the standard of living and the share of productive resources devoted to industrial activity. We estimate a loglinear model of GDP per capita, explained by the share in GDP of industries that can produce capital, the level of institutional development and the level of technological development, which is assumed to be endogenous and instrumented accordingly. The model is estimated with: (i) two-stage least squares (2sls), assuming robust standard errors to account for heteroscedasticity in the residuals; and (ii) the general method of moments (gmm), with a weighting matrix that accounts for arbitrary correlation among observations within the development clusters identified. We find a high correlation between the GDP per capita and: (i) the share in GDP of industries that can produce capital; (ii) the level of technological development; and (iii) the level of institutional development of the society. We also find that these three forces form an integrated competitive development strategy. Further, we use counterfactual (Rubin causal) modelling to provide evidence that in this case correlation also represents causation. The results imply a more general principle than was advocated by Kaldor. To raise its standard of living, every country can go beyond the narrow focus on manufacturing by simultaneously devoting resources to upgrade its institutions, improve its level of technology, and build its capacity to produce (and export) capital.

Key Words:
capital; development; institutions; technology; heteroscedasticity; clusters; counterfactual; causation.

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Introduction

The famous growth laws of Kaldor (1967) were formulated to explain an observed regularity in the global economy, which is that there is a high current and past correlation between the standard of living and the share of productive resources devoted to industrial activity, up to some level of income.[3] In this paper, using data on the modern economy, we revisit and update this correlation. Our purpose is to shed further light on the characteristics of the engine of GDP per capita growth and therefore the nature and range of strategic options available to economies seeking to improve their development performance in the global marketplace.

Consistent with the classical system embraced by Lewis (1954; 1955), revived by Sraffa (1960) and elaborated by Nell (1998), we explore the role of the industries capable of producing capital, defined as output that can be used as inputs into production. We also explore the joint influence of the level of institutional and technological development of the economy, in the context of which the quality of industrial output, the flow of credit to support capital production and other aspects of market development are considered. In the analysis, consideration is given to the significance of the heterogeneity of the development challenges countries face and to whether the observed correlations reflect an underlying causal process. Some of the country-level indicators for these updated explorations have only recently become available.

First, the paper briefly reviews relevant literature and then justifies and specifies the guiding model, featuring the interactive process defined by the identified variables and the endogeneity of the level of technology. Second, it describes the data used to estimate the model, highlighting key correlations and expected heterogeneity among countries. Third, the model is estimated using an instrumental variables methodology implemented with 2-stage least-squares regression (2sls), assuming heteroscedastic residuals. Fourth, the model is re-estimated using the generalised method of moments (gmm) and a weighting matrix that accounts for homogeneity (spatial correlation of observations) of countries clustered according to their development status. Fifth, counterfactual modelling is used to determine if the identified correlations point to a causal process at work. Finally, the results are summarized.

The Literature

One might describe the cross-country correlation between GDP per capita and the share of industrial activity in GDP as the first global empirical regularity of Kaldor (1967), the second being the correlation between the rate of industrial growth and the rate of growth of GDP. The first global regularity might be expressed as a simple univariate homogeneous power law:

1. $\frac{Y}{L} = a(\frac{M}{Y})^{b}$

[3] Excepting outliers such as Australia, Canada and New Zealand.

where Y is GDP, M is the output of the manufacturing sector, L is population size, a is a scaling (or similarity) factor and $b > 0$ is the exponent of the share of the manufacturing sector in GDP, $\frac{M}{Y}$. Equation (1) is an assertion that the principle of self-similarity applies to the standard of living; that GDP per capita obeys a law that is invariant to multiplicative changes of scale, presumably up to some income limit that was not specified. In short, it applies to small countries and to large, to rich and to poor. If $\frac{M}{Y}$ is rescaled, i.e., multiplied by a constant, then $\frac{Y}{L}$ is still proportional to $(\frac{M}{Y})^b$, although with a different constant of proportionality. The law has no built-in scale of its own, so an increase in $\frac{Y}{L}$ could be achieved at will, if a country was willing and able to scale up $\frac{M}{Y}$.

In contrast to the second regularity, little subsequent attention has been given to empirical evidence supporting the first, expressed as equation (1). Might it be, for example, that the principle as stated is not unchanged under changes of scale, such as if a country has a pool of surplus labour that is too small to facilitate effective competition in global markets for manufactured goods? Is it possible, therefore, that Kaldor's first regularity can only take hold if the initial labour force and capital stock are large enough and versatile enough to enable mastery of certain technologies and profitable production of a sufficient supply of manufactured capital goods below average global market prices? If larger countries face different labour and capital constraints on competitive supply of manufactured goods, such deviations could force a minimum necessary ratio $((\frac{M}{Y})_{min})$ as well as a natural scale and dissimilarity into the Kaldor principle represented by equation (1). Below $(\frac{M}{Y})_{min}$, persistent underdevelopment and poverty might prevail.

Further, Kaldor's hint at an upper income per capita limit might be imposed by the restriction that $0 < b < 1$, which would make $\frac{Y}{L}$ concave down everywhere but could prove to be inconsistent with the empirical evidence. Or, in combination with $(\frac{M}{Y})_{min}$, it might be better interpreted as a characteristic upper cut-off $(\frac{M}{Y})_{max}$, a carrying capacity of sorts, reflecting the intensity of competition among countries for development opportunity (resources and markets), which must be incorporated into equation (1). This would remove its status as a homogeneous power law and self-similar process. Since dissimilarity due to competition is likely to be more pervasive than similarity in human society, the self-similarity properties governing GDP per capita might have to be more precisely stated and be treated as *approximate* or applicable only under special conditions. Our inquiry therefore considers whether the direction the literature has taken sheds any light on whether equation (1) is incomplete and how it might be updated.

Thirlwall (1987a; 1987b; 2002) and McCombie and Thirlwall (1994) led the literature to focus on Kaldor's growth laws that explain the correlations. In that spirit, Wells and Thirlwall (2003) found that the laws held for the set of countries in Africa, Libanio (2006) probed the claim that manufacturing is the growth engine of Latin America, and Keho (2018) did the same for ECOWAS countries.

Su and Yao (2016) examined the claim that growth of manufacturing is highly correlated with economic growth of “middle income” countries. UNIDO (2014) adopted the claim and inquired after the best way to facilitate growth of the sector, while UNIDO (2016) found that the importance of manufacturing as a growth engine has not really changed since Kaldor’s study. The general flavour of this set of literature was to embrace the pre-eminence of the manufacturing sector as the engine of growth, including the implication that it is a causal factor, even though none of the studies has sought to establish empirically that the correlations identified by Kaldor are underpinned by a causal process. With respect to the first Kaldor regularity, as in equation (1), the general implication is that the global empirical regularity that holds is still that the countries with the highest GDP per capita also tend to have a high share of manufacturing in GDP.

One key implication of concern is that countries that cannot develop a strong and internationally competitive manufacturing sector cannot expect to achieve Kaldorian growth, making equation (1) inapplicable to them. A second concern that implies limits to the application of equation (1) is that, following Kaldor’s second law, this literature generally adopted the argument that the effects are generated through productivity growth, treating the manufacturing sector as a monolith. However, the manufacturing sector produces both consumer goods and capital goods. Thus, the implicit assumption is that consumer goods and capital goods have the same inherent properties as drivers of productivity growth, despite the longstanding recognition that capital goods are outputs used as inputs in the production of commodities while consumer goods are not (Sraffa, 1960). This is clearly an excessively strong assumption that leaves unaddressed the need to distinguish the key role of capital production in the ability of the manufacturing sector to serve as an engine of productivity growth, as is common in the classical and neoRicardian literature (Sraffa, 1960; Nell, 1998).

Other studies have investigated whether growth of sectors other than manufacturing correlate highly with GDP growth. Inspired in part by the effort by Thirlwall (1982) to address “deindustrialisation” in the UK, recent regional and country studies, such as Timmer and de Vries, (2009), Noland, et al (2012) and Sukti, et al (2019), and Singh and Singh (2013) considered development of services as an alternative engine of growth. Park and Shin (2012) affirmed that services could serve as an engine of growth for Asia. Attiah (2019) suggested evidence that services could complement manufacturing in generating growth for ‘developing countries”. Chun et al. (2021) recognized the “servicification of manufacturing”, while Fagerberg (1999) has highlighted the growing contribution of services and science-based industries, especially ICTs, to GDP. Most recently, Di Meglio and Gallego (2022: 228) analyzed the contribution of services vis-à-vis manufacturing as a driving force of economic growth and supported modernising industrial policy that promotes but is not limited to manufacturing, with “attention to knowledge- and technology-based services with strong inter-industry linkages.” With respect to Kaldor’s first global regularity, the implication is that the richest countries around the world may have either a high share of services or a high share of manufacturing in their GDP.

The first concern with this literature is that none of these studies that make a case for services as a growth engine has provided evidence that among the richest countries are those that tend to have a high share of services in GDP. The second concern is that none of the studies addressed "Baumol's disease", the claim that because services are labour-intensive and tend to rely on non-routine human interaction or activities, they generally do not experience much productivity growth when compared to manufacturing (Baumol and Bowen, 1966). Yet, if true, Baumol's disease would imply that countries with a high share of services will also tend to be relatively poor and that Kaldor's second law could not apply to services with the same force as it does to manufacturing, even if it was to apply to some extent. The third concern is that, as with the previous studies that focus on the manufacturing sector, this literature ignores the important distinction between the consumer services and the capital services, and their distinctive roles in generating productivity growth consistent with Kaldor's second law. All of these concerns point to misspecification of equation (1).

The two strands of the literature addressing Kaldor's global regularities also tend to ignore the possibility that the first global regularity (equation 1) should be extended to embrace the complementary roles of the quality of the institutions and level of technological development in explaining economic phenomena. However, given the contributions by Lewis (1955), North (1990), and Nell (1998) clarifying that institutions and technology are the foundations of every society, it is highly likely that the core mechanism through which the manufacturing and service industries generate productivity growth is the production and distribution of capital (including human capital), complemented by the development of supportive institutions and technologies. Indeed, as suggested by Bosworth and Triplett (2003), the general reason services can contribute to productivity growth is the production of the knowledge, skills and self-confidence of workers used in the definition of production technology. Baumol's disease could be banished because, as the knowledge, skills, and self-confidence of workers grow over time, the same chronological time used now by service workers delivers a higher rate and quality of output than in the past, hence more output after adjusting for quality changes. A nurse today may take the same time to change a bandage as a nurse yesterday, but when doing so and when undertaking other tasks in health-care delivery aided by improved knowledge and technologies, the nurse today delivers better and more effective healthcare than a nurse of yesterday. In other words, once adjustment is made for the quantity of capital and the technology produced and used, the service worker can be more productive today than yesterday in much the same way workers in the manufacturing sector can be when working with updated amounts of capital and updated technologies, defined to include their knowledge, skills, and self-confidence.

This paper contributes by addressing the identified gaps and updating Kaldor's first regularity, as summarized in equation (1), with a focus on the output of sectors that can produce capital, not merely manufacturing. It adds the roles of the level of institutional development and the technology of production to create a multivariate power law, and it proves that the resulting correlations are indeed underpinned by a causal process even if only observational data on model variables are available.

The Updated Model

Let Y be GDP and L be population. So, as above, GDP per capita is defined as $\frac{Y}{L}$. This definition can be further decomposed to account for the role of other variables, such as the price level, P, the GDP deflator, ϱ, and the employment rate $\frac{N}{L^*}$, where N is the level of employment and L^* is the labour force. That is, as suggested by ul Haque (1995: 18), we can write:

2. $$\frac{Y}{L} = \frac{P}{\varrho}\frac{Y}{N}\frac{N}{L^*}\frac{L^*}{L}$$

Equation (2) can motivate a line of research that generalizes the work of Kaldor (1967) and equation (1). In particular, behavioural propositions about the role of the share of capital production, the level of institutional development, and the capacity to innovate can be introduced by using the classical idea that total output is generated by industries that can produce final capital (Y_c) and industries that cannot (Y_{nc}) (Sraffa, 1960; Nell, 1998: 292). Then, for $\frac{Y_c}{Y} + \frac{Y_{nc}}{Y} = 1$, it holds that:

3. $$\frac{Y}{L} = \left(\frac{Y_c}{Y} + \frac{Y_{nc}}{Y}\right)\frac{P}{\varrho}\frac{Y}{N}\frac{N}{L^*}\frac{L^*}{L}$$

Two behavioral postulates can now be introduced. First, $\frac{Y_{nc}}{Y}$ is directly proportional to $\frac{Y_c}{Y}$. That is, for β the factor of proportionality:

4. $$\frac{Y_{nc}}{Y} = \beta\frac{Y_c}{Y}$$

Here, β adjusts so that as $\frac{Y_c}{Y}$ increases $\frac{Y_{nc}}{Y}$ falls. Second, underpinned by different dynamic sectoral productivity growth principles and the movement of labour between sectors, we postulate that economy-wide average labour productivity, $\frac{Y}{N}$, emerges as a nonlinear function of $\frac{Y_c}{Y}$, the quality of the political, regulatory, and business institutions of the economy, μ, and the level of technology, ϕ. The influence of ϕ could be further justified by the classical theorem, emphasized by Polanyi, et al (1957), that markets are coordinated by the process of competition and that technological progress is a key tool of successful competition in modern markets. Economy-wide productivity varies as a product of positive powers of these variables, typically greater than 1, independent of initial conditions – a multivariate canonical power law representing their joint, inseparable, and complex[4] contributions. In particular,

5. $$\frac{Y}{N} = \mu^a \phi^b \left(\frac{Y_c}{Y}\right)^\gamma$$

[4] So that small changes in any of the variables tend to produce cascading changes in the others that together produce much larger changes in labour productivity.

Using (4) and (5) in (3) gives:

6. $\frac{Y}{L} = (1+\beta)\mu^{a}\,\phi^{b}\,(\frac{Y_c}{Y})^{1+\gamma}\,\frac{P}{\varrho}\,\frac{N}{L^*}\,\frac{L^*}{L}$

Here, $(1+\beta)$ emerges as a proportionate scaling factor reflecting history, natural assets, talents, and dispositions over which the society has little control. If we choose $\varrho = P^{\theta}\,P_f^{\,1-\theta}$, the geometric mean of the domestic price level (P) and foreign price level (P_f), with θ the share of income spent on domestic output, then $\frac{P}{\varrho} = \frac{P^{1-\theta}}{P_f^{\,1-\theta}} = (\frac{P}{P_f})^{1+\theta}$, with $\frac{P}{P_f}$ the terms of trade, operates as a scaling factor on the employment/population ratio. We can then plausibly set $(\frac{P}{P_f})^{1+\theta}\,\frac{N}{L^*}\,\frac{L^*}{L} \approx e^{u}$ to account for random variation, where u is a random variable that captures the effects of unobserved factors, measurement errors in the core variables, and other random shocks. Introduction of random variation provides a simple way for observations to deviate from the power-law function itself. The result is that:

7. $\frac{Y}{L} = (1+\beta)\mu^{a}\,\phi^{b}\,(\frac{Y_c}{Y})^{1+\gamma}e^{u}$

where the only restriction on the parameters is that a, b, and 1+ γ are non-zero. Equation (7) describes GDP per capita with a generalized multivariate power law, the result of a multidimensional complex process forged by three interactive capacities along with unobserved random processes: (i) the capacity to produce capital; (ii) the level of technological development; and (iii) the suitability of supportive political, regulatory, and business support institutions. By equations (2) to (5), the associated power laws influence GDP per capita through economy-wide productivity. Taking natural logarithms gives:

8. $y = \alpha_0 + ah + b\,\Upsilon + (1+\gamma)\,k + u$

where $y = ln\,(\frac{Y}{L})$, $k = ln\,(\frac{Y_c}{L})$, $h = ln(\mu)$, and $\Upsilon = ln(\phi)$, and a, b and $(1+\gamma)$ are the characteristic elasticities of the process. Thus, $\frac{d\phi}{\phi}$ is the rate of technical innovation that produces intellectual property and $b = \frac{dy}{y} / \frac{d\phi}{\phi}$ measures how much GDP per capita growth is induced by technical innovation, assuming a causal interpretation can be validated. We further postulate that Υ is endogenous in the sense that random changes in u causes simultaneous changes in Υ and y. Further, let q be the log of the quality of manufactured output, c the log of the quality of the output of the industrial services, and m the log of the level of development of the market as an instituted process. Through Υ, GDP per capita is also associated with the quality of manufactured output, the quality (novelty) of creative output, and the level of market development.

Thus, we fit the following triangular cross-sectional model:

9. $$y_i = \alpha_0 + \alpha_1 k_i + \alpha_2 h_i + \alpha_3 Y_i + u_i$$
$$Y_i = \beta_0 + \beta_1 q_i + \beta_2 c_i + \beta_3 m_i + v_i$$

where i indexes countries, u_i and v_i are residuals, and the coefficients αj, j = 1…3 , are characteristic elasticities. In particular, the structural equation suggests that GDP per capita is directly associated through an interactive non-linear process with the capital share of output, the level of development of the institutions of the economy, and its level of technology, but while $E(k,u) = 0$ and $E(h,u) = 0$, $E(Y,u) \neq 0$. Shocks to u that affect y also affect the level of technology, Y, so it is treated statistically as an endogenous variable. It is assumed that $E(q,v) = 0$, $E(c,v) = 0$ and $E(m,v) = 0$. More important, it is also assumed that $E(q,u) = 0$, $E(c,u) = 0$ and $E(m,u) = 0$. Further, it is assumed that the variables q, c and m do not affect GDP per capita directly, so they are not included in the y equation. These assumptions can be tested for their statistical validity. Together, k, h, q, c and m are the instruments of the model. It has been argued by Acemoglu, et al (2001) that institutions are endogenous, because of feedback from GDP per capita. Development of institutions will lead to growth of GDP per capita but GDP per capita growth also enables improvement of institutions. Our position is that this feedback is possible but not inevitable. In the typical case, institutional development must be achieved by deliberate strategic policy and actions by politicians. In any event, its endogeneity is a statistical matter and tests can be done to let the data speak to the issue.

It is perhaps useful to observe here that, in cross-country comparisons, interpretation of the time derivatives of equation (9) is complicated by the fact that in human society, time scales (t) are dominated by the rate at which institutions develop – institution-time so to speak. Thus, for any variable x, the rate of change $\frac{dx}{xdt}$ is adjusted by the length of dt. If a society's institutions are slow to change, dt is long and $\frac{dx}{xdt}$ is relatively slow. On the other hand, if a society's institutions change rapidly, then dt is short and $\frac{dx}{xdt}$ is relatively fast. Further, in the case of $k = ln\,(\frac{Y_c}{Y})$, Y_c is a composite variable, since there are many forms of capital, some in the form of physical goods and infrastructure, some in the form of knowledge, skills, self-confidence, and other intangible human capital, some in the form of intellectual property products and their capital services, and so on. Thus, $\frac{dk}{kdt}$ is also a composite of different growth rates relative to k that reflect the capacity of each country to produce the various forms of k competitively for the global marketplace.

The Data

For data on GDP per capita (y) and the production share of the capital sector in GDP (k), we use national accounting country profiles data supplied by the United Nations Statistics Division up to 2019, before the advent of the global COVID-2019 pandemic. The GDP per capita achieved by 2019 and the average share in GDP of the total output of the sectors that can produce capital, from 2010 to 2019, are used for the cross-country correlations with GDP per capita for 2019. The capital-producing sectors considered are the manufacturing sector, which can produce capital goods, and the set of service industries, including construction, that can produce plant, hard and soft infrastructure, and capital services such as financial intermediation, “real estate, renting and business activities”, education, healthcare, and a range of creative output that generate intellectual property assets. For proxy indicators of the level of technology (Υ), the quality of the institutional framework of the economy (h), the quality of industrial output (q,c), and the level of development of the market as instituted process (m), we use data produced by Cornell University, INSEAD and WIPO (2019) to prepare their 2019 Global Innovation Index (GII). The economy-wide index of innovation developed up to 2019, GII2019, is used as the proxy for Υ.

Subindices of the GII2019 are used to measure the level of institutional development of the economy, the quality of industrial output, and the level of market development to support capital production. In particular, h is measured by the score on the overall “institutions” subindex of the GII, capturing progress on government effectiveness, the rule of law, and the quality of the business environment. The quality of the industrial sector is measured by scores on two GII subindexes: (i) the subindex on “knowledge and technology outputs”, q, which captures the extent of knowledge creation, knowledge impact (such as through production of medium-to high-technology capital outputs), and knowledge diffusion; and (ii) the subindex on production of “creative outputs”, c, which captures the creation of intangible assets (such as trademarks, industrial designs, and copyright), the production of creative goods and services, and online creativity. The level of development of the market driving industrial production, m, is measured by the “market sophistication” subindex of the GII, which covers the ease of getting credit and the share of credit in GDP flowing to various groups of investors, institutional support for investment, the intensity of, and openness to, competition, and domestic market size. Thus, embedded in m is the importance of the flow of credit to support competitive capital production for the market, highlighted long ago by Lewis (1954).

The data used in the analysis cover 128 countries for which all variables (including GDP per capita and the capital share of GDP) are also available.

Key Correlations

The key correlations observed among the variables are reported in **Tables 1** and **2**. Across countries, there is a correlation of 0.75 between GDP per capita and the capital share of GDP. This correlation provides a reasonable basis for considering the role of the capital-producing industries as an engine of growth. Just as interesting, however, there is an even higher correlation of 0.81 between GDP per capita and the level of institutional development of the economy by 2019, and of 0.87 between GDP per capita and the economy-wide level of technology. The correlation of 0.88 between the level of technology and the level of institutional development raises no concern with variance inflation because the level of technology will be instrumented. Further, there is a correlation of 0.88 between the level of technology and the quality of industrial output, of 0.79 between the level of technology and the quality of creative service output, and of 0.65 between the level of technology and the quality of markets that support production.

Table 1: Correlations of y, k, h, and Y, all countries

	y	k	h	Y
y	1.0000			
k	0.7484	1.0000		
h	0.8133	0.6182	1.0000	
Y	0.8716	0.7187	0.8793	1.0000

Table 2: Correlations of Y, q, c, and m, all countries

	Y	k	h	m
Y	1.0000			
q	0.8770	1.0000		
c	0.7900	0.5973	1.0000	
m	0.7855	0.6267	0.6182	1.0000

Development Clustering

Countries in the global economy face different development challenges that are closely related to their capacities to produce capital for the market. Here, we take account of the commonplace clustering of countries according to their level of development adopted by the international development and coordination institutions for statistical and other purposes (World Bank, various years; IMF, various years; UN DESA, 2014). We first adopt their classification of countries into 4 clusters identified as developed, transition, emerging, and developing. To support application of gmm estimation with 5 instruments, these are then adjusted to yield 8 clusters each of which should feature considerable homogeneity resulting from within group spatial correlation of the capacity to produce capital. The clusters were selected to maximize homogeneity within groups and heterogeneity across groups.

In the developed cluster[5], a typical country has established a substantial capacity to produce and export capital competitively, a high share of capital output in GDP (kshare), and an abundant supply of capital that can fully employ its labour force, if the money supply and credit generates supporting effective demand. Such a country must grapple with diminishing returns to capital that is mainly addressed by continuous capital-deepening and technical progress. It therefore tends to have a high level of labour productivity and a high GDP per capita (gdppc) linked to its high share of capital in GDP. Moreover, a high degree of homogeneity around GDP per capita could be expected within this cluster. In the developing cluster[6], a typical country tends to have established a very limited capacity to produce and export capital competitively, a low share of capital in GDP, and therefore a stock of capital that is inadequate to fully employ the available labour force, whatever the level of effective demand enabled by the supply of money and credit. Such a country has a substantial problem of diminishing returns to labour and a relatively large sector of underemployed labour characterized by low productivity. This

[5] The 24 countries in the developed cluster are Australia, Austria, Belgium, Canada, Denmark, France, Germany, Iceland, Ireland, Israel, Italy, Japan, South Korea, Luxembourg, Netherlands, New Zealand, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom, and United States.

[6] The 26 countries in the developing cluster are Argentina, Azerbaijan, Belarus, Bosnia & Herzegovina, Botswana, Brazil, Chile, Colombia, Costa Rica, Croatia, Czech Republic, Dominican Republic, Ecuador, Jamaica, Kazakhstan, Lebanon, Mauritius, Mexico, Montenegro, North Macedonia, Panama, Paraguay, Peru, South Africa, Trinidad and Tobago, and Uruguay.

causes a low GDP per capita. The problem is mainly addressed by increasing capital production and exports, thereby creating increasing returns to labour. A relatively high degree of heterogeneity around GDP per capita could be expected within this cluster.

The transition[7] and emerging[8] clusters lie somewhere between these extremes, depending on their success in building competitive capital production and export capacity and the extent to which they rely on natural resources for GDP per capita. Overall, this configuration leads to patterns of association between GDP per capita and the capital share of GDP that vary by development cluster. Four clusters are added by distinguishing: (i) economies that rely on the production of hydrocarbons to generate their GDP per capita;[9] and (ii) economies with GDP per capita of $1000 or less, which accounts for the existence of countries with very low GDP per capita in the global economy;[10] (iii) economies with GDP per capita between $1000 and $2000;[11] and (iv) other lower-middle-income developing economies with GDP per capita between $2000 and $5000.[12]

Table 3 reports the observed heterogeneity among clusters and homogeneity within clusters, as indicated by the coefficient of variation of the capital share of GDP that suggests existence of cross-country correlation of the capacity to produce capital. The developed economies had the highest average share of capital in GDP at 64.7% and the highest average GDP per capita of US$50,218.7. The coefficient of variation of their capital share was smallest at 0.05. The emerging economies had an average capital share of 55.8% and an average GDP per capita of $18,111.6. The coefficient of variation of their capital share was 0.11. The transition economies featured average capital share of 51.1% and GDP per capita of $7,743, with a coefficient of variation of the capital share of 0.09. The subset of energy-dependent economies has an average capital share of GDP of 51.8% and average GDP per capita of $31,479.9, second only to the developed economies. These economies feature a coefficient of variation of 0.18 for the capital share of GDP. The subset of developing economies has an average capital share of GDP of 53.5% and average GDP per capita of $9,595.8, with a coefficient of variation of the capital share of 0.13. Among the lower-middle income countries, the average share of capital in GDP is 49.5%, the average GDP per capita is $3,465.7, and the coefficient of variation of the capital share is 0.16. The low-income countries have a capital share of 44.1%, an average GDP per capita of

[7] The 8 countries in the transition cluster are Armenia, Bulgaria, Georgia, Latvia, Romania, Russia, Serbia, and Tajikistan.

[8] The 15 countries in the emerging cluster are China, Cyprus, Estonia, Greece, Hungary, Indonesia, Lithuania, Malaysia, Malta, Poland, Slovakia, Slovenia, Thailand, Turkey, and United Arab Emirates.

[9] The 8 countries classified as energy-dependent are Bahrain, Brunei, Kuwait, Nigeria, Norway, Oman, Qatar, and Saudi Arabia.

[10] The 14 poorest countries with GDP per capita below $1000 are Burkina Faso, Burundi, Ethiopia, Guinea, Madagascar, Malawi, Mali, Mozambique, Nepal, Niger, Rwanda, Togo, Uganda, and Yemen.

[11] The 12 economies with 2019 GDP per capita between $1000 and $2000 are Bangladesh, Benin, Cambodia, Cameroon, Kenya, Kyrgyzstan, Nicaragua, Pakistan, Senegal, Tanzania, Zambia, and Zimbabwe.

[12] The 21 lower middle-income developing economies are Albania, Algeria, Bolivia, Cote D'Ivoire, Egypt, El Salvador, Ghana, Guatemala, Honduras, India, Iran, Jordan, Mongolia, Moldova, Morocco, Namibia, Philippines, Sri Lanka, Tunisia, Ukraine, and Vietnam.

$1,421.3, and a coefficient of variation of the capital share of 0.11. Finally, the poorest countries have a capital share of 40%, an average annual GDP per capita of just $689.9 and a coefficient of variation of the capital share of 0.20.

Table 3: Heterogeneity and Homogeneity in the Global Economic Community

Classification	Mean kshare	Std kshare	Mean gdppc	Std gdppc	N	Coefficient of Variation kshare	Coefficient of Variation gdppc
Developed	0.647	0.035	50,218.7	18895.4	24	0.05	0.376
Emerging	0.558	0.061	18,111.6	9494.7	15	0.11	0.524
Transition	0.511	0.047	7,743.0	4673.1	8	0.09	0.604
Energy-Dependent	0.518	0.092	31,479.9	24450.3	8	0.18	0.777
Developing	0.535	0.068	9,595.8	4285.6	26	0.13	0.447
Lower Middle Income	0.495	0.079	3,465.7	938.5	21	0.16	0.271
Low Income	0.441	0.049	1,421.3	223.1	12	0.11	0.157
Poorest	0.400	0.080	689.9	205.8	14	0.20	0.298

Model Estimation

We first estimate the specified model across all countries using 2sls with heteroscedasticity-robust standard errors and test the specification for the endogeneity of Y, the relevance of q, c and m in explaining Y, and whether one or more of q, c and m should be included in the structural equation (for y). **Table 4** reports the estimated parameters of the structural equation. The explanatory power of the model is high, with an R^2 of 0.8. As expected from the key correlations, all the included variables have a significant influence on GDP per capita. Since all variables are expressed in logarithms, the model coefficients are elasticities. Further, the derivative of k is interesting because it is the difference of the rate of growth of capital output and the rate of growth of GDP. Thus, the associated elasticity is also a measure of the effects on GDP per capita of economic restructuring towards capital production. This is a key aspect of the role of capital production as the economic growth engine. Among the set of elasticities, the highest is that of the elasticity of restructuring towards the capital sector (2.215889), followed closely by that of the level of institutional development (2.060912), and then the level of technology (1.465339). Even though capital production is the sectoral growth engine, the prominence of institutional development in the growth of GDP per capita, as highlighted by Lewis (1955), is reaffirmed by these results.

The fact that the estimated elasticities are individually and collectively greater than 1 is a measure of the enormous competitive advantage in the development process achieved and continuously accumulated by the countries that invest in joint improvement of the strategic factors. The size of the elasticities also indicates the corresponding tendency for the countries that do not invest in the simultaneous improvements of the strategic factors to lose competitive advantage over time. In practice, the strategic factors jointly generate development through dynamic accumulation of gains resulting from learning by doing.

We check the endogeneity of the level of technology (Υ) using an heteroscedasticity-robust variance-covariance error matrix of parameter estimators with: (i) the Wooldridge (1995) Chi-square (1) test statistic, which uses an estimate of the error variance that assumes that Υ is exogenous; and (ii) the F(1, N-n) regression-based statistic, where N is the sample size and n is the number of instruments in the model. This statistic follows Hausman (1978) in using estimated residuals generated from a first-stage regression that therefore assumes that Υ is endogenous. Both tests assume that the residuals are heteroscedastic though independently distributed. The null hypothesis of these tests is that Υ is exogenous. Both test statistics reported in **Table 4** are highly significant, indicating that it is not appropriate to treat Υ as exogenous. The data supports its treatment as an endogenous variable.

Table 4: Instrumental variables (2SLS) regression

Number of obs = 128
Wald chi2(3) = 601.83
Prob > chi2 = 0.0000
R-squared = 0.7974
Root MSE = 0.63957

y	Coefficient	Robust Std. error	z	Pr>(z)	95% Confidence Interval	
Υ	1.465339	.5130068	2.86	0.004	.4598639	2.470813
k	2.215889	.4433263	5.00	0.000	1.346985	3.084792
h	2.060912	.6914136	2.98	0.003	.7057665	3.416058
_cons	-3.378359	1.900385	-1.78	0.075	-7.103046	.3463279

Instrumented: Υ

Instruments: k, h, q, c and m

Endogeneity test statistics

Wooldridge Robust score chi2(1) = 9.30727 (p = 0.0023)

Hausman Robust regression F(1,123) = 9.18137 (p = 0.0030)

For q, c and m to be statistically valid instruments, they must be sufficiently correlated with Υ but uncorrelated with u,v. This is achieved partly by the choice of the q, c and m as subcomponents used in the construction of Υ by Cornell, INSEAD and WIPO (2019). We explore those correlations using the first stage model of Y, specified as:

10. $\Upsilon = \beta_0 + \beta_1 k_i + \beta_2 h_i + \beta_3 q_i + \beta_4 c_i + \beta_5 m_i + v_i$

The results are reported in **Table 5**. The null hypothesis of the statistics is that q, c and m are weakly correlated with Υ.

The R^2 from the specified first stage regression is high at 0.9700 and the associated adjusted R^2 is close at 0.9688. The partial R^2 of 0.8309 indicates a strong correlation between Υ and the set q, c and

m, even after adjusting for the correlation between Y and the included regressors k and h. This means that a strong correlation between Y and the included regressors k and h does not mask weakness of the instruments q, c and m. So, as expected, the set of instruments are very strong. The F(3,122), with 3 degrees of freedom in the numerator and N-(n+1) degrees of freedom in the denominator (i.e., including the constant term), tests the joint significance of the coefficients on q, c and m in the first stage equation. The statistic of 135.899 exceeds the threshold value of 10 derived by Stock, Wright, and Yogo (2002) and, with its p-value near zero, indicates that q, c and m have a highly significant joint influence on Y after controlling for the effects of included regressors k and h.

Finally, since there are 3 excluded regressors, the model is over-identified and we can test the overidentifying restrictions, which is to say whether the assumption holds that $E(q,u) = 0$, $E(c,u) = 0$ and $E(m,u) = 0$. Only one of these is needed for the model to be just identified. Further, we can also test whether the model is well-specified in the sense of whether one or more of q, c and m should really be included in the structural equation for y. Here, the appropriate test statistic is the $\chi^2(\tau)$ test that is robust to heteroscedasticity which was derived by Wooldridge (1995), where τ is the number (here 2) of overidentifying restrictions. In this case, the Wooldridge $\chi^2(2)$ = 4.83403 with p = 0.0892. The test statistic is statistically insignificant at the 5% level of significance. It indicates that the instruments are uncorrelated with the structural error and all the instruments are properly excluded from the structural equation. As a cross check on the exogeneity of k and h, it is also confirmed that both variables exhibit no correlation with the structural error. The evidence is that $E(k,u) = 0$ and $E(h,u) = 0$, as required for exogeneity.

Table 5: Statistics for Diagnostic Tests of Overidentifying Restrictions

Variable	R-sq.	Adjusted R-sq.	Partial R-sq.	F(3,122)	Prob > F
Y	0.9700	0.9688	0.8309	135.899	0.0000
Test of overidentifying restrictions					
Wooldridge Robust Score $\chi^2(2)$ = 4.83403, (p = 0.0892)					

The Significance of Clustering

The 8 country clusters reported above are sufficiently different to apply the method of instrumental variables estimation with 5 instruments, implemented with the gmm estimator. This enables use of a weighting matrix that relaxes the assumption that the heteroscedastic residuals are independently distributed within clusters and accounts for within-group spatial correlation of observations

.

The results of this estimation method are reported in **Table 6**. Clustering yields somewhat different parameters to the heteroscedasticity-robust methods reported in **Table 4**, only because the importance of the roles of the level of technology and the quality of political, regulatory, and business-supportive institutions are reversed. The explanatory power of the model is virtually the same as that estimated with 2sls and heteroscedasticity-robust standard errors, as indicated by the R^2 of both the structural

(0.8) and first-stage equations (0.97). However, the cluster-robust standard errors are substantially smaller than those generated by 2sls with heteroscedasticity-robust standard errors in **Table 4**. More interesting, industrial restructuring remains the leading force driving up GDP per capita. However, the size of its elasticity is somewhat larger, increasing from 2.21 to 2.27. Further, the cluster-adjusted estimate of the elasticity of the GDP per capita with respect to the level of institutional development is now smaller (1.567) than the technology elasticity (1.912).

The C-statistic that tests for the endogeneity of Υ (Hayashi, 2000: 220) has a value of 3.84704 with p-value of 0.0498, which rejects the null of exogeneity and indicates that the variable must indeed be treated as endogenous in the model. The first stage results yield the same finding that q, c and m have a highly significant joint influence on Υ after controlling for the effects of included regressors k and h. Hansen's J $\chi^2(2)$ test of overidentifying restrictions (Hansen, 1982) (4.40489, (p = 0.1105)) is statistically insignificant at all conventional levels of significance, confirming that, even in the presence of substantial correlation within clusters associated with the development clustering of countries, the instruments are uncorrelated with the structural errors, and all are properly excluded from the structural equation.

Table 6: Instrumental variables (gmm) regression with Development Clustering

					Number of obs = 128
					Wald chi2(3) = 1027.36
					Prob > chi2 = 0.0000
					R-squared = 0.7928
GMM weight matrix: with Cluster (cdcode)					Root MSE = .64684
				(Std. Err. adjusted for 6 clusters in cdcode)	
y	Coefficient	Robust Std. error	z	Pr>(z)	95% Confidence Interval
Υ	1.912265	0.3758944	5.09	0.000	1.175526 2.649005
k	2.274166	0.3109923	7.31	0.000	1.664632 2.88369
h	1.567261	0.4353848	3.60	0.000	.7139224 2.4206
_cons	-2.99431	1.053757	-2.84	0.000	-5.059639 -.9289856
Instrumented: Υ					
Instruments: k, h, q, c and m					

Test of Endogeneity

GMM C statistic chi2(1) = 3.84704 (p = 0.0498)

First-stage regression summary statistics

Variable	R-sq.	Adjusted R-sq.	Partial R-sq.	*Robust F(3,5)	Prob > F
Υ	0.9700	0.9688	0.8309	268.697	0.0000

*F-statistic adjusted for 8 clusters in cdccode

Test of overidentifying restrictions:

Hansen's J chi2(2) = 4.40489 (p = 0.1105)

Causal Interpretation

The development classifications into which countries fit reflect nonlinear combinations of their capital shares, institutional development, and technology, what might be properly called their competitive development strategies in a global market context in which success is achieved through market competition. An important question to be addressed is whether the class of competitive strategies that characterizes an economy can be given a causal interpretation. In particular, can it be said that the GDP per capita of an economy is an effect caused by the characteristic combinations of the capital share, institutional development and level of technology? Here, the causal effect of a competitive strategy on the GDP per capita of any country at any point in time is defined as the difference between the GDP per capita with the competitive strategy and the GDP per capita without the competitive strategy. The difficulty that arises – the fundamental problem of causal inference - is that the data used is non-experimental and, at any given time, countries cannot be simultaneously observed when they are and are not deploying a given class of competitive strategies identified. If they could be, it would be sufficient to compute the difference in GDP per capita under the contrasting classes of competitive strategies, average them across all countries and judge that causality operates if the differences are statistically significant.

To investigate the question, we use the counterfactual (missing data) framework as developed by Rubin (1974), extended in Cattaneo (2010) and Imbens (2000), and explained at length in Wooldridge (2010: Ch. 21). We focus on three classes of competitive strategies (s) consistent with the country classifications identified in **Table 3** above: the developed (s_2); the emerging (s_1); and all other countries treated as "developing". That is, analytically we treat the observed GDP per capita (y_i) as taking the value y_{0i} when $s_1 = s_2 = 0$; y_{1i} when $s_1 = 1$ and $s_2 = 0$; and y_{2i} when $s_2 = 1$ and $s_1 = 0$. That is:

11. $y_i = y_{0i} + s_1 (y_{1i} - y_{0i}) + s_2 (y_{2i} - y_{0i})$

We first want to compare developed and developing countries, then emerging and developing countries; and then use those results to compare developed and emerging countries.

Since all variables in equations (9) and (10) are in natural logs to capture the integrated nature of the competitive strategy, log-linear regression models of the GDP per capita are estimated for each type of competitive strategy. Thus, y_{0i}, y_{1i} and y_{2i} are modeled as:

12. $y_{oi} = a_{00} + a_{01}k_i + \alpha_{02}h_i + \alpha_{03}\widehat{Y}_i + u_{0i}$

13. $y_{1i} = a_{10} + a_{11}k_i + \alpha_{12}h_i + \alpha_{13}\widehat{Y}_i + u_{ii}$

14. $y_{2i} = a_{20} + a_{21}k_i + \alpha_{22}h_i + \alpha_{23}\widehat{Y}_i + u_{2i}$

where $\hat{Y}_i$ are predictions from the first-stage regression in equation (10) and where the coefficients α_{jq}, $j = 0,1,2$; $q = 0,1,2,3$ are characteristic parameter vectors to be estimated, u_{0i}, u_{1i} and u_{2i} are unobservable error terms that are not correlated with k_i, h_i, and Y_i or with w and z, the observed covariates that explain s_1 and s_2. The latter covariates may coincide with k_i, h_i, and $\hat{Y}_i$.

Further, the competitive strategy adopted is modeled as:

15. $$s = \begin{cases} s_1 = 1, \text{ if } s_2 = 0 \text{ and } w'\gamma_1 + \eta_1 > 0 \\ s_2 = 1, \text{ if } s_1 = 0 \text{ and } z'\gamma_2 + \eta_2 > 0 \\ 0 \text{ otherwise} \end{cases}$$

where γ_1 and γ_2 are vectors of coefficients and η_1 and η_2 are unobservable error terms assumed to be uncorrelated with k_i, h_i, and $\hat{Y}_i$ and with w and z. For any given i, the data do not reveal y_{0i}, y_{1i} and y_{2i} simultaneously. The model for s determines how y_{0i}, y_{1i} and y_{2i} are missing.

We also make the conditional mean independence assumption. That is, all the variables that affect GDP per capita and country competitive development strategy are observable and, once we control for them, random shocks to the model residuals do not simultaneously determine the competitive strategy adopted by a country and its potential (predicted) GDP per capita. To help ensure that this assumption will hold, the predictions of the first stage regression of Y on the model instruments are used in the models to ensure that no unobserved variable influences both the technology and GDP per capita simultaneously, and thus spillover to simultaneously influence GDP per capita and the competitive strategy that a country employs. Further, the cross-country data being used reflect the fact that each country's competitive development strategy is continually adjusting on its own initiatives, and none is dictated by a general equilibrium in the global economy. So, it can be assumed that the GDP per capita and competitive development strategy of a country are statistically independent of the GDP per capita and competitive development strategy of all others. Finally, it is assumed that each country, whatever the elements of its competitive development strategy, has a strictly positive chance to become either emerging or developed.

We use the regression-adjustment estimator to predict the GDP per capita caused by a country manifestly adopting one competitive development strategy rather than another. The estimated elasticities of the regression equation for countries in each development class characterize the competitive strategy used by the class to determine its GDP per capita. Thus, the estimated characteristic vector of elasticities of the regression equation (14) of countries adopting the developed country competitive strategies are used to combine the elements of each country's competitive strategy and predict its GDP per capita, as if it adopted a developed country strategy. Similarly, the estimated characteristic vector of elasticities of the regression equation (13) of countries using emerging country competitive development strategies are used to combine the elements of each country's competitive strategy and predict its GDP per capita, as if it employed an emerging country strategy. Finally, the estimated characteristic vector of elasticities of the regression equation (12) of countries adopting developing country competitive strategies are used to combine the elements of each country's competitive strategy and predict its GDP per capita, as if it adopted a developing country competitive strategy.

countries adopting developing country competitive strategies are used to combine the elements of each country's competitive strategy and predict its GDP per capita, as if it adopted a developing country competitive strategy.

Thus, for each country three values are estimated: $\widehat{y_{dng,i}}$, $\widehat{y_{em,i}}$, and $\widehat{y_{dev,i}}$. The means of these variables, $\overline{y_{dng}}$, $\overline{y_{em}}$ *and* $\overline{y_{dev}}$, represent the potential (counterfactual) average GDP per capita of each class of competitive development strategies. The average effect of pushing a country to adopt the competitive strategy characteristic of developed countries rather than remaining with that of the developing economies is the mean of the difference $\widehat{y_{dev,i}}$ - $\widehat{y_{dng,i}}$. The average effect of adopting the characteristic competitive strategy of emerging economies rather than remaining with that of the developing economies is the mean of the difference $\widehat{y_{em,i}}$ - $\widehat{y_{dng,i}}$. The average effect of pushing from the characteristic competitive strategy of emerging countries up to that of the developed countries is the mean of the difference $\widehat{y_{dev,i}}$ - $\widehat{y_{em,i}}$.

Table 7 reports the estimated potential outcome means of each development class along with applicable diagnostics. The results indicate that if all countries adopted the competitive development strategy typical of the developing countries, then their expected average log GDP per capita would be 8.82 or the equivalent of about $6760.4. If all countries adopted the competitive strategy of emerging economies, then their expected average log GDP per capita would be 9.25 or the equivalent of about $10,384.68, a significant difference of $3,624.2 (or 54%) above that of the developing countries. On the other hand, if all countries could adopt the competitive strategy of the developed economies, their expected average log GDP per capita would be 9.63 or about $15,225.7, a significant difference of $8,465.2 (or 125%) above that of the developing countries and $4,841 (or 47%) above that of the emerging economies. Overall, the results indicate that the competitive strategies of the countries can be properly treated as causes of their GDP per capita.

Table 7: Estimation of Causal Effects of Competitive Development Strategy

				Number of observations = 128	
Estimator: Regression adjustment					
lgdppc model: linear					
Log of GDP per capita					
Competitive Development Strategy	Coef.	Robust Std. Err.	z	P>z	95% Conf. Interval
Developing	8.818843	0.14873	59.29	0.000	8.527337 ….9.110349
Emerging	9.248087	0.19095	48.43	0.000	8.873832….9.622343
Developed	9.630738	0.324293	29.70	0.000	8.995136….10.26634

Summary

Using data from 128 countries in the global system, this paper updated the first Kaldor regularity by considering the role of the capital share of GDP, the quality of institutions and the level of technology in the GDP per capita attained by economies. Empirical exploration of the role of the industries capable of producing capital reveals that countries with a substantial capacity to produce (and export) capital competitively, and an associated high share of capital output in GDP, buttressed by a substantial capacity to innovate and a high level of institutional development, also tend to have a high GDP per capita. There is only one outlier, Qatar, which is an energy-based economy. On the other hand, countries with an inadequate capacity to produce and export capital competitively, and an associated low share of capital output in GDP, along with a low level of technology and weak institutions, also tend to have a low GDP per capita.

The results suggest a more general principle than was identified by Kaldor (1967). There is a high correlation between the GDP per capita a country can attain and: (i) the share of resources devoted to capital production, presumably up to some limit; (ii) the resources devoted to upgrading the level of technology; and (iii) the resources devoted to developing the institutional foundations of the economy. These three forces form an integrated development fabric whose components work interactively. Among them, the most important allocation is the development of capacity to produce capital, but it is almost as important to allocate resources to institutional development and to the level of technology. The combinations of these forces adopted by any country can be treated as a manifestation of its global competitive strategy. The estimated parameters of a class of countries characterise the competitive strategies of the class. The competitive strategies of three classes of countries were considered: developed, emerging, and developing. When the estimated characteristic parameters of these classes of countries are used for counterfactual modelling with the observed country strategies, the results support the interpretation that the adopted competitive strategy causes GDP per capita.

In general, output structures are slow to change, and the integrated competitive strategy driving the development process means that it is a substantial and ambitious project to move an economy from the lower capital shares and lower GDP per capita evident in the development clusters to the highest capital shares and GDP per capita achieved. Nevertheless, the results provide confidence that, in addition to devoting resources to building capacity to produce (and export) capital, there are other avenues through which countries could invest to improve their economic performance in the global space, namely institutional progress and technological innovation.

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