Empirics of Economic Growth and Industrialization Using Growth Identity Equation

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Abstract

The Growth Identity Equation gives an identity relationship between economic growth measured by the real per capita GDP and the performance of the three economic sectors of agriculture, industry and service measured in their output to GDP ratio and their own output growth. The use of the Growth Identity Equation verifies that the variables that determine economic growth also affect these six sectorial variables. The empirical study uses data from over 150 countries for the period from 1970 to 2010. The variables explaining both total output growth and the performance of the three sectors include economic, institutional, and non-institutional variables. As industrialization is reflected in the structural shift of the output ratios of agriculture, industry, and service sectors to GDP, we found that the variables used to explain economic growth are also important to explain industrialization and structural shift of sectors.

Keywords: Growth, industrialization, world economy, economic sectors, Growth Identity Equation.

Classifications: C22, O11, O50.

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I Introduction

The link between economic growth and industrialization is originated from the Industrial Revolution. Maddison (1982) and Goodfriend and McDormott (1995), for example, showed that total production and per capita output have increased tremendously since the Nineteenth Century as a result from the Industrial Revolution. With the development of various economic growth theories such as neo-classical growth models (Ramsey, 1928; Solow, 1956, 1957; Swan, 1956; Cass, 1965; Koopmans, 1965) and endogenous growth models (Romer, 1986, 1990; Lucas, 1988, 1990; Rebelo, 1991), numerous empirical studies using different growth models to explain economic growth started to emerge since 1990s. One concern, for example, is whether physical capital produced increasing or decreasing returns, or in the convergence theory, whether growth in poor countries has caught up with rich countries (Mankiw *et al*., 1992). These studies focus on finding statistically significant variables to explain economic growth. The variables commonly used in empirical literature include economic, institutional and non-institutional variables such as religion, culture, geography, and social fractionalization (Barro, 1991; Sachs, 2003; Durlauf, 2005; Li and Zhou, 2010). Durlauf *et al*. (2005), for example, identified more than 140 variables in explaining economic growth.

With many possible independent variables, researchers encounter the variable selection issue, as indicated by the sensitivity analysis (Levine and Renelt, 1992; Sala-i-Martin, 1997). The solution involves using new modelling approaches such as model-averaging methods and non-linear and non-parametric models (Sala-i-Martin *et al*., 2004; Henderson *et al*., 2011). In sum, most empirical studies have used various macroeconomic theories, proxies for economic variables, econometric modelling with different functional forms, estimation techniques and different data sets. A common feature among these studies is that the dependent variable is the growth of aggregate output measured by the growth of real GDP per worker or per capita. However, industrialization is a separate domain in economic growth, but is seldom linked to current economic growth models and empirics.

To address industrialization and structural shift of economic sectors, the dependent variables in our study include the output growth and the variables related to economic sectors. Since economies are divided into agriculture, industry and service sectors, the importance of each sector is represented by their shares in total output (GDP) and employment. Descriptive statistics of these shares can show how these three sectors have moved in different development

stages (Lewis, 1954). Given that the shares of these three sectors sum to unity, the process of industrialization can be seen from the increase in the shares of the industrial or service sectors and decrease in the share of the agricultural sector. The focus on the choice of dependent variables is similar to some recent studies. For example, based on the growth decomposition of output into inputs, Durlauf *et al*. (2008) used the growth of physical and human capital and total factor productivity as dependent variables. In analyzing economic opportunity, Li (2014) reclassified a number of dependent variables that reflected the outcome of economic opportunity.

To establish an economic model to explain industrialization and structural shift of the three sectors, we introduce the "Growth Identity Equation" that shows the relationship between the total output and the performance of the three sectors measured in the share of sector output to GDP as well as growth in each of the three sectors. The hypothesis is that the variables that are used to explain total output growth can also be used to explain industrialization and the structural shift of the three economic sectors. Thus, two types of dependent variables, namely the shares of three sectors output to total GDP and the growth in each of the three sectors, are considered. We apply the conventional growth models to these six dependent variables. This approach of using independent variables from the conventional growth models can also be seen in Durlauf *et al*. (2008) which used those independent variables that explained total output growth as the independent variables to explain physical human capital and total factor productivity.

Section II shows the regression methodology and data categories, while section III reports the empirical findings. The last section concludes the paper.

II Regression Methodology and Data

To relate output growth to the three economic sectors, we begin with the three-sector classification of the total real per capita output:

$$y_t = a_t + i_t + s_t, \tag{1}$$

where y_t is real per capita GDP; a_t is real per capita agriculture output; i_t is real per capita industrial output; and s_t is real per capita service output expressed at time t. Dividing each term in Equation (1) by total output, y_t, gives the following equation:

$$(a/y)_t + (i/y)_t + (s/y)_t \equiv 1, \quad (2)$$

where $(a/y)_t = \frac{a_t}{y_t}$ is the share of agriculture output to GDP; $(i/y)_t = \frac{i_t}{y_t}$ is the share of industrial output to GDP; $(s/y)_t = \frac{s_t}{y_t}$ is the share of service output to GDP. This equation shows the sum of the shares of three sectors' output is equal to one. The industrialization and structural shift of the sectors can be seen from the changes of the components in this equation. During the process of industrialization, we observe the shift of the agriculture sector to industrial and service sector and hence the decrease in the share of the agriculture sector and the increase in the shares of industrial and service sectors. In addition to these three sectors, we are also concerned with the output growth of the three sectors. Define the following output growths:

$$\dot{y}_t = \frac{y_t - y_{t-1}}{y_{t-1}}, \dot{a}_t = \frac{a_t - a_{t-1}}{a_{t-1}}, \dot{i}_t = \frac{i_t - i_{t-1}}{i_{t-1}}, \dot{s}_t = \frac{s_t - s_{t-1}}{s_{t-1}}, \quad (3)$$

where $\dot{y}_t$ is the growth of real per capita GDP, which is the measure of economic growth; $\dot{a}_t$ is the growth of real capita agriculture output; $\dot{i}_t$ is the growth of real per capita industrial output; and $\dot{s}_t$ is the growth of real per capita services output. Using Equation (1) for y_t and y_{t-1} and Equation (3), we calculate the total output growth $\dot{y}_t$ and derive the following Growth Identity Equation (GIE):

$$\dot{y}_t \equiv (a/y)_{t-1}\, \dot{a}_t + (i/y)_{t-1}\, \dot{i}_t + (s/y)_{t-1} \dot{s}_t. \quad (4)$$

This identity shows the total output growth is equal to the weighted sum of sectors growth; the weight for each sector is the share of the sector's output to GDP in the previous period. We follow other growth empirics that identified the variables used to explain the total output growth. Based on this identity, we expect the variables that affect the total output growth on the left-hand side of the identity should affect the six variables on the right-hand side. This implies that we can consider the regression with each of these six variables as the dependent variable and the variables from the growth model as the independent variables. The regression model is:

$$z = f(X), \quad (5)$$

where z is one of the seven variables in the set $\left\{\dot{y}, \frac{a}{y}, \frac{i}{y}, \frac{s}{y}, \dot{a}, i, \dot{s}, \right\}$ and X is a vector of variables with all independent variables from other growth empirics. Since there are six variables on the right-hand side of the identity, each given independent variable may not have the same impact on each of these six variables. Suppose x_t is one of the independent variable, and based on Equation (2), we derive the following constraint equation:

$$\frac{\partial(a/y)_t}{\partial x_t} + \frac{\partial(i/y)_t}{\partial x_t} + \frac{\partial(s/y)_t}{\partial x_t} \equiv 0 \,. \tag{6}$$

This equation indicates that total impacts from any independent variable on the output shares of the three sectors should be zero. This equation also provides a base of understanding the structural shift. For example, $\frac{\partial(a/y)_t}{\partial x_t} < 0$, $\frac{\partial(i/y)_t}{\partial x_t} > 0$, and $\frac{\partial(s/y)_t}{\partial x_t} > 0$ implies the decrease in the share of agriculture sector and the increase in the shares of industrial and services sectors. This is an indication of industrialization caused by the x variable. When we observe industrialization in the world economy, we expect the coefficients of most independent variables are negative for the regression with the share of agriculture output as the dependent variable, and the coefficients of most independent variables are positive for the regression with the share of industrial and service outputs as the dependent variables.

In our estimations, we use the data from 165 countries (with the data for all seven dependent variables) from 1970 to 2010. The data are collected from the World Bank, Penn World Table (PWT 8), Global Development Network Growth Database, CIRI Human Rights Dataset and studies by La Porta (1999) and Alesina (2003) (see Appendix Table A1). The real per capita output data are from PWT 8. The independent variables include six sub-categories:

1) Solow Variables: investment to GDP ratio, secondary school enrollment percentage, population growth, and initial year GDP;
2) Policy Variables: exports and imports to GDP ratios, foreign direct investment as percent of GDP, net inflows of portfolio equity in balance of payment as percent of GDP, domestic credit to private sector as percent of GDP, development assistance and aid received as percent of GDP, inflation rate, and CO2 emission;

3) Demographic Variables: life expectancy, fertility rate, and mortality rate;
4) Geographic Variables: land locked, latitude, tropical area, eight regions, and area;
5) Institutional Variables: legal origin, religion, political right, property right, and regulation business index, ethnic, language and religion fractionalization, transition economies, and export categories (manufactures, fuels, nonfuel primary products, services, diversified and others); and
6) Human Rights Variables: speech freedom, religion freedom, independence of judiciary, electoral self-determination, assembly freedom, freedom of domestic and foreign movement, worker's rights, women's economic and social rights, Physical Integrity Rights index based on torture, killing, political imprison, and disappearance.

In our estimation, we use cross-section data with the General to Specific (G-to-S) modelling (Hoover and Perez, 2004). In this approach, all independent variables are used in the regression in the first step. Then the insignificant variable with the highest p-value is removed in each step until all variables are significant. In each step of removing independent variables, an F test for the most recent three removed variables is conducted for the redundant variables test. An advantage of the G-to-S modelling is that it avoids the issue raised by the sensitivity analysis.

III Empirical Results

Table 1 shows the average of the seven variables in the Growth Identity Equation shown in Equation (4). The averages are for the samples of all countries and for different income groups classified by the World Bank. The results show the fitted output growth on the right-hand side of Equation (4) is identical to the output growth on the left-hand side. For the total output growth, the lower-middle income (LM) countries grew fastest among three income groups during 1970-2010, and the upper-middle income (UM) countries grew fastest among four income groups during 1987-2010. High income countries have high output ratios of industry and service sectors to GDP, and low income countries have high ratio in output ratio of agriculture sector to GDP (Todaro and Smith, 1013). Comparing the growth of three sectors, the agriculture sector has slower growth rates than the other two sectors. The services sector is growing faster than the industrial sector, except in low income countries.

To apply the growth empirics to Growth Identity Equation, we first consider four Solow variables: investment to GDP ratio (GDI), secondary school enrollment percentage (Education), population growth (Population), and the logarithm of initial year GDP. Using these four variables as the independent variables, we consider each of the seven variables in Equation (4) as the dependent variable. The regression results are shown in Table 2. The results in the first column under "Output Growth" should be consistent with the current growth empirics, and that both GDI and Education should be positive and significant, while both population growth and initial GDP should be negative and significant. Two of these four variables in our results are consistent with the current literature.

With the given variables to explain total output growth, this paper is intended to focus on the regressions of the six dependent variables in the Growth Identity Equation. When we examine the estimated coefficient for each independent variable, we can compare the estimated coefficients in different columns. For the three columns with sector output to GDP ratios as the dependent variables, we note that the sum of the coefficients of each independent variable in these three columns is always sum to zero, as stated in Equation (6). For example, the absolute value of GDI coefficient for the share of agriculture output is very close to the sum of the positive values of the two output shares of industrial and service sectors. This shows that we can compare the coefficients in the three columns for the sector output shares to explain industrialization and structural shifts between the sectors. For the two significant variables (GDI and initial GDP) in the first column to explain total output growth, GDI has a negative impact on the share of the agriculture sector and a positive impact on the share of the industrial sector; initial GDP has a negative impact on the share of the agricultural sector and positive impact on the shares of the industrial and services sectors. We can conclude that GDI has contributed to the industrialization and the sector shift. This is an empirical evidence for finding the sources of industrialization and sector shifts.

The negative coefficient of the initial GDP in the first column is to support the convergence theory, which argues that the poorer countries (lower income) in the initial years are growing faster than the richer countries (higher income). When the initial GDP is used to explain the output shares of the three sectors, we found that the countries with a higher initial GDP have higher industrialization process such that both industrial and service sectors have an increasing share in GDP when compared to the agriculture sector. This result has an interesting implication:

the lower income countries may grow faster, but their industrialization process is not as favorable as those in high income countries. The last three columns in Table 2 show that the Solow variables have relative low explanatory power in the sector growth. Only GDI has a positive and significant impact on the growth of industrial sector.

Table 3 shows the results when the policy variables and demographic variables are added to the regressions in Table 2. It shows that GDI has a negative and significant impact on the share of service sector. This result is different from Table 2 and implies that GDI contributes to the structural shift from service sector to industrial sector. This possibly suggests that the policy variables are important in explaining the sector shift. The inclusion of these variables can change the results from the regressions with only Solow variables. The other results of Table 3 can be summarized as follows:

i) Export as a percentage of GDP causes the sector shift from agriculture and service sectors to the industrial sector; while import as a percentage of GDP causes the structural shift from industrial sector to service sector.

ii) The domestic credit to private sector as a percentage of GDP causes the structural shift from industrial sector to service sector, but inflation has a negative impact on the share of service sector.

iii) Net official development assistance and official aid received as percentage of GDP have a positive impact to the share of agriculture sector. This probably relates to low income countries.

iv) Life expectance increases output growth and also the share of services sector. High mortality rate causes the structural shift from industrial sector to agriculture sector.

v) Comparing with Table 2, the inclusion of these policy and demographic variables doubled the adjusted R-squares for the regressions for both the shares of industrial and service sectors and the growth of industrial sector, while the adjusted R-squared increased by 0.111, 0.118, and 0.088 for total output growth, the share of agriculture sector, and the growth of service sector, respectively. The impact on the growth of agriculture sector is relatively milder with only 0.029.

Next, we consider adding geographic and institutional variables, and human rights variables to the regressions. The geographic and institutional variables are country fixed factors that do not vary over time. The inclusion of these fixed factor controls for countries'

characteristics. As these geographic and institutional variables are added to regressions, the adjusted R-squared for each regression increases by a range from 0.10 for the share of agricultural sector to 0.284 for the growth of service sector. The details of the regression results are shown in Table A2 in the appendix. The results show that the fixed country factors contribute both sector shift and growths.

When added to regressions, the human rights variables further increase the adjusted R-squares from 0.128 to 0.207 for each regression, except for the share and growth of agriculture sector. The impacts of each variable in each sub-category on three sets of dependent variables of total output growth, sector shares and shift, and sector growths are summarized in Table 4. The details of the regression results with all independent variables are shown in the appendix Table A3. The initials A, I and S represent, respectively the agriculture, industry and service sector, while the upward and downward arrows indicate, respectively, the regression results of increase and decrease, while the sideway arrow means sector share changes or sector shift.

Table 4 shows that among the Solow variables, GDI is most important as it promotes growth, leads to sector shift in favor or industry as well as growth in I and S sectors. High initial GDP is related to the sector shift from agriculture to service, and it has a positive impact on the growth of industry. This implies that growth convergence is only for total output growth. The industrialization process is higher for those countries with high initial income and sector shift is moving more toward service than industry sector. The population and education variables do not seem to show strong results. The policy variables are important to all three sets of dependent variables, though the impacts of individual variable on the three sectors vary. For example, most policy variables have positive impact on I and S sectors, while aid is exclusively relevant to the agriculture sector. As FDI and portfolio are highly correlated, the negative impacts of portfolio are offset by the positive impacts of FDI. These results point to the importance of economic openness, supporting the arguments in other studies (e.g. Li and Zhou, 2010).

For the demographic variables, the increase in life expectancy only moves the sector share from industry sector to agriculture and service sectors. It does not have impact on growths. The increase in the fertility reduced output growth and the share in industry sector. Mortality improves growth probably through its impact on the increase of share in the agriculture sector and growth in service. The results of the geographical variables are mixed with different groups of countries performing either better or worse than the base group of countries in Western

Europe. The sector shift tends to favor industry in three regions (East Asia and Pacific, and North America and landlocked). The latitude variable shows that the further away from the Equator, the sector shift from agriculture to industry is more significant.

The set of institutional variables show some interesting results. For total output growth, regulations on business actually promote output growth. Ethnic divisions and conflicts are harmful to growth, but religious divisions are positive forces to growth. Sector shifts tend to favor industry, except the Muslim and ethnic and language fractions. Too much regulation will lead the economy away from industry. In the sector growth, improvements in political rights and property rights will lead to growth in industry and service. Fuel-export countries do not do well: they are not growth-promoting, show a shift to industry sector but a lower growth in both industry and service sectors. Similarly, the human rights variables show a mixed result, including the women rights. Religious freedom does lead to a sector shift from agriculture to industry, while workers and women political rights tend to promote growth either in agriculture or service sectors.

One can argue that in aggregate, the policy variables are most important to growth and industrialization, followed by the Solow variables, geographical and institutional variables, while the impact from the human rights and demographic variables is less obvious.

IV Conclusion

This paper uses Growth Identify Equation to demonstrate the relationship between economic growth and industrialization, which is represented by the structural shift from agriculture sector to industry and service sectors. Using the variables that explain total output growth as in the current growth empirics, we set up the regression models for sector share and growth for agriculture, industry and service sectors. We include a total of 41 independent variables to explain seven dependent variables identified in Growth Identity Equation with the data from more than 150 countries for the period from 1970 to 2010. The independent variables include three main categories: 14 economic policy and demographic variables (with four Solow variables), 16 institutional and geographical variables, and 11 human rights variables. To address the sensitivity analysis issue in selecting independent variables, we adopted the General to Specific Modelling.

There are several key findings. We show that those variables to explain total output growth can also explain the sector shares and growths with similar high regression explanatory powers, except for the growth of agriculture sector. Secondly, as the sum of the impacts of each independent variable on three sector shares should be equal to zero, we determine the factors that cause the structural shift of the three sectors and industrialization through the regressions with the three sector shares as the dependent variables.

Our empirical results on output growth are in line with the current growth empirics, both economic policy and non-policy variables are important for output growth. Among the different categories of variables, the non-policy variables are having similar impact on industrialization as economic policy do. Although the overall impacts of the variables in each category are significant as evidenced by the increase in the adjusted R-square, the impacts of each individual variable are more scattered. Some variables have clear impact on the trend of sector shifts and other variables do not. The impact in the growth of economic sectors has less uniform conclusions. The institutional and geographical variables have higher impacts on the agriculture growth than economic policy variables and human rights variables do. This probably implies that agriculture sector is a fading sector. Each of the three categories has similar impact on the growth of industrial sector; the human rights variables have less impact on the growth of service sector than other two categories variables do. In general, as more variables from each additional category are included in the regression analysis, the adjusted R-squares improved.

The overall contribution of this paper is that we use Growth Identity Equation to establish a theoretical link between economic growth and industrialization. Our empirical results not only support this theoretic finding, but also provide some insights on the variables that cause industrialization.

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Table 1 Growth Identity Equation

	N	Number of Countries	Total Output Growth	Fitted Output Growth*	A/GDP	I/GDP	S/GDP	Agricul. Growth	Industry Growth	Service Growth
1970−2010										
All	4989	165	2.07	2.07	17.81	29.96	52.22	0.00	2.74	3.37
LI	1422	62	1.31	1.31	36.04	22.80	41.15	0.65	3.51	2.97
LM	1394	105	2.72	2.72	18.04	31.65	50.31	0.59	3.90	4.23
UMH	2173	98	2.15	2.15	5.74	33.58	60.69	-0.80	1.48	3.08
1987−2010										
All	3656	165	2.16	2.16	16.44	29.34	54.22	-0.15	2.88	3.52
LI	1097	63	1.91	1.91	34.28	23.67	42.04	1.35	4.06	3.47
LM	1038	92	2.35	2.35	15.10	32.37	52.54	-0.11	3.43	4.45
UM	683	67	2.60	2.60	6.53	32.76	60.71	-0.83	2.12	3.62
HI	838	49	1.89	1.89	2.83	30.22	66.95	-1.59	1.26	2.35

Notes: * The fitted output growth is the average for the sum of the right-hand side of Equation (4). With the exception of N and the numbers of countries, all entries are expressed in percentages. The income group classification based on the World Bank divides countries into three groups before 1987 and four groups since 1987. LI is for low income group; LM is for lower-middle income group; UMH is for upper-middle or high income groups; UM is for upper-middle income group; HI is for high income group.

Table 2 Cross-Country Regressions with Solow Variables (1970-2010)

	Output Growth	A/GDP	I/GDP	S/GDP	Agriculture Growth	Industry Growth	Service Growth
GDI	0.176***	-0.440*	0.400**	0.041	0.022	0.334*	0.343
	(0.04)	(0.17)	(0.13)	(0.16)	(0.04)	(0.15)	(0.21)
Education	0.015	-0.102	0.013	0.089	-0.016	-0.017	-0.031
	(0.01)	(0.06)	(0.06)	(0.07)	(0.02)	(0.02)	(0.03)
Population	-0.096	-0.224	0.768	-0.548	0.369	0.286	-0.352
	(0.15)	(0.84)	(1.13)	(0.92)	(0.31)	(0.30)	(0.26)
Initial GDP	-0.637**	-6.503***	2.929*	3.582*	-0.380	-0.661	-0.202
	(0.19)	(1.17)	(1.38)	(1.59)	(0.36)	(0.43)	(0.45)
$\bar{R}^2$	0.384	0.622	0.166	0.287	0.117	0.215	0.160
F-Stat	13.088	65.834	9.520	22.460	7.958	5.437	4.114
N	164	164	164	164	164	164	164

Notes: The numbers in parenthesis are robust standard errors. The superscripts *, **, and *** denote the significance with the 5%, 1%, and 0.1% levels, respectively.

Table 3 Cross-Country Regressions: Including Policy and Demographic Variables (1970-2010)

	Output Growth	A/GDP	I/GDP	S/GDP	Agriculture Growth	Industry Growth	Service Growth
GDI	0.151***	-0.246	0.578***	-0.317*	0.053	0.350**	0.275
	(0.05)	(0.13)	(0.15)	(0.14)	(0.04)	(0.12)	(0.18)
Education	-0.007	0.043	0.007	-0.025	-0.013	-0.005	-0.033
	(0.01)	(0.05)	(0.05)	(0.06)	(0.02)	(0.02)	(0.03)
Population	-0.045	-0.529	-0.792	0.819	0.312	0.176	-0.298
	(0.13)	(0.68)	(1.12)	(0.83)	(0.30)	(0.28)	(0.30)
Initial GDP	-0.975***	-4.030***	1.940	2.670	-0.393	-0.626	-0.156
	(0.21)	(1.05)	(1.36)	(1.51)	(0.38)	(0.40)	(0.46)
Export	0.007	-0.069*	0.316*	-0.208**		0.088*	
	(0.00)	(0.03)	(0.12)	(0.08)		(0.04)	
Import			-0.336*	0.310***	-0.018	-0.129**	
			(0.13)	(0.08)	(0.01)	(0.05)	
FDI			-0.066			0.428**	0.317
			(0.04)			(0.16)	(0.18)
Portfolio						-0.170**	-0.121
						(0.06)	(0.07)
Credit	0.010*	-0.066***	-0.062**	0.117***			
	(0.00)	(0.02)	(0.02)	(0.03)			
Inflation				-0.017*			
				(0.01)			
Dev. Aid		0.457**	-0.281			0.217*	
		(0.14)	(0.16)			(0.09)	
Life	0.097***		-0.579*	0.483***			
	(0.03)		(0.23)	(0.14)			
Mortality		0.068**	-0.069*				
		(0.02)	(0.03)				
$\bar{R}^2$	0.495	0.740	0.384	0.530	0.146	0.409	0.248
$\Delta\,\bar{R}^2$	0.111	0.118	0.218	0.243	0.029	0.194	0.088
F-Stat	19.154	52.232	14.653	34.292	7.310	4.186	3.727
DF	7	8	11	9	5	9	6
N	161	161	161	161	161	161	161

*Note*s: The numbers in parenthesis are robust standard errors. The superscripts *, **, and *** denote the significance with the 5%, 1%, and 0.1% levels, respectively. The four Solow variables, GDI, Education, Population, and Initial GDP, are included in all regressions. For all other variables, the variables with significance level less than 10% are dropped in the final estimated equation. $\Delta\bar{R}^2$ is the difference of the $\bar{R}^2$ in this table and the $\bar{R}^2$ in the previous table.

Table 4 Summary of the Regressions with All Independent Variables

Variables	Total Output Growth	Sector Shift, Share	Sector Growth
Solow	GDI: ↑ Initial GDP: ↓	GDI: A&S→I Population: S↑ Initial GDP: A→S	GDI: A↑, I & S ↑ Education: I ↓ Population: I & S ↓ Initial GDP: I ↑
Policy	Trade: ↑ FDI:↑ Portfolio: ↓	Export: A→I Import: I→S FDI: S↑ Portfolio: I ↓ Credit: A→S Inflation: I ↑ Aid: I→A	Trade: I & S ↑ FDI: I & S ↑ Portfolio: I & S↓ Credit: I ↓ Aid: S ↑
Demographic	Fertility: ↓ Mortality: ↑	Life expectancy: I→A&S Fertility: I ↓ Mortality: I→A	Fertility: S ↑
Geographic	E.Europe&C.Asia: ↑ M-East&N-Africa: ↑ Sub-Sahara: ↓ Latin America: ↓ Trans. Economies:↓ Latitude: ↑ Tropical: ↑ Landlocked: ↓	E.Asia & Pacific: A&S→I S. Asia: A ↓ Sub-Sahara: A ↓ N. America: I ↑ L. America: S ↓ Latitude: A→I Landlocked: S→I	E. Europe & C.Asia: I&S↑ Sub-Sahara: I&S ↓ Latin America: I&S ↓ Trans. Economies: A&I ↓ Latitude: A ↓ Tropical: S ↑ Landlocked: S ↓
Institutional	Catholic: ↑ Legal-Scandi: ↑ Regulation: ↑ Frac_Ethnic: ↓ Frac_Religion: ↑ Fuel Export: ↓	Catholic: S→I Muslim: I→A Legal-French: A→I&S Regulation: I→A Frac_Ethnic: A↓ Frac_Language: I→A&S Fuel Export: A&S→I	Catholic: S ↑ Muslim: S ↓ Legal-French: S ↓ Legal-German: S ↓ Legal-Socialist: A ↑, S ↓ Political Rights: I ↑ Property Rights: S ↑ Frac_Ethnic: S ↓ Fuel Export: I & S ↓
Human Rights	Speech: ↓ Election: Mixed Worker Rights: ↓ Women Econ: ↓ Women Political: ↑ Physical Integrity: ↑↓	Speech: I→A Religion Freedom: A↓ Independent Juridical: A→I Election: I↓ Domestic Freedom: I→S Foreign Freedom: I→A Worker Rights: I→A Women Econ: S↓ Women Political: A→S Physical Integrity: S→I	Speech: I & S↓ Religion Freedom: I Indep. Judiciary: I & S↓ Election: I & S ↓ Assembly: A ↑ Domestic Freedom: A↓ Foreign Freedom: S↑ Worker Rights: S↓ Women Econ: A & I & S↓ Women Political: I & S ↑ Physical Integrity: I & S↑↓

Notes: Base groups used are: Region: West Europe; Religion: Others; Legal origin: British; Export category: Export of others

Appendix

Table A1 Variable Descriptions and Sources

Variable	Description	Source
RGDP	Real per capita GDP	PWT 8.0
GDI	Gross capital formation (% of GDP)	World Bank
Education	School enrollment, secondary (% gross)	World Bank
Population	Population growth (annual %)	World Bank
Initial GDP	Initial Real GDP	
Export	Exports of goods and services (% of GDP)	World Bank
Import	Imports of goods and services (% of GDP)	World Bank
FDI	Foreign direct investment, net inflows (% of GDP)	World Bank
Portfolio	Portfolio equity, net inflows (% of GDP)	World Bank
Credit	Domestic credit to private sector (% of GDP)	World Bank
Inflation	Inflation, GDP deflator (annual %)	World Bank
Dev. Aid	Net official development assistance and official aid received (% of GDP)	World Bank
CO2	CO2 emissions (metric tons per capita)	World Bank
Life	Life expectancy at birth, total (years)	World Bank
Fertility	Fertility rate, total (births per woman)	World Bank
Mortality	Mortality rate, under-5 (per 1,000 live births)	World Bank
E-Asia & Pacific	region: East Asia and Pacific	Global Development Network
South Asia	region: South Asia	Global Development Network
E-Europe & Cent-Asia	region: East Europe and Central Asia	Global Development Network
West Europe	region: West Europe	Global Development Network
Mid-East & N-Africa	region: Middle East and North Africa	Global Development Network
Sub-Sahara	region: Sub Sahara Africa	Global Development Network
North America	region: North America	Global Development Network
Latin America	region: Latin America and Caribbean	Global Development Network
Tropical	tropical	Global Development Network
Transi Econ	Transition Economies	Global Development Network
Latitude	Abs(latitude of capital)/90	LaPorta JLEO 1999
Landlocked	landlocked	Global Development Network
Area	area	Global Development Network
Catholic	Catholic as %pop 1980 wce95	LaPorta JLEO 1999
Muslim	Muslims as % pop 1980 wce95	LaPorta JLEO 1999
Protestants	Protestants &MgProtestantsin1980	LaPorta JLEO 1999
No_cpm80	100-Cath-Protest-Muslim in 1980	LaPorta JLEO 1999
Legal-British	legal origin: British	Global Development Network
Legal-French	legal origin: French	Global Development Network
Legal-German	legal origin: German	Global Development Network

Legal-Scandi	legal origin: Scandinavian	Global Development Network
Legal-Socialist	legal origin: Socialist	Global Development Network
Ex_Manuf	exporters of manufactures	Global Development Network
Ex_NonFuel	exporters of nonfuel primary products	Global Development Network
Ex_Fuels	exporters of fuels (mainly oil)	Global Development Network
Ex_Services	exporters of services	Global Development Network
Ex_Diversified	diversified exporters	Global Development Network
Ex_Other	not classified by export category	Global Development Network
Political Rts	Political Rights index (FW96)	LaPorta JLEO 1999
Property Rts	Property rights index	LaPorta JLEO 1999
Regulation	Regulation business Index	LaPorta JLEO 1999
Frac_Ethnic	Fractionalization ethnic	Alesina JEG 2003
Frac_Language	Fractionalization language	Alesina JEG 2003
Frac_Religion	Fractionalization religion	Alesina JEG 2003
Speech (2)	Freedom of Speech	Human Rights Dataset
Reli Free (2)	Freedom of Religion	Human Rights Dataset
Ind. Jud (2)	Independence of the Judiciary	Human Rights Dataset
Elec. Self (2)	Electoral Self-Determination	Human Rights Dataset
Assembly (2)	Freedom of Assembly and Association	Human Rights Dataset
Dom. Movement (2)	Freedom of Domestic Movement	Human Rights Dataset
For. Movement (2)	Freedom of Foreign Movement	Human Rights Dataset
Worker's Rights (2)	Worker's Rights	Human Rights Dataset
Women economic (3)	Women's Economic Right	Human Rights Dataset
Women social (3)	Women's Social Rights	Human Rights Dataset
Torture	Torture	Human Rights Dataset
Killing	Extrajudicial Killing	Human Rights Dataset
Political imprison	Political Imprisonment	Human Rights Dataset
Disappearance	Disappearance	Human Rights Dataset
Physical Rights (8)	Physical Integrity Rights Index	Human Rights Dataset

Notes: For the regional variables, the dummy variables are created for each region with the West Europe excluded from the regression as the base. For legal origin variables, the British origin is excluded from the regression as the base. For the export category, not classified by export category is excluded from the regression. The dummy variables are created for each human right variable as these variables are indicators with the values of 0, 1, 2, … The higher value indicates a higher level of human right. The numbers in the parentheses are the highest value of the indicator. The dummy variable with the indicator of zero is excluded from the regression.

Table A2 Cross-Country Regressions: Adding Institutional and Geographical Variables (1970-2010)

	Output Growth	A/GDP	I/GDP	S/GDP	Agriculture Growth	Industry Growth	Service Growth
GDI	0.128***	-0.416***	0.558**	-0.291	-0.029	0.302*	0.404*
	(0.03)	(0.11)	(0.19)	(0.16)	(0.04)	(0.12)	(0.17)
Education	-0.000	-0.024	0.034	0.035	-0.009	-0.047*	-0.028
	(0.01)	(0.04)	(0.05)	(0.06)	(0.02)	(0.02)	(0.02)
Population	0.039	-1.520*	2.083	-0.015	0.038	0.294	0.450
	(0.18)	(0.71)	(1.18)	(0.98)	(0.37)	(0.43)	(0.55)
Initial GDP	-1.058***	-4.165***	-1.122	4.391**	0.342	-0.126	0.009
	(0.17)	(1.05)	(1.70)	(1.62)	(0.57)	(0.54)	(0.49)
Export	0.048***	-0.087***	0.293**	-0.192*		0.065*	
	(0.01)	(0.02)	(0.09)	(0.08)		(0.03)	
Import	-0.059***		-0.287**	0.295**		-0.132**	-0.058*
	(0.01)		(0.10)	(0.09)		(0.05)	(0.03)
FDI	0.273**					0.918**	0.820*
	(0.08)					(0.27)	(0.34)
Portfolio	-0.104**		-0.035*			-0.366***	-0.306*
	(0.03)		(0.01)			(0.11)	(0.13)
Credit		-0.076***		0.140***		-0.028*	
		(0.02)		(0.03)		(0.01)	
Inflation		-0.015*	0.022**				
		(0.01)	(0.01)				
Dev. Aid		0.449**	-0.260*				
		(0.15)	(0.12)				
CO2						0.163	
						(0.10)	
Life		0.748**	-0.864***				
		(0.24)	(0.24)				
Mortality		0.136***	-0.132***		0.021		0.043*
		(0.03)	(0.03)		(0.01)		(0.02)
E-Asia & Pacific	-0.897*				1.807*		-2.779*
	(0.39)				(0.80)		(1.26)
South Asia	-1.116*			6.109**	1.756*		
	(0.46)			(2.21)	(0.81)		
E-Europe & Cen-Asia	0.927**				-2.737*		
	(0.34)				(1.10)		
Mid-East N-Africa					1.958*		
					(0.75)		
Sub-Sahara	-1.737***	-5.148		7.290*		-1.643	-3.644**
	(0.44)	(2.95)		(2.84)		(0.87)	(1.37)
Latin America	-0.669*	-4.663**		9.459***	1.406*	-1.238	-2.300*
	(0.27)	(1.59)		(1.91)	(0.59)	(0.67)	(0.97)
Transi. Econ	-3.108***					-5.515**	
	(0.72)					(1.65)	
Latitude			14.444**				
			(5.49)				
Landlocked			4.270*	-4.573**			-3.071*
			(1.77)	(1.65)			(1.21)

Area	-0.728				1.546		
	(0.40)				(0.87)		
Muslim		-0.052*					-0.059**
		(0.02)					(0.02)
Protestants		-0.055**		0.114*	0.020*		
		(0.02)		(0.05)	(0.01)		
Legal-French		-5.107***	4.397**				
		(1.20)	(1.55)				
Legal-Sandi				-9.221*			
				(4.32)			
Legal-Socialist					2.563*		
					(1.00)		
Ex_Manuf	0.952**		-13.954**	5.063*		5.413**	
	(0.34)		(4.29)	(2.36)		(1.91)	
Ex_NonFuel		5.040***	-15.100***			4.367*	
		(1.48)	(3.64)			(1.72)	
Ex_Services			-13.952**	4.821		4.595*	
			(5.03)	(2.82)		(1.86)	
Ex_Diversified	0.465*		-12.350**	4.494**		4.352**	
	(0.19)		(3.92)	(1.70)		(1.60)	
Political Rts		-1.070**					-0.533*
		(0.39)					(0.26)
Property Rts		-1.844**	1.849*			-0.630*	1.081*
		(0.64)	(0.84)			(0.28)	(0.51)
Regulation		2.246**	-2.812**				
		(0.75)	(1.03)				
Frac_Ethnic	-1.899***					-2.039	-3.842*
	(0.50)					(1.14)	(1.56)
Frac_Language		6.638**	-9.609**				
		(2.27)	(2.87)				
Frac_Religion	0.961*		6.007	-10.500*			
	(0.46)		(3.19)	(4.34)			
$\bar{R}^2$	0.649	0.840	0.575	0.682	0.269	0.555	0.532
$\Delta\,\bar{R}^2$	0.154	0.100	0.191	0.152	0.123	0.146	0.284
F-Stat	.	34.434	13.405	25.449	6.319	4.205	3.107
DF	18	20	22	17	13	19	16
N	124	124	124	124	124	124	124

Note: See notes in Table 3.

Table A3 Cross-Country Regressions: Adding Human Rights Variables (1970-2010)

	Output Growth	A/GDP	I/GDP	S/GDP	Agriculture Growth	Industry Growth	Services Growth
GDI	0.104***	-0.349***	0.541***	-0.332**	-0.042	0.264***	0.534***
	(0.02)	(0.07)	(0.14)	(0.12)	(0.04)	(0.06)	(0.12)
Education	-0.008	-0.060	-0.075	0.069	-0.017	-0.053**	-0.022
	(0.01)	(0.03)	(0.05)	(0.04)	(0.02)	(0.02)	(0.02)
Population	0.134	-0.972	1.175	3.973***	0.099	-1.038*	-1.175*
	(0.25)	(0.66)	(1.35)	(0.76)	(0.32)	(0.41)	(0.50)
Initial GDP	-0.528**	-3.559***	-0.179	4.338**	0.066	1.451**	0.930
	(0.18)	(0.73)	(1.36)	(1.34)	(0.42)	(0.50)	(0.59)
Export	0.032**	-0.142***	0.240***			0.057**	0.075
	(0.01)	(0.02)	(0.06)			(0.02)	(0.04)
Import	-0.042**		-0.202**	0.119***		-0.093***	-0.144**
	(0.01)		(0.07)	(0.03)		(0.02)	(0.05)
FDI	0.215***			0.105**		0.598***	0.652**
	(0.06)			(0.03)		(0.16)	(0.21)
Portfolio	-0.080***		-0.054***			-0.243***	-0.244**
	(0.02)		(0.01)			(0.06)	(0.08)
Credit		-0.050***		0.040*		-0.022*	
		(0.01)		(0.02)		(0.01)	
Inflation			0.021*				
			(0.01)				
Dev. Aid		0.280**	-0.300**				0.161*
		(0.10)	(0.10)				(0.08)
Life		0.365*	-0.675**	0.222*			
		(0.17)	(0.21)	(0.11)			
Fertility	-0.710**		-2.997*				
	(0.25)		(1.44)				
Mortality	0.011**	0.082***	-0.072*				0.050***
	(0.00)	(0.02)	(0.03)				(0.01)
E-Asia & Pacific		-6.698**	7.699***	-5.185**			-2.257
		(2.07)	(2.08)	(1.84)			(1.32)
South Asia		-5.499*					
		(2.67)					
E-Europe & Cen-Asia	1.771***					3.791**	2.524
	(0.46)					(1.12)	(1.41)
Mid-East N-Africa	0.743*						
	(0.32)						
Sub-Sahara	-1.947***	-5.510				-3.637***	-5.973***
	(0.45)	(2.84)				(0.70)	(1.53)
North America			7.155**				
			(2.36)				
Latin America	-0.793**	-7.609**				-2.605***	-2.788*
	(0.30)	(2.41)				(0.74)	(1.09)
Transi. Econ	-3.404***				-5.745***	-8.800***	
	(0.66)				(1.22)	(1.78)	
Latitude	2.176	-31.536***	14.212**			-9.481***	
	(1.29)	(6.11)	(5.15)			(2.48)	

Tropical	1.417***					3.708**
	(0.40)					(1.10)
Landlocked	-0.567*		4.539**	-4.356***		-3.384***
	(0.24)		(1.36)	(1.21)		(0.89)
Catholic	0.007*		0.051*	-0.086***		0.017
	(0.00)		(0.02)	(0.02)		(0.01)
Muslim		-0.093***	0.082**			-0.056**
		(0.02)	(0.02)			(0.02)
Legal-French		-4.656***	3.229*	3.599**		-1.459*
		(1.02)	(1.28)	(1.25)		(0.67)
Legal-German						-3.410*
						(1.35)
Legal-Sandi	1.337*				3.323**	
	(0.51)				(1.14)	
Legal-Socialist		7.112**			3.828***	-6.164**
		(2.26)			(0.89)	(2.05)
Ex_Fuel	-0.955	-8.399***	16.495***	-6.680*	-5.666***	-4.385*
	(0.50)	(1.54)	(3.02)	(3.06)	(1.36)	(1.77)
Ex_NonFuel		2.430*				
		(1.12)				
Political Rts					0.401*	
					(0.19)	
Property Rts						0.820*
						(0.36)
Regulation	0.242	1.987**	-1.679*			
	(0.13)	(0.61)	(0.80)			
Frac_Ethnic	-1.573***	-5.623*				-4.404***
	(0.43)	(2.32)				(1.25)
Frac_Languag		8.544***	-12.365***	4.979*		
		(2.12)	(2.00)	(2.13)		
Frac_Religion	1.585***					
	(0.46)					
Speech_d1		-15.219***	15.623***			-5.120*
		(3.12)	(4.19)			(2.19)
Speech_d2	-2.398***	-10.417*	12.024*		-5.890***	-8.615**
	(0.62)	(4.51)	(4.87)		(1.40)	(2.93)
Reli. Free_d1		-6.135*			2.770	5.572***
		(2.41)			(1.41)	(1.46)
Reli. Free_d2		-7.772**			3.942**	
		(2.42)			(1.28)	
Ind. Jud_d1			8.466**		-3.840**	-5.797***
			(2.89)		(1.36)	(1.63)
Ind. Jud_d2		-11.481***	18.308***		-4.361**	-4.511*
		(2.61)	(3.64)		(1.46)	(2.03)
Elec. Self_d1	-2.491***		-10.740*		-8.547***	-6.123***
	(0.55)		(4.55)		(1.57)	(1.71)
Elec. Self_d2	1.357*		-8.913			
	(0.60)		(5.11)			
Assembly_d1				2.693*		
				(1.27)		

Assembly_d2					3.251*		
					(1.42)		
Dome. Mov_d1			-5.025	14.296***	-3.385*		
			(2.74)	(3.87)	(1.55)		
Dome. Mov_d2				11.311**	-3.875*		
				(3.44)	(1.84)		
For. Mov_d1		9.207***	6.539	-20.325***			
		(2.56)	(3.94)	(3.31)			
For. Mov_d2		10.845***	-7.733*				3.847*
		(2.34)	(3.15)				(1.47)
Worker Rts_d1		6.428*					
		(2.61)					
Worker Rts_d2	-1.217*	14.503***	-7.757**				-2.853
	(0.48)	(3.35)	(2.88)				(1.46)
Wom. Econ_d1	-2.702***			-12.570***		-5.256**	-3.373
	(0.79)			(3.56)		(1.58)	(1.77)
Wom. Econ_d2	-4.262***		-7.566**	-9.105*	-2.619**	-7.785***	-9.119***
	(0.90)		(2.62)	(3.98)	(0.94)	(1.82)	(2.29)
Wom. Econ_d3	-2.469*			-34.135***			
	(1.21)			(9.28)			
Wom. Pol_d1	4.890***		-10.767***	36.757***		7.167***	8.172**
	(1.23)		(2.61)	(8.74)		(1.85)	(2.50)
Wom. Pol_d2	4.028**	-10.108***		36.716***		4.546**	4.452*
	(1.23)	(1.84)		(9.05)		(1.53)	(1.74)
Wom. Pol_d3	2.711	-11.482***		45.725***			
	(1.37)	(3.09)		(10.38)			
Phys. Int_d1	-5.450***					-9.488***	-7.484
	(1.11)					(2.55)	(4.14)
Phys. Int_d2		6.895	17.511**	-26.232***			19.934***
		(3.67)	(6.23)	(6.59)			(5.04)
Phys. Int_d3	2.832*			-12.848*		12.853***	
	(1.25)			(6.18)		(2.99)	
Phys. Int_d4	-2.965***	-8.588**		11.506***		-3.369	
	(0.81)	(2.83)		(3.32)		(1.96)	
Phys. Int_d5			20.051***	-21.331***			7.609*
			(4.55)	(5.45)			(3.67)
Phys. Int_d6							5.366
							(2.73)
Phys. Int_d7							8.052***
							(2.25)
Phys. Int_d8		7.502**	9.667*	-13.332***			7.553*
		(2.64)	(4.22)	(3.83)			(2.91)
$\bar{R}^2$	0.782	0.919	0.743	0.810	0.304	0.752	0.739
$\Delta\ \bar{R}^2$	0.133	0.079	0.173	0.128	0.036	0.197	0.207
F-Stat	.	69.854	21.123	64.130	7.607	.	4.846
DF	36	36	37	28	11	29	42
N	123	123	123	123	123	123	123

Note: See notes in Table 3.