ABSTRACT

To identify the effect of competition law on productivity growth, this article conducts a cross-country study using a sample of 101 countries that enforce competition law. The evidence shows that the effect exhibits an asymmetrical pattern depending on the stage of development of each country. For the poor less developed countries (LDCs) whose institutional frameworks cannot exceed a threshold level, competition law has a very limited effect on changing economic activity, and its legislation is neither harmful nor helpful in terms of market competition or economic growth. As to the developed countries (DCs) and middle-income LDCs, although their institutional frameworks have passed the threshold level, the effect of competition law on growth still depends on the law enforcement efficiency of the government. Without an efficient enforcement scheme, a stronger competition law not only cannot support productivity growth, but might also slow down the potential path of growth.

JEL: K210

I. INTRODUCTION

The relationship between competition law and economic growth is controversial in economic theory. Although there have been plenty of studies regarding the impact of competition law on country performance, such as productivity growth and price stability, the results obtained are somewhat ambiguous. For instance, Aghion and Howitt and Aghion, Bloom, Blundell, Griffith, and Howitt picked up Schumpeter's argument and suggested that a successful innovation is motivated by the prospect of monopoly rents that can be captured. However, those rents in turn will be destroyed by the next innovation such that there is no scope for competition law to correct market failure. Empirically, the survey paper of Crandall and Winston also points out that there is little evidence to show that past interventions of

* Professor, Department of Economics, Chinese Culture University. E-mail: tcma1234@gmail.com.

competition agencies have been of much direct benefit to economic growth.² Besides, until very recently, the four fastest-growing economies in the world (China, India, Hong Kong, and Singapore) had even no antitrust enforcement to safeguard market competition.³ Thus, it might be possible to secure effective competition and economic growth through sound institutions (such as deregulation, liberalization, or a high degree of economic freedom), without actually having a competition law.

In the real world, however, more than 100 countries have established competition law regimes. Numerous textbooks highlight the importance of market competition and argue that competition law can secure competition against market failures such as monopoly or unfair competition. In addition, there has been a growing empirical literature that provides support for the theories of competition law advocates. These studies find a high correlation between competition law and performance measured in terms of the growth of gross domestic product (GDP)⁴ or the level of total factor productivity.⁵

The weak side of this line of study is the lack of useful statistical information on the scope or intensity of competition law, such that its approach cannot objectively identify the causality between law and growth. Auspiciously, this quandary has recently been settled through various comprehensive reviews of competition laws in respective countries. These reviews construct a series of indicators on various aspects of competition law and hence make competition policies comparable across countries. For instance, Voigt, Lee and Hoekman, Hylton and Deng, and Nicholson constructed survey-based measures of competition law and provide considerably more quantitative information on the law’s scope and intensity⁶ than is

³ China had only “Price Law” and “Countering Unfair Competition Law” to regulate certain anticompetitive business practices, such as dominance abuses and price setting. Its comprehensive competition law was not fully enforced until 2008. The same situation is also observed in India and Singapore. Furthermore, Hong Kong does not yet enforce its competition law.
possible with the traditional dummy variable approach.\textsuperscript{7} This information allows us to compare competition law regimes around the world based on a fixed metric.

Thus, in this article, I simply let the data speak for themselves and use a regression to identify whether competition law has any discernible effect on economic growth. My approach differs from the previous literature in three respects. First, most of the literature deals with this issue without a generally agreed-upon theoretical basis regarding the transmission mechanisms through which competition law can have an effect on economic growth. In contrast, the framework of this article is based on a standard Solow growth model in which one can hypothetically identify the role of competition law in growth.\textsuperscript{8} This approach allows the empirical evidence to be based on persuasive theoretical foundations.

Second, the earlier literature investigates the effect of competition legislation on growth by assuming that all countries adhere to a common linear model. However, Baumol\textsuperscript{9} examined the growth performances of some 60 capitalist economies for the period from 1950 to 1980 and concluded that there were several different groups at different stages of development. He observed that economic activities within the rich group are quite different from those within the poor group. Abramovitz observed a similar trend, putting forward a variety of technological or institutional factors to explain this asymmetry.\textsuperscript{10} Based on these arguments, I focus here on a stylized version of the Baumol-Abramovitz hypothesis, which is as follows: The less developed countries (LDCs) introduce competition laws far later than the developed countries (DCs). This lag in introduction of competition laws gives the LDCs an advantage of being backward in that it enables them to catch up through technology transfers and a learning effect (that is, the spread of ready-made competition law expertise). However, the capacity of LDCs to benefit from such technology spillovers depends on their

\textsuperscript{7} The conventional approach generally uses dummy variables to identify the effect of competition law on growth. The dummies indicate whether the country has a competition law.


\textsuperscript{9} William J. Baumol, Productivity Growth, Convergence and Welfare: What the Long-Run Data Show, 76 AM. ECON. REV. 1072 (1986).

\textsuperscript{10} Moses Abramovitz, Catching Up, Forging Ahead and Falling Behind, 46 J. ECON. HIST. 385 (1986).
governmental efficiency and on whether they can pass a threshold level of infrastructural development. In this article, I emphasize that there is a threshold that seems to limit the ability of LDCs to benefit from the spillover of competition law from DCs. Economies below this threshold, with an undeveloped socioeconomic framework are unable to follow—let alone catch up with—innovations within the law, and therefore languish in the wake of the high productivity economies.

Third, this article uses a battery of robust tests, ranging from whether the results are robust to the estimation method to the inclusion or exclusion of other determinants of growth, as well as to the removal of outlier observations. Again and again, the regression estimates suggest that the higher the enforcement efficiency, the more powerful are the effects of competition law on growth. A country’s competition legislation can provide only the preconditions for intense competition but not the intense competition itself. The competition legislation’s success or failure depends on the competition culture shaped by the country’s socioeconomic ideology and institutional framework.

The remainder of this article is organized in the following manner. Part II describes the state of competition legislation and its enforcement in developing countries. Part III describes the article’s empirical strategy. Part IV presents the empirical results. Part V investigates the robustness of the empirical results. Finally, Part VI concludes the article.

II. EFFECTIVE ENFORCEMENT OF COMPETITION LAW

A. Implementation of Competition Legislation

In LDCs, the implementation of competition legislation has a relatively short history. Table 1-1 indicates that the number of LDCs that have enforced competition law has grown exponentially since the 1990s. Nevertheless, establishing a law does not necessarily imply that it will be enforced effectively and sensibly, especially in a developing country setting.

B. Infrastructure and Law Enforcement

To enforce the competition law effectively, an appropriate regulatory framework needs to be put in place in order to support the process of change. However, Gal indicated that LDCs are generally faced with a low level of institutional infrastructure that is accompanied by a socioeconomic ideology

11 The reason for this accelerating trend is partly attributed to the view that former centrally planned economies in Central and Eastern Europe introduced comprehensive programs of investment liberalization, deregulation, privatization, and competition law in the 1990s.
directed against competition law.\textsuperscript{12} Gal’s argument can be justified on the basis of the following two points. First, competition law is not a stand-alone regulatory tool, but is part of a wider set of public policies in pursuit of economic growth. As such, it needs to be in conformity with the existing socioeconomic infrastructure and other policies already implemented. Its success or failure depends on the competition culture shaped by the socioeconomic ideology and institutional framework. Krakowski also indicated that some poor LDCs or those in the early stages of economic development have had antitrust laws for several decades, but until recently none appeared to have been regularly enforced to secure the market competition.\textsuperscript{13} Both Gal and Krakowski believe that, in these poor LDCs, competition law is in conflict with the existing socioeconomic ideology and hence does not receive full and consistent support from the enforcing government or socioeconomic infrastructure. Without a supporting framework to ensure its effective enforcement, competition legislation itself is neither harmful nor helpful in terms of market competition and economic growth.\textsuperscript{14} Thus, competition law has a

\begin{table}
\caption{Data description: Number of LDCs that have adopted competition law}
\begin{center}
\begin{tabular}{lccccccc}
\hline
\hline
Asia/Pacific & 0 & 0 & 2 & 2 & 2 & 14 & 20 \\
Central/Eastern Europe & 0 & 0 & 0 & 1 & 16 & 17 & 17 \\
Latin America & 1 & 2 & 1 & 10 & 6 & 11 & 14 \\
Africa & 0 & 1 & 0 & 2 & 14 & 18 & 18 \\
Total & 1 & 3 & 3 & 4 & 5 & 50 & 66 \\
\hline
\end{tabular}
\end{center}
\end{table}

\textsuperscript{12} Michal Gal, \textit{The Ecology of Antitrust Preconditions for Competition Law Enforcement in Developing Countries, in Competition, Competitiveness and Development: Lessons from Developing Countries} 20 (UNCTAD 2004).


\textsuperscript{14} Gal used the experience of Israel as an example to illustrate the fact that the law alone has no effect on changing economic activity. The Israeli Competition Act dates back to 1959, only 11 years after the country was established, at a time when it faced an inflexible economy that was characterized by low elasticity of substitution among both commodities and factors, and that responded only slowly to market signals. This kind of market failure not only rendered the economy incapable of allocating resources efficiently, but also gave rise to a chronic balance of payments deficit. Under such a disequilibrium, there existed the potential for government intervention to serve as a means of correcting the external diseconomies by reallocating resources to sectors with high productivity. To do so, the Israeli government adopted a highly interventional policy that regulated almost all aspects of economic activity. Thus, the intervention played a crucial role in determining the resource allocation, and the government held the reins of the market through various forms of import restrictions, licensing restrictions, investment permits, and administrative guidance. As prices were
very limited effect on changing economic activity if the socioeconomic framework does not exceed a threshold level.

Second, this article emphasizes that the effectiveness of competition law is mainly determined by the ability of government to enforce the law. Such ability determines whether appropriate measures are implemented to ensure that the law is workable and its enforcement is credible. Although some middle-income LDCs have passed the threshold level and their competition law has become conformable to the socioeconomic infrastructure, the mere adoption of a competition law is only a necessary—but not sufficient condition—for it to ensure that market competition exists. To achieve the final goal, one still needs high governmental efficiency of the enforcing bodies to limit anticompetitive conduct. Nevertheless, the competence and credibility of the enforcing agency are highly dependent on the existence of adequate human and financial resources for monitoring, detecting, and proving violations so as to apply the law effectively. A staff of sufficient size with adequate professional expertise is especially important in the area of competition law, which often involves high-level economic analysis that complements legal analysis in order to detect and investigate the effects of business conduct. A lack of such governmental efficiency may lead to under-enforcement of the law.

However, most LDCs lack this kind of governmental efficiency in enforcing competition laws. They often face practical difficulties such as incompetent judicial systems, a lack of economists and lawyers familiar with competition law, a lack of transparency, and even corruption. They can only begin their learning process after the enforcement of the law. It is thus clear that competition law, of the kind known and accepted in most developed economies, can bloom only in a society with effective law enforcement. Competition legislation alone does not necessarily lead to more competitive markets. This argument is supported by the experiences of the United States in the twentieth century, when the nation first enforced competition law and lacked personnel experienced in the application of this type of law. Crandall and Winston have investigated several landmark antitrust cases during that time period and found that the enforcement of competition law might have even weakened competition and resulted in an efficiency loss,15 because the enforcing agencies were still in the process of learning and could

15 Crandall & Winston, supra note 2.
not effectively distinguish conduct that was procompetitive from that which was anticompetitive.\textsuperscript{16}

C. Asymmetry of Effects on Growth

Based on the previous argument, this article classifies the sample of countries into a rich group and a poor group according to their socioeconomic infrastructure.\textsuperscript{17} First consider the \textit{Poor Group}. In poor LDCs that fail to exceed the threshold level, the governments do not really want to enforce the law, since the law conflicts with the existing socioeconomic ideology. Competition law has a very limited effect on changing economic activity, and its legislation is neither harmful nor helpful in terms of economic growth. Second, there is the \textit{Rich Group} of middle-income LDCs and DCs. As to the middle-income LDCs and DCs, although their institutional frameworks have passed the threshold level, the effect of competition law on growth still depends on the law enforcement efficiency of the government. The higher the enforcement efficiency is, the more positive the effect of competition law will be. Enforcing competition law without effective investigatory powers can only worsen economic growth.

III. EMPIRICAL SPECIFICATION

A. Solow Growth Model

The empirical specification is a simplified version of the Solow growth model developed by Mankiw, Romer, and Weil in 1992,\textsuperscript{18} which considers the case in which aggregate output in country $i$ in year $t$ ($Y_{it}$) is determined by a Cobb-Douglas production function:\textsuperscript{19}

\begin{equation}
Y_{it} = K_{it}^a (A_{it}L_{it})^{1-a}.
\end{equation}

Here, $K_{it}$ is capital, $L_{it}$ is labor, and $A_{it}$ is the level of technology. Among these variables, $L_{it}$ and $A_{it}$ are assumed to grow at constant rates $n_i$ and $g$, respectively, such that the number of effective units of labor $(A_{it}L_{it})$ grows at

\textsuperscript{16} Crandall and Winston observed the impacts of some monopolization cases, such as \textit{Standard Oil}, \textit{American Tobacco}, and \textit{Alcoa}, on economic growth or consumer welfare both before and after antitrust action, and found that prices actually rose somewhat after the breakup of the monopolies and trusts. \textit{Id}.

\textsuperscript{17} The reason why I use the terms “rich” and “poor” is that the evidence presented later shows that the threshold of the socioeconomic framework mainly depends on the income level.


\textsuperscript{19} This model was first presented by Mankiw, Romer, and Weil, \textit{id.}, in order to examine whether the Solow growth model is consistent with the international variation in the standard of living, and it has been applied in testing the multiple regimes of cross-country growth behavior by Durlauf and Johnson. \textit{See} Steven N. Durlauf & Paul A. Johnson, \textit{Multiple Regimes and Cross-Country Growth Behavior}, 10 J. APPLIED ECONOMETRICS 365 (1995).
the rate \( n_i + g \). Each country augments \( K_t \) at a constant saving rate \( s_b \) while \( K_t \) depreciates at the rate \( \delta \). Hence, the evolution of \( K_t \) is governed by \( dK_t/ dt = s_tY_t - \delta K_t \). This specification makes the growth rate of output per unit of labor between any two periods \( T \) and \( T + \tau \) become

\[
GROWTH_i = g + (1 - e^{-\lambda_i \tau}) \times \left[ \theta + \frac{\alpha}{1 - \alpha} \ln(s_i) - \frac{\alpha}{1 - \alpha} \ln(n_i + g + \delta) - \ln \left( \frac{Y}{L} \right)_{iT} \right], \tag{2}
\]

in which \( GROWTH_i = \ln(Y/L)_{i,T+\tau} - \ln(Y/L)_{i,T} \) is country \( i \)'s productivity growth rate between \( T \) and \( T + \tau \), \( (Y/L)_{i,T} \) is the productivity in initial period \( T \), \( \theta = -\ln(A_0) - gT \), and \( \lambda_i = (1 - \alpha)(n_i + g + \delta) \). Note that \( \lambda_i \) is the country-specific convergence rate towards the steady state. Equation (2) sets forth several nonlinear restrictions across the regression coefficients and is referred to as the constrained version of the Solow growth model. However, assuming \( \lambda_i = \lambda \) across countries while relaxing these nonlinear restrictions—as Mankiw, Romer, and Weil20 and Durlauf and Johnson21 did—leads to the following equation:

\[
GROWTH_i = \pi_0 + \pi_1 \ln \left( \frac{I}{Y} \right)_i + \pi_2 \ln(n_i + g + \delta) + \pi_3 \ln \left( \frac{Y}{L} \right)_{iT} + \epsilon_i, \tag{3}
\]

in which \( \pi_i \) is the coefficient to be estimated, \( s_i = (I/Y)_i \), \( I_i \) is investment, and \( \epsilon_i \) is the error term. A negative estimated value for \( \pi_3 \) can be used as evidence of convergence, matching up with the intuition that low per-capita-output economies grow more quickly than high per-capita-output ones. This is because the former economies could benefit from the technology spillovers from the latter economies while enjoying the advantage of backwardness.

**B. Basic Specification**

Following the standard empirical approach as developed by Barro, Levine and Renelt, Barro and Lee, and Sala-i-Martin, Doppelhofer, and Miller, I include the scope of competition law (\( SCOPE \)) as a variable of interest in equation (3) so as to isolate the effect of the law on productivity growth:22

\[
GROWTH_i = \pi_0 + \pi_1 \ln \left( \frac{I}{Y} \right)_i + \pi_2 \ln(n_i + g + \delta) + \pi_3 \ln \left( \frac{Y}{L} \right)_{iT} + \pi_4 SCOPE_i + \epsilon_i \tag{4}
\]

20 Mankiw, Romer & Weil, supra note 18.
21 Durlauf & Johnson, supra note 19.
22 Barro, Economic Growth in a Cross-Section of Countries, supra note 8; Barro, Determinants of Democracy, supra note 8; Barro & Lee, supra note 8; Levine & Renelt, supra note 8; Sala-i-Martin, Doppelhofer & Miller, supra note 8.
As I mentioned in the Introduction, economic theory suggests that there are two opposing effects of \textit{SCOPE} on growth. Therefore, the sign of \( \pi_4 \) is \textit{a priori} ambiguous.

\textbf{C. Extended Model}

The approach outlined above enables one to identify a scope-wide effect of competition law, which is common to all countries by assuming that the efficiency of law enforcement is the same across countries. However, enforcement efficiency is not globally the same, and competition legislation promotes productivity growth only if it is enforced effectively and sensibly. In order to assess the effectiveness of competition law, it is therefore necessary to differentiate between the scope of the law and its enforcement efficiency as follows:

\[
\text{GROWTH}_i = \pi_0 + \pi_1 \ln \left( \frac{I}{Y} \right)_i + \pi_2 \ln \left( n_i + g + \delta \right) + \pi_3 \ln \left( \frac{Y}{L} \right)_{iT} + \pi_4 \text{SCOPE}_i + \pi_5 \left( \text{SCOPE}_i \cdot \text{EFFICIENCY}_i \right) + \epsilon_i
\]  

This specification decomposes the total effect of competition law into a scope effect (\( \pi_4 \cdot \text{SCOPE}_i \)) and an enforcement efficiency effect (\( \pi_5 \cdot \text{SCOPE}_i \cdot \text{EFFICIENCY}_i \)), in which \( \text{EFFICIENCY}_i \) denotes different governmental efficiency for each country. Here, the enforcement efficiency effect appears as the interaction term between \textit{SCOPE} and \textit{EFFICIENCY}. This is because the application of the law is not easy. I must assume that its effectiveness increases with \textit{EFFICIENCY}. This interaction term allows one to test whether countries that exhibit stronger competition law regimes grow disproportionately faster or slower if they are more efficient in the enforcement of law.

\textbf{D. Coding of Competition Law and Governmental Efficiency}

The data for \textit{SCOPE} and \textit{EFFICIENCY} are obtained from the survey-based measures of Hylton and Deng\textsuperscript{23} and Kaufmann, Kraay, and Mastruzzi,\textsuperscript{24} respectively. Hylton and Deng surveyed the competition law implemented in 102 countries during the period from 2001 to 2004. Based on this dataset, they built up a “scope index” to measure the breadth of the overall competition law. This index provides a quantitative measure of the size of the overall competition law net in a country. It is used as a proxy for \textit{SCOPE} in the empirical study presented later. Table 2 shows that the strongest regimes are those of the European Union (“EU Europe”) and North America, with Oceania and non-EU Europe following. It also reports the “average country

\textsuperscript{23} Hylton & Deng, supra note 6.
“GDP per capita” in each region. Evidently, there exists a positive relationship between regional income and SCOPE, except for the case of South America. In general, it is observed that the higher the income level, the stricter the regulation imposed by the competition law.

On the other hand, SCOPE does not indicate the extent to which a country enforces the competition law. It points out merely the size of the competition law net, but says nothing about the governmental efficiency in enforcing the law. In other words, it points out the number of ways in which a firm might get into trouble under a country’s competition law without saying anything about the likelihood that the firm could get caught in a real investigation.

As to the measurement of EFFICIENCY, I use the index for “government effectiveness” developed by Kaufmann, Kraay, and Mastruzzi as the proxy variable. They provided the relevant data for 160 countries derived from several surveys. The data were aggregated using an unobserved components model. This indicator assesses the quality of public service provision, the quality of the bureaucracy, the competence of civil servants, the independence of the civil service from political pressures, and the credibility of the government’s commitment to policies. It mainly focuses on the quality of inputs required for the government to enforce policies and provide public service. The EFFICIENCY data are average values over a period of 9 years between 1996 and 2004.

Table 2. The SCOPE and average country GDP per capita, ranked by GDP per capita

<table>
<thead>
<tr>
<th>Country</th>
<th>SCOPE</th>
<th>GDP Per Capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU Europe</td>
<td>27.00</td>
<td>$37,900</td>
</tr>
<tr>
<td>North America</td>
<td>21.50</td>
<td>$25,804</td>
</tr>
<tr>
<td>Oceania</td>
<td>18.00</td>
<td>$19,900</td>
</tr>
<tr>
<td>Non-EU Europe</td>
<td>18.24</td>
<td>$12,694</td>
</tr>
<tr>
<td>Middle East</td>
<td>16.60</td>
<td>$9,800</td>
</tr>
<tr>
<td>Caribbean</td>
<td>17.00</td>
<td>$9,466</td>
</tr>
<tr>
<td>South America</td>
<td>12.22</td>
<td>$7,788</td>
</tr>
<tr>
<td>Asia</td>
<td>17.50</td>
<td>$7,627</td>
</tr>
<tr>
<td>Central America</td>
<td>15.40</td>
<td>$7,540</td>
</tr>
<tr>
<td>Africa</td>
<td>16.07</td>
<td>$3,385</td>
</tr>
<tr>
<td>Average</td>
<td>17.95</td>
<td>$14,920</td>
</tr>
</tbody>
</table>

Note: The GDP per capita is the average GDP per capita among countries enforcing competition laws in each region.

Source: Hylton & Deng, supra note 6.

Because the Hylton-Deng countries are restricted to those having competition laws, the GDP per capita figures are thus generally higher than what would appear if the averages of the per-capita GDPs for “all” of the countries in each region were taken.

Kaufmann, Kraay & Mastruzzi, supra note 24.

In the empirical study presented later, I also use alternative variables, such as the years of the application of competition law, to proxy for governmental efficiency. These alternate proxies almost yield the same results as those for EFFICIENCY.
E. Threshold of Infrastructure

This subsection discusses the issue related to the Baumol-Abramovitz hypothesis that there exist some human capital or infrastructure thresholds that induce shifts in aggregate productivity. As regards to this issue, Murphy, Shleifer, and Vishny\(^{28}\) and Durlauf and Johnson\(^{29}\) argued that equation (5) should be replaced by a production technology embodying a certain kind of threshold such that a country will fall into the representation of either equation (6) or equation (7), depending on whether it oversteps the threshold. By using a socioeconomic infrastructure indicator, the “Rule of Law” (\(LAW\)), developed by Kaufmann, Kraay, and Mastruzzi\(^{30}\), one can split the sample into a rich group and a poor group:

\[
GROWTH_i^{\text{poor}} = \pi_0^{\text{poor}} + \pi_1^{\text{poor}} \ln\left(\frac{I}{Y}\right)_i + \pi_2^{\text{poor}} \ln(n_i + g + \delta) + \pi_3^{\text{poor}} \ln\left(\frac{Y}{L}\right)_iT + \pi_4^{\text{poor}} SCOPE_i + \pi_5^{\text{poor}} (SCOPE_i \cdot EFFICIENCY_i) + \varepsilon_i^{\text{poor}},
\]

\[
\quad \text{if } LAW < LAW^* \tag{6}
\]

\[
GROWTH_i^{\text{rich}} = \pi_0^{\text{rich}} + \pi_1^{\text{rich}} \ln\left(\frac{I}{Y}\right)_i + \pi_2^{\text{rich}} \ln(n_i + g + \delta) + \pi_3^{\text{rich}} \ln\left(\frac{Y}{L}\right)_iT + \pi_4^{\text{rich}} SCOPE_i + \pi_5^{\text{rich}} (SCOPE_i \cdot EFFICIENCY_i) + \varepsilon_i^{\text{rich}},
\]

\[
\quad \text{otherwise.} \tag{7}
\]

The index of \(LAW\) measures the extent to which people have confidence in and abide by the rules of society. It reflects the quality of a country’s institutions and socioeconomic environment. Thus, it can be interpreted as a proxy for identifying the threshold effect associated with the unobserved human stock. The use of \(LAW\) as a segregating variable makes sense if one thinks of the potential regimes in the data as stemming from differences in the socioeconomic framework, which gives rise to the awkward situation where some LDCs governments do not, in fact, want to enforce the law. In such circumstances, the level of \(SCOPE\) and its interaction term together with \(EFFICIENCY\) would fail to explain \(GROWTH\).

This specification will generate multiple steady-state equilibria such that different groups of countries converge to different steady states at the same convergence rate (\(\lambda\)). This case motivates the later empirical strategy by testing equation (5) versus equations (6) and (7) to determine whether the data obey a single Solow-type growth equation or whether the data exhibit


\(^{29}\) Durlauf & Johnson, supra note 19.

\(^{30}\) Kaufmann, Kraay & Mastruzzi, supra note 24.
multiple regimes, in the sense that subsets of countries identified by \( \text{LAW} \) obey distinct Solow-type regressions. If the cross-country regressions of equations (6) and (7) are correctly specified for subsets of countries conditional upon \( \text{LAW} \), then an over-emphasis on equation (5) might lead to a biased interpretation of data.

F. Data on the Solow Variables

The data on economic activity (the Solow variables) are mainly based on version 6.2 of the Penn World Table (PWT) compiled by Heston, Summers, and Aten in 2002.\(^{31}\)

\[
\text{GROWTH}_i = \text{average annual growth rate of productivity (real GDP per worker) for the period from 1990 to 2004.}
\]

\[
(\frac{\text{I}_i}{\text{Y}_i}) = \text{fraction of real GDP devoted to investment (including government investment), taking the annual averages over the period from 1990 to 2004.}
\]

\[
(\frac{\text{Y}_{iT}}{\text{Y}_i}) = \text{real GDP per worker in 1990.}
\]

\[
n_i = \text{average annual growth rate of population from 1990 to 2004. This article also follows Mankiw, Romer, and Weil in assuming that the technology growth rate } g = 0.02 \text{ and the depreciation rate } \delta = 0.03. \text{ Thus, I impose } (n_i + g + \delta) = n_i + 0.05 \text{ in the regression later on.}
\]

\[
\text{SCOPE}_i = \text{the scope index, obtained from Hylton and Deng.}\(^{32}\)
\]

\[
\text{EFFICIENCY}_i = \text{the governmental efficiency, proxied by the “government effectiveness” variable developed by Kaufmann, Kraay, and Mastruzzi.}\(^{33}\)
\]

\[
\text{LAW}_i = \text{the “rule of law” variable, developed by Kaufmann, Kraay, and Mastruzzi,}\(^{34}\) \text{ and used as the separating variable to divide the data into a rich group and a poor group.}
\]

Each of these sources provides data on relevant variables for sizeable sub-samples of the 102 Hylton-Deng countries,\(^{35}\) and the overlap gives me a final sample of usable data for 101 observations.\(^{36}\) Table 1-2 shows the data description of Solow and other policy variables.

---

31 Heston, Summers, and Aten have developed measures of real GDP that adjust for international differences in price levels and are therefore more comparable across countries than measures based on market exchange rates. See Alan Heston, Robert Summers & Bettina Aten, Penn World Table Version 6.1, Center for International Comparisons at the University of Pennsylvania (CICUP) (Oct. 2002).

32 Hylton & Deng, supra note 6.

33 Kaufmann, Kraay & Mastruzzi, supra note 24.

34 Id.

35 Hylton-Deng countries refer to countries that enforce competition laws.

36 One of the Hylton-Deng countries, the Faroe Islands, is not contained in the dataset of \( \text{LAW} \) so that I have 101 observations.
IV. EMPIRICAL RESULTS

A. Multiple Regimes

This Part first attempts to identify the presence of multiple regimes in the data through the use of a specification test that takes a single regime model as the null hypothesis. Because the point of the structural break is unknown, the traditional tests on structural breaks, such as the Chow and Wald tests, become useless at this point. Furthermore, economic theory provides no prior guidance as to the location of the structural break. To identify whether the effect of competition law on economic growth changes with different regimes, it is desirable to employ a data-sorting method that allows the data themselves to determine the location of different regimes endogenously. Thus, I perform Bruce Hansen’s Gauss-procedure threshold test to identify various regimes by using LA\text{W} as a segregating variable.\textsuperscript{37} The result indicates a significant structural break at the level of LA\text{W} = -0.07.\textsuperscript{38} This break divides the 101 Hylton-Deng countries into a “rich group” with 53 observations and a “poor group” with 48 observations, corresponding closely to the World Bank’s distinction between the lower-middle-income countries (the poor group) and the upper-middle-income countries plus the high-

\textbf{Table 1-2. Data description: Solow and other policy variables}  

<table>
<thead>
<tr>
<th>Series</th>
<th>Observations</th>
<th>Mean</th>
<th>Std. Error</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROWTH (%)</td>
<td>172</td>
<td>1.24</td>
<td>2.88</td>
<td>-11.97</td>
<td>22.64</td>
</tr>
<tr>
<td>I/Y (%)</td>
<td>188</td>
<td>14.16</td>
<td>7.61</td>
<td>2.41</td>
<td>37.75</td>
</tr>
<tr>
<td>Y/L</td>
<td>188</td>
<td>6401.10</td>
<td>6220.61</td>
<td>345.72</td>
<td>25670.57</td>
</tr>
<tr>
<td>$n + g + \delta$</td>
<td>188</td>
<td>0.07</td>
<td>0.01</td>
<td>0.03</td>
<td>0.10</td>
</tr>
<tr>
<td>EFF\text{LAW}</td>
<td>101</td>
<td>7.02</td>
<td>19.42</td>
<td>-30.00</td>
<td>51.50</td>
</tr>
<tr>
<td>SCOPE</td>
<td>101</td>
<td>17.57</td>
<td>4.94</td>
<td>2.02</td>
<td>25.00</td>
</tr>
<tr>
<td>OPENNESS (%)</td>
<td>188</td>
<td>87.90</td>
<td>49.04</td>
<td>2.02</td>
<td>363.51</td>
</tr>
<tr>
<td>EFFICIENCY</td>
<td>160</td>
<td>-0.01</td>
<td>1.00</td>
<td>-2.08</td>
<td>2.30</td>
</tr>
<tr>
<td>REGULATION</td>
<td>160</td>
<td>-0.03</td>
<td>0.99</td>
<td>-2.29</td>
<td>1.96</td>
</tr>
<tr>
<td>LA\text{W}</td>
<td>160</td>
<td>-0.04</td>
<td>1.00</td>
<td>-2.26</td>
<td>2.01</td>
</tr>
<tr>
<td>RERD</td>
<td>115</td>
<td>125.64</td>
<td>40.31</td>
<td>51.00</td>
<td>277.00</td>
</tr>
<tr>
<td>TOT</td>
<td>119</td>
<td>0.01</td>
<td>0.04</td>
<td>-0.07</td>
<td>0.15</td>
</tr>
<tr>
<td>GOV\text{SH} (%)</td>
<td>188</td>
<td>23.95</td>
<td>10.36</td>
<td>4.04</td>
<td>60.36</td>
</tr>
<tr>
<td>INFLATION</td>
<td>186</td>
<td>0.01</td>
<td>0.05</td>
<td>-0.12</td>
<td>0.34</td>
</tr>
<tr>
<td>PI</td>
<td>188</td>
<td>89.60</td>
<td>48.41</td>
<td>20.60</td>
<td>344.90</td>
</tr>
<tr>
<td>SE (%)</td>
<td>162</td>
<td>19.31</td>
<td>18.13</td>
<td>0.20</td>
<td>90.20</td>
</tr>
</tbody>
</table>

\textit{Note:} Series Y/L denotes the GDP per capita in purchasing power parity in international dollars adjusted for purchasing power parity.

\textsuperscript{37} This test computes the $F$-test, which is the same as what one could obtain by performing a Chow test that breaks at the indicated value. See Bruce E. Hansen, \textit{Inference in TAR Models}, 2 ST\textit{UDY. NONLINEAR DYNAMICS & ECONOMETRICS} 1 (1997).

\textsuperscript{38} A negative breaking point of the segregating variable ($LA\text{W} = -0.07$) might simply reflect random error.
It is notable that the Hylton-Deng sample excludes almost all of the low-income countries, because they lack competition law. Thus, I am limited to testing the model on the rich and low-income countries (the rich group). It is not clear that the Hylton-Deng sample excludes almost all of the low-income countries, because they lack competition law. Thus, I am limited to testing the model on the rich and low-income countries (the rich group). It is notable that the Hylton-Deng sample excludes almost all of the low-income countries, because they lack competition law. Thus, I am limited to testing the model on the rich and low-income countries (the rich group). It is notable that the Hylton-Deng sample excludes almost all of the low-income countries, because they lack competition law. Thus, I am limited to testing the model on the rich and low-income countries (the rich group).

### Table 3. Classification of countries by $LAW$

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Group</th>
<th>Rank</th>
<th>Country</th>
<th>Group</th>
<th>Rank</th>
<th>Country</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Zimbabwe</td>
<td>P</td>
<td>35</td>
<td>Dominica</td>
<td>P</td>
<td>69</td>
<td>Korea</td>
<td>R</td>
</tr>
<tr>
<td>2</td>
<td>Nigeria</td>
<td>P</td>
<td>36</td>
<td>Bolivia</td>
<td>P</td>
<td>70</td>
<td>Czech Rep.</td>
<td>R</td>
</tr>
<tr>
<td>3</td>
<td>Cote d'Ivoire</td>
<td>P</td>
<td>37</td>
<td>Jamaica</td>
<td>P</td>
<td>71</td>
<td>Israel</td>
<td>R</td>
</tr>
<tr>
<td>4</td>
<td>Uzbekistan</td>
<td>P</td>
<td>38</td>
<td>Tanzania</td>
<td>P</td>
<td>72</td>
<td>Greece</td>
<td>R</td>
</tr>
<tr>
<td>5</td>
<td>Belarus</td>
<td>P</td>
<td>39</td>
<td>El Salvador</td>
<td>P</td>
<td>73</td>
<td>Taiwan</td>
<td>R</td>
</tr>
<tr>
<td>6</td>
<td>Venezuela</td>
<td>P</td>
<td>40</td>
<td>Mexico</td>
<td>P</td>
<td>74</td>
<td>Hungary</td>
<td>R</td>
</tr>
<tr>
<td>7</td>
<td>Tajikistan</td>
<td>P</td>
<td>41</td>
<td>China</td>
<td>P</td>
<td>75</td>
<td>Estonia</td>
<td>R</td>
</tr>
<tr>
<td>8</td>
<td>Paraguay</td>
<td>P</td>
<td>42</td>
<td>Brazil</td>
<td>P</td>
<td>76</td>
<td>Cyprus</td>
<td>R</td>
</tr>
<tr>
<td>9</td>
<td>Laos</td>
<td>P</td>
<td>43</td>
<td>Malawi</td>
<td>P</td>
<td>77</td>
<td>Slovenia</td>
<td>R</td>
</tr>
<tr>
<td>10</td>
<td>Guatemala</td>
<td>P</td>
<td>44</td>
<td>Macedonia</td>
<td>P</td>
<td>78</td>
<td>Chile</td>
<td>R</td>
</tr>
<tr>
<td>11</td>
<td>Kenya</td>
<td>P</td>
<td>45</td>
<td>Senegal</td>
<td>P</td>
<td>79</td>
<td>Portugal</td>
<td>R</td>
</tr>
<tr>
<td>12</td>
<td>Kazakhstan</td>
<td>P</td>
<td>46</td>
<td>Romania</td>
<td>P</td>
<td>80</td>
<td>Spain</td>
<td>R</td>
</tr>
<tr>
<td>13</td>
<td>Bangladesh</td>
<td>P</td>
<td>47</td>
<td>Mali</td>
<td>P</td>
<td>81</td>
<td>Barbados</td>
<td>R</td>
</tr>
<tr>
<td>14</td>
<td>Albania</td>
<td>P</td>
<td>48</td>
<td>Panama</td>
<td>P</td>
<td>82</td>
<td>Japan</td>
<td>R</td>
</tr>
<tr>
<td>15</td>
<td>Pakistan</td>
<td>P</td>
<td>49</td>
<td>Bulgaria</td>
<td>R</td>
<td>83</td>
<td>Malta</td>
<td>R</td>
</tr>
<tr>
<td>16</td>
<td>Indonesia</td>
<td>P</td>
<td>50</td>
<td>India</td>
<td>R</td>
<td>84</td>
<td>France</td>
<td>R</td>
</tr>
<tr>
<td>17</td>
<td>Papua New Guinea</td>
<td>P</td>
<td>51</td>
<td>Namibia</td>
<td>R</td>
<td>85</td>
<td>US</td>
<td>R</td>
</tr>
<tr>
<td>18</td>
<td>Russia</td>
<td>P</td>
<td>52</td>
<td>Sri Lanka</td>
<td>R</td>
<td>86</td>
<td>Belgium</td>
<td>R</td>
</tr>
<tr>
<td>19</td>
<td>Azerbaijan</td>
<td>P</td>
<td>53</td>
<td>Morocco</td>
<td>R</td>
<td>87</td>
<td>Ireland</td>
<td>R</td>
</tr>
<tr>
<td>20</td>
<td>Kyrgyzstan</td>
<td>P</td>
<td>54</td>
<td>Thailand</td>
<td>R</td>
<td>88</td>
<td>Germany</td>
<td>R</td>
</tr>
<tr>
<td>21</td>
<td>Colombia</td>
<td>P</td>
<td>55</td>
<td>Mongolia</td>
<td>R</td>
<td>89</td>
<td>UK</td>
<td>R</td>
</tr>
<tr>
<td>22</td>
<td>Georgia</td>
<td>P</td>
<td>56</td>
<td>Turkey</td>
<td>R</td>
<td>90</td>
<td>Netherlands</td>
<td>R</td>
</tr>
<tr>
<td>23</td>
<td>Serbia/Montenegro</td>
<td>P</td>
<td>57</td>
<td>Croatia</td>
<td>R</td>
<td>91</td>
<td>Cameroon</td>
<td>R</td>
</tr>
<tr>
<td>24</td>
<td>Ukraine</td>
<td>P</td>
<td>58</td>
<td>South Africa</td>
<td>R</td>
<td>92</td>
<td>Austria</td>
<td>R</td>
</tr>
<tr>
<td>25</td>
<td>Argentina</td>
<td>P</td>
<td>59</td>
<td>Tunisia</td>
<td>R</td>
<td>93</td>
<td>Australia</td>
<td>R</td>
</tr>
<tr>
<td>26</td>
<td>Algeria</td>
<td>P</td>
<td>60</td>
<td>Canada</td>
<td>R</td>
<td>94</td>
<td>Sweden</td>
<td>R</td>
</tr>
<tr>
<td>27</td>
<td>Mauritius</td>
<td>P</td>
<td>61</td>
<td>Jordan</td>
<td>R</td>
<td>95</td>
<td>New Zealand</td>
<td>R</td>
</tr>
<tr>
<td>28</td>
<td>Bosnia/Herzegovina</td>
<td>P</td>
<td>62</td>
<td>Poland</td>
<td>R</td>
<td>96</td>
<td>Finland</td>
<td>R</td>
</tr>
<tr>
<td>29</td>
<td>Moldova</td>
<td>P</td>
<td>63</td>
<td>Uruguay</td>
<td>R</td>
<td>97</td>
<td>Denmark</td>
<td>R</td>
</tr>
<tr>
<td>30</td>
<td>Philippines</td>
<td>P</td>
<td>64</td>
<td>Slovak</td>
<td>R</td>
<td>98</td>
<td>Norway</td>
<td>R</td>
</tr>
<tr>
<td>31</td>
<td>Peru</td>
<td>P</td>
<td>65</td>
<td>Latvia</td>
<td>R</td>
<td>99</td>
<td>Luxembourg</td>
<td>R</td>
</tr>
<tr>
<td>32</td>
<td>Zambia</td>
<td>P</td>
<td>66</td>
<td>Lithuania</td>
<td>R</td>
<td>100</td>
<td>Switzerland</td>
<td>R</td>
</tr>
<tr>
<td>33</td>
<td>Burkina Faso</td>
<td>P</td>
<td>67</td>
<td>Costa Rica</td>
<td>R</td>
<td>101</td>
<td>Iceland</td>
<td>R</td>
</tr>
<tr>
<td>34</td>
<td>Armenia</td>
<td>P</td>
<td>68</td>
<td>Italy</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Notes:* $R$ ($P$) denotes Rich (Poor) group. Countries are ranked by their values of $LAW$.  

The classifications of the World Bank include: low income countries, lower middle income countries, upper middle income countries, and high income countries (DCs).
middle-income countries. Table 3 details the countries in each subsample.

To be sure, I also use another segregating variable, the initial income \( (Y/L)_{1990} \) to group countries so as to check whether the results change significantly when an alternative variable is used. The evidence from the threshold test divides the 102 Hylton-Deng countries into a rich group with 57 observations and a poor group with 45 observations. The alternate break almost yields the same result as that of \( LAW \). For brevity and later convenience, the empirical study that follows reports only the results for subsamples grouped by \( LAW \).

B. Endogeneity and Instrumental Variables

As previously mentioned, the majority of competition laws were passed only after 1990. Since my productivity growth variable refers to the average value over the period from 1990 to 2004, it seems unlikely that the laws would have an important effect on productivity over a relatively short period of time. Thus, I am exposed to a potential problem that an \( ex \ post \) variable could generate, such as endogeneity. Although I can restrict the estimation merely to those countries that have enforced competition law for at least 10 or 15 years, this would in fact considerably reduce the number of observations.

Still on the issue of endogeneity, one could also argue that, at least until the last decade, the introduction of competition law seemed to be systematically correlated with per-capita income. Thus, competition legislation might simply adjust to a level that is optimal for a country’s productivity (or income), and hence the causality could run from income to competition law, but not in the other direction. This might also constitute an endogeneity problem.

However, regarding this particular case, I believe that these concerns would not seriously bias the estimation results. First, this article draws on changes in productivity as the dependent variable, rather than using its absolute level of performance. This can strengthen the influence of competition law on the dependent variable: changes in productivity \( (GROWTH) \). Second, the previous considerations overlook the fact that there are political and institutional factors that maneuver around competition legislation. Interest groups, governments, or both will shape the legal, institutional, and economic environment for private gains that may not necessarily coincide with the proper development of competition legislation. Moreover, in general, competition law is a favorite policy variable for reasons not necessarily related to productivity growth. Hence, the objective function of the regulator is such that the “optimal” level of competition legislation may be unrelated to that required by economic growth.

40 Middle income countries include lower middle income countries and upper middle income countries.

41 For instance, the governments often do not truly intend to implement competition law, but merely use it as a recourse to alleviate the pressures from the international community under the framework of multilateral trade negotiations.
Beyond this line of discussion, this article resolves the concerns regarding the potential endogeneity of competition legislation using instrumental variables (IV) estimation. I select instruments from two sources of variables that determine a country’s legal infrastructure. The first instrument concerns the legal origin variables of La Porta Lopez-de-Silanes, Shleifer, and Vishny. These variables indicate whether the legal system in a country has its origins in the English, French, Scandinavian, German, or Socialist legal traditions. The other instrument is a set of religious variables that include Protestant, Catholic, Muslim, and Others. These IVs are clearly unaffected by productivity growth. However, they may have an impact on the likelihood that a country will adopt a competition law, since the tendency toward law enforcement appears to be influenced by legal origin and religion. Based on these IVs, I perform a Durbin-Wu-Hausman (DWH) test of over-identifying restrictions for each of the regressions in the article. The test verifies the null hypothesis that the utilization of IVs has no effect on the estimates of the estimated coefficients.44

There are two terms pertaining to the problem of endogeneity, namely, the level of SCOPE and its interaction term with EFFICIENCY. When both terms are present in the regression, instruments must also be used for both variables. Therefore, for each of the regressions, I perform a DWH $F$-test, whose results are reported at the bottom line in each table. If the $p$-value of the $F$-test is below 10 percent (that is, the null hypothesis is rejected and the IVs are jointly accepted), then IV estimates are reported. Otherwise, OLS estimates are reported. I choose the 10-percent significance level for prudence, because I want to correct for possible endogeneity when there is the slightest risk of its occurrence. Instead of using IV estimation all the time, this way of doing the work might improve estimation efficiency.45 I expect to find in my results that, in the vast majority of the regressions, the test fails to reject the null hypothesis and that, even when they are used, IVs do not particularly

43 All IVs are in the form of dummy variables.
44 See RUSSELL DAVIDSON & JAMES G. MACKINNON, ESTIMATION AND INFEERENCE IN ECONOMETRICS 237-42 (Cambridge Univ. Press 1993).
45 Although the IV estimation can ensure a consistent estimation, it also leads to a loss of precision. The IV estimation is a treatment that brings about exogenous movement in SCOPE, but does so with considerable noise. It inevitably leads to a loss in precision and increases standard errors. For instance, in the case of a single endogenous regressor ($x$) and single instrument ($z$) with iid errors, the asymptotic variance becomes $\text{var}(\hat{\beta}_{\text{IV}}) = \text{var}(\hat{\beta}_{\text{OLS}})/r_{xz}^2$. See ADRIAN COLIN CAMERON & PRavin K. TRIVEDI, MICROECONOMETRICS: METHODS AND APPLICATIONS 107 (Cambridge Univ. Press 2005). If the squared correlation coefficient $r_{xz}^2$ is 0.1, then the IV standard errors will be ten times those of the OLS. Unless $r_{xz}^2 = 1$, the IV estimator always has a larger variance than the OLS estimator. Thus, the test for endogeneity may serve as a guide as to when to use the OLS and when to use the IV estimation so that one can use the appropriate procedure. If a set of estimates obtained using the OLS is consistent and endogeneity is not a concern, then one should use the OLS estimator to improve estimation efficiency.
alter the results of the OLS estimations. Therefore, the SCOPE variable is robust to the issue of endogeneity, both in level and in interaction.

C. Basic Results

Table 4 reports the results of the regressions based on the specifications in equations (5), (6), and (7). The covariance matrix is corrected for conditional heteroskedasticity and serial correlation. The evidence shows that all Solow variables have the expected sign. The estimated coefficients of $I/Y$ are significantly positive, as expected. Besides, the estimated coefficients of $(n_i + g + d)$ for all regressions are negative, although those for the rich group are insignificant. Finally, that the coefficients of $Y/L$ are negative and significant for all regressions captures the convergence effect of the economy to its long-run steady state: countries that have already grown substantially in the past and that have enjoyed a high level of income are unlikely to continue to grow at a high rate in the future.

Additionally, there is substantial evidence that the growth model is different across rich and poor countries. In terms of overall fit, Columns (A), (B), and (C) in Table 4 indicate that the regression on the rich group ($R^2 = 0.66$) shows some improvement over both the full sample ($R^2 = 0.43$) and the poor group ($R^2 = 0.30$). As to the difference in estimates across rich and poor groups, Columns (B) and (C) indicate that most subsample coefficients are substantially different from both each other and from the full sample regression. The Chow test also rejects the null hypothesis that all parameters are equal across the subsamples, under an analysis at the 1-percent significance level.

With respect to the variables of primary concern, SCOPE and its interaction term SCOPE · EFFICIENCY (for brevity, hereinafter referred to as "EFFLA W"), the results show two interesting pieces of evidence. First, all regressions fail to show a statistically significant impact for SCOPE. Thus, the size or intensity of the competition law net is irrelevant to the economic growth. Second, the impact of competition law enforcement on productivity growth is asymmetrical between rich and poor countries. Column (C) indicates that the estimated coefficient for the interaction term (EFFLA W) of 0.04 is insignificantly different from zero for the poor group. This failure to find an impact of competition law on productivity among the poor countries parallels the inference of Gal. For these countries, competition legislation is neither harmful nor helpful in terms of aggregate productivity. As to the rich group, Column (B) shows that the estimated coefficient for EFFLA W of

---

47 Equation (2) shows that the expected sign of this term is negative.
Table 4. Basic results (dependent variable: \textit{GROWTH})

<table>
<thead>
<tr>
<th>Variable</th>
<th>(A) Equation (5) Full Sample</th>
<th>(B) Equation (6) Rich</th>
<th>(C) Equation (7) Poor</th>
<th>(D) Equation (6) Rich</th>
<th>(E) Equation (7) Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>4.238 (1.800)</td>
<td>4.181 (1.912)</td>
<td>5.926 (3.283)</td>
<td>2.451 (1.515)</td>
<td>5.631 (2.859)</td>
</tr>
<tr>
<td>$\ln(Y_i)$</td>
<td>0.084 (0.035)</td>
<td>0.057 (0.034)</td>
<td>0.113 (0.065)</td>
<td>0.058 (0.035)</td>
<td>0.111 (0.063)</td>
</tr>
<tr>
<td>$\ln(n + g + \delta)$</td>
<td>-42.170 (21.006)</td>
<td>-26.408 (22.920)</td>
<td>-65.841 (37.425)</td>
<td>-24.528 (23.149)</td>
<td>-63.656 (35.214)</td>
</tr>
<tr>
<td>$\ln(E_i)$</td>
<td>-0.0002 (0.0001)</td>
<td>-0.0002 (0.0001)</td>
<td>-0.0004 (0.0002)</td>
<td>-0.0001 (0.0006)</td>
<td>-0.0004 (0.0002)</td>
</tr>
<tr>
<td>SCOPE$_i$</td>
<td>-0.036 (0.043)</td>
<td>-0.085 (0.059)</td>
<td>-0.016 (0.086)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$EFFECTIVE(SCOPE_EFFICIENCY)$</td>
<td>0.049 (0.020)</td>
<td>0.064 (0.026)</td>
<td>0.040 (0.057)</td>
<td>0.044 (0.023)</td>
<td>0.046 (0.047)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.43</td>
<td>0.66</td>
<td>0.30</td>
<td>0.65</td>
<td>0.30</td>
</tr>
<tr>
<td>Chow test</td>
<td></td>
<td>21.86***</td>
<td>21.86***</td>
<td>22.10***</td>
<td>22.10***</td>
</tr>
<tr>
<td>Observations</td>
<td>101</td>
<td>53</td>
<td>48</td>
<td>53</td>
<td>48</td>
</tr>
<tr>
<td>DWH F test</td>
<td>1.04</td>
<td>0.84</td>
<td>1.46</td>
<td>0.54</td>
<td>1.23</td>
</tr>
</tbody>
</table>

Notes: The figures in parentheses are standard errors. *** indicates that the estimates are significant at the 1% level, ** at the 5% level, and * at the 10% level.
0.064 is significantly positive. This indicates that countries exhibiting high efficiency in enforcing competition law will grow disproportionately faster if they have stricter regimes for the law. Thus, the impact of competition law on growth is not uniform between rich and poor groups. From the viewpoint of threshold externalities, the difference in the impact of law can be explained by the incidence of multiple regimes. The reasoning is that competition law affects economic growth through various production regimes in a way that is similar to that put forth by Azariadis and Drazen and by Durlauf and Johnson. This result reveals the fact that certain types of channels through which competition law has an effect on productivity growth are constrained by the socioeconomic infrastructure (LAW). Once this constraint is no longer binding, the impact of the competition law will increase with its scope and enforcement efficiency.

D. Competition Law Effect in the Rich Group

This subsection evaluates the magnitude of the effect of competition law on the growth of rich countries with different levels of governmental efficiency (EFFICIENCY). Since SCOPE is not significant, I drop it from the regression and report the regression results in Columns (D) and (E) of Table 4. First, Column (D) shows that the coefficient of EFFLA W is 0.044. Conditional upon the sample mean of governmental efficiency (EFFICIENCY = 0.32), for every one-point increase in SCOPE, GROWTH increases by 0.01 percentage points. To consider a concrete example of the implications of this evidence, take the case of Ireland, which has SCOPE = 18 (25th percentile), EFFICIENCY = 1.58, and GROWTH = 4.81 percent. Consider that Ireland were to revamp its competition statute, so that its SCOPE increases from the level at the 25th percentile to the one at the 75th percentile of the distribution (SCOPE = 21), which is equivalent to the level for the Netherlands. The results of Table 4 suggest that the maximum

50 Durlauf & Johnson, supra note 19.
51 The p-values of the t-test for both the estimated constant term in Column (D) and the estimated coefficient of SCOPE in Column (B) are 0.11 and 0.15, respectively. These values are only slightly larger than the usual standard for statistical significance (p = 0.10). If I continue to use these estimated coefficients, then the differences in the scale and significance of the constant estimates comparing Columns (B) and (D) may simply reflect that the impact of SCOPE (the omitted variable) on GROWTH is captured in the regression constant in Column (D). This can be seen by noting that the difference between constant estimates in Columns (B) and (D) is approximately equal to the estimated coefficient of SCOPE (∼-0.085) in Column (B) multiplied by the mean value of SCOPE (19). That is, we have 2.451 - 4.181 = -1.730 ∼ -0.085 × 19.
52 Here, the level of the 25th percentile is based on the distribution of SCOPE in the rich country samples.
increase in $GROWTH$ that would result is 0.21 percentage points. In other words, a 3 point increase in $SCOPE$ could increase the growth rate from 4.81 percent to 5.02 percent.53

To highlight the importance of $EFFICIENCY$, Table 5 calculates the effect of $SCOPE$ on $GROWTH$ for countries with different levels of $EFFICIENCY$ if one increases the $SCOPE$ by three points.54 As I did above, I perform this calculation based on the estimation results in Column (D) of Table 4. For a country (for example, Morocco) at the 5th percentile of the distribution of $EFFICIENCY$ ($EFFICIENCY = -0.18$), the coefficient of $EFFLA W$ reveals a negative effect of $0.044 \cdot (-0.18) = -0.02$ percent on growth. In Morocco, a stronger competition law not only cannot support productivity growth, but might also slow down the potential path of growth. The overreach of anti-trust law has not been found to increase productivity growth in any systematic way, and in some instances the intervention may even have retarded economic growth. To ensure a credible and impartial enforcement, the infrastructure landscape should provide the enforcing agencies an effective apparatus to enforce the law.

Alternatively, if one performs this calculation for a country (for example, Portugal) at the 75th percentile of the distribution of $EFFICIENCY$ (1.79), the result shows that the effect of a stronger competition law increases to 0.24 percentage points. In conclusion, a high $SCOPE$ indeed can promote growth, but only on the condition that the agency can enforce the law effectively. Just as Crandall and Winston have indicated, a tough and broad anti-trust policy must rest on adequate infrastructure that ensures that such policies can be enforced effectively. The mere adoption of a competition law is a necessary condition, but not a sufficient condition, to promote economic growth.

53 The effect size of competition law on growth will be discussed in the next Part.
54 This means that I increase $SCOPE$ from a level at the 25th percentile to one at the 75th percentile of the distribution.
V. ROBUSTNESS ANALYSIS I: L-R TEST AND S TEST

A. Robustness of Growth Model

In econometric models, the variables employed to explain growth are often crude proxies for some underlying factors; hence, their inclusion probabilities may possibly covary positively, as each helps to measure some common growth determinants. For instance, the likelihood that antitrust policy predicts growth could be positively associated with the likelihood that trade openness predicts growth, as each helps to instrument the unobservable “market competition.” Thus, Brock and Durlauf55 indicated that the basic problem in testing the validity of the growth model is that there does not exist a clear-cut criterion by which to judge a particular model. This is because growth theories are open-ended, and hence various models are typically compatible with one another. The proposition that competition legislation matters for economic growth is not logically inconsistent with models that emphasize the role of other public policies. This raises an interesting question: If one has a set of public policies all of which are not mutually exclusive, then how can one identify which policies are truly correlated with growth? For instance, if one runs regressions containing the various combinations of policy variables, policy A will soon be found to be significant in explaining growth when the regression includes policies B and C. However, it might become insignificant when policy D is included. Because the “true” policy variables for explaining growth are generally not known, one is left with the question: What are the variables that are truly robust in explaining economic growth?

B. Various Policy Variables

Since there is no uniform definition for robustness, in this part, the robustness tests will consider the empirical methods of both Levine and Renelt (L-R)56 and Sala-i-Martin (S)57 and will concurrently investigate the sign and significance of the regression results before arriving at a conclusion regarding the robust relationship between competition law and productivity growth. Each test is conducted by regressing GROWTH on Solow variables as well as a list of potential explanatory variables pertaining to various public policies. Other than the competition policy variable, these policy variables are commonly used in the literature to explain economic growth.58 The advantage of using these public policies in the robustness analysis is that one can compare the effect of competition policy with the effects of other public policies. If the interaction term (EFF\text{LAW} = SCOPE \cdot EFFICIENCY) can

56 Levine & Renelt, supra note 8.
57 Xavier Sala-i-Martin, I Just Ran Two Million Regressions, 87 AM. ECON. REV. 178 (1997).
58 See id.
survive in the robustness test, then I can safely claim that SCOPE has an impact on GROWTH, but the strength of that impact depends upon EFFICIENCY. The entire vector of policy variables is described as follows. Table 1-2 shows the data description including the policy variables.

First, with respect to education policy, the secondary schooling variable ("SE") is used as a proxy to evaluate policy regarding human resources. This variable is the enrollment rate in secondary education in 1990. Second, with respect to monetary policy, the average inflation rate ("INFLATION") is used as a proxy variable for monetary policy tightness. INFLATION is measured as the average annual change in the GDP deflator over the period from 1990 to 2004. Third, the real exchange rate distortion ("RERD") is used to proxy the exchange rate policy. Fourth, the openness measure ("OPENNESS") is used as the proxy for trade liberalization policy. This index is the ratio of exports plus imports to GDP, averaged over the period from 1990 to 2004. Fifth, to evaluate the effect of fiscal policy, the government share of GDP ("GOVSH") serves as the average share of government expenditure to GDP from 1990 to 2004. Finally, sixth, to evaluate industrial policy, the average investment price level on a purchasing power parity basis from 1990 to 2004 ("PI") and the changes in the “terms of trade” ("TOT") are both used to proxy the orientation of industrial policy.

The robustness test starts with the estimation of the following regression:

\[ GROWTH_i = \beta_{yj}F + \beta_{zj}z + \beta_{xj}x_j + \varepsilon, \tag{8} \]

in which F is a vector of variables that always appear in the regression, z is the variable of interest, and \( x_j \in \Xi \) is a vector of a subset of conditioning variables taken from the full set of potentially explanatory variables for economic growth. This set of variables includes eight policy variables: EFFLAFL, SE, INFLATION, RERD, OPENNESS, GOVSH, PI, and TOT. One needs to estimate equation (8) for all the possible combinations of \( x_j \in \Xi \). For each regression j, one estimates a coefficient \( \beta_{zj} \) and a standard deviation \( \sigma_{zj} \).

59 TASK FORCE ON HIGHER EDUC. & SOC’Y, WORLD BANK, HIGHER EDUCATION IN DEVELOPING COUNTRIES: PERIL AND PROMISE (2000).
60 Alan Heston, Robert Summers & Bettina Aten, Penn World Table Version 6.2, Center for International Comparisons at the University of Pennsylvania (CICUP) (Sept. 2002) [hereinafter PWT 6.2].
61 Sala-i-Martin, Doppelhofer & Miller, supra note 8.
62 PWT 6.2, supra note 60.
63 Id.
64 Id.
65 Sala-i-Martin, Doppelhofer & Miller, supra note 8.
C. Levine-Renelt Test

The initial approach used to assess the robustness of the regression evidence was given by Levine and Renelt, who applied Leamer’s extreme bounds analysis (EBA) to examine the robustness of the empirical relationships in the economic growth literature. The L-R test is performed by regressing equation (8).

First, the variables that I take as fixed (the F set) are a constant term, as well as the Solow variables \( I/Y, n + g + \delta, \) and \( Y/L \), which are always included in all the regressions. Second, I choose a variable of interest from the full set of eight potentially explanatory variables. Then I run the regression for all possible linear combinations of “three” conditioning variables. The subset of the conditioning variables is also taken from the same full set of variables, except for the variable of interest under consideration. Thus, I have four fixed variables, one variable of interest and three conditioning variables in each regression. Since there are eight potential explanatory variables and I use one of them as the variable of interest and three of them as the conditioning variables, for each variable of interest, I combine the remaining seven variables into sets of three. Hence I will estimate \( (8-1)!/(3!(8-4)!) = 35 \) regressions for each variable of interest, or a total of \( 8!/4!(8-4)! = 70 \) regressions. These regressions are estimated with MetaGrowth 1.0, developed by Heijungs, de Groot, and Florax.

Finally, I obtain the estimated values of the coefficients of the variable of interest \( \beta_{zj} \) for each regression. The EBA criterion is quite strict, because the estimated results are identified as being “robust” if and only if these coefficient estimates remain significant and conform to the theoretically expected sign in each and every regression. If the estimate of \( \beta_{zj} \) fails to be significant or changes in sign in any one regression, then the result will be referred to as being “fragile.” If the evidence turns out to be fragile, then one might feel less confident in terms of the estimated relationship between the variable of interest and growth, because an alteration in the conditioning information set changes the statistical inference that one can draw regarding the estimated \( \beta_{zj} \). Needless to say, this strict condition makes very few variables sufficiently robust to explain growth.

66 Levine & Renelt, supra note 8.
67 Edward E. Leamer, Let’s Take the Con Out of Econometrics, 73 AM. ECON. REV. 31 (1983).
68 The number of regressors is eight, which is the same as that of Sala-i-Martin, Doppelhofer & Miller, supra note 8. Because this number might be arbitrary, I have experimented with including two or four conditioning variables. However, this hardly changes the empirical results.
70 See Levine & Renelt, supra note 8, at 959.
D. Sala-i-Martin Test

Sala-i-Martin commented that the L-R test is too strict and suggests relaxing the criterion imposed by Leamer.\textsuperscript{71} His S test moves away from the 0-1 labeling of variables as robust versus non-robust and emphasizes: (1) the entire distribution of the estimated $\beta_{zj}$ and (2) their significance levels in each regression. In this approach, Sala-i-Martin recursively computed the likelihood ($L_{zj}$), point estimate ($\hat{\beta}_{zj}$), and standard deviation ($\hat{\sigma}_{zj}$) for each regression. Then, he constructed a mean estimate ($\bar{\beta}_z$) as the weighted average of the estimated $\beta_{zj}$ in each regression, $\bar{\beta}_z = \sum_j \omega_{zj} \hat{\beta}_{zj}$, where the weights ($\omega_{zj}$) are proportional to the likelihoods $\omega_{zj} = L_{zj}/\sum_i L_{zi}$. Finally, the average variance was computed by the weighted average of the estimated variance: $\bar{\sigma}_z^2 = \sum_j \omega_{zj} \hat{\sigma}_{zj}^2$.\textsuperscript{72} These estimated means and variances are used to compute the fraction of the weighted CDF (cumulative density function) that is to the right of zero.\textsuperscript{73} If this area is sufficiently large (or small) for a positive (or negative) relationship, the relationship is guaranteed to be robust. Evidently, this relaxation of the criterion leads to more robust relationships regarding the growth literature.

E. Results

I now use these two tests to check if the evidence regarding the rich group is robust or not. Table 6 gives the results of the estimation of equation (8), containing the estimated mean ($\bar{\beta}_z$), standard deviation ($\bar{\sigma}_z$), confidence intervals, fraction of significant estimates, as well as the results of the L-R and S tests. The L-R test indicates whether “all” estimates of $\beta_{zj}$ are significant and of the same sign. If they are, then one can claim that the variable of interest is robust in explaining the productivity growth. The results show that none of the policy variables passes the L-R test. However, the variable of concern (EFFLAW) is significant in 83 percent of the cases. This fraction of significant estimates is higher than those of other variables, such as INFLATION (significant in 37 percent of the cases).

As to the result of the S test, the last column of Table 6 reports the fraction of the CDF that is to the right of zero for each policy variable. If this fraction is larger than 95 percent or is less than 5 percent, then one may claim that the variable of interest is significantly correlated with productivity growth. The evidence shows that 5 out of 11 variables appear to be “significant;” all Solow variables ($I/Y$, $n + g + \delta$, and $Y/L$) pass the S test. The

\textsuperscript{71} Sala-i-Martin, supra note 57.
\textsuperscript{72} This approach gives more weight to the regressions that are more likely to represent the true model.
\textsuperscript{73} It is the area below the density function of the estimated coefficient that is lying to the right-hand side of zero. The CDF is calculated using the standard normal distribution.
other two significant variables include EFFLA W and INFLATION. This finding supports the existence of a positive relationship between EFFLA W and GROWTH and indicates that the effect of competition law on growth depends on law enforcement efficiency.

VI. ROBUSTNESS ANALYSIS II: OTHER POTENTIAL CONFOUNDING FACTORS

A. Effect Size of the Estimated Coefficient

The previous robustness tests focused on the sign and significance of the estimated coefficients. However, it is often useful to know not only whether an experiment has a statistically significant effect, but also the sizes of any observed effects. Thus, this subsection investigates the robustness in terms of the effect sizes of estimated coefficients reported in Table 6. The empirical method includes comparing the effects of various policies on GROWTH if one goes from a level at the 25th percentile to a level at the 75th percentile of the distribution for various policy variables. The results are listed in Table 7. Evidently, all Solow variables demonstrate large effect sizes in explaining economic growth. For instance, an increase in investment share (I/Y) from the 25th percentile to the 75th percentile can lead to a hypothetical 0.69 percentage points increase in productivity growth. The result for

---

**Table 6.** Robustness test results (dependent variable: GROWTH)

<table>
<thead>
<tr>
<th>Variable of Interest (z)</th>
<th>Mean $\hat{\beta}_z$</th>
<th>Standard Error $\sigma_\hat{\beta}_z$</th>
<th>Conf. Int. Left(a)</th>
<th>Conf. Int. Right</th>
<th>Frac. of Sig. (%)b</th>
<th>L-R Test</th>
<th>S Test</th>
<th>Weighted CDFc</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/Y</td>
<td>0.067</td>
<td>0.025</td>
<td>0.049</td>
<td>0.084</td>
<td>40</td>
<td>−</td>
<td>+</td>
<td>0.96</td>
</tr>
<tr>
<td>$n_i + g + \delta$</td>
<td>−52.4</td>
<td>20.4</td>
<td>−66.5</td>
<td>−38.3</td>
<td>30</td>
<td>−</td>
<td>+</td>
<td>0.05</td>
</tr>
<tr>
<td>Y/L</td>
<td>−0.00016</td>
<td>0.0001</td>
<td>−0.0002</td>
<td>−0.0001</td>
<td>50</td>
<td>−</td>
<td>+</td>
<td>0.01</td>
</tr>
<tr>
<td>EFFLA W</td>
<td>0.072</td>
<td>0.024</td>
<td>0.052</td>
<td>0.092</td>
<td>83</td>
<td>−</td>
<td>+</td>
<td>0.99</td>
</tr>
<tr>
<td>SE</td>
<td>−0.003</td>
<td>0.013</td>
<td>−0.014</td>
<td>−0.007</td>
<td>0</td>
<td>−</td>
<td>−</td>
<td>0.39</td>
</tr>
<tr>
<td>INFLATION</td>
<td>−13.80</td>
<td>4.08</td>
<td>−17.2</td>
<td>−10.4</td>
<td>37</td>
<td>−</td>
<td>+</td>
<td>0.03</td>
</tr>
<tr>
<td>RERD</td>
<td>−0.001</td>
<td>0.002</td>
<td>−0.003</td>
<td>0.0002</td>
<td>0</td>
<td>−</td>
<td>−</td>
<td>0.41</td>
</tr>
<tr>
<td>OPENNESS</td>
<td>0.008</td>
<td>0.004</td>
<td>0.004</td>
<td>0.011</td>
<td>23</td>
<td>−</td>
<td>−</td>
<td>0.90</td>
</tr>
<tr>
<td>GOVSH</td>
<td>0.004</td>
<td>0.019</td>
<td>−0.012</td>
<td>0.019</td>
<td>0</td>
<td>−</td>
<td>−</td>
<td>0.54</td>
</tr>
<tr>
<td>PI</td>
<td>0.0003</td>
<td>0.005</td>
<td>−0.004</td>
<td>0.005</td>
<td>0</td>
<td>−</td>
<td>−</td>
<td>0.52</td>
</tr>
<tr>
<td>TOT</td>
<td>−1.45</td>
<td>2.68</td>
<td>−3.69</td>
<td>0.786</td>
<td>0</td>
<td>−</td>
<td>−</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Notes: The regression sample is the rich group. The robustness test uses a 5% significance level.
a. “Conf. Int. Left” denotes the left-hand side of the symmetric interval that encloses the estimated mean at the 5% significance level.
b. “Frac. of Sig.” denotes the fraction of significant estimates that differ from 0.
c. “Weighted CDF” denotes the fraction that is to the right of 0 and is exhibited as follows: $CDF = 1 - p(z = \hat{\beta}_z/\sigma_{\hat{\beta}_z}, \text{onesided}).$

---

The OPENNESS is significant if the significance level is relatively large (for instance 10%).

The effect size of I/Y is calculated by $\Delta GROWTH = 0.067 \times \Delta (I/Y) = 0.687\%$. The value of 0.067 is the mean value of the estimated coefficient on I/Y, which is obtained from Table 6.
Y/L also indicates that the growth rate of a 25th-percentile country is higher than that of a 75th-percentile country by 2.02 percentage points.

To investigate the impact of a stronger competition law, I also set the governmental efficiency as its sample mean (\( \text{EFFICIENCY} = 0.32 \)) and calculate the effect size of an increase in \( \text{SCOPE} \) from the 25th percentile to the 75th percentile as follows:

\[
\Delta \text{GROWTH} = 0.072 \cdot \text{EFFICIENCY} \cdot \Delta \text{SCOPE} = 0.072 \cdot 0.32 \cdot 3 = 0.069\% \quad \text{76}
\]

Even though \( \text{EFFLAW} = \text{EFFICIENCY} \cdot \text{SCOPE} \) is the most robust variable in terms of sign and significance, this kind of significant increase in \( \text{SCOPE} \) merely increases the growth rate by 0.07 percentage points. The effect size of \( \text{SCOPE} \) is much lower than the effect sizes of \( \text{INFLATION} \) (–0.18 percent) and \( \text{OPENNESS} \) (0.40 percent), not to mention of the Solow variables. At most, my evidence provides only weak support for the claim of Krakowski\(^\text{77}\) and Werden\(^\text{78}\) that competition law has a positive and significant effect on economic growth.

Although market competition is of great importance to \( \text{GROWTH} \), it depends upon too many different factors of which competition law is only one. Competition law is at best a narrow aspect of competition policy. In a broader sense, all policies designed to ensure the satisfactory functioning of market competition—for instance, trade liberalization, privatization, deregulation, and especially enforcement efficiency as emphasized in this article—should also be considered as being part of competition policy.

---

\(^{76}\) Here, 0.072 is the mean value of the estimated coefficient for \( \text{EFFLAW} \) in Table 6.

\(^{77}\) Krakowski, supra note 13.

Competition policy in the narrow sense of course cannot be expected to bring good results if it is counteracted by competition policy in the broader sense.

B. Using the Same Proxy for the Variable of Interest and Segregating

The results reported above suggest a mild preliminary support for the proposition that \( \text{EFFLAW} \) has a positive, though limited, effect on \( \text{GROWTH} \). The discussion also shows that these results are robust to the inclusion or exclusion of other variables. However, the fact that this investigation has been based exclusively on the use of \( \text{EFFICIENCY} \) as a proxy for governmental efficiency in determining \( \text{EFFLAW} \) may stand in the way of the results becoming truly persuasive. In this subsection, I address this concern by investigating the way in which the regression results are affected if an alternative proxy variable for governmental efficiency is used. Because \( \text{EFFICIENCY} \) mainly focuses on the quality of public service provision or the quality of bureaucracy in implementing competition policy, I use another indicator, \( \text{REGULATION} \), which principally concerns the policies themselves as a proxy for governmental efficiency. \( \text{REGULATION} \) assesses the appropriateness of public policies such as price liberalization, the trade and foreign exchange system, commercial law extensiveness, and financial regulations. It is used to create a new interaction term, \( \text{REGLAW} = \text{SCOPE} \cdot \text{REGULATION} \), which will be included in equations (6) and (7) to substitute for \( \text{EFFLAW} \).\(^{79}\) This specification allows me to test whether countries that exhibit stronger competition law can grow disproportionately faster if they are good in terms of regulatory policy.

Additionally, in this article, Bruce Hansen’s Gauss-procedure threshold test is used to locate a single structural break at an unknown point within the sample, which consists of observations of several variables—for example, Solow variables \( (I/Y, n + g + \delta, \text{and } Y/L) \), \( \text{SCOPE} \), and \( \text{EFFICIENCY} \). Considering the possible interaction effects among these variables, it is statistically unlikely to have a clear-cut distinction between the rich group and the poor group in the quality of law enforcement.\(^{80}\) To test the robustness of the conclusion regarding the choice of the segregating variable, I conduct a threshold effect that uses the same proxy for both the variable of interest and the segregating variable. This means that I use \( \text{EFFICIENCY} \) (\( \text{REGULATION} \)) as the segregating variable in the regression including \( \text{EFFLAW} \) (\( \text{REGLAW} \)).

\(^{79}\) The \( \text{REGULATION} \) data are average values over a period of 9 years between 1996 and 2004.

\(^{80}\) The previous analysis uses \( \text{LAWS} \) as a segregating variable to split the sample into a rich group and a poor group.
Table 8. Regression results using the same proxy for both the variable of interest and the segregating variable and excluding outliers (dependent variable: $GROWTH$)

<table>
<thead>
<tr>
<th>Sample</th>
<th>$EFFICIENCY$</th>
<th>$REGULATION$</th>
<th>OUTLIERS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(A)</td>
<td>(B)</td>
<td>(C)</td>
</tr>
<tr>
<td></td>
<td>Rich</td>
<td>Poor</td>
<td>Rich</td>
</tr>
<tr>
<td>Constant</td>
<td>2.197 (1.487)</td>
<td>6.147** (2.802)</td>
<td>0.861 (1.448)</td>
</tr>
<tr>
<td>$I/Y$</td>
<td>0.062* (0.035)</td>
<td>0.103* (0.060)</td>
<td>0.067** (0.033)</td>
</tr>
<tr>
<td>$n_{i} + g + \delta$</td>
<td>$-21.967 (23.537)$</td>
<td>$-69.651** (34.692)$</td>
<td>$-8.061 (22.362)$</td>
</tr>
<tr>
<td>$\ln(\tau_i)$</td>
<td>$-0.0001* (0.00006)$</td>
<td>$-0.0005*** (0.0002)$</td>
<td>$-0.0001* (0.00005)$</td>
</tr>
<tr>
<td>$EFFLAW$</td>
<td>0.038* (0.023)</td>
<td>0.041 (0.049)</td>
<td>0.055** (0.024)</td>
</tr>
<tr>
<td>$REGLAW$</td>
<td>0.062 (0.035)</td>
<td>0.103 (0.060)</td>
<td>0.067 (0.033)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.66</td>
<td>0.31</td>
<td>0.67</td>
</tr>
<tr>
<td>Observations</td>
<td>51</td>
<td>50</td>
<td>56</td>
</tr>
<tr>
<td>$DWH F$ test</td>
<td>1.04</td>
<td>1.69</td>
<td>0.44</td>
</tr>
</tbody>
</table>

Notes: Columns (A) through (D) report regression results when using the same proxy for both the variable of interest and the segregating variable. Thus, in Columns (A) and (B), $EFFICIENCY$ is used as the segregating variable in the regression including $EFFLAW$, and in Columns (C) and (D), $REGULATION$ is used as the segregating variable in the regression including $REGLAW$. The figures in parentheses are standard errors. ** indicates that the estimates are significant at the 1% level, * at the 5% level, and * at the 10% level.
The regression results are reported in Columns (A) to (D) of Table 8. The results show the same pattern as that of Table 4. For countries in the rich group, Columns (A) and (C) indicate that the coefficients of EFFLAW and REGLAW are positively significant, as expected. For countries in the poor group, both coefficients of the interaction terms are not significant, as shown in Columns (B) and (D), suggesting that the enforcement of competition law still has a very limited effect on changing economic activity.81

C. Outliers

A general concern is that the results based on these growth regressions could be driven by the exceptional performance of some countries (for example, East Asian countries) or certain countries that could not be fully captured by the inclusion of the Solow variables. To be sure, I run a regression dropping three countries (Luxembourg, Mongolia, and Taiwan) for which the residual is larger than two standard errors. The results, reported in Column (E) of Table 8, show that the coefficient for EFFLAW becomes larger in magnitude and more significant compared with the results in Column (D) of Table 4. Thus, the effect of EFFLAW is, in fact, strengthened.

D. Panel Regression

Another possible concern is that growth rates for many different countries changed over this period. Because this article investigates the 15-year average growth rate of productivity for each country, it may not be able to detect some extreme changes within a relatively short period, like those in Zimbabwe.82 Moreover, although the dependent variable (GROWTH) is the average growth rate over the period from 1990 to 2004, the majority of competition laws were passed after 1990, and it is unlikely that passing the law could have a significant effect on the economy over a short period of time.83 This may stand in the way of the model becoming truly

---

81 It is well known that the enforcement of the competition law is no easy and straightforward mission, and hence the agencies must undergo a process of learning by doing before they can enforce the law effectively. At this point, one might expect a learning curve both for competition agencies and industry during the application of competition legislation. Thus, I use a series of the years of application of competition law (YEAR) in the respective countries to construct another interaction term, YEARLAW = SCOPE log(YEAR). However, YEARLAW is not significant in the regression of the group of rich countries. This may reflect the fact that the dependent variable GROWTH refers to the average growth rate over the period from 1990 to 2004 while the majority of competition laws were passed after 1990 and it is unlikely that passing the law could have a significant effect on the economy over a short period of time.

82 This would be the case if, for example, some of the countries go through a period of about 3 to 5 years of major economic crises, but during other periods they have offsetting fast growth, making their average GROWTH similar to those in other countries.

83 In addition, the variable SCOPE from Hylton and Deng is a snapshot as of 2004.
persuasive. I address these problems by estimating a variation of the basic regression using a panel of 5-year averages for each country between 1990 and 2004. The panel regression is estimated with time fixed effects as follows:

\[
GROWTH_{it} = \pi_t + \pi_1 \ln(I_{it}) + \pi_2 \ln(n_{it} + g + \delta) + \pi_3 \ln(Y_{it}) + \pi_4 \text{SCOPE}_{i} + \pi_5 \text{EFFLAW}_{i} + \epsilon_i
\]

where all the variables are defined similarly to those in Table 4, except that I now have a full set of time effects for every five-year episode, namely, the \( \pi_t \) terms (\( t = 1, 2, \) and 3). Theoretically, the fixed effects estimator is consistent even in the presence of a correlation between the error term and any of the explanatory variables. In this sense, it is always safe to use the fixed effects estimator to estimate panel data models. Finally, Table 9 indicates that the regression results still exhibit the same pattern as that shown in Table 4. For countries in the rich group, Columns (B) and (D) indicate that the coefficients of \( \text{EFFLAW} \) have the expected sign and are significant at the 10 percent level. As to the poor group, Columns (C) and (E) also show that the coefficients of \( \text{EFFLAW} \) are not significant, as expected. However, the \( R^2 \)s of these panel regressions are quite low, implying that the Solow model fits poorly at a 5-year horizon. Particularly in the case of the poor countries, there is no Solow variable that is significant in the analysis. I suspect that the most likely reason is the inherent limitation of my empirical specification.

First, the Solow model given in equation (5) only describes long-term growth of an economy in the steady state, and hence, it cannot be used to investigate the short-run dynamic features of the Solow model. At this point, the 5-year length of observation appears to be too short to investigate

---

84 The methodology of this approach is to combine different averaging periods for countries with various years of passing competition laws while preserving the number of observations.
85 The main interest of this article is in the institutionally determined component of \( \text{SCOPE} \) and \( \text{EFFLAW} \) (that is more clearly exogenous), hence not in the variations in \( \text{SCOPE} \) from year to year. Because these institutionally determined variables are constant across time, I have more than one observation per country, but the key regressors (\( \text{SCOPE} \) and \( \text{EFFLAW} \)) only vary by country. Thus, this regression does not and cannot control for a full set of country dummies.
87 I try to control the impact of the financial crisis (1997-1998) on \( GROWTH \), but this variable turns out to be insignificant. I suspect that its impact is absorbed by the time fixed effect in the panel model.
Table 9. Regression results for 5-year panels, 1990-2004 (dependent variable: GROWTH)

<table>
<thead>
<tr>
<th>Variable</th>
<th>(A) Equation (5) Full Sample</th>
<th>(B) Equation (6) Rich</th>
<th>(C) Equation (7) Poor</th>
<th>(D) Equation (6) Rich</th>
<th>(E) Equation (7) Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(IY)</td>
<td>0.084** (0.042)</td>
<td>0.071** (0.036)</td>
<td>0.089 (0.081)</td>
<td>0.072** (0.036)</td>
<td>0.087 (0.080)</td>
</tr>
<tr>
<td>ln(n + g + δ)</td>
<td>0.477 (21.590)</td>
<td>1.509 (21.958)</td>
<td>6.138 (37.574)</td>
<td>0.462 (22.034)</td>
<td>8.012 (35.486)</td>
</tr>
<tr>
<td>ln(YL)</td>
<td>0.0001 (0.00006)</td>
<td>0.0001* (0.00005)</td>
<td>0.0001 (0.0002)</td>
<td>0.0001 (0.00004)</td>
<td>0.0001 (0.0002)</td>
</tr>
<tr>
<td>SCOPEi</td>
<td>-0.053 (0.053)</td>
<td>-0.091 (0.063)</td>
<td>-0.017 (0.110)</td>
<td>-0.0001 (0.00004)</td>
<td>-0.0001 (0.0002)</td>
</tr>
<tr>
<td>EFFLAWi  (SCOPE-EFFICIENCY)</td>
<td>0.048** (0.024)</td>
<td>0.046* (0.027)</td>
<td>0.066 (0.077)</td>
<td>0.046* (0.028)</td>
<td>0.073 (0.064)</td>
</tr>
<tr>
<td>R²</td>
<td>0.19 0.39 0.13 0.38 0.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>299 158 141 158 141</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: The figures in parentheses are standard errors. *** indicates that the estimates are significant at the 1% level, ** at the 5% level, and * at the 10% level. The (Y/L) term is measured at the start of each 5-year period (at 1990 for the period from 1990 to 1994, and so forth).
Table 10. Regression results when EFFICIENCY is included in the model (dependent variable: GROWTH)

<table>
<thead>
<tr>
<th>Variable</th>
<th>(A) Full Sample</th>
<th>(B) Rich</th>
<th>(C) Poor</th>
<th>(D) Rich</th>
<th>(E) Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>5.942*** (1.990)</td>
<td>3.686* (1.946)</td>
<td>10.862*** (3.959)</td>
<td>2.451 (1.515)</td>
<td>5.631* (2.859)</td>
</tr>
<tr>
<td>ln((\hat{\beta}_j))</td>
<td>0.072** (0.035)</td>
<td>0.054 (0.035)</td>
<td>0.077 (0.065)</td>
<td>0.058* (0.035)</td>
<td>0.111* (0.063)</td>
</tr>
<tr>
<td>ln((n_i + g + \delta))</td>
<td>-59.469*** (22.722)</td>
<td>-20.703 (23.327)</td>
<td>-116.891*** (44.038)</td>
<td>-24.528 (23.149)</td>
<td>-63.656* (35.214)</td>
</tr>
<tr>
<td>ln((\hat{\beta}_j))</td>
<td>-0.0002*** (0.0001)</td>
<td>-0.0001** (0.00006)</td>
<td>-0.0005*** (0.0002)</td>
<td>-0.0001** (0.00006)</td>
<td>-0.0004** (0.0002)</td>
</tr>
<tr>
<td>SCOPE_i</td>
<td>-0.057 (0.044)</td>
<td>-0.078 (0.060)</td>
<td>-0.068 (0.087)</td>
<td>-0.068 (0.087)</td>
<td>-0.068 (0.087)</td>
</tr>
<tr>
<td>EFFICIENCY_i</td>
<td>0.183 (0.376)</td>
<td>0.211 (0.305)</td>
<td>-0.284 (1.394)</td>
<td>-0.284 (1.394)</td>
<td>-0.284 (1.394)</td>
</tr>
<tr>
<td>EFFLAW(SCOPE-EFFICIENCY)</td>
<td>0.047** (0.021)</td>
<td>0.054* (0.028)</td>
<td>0.054 (0.055)</td>
<td>0.044* (0.023)</td>
<td>0.046 (0.047)</td>
</tr>
<tr>
<td>R²</td>
<td>0.44</td>
<td>0.66</td>
<td>0.37</td>
<td>0.65</td>
<td>0.30</td>
</tr>
<tr>
<td>Chow test</td>
<td></td>
<td>20.48***</td>
<td></td>
<td>21.04***</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>101</td>
<td>53</td>
<td>48</td>
<td>53</td>
<td>48</td>
</tr>
<tr>
<td>DWH F test</td>
<td>0.31</td>
<td>1.08</td>
<td>0.24</td>
<td>0.54</td>
<td>1.23</td>
</tr>
</tbody>
</table>

Notes: Columns (D) and (E) are replicated from Table 4. The figures in parentheses are standard errors. *** indicates that the estimates are significant at the 1% level, ** at the 5% level, and * at the 10% level.
the long-term evolution of output growth. Second, the unsatisfactory performance of the panel regression for the poor group may be related to the convergence prediction of the Solow model. The Solow model predicts that the LDCs converge to their respective steady states. According to the catching-up theory, one of the major factors that determine a LDC’s steady state is the technological level of the most advanced countries. This is because the LDCs can adopt modern technologies from the DCs without having to develop those technologies and thus can benefit from technological progress in the DCs. Applying this line of argument to my study means that international technology transfer will generate an externality that affects the dependent variable in the regressions of Columns (C) and (E). However, the sample of poor countries does not include the most advanced countries (for example, the United States and EU countries). This inevitably reduces the explanatory power of the model when examining the Solow concept of convergence toward steady state.

E. Missing Variable: EFFICIENCY

The main finding of the previous analysis is the significance of the interaction term \( \text{EFFLAW} = \text{SCOPE} \cdot \text{EFFICIENCY} \) and the insignificance of the individual variable (SCOPE). This outcome raises another concern: the explanatory variables include only SCOPE and \( \text{SCOPE} \cdot \text{EFFICIENCY} \), while the individual variable EFFICIENCY in the interaction term is missing in the regression. To address this concern, Columns (A) to (C) of Table 10 test the robustness of the previous evidence by including EFFICIENCY in the regression. First, the results indicate that EFFICIENCY is insignificant in all regressions. Second, the results in Columns (A) and (B) show that the coefficients of interaction term (EFFLAW) are still significant in explaining GROWTH for the full and rich samples. Moreover, in Column (C), the coefficient of EFFLAW for the poor sample is not significant, as expected. For comparison’s sake, I also replicate the regression results of Table 4 in Columns (D) and (E). The comparison evidently shows that regressions containing EFFICIENCY exhibit the same pattern as the regressions shown in Table 4.

VII. CONCLUSION

This article has performed a cross-country study and has found a positive relationship between the effective enforcement of competition law and productivity growth. The enforcement of competition law provides only the

90 This is likely due to its multicollinearity with the Solow variables (I/Y and Y/L).
preconditions for intense competition but not the intense competition itself. The success or failure of the law depends on the competition culture that is shaped by the country’s socioeconomic ideology and institutional framework.