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Special Issue on Potential Growth and Misallocation in Asia
Guest Editor: Miguel A. León–Ledesma

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Please direct all editorial correspondence to the Managing Editor, *Asian Development Review*, Economic Research and Regional Cooperation Department, Asian Development Bank, 6 ADB Avenue, Mandaluyong City, 1550 Metro Manila, Philippines. E-mail: asiandevreview@adb.org

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Asia's future growth prospects are key to the evolution of the world economy. By the middle of this decade, Asia's contribution to the world's gross domestic product growth had surpassed 60%. The spectacular growth performance of the People's Republic of China and the growth acceleration of India have had significant implications for poverty reduction and shifted the axis of the global economy toward Asia. Studying Asia's future potential growth—including its determinants, obstacles, and policy influences—is essential to understanding the direction of the world economy.

This special issue of the *Asian Development Review* presents a series of studies that focus on potential growth and its determinants, which we define as the maximum capacity of an economy, or the growth rate of the labor force plus the growth rate of technical progress (labor productivity). Potential growth is not policy invariant and certainly not a constant. While there are certain secular trends, particularly related to demographics that can be considered independent of policies, one of the essential drivers of potential growth is enhanced productivity. This is where policies can play an important role, thus reducing the gap between potential growth and its frontier. This special issue focuses on the reallocation of factors of production between sectors and firms as a determinant of potential growth, and explores aspects of the political economy that are usually ignored in the study of potential growth.

The papers included in this issue provide in-depth analyses of the (i) trends and determinants of potential growth in Asia, (ii) role of demographics, (iii) importance of firm-level misallocation and sectoral transformation in determining productivity, and (iv) political economy of reforms. The papers explore the influences of potential growth in Asia and policies to improve growth potential amid structural headwinds such as aging populations and the exhaustion of the initial stages of economic transformation. Although the main focus is the Asian experience and the region's future growth prospects, the theoretical and methodological insights put forth extend beyond Asia.

In the first paper, Lanzafame estimates the growth rate that an economy will achieve absent any significant macroeconomic imbalances in inflation or unemployment. This is the rate of growth of gross domestic product toward which the economy tends to gravitate ceteris paribus. Lanzafame constructs time-varying estimates of potential growth for 21 Asian economies using Kalman filtering techniques and finds robust determinants of potential growth among a large set of possible variables. The findings identify technology gaps, demographic factors, education, and institutional quality as key determinants of potential growth. In addition, the recent growth slowdown in Asia is shown to be associated with a slowdown in potential growth, rather than cyclical aspects.

Burns estimates potential output (rather than potential growth) for 23 Asian economies using a production function approach. Potential output is decomposed into the contributions of demographics, labor market efficiency, capital–output ratios, structural change, and total factor productivity growth. Burns then estimates potential output for the next 25 years under a set of scenarios. The conclusions point toward demographics and stabilizing capital–output ratios as possible forces slowing down growth in the long run. At the same time, there is still room for structural transformation to boost growth in many economies.

Otsu and Shibayama focus on the impact of population aging on economic growth. They develop a general-equilibrium quantitative macro model where households comprise working-age and retired adults. The model yields output growth projections for 33 Asian economies through 2050 and finds that population aging can reduce potential growth by about 0.55 percentage points per annum. They also consider indirect channels such as the effect of aging on government spending, labor income taxes, and a decline in productivity growth.

Foster–McGregor and Verspagen offer an empirical decomposition of the sources of growth for 43 Asian and non-Asian economies. They focus on the contribution of productivity growth within sectors, resource reallocation between sectors, and labor participation margins. Their findings for Asian economies show the importance of within-sector productivity growth, especially for richer economies. Structural change is particularly relevant for poorer economies with scope for productivity gains from reallocation between sectors, and for rich economies undergoing the transition from manufacturing- to services-led development.

Ha, Kiyota, and Yamanouchi explore misallocation at the micro level by focusing on manufacturing in Viet Nam. Using firm-level data, they calculate measures of allocative distortions to find that reallocating capital and labor across firms in Viet Nam could yield substantial total factor productivity gains. If Vietnamese firms shared the hypothetical allocative efficiency of firms in the United States, their total factor productivity would be almost 31% higher. The distortions appear to constrain large and efficient firms, while protecting smaller and less efficient ones. Therefore, removing certain barriers to the reallocation of capital and labor between firms could lead to enormous productivity gains.

León–Ledesma and Christopoulos tackle the issue of financial distortions that prevent firms from investing optimally in capital. They use a large data set of 15,000 firms across 43 economies to test the impact of access to finance on misallocation and the role of access to public and private credit. They find that access-to-finance obstacles are significant drivers of misallocation. However, quantitatively, financial access can only explain a very small proportion of firm-level misallocation. They also find that access to public credit can worsen misallocation for firms that have access to other sources of finance and improve it for those that face financial constraints. Overall, public credit does not appear to undo the negative effects of lack of access to finance.

Ghate, Glomm, and Streeter study the role of differential sectoral tax rates, sectoral infrastructure investment, and labor market frictions in India using a two-sector model that quantifies the effects of policies in reducing the misallocation of resources between the agriculture and modern (manufacturing and service) sectors in India. The results of policy reforms depend on whether public and private capital are complements or substitutes. A key policy recommendation is that investment in infrastructure in both the agriculture and modern sectors, financed through increasing labor income taxes in agriculture, could boost potential growth in India.

Finally, Wang studies the problem of the middle-income trap from a political economy perspective. Consistent with the concept of frontier potential growth, an economy's ability to avoid the middle-income trap depends on the introduction of policy reforms. Wang offers a politico-economic interpretation of the incentives that policy makers face: reforms that lead to a growth strategy driven by innovation might harm policy maker interests, therefore they might instead implement policies that harm innovation and potential growth. The paper then analyzes the political institutions that shape policy maker incentives and offers a framework to study which policies are key to escaping the middle-income trap.

Jesus Felipe
Managing Editor
Asian Development Review

Miguel A. León–Ledesma
Guest Editor
School of Economics and
the Macroeconomics, Growth, and
History Centre, University of Kent

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Potential Growth in Asia and Its Determinants: An Empirical Investigation

Matteo Lanzafame*

This paper contributes to the literature on growth in Asia in several respects. I provide estimates of potential growth for 21 Asian economies using an aggregate supply model with time-varying parameters and a Kalman filtering methodology. My estimates indicate that the actual growth slowdown experienced by many of these economies in the 2000s is associated with a falling trajectory in potential growth. Relying on Bayesian model averaging, I select robust determinants of potential growth and find that the latter is driven by the technology gap, trade, tertiary education, and institutional quality, as well as by working-age population growth. Effective reforms in these areas can help counterbalance declines in potential growth in Asia. I also investigate the relationship between business cycle features and potential growth, finding that higher volatility in actual growth has significantly negative effects on potential growth. Thus, stabilization policies can have beneficial effects on Asian economies' long-term growth performance.

Keywords: Asian economies, Kalman filter, potential growth
JEL codes: C23, O40, O47

I. Introduction

Many Asian economies have enjoyed a remarkable growth performance over the last 3 decades. With annual growth rates often close to 8%–10%, the People's Republic of China (PRC) and Southeast Asian economies, in particular, have been referred to as growth miracles and their experience has fueled a growing debate in the economic literature regarding the determinants of this performance and whether it can be replicated in other emerging economies. Growth theory indicates that, in the long run, economies tend to grow at a rate consistent with the full utilization of productive resources, which is known as the natural or potential growth rate (see, for example, Blinder and Solow 1973, León–Ledesma and Thirlwall 2002). Short-term shocks can lead to temporary deviations from the potential growth rate that give rise to changes in unemployment and inflation. Over time, these changes will be corrected via the adjustment of relative prices, and growth will return to its potential

*Matteo Lanzafame: Department of Economics, University of Messina, Italy. E-mail: mlanzafame@unime.it. The author would like to thank the participants at the Asian Development Outlook–Asian Development Review Conference held in Seoul in November 2015, the managing editor, and an anonymous referee for helpful comments. He would also like to thank Noli Sotocinal and Connie Bayudan–Dacuycuy for excellent research assistance. The usual disclaimer applies.

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rate. There is wide agreement that the persistently high growth rates characterizing Asian economies reflect their high potential growth rates.

Though still generally higher than that of other emerging and advanced economies, average growth in Asia has declined in the last decade. In many cases, growth performance seems to have deteriorated since the 2008–2009 global financial crisis. This raises the question of whether such a decline reflects a transitory (though persistent) deviation of actual growth from the potential growth rate, or if it signals a fall in the potential growth rate itself. If Asian economies are entering a new phase of permanently lower long-run growth, there will be implications for a number of economic and social policies.

This paper proposes an empirical investigation of the issues discussed above. I estimate the potential growth rate for a sample of 21 Asian economies, relying on an unbalanced panel of annual data over the period 1960–2014. Given my interest in the dynamics of potential growth in Asia, my approach is based on a time-varying parameter aggregate supply (AS) model that is consistent with the concept of the natural growth rate proposed by Harrod (1939) and its relation to Okun's Law and the Phillips curve. I consider different versions of the AS model and estimate it via a Kalman filtering methodology to obtain time-series estimates of Asian economies' potential growth rates. I find that the potential growth rate of most Asian economies has been on a downward trajectory since the 2000s, and that this pattern either continued or worsened during 2008–2014. In most cases, the estimated potential growth rate was lower in 2014 than during 2000–2007. Given that actual growth will tend to return to the potential growth rate in the long term, this outcome raises concerns regarding the growth performance of Asian economies in the medium to long term, and reinforces the need to investigate the determinants of potential growth.

To carry out this task, I rely on a larger panel of annual data for 69 advanced and emerging economies over the period 1960–2014. The objective is to obtain more efficient and reliable estimates, exploiting the additional information that is available beyond the data in the sample of 21 Asian economies. From an econometric viewpoint, my search for robust determinants of potential growth is based on a recently proposed methodology for model selection: the Bayesian model averaging (BMA) approach developed by Magnus, Powell, and Prüfer (2010) for the estimation of classical linear regression models with uncertainty about the choice of the explanatory variables. Harrod's natural growth rate is defined as the sum of the growth rates of labor productivity and the labor force. I introduce (trend) working-age population growth (used as a proxy for labor force growth) in the model as a fixed regressor, while letting BMA estimations select the additional robust regressors. I find that out of 35 variables considered, seven are considered to be robust determinants of potential growth. My estimates confirm that the growth rate of the working-age population has a direct relationship with potential growth, as suggested by theory, with a 1% increase in this variable leading a similar increase in the potential growth rate. The implication is that, as with advanced economies, aging populations will gradually become a significant drag on (potential) growth in emerging Asian economies such as the PRC. Other variables that play a significant role in shaping the trajectory of the potential growth rate include a proxy for the technology gap (as measured by an economy's differences with the United States [US]), a measure of tertiary education levels, proxies for labor market rigidity, and proxies for institutional quality (as measured by indexes for perceived government efficiency and accountability). Integration with the world economy via trade and financial links is also important and has the expected positive impact on potential growth. In particular, the effects of financial integration depend on the quality of institutions. I find that economies characterized by lower perceived regulatory quality enjoy positive effects from greater connection to international financial markets, but these gains gradually disappear as institutional quality increases. Overall, the results indicate that effective economic policy interventions and, more generally, improvements in institutional quality (e.g., more flexible labor markets, more efficient and accountable government) have the potential to positively affect the trajectory of potential growth, thus counteracting the effects of the recent slowdown in many Asian economies.

Next, I turn to the question of whether the 2008–2009 global financial crisis left persistent, or even permanent, scars on the potential growth rates of Asian economies. For this to be the case, potential growth should be endogenous with respect to the actual growth rate (or, more generally, business cycle features such as deviations of the actual from the potential growth rate and growth volatility). I investigate this hypothesis using two different approaches and find that a higher volatility of actual growth with respect to the potential growth rate has a significantly negative impact on the latter. This result suggests that policy measures leading to a more stable macroeconomic and growth environment can have long-lasting positive effects on growth performance. On the other hand, my estimates do not provide evidence indicating that short-term deviations from actual growth affect the potential growth rate, either positively or negatively. Taken at face value, this result indicates that the effects of the 2008–2009 global financial crisis on potential growth rates in Asia, however deep and persistent, will not be permanent.

The remainder of the paper is organized as follows. The next section describes the model and empirical methodology used to estimate the potential growth rates of my sample of Asian economies. Section III is devoted to the investigation of the determinants of potential growth. Section IV considers the relationship between business cycle features and the dynamics of the natural or potential growth rate. Section V concludes.

II. Model and Estimation Methodology

The concept of the natural rate of growth was formally introduced in growth theory by Harrod (1939), who defined it as the sum of the growth rates of the labor force and labor productivity, both of which were assumed to be exogenous. This implies that Harrod's natural rate of growth is the particular growth rate associated with full employment and a stable inflation rate. As such, the role played by the natural growth rate is twofold: it is both the trend growth rate of the economy and the short-term upward limit to (noninflationary) growth that turns cyclical expansions into recessions.

Since the natural growth rate is defined as the sum of the growth rates of labor productivity and the labor force, unemployment will rise whenever the actual rate of growth (g_t) falls below the natural rate, and it will fall when g_t rises above g^N; that is, the natural rate of growth is the particular growth rate consistent with a nonchanging unemployment rate. Thus, a simple estimation framework to pin down the value of g^N is provided by the following specification of Okun's Law:

$$\Delta U_t = \sigma - \varsigma g_t \tag{1}$$

where ΔU_t is the percentage change in the unemployment rate U_t, and g_t is the growth rate of output.

This specification has been widely used in the literature to estimate g^N for economies and regions and, among other things, to investigate its possible endogeneity (see, for example, León–Ledesma and Thirlwall 2002, Lanzafame 2010). For my purposes, the specification in equation (1) presents two drawbacks. It produces a single estimate of the natural or potential growth rate for the time period under analysis, while I am interested in studying its evolution over time. Thus, I rely on a time-varying-parameter approach to estimate a time series for g_t^N; on the other hand, unemployment (including underemployment) and labor market data in general are notoriously unreliable for some of the economies in my panel. To address this, I link Harrod's definition of g^N to the relationship between unemployment and growth, and estimate the natural or potential growth rates of Asian economies relying on an AS model. Since in the long run, unemployment will be constant when it is equal to the nonaccelerating inflation rate of unemployment, the natural growth rate can be defined as the growth rate consistent with $U_t = U_t^N$ and, thus, $\Delta U_t = 0$. I formalize this in Okun's relation as

$$U_t = U_t^N - \beta_t \left(g_t - g_t^N\right) \tag{2}$$

where the Okun coefficient (β_t) and the nonaccelerating inflation rate of unemployment (U_t^N) are assumed to be time varying. The relationship between inflation and unemployment is given by the following Phillips curve in which

$$\pi_t = \pi_t^e - \gamma_t \left(U_t - U_t^N\right) \tag{3}$$

where π_t and π_t^e are, respectively, the actual and expected inflation rates, while γ_t is a time-varying parameter. Combining equations (2) and (3), I get

$$\pi_t = \pi_t^e + \phi_t \left(g_t - g_t^N\right) \tag{4}$$

where $\phi_t = \beta_t \gamma_t$. The specification in equation (4) formalizes an AS model with time-varying parameters.

To estimate the model in equation (4), I need an estimate of the expected inflation rate, π_t^e. Since there is very limited availability of time-series data for expected inflation, I model π_t^e as a function of the actual inflation rate (π_t), assuming two possible specifications. The first is in equation (5), where expected inflation in time *t* is a time-varying function of actual inflation in *t*:

$$\pi_t^e = \alpha_t \pi_t + \varepsilon_t \tag{5}$$

where α_t is a time-varying parameter reflecting the public's degree of accuracy in forecasting inflation and ε_t is an independent normally distributed error term, with zero mean and constant variance. The estimated model in this case is

$$g_t = g_t^N + \frac{(1-\alpha_t)}{\phi_t}\pi_t + \varepsilon_t \tag{6}$$

The second specification assumes an extreme form of adaptive expectations in which expected inflation in *t* is equal to actual inflation in $t-1$ plus a random error term:

$$\pi_t^e = \pi_{t-1} + \varepsilon_t \tag{7}$$

and the relative model is

$$g_t = g_t^N + \frac{1}{\phi_t}\Delta\pi_t + \varepsilon_t \tag{8}$$

Equations (6) and (8) can both be specified in state-space form. Specifically, the measurement equations are

$$g_t = \mu_t + \beta_t \pi_t + \varepsilon_t \tag{6'}$$

$$g_t = \mu_t + \beta_t \Delta\pi_t + \varepsilon_t \tag{8'}$$

with $\mu_t = g_t^N$. Following standard practice in the literature (see, for example, Harvey 1989), to capture possible level breaks or trend patterns, the transition equations are assumed to follow a unit root:

$$\mu_t = \mu_{t-1} + \upsilon_t \tag{9}$$

$$\beta_t = \beta_{t-1} + \upsilon_t \tag{10}$$

Following Romer (1993), I take account of the possible effects of the degree of openness on the slope of the Phillips curve, and thus of the AS models in equations (6’) and (8’), and also consider the following transition equation for β_t:

$$\beta_t = \beta_{t-1} + \kappa m_t + \upsilon_t \tag{11}$$

where m_t is the share of imports in gross domestic product (GDP). For each economy, I select the most appropriate version of the model according to the significance of the estimated parameters and rely on the Akaike Information Criterion.[1]

My estimation is carried out relying on the Kalman filter recursive algorithm, which is commonly used in the literature to obtain optimal estimates for state variables in models with time-varying parameters (see, for example, Lanzafame and Nogueira 2011). More specifically, to obtain a time series for the potential growth rate g_t^N, I apply the Kalman smoothing procedure, which uses all the information in the sample to provide smoothed-state estimates. This procedure differs from Kalman filtering in the construction of the state series, as this technique uses only the information available up to the beginning of the estimation period. Smoothed series tend to produce more gradual changes than filtered ones and, as discussed by Sims (2001), they provide more precise estimates of the actual time variation in the data.

Figure 1 below presents estimated potential growth rates and actual growth rates for 12 Asian economies, including the region’s four most developed economies and eight largest economies. The corresponding graphs for all other Asian economies are included in Figure A.1 in the Appendix.

Overall, the Kalman smoother seems to perform well in fitting the data, both in terms of the significance of the regressors and in providing a realistic approximation for the long-run growth paths of Asian economies. The estimates show the potential growth rate as being more stable than the actual growth rate, as well as being fairly high and/or increasing in the 1980s and 1990s for most economies, which is in line with expectations. It can also be seen that in most cases, the estimated potential growth rate declined in the 2000s and with few exceptions, this trend either remained stable or worsened during the period 2008–2014. Comparisons between the mean

[1]As an alternative, I also considered a different model augmented with financial factors along the lines of Felipe, Sotocinal, and Bayudan–Dacuycuy (2015). This turned out to be the most appropriate model only in the cases of Thailand and Singapore.

Figure 1. **Actual and Potential Growth Rates in Select Asian Economies**

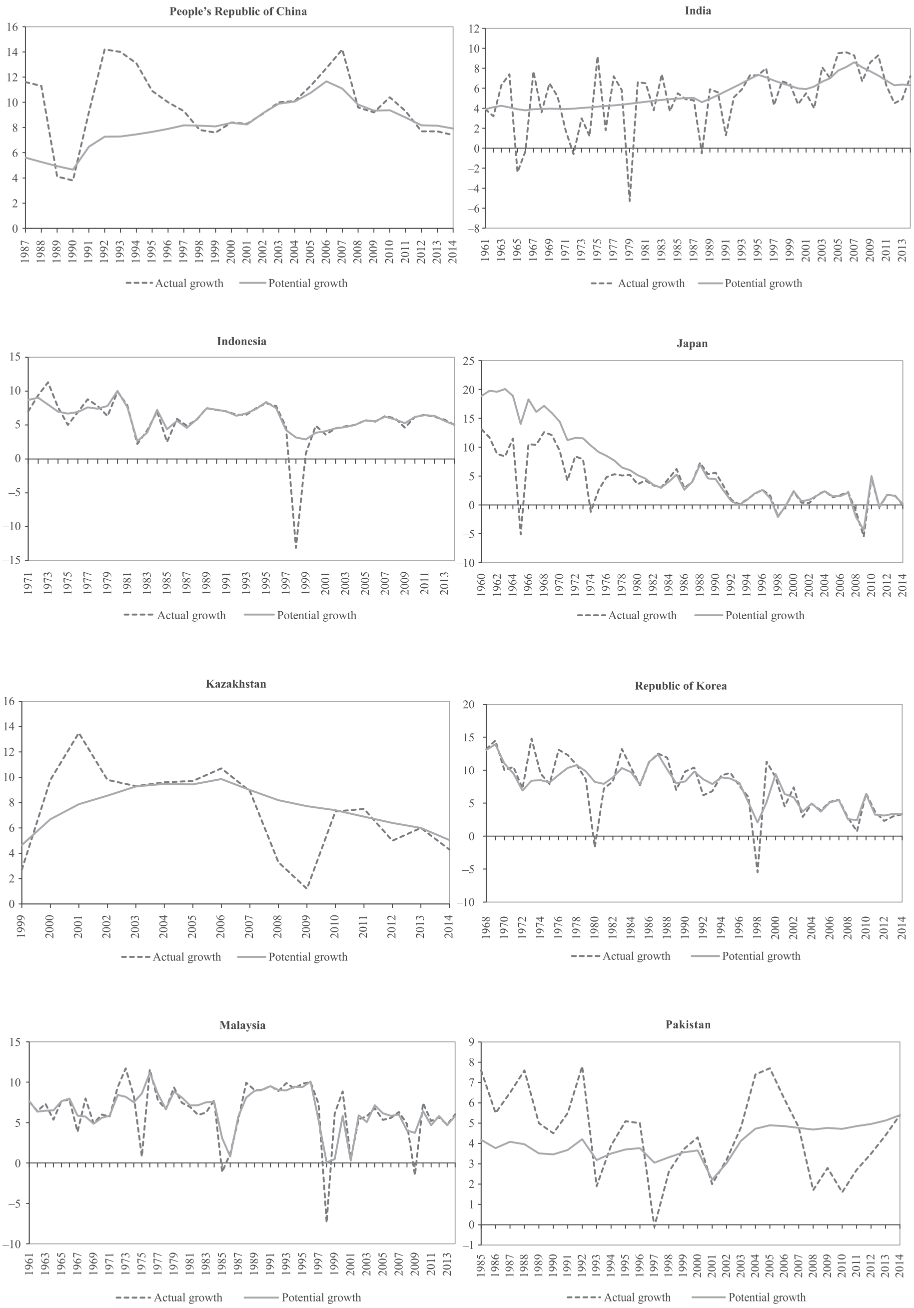
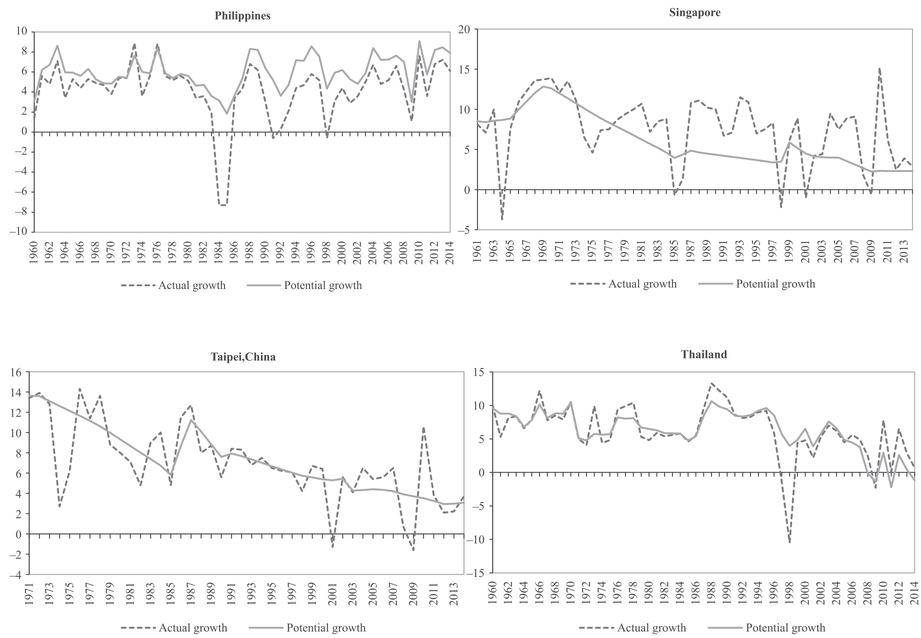


Figure 1. *Continued.*



Source: Author's calculations.

values for the 2000–2007 and 2008–2014 periods (and the 2014 estimates), which are reported in Table 1, confirm that this is the case.

As mentioned, a falling potential growth rate has significant negative consequences for an economy that can be particularly difficult to cope with in an emerging economy. Thus, an analysis of what drives potential growth and whether its determinants may be influenced by policy interventions is of critical importance for emerging Asian economies.

III. Determinants of Potential Growth

Having obtained time-series estimates for g_t^N for all Asian economies in my panel, in this section, I turn to the investigation of the determinants of the potential growth rate. My objective is to obtain robust and reliable estimates of variables that are significantly correlated with the potential growth rate. To achieve this, I extend the unbalanced panel to a group of 69 economies to include several other emerging and advanced non-Asian economies. The list of economies included in the panel is presented in Table A.1 in the Appendix.

My definition of potential growth is consistent with Harrod's (1939) concept of the natural growth rate represented as the sum of the growth rates of labor productivity and the labor force; thus, in my search for the main drivers of g_t^N, I

Table 1. **Mean Estimates of Potential Growth Rates**
(%)

	Azerbaijan	**Bangladesh**	**Cambodia**	**PRC**	**Hong Kong, China**	**India**	**Indonesia**
2000–2007	17.90	5.84	9.26	9.90	4.83	7.03	4.95
2008–2014	5.26	5.97	7.42	8.80	3.01	6.97	5.81
2014	3.03	6.12	7.08	7.91	2.25	6.29	5.01

	Japan	**Kazakhstan**	**Republic of Korea**	**Malaysia**	**Pakistan**	**Philippines**	**Singapore**
2000–2007	1.63	8.77	5.58	5.27	4.04	6.58	4.05
2008–2014	0.24	6.81	3.49	5.02	4.93	7.06	2.36
2014	0.15	5.05	3.33	5.81	5.40	7.90	4.10

	Sri Lanka	**Taipei,China**	**Tajikistan**	**Thailand**	**Turkmenistan**	**Uzbekistan**	**Viet Nam**
2000–2007	6.67	4.70	8.46	5.44	15.48	6.12	7.38
2008–2014	5.58	3.34	6.93	0.15	11.03	8.34	6.01
2014	6.84	3.06	6.74	2.90	10.28	8.13	6.06

PRC = People's Republic of China.
Source: Author's calculations.

need to take account of both of its components. As mentioned, labor market data are not entirely reliable for Asian economies and emerging economies in general. Therefore, I proxy labor force growth using data on working-age population growth, duly filtered to purge short-term variability (e.g., transitory migration flows) and obtain a better estimate for potential long-term labor force growth.[2] However, the search for the determinants of productivity growth is more complex and many possible determinants are considered in the literature.

Faced with this issue, a number of recent studies have implemented various model selection procedures to ascertain which variables have a robust association with economic growth (see, for example, Fernández and Steel 2001; Sala-i-Martin, Doppelhoffer, and Miller 2004). In this paper, I rely on the version of the BMA approach developed by Magnus, Powell, and Prüfer (2010) for the estimation of classical linear regression models with uncertainty about the choice of the explanatory variables. This estimator fits the model nicely and the approach used in this paper is based on a classical linear regression framework with two subsets of explanatory variables: (i) The "focus regressors," which are explanatory variables always included in the model for theoretical reasons or other considerations about the phenomenon under investigation. In my case, the growth rate of the working-age population (*gwap*) is one such focus regressor; and (ii) The "auxiliary regressors," which are additional explanatory variables whose inclusion in the model is less certain. The problem of model uncertainty and variable selection arises because

[2]I rely upon the frequency domain filter developed by Corbae, Ouliaris, and Philipps (2002) and Corbae and Ouliaris (2006).

different subsets of auxiliary regressors can be excluded from the model to improve (in the mean-squared error sense) the unrestricted ordinary least squares estimates. When there are k_2 auxiliary regressors, the number of possible models to be considered is 2^{k_2}. The BMA estimator provides a coherent method of inference on the regression parameters of interest by taking explicit account of the uncertainty due to both the estimation and the model selection steps. The BMA estimator uses conventional noninformative priors on the focus parameters and the error variance, and a multivariate Gaussian prior on the auxiliary parameters. The unconditional BMA estimates are obtained as a weighted average of the estimates from each of the possible models in the model space, with weights proportional to the marginal likelihood of the dependent variable in each model. An auxiliary regressor is considered to be robust if the t ratio on its coefficient is greater than 1 in absolute value or, equivalently, the corresponding one-standard error band does not include zero. Alternatively, researchers can rely on their posterior inclusion probabilities. Masanjala and Papageorgiou (2008) suggest that a posterior inclusion probability of 0.5 corresponds approximately to a t ratio of 1 in absolute value.[3]

Despite being a useful tool for establishing a set of robust regressors given a large set of possible explanatory variables, the BMA approach also has some weaknesses. Ciccone and Jarocinski (2010), for example, show that the results of BMA estimations can be highly sensitive to measurement errors. Ghosh and Ghattas (2015) show that high collinearity in three or more covariates tends to push the posterior inclusion probabilities downward and that all collinear variables may be falsely excluded.[4] Sala-i-Martin, Doppelhofer, and Miller (2004) note that the BMA approach's emphasis on marginal measures of variable importance make it difficult (if not impossible) to detect dependence among explanatory variables. They stress that the extent of interdependence between explanatory variables will affect the posterior inclusion probability of any given model, as well as the form of the posterior probability distribution of variables over the model space.

To deal with these issues, I implement a hybrid two-stage approach. In the first stage, I exploit the properties of the BMA methodology by Magnus, Powell, and Prüfer (2010) to assess the robustness of possible determinants of potential growth. Since some of the variables in my data set have very high correlations, I implement successive BMA estimation procedures to eliminate redundant indicators from the analysis and further reduce the model space by removing variables that are not robust. In doing this, I estimate multiple specifications of the model by adding highly collinear robust determinants (e.g., institutional quality variables) one at a

[3]While the BMA helps deal with model uncertainty, it does not deal with issues of causality. Thus, the definition of regressors as robust should be intended as indicating that they are significantly correlated with potential growth.

[4]In particular, Ghosh and Ghattas (2015) note that strong collinearity leads to a multimodal posterior distribution such that if there are three or more highly collinear variables, the median probability model could potentially discard all of them.

time. In the second stage, the robust determinants that are identified using the BMA approach are used as regressors in a fixed effects panel data regression to gauge their effects on potential output growth. I also consider the possible presence of nonlinearities and test separately for the significance of interaction effects between an index of financial integration (selected as a robust determinant of potential growth by the BMA methodology) and institutional quality variables, which is in line with the literature on the nonlinearity of effects of financial openness on economic growth. I also examine whether there is a statistically significant interaction effect between institutional quality and the technology gap with the US, which is another regressor defined as robust by the BMA approach.

A detailed description of the two stages and the associated results are presented in the next section.

A. BMA and Fixed Effects Results

I consider 35 potential determinants of g_t^N, including the focus regressor *gwap*. These potential determinants and their definitions and data sources are presented in Table A.2 in the Appendix. Since the potential growth rate is the particular rate toward which actual growth tends in the long run, the set of determinants of potential growth I consider reflects a broad set of variables typically deemed to affect actual growth in the long run. To control for the presence of fixed effects, I applied the forward-orthogonal-deviation transformation to the data before implementing the BMA procedure. The number of possible determinants considered is much larger than those included in a typical growth regression, but my data set contains variables that can be considered to be close alternatives (e.g., proxies for education, openness, and institutional quality) and are highly correlated. Thus, as well as using all 35 variables at once, I also carried out BMA regressions using subsets of the various proxies to reduce the computation burden and the number of auxiliary regressors, as well as to lessen the impacts of the presence of correlated regressors in the BMA analysis. I then excluded from the final specification the ones that never turned out to be robust. Following this approach, I reduced the number of possibly robust auxiliary regressors to 13. The BMA results for this specification are reported in Table 2.

As can be seen, out of the 13 auxiliary regressors, only seven are selected by the BMA approach as robust determinants of potential growth with a posterior inclusion probability equal to or greater than 0.5: (i) gross enrollment ratio in tertiary education (*es3enrot*); (ii) technology gap vis-à-vis the US (*gap*); (iii) degree of labor market rigidity (*lamrig*); (iv) and (v) two indexes reflecting aspects of perceived institutional quality (voice and accountability index, *voa*; government efficiency index, *goveff*); (vi) trade-to-GDP ratio (*trade*); and (vii) a proxy of integration into international financial markets (ratio of overall financial flows with respect to GDP, *integr*).

Table 2. **Bayesian Model Averaging Estimates**

	Coefficient	SD	t_stat	pip	1-SD Band	
gwap	0.697	0.273	2.560	**1.000**	0.424	0.970
agrempsh	0.002	0.013	0.160	0.070	−0.011	0.015
di16merdt	−0.459	0.683	−0.670	0.380	−1.142	0.224
es10schom	0.295	0.395	0.750	0.430	−0.101	0.690
es1enrop	−0.006	0.020	−0.310	0.130	−0.026	0.014
es2enros	0.004	0.011	0.380	0.180	−0.007	0.016
es3enrot	−0.089	0.021	−4.240	**1.000**	−0.110	−0.068
finref	0.046	0.572	0.080	0.060	−0.526	0.618
gap	0.031	0.030	1.040	**0.610**	0.001	0.061
goveff	2.276	0.759	3.000	**0.970**	1.517	3.035
integr	−0.002	0.001	−2.550	**0.940**	−0.003	−0.001
lamrig	−1.328	1.245	−1.070	**0.610**	−2.573	−0.083
trade	0.029	0.009	3.160	**0.980**	0.020	0.038
voa	0.712	0.829	0.860	**0.500**	−0.118	1.541
Model space: 8,192 models						

pip = posterior inclusion probability, SD = standard deviation.
Note: Bold signifies a pip exceeding 0.5.
Source: Author's calculations.

In the next step of my empirical investigation, I exclude from the analysis the variables that turned out not to be robust using the BMA estimation and, relying on the standard fixed effects technique, estimate the following model for all economies in my panel as well as for the subpanel of Asian economies:

$$g_{it}^{N} = \eta_i + \theta_1 gwap_{it} + \theta_2 es3enrot_{it} + \theta_3 gap_{it} + \theta_4 goveff_{it} + \theta_5 intergr_{it} + \theta_6 lamrig_{it} + \theta_7 trade_{it} + \theta_8 voa_{it} + \xi_{it} \quad (12)$$

To control for the effects of the possible presence of cross-sectional dependence in the error term, I rely on Driscoll and Kraay (1998) for standard errors, which assume the error structure to be heteroskedastic, autocorrelated (up to some lag), and possibly correlated between the groups. As such, Driscoll–Kraay standard errors are robust to very general forms of temporal dependence and/or cross-sectional dependence due to, for example, spatial correlation or time effects.

The results from equation (12), reported in the first two columns on the left-hand side of Table 3, are very much in line with expectations for all economies and Asian economies, even though the latter are based on a fairly small sample size. In particular, the coefficient on *gwap*, which is the elasticity of potential output with respect to the working-age population, is significant and very close to 1, suggesting that a 1% increase in the working-age population leads to a 1% increase in potential output growth. This is consistent with the definition of the natural or potential growth rate used in this paper and indicates that *gwap* is a good proxy for the potential long-run growth rate of the labor force. The signs of all other variables are also as expected, with the possible exception of tertiary enrollment (*es3enrot*) and

Table 3. **Determinants of g_t^N: Fixed Effects Estimations**

	All Economies	Asian Economies	All Economies	
gwap	1.002**	0.942^	0.867**	1.157**
es3enrot	−0.052	−0.155**	0.158**	0.163**
es3enrot_sq	-	-	−0.001**	−0.002**
gap	0.069**	0.097^	0.042*	0.073*
gap_polstab	-	-	-	−0.006*
goveff	1.147*	2.824*	0.963*	1.361**
integr	−0.003**	−0.001	−0.003	0.004^
integr_regq	-	-	-	−0.003**
lamrig	−1.619*	−8.757**	−1.933**	−2.924**
trade	0.054**	0.063**	0.082**	0.065**
trade_sq	-	-	−0.0001**	−0.0001**
voa	1.456**	−1.070*	0.726*	1.651^
dummy0814	-	-	−2.432**	−2.727**
Constant	−0.995	7.120	−5.014**	−5.576**
F-statistic for $H_0 : \theta_1 = 1$	0.00	0.01	0.39	0.51
No. of economies	61	18	61	61
No. of observations	655	188	655	425

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Variables instrumented with first lag. Standard errors from Driscoll and Kraay (1998) used.
Source: Author's calculations.

the financial integration index (*integr*), both of which enter the regression with a negative sign.

These last results are somewhat puzzling and warrant further investigation, which I carry out by modifying the model in two steps to allow for some form of nonlinearity.[5] In the first step, I start by assessing whether the regressors in equation (12) may affect potential growth nonlinearly. Extending the model with the introduction of various quadratic terms, I find that this is the case for both *es3enrot* and *trade*. Interestingly, the coefficient on the quadratic term *es3enrot_sq* is negative, but once this is included in the model, *es3enrot* enters with a significantly positive sign; that is, enrollment in tertiary education affects g_t^N positively, but its impact decreases as *es3enrot* rises. The outcomes for *trade* and *trade_sq* are the same. Moreover, the evidence of a significant downward shift in potential growth during 2008–2014 due to the global financial crisis points to the possibility of a structural break in the g_t^N series for many economies. To control for this, I introduce an intercept dummy variable (*dummy0814*) equal to 1 for the period 2008–2014 and zero otherwise. The dummy turns out to be negative and strongly statistically significant. These changes to the benchmark model result in the specification in the third column in Table 3, where I can see that all other results remain fairly similar. In particular, the financial integration index (*integr*) still enters with a negative sign, even though it is not significant.

[5]Because of the small panel size, the estimation of this extended model is not feasible for the subpanel of Asian economies.

In the second step of the benchmark model extension, I consider whether institutional quality may affect potential growth not only directly, as indicated by the significant coefficients on *goveff*, *lamrig*, and *voa*, but also via indirect channels. It has been suggested that the effects of integration on international financial markets may depend on institutional quality (see, for example, Kose et al. 2009). Similar arguments have been advanced on the potential benefits associated with technology spillovers. To explore this possibility, I interact the *gap* and *integr* variables with a number of proxies for the quality of institutions. If (on average) the impacts of the technology gap and integration indexes depend on institutional quality, then the interaction terms should turn out to be significant. I find that this is the case when the gap variable is interacted with the index of political stability (*gap_polstab*), while the effects of *integr* on the potential growth rate appear to depend significantly on regulatory quality (*regq*). Results are reported in the last column of Table 3.

The estimates show that once the interaction terms are introduced as variables on the right-hand side, *integr* turns positive and is significant at the 10% level, while *gap* remains positive and significant too; the interaction terms are always negative and significant. The interaction terms are constructed as simple products of the gap and integration indexes with the institutional quality indexes: $gap\_polstab = gap \times polstab$ and $integr\_regq = integr \times regq$. As such, the sign, size, and significance of the effect of *gap* and *integr* on the potential growth rate will vary according to the value of the institutional quality index. Using *regq* and *integr* as an example, if θ_5 is the estimated coefficient on *integr* and θ_{5_1} the estimated coefficient on *integr_regq*, then the overall impact of financial integration is given by $(\theta_5 + \theta_{5\_1} \times regq)$. The size and significance of this product will vary for different values of *regq*. The institutional quality indexes range from –2.5 (weak) to 2.5 (strong) to reflect governance performance. To test for the effect of the financial integration index, I can conduct a series of F-tests to determine whether $(\theta_5 + \theta_{5\_1} \times regq)$ is significantly different from zero for different values of *regq*.

The F-tests conducted show that, when taking into account institutional quality via the interaction term, the overall impact of financial integration is positive and significant for $regq < (0.5)$. This indicates that financial integration has larger positive effects on potential growth for economies with weaker institutions, thus acting as a substitute for high-quality institutions. For emerging economies with weaker institutions, including some of the Asian economies in my sample, the implication is that successful integration into international financial markets may bring about significant long-term growth benefits by raising the potential growth rate. Meanwhile, the gap variable has a positive and significant impact on potential growth for the entire range of *polstab* values, but again its effect is smaller for economies with better institutions (as proxied by greater political stability). This is not surprising since emerging economies, which can be expected to reap larger benefits from technology spillovers, are also characterized by lower *polstab* values.

The BMA procedure and the estimates reported in Table 3 depict a fairly clear picture of the main determinants of potential growth. From a policy viewpoint, the main result of this analysis is that institutional quality and other supply-side characteristics matter for potential growth. Structural reforms in these areas can significantly improve long-term growth performance. In the next section, I address the question of whether demand-management policies can play a role too.

IV. Business Cycles and the Endogeneity of Potential Growth

Standard macroeconomic theory assumes business cycles and potential growth as separate phenomena. As a result, business cycle features such as the depth of a recession are deemed to have no significant effects on long-term economic growth. Recent theoretical and empirical contributions, however, have challenged this view (see, for example, Christopoulos and León–Ledesma 2014), while the length and significant economic impacts of the 2008–2009 global financial crisis have reignited the debate on the relationship between short- and long-term growth. This issue takes on particular importance in Asia as the PRC and other economies have seen their growth performance deteriorate between 2008 and 2014 to the point that it has been argued this may be the beginning of a "new normal" for growth patterns in Asia (see, for example, Asian Development Bank 2016). If potential growth is, at least to some extent, endogenous with respect to actual growth and its short-term cyclical features, this view may be shown to be correct and the growth slowdown in Asia may be structural.

As mentioned, León–Ledesma and Thirlwall (2002) develop an econometric framework that allows us to estimate Harrod's natural growth rate (g^N) and test for its endogeneity with respect to the actual growth rate (g). The methodology is based on two steps. First, an estimate of g^N, which is assumed to be constant over time, is produced using the version of Okun's Law specified in equation (1) and the condition that $g_t = g^N$ when $\Delta U_t = 0$. Next, a reversed version of the Okun's Law relation is augmented with a dummy variable (D_t^{gdev}) that takes the value of 1 when g_t is greater than the estimated g^N ($gdev_t = g_t - g^N > 0$) and zero otherwise. Thus, the following model is estimated:

$$g_t = \eta - \psi \Delta U_t + \lambda D_t^{gdev} + \varepsilon_t \tag{13}$$

If the estimated $\hat{\lambda}$ is positive and significant, then the actual growth rate needed to keep unemployment constant in boom periods ($g_t > g^N$ or, equivalently, $gdev_t > 0$) has risen. That is, the actual growth rate has pulled up the natural growth rate.

Relying on the definition of g_t^N used in this paper, I construct a test for the endogeneity hypothesis, which is very much in line with the methodology of León–Ledesma and Thirlwall (2002). I start by noticing that since g_t^N is defined as the particular growth rate consistent with a stable inflation rate, the estimated α in equation (14) below is expected to be equal to zero, while the estimate of β should be positive:

$$gdev_t = \alpha + \beta \Delta\pi_t + \varepsilon_t \tag{14}$$

Rising inflation ($\Delta\pi_t > 0$) should be associated with an actual growth rate higher than the potential growth rate ($gdev_t > 0$) so that $\beta > 0$; meanwhile, a stable inflation rate ($\Delta\pi_t = 0$) is expected to correspond to $gdev_t = 0$, so that $\alpha = 0$. Introducing D_t^{gdev} to equation (14), I obtain

$$gdev_t = \alpha + \beta \Delta\pi_t + \lambda D_t^{gdev} + \varepsilon_t \tag{15}$$

A positive estimate of λ in equation (15) is expected as $D_t^{gdev} = 1$ when $gdev_t > 0$. In addition, the size of $gdev_t$ in boom periods ($gdev_B$) will be given by the sum of the two estimates $\hat{\alpha}$ and $\hat{\lambda}$. Since $gdev_B$ is determined by the changes in actual and potential growth during booms ($gdev_B = \Delta g_B - \Delta g_B^N$), I can test the null hypothesis $H_0 : gdev_B - \Delta g_B = 0$—if the latter is rejected, it follows that Δg_B^N is significantly different from zero. That is, rejection of the null indicates that the potential growth rate rises when $g_t > g_t^N$ (or, equivalently, $gdev_t > 0$), which is in line with the endogeneity hypothesis proposed by León–Ledesma and Thirlwall (2002). Allowing substantially more degrees of freedom than estimations based on my benchmark model, this testing framework makes it feasible to obtain efficient estimates of the model parameters for the subpanel of Asian economies. In addition to the usual fixed effects estimator, I can also rely on the mean-group estimator (Pesaran and Smith 1995) to allow for parameter heterogeneity.

I also investigate the endogeneity of the potential growth rate introducing the dummy D_t^{gdev} in my benchmark model. Just as in the testing framework proposed by León–Ledesma and Thirlwall (2002), a positive and significant coefficient on D_t^{gdev} would support the hypothesis that potential growth is, at least to a certain extent, endogenous to the actual growth rate. Concurrently, I also explore the possibility that other business cycle features may play a role by including in the model as additional regressors the following two variables: (i) $gdev5_t$, which is the average deviation of actual growth from the potential growth rate ($gdev_t = g_t - g_t^N$) over the previous 5 years; and (ii) $gdev5sd_t$, which defines the standard deviation of $gdev_t$ over the previous 5 years.[6]

Table 4 reports the estimates based on the first approach to testing the endogeneity hypothesis as formalized in equation (15). Independently of whether I

[6]I also considered the first lag of $gdev_t$ (predetermined with respect to g_t^N) and the standard deviation of actual growth over the previous 5 years as alternative variables to capture business cycle features. These turned out not to be significant in my estimations and therefore the results are not reported.

Table 4. **Tests of the Endogeneity Hypothesis**

	Fixed Effects Estimations			
	All Economies		**Asian Economies**	
$\Delta\pi$	0.030	0.015	0.051*	0.020
D^{gdev}	-	2.209**	-	2.859**
Constant	−0.096	−1.138**	−0.353**	−1.669**
Estimate of $gdev_B$	-	1.071**	-	1.189**
t-statistic on $H_0 : gdev_B - \Delta g_B = 0$	-	0.031	-	−0.012
No. of economies	69	69	21	21
No. of observations	2,456	2,456	671	671
	Mean Group Estimations			
	All Economies		**Asian Economies**	
$\Delta\pi$	0.068**	0.045*	0.054*	0.062**
D^{gdev}	-	1.721**	-	2.325**
Constant	−0.034	−0.891**	−0.100	−1.306**
Estimate of $gdev_B$	-	0.830**	-	1.019*
t-statistic on $H_0 : gdev_B - \Delta g_B = 0$	-	−0.210	-	−0.182
No. of economies	69	69	21	21
No. of observations	2,456	2,456	671	671

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Variables instrumented with first lag. Standard errors from Driscoll and Kraay (1998) used. To avoid undue influence from high-inflation episodes, years with average inflation rates higher than 25% for the "All Economies" specifications and higher than 45% for the "Asian Economies" specifications are excluded from the estimations.
Source: Author's calculations.

refer to the fixed effects or mean group estimates, the estimations for all economies and Asian economies estimations both return clear-cut results. As expected, the dummy variable D_t^{gdev} turns out always to be positive and highly significant, as does $gdev_B$. However, the null hypothesis that $gdev_B$ is not significantly different from Δg_B is never rejected, implying that there is no significant evidence of an increase in potential growth ($\Delta g_B^N > 0$) during boom periods.

Table 5 reports the results from my investigation of the endogeneity hypothesis using the second approach outlined above that relies on my benchmark model. As can be seen, D_t^{gdev} turns out to be positive but not statistically significant. This outcome is consistent with the results in Table 4 as I again do not find significant evidence supporting the endogeneity hypothesis for potential growth. Moreover, there is no significant evidence that deviations of the actual from the potential growth rate (proxied by $gdev5_t$) play a significant role. This result implies that, however deep and persistent, the decline in actual growth associated with the 2008–2009 global financial crisis can be expected not to leave permanent scars on long-term growth. An additional implication is that an economic policy intervention to boost short-term growth above the potential growth rate will not affect the latter significantly. Indeed, my results indicate that, by increasing growth volatility, this type of policy intervention may actually indirectly harm long-term growth

Table 5. **The Endogeneity Hypothesis: Fixed Effects Estimations**

	All Economies	Asian Economies
gwap	1.229**	3.687**
es3enrot	0.124**	0.156
es3enrot_sq	−0.001*	−0.004*
gap	0.075^	0.013
gap_polstab	−0.008^	0.005
goveff	1.194*	−1.198
integr	0.004	0.005
integr_regq	−0.003*	−0.010^
lamrig	−2.812*	−12.869**
trade	0.081**	0.165**
trade_sq	−0.0001*	−0.0003*
voa	2.017^	−0.836
dummy0814	−2.825**	−2.009**
D^{gdev}	0.154	0.192
gdev5	0.026	0.152
gdev5sd	−0.191*	−0.314*
Constant	−5.712**	7.964^
F-statistic for $H_0 : \theta_1 = 1$	1.14	13.22*
No. of economies	61	18
No. of observations	421	121

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Variables instrumented with first lag. Standard errors from Driscoll and Kraay (1998) used.
Source: Author's calculations.

performance. I find that *gdev5sd* turns out to be robustly significant and enters with a negative sign, both in the "All Economies" and the "Asian Economies" estimations in Table 5, which is in line with other evidence in the literature (see, for example, Ramey and Ramey 1995).

Therefore, the analysis carried out in this section suggests that the effects of demand-management policies aimed at increasing actual growth above the potential growth rate will not affect the trajectory of the latter and will be short-lived at best. To have a positive impact on long-term growth performance, demand-management policies should aim at stabilizing the actual growth rate as close as possible around the path of potential growth.

V. Conclusions

Focusing on the performance of Asian economies over the period 1960–2014, this paper contributes to the empirical literature on potential growth in several respects. I provide estimates of potential growth for 21 Asian economies using an AS state-space model with time-varying parameters and a Kalman filtering methodology. My estimates appear to fit well with the growth experiences of Asian economies and indicate that the actual growth slowdowns experienced by many of these economies in the 2000s can be associated with the falling trajectories of their potential growth rates. Next, I investigate the determinants of potential growth using a larger panel of 69 advanced and emerging economies and data for 35 possible growth determinants. Relying on the BMA selection procedure, I select seven variables that, together with the growth rate of the working-age population, can be considered robust determinants of potential growth. The results are in line with expectations and indicate that potential growth is influenced by various aspects of institutional quality, the technology gap with the US, trade, and tertiary education, as well as by the growth rate of the working-age population. In particular, I find that the effects of integration with international financial markets are positive and significant only for economies with weak institutions.

With the objective of providing evidence regarding the possible effects of the 2008–2009 global financial crisis on the dynamics of the potential growth rate, I extend the benchmark model to include proxies for business cycle features. I also carry out a new test of the endogeneity hypothesis proposed by León–Ledesma and Thirlwall (2002). My results indicate that deviations of actual growth from the estimated potential growth rate do not have a significant impact on potential growth itself, which is in line with the hypothesis that recessions and booms do not have long-lasting effects on long-term growth performance. On the other hand, I find that actual growth volatility with respect to potential growth does have a significant negative effect on g_t^N. This indicates that policies aimed at stabilizing actual growth in the proximity of the potential growth rate can have beneficial effects on an economy's long-term growth performance.

Overall, the evidence gathered supports the hypothesis that Asian economies may have entered a new era of slower potential and actual growth rates. My results also suggest that appropriate changes in economic policies and institutions can play a significant role in lifting the potential growth rate. If these are carried out effectively, the "new normal" in Asia may come to resemble previous growth patterns more than would otherwise have been expected.

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Appendix

Table A.1. **Economies Included in the Analysis**

Asian economies	Azerbaijan; Bangladesh; Cambodia; People's Republic of China; Hong Kong, China; India; Indonesia; Japan; Kazakhstan; Republic of Korea; Malaysia; Pakistan; Philippines; Singapore; Sri Lanka; Taipei,China; Tajikistan; Thailand; Turkmenistan; Uzbekistan; Viet Nam
Other emerging economies	Algeria, Argentina, Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, Egypt, Hungary, Mexico, Morocco, Panama, Peru, Poland, Qatar, Saudi Arabia, South Africa, Turkey, Uruguay, Venezuela
Advanced economies	Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxembourg, The Netherlands, New Zealand, Norway, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States

Source: Author's compilation.

Table A.2. **Variables and Data Sources**

	Variable	Definition	Source
	gn	Potential growth rate estimate	Author's estimates using WDI–IFS data
	g	Actual growth rate	WDI–IFS data
	gdev	*g-gn*	Author's calculations
	gdev5	Average of *g_dev* over previous 5 years	Author's calculations
	gdev5sd	Standard deviation of the *g_dev5* over the previous 5 years	Author's calculations
	Gwap	Growth rate of working-age population (aged 15–64 years)	Author's calculations using WDI–IFS data
	Auxiliary regressors used for the BMA selection procedure		
1	*di16merdt*	R&D expenditures as a percentage of GDP	CANA Database (v. Jan 2011) by Castellacci and Natera (2011); original source: UNESCO, OECD, RICYT

Continued.

Table A.2. *Continued.*

	Variable	Definition	Source
2	*es1enrop*	Gross enrollment ratio (primary): ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the primary level	CANA Database (v. Jan 2011) by Castellacci and Natera (2011); original source: UNESCO
3	*es2enros*	Gross enrollment ratio (secondary): ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the secondary level	CANA Database (v. Jan 2011) by Castellacci and Natera (2011); original source: UNESCO
4	*es3enrot*	Gross enrollment ratio (tertiary): ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the tertiary level	CANA Database (v. Jan 2011) by Castellacci and Natera (2011); original source: UNESCO
5	*es10schom*	Mean years of schooling: average number of years of school completed in population over the age of 14 years	CANA Database (v. Jan 2011) by Castellacci and Natera (2011); original sources: Barro and Lee (2001) and World Bank's WDI (national accounts data)
6	*es12educe*	Public expenditure on education: current and capital public expenditure on education	CANA Database (v. Jan 2011) by Castellacci and Natera (2011); original source: UNESCO
7	*es14teacr_plus*	Primary pupil–teacher ratio: number of pupils enrolled in primary school / number of primary school teachers	CANA Database (v. Jan 2011) by Castellacci and Natera (2011); original source: UNESCO
8	*ghc*	Percentage growth rate in index of human capital per person based on years of schooling (Barro and Lee 2013) and returns to education (Psacharopoulos 1994)	Author's calculations using PWT 8.1 data
9	*econglob*	Index of Globalization: long distance flows of goods, capital, and services, and information, and perceptions that accompany market exchanges measured on a scale ranging from 0 (lowest) to 10 (highest)	KOF Index of Globalization
10	*overallglob*	Overall Globalization Index: weighted average of *econ_glob*, *soc_glob*, and *pol_glob* on a scale ranging from 0 (lowest) to 100 (highest)	KOF Index of Globalization
11	*agrempsh*	Employment in agriculture (% of total employment)	International Labour Organization, Key Indicators of the Labour Market database; Global Employment Trends Dataset (2014)
12	*indempsh*	Employment in industry (% of total employment)	International Labour Organization, Key Indicators of the Labour Market database; Global Employment Trends Dataset (2014)

Continued.

Table A.2. *Continued.*

	Variable	Definition	Source
13	*serempsh*	Employment in services (% of total employment)	International Labour Organization, Key Indicators of the Labour Market database; Global Employment Trends Dataset (2014)
14	*gap100*	Technology gap variable: 1 minus the ratio of the level of labor productivity vis-à-vis that of the US in purchasing power parity terms, multiplied by 100; labor productivity computed as a ratio (*rgdpo/emp)*, where *rgdpo* is output-side real GDP at chained purchasing power parity (in millions of 2005 US dollars) and *emp* is number of persons engaged (in millions); follows specification proposed by León–Ledesma (2002)	Author's calculations using PWT 8.1 data
15	*gckemp*	Percentage growth rate of the capital–labor ratio	Author's calculations using PWT 8.1 data
16	*lmr*	Index of labor market regulations measuring economic freedom (e.g., market forces determine wages and the conditions of hiring and firing, government refrains from the use of conscription) on a scale ranging from 0 (lowest) to 10 (highest)	Gwartney et al. (2014) EFW 2014 Annual Report
17	*lamrig*	Index of labor market rigidity on a scale ranging from 0 (lowest) to 3 (highest); data for 2004–2013 are from the World Bank's Doing Business database, pre-2004 data are from the LAMRIG database from Campos and Nugent (2012); since the index exhibits very little variation, annual values are assumed constant over the 5-year periods considered by Campos and Nugent (2012); Campos and Nugent (2012) state the LAMRIG index is consistent with the World Bank's Doing Business database	World Bank's Doing Business database; LAMRIG database from Campos and Nugent (2012)
18	*cocorr*	Control of Corruption Index reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as the capture of the state by elites and private interests on a scale measuring governance performance ranging from −2.5 (weak) to 2.5 (strong)	World Bank's Worldwide Governance Indicators (2014 Update)

Continued.

Table A.2. *Continued.*

	Variable	Definition	Source
19	*goveff*	Government Effectiveness Index reflects perceptions of the quality of public services, quality of the civil service and the degree of its independence from political pressures, quality of policy formulation and implementation, and credibility of the government's commitment to such policies on a scale measuring governance performance ranging from approximately –2.5 (weak) to 2.5 (strong)	World Bank's Worldwide Governance Indicators (2014 Update)
20	*pf1corri*	Corruption Perception Index on a scale measuring corruption ranging from 0 (highest) to 10 (lowest)	CANA Database (v. Jan 2011), by Castellacci and Natera (2011), for pre-2008 data, Transparency International for 2008–2014 data; original source: Transparency International
21	*polstab*	Political Stability (and Absence of Violence and Terrorism) Index reflects perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically motivated violence and terrorism on a scale measuring governance performance ranging from –2.5 (weak) to 2.5 (strong)	World Bank's Worldwide Governance Indicators (2014 Update)
22	*regq*	Regulatory Quality Index reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development on a scale measuring governance performance ranging from –2.5 (weak) to 2.5 (strong)	World Bank's Worldwide Governance Indicators (2014 Update)
23	*rol*	Rule of Law Index reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, particularly the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence on a scale measuring governance performance ranging from –2.5 (weak) to 2.5 (strong)	World Bank's Worldwide Governance Indicators (2014 Update)

Continued.

Table A.2. *Continued.*

	Variable	Definition	Source
24	*voa*	Voice and Accountability Index reflects perceptions of the extent to which an economy's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media on a scale measuring governance performance ranging from –2.5 (weak) to 2.5 (strong)	World Bank's Worldwide Governance Indicators (2014 Update)
25	*trade*	Index of Openness: the sum of exports and imports of goods and services measured as a share of GDP	World Bank's WDI (national accounts data) and OECD's national accounts data
26	*rmex*	Raw materials as a share of total exports	UN Comtrade Database, SITC Aggregate 2, Revision 1. For Taipei,China, Customs Administration of the Ministry of Finance. https://portal.sw.nat.gov.tw/APGA/GA03E
27	*fmex*	Fuels and mining products as a share of total exports	
28	*rmfmex*	Sum of raw materials and fuel and mining products as a share of total exports	
29	*kaopen*	Kaopen Index measuring capital account openness; normalized to be between 0 (less open) and 1 (more open)	Chinn and Ito (2006)
30	*finref*	Financial Reform Index measuring financial market liberalization; normalized to be between 0 (less liberalized) and 1 (more liberalized)	Abiad, Detragiache, and Tressel (2010)
31	*peindex*	Portfolio Equity Integration Index reflects the sum of the stocks of portfolio equity assets and liabilities as a share of GDP; follows suggestions in Kose et al. (2009)	Updated and extended version of data set constructed by Lane and Milesi–Ferretti (2007)
32	*fdiindex*	FDI Integration Index reflects the sum of the stocks of FDI assets and liabilities as a share of GDP; follows suggestions in Kose et al. (2009)	
33	*integr*	Integration Index reflects the sum of total foreign assets and liabilities as a share of GDP; follows suggestions in Kose et al. (2009)	
34	*nfagdp*	Net foreign assets as a share of GDP	

BMA = Bayesian model averaging; EFW = Economic Freedom of the World; FDI = foreign direct investment; GDP = gross domestic product; IFS = International Financial Statistics; OECD = Organisation for Economic Co-operation and Development; PWT = Penn World Tables; RICYT = Red Iberoamericana de Indicadores de Ciencia y Tecnología; R&D = research and development; UN = United Nations; UNESCO = United Nations Educational, Scientific and Cultural Organization; WDI = World Development Indicators.
Source: Author's compilation.

Figure A.1. **Potential Output Growth Rate Estimates and Actual Output Growth Rates**

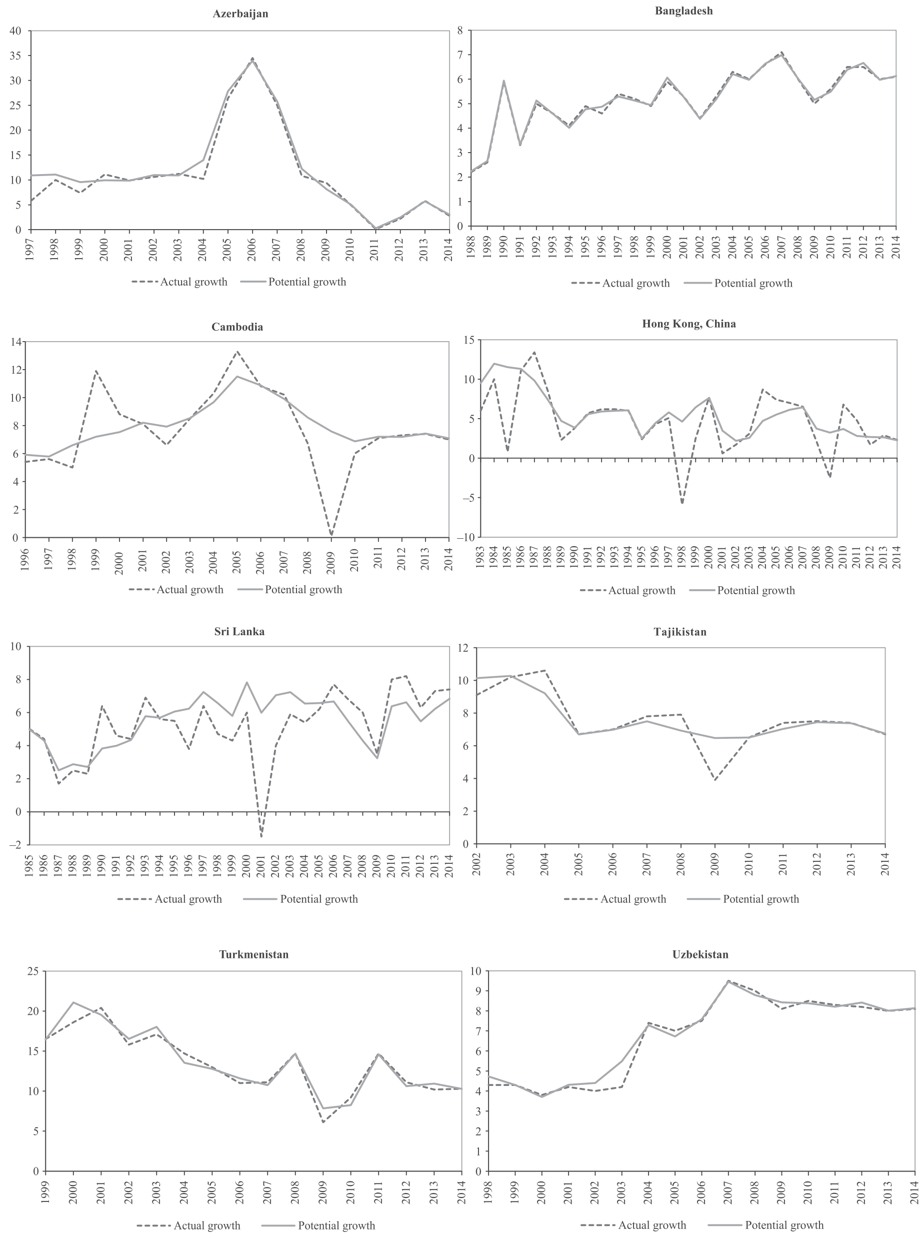
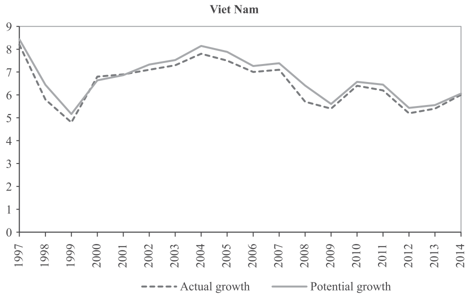


Figure A.1. *Continued.*



Source: Author's calculations.

Potential Output in Asia: Some Forward-Looking Scenarios

Andrew Burns*

This paper presents estimates of potential output growth for a sample of 26 Asian economies and projects potential output growth through 2040 under several scenarios. Results suggest that in the absence of further capital deepening, and assuming continued total factor productivity growth at recent rates, potential output growth across economies could slow from a median of 4.6% during 2010–2015 to 2.7% between 2035 and 2040. Demographic trends and an assumed stabilization in capital–output ratios account for most of the slowing. Much better outcomes are possible if trends are supported by policy. Better total factor productivity growth could raise potential output by between 11% and 24% by 2040, while lower unemployment and higher participation rates could boost potential output by 10% or more in some South Asian economies. An improved investment climate could add between 6% and 10% to potential output in most economies, while accelerating structural convergence (moving labor from lower to higher productivity sectors) could raise potential output by 10% or more in half of the examined countries.

Keywords: cross-economy growth comparisons, potential output, total factor productivity, sectoral change
JEL codes: E17, O11, 047

I. Introduction

Potential output is a key concept in macroeconomics, but one whose measurement is fraught with uncertainty mainly because (like many other economic notions) it is not directly observable. Nor is the concept itself unambiguous. Some authors speak of potential as the level of activity that would be observed if all constraints were removed. In a developing economy context, this could be the level that might be observed if the capital stock, skills of the population, and economic institutions were on the par with the best-performing high-income economies. More commonly, potential is used to reflect a level of activity consistent with the full

*Andrew Burns: Global Lead for Macroeconomic Modeling, World Bank, Washington, DC. E-mail: aburns@worldbank.org. The author would like to thank the participants at the Asian Development Outlook–Asian Development Review Conference held in Seoul in November 2015, the managing editor, and an anonymous referee for helpful comments. The findings, interpretations, and conclusions expressed in this paper are entirely those of the author. They do not necessarily represent the views of the International Bank for Reconstruction and Development and its affiliated organizations, or those of the executive directors of the World Bank or the governments they represent. The usual disclaimer applies.

utilization of existing resources given the existing institutions and technology of an economy. Even with this definition, there are many different approaches that can be taken to identify the unobservable true level of potential output. Common identification strategies include

(i) equating potential output as the level of output consistent with a statistically average growth rate of output (e.g., Hodrick–Prescott or Kalman filters, and other frequency or time-domain filters);

(ii) using nonaccelerating inflation as an indicator of potential (see, for example, Lanzafame 2016); and

(iii) using a notion of full utilization of the factors of production at trend levels of factor productivity to identify potential output (as this paper does).

II. Methodology

The estimates of potential output presented here are based on the production function approach similar to that used by, among others, the World Bank in its Macro-Fiscal Model (World Bank 2016b); the United States (US) Congressional Budget Office (Congressional Budget Office 2001); the Organisation for Economic Co-operation and Development (Beffy et al. 2006); the European Commission (Economic Policy Commission 2001, D'Auria et al. 2010, Denis et al. 2006); and the US Federal Reserve in its Federal Reserve Board model (Brayton, Laubach, and Reifschneider 2014). In this approach, the supply side of gross domestic product (GDP) is described by a simple Cobb–Douglas function of the form given below:[1]

$$GDP_t = TFP_t K_t^{\alpha} L_t^{1-\alpha} \tag{1}$$

where GDP is gross domestic product, K is the capital stock, L is labor employed, TFP represents total factor productivity (TFP), α is the income share of capital (assumed to be 0.3), and the subscript t denotes time.[2] This paper's measure of labor differs from that of Burns et al. (2014) by using labor market data (labor force participation, sectoral employment, and unemployment) produced by the

[1] There exist variants of this form. For example, the Federal Reserve Board model includes trend energy services as an independent factor of production.

[2] Data appear to support the use of the Cobb–Douglas production function. In this paper, an economy-by-economy estimation of a constant elasticity of substitution function yields a mean elasticity of substitution of 0.95. For a sample of 157 developing economies, the mean freely estimated capital share is 0.4, with the modal value lying between 0.23 and 0.34. For the Asian subsample, the mean freely estimated capital share is 0.55.

International Labour Organization to measure labor inputs.[3] Burns et al. (2014) and other earlier work used the working-age population as an alternative proxy. It is recognized that the labor market data capture labor market behavior imperfectly, especially in economies characterized by a sizable informal labor sector.

Equation (1) can be rewritten by expressing employment L as the product of the working-age population, P_{1564}; the labor force participation rate, Pr; and 1 minus the unemployment rate, UNR, or employment as a percentage of the labor force; which gives

$$GDP_t = TFP_t \cdot K_t^{\alpha} \cdot (P_{1564,t} \cdot Pr_t \cdot (1 - UNR_t))^{1-\alpha} \quad (2)$$

The above decomposition is widely used in macroeconomic analysis because it is simple, intuitive, and lends itself to straightforward interpretation. However, its application to developing economies is complicated by data limitations. While the majority of economies publish time series of GDP and the size of the working-age population, data on the capital stock are not widely available and labor market data (labor force participation and unemployment) are often not measured. When measured, labor market data are often ill-defined in economies characterized by widespread informal employment and subsistence agriculture.[4] The following discussion describes how these limitations have been dealt with in this paper.

A. Estimating the Capital Stock

Most developing economies do not have official estimates of their capital stock. This shortcoming is overcome by estimating the capital stock using a highly simplified version of the perpetual inventory method from investment data, dating back to 1960 in many cases, and assuming a depreciation rate of 7%.[5] The same basic methodology was employed for estimating capital stocks in developing economies by Nehru and Dhareshwar (1993) and is used by the Organisation for Economic

[3]The International Labour Organization data set is derived from economy-level sources but data for some years and economies contain gaps (International Labour Organization 2011). Missing data are estimated by various methods. Even when data are derived directly from well-defined surveys, the surveys are not always comparable across economies.

[4]GDP and investment data are sourced from the World Bank's Macro-Fiscal Model (World Bank 2016b), which in turn relies on World Development Indictors as a primary source and is supplemented by the International Monetary Fund's World Economic Outlook database and national source data. Population data are sourced from the World Development Indicators and United Nations (2015) population forecasts are spliced on for the forecast period.

[5]The Organisation for Economic Co-operation and Development (2001) provides a comprehensive manual of methods for calculating the capital stock, mainly relying on disaggregated sectoral investment data, sectoral differentiation in depreciation rates, and a careful accounting of the cohort structure of the capital stock while also accounting for price changes in the capital stock. The method employed here assumes the same depreciation rate for all forms of capital and abstracts from the obsolescence implied by relative price changes over time. See Wolf (1997) for an exposition of simplified capital stock calculations that are nevertheless much more sophisticated than the procedure employed here.

Co-operation and Development in its Interlink Model for economies where the statistical agency does not produce an independent measure of the capital stock.

Using this methodology, a capital stock series, K_i, is generated for each economy using the following capital accumulation equation, where i denotes the initial estimate:[6]

$$K_{i,t} = K_{i,t-1}(1-\delta) + Inv_t \tag{3}$$

Because at the starting point (t = 0) the capital stock is zero, this method underestimates the capital stock in early years. To get around this problem, a two-step procedure is employed. An initial estimate of an economy's capital stock is calculated and then divided by GDP to derive a preliminary estimate of the capital–output ratio for each economy.[7] Taking this initial estimate of the capital stock after 15 years, $K_i(15)$, and dividing by GDP in the same year (t = 15), gives an estimate of the economy's steady-state capital–output ratio.[8] In the second step, this estimate of the capital–output ratio in t = 15 is multiplied by GDP in t = 0 to derive a nonzero starting point for the capital stock of each economy as shown in equation (4). The capital stock for t = 1. . .n was then recalculated using equation (3), resulting in a much more accurate estimate of the capital stock:[9]

$$K(0) = GDP(0)\,\frac{K_i(15)}{GDP_i(15)} \tag{4}$$

B. Accounting for the Influence of Structural Change

After accounting for labor and capital, the unexplained part of GDP is TFP. An expression for TFP can be obtained after rewriting equation (1) as the product of output per worker and the capital–labor ratio raised to the labor share:

$$GDP = TFPK^{\alpha}L^{1-\alpha} \tag{1'}$$

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[6]Arnaud et al. (2011) cite an alternative method following Kohli (1982) that sets the initial capital stock equal to the level of investment in t = 0 and divides by the depreciation rate plus the long-run growth rate of investment.

[7]In a steady-state model with a 7% annual depreciation rate, 85% of the initial capital, Inv(t = 0), will have depreciated after 25 years and the initial estimate of the capital stock will be 92% of the actual. After 15 years, the capital stock will have reached 80% of its long-term equilibrium level. Mathematically, the amount of the capital stock that existed at t = 0 will equal $K0_t = K_0 * 0.93^t$ at any given time t.

[8]To deal with outliers, if the estimated capital–output ratio for an economy fell outside the 25th and 75th percentiles of its income cohort, the estimated capital–output ratio was set equal to either the 25th or 75th percentile level.

[9]Assuming a steady-state model with 3% GDP growth per annum, the error in estimation of the capital stock would be 8% in year 0, 3.2% in year 10, and less than 1% in year 25. Of course, in most developing economies, GDP growth and investment rates have accelerated significantly over the past 20 years, suggesting that the actual estimation error is significantly smaller than suggested by the steady-state model.

$$TFP = GDP/(K^{\alpha}L^{1-\alpha})$$

$$TFP_t = \frac{GDP_t}{L_t}\left[\frac{\mathrm{K_t}}{\mathrm{L_t}}\right]^{-\alpha} \tag{5}$$

Output per worker can be decomposed as the change in sectoral output per worker (w_i) and the change in the share of workers in each sector (s_i):

$$w_t = \frac{GDP_t}{L_t}$$

$$w_t = \sum_i^n \frac{GDP_{i,t}}{L_{i,t}} * \frac{L_{i,t}}{\sum L_{i,t}}$$

$$w_t = \sum_i^n w_i * s_i$$

$$\Delta w_t = \sum_i^n \Delta w_i \left[\left(\frac{s_i}{L} + \left(\frac{s_i}{L}\right)_{t-1}\right)\Big/ 2\right] + \sum_i^n \Delta s_i \left[\left(\frac{w_i}{w} + \left(\frac{w_i}{w}\right)_{t-1}\right)\Big/ 2\right]$$

Expressing the two terms in the above expression as Δww (change in within-sector output per worker) and Δwb, the change in the relative size of the sectors gives

$$\Delta w = \Delta ww + \Delta wb$$

wB_t can then be defined as the cumulative summation of earlier changes in a sector's influence on output per worker:

$$wB_t = \sum_{t=0}^{t} \Delta wb$$

And equation (5) above can be rewritten as

$$\frac{GDP}{L_t} - w\mathrm{B_t} = \widetilde{TFP}_t * \left[\frac{\mathrm{K}}{\mathrm{L}}\right]_t^{1-\alpha} \tag{6}$$

Rewriting (6) gives a new expression for output as a function of TFP net of structural change, labor supply, and structural change:

$$GDP_t = \widetilde{TFP}_t K_t^{\alpha} L_t^{1-\alpha} + wB_t * L_t \tag{7}$$

C. Estimating Trend Productivity Growth

After the capital stock and the contribution of structural change to the evolution of output per worker have been estimated, TFP net of structural change over time can be quantified by rearranging the production function shown in equation (6) and solving for $\widetilde{TFP}_t$ as a residual:

$$\widetilde{TFP}_t = \frac{GDP_t}{K_t^{\alpha}\left(P_{1564,t} \cdot Pr_t \cdot (1 - UNR_t)\right)^{1-\alpha} + wB_t * L_t} \tag{8}$$

Trend net TFP, $\widetilde{TFP}_t^{\,*}$, which is necessary to estimate potential output, can be calculated using the Hodrick–Prescott filter through the spot estimate of $\widetilde{TFP}_t$. The endpoint problem (Mise, Kim, and Newbold 2005) is resolved by assuming that for each economy, TFP growth from the endpoint of actual data through 2040 is equal to the economy's average rate of growth of $\widetilde{TFP}_t$ during the period 1995–2015 (or 2014 where 2015 data are not yet available).[10]

D. Calculating Potential Output

Assuming that (i) the labor force is fully employed (UNR and Pr are at their equilibrium values of UNR^* and Pr^* such that $L_t^* = P_{1564,t}^* Pr_t^* UNR_t^*$), (ii) all of the services of the available capital stock are used, and (iii) TFP net of structural change is at a level consistent with its long-term trend, $\widehat{TFP}_t^*$, gives an expression for the growth rate of potential GDP_t^*.[11] Unlike labor, there is no separate estimate of the value of the capital stock at full employment because the relevant input here is capital services, which at full utilization rates are the services from the total capital stock raised to the power α:

$$GDP_t^* = \widehat{TFP}_t^* K_t^{\alpha} L_t^{*1-\alpha} + wB_t * L_t^* \tag{9}$$

Armed with actual GDP and the estimate of potential GDP, GDP_t^*, it is possible to calculate the output gap, OG_t, which is defined as the percentage difference between the actual output observed and the estimated potential output:

$$OG_t = \frac{GDP_t - GDP_t^*}{GDP_t^*} * 100 \tag{10}$$

[10] Historical data for GDP in 2015 were not available for all economies. For those economies where such data were unavailable, trend TFP growth was calculated using data for the period 2000–2014.

[11] The equilibrium unemployment rate and participation rate are estimated using the Hodrick–Prescott filter, assuming that future levels of these variables are equal to their average level in 2000–2015.

If actual output rises above its potential (positive output gap), then capacity constraints begin to bind and one would expect to see inflationary pressures build and also perhaps an increase in the current account deficit. On the other hand, if the output gap is negative, resources are underutilized and inflationary pressures subside. Normally, actual GDP growth will fluctuate around its estimated potential growth path.

III. Baseline Results

Using the methodology described above, Table 1 reports historical growth rates and estimates of potential output growth, TFP growth, the natural rate of unemployment, and the natural labor force participation rate for 23 Asian economies. Due to data limitations, labor's share of income in output is assumed to be 70% for all economies, the rate of depreciation of capital is 7%, and a relatively tight smoothing parameter (lambda equals 100) is used for the Hodrick–Prescott filter when calculating both the natural rates of unemployment and trend TFP.[12] Burns et al. (2014) report sensitivity analysis for alternative assumptions regarding labor's share of income in output (30%, 50%, and 70%); the capital depreciation rate (6%, 7%, and 8%); and different levels for the TFP smoothing parameter lambda. While historical estimates are impacted by the different assumptions, the extent of the influence is small.

A. Historical Trends

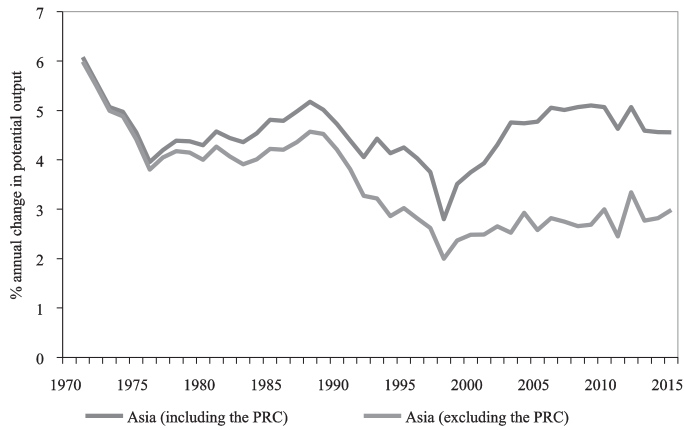
For the region as a whole, potential output growth per annum has accelerated markedly from around 4.1% in the early 1990s to around 5% in the 2000s, before easing somewhat during the first half of the 2010s (Figure 1).[13] Excluding the People's Republic of China (PRC), where potential output growth has been relatively stable until recently, the acceleration is less evident and potential output grows at just under 3% per annum, which is more or less the same rate as just before the 1997/98 Asian financial crisis.

Notwithstanding frequent concerns voiced in the international press about the slowing of developing economy growth after the recent global financial crisis,

[12]Ravn and Uhlig (2002) show that a lambda value of 6.25 for annual data is consistent with a value of lambda of 1,600 as first proposed by Hodrick and Prescott for quarterly data. However, they do not show that 1,600 is the appropriate value for quarterly data. That value was proposed originally on the basis of the somewhat arbitrary assumption that "a 5% cyclical component is moderately large, as is a one-eighth of 1% change in the growth rate." An equally arbitrary but plausible assumption about the influence of the cycle on quarterly growth of 0.5, for example, would result in a quarterly lambda of 25,600, which in the Ravn–Uhlig methodology would give rise to an annual lambda of 100, which is the number used by the European Commission (Economic Policy Commission 2001).

[13]Most tables and figures presented in this report are focused on the period after 1990 because labor market data necessary for the structural change decomposition are only available in the post-1990 period. However, the TFP (inclusive of structural change) and potential output calculations themselves are not dependent on this decomposition. As a result, calculations of TFP inclusive of structural change and potential output data are available as far back as 1970 for many economies.

Figure 1. **Asia's Potential Output Growth**



PRC = People's Republic of China.
Source: Author's calculations.

potential output grew faster during the postcrisis period (2009–2014) than in the preboom period (1993–1998) in 13 of the 23 Asian economies for which sufficient data exist (Table 1a). Overall, the contribution from capital accumulation and TFP growth on potential output, excluding the PRC, has increased over time, while the contribution of labor to growth has declined in most of the economies covered. The largest accelerations were observed in the economies of the former Soviet Union, many of which underwent profound structural adjustments and reform in the 1990s that set the groundwork for stronger growth in the 2000s.

Table 1a groups the 13 economies in which potential output growth in the most recent 5-year period (2009–2014) was higher than during the 1990s by their most important source of acceleration. Of these economies, only Kazakhstan saw labor force growth as the largest contributor to the acceleration in potential output growth. Although labor was the largest contributor to the acceleration in Kazakhstan, the contribution that labor made to the acceleration of growth in Georgia was actually larger. However, Georgia is not included in this group of economies because the contribution of capital to the acceleration in its potential output growth was even larger. In addition to Georgia, accelerated capital deepening was also the largest driver of improved potential output in Mongolia and Papua New Guinea, likely reflecting a boost in resource-related investment associated with the commodity boom. As global commodity prices have eased and are expected to remain low for some time (World Bank 2016a), it is unlikely that these economies' strong capital deepening will be sustained over the medium term.

Improved TFP growth (net of structural change) was the largest contributor to accelerating potential output growth in Bangladesh, India, Indonesia, Pakistan, the Philippines, Solomon Islands, and Sri Lanka. Importantly, TFP is growing strongly (close to 2% or more per annum) in all of these economies except Pakistan. Continued TFP growth, and therefore a sustained acceleration of potential output in

Table 1a. **Countries with Improved Potential Output Growth between 2009−2014 and 1993−1998**

		Contribution to Potential Growth						Contribution to Potential Growth			
	Potential Growth	**Employment**	**Capital**	**TFP**	**Structural Change**		**Potential Growth**	**Employment**	**Capital**	**TFP**	**Structural Change**
Countries where stronger employment growth explains most of the acceleration between the 1993–1998 and 2009–2014 periods											
Kazakhstan											
1993–1998	−0.7	−0.7	−1.4	1.8	−0.4						
1998–2003	6.0	0.6	−1.2	5.3	1.3						
2003–2008	7.7	1.5	0.3	4.6	1.3						
2009–2014	5.2	1.0	0.9	2.5	0.8						
Change 2009–2014 less 1993–1998	5.9	1.6	2.3	0.8	1.2						
Countries where stronger capital accumulation explains most of the acceleration between the 1993–1998 and 2009–2014 periods											
Georgia						**Mongolia**					
1993–1998	1.5	−1.4	−1.4	2.6	1.7	1993–1998	2.6	1.4	0.2	1.8	−0.9
1998–2003	3.9	−0.4	−0.4	6.2	−1.4	1998–2003	5.1	2.0	0.2	2.1	0.9
2003–2008	7.4	0.5	0.3	4.9	1.7	2003–2008	8.0	1.9	1.2	3.0	1.9
2009–2014	4.8	0.4	0.8	2.0	1.6	2009–2014	8.6	1.3	2.4	3.7	1.2
Change 2009–2014 less 1993–1998	3.3	1.8	2.3	−0.6	−0.1	Change 2009–2014 less 1993–1998	6.0	−0.1	2.1	1.9	2.0
Papua New Guinea											
1993–1998	2.3	2.1	0.1	−0.1	0.1						
1998–2003	1.2	2.0	0.6	−1.4	0.0						
2003–2008	3.2	1.9	0.6	0.1	0.7						
2009–2014	9.6	1.9	3.8	2.0	1.9						
Change 2009–2014 less 1993–1998	7.3	−0.2	3.6	2.1	1.8						

Continued.

Table 1a. *Continued.*

		Contribution to Potential Growth						Contribution to Potential Growth			
	Potential Growth	**Employment**	**Capital**	**TFP**	**Structural Change**		**Potential Growth**	**Employment**	**Capital**	**TFP**	**Structural Change**
Countries where stronger TFP growth explains most of the acceleration between the 1993–1998 and 2009–2014 periods											
Bangladesh						**Indonesia**					
1993–1998	4.6	1.9	2.2	0.1	0.3	1993–1998	4.4	1.6	2.8	−0.8	0.8
1998–2003	6.1	1.7	2.3	−0.3	2.4	1998–2003	2.8	1.2	0.8	0.5	0.2
2003–2008	5.3	1.3	2.4	1.0	0.6	2003–2008	5.5	1.2	1.5	2.0	0.8
2009–2014	6.2	1.3	2.5	1.9	0.4	2009–2014	5.8	1.2	1.9	2.2	0.5
Change 2009–2014 less 1993–1998	1.6	−0.6	0.4	1.7	0.1	Change 2009–2014 less 1993–1998	1.4	−0.4	−0.9	3.0	−0.3
India						**Pakistan**					
1993–1998	6.1	1.6	1.9	2.3	0.3	1993–1998	3.6	2.1	1.2	0.1	0.2
1998–2003	6.1	1.4	2.0	2.2	0.6	1998–2003	4.3	2.4	0.7	0.4	0.8
2003–2008	8.1	1.1	3.1	2.9	1.0	2003–2008	3.8	2.4	1.0	0.6	−0.2
2009–2014	7.7	0.9	2.6	3.2	1.0	2009–2014	3.8	2.1	0.5	0.8	0.4
Change 2009–2014 less 1993–1998	1.6	−0.7	0.7	0.8	0.7	Change 2009–2014 less 1993–1998	0.2	0.0	−0.7	0.7	0.3
Philippines						**Sri Lanka**					
1993–1998	4.8	1.8	1.2	0.6	1.2	1993–1998	4.1	1.5	1.6	1.2	−0.2
1998–2003	3.7	1.7	0.6	1.3	0.1	1998–2003	4.7	0.8	1.5	1.4	1.1
2003–2008	4.5	1.7	0.8	2.1	−0.1	2003–2008	6.0	0.9	2.1	2.9	0.1
2009–2014	5.9	1.6	1.3	2.3	0.8	2009–2014	6.4	−0.1	2.4	4.1	0.0
Change 2009–2014 less 1993–1998	1.1	−0.3	0.1	1.7	−0.4	Change 2009–2014 less 1993–1998	2.3	−1.6	0.8	2.9	0.2

Continued.

Table 1a. *Continued.*

		Contribution to Potential Growth						Contribution to Potential Growth			
	Potential Growth	**Employment**	**Capital**	**TFP**	**Structural Change**		**Potential Growth**	**Employment**	**Capital**	**TFP**	**Structural Change**
Countries where structural change explains most of the acceleration between the 1993–1998 and 2009–2014 periods											
Azerbaijan						**Lao People's Democratic Republic**					
1993–1998	1.1	1.0	1.6	−0.7	−0.8	1993–1998	6.3	1.6	3.1	0.9	0.6
1998–2003	11.3	1.4	5.2	4.0	0.7	1998–2003	6.0	1.5	4.1	0.3	0.1
2003–2008	14.5	2.1	5.3	5.9	1.2	2003–2008	8.3	1.9	5.4	0.0	1.0
2009–2014	6.6	1.5	2.1	1.3	1.6	2009–2014	7.6	1.7	3.3	0.5	2.0
Change 2009–2014 less 1993–1998	5.5	0.6	0.6	2.0	2.4	Change 2009–2014 less 1993–1998	1.3	0.1	0.2	−0.4	1.4
Nigeria						**Solomon Islands**					
1993–1998	3.7	1.9	0.5	1.2	0.0	1993–1998	2.1	2.5	1.2	−1.9	0.3
1998–2003	4.5	1.8	0.2	3.0	−0.4	1998–2003	−1.6	2.2	−0.1	−3.3	−0.4
2003–2008	5.4	1.8	1.2	3.3	−0.9	2003–2008	3.8	1.8	2.5	−1.0	0.5
2009–2014	6.5	1.9	1.0	1.7	1.9	2009–2014	4.9	1.7	2.5	0.6	0.1
Change 2009–2014 less 1993–1998	2.8	0.0	0.5	0.4	1.9	Change 2009–2014 less 1993–1998	2.9	−0.8	1.4	2.5	−0.2

TFP = total factor productivity.
Source: Author's calculation.

Table 1b. **Countries with Slower Potential Output Growth between 2009–2014 and 1993–1998**

		Contribution to Potential Growth						Contribution to Potential Growth			
	Potential Growth	**Employment**	**Capital**	**TFP**	**Structural Change**		**Potential Growth**	**Employment**	**Capital**	**TFP**	**Structural Change**
Countries where weaker employment growth explains most of the slowdown between the 1993–1998 and 2009–2014 periods											
New Zealand											
1993–1998	3.4	1.1	1.2	1.0	0.0						
1998–2003	3.2	1.3	1.3	0.7	0.0						
2003–2008	3.0	1.2	1.6	0.3	−0.1						
2009–2014	2.1	0.4	0.9	0.7	0.0						
Change 2009–2014 less 1993–1998	−1.3	−0.7	−0.3	−0.3	0.0						
Countries where weaker capital accumulation explains most of the slowdown between the 1993–1998 and 2009–2014 periods											
Japan						**Republic of Korea**					
1993–1998	1.4	−0.2	0.9	0.6	0.2	1993–1998	6.0	0.8	3.0	3.5	−1.4
1998–2003	1.0	−0.5	0.4	0.9	0.2	1998–2003	5.1	0.5	1.7	3.2	−0.3
2003–2008	0.8	−0.7	0.2	1.2	0.1	2003–2008	3.7	0.4	1.4	2.5	−0.6
2009–2014	0.5	−0.9	0.0	1.4	0.0	2009–2014	3.4	0.5	1.0	1.8	0.1
Change 2009–2014 less 1993–1998	−0.9	−0.7	−0.9	0.9	−0.2	Change 2009–2014 less 1993–1998	−2.7	−0.4	−2.0	−1.7	1.4
Malaysia						**Singapore**					
1993–1998	7.0	2.2	3.6	1.3	0.0	1993–1998	7.5	2.2	2.9	2.3	0.1
1998–2003	4.7	1.9	0.9	1.7	0.1	1998–2003	4.7	1.0	1.6	2.2	−0.1
2003–2008	4.7	1.7	1.1	2.4	−0.4	2003–2008	6.1	2.7	1.4	2.2	−0.2
2009–2014	5.2	1.5	1.6	1.9	0.2	2009–2014	4.8	1.4	1.7	1.7	−0.1
Change 2009–2014 less 1993–1998	−1.8	−0.7	−2.0	0.7	0.2	Change 2009–2014 less 1993–1998	−2.7	−0.8	−1.2	−0.6	−0.2
Armenia						**Australia**					
1993–1998	7.7	−1.6	−1.7	8.4	2.6	1993–1998	3.3	0.9	1.2	1.2	−0.1
1998–2003	9.1	−0.4	−1.3	9.7	1.1	1998–2003	3.4	1.2	1.4	0.8	0.0
2003–2008	7.8	0.3	0.4	5.3	1.7	2003–2008	3.2	1.3	1.8	0.1	0.1
2009–2014	3.1	1.1	−0.1	1.8	0.2	2009–2014	2.9	1.0	1.6	0.2	0.1
Change 2009–2014 less 1993–1998	−4.6	2.7	1.6	−6.6	−2.4	Change 2009–2014 less 1993–1998	−0.4	0.0	0.4	−1.0	0.2

Continued.

Table 1b. *Continued.*

		Contribution to Potential Growth						Contribution to Potential Growth			
	Potential Growth	Employment	Capital	TFP	Structural Change		Potential Growth	Employment	Capital	TFP	Structural Change
Countries where weaker productivity growth explains most of the slowdown between the 1993–1998 and 2009–2014 periods											
People's Republic of China											
1993–1998	10.0	0.8	3.9	5.5	−0.2						
1998–2003	10.0	0.9	3.3	4.6	1.2						
2003–2008	10.8	0.6	3.6	4.7	1.9						
2009–2014	8.2	0.0	3.6	4.6	0.0						
Change 2009–2014 less 1993–1998	−1.7	−0.8	−0.3	−0.9	0.2						
Countries where less structural change explains most of the slowdown between the 1993–1998 and 2009–2014 periods											
Cambodia						**Thailand**					
1993–1998	NA	2.6	2.2	0.7	NA	1993–1998	4.4	1.0	2.3	−0.4	1.4
1998–2003	9.7	3.0	3.3	0.4	2.9	1998–2003	3.3	0.9	0.1	0.6	1.7
2003–2008	7.9	2.2	3.8	1.3	0.7	2003–2008	3.5	0.6	0.9	2.3	−0.2
2009–2014	6.4	1.7	2.2	2.3	0.3	2009–2014	2.7	0.2	0.8	2.9	−1.2
Change 2009–2014 less 1993–1998	−3.3	−0.9	0.0	1.6	−2.6	Change 2009–2014 less 1993–1998	−1.7	−0.8	−1.6	3.3	−2.7
Nepal						**Viet Nam**					
1993–1998	5.7	1.8	1.3	0.2	2.4	1993–1998	7.6	1.7	1.5	2.0	2.4
1998–2003	3.3	1.3	1.1	0.7	0.1	1998–2003	6.7	1.8	2.2	0.7	2.0
2003–2008	4.2	1.0	1.1	1.3	0.7	2003–2008	7.1	1.6	2.9	0.9	1.7
2009–2014	4.4	1.6	1.3	1.2	0.3	2009–2014	5.3	1.0	2.2	2.6	−0.4
Change 2009–2014 less 1993–1998	−1.3	−0.2	0.0	1.0	−2.1	Change 2009–2014 less 1993–1998	−2.3	−0.7	0.7	0.6	−2.8

NA = not available, TFP = total factor productivity.
Source: Author's calculations.

these economies, will depend on maintaining the reform process and technological progress. This may be particularly challenging in economies like Sri Lanka where the recent large gains in TFP growth likely reflect a temporary boost following the cessation of hostilities.

In Azerbaijan, the Lao People's Democratic Republic (Lao PDR), and Nigeria, TFP growth from structural change has been the biggest driver of growth acceleration. The contribution was particularly large in Azerbaijan for both TFP net of structural change and structural change. Partly because of base effects, the contribution of each to potential output growth during 1993–1998 was actually negative.

The contribution of employment to potential output growth weakened in every economy where potential output growth slowed in the latest period relative to 1993–1998, but only in New Zealand was this the largest factor in explaining the slowdown. Weaker capital accumulation was the largest factor in four of the 10 economies—Japan, the Republic of Korea, Malaysia, and Singapore—partly resulting from an end to the rapid capital accumulation that occurred in these economies in the 1990s prior to the 1997/98 Asian financial crisis. Except for Japan, where capital accumulation did not contribute to potential output growth during 2009–2014, capital accumulation continued to be a major factor in explaining growth in each of these economies.

Weaker productivity growth (net of structural change) was the main factor behind the deceleration in potential output growth in Armenia, Australia, and the PRC, although in the cases of Armenia and the PRC, TFP continued to expand relatively quickly. In Cambodia, Nepal, Thailand, and Viet Nam, the largest factor driving the slowdown in potential output appears to have been weaker TFP growth due to structural change, which in the case of Thailand appears to be reflected in the stabilization of the employment share of agriculture in the economy.

IV. Long-Term Projections

The future of potential output in Asian economies will depend on a wide range of factors, including initial conditions, improvements in education policies (human capital), health outcomes, regulatory reforms, industrial policies, and demographics. The identification of the potential impact that individual polices may have on unemployment, labor participation, TFP growth, and investment lie well outside the scope of this paper. However, it is possible to examine the likely impact on potential output from convergence toward best practice along each of these dimensions.

To do so, a two-step procedure is followed. First, a business-as-usual or baseline scenario grounded in specific assumptions as to how each of the principal drivers of potential output is expected to behave over the next 25 years (2016–2040) is generated. In the second step, a series of alternative scenarios are generated to examine the influence that better performances in terms of capital, labor, TFP, and structural change might have on potential output.

For the purposes of constructing the baseline, it is assumed that

(i) demographics proceed in a manner consistent with the baseline assumption of the United Nations' population projections,

(ii) labor market efficiency is unchanged (constant natural unemployment and participation rates),

(iii) investment continues at a rate consistent with current capital–output ratios (no capital deepening),

(iv) the sectoral transformation of an economy continues along the same path as during the past 15 years, and

(v) TFP growth continues to grow at the same average pace as during the past 15 years.

Table 2 shows potential output growth rates for Asian economies during 2010–2015 and projected potential output growth rates for the period 2035–2040 based on these five assumptions. It presents the change in potential growth between these two periods and breaks down the individual contributions of employment, capital, TFP, and structural change. Figure 2 shows the same changes graphically, with the contributions for each economy sorted from the largest negative contribution to the smallest (or largest positive contribution).

These results are not a forecast but rather a projection of what might occur should the assumptions described above hold. In some cases, the projected change in potential growth and its sources may say more about the 2010–2015 period than it does about the forecast period. For example, in the case of the Lao PDR, where recently there has been rapid capital deepening, the sharp slowdown projected in the business-as-usual scenario mainly reflects the assumption of a stable capital–output ratio, and therefore an end to the rapid capital deepening that has driven recent growth. While probably not a short-term concern, the very slow long-term growth in this scenario highlights the challenge that authorities in the Lao PDR will face in transitioning the economy toward a more sustainable TFP-led growth model. On the other hand, the reduced contribution to potential growth from labor in the baseline scenario reflects a real influence.

With these important caveats in mind, Table 2 shows that average median potential growth among Asian economies is projected to fall by 2 percentage points by the period 2030–2040, with potential output growth in virtually every economy slowing to some degree or another. Slower growth of the working-age population (driven entirely by demographics) and the stabilization of capital–output ratios each account for –0.8 percentage points of the median slowdown. The median decline

Table 2. **Baseline Change in Potential Output Growth between 2010–2015 and 2045–2040 and Contributions from Different Sources**

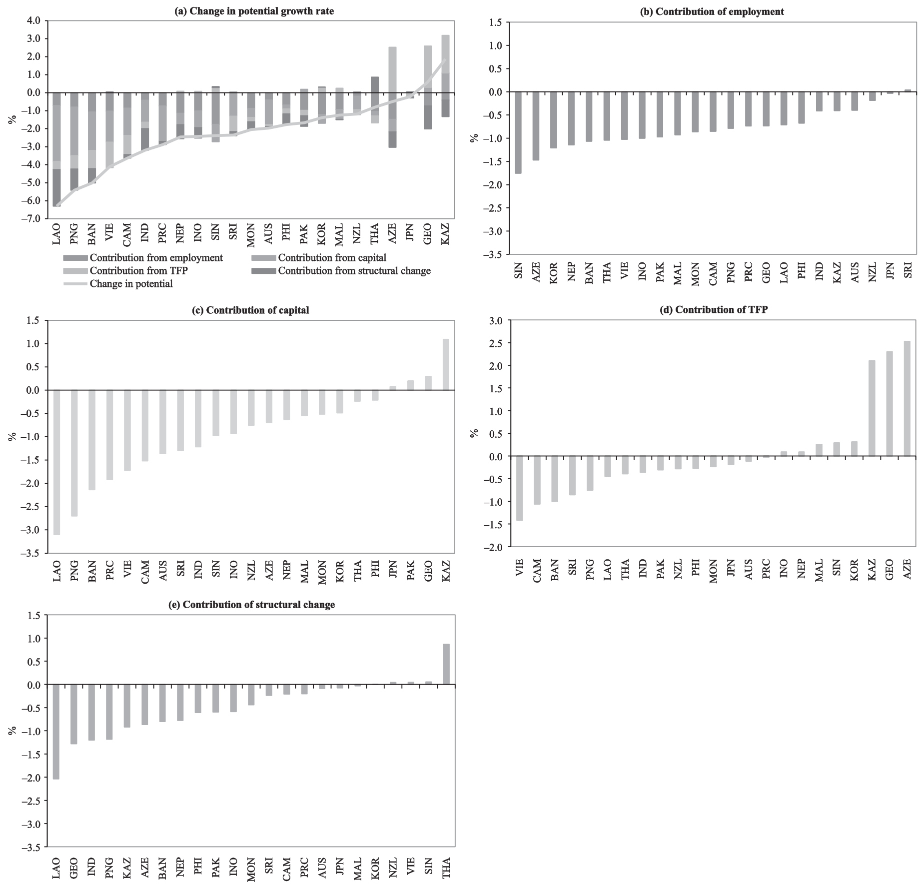
	Potential Growth Rate			Contribution to Change in Potential Growth			
	2010–2015	**2035–2040**	**Delta**	**Employment**	**Capital**	**TFP**	**Structural Change**
LAO	6.8	1.3	−6.3	−0.7	−3.1	−0.4	−2.0
PNG	4.4	3.5	−5.4	−0.8	−2.7	−0.8	−1.2
BAN	6.1	1.3	−5.0	−1.1	−2.1	−1.0	−0.8
VIE	5.2	1.0	−4.1	−1.0	−1.7	−1.4	0.0
CAM	6.5	2.7	−3.6	−0.8	−1.5	−1.1	−0.2
IND	6.7	4.1	−3.2	−0.4	−1.2	−0.4	−1.2
PRC	6.8	4.9	−2.9	−0.7	−1.9	0.0	−0.2
NEP	4.6	2.0	−2.5	−1.1	−0.6	0.1	−0.8
INO	5.3	3.1	−2.4	−1.0	−0.9	0.1	−0.6
SIN	4.1	2.2	−2.4	−1.8	−1.0	0.3	0.1
SRI	7.2	4.0	−2.4	0.0	−1.3	−0.9	−0.2
MON	5.2	5.1	−2.0	−0.9	−0.5	−0.2	−0.4
AUS	2.5	1.0	−2.0	−0.4	−1.4	−0.1	−0.1
PHI	5.8	3.8	−1.8	−0.7	−0.2	−0.3	−0.6
PAK	4.3	2.2	−1.7	−1.0	0.2	−0.3	−0.6
KOR	2.8	1.7	−1.4	−1.2	−0.5	0.3	0.0
MAL	4.7	3.7	−1.2	−0.9	−0.5	0.3	0.0
NZL	2.3	1.0	−1.2	−0.2	−0.8	−0.3	0.0
THA	3.8	1.8	−0.8	−1.0	−0.2	−0.4	0.9
AZE	3.3	4.4	−0.5	−1.5	−0.7	2.5	−0.9
JPN	0.8	0.4	−0.2	0.0	0.1	−0.2	−0.1
GEO	4.4	4.7	0.6	−0.7	0.3	2.3	−1.3
KAZ	3.5	6.5	1.9	−0.4	1.1	2.1	−0.9
Median across countries	4.6	2.7	−2.0	−0.8	−0.8	−0.2	−0.4
Unweighted average	4.7	2.9	−2.2	−0.8	−0.9	0.0	−0.5
Maximum	7.2	6.5	1.9	0.0	1.1	2.5	0.9
Minimum	0.8	0.4	−6.3	−1.8	−3.1	−1.4	−2.0
Standard deviation	1.7	1.6	1.9	0.4	1.0	1.0	0.6

AUS = Australia, AZE = Azerbaijan, BAN = Bangladesh, CAM = Cambodia, GEO = Georgia, IND = India, INO = Indonesia, JPN = Japan, KAZ = Kazakhstan, KOR = Republic of Korea, LAO = Lao People's Democratic Republic, MAL = Malaysia, MON = Mongolia, NEP = Nepal, NZL = New Zealand, PAK = Pakistan, PNG = Papua New Guinea, PHI = Philippines, PRC = People's Republic of China, SIN = Singapore, SRI = Sri Lanka, TFP = total factor productivity, THA = Thailand, VIE = Viet Nam.
Source: Author's calculations.

from slower TFP growth is a relatively small –0.2 percentage points, while structural change contributes –0.4 percentage points.

Almost every economy is likely to see the contribution of labor to potential growth decline during the review period, assuming no further declines in equilibrium unemployment or in the rate of labor participation (Figure 2b). Only Sri Lanka is projected to see the growth rate of its working-age population pick up between 2015 and 2040; therefore, the baseline contribution of employment to output growth rises marginally in Sri Lanka. Elsewhere, working-age population growth slows, with the

Figure 2. **Baseline Scenario—Changes in Potential Output Growth and Contributions to Changes in Potential Output Growth**



AUS = Australia, AZE = Azerbaijan, BAN = Bangladesh, CAM = Cambodia, GEO = Georgia, IND = India, INO = Indonesia, JPN = Japan, KAZ = Kazakhstan, KOR = Republic of Korea, LAO = Lao People's Democratic Republic, MAL = Malaysia, MON = Mongolia, NEP = Nepal, NZL = New Zealand, PAK = Pakistan, PNG = Papua New Guinea, PHI = Philippines, PRC = People's Republic of China, SIN = Singapore, SRI = Sri Lanka, TFP = total factor productivity, THA = Thailand, VIE = Viet Nam.

Notes: The main assumptions of the baseline scenario include constant natural rates of unemployment and labor force participation, constant capital–output ratio, TFP growth equal to an economy's 2000–2015 average, and sector change equal to an economy's 2000–2015 average.

Source: Author's calculations.

contribution of labor to potential output growth declining the most in Azerbaijan, the Republic of Korea, and Singapore.

Capital's largest contribution to slowing potential growth is observed in economies, such as the Lao PDR and Viet Nam, that have undergone an intense process of capital deepening in recent years. In these and similar economies, the assumption of a stable capital–output ratio implies that the rapid capital deepening of recent years will end, resulting in a substantial decline in the potential growth rate (e.g., 1.9 percentage points in the case of the PRC). Figure 2c provides a breakdown of which economies are most affected by this assumption.

Insofar as the recent pace of capital deepening is unsustainable, these slowdowns point to a real growth challenge in the medium term. If these economies want to maintain recent potential output growth rates, policies will either have to continue to create conditions that support the very high investment rates of recent years or substitute this investment with faster TFP growth and/or increased labor utilization.

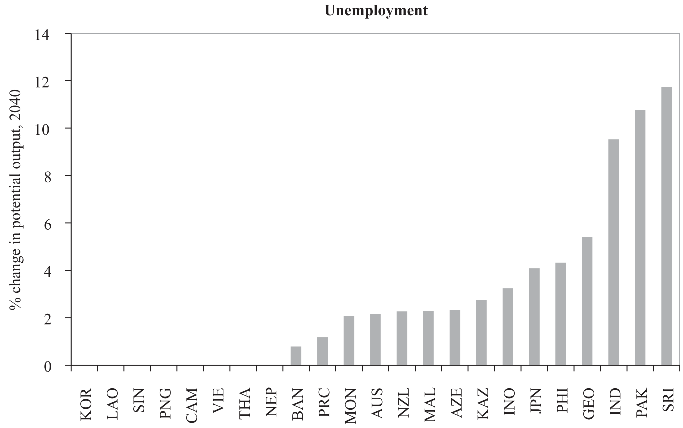
For most economies, the assumption to hold TFP growth at the average rate observed during 2000–2015 has only a small impact on the contribution of TFP growth, with the notable exceptions of Georgia and Kazakhstan, where TFP growth in the postcrisis period (2010–2015) was much lower than in the boom period (2000–2010). As a result, the baseline assumption of average TFP growth implies a substantial boost to potential output growth for these economies. In contrast, TFP growth in Bangladesh, Cambodia, and Viet Nam was higher in the most recent period. As a result, assuming TFP grows at the slower-period average implies a significant decline in potential growth.

Slower structural change, which is largely a function of the assumption to hold the pace of structural change at a constant rate, implies slower growth of 0.4% for the median Asian economy, with impacts in excess of at least 1 percentage point in economies where structural change has picked up in the postcrisis period (2010–2015), including Georgia, India, the Lao PDR, and Papua New Guinea. In contrast, structural change in Thailand slowed sharply in the postcrisis period and a return to more normal rates would imply faster potential output growth.

V. Convergence Scenarios

As discussed above, the baseline scenario is not a forecast but rather a mechanism to help identify potentially untapped sources of growth. In this section, the baseline projection is compared with scenarios employing different assumptions consistent with success in advancing more quickly than under the baseline scenario in one or more aspects of economic convergence. Each of these alternative scenarios assumes that an economy will put in place policies that allow different drivers of potential output growth (e.g., employment to working-age population ratio, capital–output ratio, level of TFP, and economic structure) to converge with the path followed by the Republic of Korea, an economy that made the transition from low- to high-income status relatively rapidly. As such, these alternative scenarios indicate in which area lie the greatest latent possibilities for sustained improvement in economic performance. While the Republic of Korea is a somewhat arbitrary convergence point at which to aim, it has the merit of being concrete and is rooted in one of the more successful Asian development stories of the past 100 years.

Figure 3. **Impact on Potential Output in 2040 of Labor Market Convergence with the Republic of Korea**



AUS = Australia, AZE = Azerbaijan, BAN = Bangladesh, CAM = Cambodia, GEO = Georgia, IND = India, INO = Indonesia, JPN = Japan, KAZ = Kazakhstan, KOR = Republic of Korea, LAO = Lao People's Democratic Republic, MAL = Malaysia, MON = Mongolia, NEP = Nepal, NZL = New Zealand, PAK = Pakistan, PNG = Papua New Guinea, PHI = Philippines, PRC = People's Republic of China, SIN = Singapore, SRI = Sri Lanka, THA = Thailand, VIE = Viet Nam.
Source: Author's calculations.

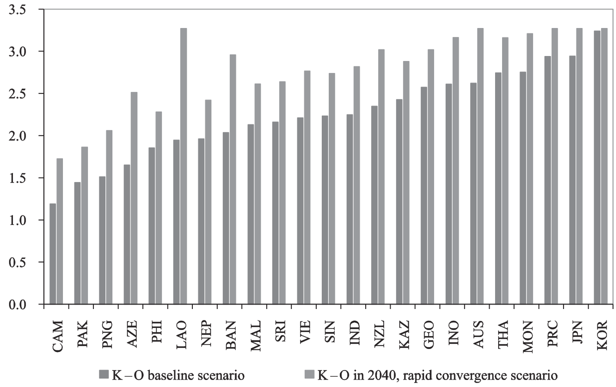
A. Employment Convergence

The first alternative scenario examines the impact on potential output if authorities succeed in reducing the unemployment rate and increasing the equilibrium labor participation rate in their respective economies to the levels observed in the Republic of Korea in 2014. This scenario is implemented by reducing the unemployment rate by 0.2 percentage points per annum until it reaches the Republic of Korea's 2014 level, and by raising the participation rate by the same 0.2 percentage points per annum until it reaches the Republic of Korea's levels.[14] Figure 3 reports for each economy the impact on potential GDP in 2040 expressed as a percent of baseline potential GDP.

The largest benefits from improved labor market efficiency, with around a 10% increase in potential GDP in 2040, are for India, Pakistan, and Sri Lanka, which are economies with relatively low participation rates due mainly to low rates of female labor force participation. The second-biggest improvements come from economies with high unemployment rates like Georgia, Indonesia, and the Philippines. Bringing more of the working-age population into employment could raise potential output by as much as 5.5% in these economies by 2040.

[14]The modeled convergence rate is based on the average reduction or improvement observed in these rates among economies with falling unemployment and rising participation rates over the past 15 years. It implies a maximum improvement in both rates of 5 percentage points between 2015 and 2040.

Figure 4. **Capital−Output Ratios in 2040—Baseline Scenario versus Convergence Scenario**



AUS = Australia, AZE = Azerbaijan, BAN = Bangladesh, CAM = Cambodia, GEO = Georgia, IND = India, INO = Indonesia, JPN = Japan, KAZ = Kazakhstan, K−O = capital−output, KOR = Republic of Korea, LAO = Lao People's Democratic Republic, MAL = Malaysia, MON = Mongolia, NEP = Nepal, NZL = New Zealand, PAK = Pakistan, PNG = Papua New Guinea, PHI = Philippines, PRC = People's Republic of China, SIN = Singapore, SRI = Sri Lanka, THA = Thailand, VIE = Viet Nam.
Source: Author's calculations.

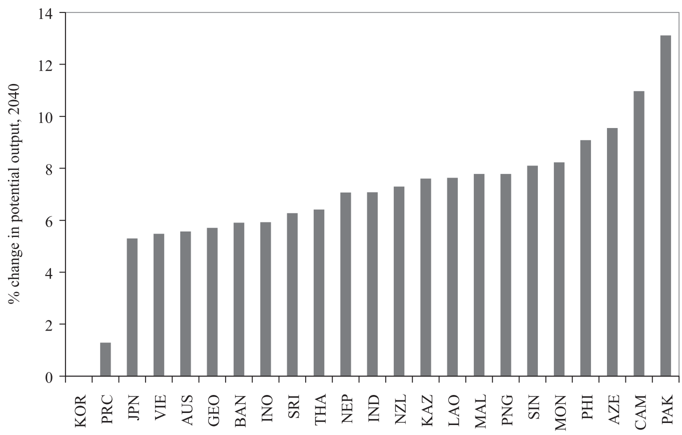
B. Capital Convergence

In the second alternative scenario, the capital–output ratios in Asian economies slowly converge to the same level currently observed in the Republic of Korea. Figure 4 indicates that the Republic of Korea's capital stock was 3.2 times potential output in 2014, with the capital-to-potential output ratio among economies in the sample ranging from 1.2 to just under 3 in the case of the PRC.

In this scenario, economies were assumed to grow their capital–output ratios during the projection period until they reached that of the Republic of Korea in 2014, at which point the capital–output ratio would be held constant. The growth rate used was the greater of 2% per year or the average growth rate of an economy's capital–output ratio during 2000–2015. The 2% growth rate is roughly equal to the mean plus one standard deviation of the rate of growth of the capital–output ratio for all developing economies during the period 1980–2000, implying that the rate of growth of the capital–output ratio exceeded 2% in only roughly 15% of economies during this period.

Figure 5 shows the percentage change in potential output in Asian economies in 2040 resulting from convergence with the Republic of Korea's 2014 capital–output ratio. For most economies, faster capital deepening adds 6–8 percentage points to potential output by 2040. For economies such as the PRC where the capital–output ratio was already close to the Republic of Korea's levels in 2014, the gains are minimal. Gains of as much as 13% are captured by economies such as Cambodia and Pakistan where the pace of capital deepening has been particularly rapid in recent years.

Figure 5. **Impact on Potential Output in 2040 of Capital Convergence**



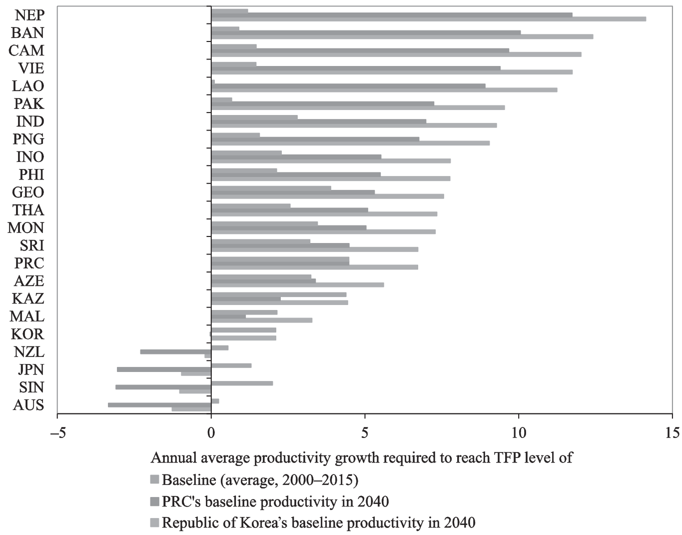
AUS = Australia, AZE = Azerbaijan, BAN = Bangladesh, CAM = Cambodia, GEO = Georgia, IND = India, INO = Indonesia, JPN = Japan, KAZ = Kazakhstan, KOR = Republic of Korea, LAO = Lao People's Democratic Republic, MAL = Malaysia, MON = Mongolia, NEP = Nepal, NZL = New Zealand, PAK = Pakistan, PNG = Papua New Guinea, PHI = Philippines, PRC = People's Republic of China, SIN = Singapore, SRI = Sri Lanka, THA = Thailand, VIE = Viet Nam.
Source: Author's calculations.

C. TFP Convergence

The third scenario examines the impact on potential GDP of faster TFP growth (net of restructuring). Here the challenges and potential gains are immense. Figure 6 reports three productivity growth rates for each economy in the sample. The first represents the average growth rate of TFP during 2000–2015, which is used as the baseline projection. The second reports the productivity growth that each economy would need to attain to converge to the PRC's baseline TFP level in 2040. The third shows the productivity growth rate that each economy would need to attain the Republic of Korea's baseline TFP level in 2040. Figure 6 confirms that TFP levels in most economies in the region lie well below the Republic of Korea's levels; even the PRC would need to increase the pace of its TFP growth by 50% if it were to close the gap with the Republic of Korea by 2040.

Figure 6 shows that there is substantial variation in TFP growth across Asian economies, with top performers like the PRC recording TFP growth of 4.5% or more per annum during 2000–2015, while others such as Bangladesh, the Lao PDR, and Pakistan had TFP growth of less than 1% per annum during the same period. Overall, the median and mean TFP growth rates for the sampled economies are about 2.1%, and the standard deviation across economies is about 1.25%. Figure 6 also illustrates that the kind of sustained increases in TFP growth required to converge to the Republic of Korea's (or even the PRC's) levels of TFP do not appear attainable for most Asian economies. To reach the Republic of Korea's or the PRC's TFP levels

Figure 6. **TFP Growth Rates Needed to Converge with Productivity Levels in the People's Republic of China and the Republic of Korea by 2040**



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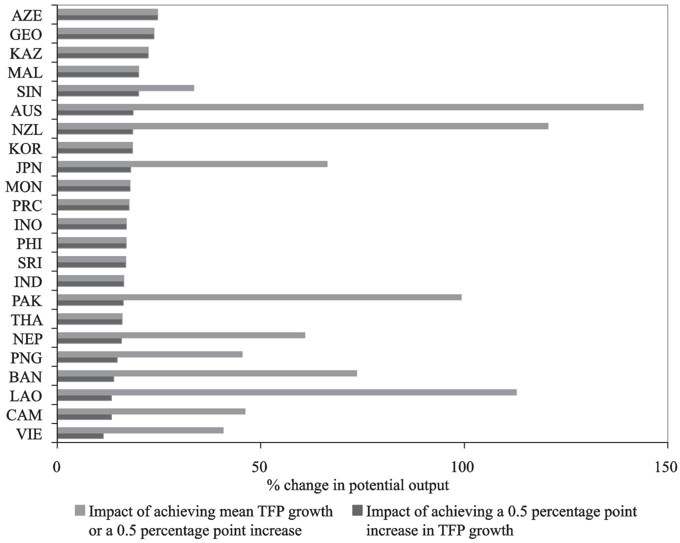
Source: Author's calculations.

in 2040, most economies would need to attain TFP growth of more than 5% per annum, and substantially more in some cases, which is more rapid TFP growth than any economy recorded during 2000–2015.

Figure 7 reports the results of two simulations that evaluate the potential gains from exceeding baseline TFP growth, which is no simple task given that 2000–2015 was a period of record growth for most developing economies. This suggests that simply maintaining TFP growth rates from this period would be an achievement. The first scenario estimates the impact on potential output in 2040 of increasing the TFP growth rate of all economies by 0.5 percentage points per annum. The second scenario estimates the effect on potential output in 2040 of increasing TFP growth by the amount needed to match the developing economy mean for TFP growth during 2000–2015 (2.1%), or of raising those economies already above the mean by 0.5 percentage points.

In the first scenario, raising TFP growth by 0.5 percentage points per annum generates end-of-period increases in potential output ranging from 11% to 24% of GDP. In the second scenario, those developing economies where TFP growth during 2000–2015 was well below the median could see potentially huge increases in output of as much as 110% by 2040. The large increases recorded for high-income

Figure 7. **Impact on Potential Output in 2040 under Two Total Factor Productivity Scenarios**



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Source: Author's calculations.

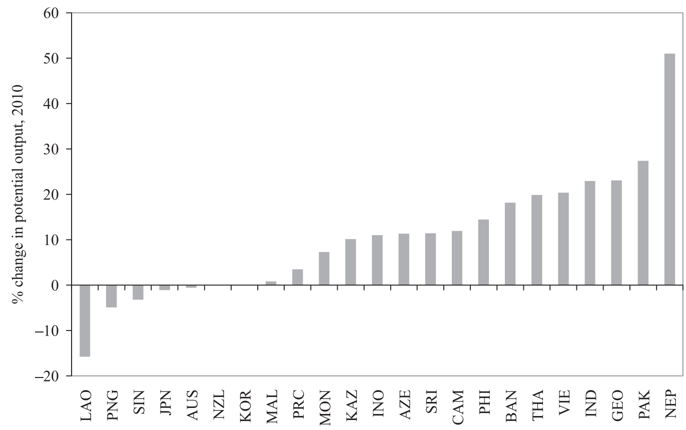
economies like Australia and New Zealand almost certainly overstate their prospects as their TFP levels in 2014 were already higher than the Republic of Korea's.

The sharp increase in potential GDP among some developing economies in the second scenario reflects how weak TFP growth was during 2000–2015 for these economies, which in turn reflects how reliant GDP growth in these economies was on capital deepening. Switching from a growth model dependent on high investment rates to one more reliant on improved efficiency will not be easy, though even attaining the median TFP growth rate among developing economies could generate huge benefits.

D. Convergence of Economic Structure

The final scenario analyzes structural change (Figure 8). An important contributor to income growth in a developing economy is the gradual movement of firms and workers from lower to higher productivity sectors (Lewis 1954). For the baseline, it was assumed that economies maintained the same rate of structural change for the period 2015–2040 as they had during 2000–2015. For the alternative scenario, economic structure was assumed to follow more or less the same pattern

Figure 8. **Impact on Potential Output in 2040 of Structural Convergence**



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Source: Author's calculations.

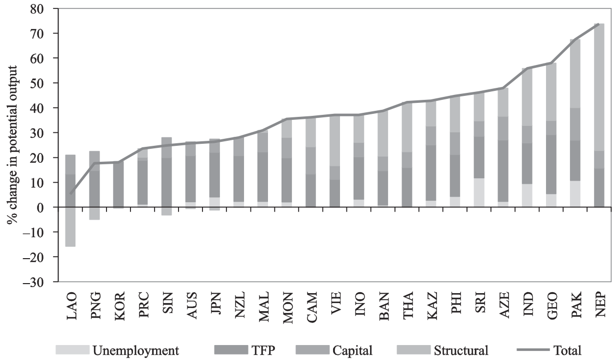
of structural evolution as occurred in the Republic of Korea. This hypothesis fits the data surprisingly well for many economies. For example, simple regressions of the employment share of the service sectors for the PRC, Indonesia, and Malaysia on the Republic of Korea's service sector's employment share generated R-squared values of 0.98, 0.74, and 0.96, respectively.[15]

In the structural change scenario, sectoral employment shares were assumed to follow the pattern of development in the Republic of Korea from that point in time when its agriculture employment share was closest to an individual economy's.[16] Using this assumption for structural change, economies such as the Lao PDR and Papua New Guinea, which saw a great deal of structural change during 2000–2015, would see less structural change than under the baseline scenario where it was assumed that structural change would continue at the same rapid pace as the period 2000–2015. For most economies, however, the pace of structural change increases under the alternative scenario, with strong positive impacts on potential output in 2040, including GDP increases of 20% or more in several cases.

[15]The regression is based on a simple model of $eserv_{it} = \alpha + \beta eserv_{kor,t-lag}$, where the lag is determined by the period with the best fit (27 years, 27 years, and 10 years for the PRC, Indonesia, and Malaysia, respectively) and where the lags are selected based on a rolling regression designed to find the lag year with the best fit.

[16]More explicitly, a log linear regression of the Republic of Korea's employment share against time was run and then inverted to solve for the lag to be used by substituting economy x's agricultural share of employment for the Republic of Korea's in the equation such that $t_x = e^{(eagr_x - \alpha/\beta)}$.

Figure 9. **Impact on Potential Output in 2040 with Convergence in All Dimensions**



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Source: Author's calculations.

E. Overall Impact

Figure 9 presents the cumulative impacts of the four convergence scenarios examined. The alternative TFP scenario has the most consistently large impact, mainly because in contrast to the labor market scenario or the capital-deepening scenario, the TFP scenario assumes continued improvement every year. In the capital-deepening and labor market scenarios, once convergence with the Republic of Korea's levels has been achieved, no further improvement occurs and the contribution of convergence to annual potential growth along these dimensions falls to zero. While reforms in earlier years boost the level of potential output, they no longer contribute to raising the rate of growth of potential output in later years. Consistent with the Lewis (1954) turning point, the contribution to potential output growth of structural change is larger in less-developed economies because as income levels and economic structure converge, productivity gains from labor reallocation across sectors decline.

The structural change scenario yields large improvements in those economies where there has been relatively little structural change in recent years as the baseline scenario assumes structural change continuing at the average pace observed during 2000–2015.

VI. Concluding Remarks

In this paper, a relatively simple methodology for estimating potential output is presented and used to project potential output over the next 15 years. The first set of simulations, which roughly translate into a business-as-usual scenario, employs a set of baseline assumptions consistent with United Nations population projections; stable labor market efficiency; long-term trends of TFP growth; and a constant capital–output ratio, which implies capital growth consistent with the long-term equilibrium properties of the Cobb–Douglas production function and the pace of TFP and labor force growth.

These simulations reveal that, all things being equal, potential output growth across the 26 Asian economies in the sample would fall from a median of 4.6% per annum during 2010–2015 to 2.7% per annum by the period 2035–2040. In the baseline scenario, about 0.8 percentage points of the slowing is due to a decline in working-age population growth, while a stabilization of capital–output ratios at current levels would contribute a similar amount to the slowdown. TFP growth (net of structural change) in the baseline is assumed to stabilize at the average rate observed between 2000 and 2014. As a result, slower TFP growth contributes a relatively modest 0.2 percentage points to the slowdown, while assumed stagnation in the pace of structural change (the movement of labor from lower to higher productivity sectors) cuts 0.4 percentage points from potential output growth between the two periods.

The alternative scenarios presented illustrate the potential to improve on these results by implementing better polices that improve labor market efficiency, prompt more rapid capital deepening, boost structural change, and generate faster TFP growth. The specific policies that could yield these benefits at the economy level lie well outside of the scope of this paper. Nevertheless, the reported scenarios give a sense of the size of potential gains.

In particular, the scenarios suggest that raising TFP growth in economies in which TFP growth has been weak to the developing economy average of 2% per annum, and in all other economies by 0.5 percentage points per annum, could increase potential output in 2040 by between 11% and 24% over the baseline. Reducing unemployment rates and boosting labor force participation rates to the same levels as observed in the Republic of Korea in 2014 would raise end-of-period potential output by less than 6% for two-thirds of economies (as labor utilization rates are already relatively high in many economies), but could boost potential output by 10% or more in some South Asian economies where female labor participation rates are low. Capital deepening—either raising capital–output ratios by 2% per annum over an economy's average for the period 2000–2014, or attaining the sample's capital–output ratio average for the period 2000–2014—could add between 6% and 10% to potential output in most economies. In the alternative scenarios, the largest potential benefit comes from a pick-up in structural convergence toward the average rate observed in the Republic of Korea during the last 50 years. The removal of policies that may be restricting structural change, such as rural income support schemes and limits on rural–urban migration, could help boost potential output in 2040 in almost half of all economies by 10% or more above the baseline.

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Population Aging and Potential Growth in Asia

KEISUKE OTSU AND KATSUYUKI SHIBAYAMA*

We study the effects of projected population aging on potential growth in Asian economies over the period 2015–2050. We find that an increase in the share of the population over 64 years of age will significantly lower output growth through decreased labor participation. Population aging can also reduce economic growth through increased labor income taxes and dampened productivity growth.

Keywords: economic growth, population aging
JEL codes: E13, O40

I. Introduction

Many Asian economies are faced with the challenge of rapidly aging populations, which can be harmful to an economy over the long run as an increase in the share of the elderly population reduces both the labor participation rate and output per adult, and increases social security dependency. In this paper, we quantitatively assess the impacts of an expanding share of the population aged 65 years and older on long-run output over the period 2015–2050.

Many studies have discussed the effects of Japan's rapidly aging population. Braun, Ikeda, and Joines (2009) use an overlapping generations model and show that population aging was a factor in the decline in the Japanese savings rate and output during the 1990s. Katagiri (2012) constructs a new Keynesian model and argues that unexpected upward revisions to population aging forecasts operate as a shock to demand, causing deflation, unemployment, and a decline in output. Otsu and Shibayama (2016) construct a representative household model and show that population aging has played a significant role in accounting for the decline in Japan's output since the 1990s through a reduced labor participation rate.

Studies on the economic impacts of population aging in other Asian economies have been relatively sparse. Estrada, Park, and Ramayandi (2011) show that while population aging had a positive effect on global consumption over the period 1998–2007, the 31 developing Asian economies in the sample exhibited

*Keisuke Otsu (corresponding author): Lecturer in Macroeconomics and Growth and Deputy Director of Macroeconomics Growth and History Centre, School of Economics, University of Kent, United Kingdom. E-mail: k.otsu@kent.ac.uk; Katsuyuki Shibayama: Lecturer in Economics, School of Economics and Macroeconomics, Growth, and History Centre, University of Kent, United Kingdom. E-mail: k.shibayama@kent.ac.uk.
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a weaker positive relationship than the rest of the sample. Park and Shin (2011) conduct an empirical analysis of demographic transitions and economic growth for 12 developing Asian economies and find that a rise in the old age dependency ratio should lead to a decline in economic growth through reduced labor participation, total factor productivity growth, and capital accumulation. Our paper projects potential output growth in 17 Asian economies using simulation methods based on a dynamic general equilibrium model similar to that used by Otsu and Shibayama (2016).

The main findings of our paper are that population aging in Asian economies is harmful for potential growth in terms of (i) reduced labor participation and capital accumulation, (ii) increased labor income taxes, and (iii) reduced total factor productivity.

The remainder of this paper is organized as follows. Section II briefly discusses the projections for demographic transitions in Asian economies. Section III describes the dynamic general equilibrium model that we employ and section IV presents our quantitative analysis. Section V concludes.

II. Demographic Data for Asian Economies

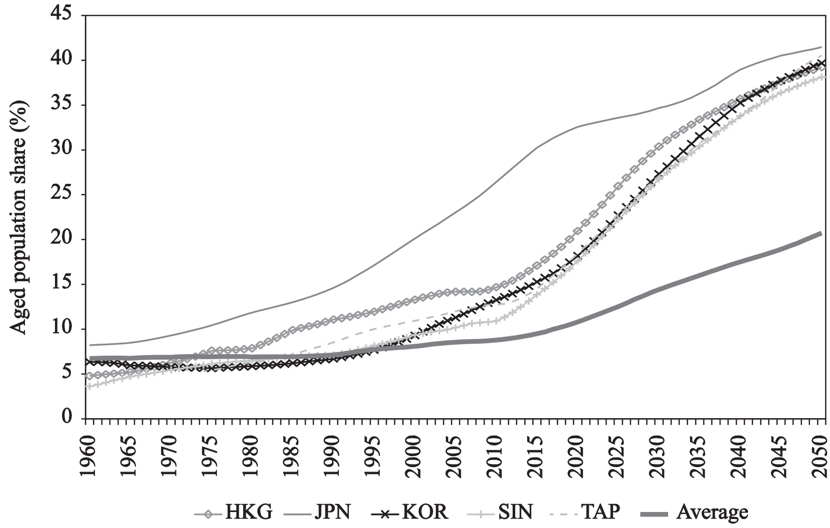
In this paper, we rely on population projections from the World Bank's Health, Nutrition, and Population Statistics.[1] We use projections for Asian economies of the shares of the population between the ages of 15 and 64, and aged 65 years and older. The former group is usually considered the economically active population, while the latter is considered to be the aged population. The sum of the two groups represents the total adult population. We define population aging as the change in the share of the aged population among the total adult population.

Figure 1 plots population aging in 43 Asian Development Bank member economies over the period 1960–2050. Japan had the highest share of aged population among the total adult population in 2015 at 30%; this figure is projected to increase to more than 40% by 2050. Hong Kong, China; the Republic of Korea; Singapore; and Taipei,China will each also have about 40% of their total population aged 65 years or older in 2050. While all economies in the sample are projected to experience population aging during the review period, Afghanistan, Papua New Guinea, and Timor-Leste are projected to have an aged population that comprises only about 10% of the total population in 2050.

An increase in the aged population share in an economy can be driven by lower fertility rates, increased longevity, or both. Figure 2 shows that the average projected adult population growth rate for Asian economies is declining over time, which implies that the fertility effect is stronger than the longevity effect. While the decline in the adult population growth rate affects our results through the capital

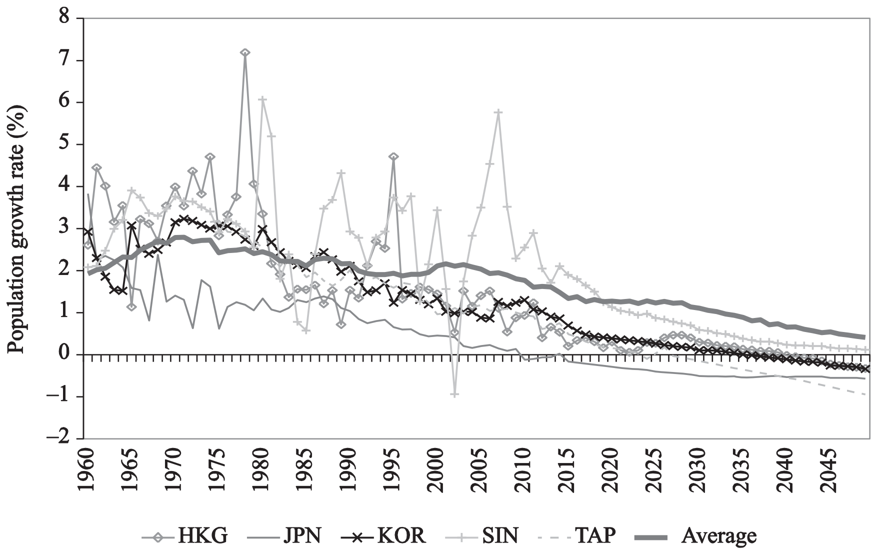
[1] For Taipei,China, we use population projections from http://eng.dgbas.gov.tw/lp.asp?CtNode=2351&CtUnit=1072&BaseDSD=36&mp=2

Figure 1. **Population Aging in Asia**



HKG = Hong Kong, China; JPN = Japan; KOR = Republic of Korea; SIN = Singapore; TAP = Taipei,China.
Note: "Average" refers to the simple average for Asian Development Bank member economies.
Source: World Bank. Health, Nutrition, and Population Statistics. http://data.worldbank.org/data-catalog/health-nutrition-and-population-statistics

Figure 2. **Population Growth Rate in Asia**



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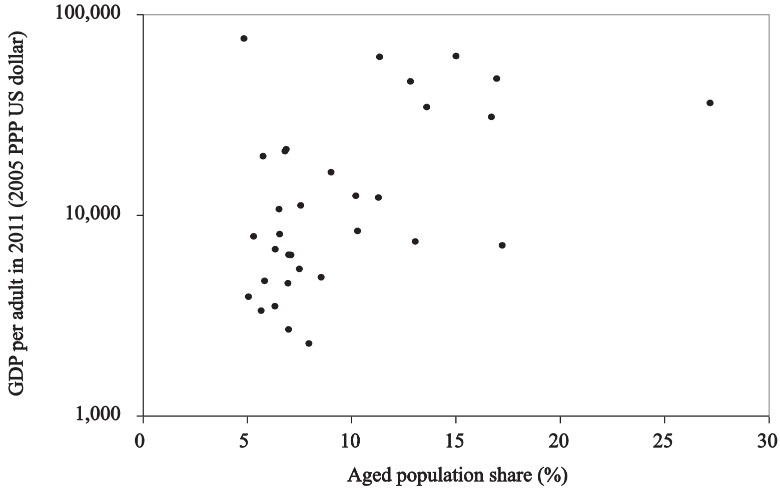
Note: "Average" refers to the simple average for Asian Development Bank member economies.
Sources: Feenstra, R. C., R. Inklaar, and M. P. Timmer. 2015. The Next Generation of the Penn World Table. *American Economic Review* 105 (10): 3150–82; World Bank. Health, Nutrition, and Population Statistics. http://data.worldbank.org/data-catalog/health-nutrition-and-population-statistics

Figure 3. **Aging and GDP**



GDP = gross domestic product, PPP = purchasing power parity, US = United States.
Source: Feenstra, R. C., R. Inklaar, and M. P. Timmer. 2015. The Next Generation of the Penn World Table. *American Economic Review* 105 (10): 3150–82.

dilution effect, we will not further discuss the sources of population growth and aging in this paper as they do not directly affect our analysis.

Figure 3 plots real gross domestic product (GDP) per adult in purchasing power parity terms and aged population shares for 33 Asian Development Bank member economies in 2011. Figure 3 shows that developed economies tend to face more severe population aging. Although the impact of economic development on demographics is an interesting topic, we take demographic projections as given and analyze their impacts on economic growth.

III. Model

The model we use for our quantitative analysis builds on that of Otsu and Shibayama (2016). It consists of a representative household of young and aged adults, a representative firm, and the government. In this model, the young work and the old are retired, while the head of the household makes decisions on the optimal allocation of hours worked by the young, consumption, and investment. The firm hires labor and capital from the household. The government taxes labor to spend for exogenous reasons and rebates the remaining amount to the household.

A. Household

The utility of the members of the household depends on consumption and leisure. The leisure of the young depends on the hours worked; the old do not work.

The utility of the household is the weighted average of the utility of the young and the old:

$$U = \sum_{t=0}^{T} \beta^t \begin{bmatrix} \eta_{y,t}\{\Psi ln c_{y,t} + (1-\Psi)\ln(\bar{h} - h_t)\} \\ (1-\eta_{y,t})\{\Psi ln c_{o,t} + (1-\Psi)\ln \bar{h}\} \end{bmatrix} \tag{1}$$

where $\eta_{y,t}$ is the share of the young in the family; $c_{y,t}$ and $c_{o,t}$ denote individual consumption of the young and the old, respectively; h_t is the number of hours worked annually per worker; and $\bar{h}$ is the maximum hours available to allocate to leisure.[2]

The household faces the following budget constraints:

$$\eta_{y,t}c_{y,t} + (1-\eta_{y,t})c_{o,t} + i_t = (1-\tau_t)\, w_t h_t \eta_{y,t} + r_t k_t + \omega_t \tag{2}$$

where i_t is the household's investment, $(1-\tau_t)\, w_t$ is the after-tax wage rate, r_t is the rental rate on capital, k_t is the household capital stock, and ω_t is the transfer from the government. Household capital stock evolves over time according to a law of motion for capital:

$$(1+n_t)k_{t+1} = i_t + (1-\delta)k_t \tag{3}$$

where n_t is the population growth rate and δ is the physical depreciation rate. The population growth rate in this equation represents the dilution effect on capital accumulation. The head of the household maximizes (1), subject to (2) and (3).

Optimization for intragenerational consumption leads to

$$c_{y,t} = c_{o,t} \equiv c_t$$

due to the separability of the preference function.[3] Optimization for the consumption–leisure choice leads to

$$\frac{1-\Psi}{\Psi}\frac{c_t}{(\bar{h} - h_t)} = (1-\tau_t)\, w_t$$

---

[2]This is similar to the indivisible labor models of Hansen (1985) and Rogerson (1988) in the sense that employment and working hours are considered separately. However, in our model, employment is given and the head of the household chooses the number of hours worked; in the indivisible labor model, hours worked are given and the household chooses employment.

[3]If we assume a nonseparable preference function such as

$$u(c_{y,t}, c_{o,t}, h_t, \eta_{y,t}) = \eta_{y,t}\left(\frac{c_{y,t}^{\Psi}(\bar{h} - h_t)^{1-\Psi}}{1-\sigma}\right)^{1-\sigma} + (1-\eta_{y,t})\left(\frac{c_{o,t}^{\Psi}\bar{h}^{1-\Psi}}{1-\sigma}\right)^{1-\sigma}$$

then the head of the household will allocate more consumption to the aged in order to equate marginal utilities of consumption.

Optimization for the consumption–saving choice leads to

$$\frac{1+n_t}{c_t} = \beta \frac{1}{c_{t+1}} \left[r_{t+1} + 1 - \delta \right]$$

B. Firm

The representative firm will produce a single good by combining capital and labor according to the following Cobb–Douglas production function:

$$Y_t = A_t K_t^{\theta} (h_t \eta_{y,t} N_t)^{1-\theta}$$

where Y_t is total output, A_t is the total factor productivity, and N_t is the total population in the economy.

The firm maximizes profits

$$\pi = Y - w_t h_t \eta_{y,t} N_t - r_t K_t$$

by choosing the optimal labor and capital levels. This leads to the labor and capital first-order conditions:

$$w_t = (1-\theta) \frac{Y_t}{h_t \eta_{y,t} N_t}$$

$$r_t = \theta \frac{Y_t}{K_t}$$

which can be rewritten in per adult terms:

$$w_t = (1-\theta) \frac{y_t}{h_t \eta_{y,t}} \quad (4)$$

$$r_t = \theta \frac{y_t}{k_t} \quad (5)$$

C. Government

The government purchases goods and services for exogenous reasons, and pays for them through a labor income tax. The government rebates all excess revenue to the household through a lump-sum transfer. Therefore, the government budget constraint is

$$G = \tau_t w_t h_t \eta_{y,t} N_t + \omega_t N_t \quad (6)$$

For simplicity, we assume that the government decides the amount of expenditure as a fraction of current output so that

$$G_t = g_t Y_t$$

Combining the government budget constraint (6) with the household budget constraint (2) and firm first-order conditions (4) and (5), we get the per adult resource constraint:

$$(1 - g_t) y_t = c_t + i_t \tag{7}$$

D. Equilibrium

The competitive equilibrium is a set of quantities and prices:

$$\{y_t, c_t, i_t, h_t, k_{t+1}, \omega_t, w_t, r_t, \eta_{y,t}, n_t, \tau_t, g_t, A_t\}_{t=0}^T$$

such that

(i) The household optimizes given the series of $\{\omega_t, w_t, r_t, \eta_{y,t}, n_t, \tau_t\}_{t=0}^T$ and k_0.

(ii) The firm optimizes given $\{w_t, r_t, A_t\}_{t=0}^T$ each period.

(iii) The government budget constraint (6) holds.

(iv) The resource constraint (7) holds.

The model equilibrium can be characterized by the capital Euler equation:

$$\frac{1 + n_t}{c_t} = \beta \frac{1}{c_{t+1}} \left[\theta \frac{y_{t+1}}{k_{t+1}} + 1 - \delta \right] \tag{8}$$

and the labor optimality condition:

$$\frac{1 - \Psi}{\Psi} \frac{c_t}{(\bar{h} - h_t)} = (1 - \tau_t)(1 - \theta) \frac{y_t}{h_t \eta_{y,t}} \tag{9}$$

and the law of motion of capital (3), the resource constraint (7), and the per adult production function:

$$y_t = A_t k_t^{\theta} (h_t \eta_{y,t})^{1-\theta} \tag{10}$$

Table 1. **Spillover Effects of Population Aging**

	Dependent Variable			
	A	*g*	*t*	*A*
α: Constant	−0.021**	0.172**	0.020**	−0.011***
β: Productivity gap	−0.073**	-	-	−0.072**
γ: Dependency	-	0.157**	0.768**	−0.062***
R^2	0.117	0.596	0.862	0.118

- = not applicable.
Note: *** = 10% level of significance, ** = 5% level of significance.
Source: Authors' calculations.

IV. Quantitative Analysis

The quantitative approach we take in this paper follows several steps. First, we project the time paths of the exogenous variables over the period 2011–2050. Second, we define parameter values in the model. Third, we numerically solve the model based on the time paths of exogenous variables. For the last step, we rely on the shooting algorithm described in Otsu and Shibayama (2016).

A. Projecting Exogenous Variables

In this model, we have five exogenous variables, $\{\eta_{y,t}, n_t, \tau_t, g_t, A_t\}$. The baseline projection of total factor productivity, A_t, is based on an endogenous growth model in which the growth rate of productivity depends on the productivity gap with the technology frontier. The demographic variables in our full simulation, $\{\eta_{y,t}, n_t\}$, are computed from the World Bank's Health, Nutrition, and Population Statistics reported in Figures 1 and 2. We also consider spillover effects of demographics through $\{\tau_t, g_t, A_t\}$. The regression results are reported in Table 1.

The baseline projection of total factor productivity relies on a variation of Romer (1990) in which economies have access to common technology but the cost of innovation needed to realize technology gains in each economy depends on the productivity gap between the global leader and the home economy; that is, the lower the productivity level, the cheaper it is to adopt better technology. We assume that the productivity level of the United States (US) represents the global productivity frontier and estimate the following panel regression:

$$\widehat{A_{i,t}} = \alpha_A + \beta_A \times ln\frac{A_{i,t}}{A_{us,t}} + f_i + \varepsilon_{i,t}$$

where f_i is the economy fixed effect. We computed total factor productivity for a sample of 41 economies over the period 1975–2010 using data from the Penn World Table for capital and output, and data from the Conference Board's Total Economy Database for hours worked per worker. The first column in Table 1 shows the results in which the productivity gap has a negative coefficient, meaning that the greater the productivity is relative to the US level, the lower the productivity growth rate. Finally, we project the productivity growth rate of our Asian economies based on the productivity gap, assuming that US productivity will continue to grow at 1.3% per year over the period 2011–2050. Since we need observations of productivity in 2011 in order to project the productivity growth rate, we are limited to 17 Asian economies for all simulations. In addition, we do not use the estimated fixed effects since not all economies in the simulation sample are included in this panel regression.

For government consumption, we hypothesize that when population aging occurs, the demand for public services such as health care increases. Therefore, we conduct the following panel regression:

$$g_{i,t} = \alpha_g + \gamma_g \times \frac{1-\eta_{y,i,t}}{\eta_{y,i,t}} + f_i + \varepsilon_{i,t}$$

where $\frac{1-\eta_{y,i,t}}{\eta_{y,i,t}}$ corresponds to the aged dependency ratio. We use data of the GDP share of government consumption for 25 Asian economies over the period 1975–2011 from the Penn World Table. The regression results are listed in the second column of Table 1. This shows that an increase in the aged dependency ratio leads to an increase in the government consumption share. Since all 17 economies in our simulation sample are included in this panel regression, we project the government consumption share using the estimated regression coefficients and fixed effects.

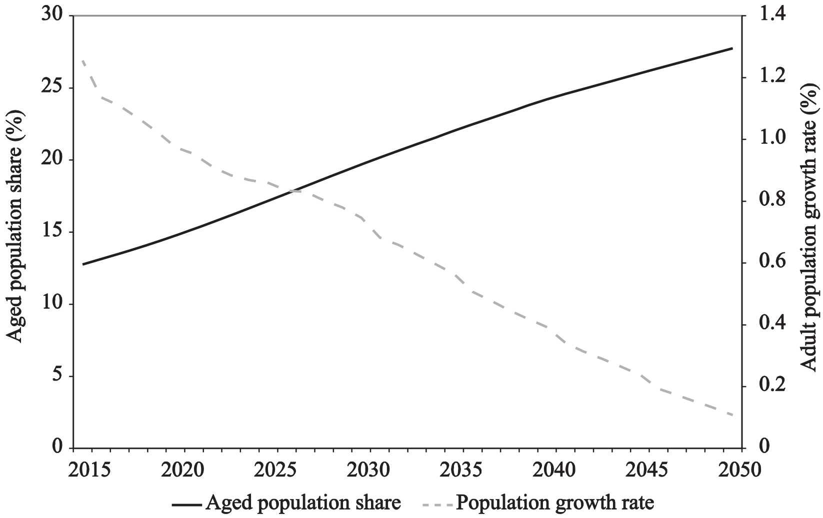
For labor income tax, we hypothesize that when population aging occurs, the tax burden on workers increases, particularly due to higher payroll taxes. Therefore, we conduct a similar panel regression

$$\tau_{i,t} = \alpha_\tau + \gamma_\tau \times \frac{1-\eta_{y,i,t}}{\eta_{y,i,t}} + f_i + \varepsilon_{i,t}$$

using the updated payroll tax rate data for 14 members of the Organisation for Economic Co-operation and Development (OECD) for the period 1960–2011 (McDaniel 2007). The regression results, which are presented in the third column in Table 1, show that an increase in the aged dependency ratio leads to an increase in the social security payroll tax rate. Since not all of the economies in our simulation sample are included in this regression, we project the future social security payroll tax rate using the regression coefficients without using any of the estimated fixed effects.

Finally, we consider a case in which productivity is affected by demographics. This can occur if population aging leads to an increase in demand for services that

Figure 4a. **Demographic Variables**



are not highly productive, including public services such as health care or publicly subsidized services such as elderly care. We run the following panel regression:

$$\widehat{A_{i,t}} = \alpha_A + \beta_A \times ln\frac{A_{i,t}}{A_{us,t}} + \gamma_A \times \frac{1-\eta_{y,i,t}}{\eta_{y,i,t}} + f_i + \varepsilon_{i,t}$$

with the same sample as the baseline productivity regression. The results, which are presented in the fourth column in Table 1, show that population aging does have a negative effect on productivity growth. In addition, the effect of the productivity gap on productivity growth seems robust as the coefficient is very close to that in the baseline regression.

The time paths of the projections are listed in Figure 4. We take a simple average of each variable of our 17 sample economies. The demographic variables show population aging and population shrinking, with the aged population share more than doubling between 2015 and 2050 as adult population growth approaches zero near the end of the period (Figure 4a). The government policy variables show a slight rise in government consumption and a rapid rise in the labor income tax rate (Figure 4b). The productivity projections show that productivity growth is noticeably hindered by the demographic effects (Figure 4c).

B. Parameter Values

The parameters we need to pin down in order to conduct our quantitative analysis are $\{\theta, \delta, \beta, \bar{h}, \Psi\}$. We keep these parameters similar across economies

Figure 4b. **Government Variables**

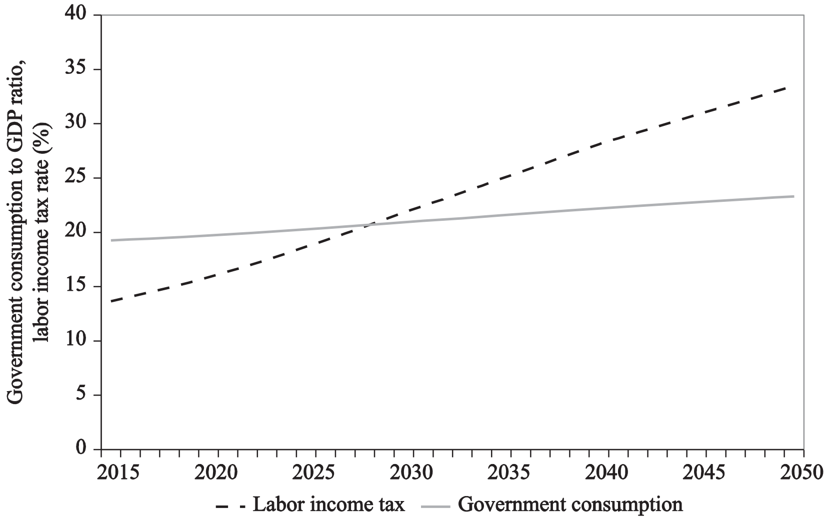
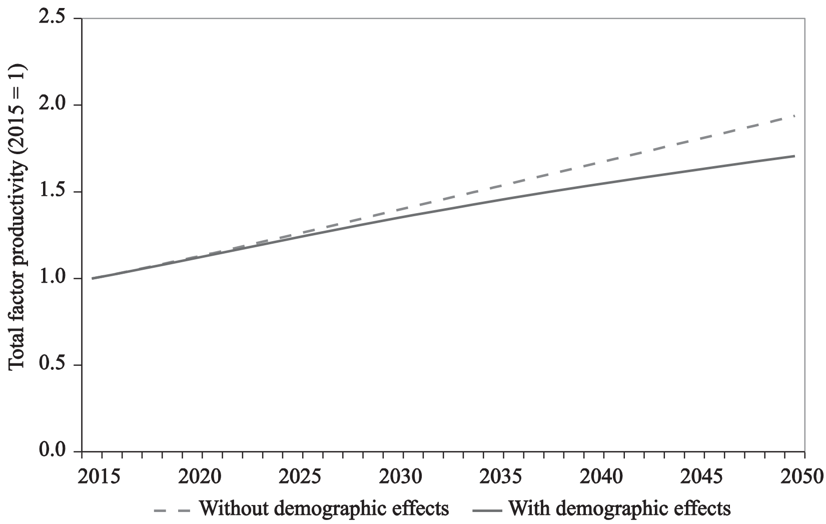


Figure 4c. **Productivity**



GDP = gross domestic product.
Sources: For Figure 4a, World Bank. Health, Nutrition, and Population Statistics. http://data.worldbank.org/data-catalog/health-nutrition-and-population-statistics; for Figures 4b and 4c, authors' calculations.

so that we can assess the impacts of exogenous variables on economic growth using a standard approach. The parameter values used in this paper are listed in Table 2.

Table 2. **Parameter Values**

θ	Capital income share	1/3
δ	Depreciation rate	0.05
β	Discount factor	0.97
h	Annual hours	3,500
Ψ	Preference weight	0.50

Source: Authors' calculations.

For the capital income share, θ, we do not have direct measures for all economies in the sample. Gollin (2002) shows that after several adjustments, capital income shares in most economies within his sample lie in the range of 0.20–0.35. We choose a share equivalent to one-third, which is at the high end of this estimate, since his data were for the late 1980s and early 1990s and studies such as Pickety (2014) and Karabarbounis and Neiman (2014) argue that capital income shares have risen over time.

We compute the average capital depreciation rate over the period 1975–2011 for each economy in the simulation sample from the Penn World Table. This rate ranges from 2.5% in Viet Nam to 5.7% in India, with an average of 4.3%. Since our simulation will run through 2050, we choose 5% for the common capital depreciation rate based on the observation by Karabarbounis and Neiman (2014) that capital depreciation rates tend to increase over time.

The discount factor is calibrated to match the capital Euler equation to the average data across the simulation sample economies over the period 1975–2011. Specifically, we plug in the parameter values of θ and δ, and the data averages into

$$\beta = \frac{(1+n_t)\, c_{t+1}/c_t}{\theta \frac{y_{t+1}}{k_{t+1}} + 1 - \delta}$$

where the average growth of total consumption, $(1+n_t)\, c_{t+1}/c_t$, is 1.005 and the average capital–output ratio, $\frac{y_{t+1}}{k_{t+1}}$, is 0.4.

The annual hours worked are set at 3,500 to correspond with the maximum number of hours a person can work each year if we assume 14 hours per day for 5 days per week for 50 weeks per year. The preference weight, Ψ, is set at 0.5, which implies a long-run average of 1,900 hours worked per year per worker in the labor optimality condition:

$$\frac{1-\Psi}{\Psi} = \frac{1-\tau_t}{\eta_{y,t}} (1-\theta) \frac{y_t}{c_t} \frac{(\bar{h} - h_t)}{h_t}$$

where the 2011 average estimated labor income tax is 0.12, the young population ratio is 0.88, and the consumption share of GDP is 0.56. The average number of hours worked in our sample is roughly 2,150, which is actually higher than the 2011 average of 1,900. However, the average number of hours worked tends to decline as economies develop.[4] For example, the OECD's average number of hours worked per year per worker is 1,770.

C. Shooting Algorithm

We use the data for capital stock in 2011 and the projected exogenous variables to solve for the time paths of the endogenous variables, $\{y_t, c_t, i_t, h_t, k_{t+1}\}_{t=0}^{T}$, such that the above five equations—(3), (7), (8), (9), and (10)—hold for all periods. In order to solve this problem, we use the shooting algorithm, which numerically solves the system of ordinary difference equations with boundary conditions. In our model, the key difference equation is the capital Euler equation. We set the boundary condition such that the economy reaches its balanced growth path in 2050 and capital stock grows at the rate implied by productivity growth between periods T and T + 1. We essentially solve for trajectories of the capital stock, which satisfies the equilibrium conditions for every period, and choose the one that satisfies the boundary condition.[5]

D. Results

The simulation results are shown in Figures 5a–5f. Figure 5a shows the simulated output path from the model with population aging and population shrinking, which we define as the benchmark model. This figure shows that demographic effects are harmful for economic growth.

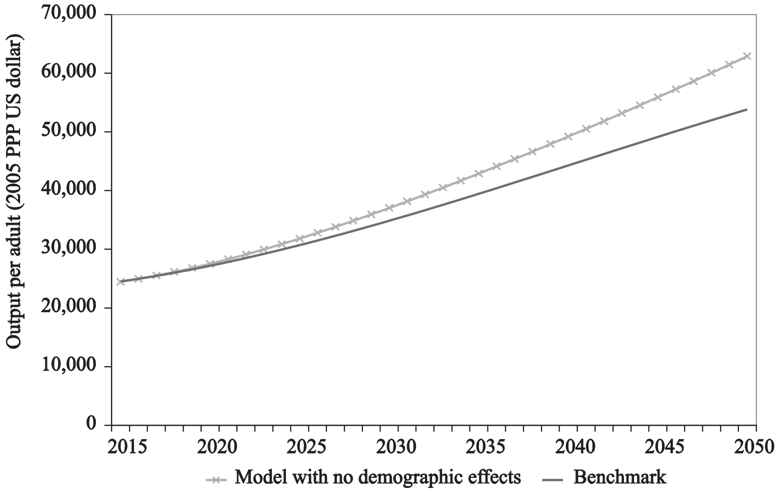
Figure 5b decomposes the demographic effects into population aging and population shrinking. Population aging is harmful for economic growth as it leads to a decline in the size of the workforce. It also hinders capital accumulation by reducing the marginal product of capital, which further harms economic growth. Population shrinking, on the other hand, enhances economic growth by easing the capital dilution effect; that is, when the population growth rate is low, the future capital stock will be shared among fewer people such that the return to capital increases and capital accumulation is encouraged.

Figure 5c shows the simulation result when government consumption increases due to population aging. This channel actually helps economic growth as the more the government increases consumption, the more the household will have to pay in taxes. This leads to a negative income effect, causing the household to increase the number of hours worked. Capital accumulation accelerates as the

[4]Otsu (2009) shows that the decline in hours worked during the postwar recovery period in Japan can be accounted for by income effects generated through subsistence consumption. Ohanian, Raffo, and Rogerson (2008) argue that labor income tax is the main driver of long-run trends in labor in OECD member countries.

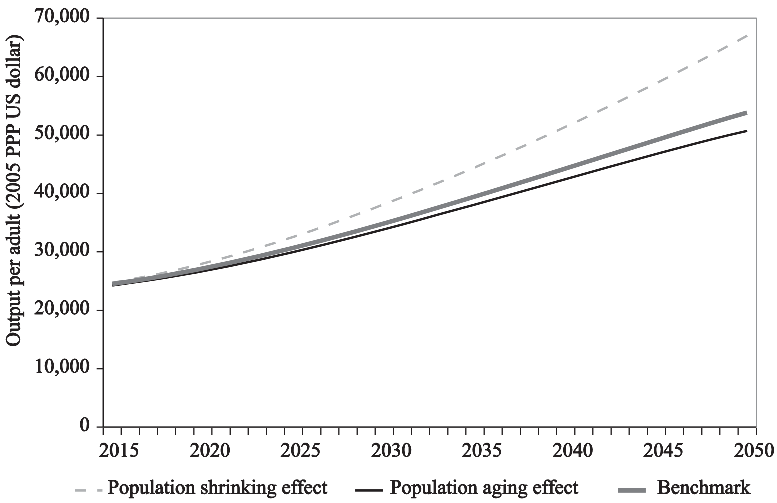
[5]Please see Otsu and Shibayama (2016) for more details on this method.

Figure 5a. **The Benchmark Model**



PPP = purchasing power parity, US = United States.
Source: Authors' calculations.

Figure 5b. **Demographic Effects**

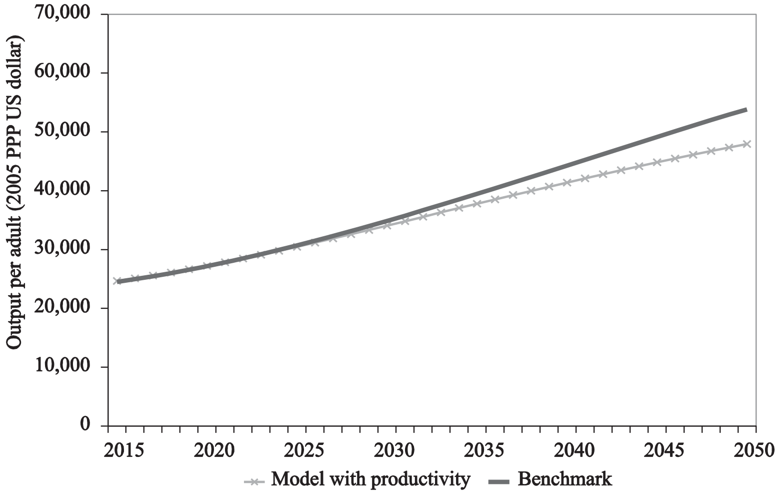


PPP = purchasing power parity, US = United States.
Source: Authors' calculations.

marginal product of capital increases. However, the difference between the results from this model and the benchmark model is small.

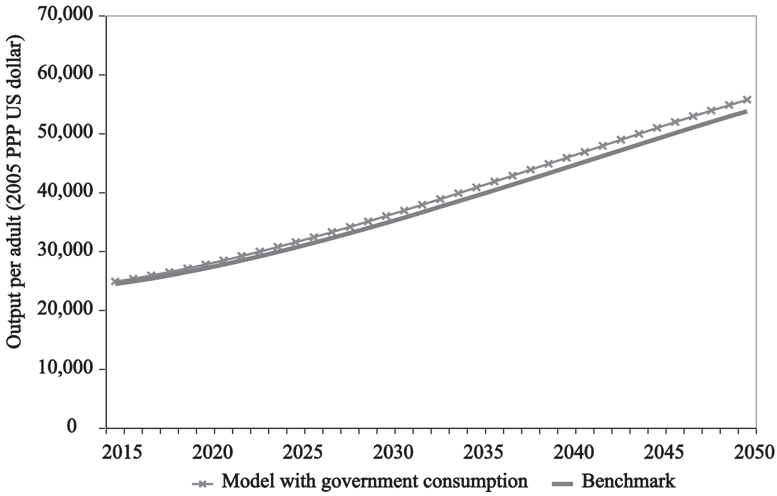
In Figures 5d and 5e, we show the results when population aging leads to an increase in the labor income tax and a decline in productivity, respectively. These channels clearly harm economic growth. An increase in the labor income

Figure 5c. **Model with Demographic Effect on Productivity**



PPP = purchasing power parity, US = United States.
Source: Authors' calculations.

Figure 5d. **Model with Demographic Effect on Government Consumption**

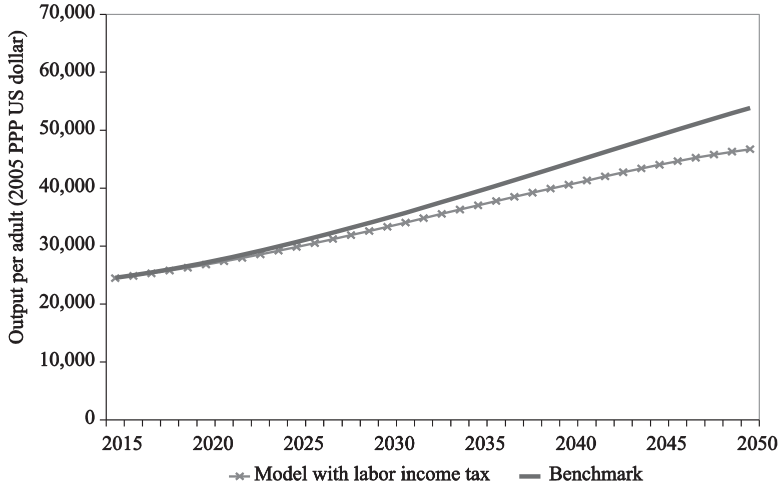


PPP = purchasing power parity, US = United States.
Source: Authors' calculations.

tax discourages the household from working and thus reduces the marginal product of capital. Productivity affects output directly through the production function and indirectly through the marginal product of inputs.

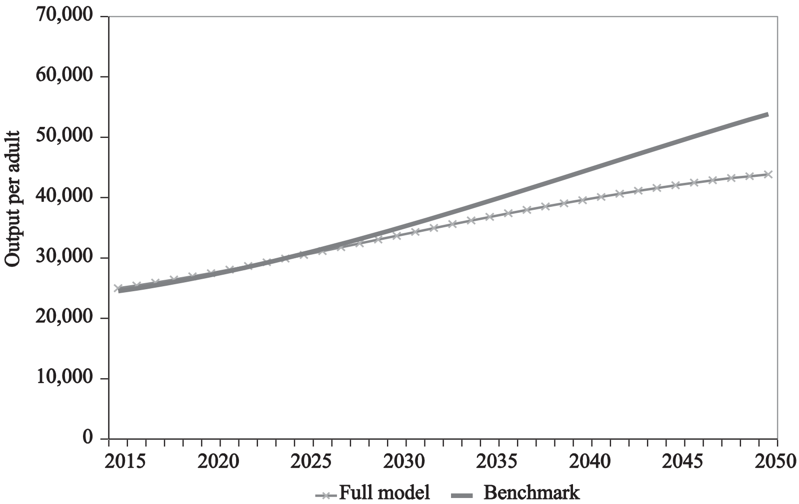
Figure 5f shows the result with all channels included. The sum of the combination of the three effects will reduce GDP per adult by 20% by 2050.

Figure 5e. **Model with Demographic Effect on Labor Income Tax**



PPP = purchasing power parity, US = United States.
Source: Authors' calculations.

Figure 5f. **Full Model**



Source: Authors' calculations.

Table 3 breaks down the effects into annual growth rates. The model without demographic effects predicts an average annual growth rate of 2.7%, while the benchmark model predicts an average annual growth rate of 2.3%. The demographic effect through government consumption increases the average annual growth rate by 0.05 percentage points. The demographic effect through the labor income tax and

Table 3. **Average Annual Growth Rates of GDP per Adult**

Model	**Growth Rate**	**Difference from Benchmark** (percentage points)
No demographic effect	2.70%	0.55
Benchmark	2.25%	0
With government consumption	2.30%	0.05
With labor income tax	1.85%	–0.40
With productivity	1.90%	–0.35
With all channels	1.60%	–0.65

GDP = gross domestic product.
Source: Authors' calculations.

productivity reduces the average annual growth rate by 0.4 percentage points and 0.35 percentage points, respectively. The model with all channels included reduces the growth rate by 0.65 percentage points.

V. Conclusion

In this paper, we took demographic projections as given and computed long-run economic growth in Asian economies using a neoclassical growth model. We find that population aging is harmful for growth due to the decline in the size of the workforce, while population shrinking is helpful for growth due to the capital dilution effect. Overall, the population aging effect will dominate, reducing the average annual economic growth rate by 0.55 percentage points below its potential. We also consider channels through which population aging affect government consumption, labor income tax, and productivity. We find that an increase in government consumption helps growth slightly, but an increase in the labor income tax and the decline in productivity growth have major effects on growth.

As the main focus of this paper is to identify ways to simulate aggregate output, we omitted several important aspects of the typical economy. First, we do not allow the household to adjust labor at the extensive margin. It would be interesting to consider a life cycle model with an endogenous retirement choice as an extension of our model. Second, while we assume that population aging will affect labor income tax through a social security payroll tax, we do not explicitly model for redistribution across the young and the aged population. In order to take this into account, we may need an overlapping generations structure. It would be interesting to see whether this redistribution channel has important implications for aggregate output growth. Finally, we do not explicitly model how population aging affects government consumption and productivity. Our assumption is that population aging increases demand for public services, which generally have lower levels of productivity than private services. It would be interesting to see if a two-sector model calibrated to an aging economy can replicate our results. As these issues are beyond the scope of this paper, we will leave them for future research.

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The Role of Structural Change in the Economic Development of Asian Economies

NEIL FOSTER–MCGREGOR AND BART VERSPAGEN*

In this paper, we combine data on gross domestic product (GDP) per capita and sectoral employment shares to undertake a decomposition of GDP per capita growth for a sample of 43 Asian and non-Asian economies. We decompose income changes into three components: (i) changes in labor productivity within sectors, (ii) employment shifts across sectors (structural change), and (iii) changes in the intensity of employment participation. We then compare the decomposition results for the Asian economies that moved between different income levels of interest with those from a representative typical economy and other comparison economies. The results suggest that in most Asian economies labor productivity growth was the dominant source of gains in GDP per capita, with the observed gains in labor productivity often driven by changing labor productivity within sectors rather than by shifts in employment across sectors. This is not to diminish the role of structural change, which at lower income levels can explain a significant proportion of overall labor productivity growth.

Keywords: labor productivity, structural change, structural decomposition
JEL codes: O14, O47

I. Introduction

Rich economies produce, consume, and invest in entirely different goods and services than poor economies. Those (few) developing economies that managed to make the transition from low-income to high-income status did so by undergoing a process of deep structural transformation in which the productive structure of their economy was changed completely. One aspect of this transformation involves the movement of capital and labor out of primary goods and into manufacturing, and ultimately into services as economies further mature. This process has been followed in most advanced economies, with differences in the speed and extent of structural change being offered as an explanation for diverging growth rates (see, for example, Denison 1967 and Maddison 1987). Less is known about developing economies, though a number of recent examples of deep structural change—often related to

*Neil Foster–McGregor (corresponding author): Research Fellow, UNU-MERIT, Boschstraat, Maastricht, Netherlands. E-mail: foster@merit.unu.edu; Bart Verspagen: Director, UNU-MERIT, Boschstraat, Maastricht, Netherlands. E-mail: verspagen@merit.unu.edu. The authors would like to thank the participants at the Asian Development Outlook–Asian Development Review Conference held in Seoul in November 2015, the managing editor, and an anonymous referee for helpful comments. The usual disclaimer applies.

improved economic performance—exist, most notably in Asia. The so-called Asian Tigers (Hong Kong, China; the Republic of Korea; Singapore; and Taipei,China) were the first generation of postwar economies that managed to make the transition from developing to developed status. Other Asian economies, including the People's Republic of China (PRC), have since embarked on this path of high gross domestic product (GDP) growth and rapid structural change.

Recently, a small number of papers have examined the extent and impact of structural change in developing economies. Timmer, de Vries, and de Vries (2014) show that the expansion of manufacturing activities led to growth-enhancing structural change in economies in Asia, Africa, and Latin America. (However, this process stalled in Africa and Latin America during the mid-1970s and 1980s and was followed by a movement into market services, which have lower possibilities for growth than manufacturing.) Using structural decomposition methods similar to those adopted in this paper, Timmer, de Vries, and de Vries (2014) find that while structural change in Africa and Latin America involved a reallocation toward sectors with above-average productivity, these sectors experienced below-average productivity growth. The resultant dynamic losses found in Africa and Latin America do not tend to be found in Asia. McMillan, Rodrik, and Verduzco–Gallo (2014) undertake a similar exercise and find that the structural change that has occurred in Africa and Latin America since 1990 has tended to reduce economic growth. In particular, McMillan, Rodrik, and Verduzco–Gallo (2014) show that the contribution of structural change to productivity growth in Africa and Latin America has been negative, with very small negative effects found in high-income economies. Meanwhile, positive effects were found in Asian economies. The authors argue that much of the difference in overall labor productivity growth among the three developing regions is due to different patterns of structural change.

Not only has deep structural change occurred in a number of Asian economies in recent decades, but economies in Asia have also been able to transition between different income levels relatively quickly. This has important policy implications. As stated by McMillan, Rodrik, and Verduzco–Gallo (2014), the speed with which structural transformation takes place is the key factor that differentiates successful economies from unsuccessful ones. Considering data from the Maddison Project Database on 133 economies for which data is available over the period 1950–2010, we observe that the average duration for Asian economies to move between an income level of \$1,500 and \$5,000 is 25 years, while for economies from other regions it took an average of 31 years.[1] Results for movements between other income levels are broadly similar, with average transition periods of 11 and 22 years, respectively, for Asian and non-Asian economies to move from an income level of \$5,000 to \$10,000; 9 and 16 years, respectively, for Asian and non-Asian economies

[1]The Maddison Project Database reports data on GDP per capita for a large number of economies. Data are in 1990 dollars.

to move from an income level of $10,000 to $15,000; and 7 and 14 years, respectively, for Asian and non-Asian economies to move from an income level of $15,000 to $20,000. In moving from an income level of $20,000 to $25,000, the duration is 10 and 9 years, respectively, for Asian and non-Asian economies, though the Asia subsample for this transition comprises only two economies (Hong Kong, China and Singapore).

In the context of Asian economic performance, much of the literature attempting to explain the rapid growth of income per capita in recent decades can be split into two camps. In the one camp are those studies arguing that fundamentals—namely inputs, and capital accumulation in particular—can explain the rapid growth of a number of Asian economies, with little or no credit given to productivity improvements. Examples from the literature include Young (1992) and Krugman (1994). As pointed out by Felipe (1997), accepting this point of view also leads to the conclusion that growth in these rapidly growing Asian economies may not be sustainable because input-driven growth is not sustainable in neoclassical growth models since there are limits to input mobilization and incremental growth in inputs is subject to diminishing returns (see, for example, Solow 1956). In steady state, growth in per capita output will equal the sum of labor force and labor productivity growth.

In the other camp are those who believe that economic performance in Asia has been driven by total factor productivity growth through, for example, adopting and assimilating foreign technology (see, for example, Romer 1993), or through rapid structural changes such as changes in firm size and sectors of specialization (Nelson and Pack 1999).

In this paper, we combine data on GDP per capita and sectoral employment shares to undertake a decomposition of growth in GDP per capita for a sample of 43 Asian and non-Asian economies. Considering transitions between different levels of GDP per capita, we decompose these income changes into three components: (i) changes in labor productivity within sectors, (ii) employment shifts across sectors (structural change), and (iii) changes in the intensity of employment participation. We undertake this decomposition for Asian economies that moved between income levels, comparing the decomposition results for these economies with those from other economies and a representative typical economy that we construct based on all available data. The paper adds to the existing literature on the performance of Asian economies by distinguishing between the roles of productivity and labor participation intensity in driving overall growth in per capita output. By considering the aggregate level effects of reallocation, this paper also adds to the existing literature on the misallocation of resources and is therefore a complement to recent studies that consider within-sector misallocation using firm-level data (see, for example, Pavcnik 2002 and Hsieh and Klenow 2009).

The results suggest that in most Asian economies labor productivity growth has been the dominant source of gains in GDP per capita, especially for movements between higher income levels. The observed gains in labor productivity were usually driven by changing labor productivity within sectors rather than by shifts in employment across sectors (again, especially for movements between higher income levels). This is not to diminish the role of structural change, which at lower income levels can explain a significant proportion of overall labor productivity growth.

The remainder of the paper is set out as follows. Section II describes the methodology used to undertake our decomposition analysis and constructs the decomposition for our representative typical economy. Section III describes the data used in our analysis. Section IV presents our results. Section V concludes.

II. Methodology

GDP per capita (Y/N) can be expressed as the product of labor productivity (Y/L) and employment participation (L/N):

$$\frac{Y}{N} = \frac{Y}{L}\frac{L}{N}$$

where Y is GDP (value added), L represents employment, and N represents population. The growth rate of GDP per capita can then be expressed as the sum of the growth rates of labor productivity and employment participation growth:

$$\left(\dot{Y} - \dot{N}\right) = \left(\dot{Y} - \dot{L}\right) + \left(\dot{L} - \dot{N}\right) \tag{1}$$

where a dot over a variable indicates a growth rate. Using standard structural decompositions (see, for example, Fabricant 1942; McMillan, Rodrik, and Verduzco–Gallo 2014; and Timmer, de Vries, and de Vries 2014), we can decompose labor productivity growth into a within effect and two structural change terms:

$$\dot{Y} - \dot{L} \equiv \dot{y} = \sum_i \frac{\left(y_i^1 - y_i^0\right)}{y^0} s_i^0 + \sum_i \frac{\left(s_i^1 - s_i^0\right)}{y^0} y_i^0 + \sum_i \frac{\left(y_i^1 - y_i^0\right)\left(s_i^1 - s_i^0\right)}{y^0} \tag{2}$$

where the subscript i denotes a sector, y is labor productivity, $\dot{y}$ denotes labor productivity growth, and s_i denotes the share of sector i in aggregate employment. The superscripts refer to time periods.

The effects on the right-hand side are (i) the within effect (the contribution of labor productivity growth rates within each sector), (ii) the static shift effect (the productivity effect from reallocating labor that results from differences in productivity levels between sectors at the start of the period), and (iii) the dynamic shift effect (the productivity effect of reallocating labor that results from differences in productivity growth rates between sectors over the period). The sum of (ii) and (iii) equals the total effect of employment reallocation. The within effect will be positive (negative) when the weighted growth in labor productivity in a sector is positive (negative), while the static effect will be positive (negative) when labor moves from less (more) to more (less) productive sectors. The dynamic effect captures the joint effect of changes in employment shares and sectoral productivity; it will be positive (negative) if workers are moving to sectors that are experiencing positive (negative) productivity growth. The static effect captures whether workers move to sectors with above-average productivity, while the dynamic effect captures whether productivity growth is higher in sectors that expand in terms of employment shares (Timmer, de Vries, and de Vries 2014).

Combining equations (1) and (2), as well as combining the two employment reallocation terms, results in a decomposition of GDP per capita growth containing three terms:

$$\left(\dot{Y} - \dot{N}\right) = \sum_i \frac{\left(y_i^1 - y_i^0\right)}{y^0} s_i^0 + \sum_i \frac{\left(s_i^1 - s_i^0\right)}{y^0} y_i^1 + \left(\dot{L} - \dot{N}\right) \tag{3}$$

The three terms represent (i) the within effect from productivity growth within sectors, (ii) the shift or reallocation effect from shifting labor across sectors, and (iii) an effect due to the growth of employment participation.

This is the starting point for our empirical analysis. In contrast to the approaches adopted in the studies of Timmer, de Vries, and de Vries (2014) and McMillan, Rodrik, and Verduzco–Gallo (2014), we do not consider the decomposition of growth rates of GDP per capita over time. Instead, we undertake this decomposition for a movement between different levels of GDP per capita, which proxy for various stages of development. This approach allows us to address the issue of whether productivity growth or employment participation dominate the movement between different levels of development, as well as the role of structural change. For example, we consider the decomposition for economies that move from an income level of \$1,500 to an income level of \$5,000—a growth rate in GDP per capita of 233.3% over an unspecified time period—finding the years in which economies reached these income levels; taking the values of y and s in these years, and the growth rate of employment participation between these years; and calculating the decomposition. We do this for all economies in our data set that managed to traverse the different income levels—\$1,500 to \$5,000, \$5,000 to \$10,000, \$10,000 to \$15,000, \$15,000 to \$20,000, and \$20,000 to \$25,000—within the period of analysis, 1950–2010.[2] We also report on the speed of transition, considering whether a certain pattern of the decomposition is associated with a quicker transition.

While this approach allows us to undertake the decomposition for particular economies—in our case, Asian economies—and allows for a comparison across economies, we also consider what the decomposition would look like for a

[2] In a small number of cases, we update the data set to 2013 using data from the Penn World Tables if it allows us to consider an additional transition to a higher income level (Feenstra, Inklaar, and Timmer 2015).

representative typical economy as it made the transition between different income levels.[3] We then assess whether the pattern of the typical economy is replicated by any of the Asian economies in our sample.

To create the decompositions for the typical economy, we need information on the employment shares, s_i, and the relative labor productivity, y_i/y, for a typical economy. We employ a locally weighted scatterplot smoothing (LOWESS) regression on the employment shares, $\frac{y_i}{y}s_i$, and upon $\frac{y^1}{y^0}$. LOWESS is a nonparametric method that is used to create a smooth line through a scatter plot to identify a relationship between two variables. The basic idea of this method is straightforward and involves fitting simple (e.g., polynomial) regression models to localized subsets of data using weighted least squares, thus allowing one to build up a function that explains the deterministic part of the variation in the data. We conduct the LOWESS analysis on s_i and $\frac{y_i}{y}s_i$ for each of our nine sectors and on the ratio of aggregate labor productivity $\frac{y^1}{y^0}$, with GDP per capita as the independent variable. This gives us estimates $\widehat{s_i}$, $\widehat{\frac{y_i}{y}s_i}$, and $\widehat{\frac{y^1}{y^0}}$. Taking these estimated values at particular income levels and combining them with equation (3) allows us to undertake the decomposition analysis for our typical economy, which is an economy with the estimated values of s_i and $\frac{y_i}{y}s_i$ at a particular income level.[4] Equation (3) is thus rewritten as

$$\left(\dot{Y}-\dot{N}\right)=\sum_i\left(\frac{y_i^1}{y^0}-\frac{y_i^0}{y^0}\right)s_i^0+\sum_i\left(s_i^1-s_i^0\right)\frac{y_i^1}{y^0}+\left(\dot{L}-\dot{N}\right)$$

Given the fact that we can write $\frac{y_i^1}{y^0}=\frac{y_i^1}{y^1}\frac{y^1}{y^0}$, we can further write

$$\left(\dot{Y}-\dot{N}\right)=\sum_i\left(\frac{y_i^1}{y^1}\frac{y^1}{y^0}-\frac{y_i^0}{y^0}\right)s_i^0+\sum_i\left(s_i^1-s_i^0\right)\frac{y_i^1}{y^1}\frac{y^1}{y^0}+\left(\dot{L}-\dot{N}\right)$$

Using our LOWESS estimates, we have

$$\left(\dot{Y}-\dot{N}\right)=\sum_i\left(\frac{\widehat{\frac{y_i^1}{y^1}s_i^1}}{\widehat{s_i^1}}\widehat{\frac{y^1}{y^0}}-\frac{\widehat{\frac{y_i^0}{y^0}s_i^0}}{\widehat{s_i^0}}\right)s_i^0+\sum_i\left(\widehat{s_i^1}-\widehat{s_i^0}\right)\frac{\widehat{\frac{y_i^1}{y^1}s_i^1}}{\widehat{s_i^1}}\widehat{\frac{y^1}{y^0}}+\left(\dot{L}-\dot{N}\right)$$

[3]While for the purpose of presentation we refer to this construct as a typical economy, the typical economy is based on a weighted average of all economies in the data set and therefore may not represent any single economy or its evolution of structural change and GDP per capita.

[4]In general, we will not obtain a prediction for one of our income levels (e.g., \$1,500 or \$5,000). Instead, we use the predicted values for two economies with income levels that are closest to these values (on either side of the income level we are interested in) and take the weighted average of these to obtain a prediction for a particular income level.

where all variables with a hat above them are obtained from the fitted values of the LOWESS models. This gives us a decomposition for the representative typical economy in our sample.

III. Data and Descriptive Statistics

Data on GDP per capita are taken from the Maddison Project Database, which reports data on GDP per capita in 1990 international Geary–Khamis dollars for a large number of economies. In our analysis, we use data on all economies for which data are recorded over the period 1950–2010, which gives us data on 133 developed and developing economies.[5]

Data for sectoral employment shares are taken from the GGDC 10-sector database (Timmer, de Vries, and de Vries 2014), which reports data on an annual basis from 1950 on value added, output deflators, and persons employed for 10 broad sectors. We use the data on persons employed to construct sectoral employment shares. The database has data for 43 economies in Africa, Asia, Europe, Latin America, and North America. The 10 sectors included in the database are (i) agriculture, hunting, forestry, and fishing (agriculture); (ii) mining and quarrying (mining); (iii) manufacturing; (iv) electricity, gas, and water supply (utilities); (v) construction; (vi) wholesale and retail trade, repair of motor vehicles and motorcycles, personal and household goods, and hotels and restaurants (trade); (vii) transport, storage, and communications (transport); (viii) financial intermediation, renting, and business services (FIRBS); (ix) public administration and defense, education, health, and social work (government services); and (x) personal services (personal). In our analysis, we combine the final two sectors into a single sector (public sector), leaving us with nine sectors.

When combining these two data sets, it is clear that the sectoral data is the limiting factor, meaning that the main analysis can only be conducted on the 43 economies for which we have sectoral data. In addition, our measure for labor participation (L/N) results from the combination of these two data sets; that is, the participation effect is the difference between the growth rates of labor productivity and GDP per capita. However, in some of the descriptive analysis of GDP per capita that follows, we refer to a larger data set of 133 economies from the Maddison Project Database. Table 1 reports from this larger sample the number of transitions between different income levels for the Asian and non-Asian economy subsamples, along with the average speed of transition between income levels for the different subsamples. Given the much smaller number of observations available for the Asian sample (21 versus 112 economies), Table 1 indicates that there is generally a higher

[5]For a small number of economies, data are missing for one or two time periods. We include additional data from the Penn World Tables for the period 2011–2013 for a small number of economies if doing so will add a transition episode from one income level to another (Feenstra, Inklaar, and Timmer 2015).

Table 1. **Descriptive Statistics on the Frequency and Speed of Transitions between Income Levels**

	$1,500–$5,000	**$5,000–$10,000**	**$10,000–$15,000**	**$15,000–$20,000**	**$20,000–$25,000**
Number of transitions					
Asia	6	7	5	5	2
Non-Asia	9	19	26	17	12
Speed of transition (years)					
Asia	25.2	11.4	9.0	7.4	10.0
Non-Asia	31.0	21.9	15.7	13.7	9.0

Notes: This table reports the number of transitions between each income level made by Asian and non-Asian economies in the 133-economy sample, along with the average speed of transition for those economies, also split into an Asian and non-Asian subsample. The Asian subsample comprises 21 economies for which we have data over the period 1950–2010. It excludes Australia and New Zealand.
Source: Authors' calculations based on the Maddison Project Database. http://www.ggdc.net/maddison/maddison-project/home.htm

probability for Asian economies than non-Asian economies to have moved between the different income levels during the period 1950–2010.[6] Table 1 also shows that except for the movement from $20,000 to $25,000, Asian economies were able to move between income levels faster than non-Asian economies by an average of between 5 and 11 years for each transition.

IV. Results

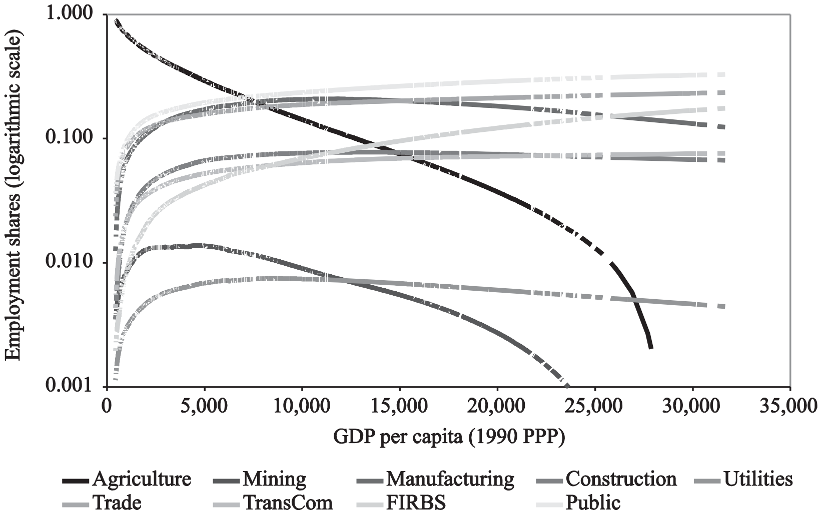
We begin our discussion of the results by reporting results from the LOWESS regression of sectoral employment shares on GDP per capita, which give an indication of how structural change occurs as economies move between different income levels. The results from this method are akin to the early work of Chenery (1960), among others, who attempted to detect the typical pattern of structural change along the path of so-called modern economic growth (Kuznets 1971). The results are displayed in Figure 1.

The most visible aspect of structural transformation in Figure 1 is the declining share of employment in agriculture as income (GDP per capita) progresses. At a level of GDP per capita below $5,000, which roughly corresponds to the cutoff between low- and middle-income economies, agriculture is the dominant sector in the economy. In low-income economies, agriculture is typically responsible for 80% or more of total employment. As income progresses, however, the share of employment in the agriculture sector declines rapidly to less than 10% at GDP per capita of $15,000 and only about 1% as the income level approaches $25,000.

When the employment share of agriculture falls, the corresponding shares of all other sectors tend to increase. These other sectors can be roughly divided into three

[6]For some economies, it was not possible to move between these income levels either because they had already done so or they had already crossed the lower bound prior to 1950.

Figure 1. **LOWESS Regression of the Relationship between Employment Shares and Income per Capita**



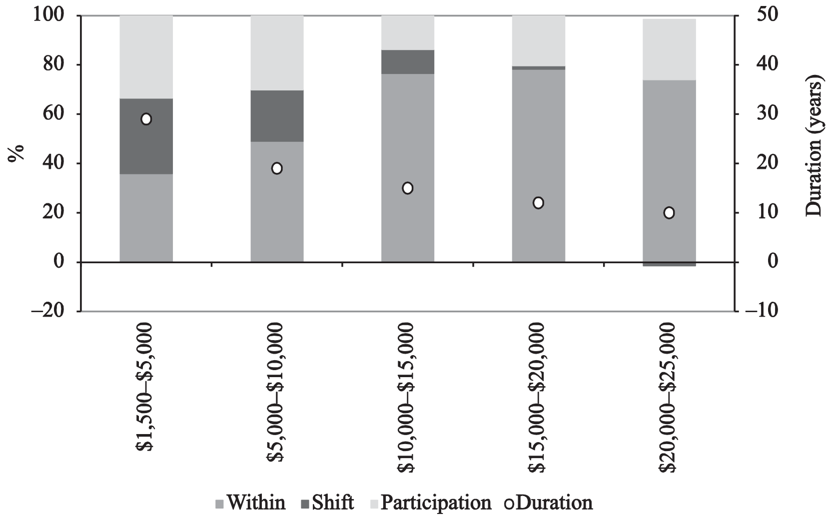
FIRBS = financial intermediation, renting, and business services; GDP = gross domestic product; PPP = purchasing power parity; TransCom = transport and communications.
Source: Authors' calculations.

groups based on the shares of total employment that they attain in the transition from a low-income to a middle-income economy. In the first group are manufacturing; trade (wholesale and retail, including restaurants and hotels); and the public sector. The employment shares of these sectors grow rapidly when the share of agriculture decreases, and they each quickly exceed 10% of total employment. The second group consists of construction, transport and communications, and FIRBS. These sectors' employment shares generally do not exceed 10% by the time the economy reaches middle-income status. The final group consists of mining and public utilities, which do see rising shares as the employment share of agriculture declines; typically these sectors remain very small, however, with an employment share of only about 1% each.

With the transition from middle-income to high-income status, another major structural change takes place. After reaching a peak employment share of around 30% when income per capita reaches \$12,000, the employment share of the manufacturing sector begins to decline as an economy further develops. Meanwhile, the employment shares of trade, the public sector, and FIRBS continue to grow. The employment share of the FIRBS sector surpasses that of manufacturing at an income level of around \$25,000.

Largely consistent with expectations, we may conclude from Figure 1 that the transition from a low-income economy to a high-income economy is a process in which an economy broadly shifts from being agricultural based to service based.

Figure 2. **Structural Decomposition for a Typical Economy**



Source: Authors' calculations.

The manufacturing sector plays a transitory role, with its importance reaching a peak at the middle-income stage. It is this process of structural transformation that we now examine further, focusing on growth and transformation in Asian economies and comparing their performance with that of a typical economy.

Prior to discussing the performance of individual Asian economies, we undertake the decomposition analysis described in section II for a typical economy in our sample. To do this, we use the results of the LOWESS regression of employment shares described in Figure 1, along with results from a similar LOWESS regression of a sector's contribution to overall labor productivity, $(\frac{y_i}{y} s_i)$. Using the fitted values from these LOWESS regressions, we obtain relative productivities and employment shares for different income levels, which we then feed into equation (3) to obtain the structural decomposition for a typical economy that moves between two income levels.

Figure 2 reports the results of this decomposition for a typical economy as it moves from an income level of \$1,500 to \$5,000 (an increase of 233%), from \$5,000 to \$10,000 (an increase of 100%), from \$10,000 to \$15,000 (an increase of 50%), from \$15,000 to \$20,000 (an increase of 33%), and from \$20,000 to \$25,000 (an increase of 25%).[7] Figure 2 also includes the duration of the movement of a typical economy from one income level to another.

The results in Figure 2 suggest a number of interesting patterns for our typical economy. First, we see that the contributions of the different decomposition terms

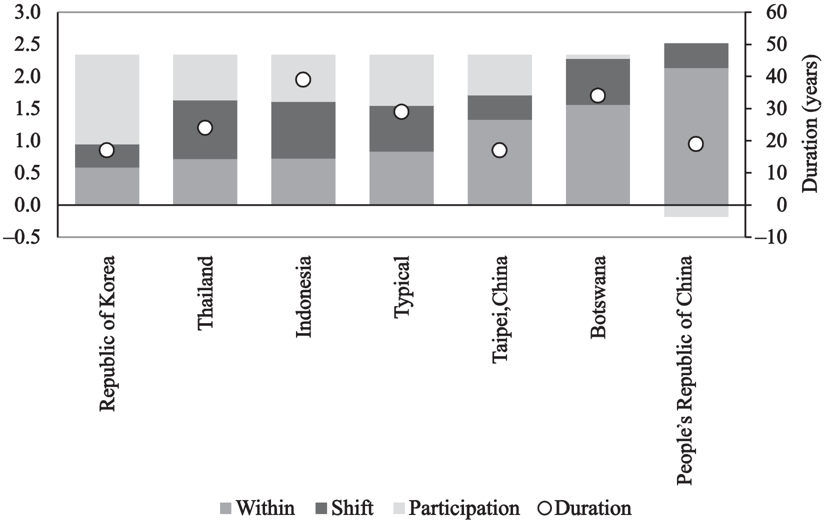
[7]Movements between these income levels can be achieved at different speeds, with higher average annual growth rates in economies that are able to traverse the different income levels more quickly.

are roughly equal as income moves from \$1,500 to \$5,000, with the shift term (30.5%) being slightly lower than the other two terms. This implies that the typical economy requires a transformation across three dimensions—increased productivity within sectors, structural change, and increased employment participation—to move from low- to middle-income status. As we shift between higher income levels, we observe a steadily declining contribution of the shift term, which becomes (slightly) negative as income moves from \$20,000 to \$25,000. This likely reflects the fact that at higher income levels, the amount of structural change that takes place is quite small—with the exception of the agriculture and mining sectors, which have very low employment shares at higher income levels (Figure 1).

While accounting for less than 50% of the required change in income at lower income levels, the within effect comes to dominate at higher income levels, accounting for more than 75% of the income change when moving from \$10,000 to \$15,000, from \$15,000 to \$20,000, and from \$20,000 to \$25,000. The growth in employment participation is found to be relatively more important for changes at lower income levels, explaining more than 30% of the change in income from \$1,500 to \$5,000 and from \$5,000 to \$10,000. Its contribution then drops to 20% or below before becoming relatively more important again for the income change from \$20,000 to 25,000 (25%). The final thing to note from this figure is the time it takes to traverse between two income levels. Here we observe something like linear decay, with it taking 29 years for the typical economy to move between income levels of \$1,500 and \$5,000, and just 10 years to move between income levels of \$20,000 and \$25,000. While useful for the comparison of the typical economy with Asian economies, these numbers do not tell us that (annual) GDP per capita growth is on average higher as economies move between higher income levels, since the percentage change in income is smaller for the movements between higher income levels. In fact, the fastest annual growth rate for GDP per capita is observed in the movement from \$1,500 to \$5,000 (an increase in GDP per capita of 233% over 29 years), and the slowest is observed in the movement from \$20,000 to \$25,000 (an increase in GDP per capita of 25% over 10 years).

The results in Figure 2 suggest that structural change—captured by the shift term—is an important factor for a typical economy moving between lower levels of income and is less relevant at higher levels, while changing productivity within sectors is relevant at all income levels, most notably higher income levels. The role of increased employment participation is varied, but tends to be stronger at lower income levels. The results for the structural change term are consistent with expectations and with existing studies. McMillan, Rodrik, and Verduzco–Gallo (2014) point out that intersectoral productivity gaps tend to diminish during the course of development. Therefore, even if the movement between higher income levels involves significant structural change, such as the observed shift from manufacturing to services, the overall impact on productivity growth will be small.

Figure 3. **Structural Decomposition of a Move in Income per Capita from $1,500 to $5,000**



Source: Authors' calculations.

We now compare this typical pattern with the decomposition results for the set of Asian economies that traversed each of these income levels during the period for which we have data. We also include non-Asian economies for comparison.

Figure 3 reports the results for the set of Asian economies that moved between the income levels of $1,500 and $5,000 over the period 1950–2010, along with results for the typical economy and for Botswana for purposes of comparison.[8] There is a wide variety of experiences in moving between these two income levels, including differences in the contributions of the three decomposition terms relative to the typical economy in most cases. Some Asian economies—most notably the Republic of Korea (17 years); Taipei,China (17 years); the PRC (19 years); and, to a lesser extent, Thailand (24 years)—were able to move quickly from an income level of $1,500 to $5,000, with average annual GDP per capita growth rates of between 9.7% and 13.7%. At the same time, the relative contributions of the three decomposition terms differed significantly among these four economies.

In the Republic of Korea, the vast majority of income growth (around 60% of the total) was due to increased employment participation, with a relatively small contribution from within-sector productivity growth (25% of the total) and only a minor role for structural change (15% of the total). Therefore, the role of productivity growth in this case is minor relative to increased labor effort. Structural change made a similarly small contribution to income growth in Taipei,China, but the

[8]Botswana and Indonesia reached the $5,000 income per capita level in 2011 and 2012, respectively. For the full sample of 133 economies for which we have GDP per capita data, 15 economies completed this transition during the period 1950–2010.

relative importance of the within and employment participation effects were reversed relative to the case of the Republic of Korea. The importance of the within effect was even stronger in the PRC, accounting for around 92% of the change in income. Interestingly, the contribution of employment participation was actually negative, indicating a declining share of the population employed in the PRC. As with the cases of Taipei,China and the Republic of Korea, the relative importance of structural change to income growth was muted, contributing around 15% of the total change in income per capita. Thailand, which also took a relatively short period of time to move between the income levels of $1,500 and $5,000, showed a pattern more similar to that for the typical economy, with a fairly even split between the three different composition terms. Structural change played the most prominent role by a slight margin, accounting for around 39% of the overall change in income per capita.

In terms of the remaining economies in Figure 3, the results for Indonesia are quite similar to those for both the typical economy and Thailand, with a fairly even split between the three decomposition terms and a relatively more important role for the structural change term, which accounts for 38% of the total change in income per capita. The major difference when compared with Thailand is the relatively long period of time it took to move from an income level of $1,500 to $5,000 (39 years), implying an average annual growth rate of GDP per capita of around 6%.

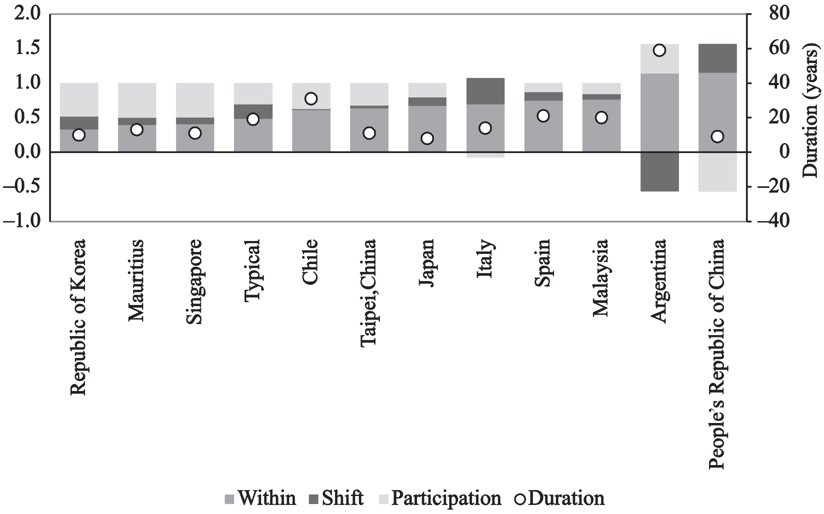
The comparison economy, Botswana, is quite different from most other economies and is most similar to the PRC with respect to the decomposition terms. In Botswana's case, we see a minor role for employment participation growth in GDP per capita growth, with a relatively large role (67% of the total) for within-sector productivity growth and a moderate role for structural change (31% of the total).

Figure 4 repeats the above exercise for a transition between income levels of $5,000 and $10,000, with results reported for seven Asian economies; the baseline typical economy; and five other comparison economies (Argentina, Chile, Italy, Mauritius, and Spain) that achieved the transition during the review period and for which we have sectoral employment data.[9] The Asian economies that moved between these two income levels did so relatively quickly, with the transition lasting between 8 and 11 years in all cases except Malaysia, which took 20 years. The average duration of Asian economies' transition was shorter than that of the typical economy (19 years) and of the other comparison economies, of which Argentina stands out with a duration of 59 years.

With respect to the contributions of the different terms, we again see a great deal of heterogeneity, with none of the Asian economies following the path of the typical economy. There are other similarities with Figure 3 as well. In particular, we again find that for the Republic of Korea—as well as Singapore and, to a lesser

[9]In the sample of 133 economies, 26 economies achieved this transition during the period 1950–2010. The PRC completed the transition in 2013.

Figure 4. **Structural Decomposition of a Move in Income per Capita from $5,000 to $10,000**

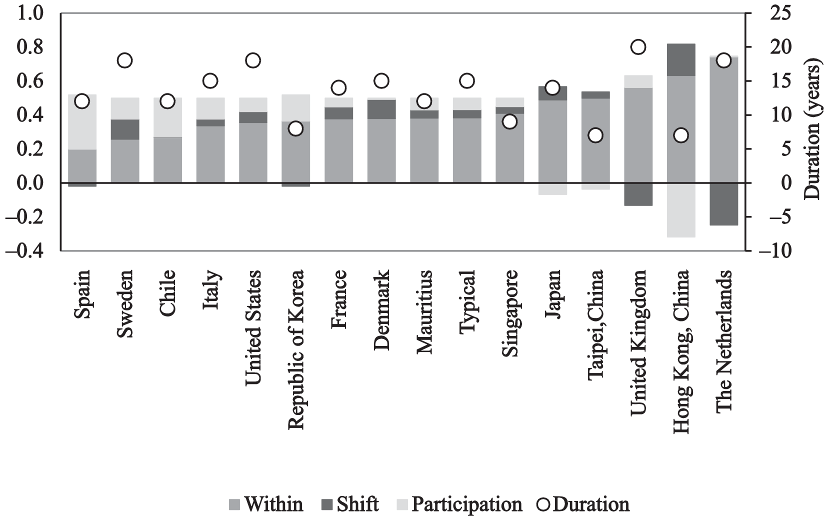


Source: Authors' calculations.

extent, Taipei,China—the growth of employment participation accounted for much of the change in income level: around 50% in the Republic of Korea and Singapore, and 32% in Taipei,China. In other Asian economies, the contribution of employment participation growth was much smaller, accounting for less than 20% in Japan and Malaysia, and making a negative contribution in the PRC (as was also the case with Figure 3). For the PRC, the negative contribution is relatively large, indicating a fairly large decline in employment participation growth. Productivity growth within sectors is an important factor for all economies in Figure 4, with the contribution of the within effect ranging from 34% in the Republic of Korea to 115% in the PRC. The shift term capturing structural change is relatively unimportant, accounting for around 21% of the change in income per capita in the typical economy and even smaller contributions in all Asian economies except the PRC, where structural change accounts for 41% of the overall change in income per capita. The average contribution of the shift term across the economies reported in Figure 4 is just 10%, which is considerably smaller than the average contribution of 27% reported in Figure 3.

An interesting comparison exists between the case of the PRC and that of Argentina. Both of these economies saw relatively large contributions of the within effect to the change in income per capita, but while the PRC also had a positive contribution from the shift term and a negative contribution from the growth of employment participation, Argentina saw a negative contribution from the shift term and a positive contribution from the growth of employment participation. These two economies were also at opposite extremes with regard to the speed of transition. Indeed, there exists a strong positive correlation between the speed of transition and

Figure 5. **Structural Decomposition of a Move in Income per Capita from $10,000 to $15,000**



Source: Authors' calculations.

the contribution of the shift term (0.57) for the observations reported in Figure 4, with similar positive correlations also found for the shift in income per capita from $10,000 to $15,000 (Figure 5) and from $15,000 to $20,000 (Figure 6).

Figure 5 repeats the decomposition exercise for the transition in income per capita from $10,000 to $15,000. The figure reports results for five Asian economies; the benchmark typical economy; and 10 other comparison economies (Chile, Denmark, France, Italy, Mauritius, the Netherlands, Spain, Sweden, the United Kingdom, and the United States) that achieved the transition during the period 1950–2010.[10] As with the previous figure, we observe that Asian economies were able to shift between these two income levels relatively quickly, with the transition taking 9 years or less in all Asian economies except Japan, where the transition took 14 years, which was slightly more than for the typical economy. The duration of the transition was longer than that of the typical economy in most other comparison economies, with only Chile, Mauritius, and Spain experiencing a transition in less than the 12 years it took the typical economy.

Figure 5 highlights the continued decline in the importance of the shift term to the change in income. On average, the contribution of the shift term is just 5% for the observations included in Figure 5, compared with 10% in the case of the movement in income from $5,000 to $10,000, and 27% for the movement from $1,500 to $5,000. For the Asian economies in the sample, only in the cases of Hong

[10]Out of the 133 economies in the broader sample for which we have GDP per capita data, 31 made the transition from an income level of $10,000 to $15,000 during the period 1950–2010.

Kong, China (37%) and, to a lesser extent, Japan (16%) does the shift term make a significant contribution to the income change; its contribution accounts for less than 10% in Singapore and Taipei,China, and is negative in the Republic of Korea. Despite the relatively small contribution of the shift term in Asian economies, we obtain a positive correlation (0.32) between the share of the income change accounted for by the shift term and the speed of the transition.

Similarly, we also see a declining role for employment participation growth. While this term accounts for between 20% and 25% of the income change in Figures 3 and 4, it only accounts for an average of 12% for the economies in Figure 5. Interestingly, employment participation growth makes a large contribution to the change in income in Spain (64%) and, to a lesser extent, Chile (46%). It also remains important in the Republic of Korea (31%), which is consistent with the other income changes shown in Figures 3 and 4. In Hong Kong, China, however, the contribution of employment participation growth is negative, indicating a decline in employment participation as the economy moved between income levels of $10,000 and $15,000.

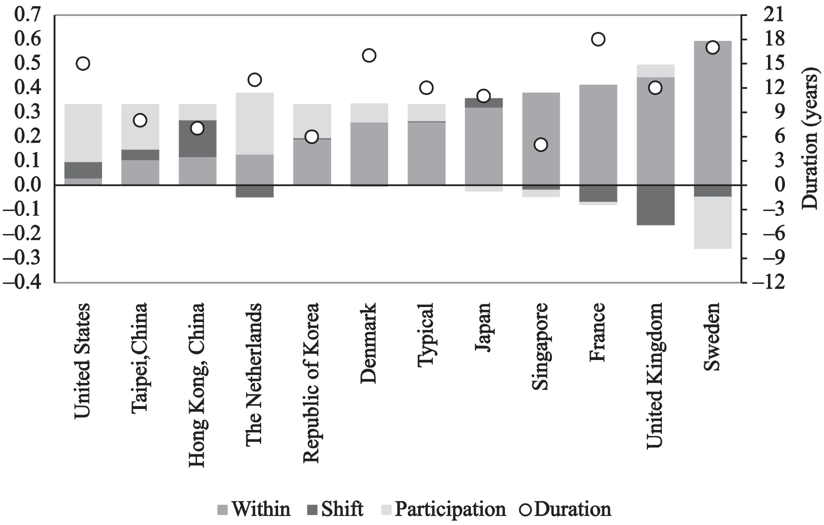
The above results imply an increasing role for the within effect and for productivity growth within sectors. This term accounts for 83% of the income change on average for the observations included in Figure 5, though only 40% in the case of Spain. For the Asian economies, the contribution of the within effect to income growth ranged from 73% in the Republic of Korea to more than 97% for Hong Kong, China; Japan; and Taipei,China.

Finally, Figure 6 presents the decomposition results for economies that observed a change in income per capita from $15,000 to $20,000 during the review period. This includes the decomposition results for five Asian economies; the typical economy; and six other comparison economies (Denmark, France, the Netherlands, Sweden, the United Kingdom, and the United States).[11] Once again, we observe that the Asian economies were able to move between the two income levels relatively quickly. The duration of the transition was 8 years or less for all Asian economies except Japan, which at 11 years still had a duration less than that for the typical economy and the other comparison economies.

We again see a declining role for the shift term, which captures structural change, in Figure 6. On average, the contribution of the shift term to the change in income is basically zero (–0.9%), though this hides differences across economies. While for some economies (France, the Netherlands, Singapore, Sweden, and the United Kingdom) the contribution of the shift term is negative, in most Asian economies the contribution is positive. In the case of Hong Kong, China, it is relatively important, accounting for 45% of the overall change in income. The fact

[11]Of the 133 economies in the sample, 22 moved between income levels of $15,000 and $20,000 during the period 1950–2010. We also conducted the decomposition for a transition between income levels of $20,000 and $25,000. Given that only two Asian economies (Hong Kong, China and Singapore) and a limited number of other economies (12) in the overall sample achieved this transition, we choose not to report the results.

Figure 6. **Structural Decomposition of a Move in Income per Capita from $15,000 to $20,000**



Source: Authors' calculations.

that structural change again becomes important for some economies around these income levels is consistent with the results reported in Figure 1, suggesting a second period of structural change—this time from manufacturing to services—at incomes above $12,000.

The within effect accounts for a similar share of the overall income change (81%) as was the case with the movement in income per capita from $10,000 to $15,000. It accounts for a particularly large share in Japan (96%) and Singapore (114%), as well as in France, Sweden, and the United Kingdom, where it accounts for more than 100% of the income change. While reaching 57% in the Republic of Korea, the within effect is relatively less important in other Asian economies, contributing between 35% and 40% of the overall income change in Taipei,China and Hong Kong, China.

The importance of employment participation growth is also mixed for the Asian economies. Its contribution is small but negative in Japan and Singapore. At the same time, this term continues to play an important role in the Republic of Korea (41%) as it has for all previous movements in income levels. It also plays a particularly important role in Taipei,China (55%), but is somewhat less important in Hong Kong, China (19%).

V. Summary and Conclusion

In this paper, we combine a standard decomposition of labor productivity growth with data on the growth of employment participation to decompose GDP per capita growth into an effect due to productivity growth within sectors, an effect due to structural change, and an effect due to changing labor force participation growth. Using this decomposition, we examine the importance of the relative contributions of these three effects as economies move between different income levels, concentrating on a set of Asian economies and comparing results for these economies with those for a typical economy and other comparison economies.

A number of interesting results emerge. First, we observe that the importance of structural change (the shift term) varies by income level. Structural change tends to be relatively important as economies move from low- to middle-income status, but its role diminishes during the transition between middle-income levels. Given the relatively large percentage change in GDP per capita as economies move from an income level of \$1,500 to an income level of \$5,000, structural change will contribute a great deal to GDP per capita growth at low-income levels. The contribution of 30% for the typical economy implies that structural change accounts for more than 70 of the 233 percentage point increase in GDP per capita, which, with an average transition period of 29 years, implies that structural change adds around 2.7 percentage points annually to GDP per capita growth in low-income economies. As economies move toward higher levels of income per capita, structural change again becomes important for some economies, likely reflecting the second structural change from manufacturing to services observed in many economies. The effect of structural change tends to be more muted at higher income levels, probably due to the fact that intersectoral productivity differences tend to diminish as economies develop.

Second, the effect due to productivity growth within sectors is relatively small for changes from low- to middle-income status, but dominates the change from middle- to high-income status. Third, the Asian economies in our sample are relatively successful in moving quickly between income levels. In general, Asian economies traverse the different income levels significantly faster than economies from other regions. Fourth, Asian economies do not tend to follow the path of the typical economy as they move toward higher income levels, with the decompositions for Asian economies tending to look quite different from those of the typical economy and other comparison economies. There is also no common path for Asian economies, with the decompositions for each Asian economy differing from one another.

Fifth, despite the different development experiences of individual Asian economies, there are certain patterns that can be observed for particular economies as they move between different income levels. In the case of the Republic of Korea, for example, we observe that employment participation growth has been an important factor in the economy's movements across different income levels, particularly during the movement from low- to middle-income status. Structural change also played a role in the Republic of Korea's movement from low- to middle-income status, but has had a small role at higher income levels. Conversely, the within effect plays a relatively minor role at lower income levels, but comes to dominate at higher income levels in the Republic of Korea. In the PRC, which experienced movements between income levels of $1,500 and $5,000 and between $5,000 and $10,000 during the review period, we observe that the within effect is relatively large, while there is a negative contribution from employment participation growth. The role of structural change, while much smaller than that of the within effect, is found to be positive and important, particularly for the move from $5,000 to $10,000. In Taipei,China, the role of structural change is generally small, making its largest contribution (16% of the total) in the movement from an income level of $1,500 to $5,000; its contribution is as low as 4% for the transition between income levels of $5,000 and $10,000. The within effect is the dominant factor for Taipei,China as it moves between most income levels, accounting for 100% of the move from an income level of $10,000 to $15,000. The exception to this is Taipei,China's move from an income level of $15,000 to $20,000, where employment participation accounts for 55% of the change in income per capita. The within effect is also the dominant factor in the case of Japan, making its smallest contribution (68%) in the move between income levels of $5,000 and $10,000, and its largest contribution (98%) in the move between $10,000 and $15,000. The role of structural change is fairly similar across the different income groups, accounting for between 10% and 15% of the change. In contrast with some Asian economies such as the Republic of Korea, the role of employment participation is fairly muted in Japan, contributing a maximum of 20% in the move from an income level of $5,000 to $10,000. Finally, in the case of Singapore we see a dominant role for the within effect at all levels except for the move from an income level of $5,000 to $10,000; in this case, employment participation growth contributes nearly half of the increase in income. Apart from this movement, neither employment participation nor the shift term contributes more than 10% to the change in income levels in Singapore.

Overall, the results suggest that for most Asian economies labor productivity growth was the dominant source of gains in GDP per capita growth—the major exception being the Republic of Korea. This observation holds at movements between higher income levels. While these gains could be due to either capital deepening (e.g., an increase in the capital–labor ratio) or to total factor productivity gains, we can say that in most cases much of the growth of labor productivity is due to within-sector changes in labor productivity growth rather than the result of labor shifting across sectors, particularly at transitions between higher income levels. This result is consistent with other recent studies, including Timmer, de Vries, and de Vries (2014), who find that the within effect is the dominant factor in explaining labor productivity growth in Asia.

Structural change remains an important factor in driving GDP per capita growth at lower income levels. Such a conclusion implies that while policies aimed at encouraging structural change are likely to be rewarded at relatively low income levels, the focus as economies develop should be aimed at increasing productivity growth rates in general and in services in particular as production tends to become more concentrated in this sector at higher income levels.

While policies encouraging structural change at lower income levels should be focused on shifting resources from agriculture to manufacturing, it is not easy to identify the exact set of policies needed to encourage structural change at lower income levels since such change takes place under widely divergent conditions across different economies. Industrial policies should therefore be tailored to an economy's specific circumstances, including the presence of manufacturing industries, stage of development, resource endowment, and economy size.

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*ADB recognizes "China" as the People's Republic of China and "Hong Kong" as Hong Kong, China.

Misallocation and Productivity: The Case of Vietnamese Manufacturing

DOAN THI THANH HA, KOZO KIYOTA, AND KENTA YAMANOUCHI*

This paper attempts to measure the effect of resource misallocation on aggregate manufacturing total factor productivity, focusing on Vietnamese manufacturing firms during the period 2000–2009. One of the major findings of this paper is that there would have been substantial improvement in aggregate total factor productivity in Viet Nam in the absence of distortions. The results imply that potential productivity gains from removing distortions in Vietnamese manufacturing are large. We also find that smaller firms tend to face advantageous distortions, while larger firms tend to face disadvantageous ones. Moreover, the efficient size distribution is more dispersed than the actual size distribution. These results suggest that Viet Nam's policies may constrain its largest and most efficient producers, and coddle its smallest and least efficient ones.

Keywords: misallocation, total factor productivity, Viet Nam
JEL codes: D22, F14, O47

I. Introduction

Differences in per capita income across economies result mainly from differences in total factor productivity (TFP).[1] Therefore, clarifying the underlying causes of low productivity in developing economies is one of the central concerns in various fields of economics such as development economics, international economics, and macroeconomics. Given the fact that production efficiency is heterogeneous across firms, some recent studies on this issue argue that aggregate

*Doan Thi Thanh Ha: Asian Development Bank Institute. E-mail: hato.doan@gmail.com; Kozo Kiyota (corresponding author): Keio Economic Observatory, Keio University, Japan. E-mail: kiyota@sanken.keio.ac.jp; Kenta Yamanouchi: Graduate School of Economics, Keio University, Japan. E-mail: ymdkntr40723331@yahoo.co.jp. The authors would like to thank Iwan J. Azis, Flora Bellone, Minsoo Lee, Qing Liu, Atsushi Ohyama, Yoichi Sugita, Kenichi Ueda, the participants at the Asian Development Outlook–Asian Development Review Conference held in Seoul in November 2015, the managing editor, and an anonymous referee for helpful comments. Kozo Kiyota gratefully acknowledges financial support received from the Japan Society for the Promotion of Science Grant-in-Aid (26220503) and the Ministry of Education, Culture, Sports, Science, and Technology-Supported Program for Strategic Research Foundations at Private Universities. The usual disclaimer applies. ADB recognizes "China" as the People's Republic of China and "Vietnam" as Viet Nam.

[1]"Large differences in output per worker between rich and poor economies have been attributed, in no small part, to differences in total factor productivity" (Hsieh and Klenow 2009, p. 1403); "[C]ross-economy income differences mostly result from differences in total factor productivity" (Waugh 2010, p. 2095). McMillan and Rodrik (2011) also argued for the importance of resource reallocation in enhancing productivity growth in developing economies.

TFP depends not only on the TFP of individual firms but also on the allocation of resources across firms.[2] In other words, low productivity in developing economies can be attributed to the misallocation of resources across heterogeneous firms.

How do we measure the misallocation of resources? One way to answer this question is to focus on distortions that reflect the difference between the actual and efficient outcomes. Such distortions are called "wedges" in the literature. The seminal work of Hsieh and Klenow (2009) estimates wedges from data on value added and factor inputs for manufacturing establishments in the People's Republic of China (PRC), India, and the United States (US). They found that the distortions were much larger in the PRC and India than in the US. Hsieh and Klenow (2009) also found that the removal of distortions has a significant effect on aggregate TFP in the PRC and India. Following Hsieh and Klenow (2009), several studies have provided a similar picture: large TFP gains could be expected from the removal of distortions.[3]

This paper extends the analysis of Hsieh and Klenow (2009) to Vietnamese manufacturing between 2000 and 2009 and asks the following questions:

(i) To what extent are resources misallocated in Viet Nam?

(ii) How large would the productivity gains have been in the absence of distortions?

(iii) Are the distortions related to firm size?

(iv) What would the distribution of firm size have been in the absence of distortions?

Answering these questions has important implications for potential growth because reallocation would lead to productivity gains that can accelerate potential growth through improved interfirm resource allocation.

Our study is closely related to Bach (2014), who also examined resource misallocation in Viet Nam using firm-level data. His study addressed the first two questions above but did not compare resource misallocation in Viet Nam with misallocation in other Asian economies. Nor did his study address the last two questions. From a policy perspective, the last two questions are important because many economies give preferential treatment to small and medium-sized enterprises (SMEs). Indeed, size-dependent policies, which limit the size of firms, could be an

[2] See Restuccia and Rogerson (2013) and Hopenhayn (2014) for a survey.

[3] See, for example, Camacho and Conover (2010) for the case of Colombia; Busso, Madrigal, and Pages–Serra (2012) for Latin America; Bellone and Mallen–Pisano (2013) for France; Hosono and Takizawa (2013) for Japan; de Vries (2014) for Brazil; Dheera–Aumpon (2014) for Thailand; Bach (2014) for Viet Nam; and Calligaris (2015) for Italy.

important source of misallocation (Restuccia and Rogerson 2013). In answering the four questions, this paper goes one step further by providing a deeper understanding of the potential productivity gains from removing distortions in Viet Nam.[4]

The rest of this paper is organized as follows. In section II, we describe the methodology of Hsieh and Klenow (2009). Section III describes the Vietnamese firm-level data used in our study. Section IV presents the results. Concluding remarks and policy implications are presented in section V.

II. Measurement of Misallocation

Hsieh and Klenow (2009) formulated an analytical framework to estimate misallocation. Although some studies such as Bartelsman, Haltiwanger, and Scarpetta (2013) developed an alternative framework, this paper employs Hsieh and Klenow's framework for the following reasons. First, their framework is tractable in the sense that it is simple and its data requirements are minimal. This provides a significant advantage in estimating misallocation in Viet Nam because of the limited data availability, as we will discuss in the next section. Second, the framework allows us to decompose the source of misallocation into distortions in output markets and those in capital markets. Such decompositions are useful if the distortions come from different sources. The Hsieh and Klenow (2009) methodology is summarized below.

Assume that a representative firm produces a single final good, Y, in a perfectly competitive final goods market. The firm produces Y, using the output Y_s of S manufacturing industries, with the following Cobb–Douglas production technology:

$$Y = \prod_{s=1}^{S} Y_s^{\theta_s}, \text{ where } \sum_{s=1}^{S} \theta_s = 1 \tag{1}$$

and θ_s is the output share of each industry s.

Each industry produces output, Y_s, using M_s differentiated goods produced by individual firm i with a constant elasticity of substitution technology ($s = 1, \ldots, S$). Output in industry s is then given by:[5]

$$Y_s = \left(\sum_{i=1}^{M_s} Y_{si}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \quad \sigma > 1 \tag{2}$$

[4]Another important difference between Bach (2014) and our study is that his study did not control for the skill differences of workers across firms in measuring quantity-based TFP and revenue-based TFP.

[5]We suppress the time subscript to avoid heavy notation, although we utilize firm-level panel data in the empirical analysis.

where σ is the elasticity of substitution between varieties and Y_{si} is the output of the differentiated good produced by firm i in industry s, using capital and labor, based on the following Cobb–Douglas technology:

$$Y_{si} = A_{si} K_{si}^{\alpha_s} L_{si}^{1-\alpha_s} \tag{3}$$

where A_{si}, K_{si}, and L_{si} denote the productivity, capital, and labor of firm i in industry s, respectively; and α_s represents the capital share, which is different across industries but the same across firms within an industry.

To assess the extent of misallocation, Hsieh and Klenow (2009) followed Foster, Haltiwanger, and Syverson (2008) in making a distinction between physical productivity, denoted by TFPQ, and revenue productivity, denoted by TFPR:

$$TFPQ_{si} \triangleq A_{si} = \frac{Y_{si}}{K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}} \tag{4}$$

and

$$TFPR_{si} \triangleq P_{si} A_{si} = \frac{P_{si} Y_{si}}{K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}} \tag{5}$$

respectively, where P_{si} represents the firm-specific output price.

In addition to firm heterogeneity in terms of productivity (see, for example, Melitz 2003), firms potentially face different output and capital distortions. More specifically, Hsieh and Klenow (2009) incorporated two types of firm-level wedges into this framework. One raises the marginal product of capital and labor by the same proportion, which is denoted by τ_{Ysi}. The other increases the marginal product of capital relative to labor, which is denoted by τ_{Ksi}. These wedges are given from the firm's viewpoint and we do not make any assumptions about what generates them.[6]

An example of such distortions is subsidized credit. If two firms have identical technologies but one of the firms can borrow from the financial market at a lower interest rate (and the other firm can borrow at a higher interest rate), the marginal product of capital of the firm that can access the subsidized credit will be lower than that of the other firm. This results in the misallocation of capital because one firm enjoys a lower interest rate even though the two firms have the same technologies.

[6]Distortions can be generated by various factors such as trade policies and credit market imperfections. In our companion paper (Ha and Kiyota 2015), we examined the determinants of distortions in Vietnamese manufacturing. León–Ledesma and Christopoulos (2016) examined the effects of access to finance obstacles on misallocation. Using firm-level data covering 45 economies, they found that access to finance obstacles and private credit increase the dispersion of distortions. However, they also found that the financial variables explain a small part of the dispersion of factor market and size distributions.

In other words, in the framework of Hsieh and Klenow (2009), the differences in factor prices mean the existence of distortions.

With these wedges, the expected profits of the firm are written as follows:[7]

$$\pi_{si} = (1 - \tau_{Ysi})\, P_{si} Y_{si} - wL_{si} - (1 + \tau_{Ksi})\, RK_{si} \tag{6}$$

where w and R denote the common wages and rental costs facing all firms, respectively. Firms maximize their profits under the following constraint:

$$Y_{si} = Y_s \left(\frac{P_s}{P_{si}} \right)^{\sigma} \tag{7}$$

where

$$P_s \equiv \left(\sum_{i=1}^{M_s} P_{si}^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \tag{8}$$

In the presence of distortions, firms will produce a different quantity compared with what they would produce without these wedges (the efficient case).

Solving the profit maximization problem under a monopolistic competition framework and the equilibrium allocation of resources across industries, we have:

$$P_{si} = \frac{\sigma}{\sigma - 1} \left(\frac{R}{\alpha_s} \right)^{\alpha_s} \left(\frac{w}{1 - \alpha_s} \right)^{1-\alpha_s} A_{si}^{-1} \frac{(1 + \tau_{Ksi})^{\alpha_s}}{1 - \tau_{Ysi}}, \tag{9}$$

$$1 - \tau_{Ysi} = \frac{\sigma}{\sigma - 1} \frac{wL_{si}}{(1 - \alpha_s)\, P_{si} Y_{si}}, \text{ and} \tag{10}$$

$$1 + \tau_{Ksi} = \frac{\alpha_s}{1 - \alpha_s} \frac{wL_{si}}{RK_{si}} \tag{11}$$

From equation (9), we have:

$$TFPR_{si} = \xi_s \frac{(1 + \tau_{Ksi})^{\alpha_s}}{1 - \tau_{Ysi}} \tag{12}$$

where

$$\xi_s = \frac{\sigma}{\sigma - 1} \left(\frac{R}{\alpha_s} \right)^{\alpha_s} \left(\frac{w}{1 - \alpha_s} \right)^{1-\alpha_s} \tag{13}$$

[7]Distortions to output and to capital relative to labor are an observationally equivalent characterization of distortions to the absolute levels of capital and labor. For more details, see Hsieh and Klenow (2009, Appendix III).

Noting that ξ_s is different across industries but constant within an industry, equation (12) implies:

$$TFPR_{si} \propto \frac{(1+\tau_{Ksi})^{\alpha_s}}{1-\tau_{Ysi}} \tag{14}$$

This equation means that the large deviation of firm TFPR from ξ_s is a sign that the firm faces large distortions.

If we denote industry TFP as TFP_s and define industry TFP as a weighted geometric average of firm i's $TFPQ_{si}$, we have

$$TFP_s \triangleq \left[\sum_{i=1}^{M_s} \left(TFPQ_{si} \frac{\overline{TFPR_s}}{TFPR_{si}} \right)^{\sigma-1} \right]^{\frac{1}{\sigma-1}} \tag{15}$$

where $\overline{TFPR_s}$ is the geometric average of the average marginal revenue product of labor and capital in industry s:

$$\overline{TFPR_s} \triangleq \frac{\sigma}{\sigma-1} \left[\frac{R}{\alpha_s \sum_{i=1}^{M_s} \frac{1-\tau_{Ysi}}{1+\tau_{Ksi}} \frac{P_{si}Y_{si}}{P_s Y_s}} \right]^{\alpha_s} \left[\frac{w}{(1-\alpha_s) \sum_{i=1}^{M_s} (1-\tau_{Ysi}) \frac{P_{si}Y_{si}}{P_s Y_s}} \right]^{1-\alpha_s} \tag{16}$$

There are two points of clarification regarding equation (15). First, the higher the dispersion in TFPR, the lower the industry TFP will be. Hsieh and Klenow (2013) showed that when TFPQ and TFPR are jointly log-normally distributed and when there is only variation in $\log(1-\tau_{Ysi})$, aggregate TFP can be expressed as follows:[8]

$$\log TFP_s = \frac{1}{\sigma-1}\left[\log M_s + \log E\left(TFPQ_{si}^{\sigma-1}\right)\right] - \frac{\sigma}{2} var\left(\log TFPR_{si}\right) \tag{17}$$

This equation suggests that industry TFP will decline if the elasticity of substitution σ and/or TFPR dispersion increase.

Second, TFPR will be equalized across firms within industry s if τ_{Ksi} and τ_{Ysi} are equalized. For example, from equation (12), $TFPR_{si} = \xi_s \forall i$ if $\tau_{Ksi} = \tau_{Ysi} = 0$. This implies that $TFPR_{si} = \xi_s = \overline{TFPR_s} \forall i$.[9] Denoting industry TFP without any

[8] A similar property is obtained even when there is variation in $\log(1+\tau_{Ksi})$, although the equation becomes more complicated. For more details, see Hsieh and Klenow (2013).

[9] Note that even when TFPR is equalized across firms, TFPQ can be different across firms because more productive firms charge lower prices (see equation [9]); that is, if $A_{si} > A_{sj}$ and $P_{si} < P_{sj}$, $P_{si}A_{si}$ could be equal to $P_{sj}A_{sj}$ for $i \neq j$.

distortions as $\overline{TFPQ}_s$ from equation (15), we can obtain

$$\overline{TFPQ}_s \triangleq \bar{A}_s = \left(\sum_{i=1}^{M_s} A_{si}^{\sigma-1} \right)^{\frac{1}{\sigma-1}} \tag{18}$$

which is called "efficient" industry TFP.

In order to obtain "efficient" TFP, one needs information on firm-level TFPQ (A_{si}). One problem is the limited availability of firm-level price data, P_{si}, which are not available for many economies, including Viet Nam.[10] Hsieh and Klenow (2009) rewrote equation (4) as

$$TFPQ_{si} = A_{si} = \kappa_s \frac{(P_{si} Y_{si})^{\frac{\sigma}{\sigma-1}}}{K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}}, \text{ where } \kappa_s = w^{1-\alpha_s} \frac{(P_s Y_s)^{-\frac{1}{\sigma-1}}}{P_s} \tag{19}$$

Noting that κ_s is a scaling constant by industry and does not affect the relative differences between firms within industry s, it can be normalized to unity ($\kappa_s = 1$). This manipulation enables us to estimate TFPQ without firm-level price data. Note that from equations (5) and (19), $TFPQ_{si} > TFPR_{si}$ if $\kappa_s = 1$ and $P_{si} Y_{si} \geq 1$. Therefore, in the Hsieh and Klenow (2009) framework the dispersion of TFPQ tends to be larger than that of TFPR.

III. Data

A. Source

This paper utilizes firm-level data from the Annual Survey of Enterprises collected by the General Statistics Office of Viet Nam.[11] The survey was conducted for the first time in 2000 and then annually thereafter to provide researchers and policy makers with comprehensive information on Vietnamese firms. These data cover registered firms operating in all sectors, including agriculture, industry and construction, and services.

The survey covers all state-owned enterprises and foreign-owned firms without any firm size threshold. However, for domestic private firms, those with fewer than 10 workers are chosen by random sampling.[12] Household business

[10] There are some economies for which firm-level (or plant-level) price data are available. For example, Eslava et al. (2004) utilized plant-level price data for Colombia to estimate plant-level TFPQ.

[11] We use the same data as Ha and Kiyota (2014); this section is based on section III of their study. Note also that the use of firm-level data is more consistent with the theory than the use of plant-level data. This is because, as Nishimura, Nakajima, and Kiyota (2005) point out, resource allocation within a firm is determined by managerial decisions. Moreover, research and development and headquarters activities are typically classified as service activities, which are not covered in the manufacturing survey.

[12] This threshold was used in surveys before 2010. From 2010, different regions set different firm size thresholds.

activities are not covered in this survey.[13] The survey information includes type of ownership, assets and liabilities, number of employees, sales, capital stock, industry that the firm belongs to, and obligations to the government (e.g., taxes) from January to December of that year.

The data have some disadvantages. Some of the input data, such as materials, are not available for all years. Information on working hours and capital utilization rates is also unavailable. Firms' year of establishment and export status are not available every year. This paper uses firms with information on inputs, outputs, and cost shares. Reentry firms, which are those that disappeared from the data and then reappeared later, are omitted from our analysis. Some firms changed industry and/or ownership during the sample period.[14] We drop firms with fewer than 10 employees, regardless of their ownership, to avoid the effects of the random sampling.

B. Variables and Parameters

The main variables that we use are the two-digit Viet Nam Standard Industry Classification (VSIC) industry code, ownership type, value added, employment, total labor costs, and capital stock. Following Hsieh and Klenow (2009), we use wage bills instead of the number of workers to capture the potential differences in employee quality.[15] Capital stock is measured as total fixed assets recorded at the end of each year. Both wage bills and capital stock are deflated by the manufacturing gross domestic product (GDP) deflator.[16]

To compute dispersion, we follow other research in setting the key parameters σ and R as follows. We assume that the elasticity of substitution σ equals 3 and R is 10%, comprising a 5% depreciation rate and a 5% interest rate. We also follow Hsieh and Klenow (2009) to set α_s equal to 1 minus the labor share in the corresponding industry in the US. Under Hsieh and Klenow's framework, the output elasticities of capital and labor (α_s and $1 - \alpha_s$) do not embed distortions. Given the assumption that the US economy is less distorted than the Vietnamese economy, the use of US shares can be justified.

The US labor share is obtained from the NBER–CES Manufacturing Industry Database, which is a joint product of the National Bureau of Economic Research and the US Census Bureau's Center for Economic Studies.[17] Industry classifications

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[13] The survey covered 62.2% of total employment in manufacturing in 2009. The data on total employment in manufacturing were obtained from the General Statistics Office online database on population and employment.

[14] If a firm has switched industries, the industry to which the firm belonged for the majority of the surveyed years is regarded as the firm's industry. If a firm belonged to more than one industry for equal amounts of time, we assign the industry code of the industry that the firm belonged to most recently.

[15] The use of wage bills as a measure of labor input implies that $w = 1$ (Camacho and Conover 2010, p. 10).

[16] As Aw, Chen, and Roberts (2001) pointed out, it is preferable to utilize the investment goods price deflator rather than the manufacturing GDP deflator to obtain the real capital stock. However, as Ha and Kiyota (2014) discussed, the investment goods price deflator is not available for our data set.

[17] Data can be downloaded from the National Bureau of Economic Research's website at http://www.nber.org/nberces/

are based on the North American Industry Classification System (NAICS) version 1997. Based on the data, we first match the NAICS code with the four-digit VSIC code using concordance tables between NAICS, International Standard Industry Classification revision 3, and VSIC. We then aggregate total payroll and total value added by two-digit VSIC sectors. To compute the labor share, we take the ratio of total payroll over total value added by sector. Because total payroll in the database does not include fringe benefits and employer's contribution to social security, this labor share only reflects two-thirds of the aggregate labor share in the whole manufacturing sector. Therefore, we follow Hsieh and Klenow (2009) to inflate the labor shares by 1.5 to obtain US labor elasticities.

As firms' output prices are not available, we have obtained TFPQ by raising nominal output to the power of $\sigma/(\sigma-1)$, assuming that normal demand relationships hold. If a firm's real output is high, one would expect its price to be low so that consumers demand more output. Following Ziebarth (2013), the dispersion of TFP is defined as the deviation of the log of TFP from its industry mean: $\log(TFPR_{si}/\overline{TFPR_s})$ and $\log(TFPQ_{si}M_s^{\frac{1}{\sigma-1}}/\overline{TFPQ_s})$, where $\overline{TFPR_s}$ and $\overline{TFPQ_s}$ are from equations (16) and (18), respectively.[18] We trim 2% of firm productivity and distortions by removing values below the first percentile and above the 99th percentile from the distribution of $\log(TFPR_{si}/\overline{TFPR_s})$ and $\log(TFPQ_{si}M_s^{\frac{1}{\sigma-1}}/\overline{TFPQ_s})$. Then, we recalculate $\overline{TFPR_s}$, $\overline{TFPQ_s}$, and $\overline{TFP_s}$. For robustness checks, section V examines whether the results are sensitive to the values of σ, α_s, and the threshold level of trimming.

IV. Results

A. To what extent are resources misallocated in Viet Nam?

This section addresses the first question of the paper: To what extent are resources misallocated in Viet Nam? To answer this question, we compare the dispersions of TFP in Viet Nam with those in the PRC, India, Japan, Thailand, and the US. The dispersions of TFPR are reported in Table 1, while those of TFPQ are reported in Table 2. Both tables present standard deviations, differences between the 90th and 10th percentiles, differences between the 75th and 25th percentiles, and average per capita GDP during the sample period.[19] Figures for the PRC, India, and the US are from Hsieh and Klenow (2009); for Japan, from Hosono and Takizawa (2013); and for Thailand, from Dheera–Aumpon (2014).

These tables indicate that the standard deviation of TFPR for Viet Nam is 0.79, which is comparable to the standard deviations for the PRC (0.68), India (0.68),

[18]Some of the effects of the changes in prices are controlled for by taking the ratio.

[19]Noting that both TFPR and TFPQ are divided by their industry means, these statistics can be interpreted as the coefficients of variation.

Table 1. **Dispersion of Revenue-Based Total Factor Productivity**

	Viet Nam 2000–2009	Thailand 2006	People's Republic of China 1998–2005	India 1987–1994	Japan 1981–2008	United States 1977–1997
SD	0.79	0.85	0.68	0.68	0.55	0.45
75–25	0.97	1.04	0.89	0.80	0.70	0.47
90–10	2.00	2.09	1.72	1.66	1.40	1.08
GDP per capita	685	2,813	1,304	400	31,101	30,533

GDP = gross domestic product, SD = standard deviation, TFPR = revenue-based total factor productivity.
Notes: Data for Thailand are from Dheera–Aumpon (2014, Table 3). Data for the People's Republic of China are arithmetic averages from Hsieh and Klenow (2009, Table 2). Data for Japan are from Hosono and Takizawa (2013). TFPR is calculated from equation (5) and then scaled by the geometric mean of TFPR across all firms in an industry *s*. Industries are weighted by value-added shares. GDP per capita is the annual average over each sample period in constant 2005 US dollars.
Sources: Hsieh, C.-T., and P. J. Klenow. 2009. Misallocation and Manufacturing TFP in China and India. *Quarterly Journal of Economics* 124 (4): 1403–48; Hosono, K., and M. Takizawa. 2013. Misallocation and the Dynamics of Establishment. *Financial Review* 112 (1): 180–209 (in Japanese); Dheera–Aumpon, S. 2014. Misallocation and Manufacturing TFP in Thailand. *Asia-Pacific Economic Literature* 28 (2): 63–76; and authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5; per capita GDP data obtained from World Bank. 2014. *World Development Indicators*. Washington, DC.

Table 2. **Dispersion of Quantity-Based Total Factor Productivity**

	Viet Nam 2000–2009	Thailand 2006	People's Republic of China 1998–2005	India 1987–1994	Japan 1981–2008	United States 1977–1997
SD	1.42	1.59	1.00	1.19	0.98	0.83
75–25	2.01	2.18	1.34	1.56	1.27	1.16
90–10	3.70	4.12	2.57	3.03	2.48	2.15

SD = standard deviation, TFPQ = quantity-based total factor productivity.
Notes: Data for Thailand are from Dheera–Aumpon (2014, Table 2). Data for the People's Republic of China, India, and the United States are arithmetic averages from Hsieh and Klenow (2009, Table 1). Data for Japan are from Hosono and Takizawa (2013, Table 1). TFPQ is calculated from equation (19) and then scaled by the geometric mean of TFPQ across all firms in an industry *s*. Industries are weighted by value-added shares.
Sources: Hsieh, C.-T., and P. J. Klenow. 2009. Misallocation and Manufacturing TFP in China and India. *Quarterly Journal of Economics* 124 (4): 1403–48; Hosono, K., and M. Takizawa. 2013. Misallocation and the Dynamics of Establishment. *Financial Review* 112 (1): 180–209 (in Japanese); Dheera–Aumpon, S. 2014. Misallocation and Manufacturing TFP in Thailand. *Asia-Pacific Economic Literature* 28 (2): 63–76; and authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

and Thailand (0.85), and is larger than the standard deviations for Japan (0.55) and the US (0.45). Similar patterns were also confirmed for the differences between the 75th and 25th percentiles, and between the 90th and 10th percentiles.[20] Although more careful examination is needed in the form of a direct comparison, the results

[20]The difference between the 75th and 25th percentile firms is 0.97, which corresponds to a TFP ratio of $e^{0.97} = 2.63$. Similarly, the difference between the 90th and 10th percentile firms is 2, which corresponds to a TFP ratio of $e^{2.00} = 7.39$. These figures are much larger than those for the US. For more details, see Syverson (2011).

suggest that distortions in developing economies, including Viet Nam, tend to be large relative to those in developed economies.

B. How large would the productivity gains be without distortions?

This section addresses the second question of this paper: How large would the productivity gains have been in the absence of distortions? To answer this question, we estimate TFP gains when the marginal products of labor and capital are equalized across firms within each industry. For each industry, the gains are computed as the ratio of actual TFP obtained from equation (15) to the "efficient" TFP obtained from equation (18). We then aggregate the gains across industries using industry value-added shares as the weights. In particular, we compute

$$\frac{Y}{Y^*} \triangleq \prod_{s=1}^{S}\left(\frac{Y_s}{Y_s^*}\right)^{\theta_s} = \prod_{s=1}^{S}\left(\frac{TFP_s}{\overline{\overline{TFPQ_s}}}\right)^{\theta_s}$$
$$= \prod_{s=1}^{S}\left\{\frac{1}{\overline{\overline{TFPQ_s}}}\left[\sum_{i=1}^{M_s}\left(TFPQ_{si}\frac{\overline{TFPR_s}}{TFPR_{si}}\right)^{\sigma-1}\right]^{\frac{1}{\sigma-1}}\right\}^{\theta_s}$$
$$= \prod_{s=1}^{S}\left[\sum_{i=1}^{M_s}\left(\frac{A_{si}}{\bar{A}_s}\frac{\overline{TFPR_s}}{TFPR_{si}}\right)^{\sigma-1}\right]^{\frac{\theta_s}{\sigma-1}} \tag{20}$$

where Y^* is the "efficient" output that corresponds to the "efficient" TFP and θ_s is the value-added share of industry s ($\sum_s \theta_s = 1$). The first equality ($Y_s/Y_s^* = TFP_s/\overline{\overline{TFPQ_s}}$) is obtained when K_s and L_s are given. As the total amount of inputs is fixed, the output gains come solely from the reallocation of resources in the absence of distortions.

Table 3 presents the TFP gains from equalizing TFPR across firms within each industry. The gains are measured relative to the TFP gains in the US in 1997.[21] To report TFP percentage gains in Viet Nam relative to those in the US, we take the ratio of Y^*/Y to the US equivalent in 1997, subtract 1, and multiply by 100. If Viet Nam hypothetically moves to "US efficiency," substantial gains (30.7%) are expected. The gains are smaller than those for the PRC (39.2%), India (46.9%), and Thailand (73.4%), but larger than those for Japan (3%).

One may be concerned that the dispersion of TFPR is larger (Table 1), while the gains are smaller in Viet Nam than in either the PRC or India (Table 3). Noting that the gains are computed from the inverse of equation (20), $(Y^*/Y - 1) \times 100$),

[21]Hsieh and Klenow (2009) called this comparison a conservative analysis because the US' gains are largest in 1997.

Table 3. **Total Factor Productivity Gains from Equalizing Revenue-Based Total Factor Productivity Relative to 1997 Gains in the United States**

	Viet Nam 2000–2009	Thailand 2006	People's Republic of China 1998–2005	India 1987–1994	Japan 1981–2008
%	30.7	73.4	39.3	46.9	3.0

Notes: The data for Thailand are calculated from Dheera–Aumpon (2014, Table 4). The data for the People's Republic of China, India, and the United States are arithmetic averages from Hsieh and Klenow (2009, Table 6). The data for Japan are calculated from Hosono and Takizawa (2013, Table 2).
Sources: Hsieh, C.-T., and P. J. Klenow. 2009. Misallocation and Manufacturing TFP in China and India. *Quarterly Journal of Economics* 124 (4): 1403–48; Hosono, K., and M. Takizawa. 2013. Misallocation and the Dynamics of Establishment. *Financial Review* 112 (1): 180–209 (in Japanese); Dheera–Aumpon, S. 2014. Misallocation and Manufacturing TFP in Thailand. *Asia-Pacific Economic Literature* 28 (2): 63–76; and authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

Y^*/Y will be small if $A_{si}/\bar{A}_s$ and/or $\overline{TFPR}_s/TFPR_{si}$ become large. The results suggest that, on average, $A_{si}/\bar{A}_s$ is larger in Viet Nam than in either the PRC or India. Similarly, we find large TFP gains for Thailand, which is possibly attributed to a small $A_{si}/\bar{A}_s$ for Thailand.[22] Although these are hypothetical exercises and thus should not be taken literally, the results suggest that substantial productivity gains are expected in Viet Nam by the kind of reallocation considered here.

C. Are the distortions related to firm size?

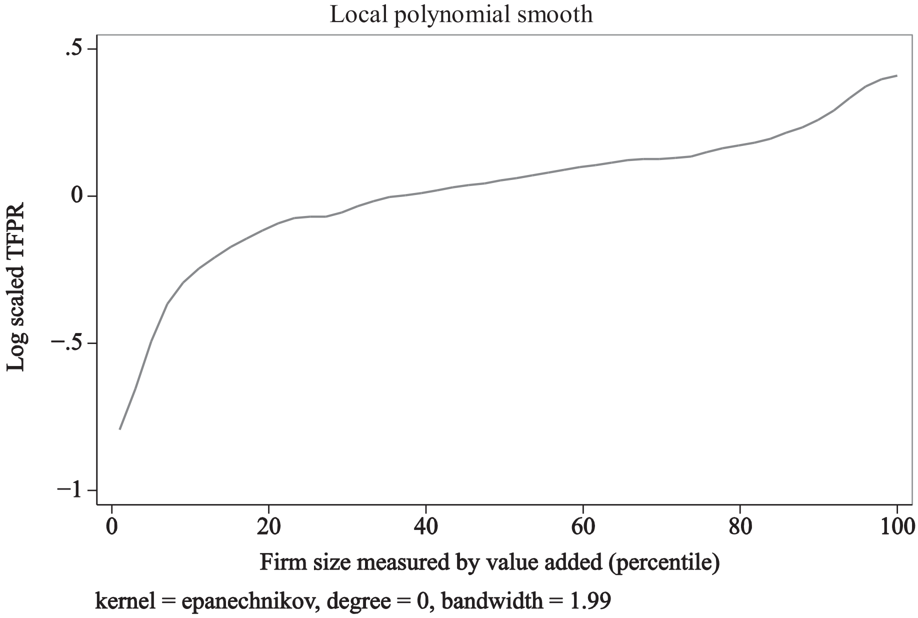
This section examines whether the distortions are related to firm size. This question has important policy implications because, for example, many economies give preferential treatment to SMEs. If SMEs tend to face larger disadvantageous distortions, preferential treatment to SMEs can be justified. Following Hsieh and Klenow (2009) and Ziebarth (2013), we examine the relationship between firm size and TFPR.

Figure 1 presents the relationship between firm size percentile as measured by value added and scaled TFPR relative to a given industry. Figure 1 indicates that TFPR is increasing as firm size increases. Noting that TFPR is proportional to the distortions (equation 14), this result implies that smaller firms tend to face advantageous distortions, while larger firms tend to face disadvantageous ones. This result is similar to that found for India (Hsieh and Klenow 2009, Figure 6) and for the US in the 19th century (Ziebarth 2013, Figure 3).

Interestingly, this correlation with firm size is different for the distortions in output and the distortions in capital markets. Figure 2 presents the relationship between the distortions in output markets and firm size (in terms of value added).

[22]Figure 1 in Dheera–Aumpon (2014) suggests that the distribution of TFPQ in Thailand moves to the left and its mean takes a negative value. Although it is not clear why the distribution moves to the left, this may be a reason why large TFP gains are expected in Thailand.

Figure 1. **Revenue-Based Total Factor Productivity and Size**



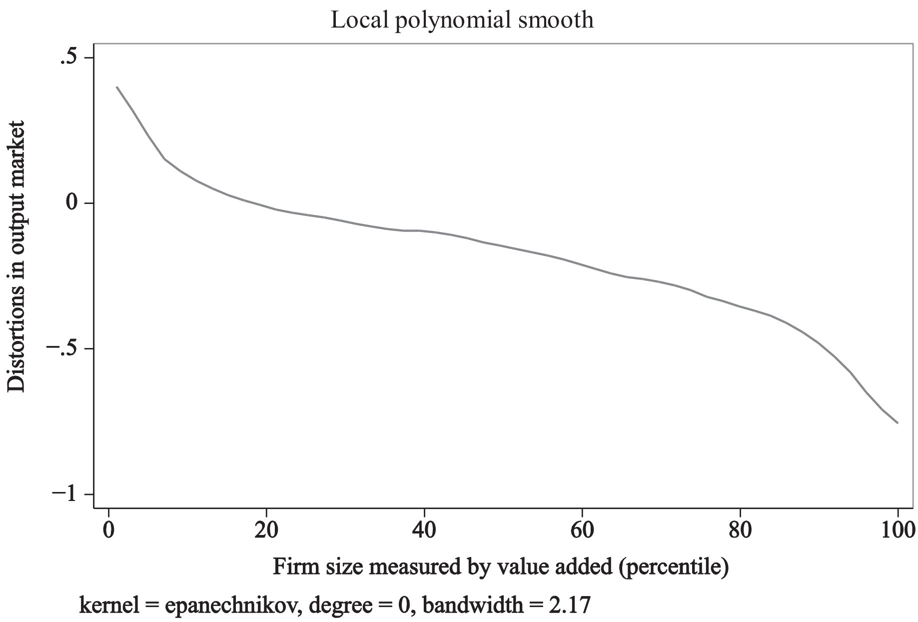
TFPR = revenue-based total factor productivity.
Note: This figure presents the relationship between scaled TFPR relative to a given industry and size percentile as measured by value added.
Source: Authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

Figure 2 indicates that the distortions in output markets decrease as firm size increases. Noting that the distortions in output markets are measured by $1 - \tau_Y$, this result is similar to that in TFPR: smaller firms tend to face advantageous distortions, while larger firms tend to face disadvantageous ones.

Figure 3 presents the relationship between the distortions in capital markets and firm size. In contrast to the distortions in output markets, Figure 3 shows an inverse U-shaped relationship. Noting that the distortions in capital markets are measured by $1 + \tau_K$, this result suggests that both small and large firms tend to face advantageous distortions. In contrast, middle-sized firms tend to face disadvantageous distortions. This pattern is different from those of TFPR and distortions in output markets. This may be because small firms are treated preferentially, while large firms can diversify their capital procurement.

It is also interesting to note that the result for TFPR mainly reflects that of distortions in output markets. This result implies that the distortions in output markets have stronger effects on TFPR than those in capital markets. This result is consistent with the findings of Midrigan and Xu (2014), who showed that financial frictions, measured by borrowing constraints, had relatively small impacts on productivity.

Figure 2. **Distortions in Output Markets and Size**



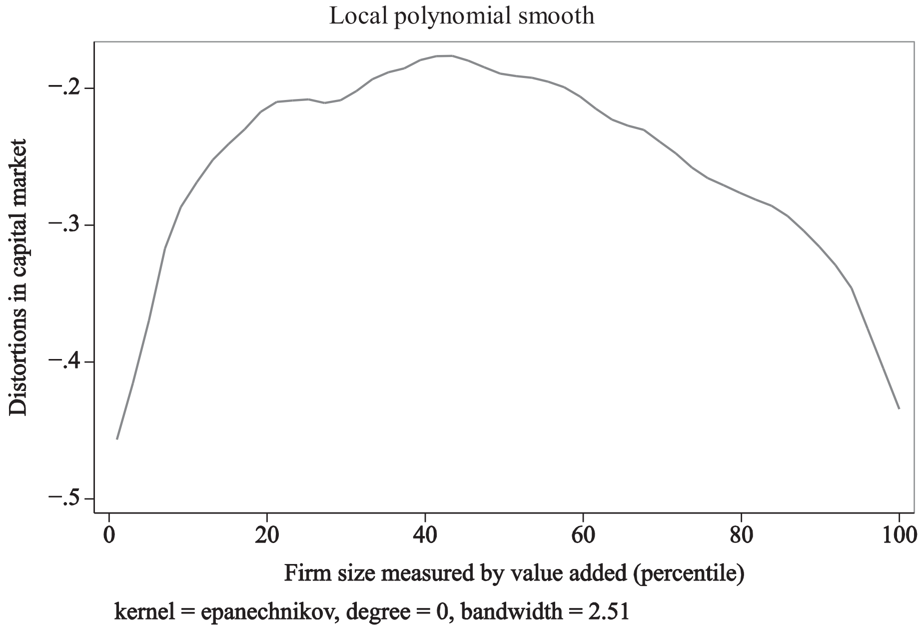
Note: This figure presents the relationship between scaled $1 - \tau_Y$ relative to a given industry and size percentile as measured by value added.
Source: Authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

One may be concerned that our measurement of firm size, following Hsieh and Klenow (2009), is based on value added rather than employment. In many economies, SMEs are defined by the number of employees rather than by the size of their value added. To address this concern, we examine the relationship between distortions and firm size as measured by employment. The results are presented in Figures 4, 5, and 6. The results are different from—but qualitatively similar to—those when firm size is measured by value added: as firm size (in terms of employment) increases, TFPR is increasing, the distortions in output markets are decreasing, and the distortions in capital markets show an inverse U-shaped relationship except for the top quintile of firms. Noting that the results for TFPR mainly reflect the distortions in output markets, we can conclude that our main messages remain unchanged even when firm size is measured by employment.

D. What would the distribution of firm size have been in the absence of distortions?

The model also has an implication for the distribution of firm size. Equation (7) is rewritten as

Figure 3. **Distortions in Capital Markets and Size**



Note: This figure presents the relationship between scaled $1 + \tau_K$ relative to a given industry and size percentile as measured by value added.
Source: Authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

$$P_{si} Y_{si} = Y_{si}^{\frac{\sigma-1}{\sigma}} P_s Y_s^{\frac{1}{\sigma}} \tag{21}$$

From equations (7) and (9), we have

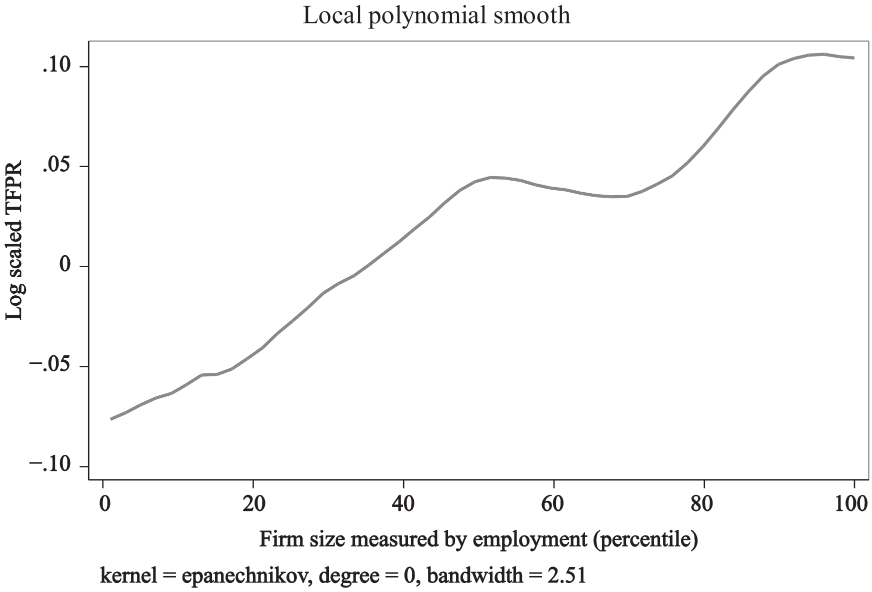
$$Y_{si} = \left[\frac{\sigma - 1}{\sigma} \left(\frac{\alpha_s}{R} \right)^{\alpha_s} \left(\frac{1 - \alpha_s}{w} \right)^{1-\alpha_s} \right]^{\sigma} P_s^{\sigma} Y_s \left[\frac{A_{si} (1 - \tau_{Ysi})}{(1 + \tau_{Ksi})^{\alpha_s}} \right]^{\sigma} \tag{22}$$

Similar to equation (14), from equations (21) and (22), we have

$$P_{si} Y_{si} \propto \left[\frac{A_{si} (1 - \tau_{Ysi})}{(1 + \tau_{Ksi})^{\alpha_s}} \right]^{\sigma - 1} \tag{23}$$

Equation (23) suggests that without distortions, more (less) productive firms tend to be larger (smaller). When A_{si} and $1 - \tau_{Ysi}$ are correlated negatively, more productive firms tend to be smaller than the efficient size. Similarly, if A_{si} and $1 + \tau_{Ksi}$ are correlated positively, less productive firms tend to be larger than the

Figure 4. **Revenue-Based Total Factor Productivity and Employment Size**



TFPR = revenue-based total factor productivity.
Note: This figure presents the relationship between scaled TFPR relative to a given industry and size percentile as measured by employment.
Source: Authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

efficient size. Both cases result in smaller size dispersion. This implies that when distortions are large, the efficient size distribution is more dispersed than the actual size distribution.

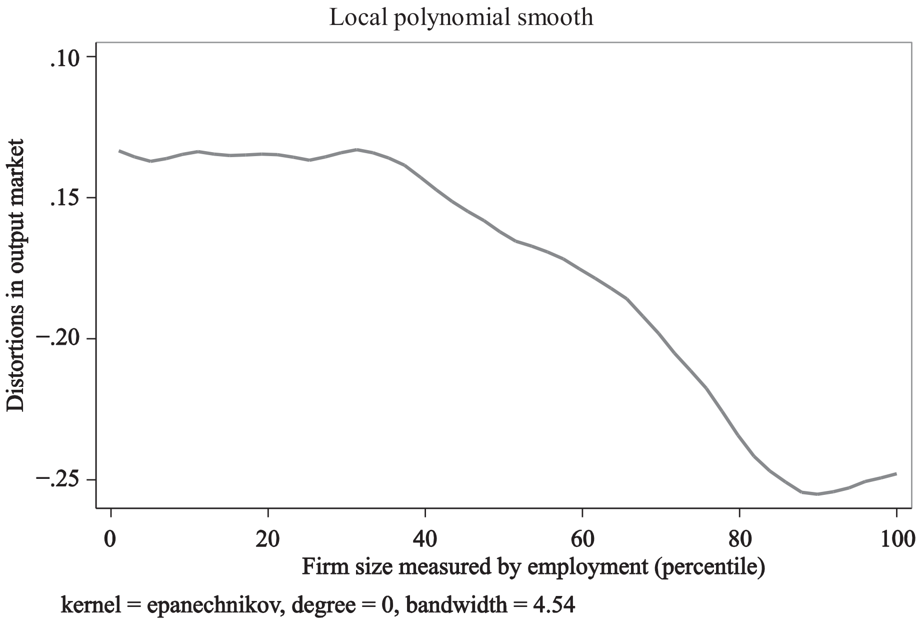
To examine this implication, we compare the actual firm size distribution with the efficient firm size distribution. The size is measured as the value added of the firms, following Hsieh and Klenow (2009). Let $P^*_{si}Y^*_{si}$ be the efficient firm size. The efficient sizes relative to actual sizes are

$$\frac{P^*_{si}Y^*_{si}}{P_{si}Y_{si}} = \frac{Y^*}{Y}\left(\frac{Y_s}{Y^*_s}\right)^{\sigma-1}\left[\frac{(1+\tau_{Ksi})^{\alpha_s}}{1-\tau_{Ysi}}\right]^{\sigma-1} \tag{24}$$

where the efficient firm size is obtained when τ_{Ksi} and τ_{Ysi} are equalized within industry s. Both Y^*/Y and Y_s/Y^*_s are obtained from equation (20).[23] We compute the actual and efficient sizes from this equation by year, and then take averages over the period.

[23] For the derivation of equation (24), see the Appendix.

Figure 5. **Distortions in Output Markets and Employment Size**



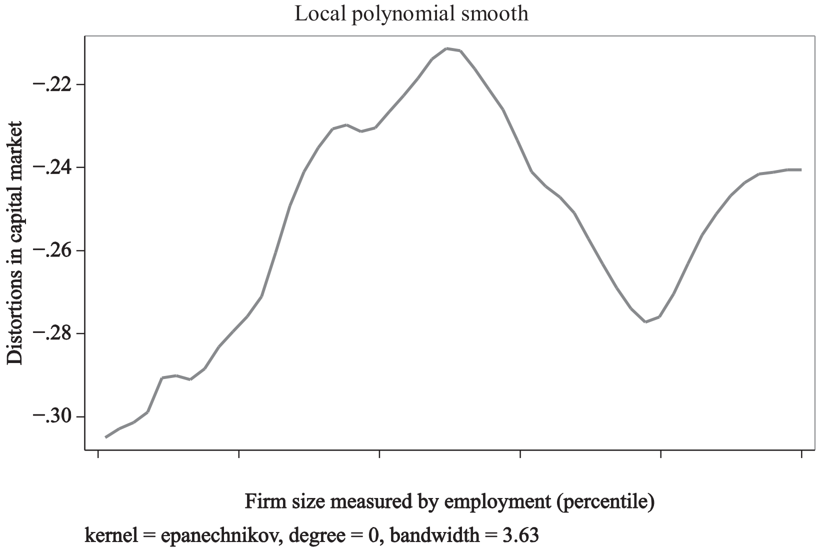
Note: This figure presents the relationship between scaled $1 + \tau_Y$ relative to a given industry and size percentile as measured by employment.
Source: Authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

Table 4 and Figure 7 present the results. In Table 4, the rows are the actual firm size quartiles with equal numbers of firms. The columns are the bins of efficient firm size relative to actual firm size. We classify firms into four bins. For example, 0%–50% means that the firm size would be less than half of the actual firm size if all distortions are removed. Similarly, 200+% means that the firm size would be more than double without distortions. The entries are the shares of firms (averaged over the period). The rows sum to 25%; the rows and columns together sum to 100%.

Examining Table 4, we highlight two results. First, although average output rises substantially (as we confirmed in section IV), many firms of all sizes would shrink without distortions. Second, the largest quartile indicates the largest expansion among all firm sizes (8.7%). This result means that large firms are less likely to shrink and more likely to expand. This finding is also confirmed by Figure 7.

As the model suggests, the efficient size distribution is more dispersed than the actual size distribution. This result is consistent with the finding of the previous section. Like the case of India (Banerjee and Duflo 2005, p. 507), Viet Nam's policies may constrain its largest and most efficient producers and coddle its smallest and least efficient ones. Indeed, Vietnamese SMEs are supported by various policies such as government-supported financing (Tran, Le, and Nguyen 2008, pp. 347–59).

Figure 6. **Distortions in Capital Markets and Employment Size**



Note: This figure presents the relationship between scaled $1 + \tau_K$ relative to a given industry and size percentile as measured by employment.
Source: Authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

Table 4. **Actual Size versus Efficient Size**

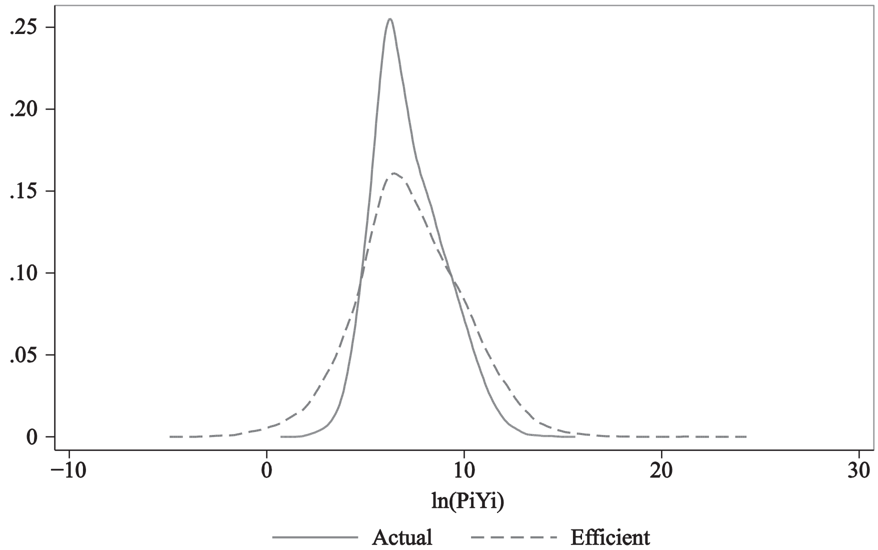
	Efficient firm size relative to actual firm size				
2000–2009 (average)	**0%–50%**	**50%–100%**	**100%–200%**	**200%+**	**Total**
Actual firm size					
Top quartile	5.1	5.5	5.7	8.7	25.0
Second quartile	8.0	5.6	4.6	6.8	25.0
Third quartile	9.1	6.3	4.4	5.2	25.0
Bottom quartile	13.7	5.1	3.0	3.1	25.0
Total	**36.0**	**22.4**	**17.6**	**23.9**	**100.0**

Notes: The rows are the actual firm size quartiles with equal numbers of firms. The columns are the bins of efficient firm size relative to actual firm size. We classify firms into four bins by the value added of firms. For example, 0%–50% means that the firm size would be less than half of the actual firm size if all distortions were removed. Similarly, 200%+ means that the firm size would be more than double without distortions. The entries are the shares of firms (averaged over the period).
Source: Authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

These results for Viet Nam are similar to those of the PRC, India, and the US in Hsieh and Klenow (2009).[24]

[24]The Government of Viet Nam has launched various schemes to improve the performance of SMEs, including credit funds and worker trainings (Tran, Le, and Nguyen 2008, pp. 347–59). However, unlike India, where size-related policies are explicitly imposed by law, such policies in Viet Nam are only guidelines. We cannot identify from the data which individual firms are eligible for support or have received any form of support. It is thus difficult for us to conduct an analysis similar to that of Hsieh and Klenow (2009).

Figure 7. **Distribution of Firm Size**



Note: The solid line indicates the actual size distribution, while the dashed line indicates the efficient size distribution.
Source: Authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

E. Robustness check: different parameter values

One may be concerned that our analysis is sensitive to the choice of parameter values and sample selection because our results are based on specific parameter values such as $\sigma = 3$. To address this concern, we reconduct all the analyses using different parameter values. Because it is tedious to examine all the results, this section examines (i) how sensitive the estimated TFPR and TFP gains (reported in section IV and in Table 3) are to the choice of parameter values and sample selection, and (ii) the correlation between alternative and baseline TFPR. In this robustness check, we report absolute TFP gains rather than relative TFP gains (to the US) because we only change the parameter values in Viet Nam (not in the US).

We first examine whether the results are sensitive to the value of the elasticity of substitution, σ. In the baseline analysis, following Hsieh and Klenow (2009), we set $\sigma = 3$. This implies that the markup is 1.5 $(= 3/(3-1))$. As a robustness check, we set $\sigma = 2$ and $\sigma = 6$, and the corresponding markups are 2 $(= 2/(2-1))$ and 1.2 $(= 6/(6-1))$, respectively. The second and third columns in Table 5 present the results. The TFP gains are somewhat sensitive to the value of the elasticity of substitution. The TFP gains are 65.3% when $\sigma = 2$ and 161.9% when $\sigma = 6$, while the baseline TFP gains are 86.8%.[25]

[25]This result is consistent with equation (17), which implies that the TFP gains will be large if the elasticity of substitution is large.

Table 5. **Robustness Check: Total Factor Productivity Gains from Equalizing Revenue-Based Total Factor Productivity Relative to 1997 Gains in the United States**

	(1) Baseline	(2) Robustness Check 1	(3) Robustness Check 2	(4) Robustness Check 3	(5) Robustness Check 4	(6) Robustness Check 5	(7) Robustness Check 6	(8) Robustness Check 7
Elasticity: σ	$\sigma = 3$	$\sigma = 2$	$\sigma = 6$	$\sigma = 3$	$\sigma = 3$	$\sigma = 3$	$\sigma = 3$	$\sigma = 3$
Technology: α	United States	United States	United States	1/3	Viet Nam	Firm specific	United States	United States
Trim	1%	1%	1%	1%	1%	1%	2%	2%
N	100,601	100,601	100,612	100,848	100,832	100,947	97,263	10,186
SD(TFPR)	0.79	0.78	0.79	0.64	0.64	0.61	0.71	0.68
TFP gains (%)	86.8	65.3	161.9	70.1	68.0	40.0	75.7	64.5
Correlation with baseline TFPR	1.000	0.997	0.994	0.927	0.889	0.794	0.995	0.948
Panel structure	Unbalanced Panel	Unbalanced Panel	Unbalanced Panel	Unbalanced Panel	Unbalanced Panel	Unbalanced Panel	Unbalanced Panel	Balanced Panel

SD = standard deviation, TFP = total factor productivity, TFPR = revenue-based total factor productivity.

Note: The baseline is obtained from Table 3.

Source: Authors' calculations based on Government of Viet Nam, General Statistics Office. Annual Survey of Enterprises. https://www.gso.gov.vn/default_en.aspx?tabid=479&idmid=5

Nevertheless, the estimated TFPR is qualitatively similar to the baseline results. Table 5 also reports the correlation with baseline TFPR, which is 0.997 when $\sigma = 2$ and 0.994 when $\sigma = 6$. These high correlations suggest that the results are quantitatively different from—but qualitatively similar to—the baseline results.[26] The standard deviation of lnTFPR is 0.78 when $\sigma = 2$ and 0.79 when $\sigma = 6$, both of which are similar to that of the baseline model (0.79).

We also examine the sensitivity of the results to the value of the technology parameter (capital share α_s). We examine two different technologies. One is $\alpha_s = 1/3$, as in Ziebarth (2013), and the other is the Vietnamese cost share, which is defined as the industry-year average capital share of the sample firms. The results are presented in the fourth and fifth columns in Table 5. The TFP gains are 70.1% when $\alpha_s = 1/3$ and 68% when we assume Vietnamese technology. The correlation with the baseline TFPR is 0.927 when $\alpha_s = 1/3$ and 0.889 when we assume Vietnamese technology. The standard deviation of lnTFPR is 0.64 for both cases. Similar to the value of the elasticity of substitution, the results are quantitatively different from—but qualitatively similar to—the baseline results.

One may also be concerned that the technology parameter α_s is heterogeneous across firms even within industries. To address this concern, we use the firm-level capital share so that the capital share can vary across firms.[27] The results are presented in the sixth column in Table 5 and are similar to the baseline results, although the TFP gains are somewhat sensitive to the technology parameters. The TFP gains are 40%. The correlation with the baseline TFPR is 0.794. The standard deviation of lnTFPR is 0.61. These results together suggest that our main messages remain unchanged even when we use different values for the technology parameter.

Another concern may be that the data are not precise, and thus Vietnamese firm-level data are subject to measurement error problems. Although we cannot rule out arbitrary measurement error, we can try to gauge whether our results are attributable to some specific forms of measurement error. We focus on two forms of measurement error. First, serious measurement error, possibly because of reporting error, tends to appear as outliers. We trimmed 2% from the tails (below the second percentile and above the 98th percentile), instead of 1% as in the baseline analysis, and examined how sensitive the results are to the trim values. The seventh column reports the results. The TFP gains are 75.7%. The correlation with the baseline TFPR remains high at 0.995. The standard deviation of lnTFPR (0.71) is slightly lower than that of the baseline model (0.79).

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[26]It may also be important to allow the elasticities to vary across industries. Although Broda, Greenfield, and Weinstein (2006) estimated the elasticity of substitution for various economies, Viet Nam is not covered in their analysis. We leave this exercise for future research.

[27]Note that ξ_s can vary across firms if the capital share is different across firms (see equation [12]); that is, TFPR will not necessarily be proportional to the capital and output wedges. We thus present the results for reference only. From equation (11), if the technology parameter is heterogeneous across firms (α_s $(= RK_{si}/P_{si}Y_{si})$, distortions appear only in τ_{Ysi} because τ_{Ksi} will be zero.

We also estimate the TFP gains for firms that survived throughout the sample period (balanced panel). This exercise enables us to control for the effects of firm entry and exit. The eighth column presents the results. This exercise reduces the sample size substantially ($N = 10{,}186$). Nonetheless, the estimated TFP gains are large and the correlation with baseline TFP is high: 64.5% and 0.948, respectively. The standard deviation of lnTFPR is 0.68, which is comparable to that of the baseline model. The results suggest that about three-quarters of TFP gains come from the incumbent firms, while the rest of the gains come from firms entering and exiting the market. We can thus conclude that the results from the balanced panel are qualitatively similar to the baseline results.

In sum, the magnitude of the TFP gains are somewhat sensitive to the choice of the values of parameters σ and α. Nonetheless, our main messages remain unchanged even if we use different parameter values or employ different sample selection criteria: the potential TFP gains from removing distortions in Vietnamese manufacturing are large.

V. Concluding Remarks

This paper employed the Hsieh and Klenow (2009) framework to investigate misallocation and productivity linkages in Vietnamese manufacturing during the period 2000–2009 using firm-level data. Our study has four major findings. First, misallocation in Viet Nam is comparable to that in the PRC, India, and Thailand. This result is consistent with the common knowledge that resources in developing economies are not efficiently allocated.

Second, there would be substantial improvement in TFP if no distortions existed. If Viet Nam hypothetically moved to "US efficiency," its TFP would be boosted by 30.7%. Third, smaller firms tend to face advantageous distortions, while larger firms tend to face disadvantageous ones. Finally, the efficient distribution of firm size is more dispersed than the actual size distribution. This result implies that Viet Nam's policies may constrain its large and most efficient producers and coddle its smallest and least efficient ones.

These findings have policy implications. The first finding suggests that, similar to other developing economies, resource misallocation caused by the distortions seems to be an important issue in Viet Nam. The second finding states that the potential productivity gains from removing distortions in Vietnamese manufacturing are large. The result implies that reallocation would lead to productivity gains that can accelerate potential growth through improved interfirm resource allocation. The last two findings together imply that Viet Nam's policies, as stated earlier, may constrain its largest and most efficient producers and coddle its smallest and least efficient ones. This suggests that policy makers need to focus more attention on the allocation of resources. An important question, therefore, is whether or not resources are being allocated to productive firms.

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Appendix. Derivation of Equation (24)

From equations (7), (8), and (9), actual firm size is written as

$$\begin{aligned} P_{si}Y_{si} &= P_s^{\sigma} Y_s P_{si}^{1-\sigma} \\ &= P_s Y_s \left(\frac{P_{si}}{P_s}\right)^{1-\sigma} \\ &= \theta_s Y \left[\frac{(1+\tau_{Ksi})^{\alpha_s}}{A_{si}(1-\tau_{Ysi})}\right]^{1-\sigma} \Bigg/ \sum_j \left[\frac{\left(1+\tau_{Ksj}\right)^{\alpha_s}}{A_{sj}\left(1-\tau_{Ysj}\right)}\right]^{1-\sigma} \end{aligned} \tag{A-1}$$

Efficient firm size is obtained when τ_{Ksi} and τ_{Ysi} are equalized within industry s (e.g., $\tau_{Ksi} = \tau_{Ks}$ and $\tau_{Ysi} = \tau_{Ys}$). From equation (A-1), the efficient firm size is written as

$$P_{si}^{*} Y_{si}^{*} = \theta_s Y^{*} \frac{A_{si}^{\sigma-1}}{\sum_j A_{sj}^{\sigma-1}} \tag{A-2}$$

From equations (A-1) and (A-2), we have

$$\frac{P_{si}^{*} Y_{si}^{*}}{P_{si} Y_{si}} = \frac{Y^{*}}{Y} \left(\frac{Y_s}{Y_s^{*}} \right)^{\sigma-1} \left[\frac{(1+\tau_{Ksi})^{\alpha_s}}{1-\tau_{Ysi}} \right]^{\sigma-1} \tag{A-3}$$

Misallocation, Access to Finance, and Public Credit: Firm-Level Evidence

Miguel A. León-Ledesma and Dimitris Christopoulos*

Using a database of 23,000 firms in 45 economies, we test the quantitative importance of access to finance and access to public and private credit for the determination of misallocation. We first derive measures of factor market and size distortions, and then use these measures within a regression framework to test the significance of self-declared access-to-finance obstacles as well as the effect of access to a credit line issued by either a government-owned or private bank. We find that access-to-finance obstacles and private credit increase the dispersion of distortions. Public credit has a very small effect. For firms that do not face financial obstacles, public credit increases the dispersion of distortions; for firms that face financial obstacles, it slightly decreases dispersion. Public credit does not appear to compensate for the distortions that exist in private credit markets. Quantitatively, however, financial variables explain a very small part of the dispersion of factor market and size distortions.

Keywords: financial access, firm level, misallocation, productivity, public credit
JEL codes: O40, O43, O47

I. Introduction

Recent literature has emphasized the role of misallocation in determining total factor productivity (TFP) differences between economies. Misallocation implies that aggregate TFP could be higher given the same amount of capital, labor, and firm-level TFP. Because of distortions that prevent factors of production from being allocated for their best use, firms with high productivity may be too small and firms with low productivity may be too large, leading to a fall in aggregate (weighted) TFP. One of the key distortions that may cause misallocation is the existence of financial access problems that generate quantity constraints and price dispersion in credit markets. In order to bypass these financial access distortions, governments often resort to public policies for the allocation of credit through government-owned credit institutions.

*Miguel León–Ledesma (corresponding author): School of Economics and Macroeconomics, Growth, and History Centre, University of Kent, United Kingdom. E-mail: M.A.Leon-Ledesma@kent.ac.uk; Dimitris Christopoulos: Department of Economic and Regional Development, Panteion University, Athens, Greece. E-mail: christod@panteion.gr. The authors would like to thank the participants at the Asian Development Outlook–Asian Development Review Conference held in Seoul in November 2015, the managing editor, and an anonymous referee for helpful comments. They would also like to thank Alessandro Cusimano and Daniel Roland for excellent research assistance. The usual disclaimer applies. ADB recognizes "China" as the People's Republic of China.

In this paper, we test empirically the quantitative importance of access-to-finance obstacles, access to public and private credit, and their interaction, for the determination of the dispersion of distortions. Using a database of around 23,000 firms in 45 economies, we first derive measures of factor market and size distortions from the theoretical framework proposed by Hsieh and Klenow (2009).[1] In this framework, the dispersion of distortions determines the degree of misallocation, and thus TFP losses, at the aggregate level. We then use these distortion measures and, within a regression framework, test the significance of self-declared access-to-finance obstacles as well as the effect of access to a credit line issued by either a government-owned or private bank. Since selection to receive a public and/or private credit line may be endogenous, we instrumentalize these variables. Then, using a factor representation of the regression results, we obtain a decomposition of the contribution of these variables to the dispersion of factor market and size distortions in order to assess whether these variables increased or decreased the dispersion of observed distortions.

Our key results are as follows. Access-to-finance obstacles increase the dispersion of both factor market distortions and size distortions. Private credit also significantly increases the dispersion of both distortions, especially the size distortion. This is an expected result since the existence of informational asymmetries in underdeveloped financial markets can lead to an inefficient allocation of private credit. Public credit, on the other hand, has a very small effect. For firms that do not face financial obstacles, it increases slightly the dispersion of both distortions. For firms that face financial obstacles, it decreases slightly the dispersion, but it is not significant in the case of size distortions. Public credit does not appear to compensate for the distortions that exist in private credit markets. Overall, however, a large part of the dispersion of distortions remains unexplained. Financial variables appear important only in driving the explained part of these distortions and are significant. Quantitatively, they explain too small part of them to be considered as the key drivers of misallocation.

Our study only looks at the effects of these variables through the misallocation channel and not through other direct channels that affect productivity and capital accumulation. Also, we are only looking at the misallocation effects and ignoring the cost of setting up and running government-owned credit institutions and the cost of subsidizing credit through taxes. In this respect, our study uncovers another channel through which credit policies can affect aggregate outcomes. Nevertheless, it is an important one given the potential TFP gains from reallocation. Government-owned credit institutions are common in many emerging markets and imply costly operations. Banks such as the China Development Bank in the People's Republic of China (PRC), the Brazilian Development Bank and Caixa Economica in Brazil,

[1]The total number of economies in the sample is 45. In many of the empirical measures, however, economies are dropped due to the unavailability of certain variables.

Bancoldex in Colombia, and a large number of state-owned banks in India are examples of the proliferation of credit institutions with an important element of government ownership and/or explicit development goals.

A. Related Literature

Our paper is related mainly to two strands of existing literature. On one hand, there is a growing body of theoretical and empirical literature on misallocation. On the other hand, there is a strand of literature analyzing the effects of public credit and development banks. The role of misallocation has been emphasized in the seminal works of Hopenhayn (1992) and Hopenhayn and Rogerson (1993), with further contributions from Banerjee and Duflo (2005); Restuccia and Rogerson (2008); Guner, Ventura, and Xu (2008); and Bartelsman, Haltiwanger, and Scarpetta (2013). An important work for our research is Hsieh and Klenow (2009), which develops a method to measure how distortions at the micro level imply aggregate TFP losses and uses this method to quantify TFP losses in the PRC and India relative to the United States (US). Their findings show that, had the PRC and India had similar levels of misallocation to the US, their TFP would be between 30% and 60% higher, respectively. Kalemli–Ozcan and Sorensen (2012) use a similar approach to ours by investigating the role of access to finance for misallocation in African economies. However, they do not analyze the effect on the dispersion of distortions or focus on the role of private and public credit.

The role of distortions to capital and credit markets in determining misallocation has attracted increasing interest in recent years. Midrigan and Xu (2014) report that the dispersion of the marginal product of capital is of an order of magnitude several times larger than that for the marginal products of labor and intermediate inputs. Furthermore, this dispersion is very persistent, which implies that capital adjustment costs cannot be the sole source of misallocation. Since financial systems channel funds from less to more productive projects, a lack of financial development can hinder TFP. Banerjee and Duflo (2005), for example, provide evidence on the role of credit constraints and other credit market imperfections in misallocation and, hence, productivity differences across economies. However, the literature on the relationship between finance and misallocation is far from settled. Moll (2014) shows that in a simple setting where firms face collateral constraints à la Kiyotaki and Moore (1997), if productivity shocks are persistent, then misallocation losses can be large and disappear only slowly. On the other hand, they are unimportant in steady state. This is because firms facing persistent shocks can use self-financing as a form of insurance against incomplete access to credit markets. Banerjee and Moll (2010) argue, however, that misallocation can still exist in steady state at the extensive rather than intensive margin (through the firm entry and exit channel). Buera, Kaboski, and Shin (2011), using a quantitative model with financial frictions, find that they account for around

50% of TFP gaps between economies. The mechanism is that firms with larger scales of operations are more productive and have more financing needs, thus financial frictions affect them disproportionately. However, Midrigan and Xu (2014), using firm-level data for the Republic of Korea, find that financial frictions have a quantitatively small effect on misallocation. This is consistent with the micro evidence reviewed by Udry (2011), who finds that financial constraints do not play a dominant role in determining misallocation.

Our paper also relates to the literature on the role of public credit and government-owned banks for development. Early empirical literature such as La Porta, Lopez de Silanes, and Shleifer (2002) find a negative effect of public ownership of banks on subsequent productivity growth. Carvalho (2014), using firm-level data for Brazil, finds that public credit is directed to shifting employment toward politically attractive areas before elections. Ribeiro and de Negri (2009), using firm-level data for firms accessing credit from the Brazilian Development Bank, find very limited effects of public credit on TFP levels and growth. Banerjee and Duflo (2014) use a policy change in India that modified eligibility for directed credit and find that public credit was used to expand economic activity rather than substitute for other forms of credit. This is interpreted as evidence that firms were credit constrained before accessing public credit. Eslava, Maffioli, and Meléndez (2014) also find that access to financing from a nontargeted, unsubsidized program of Bancoldex in Colombia had positive effects on employment and investment, especially for long-term lending. Using a heterogeneous-agents model calibrated to the US and Brazil, Antunes, Cavalcanti, and Villamil (2015) find that credit subsidy policies have no effect on output and almost no aggregate effects. Our paper complements this literature by providing a direct empirical analysis of the effect of credit policies on productivity through the misallocation channel for a large number of economies. Our findings are consistent with previous results. Public credit reduces misallocation only for financially constrained firms that face financial obstacles. However, it increases misallocation for the rest and, on aggregate, the total effect is very small.

The rest of the paper is organized as follows. Section II presents the theoretical framework used to derive distortions from the data. Section III discusses the econometric methodology. Section IV presents and describes the data. Section V presents the results. Section VI concludes.

II. Measuring Distortions

In Hsieh and Klenow (2009), misallocation arises as a consequence of distortions or wedges that affect heterogeneous firms in an idiosyncratic manner. These wedges, which are akin to taxes, prevent heterogeneous firms from achieving their optimal size, thereby leading to aggregate TFP losses. Below, we briefly explain the quantitative measures of distortions proposed by Hsieh and Klenow (2009), which we will use later in the empirical analysis.

There are $s = 1, \ldots, S$ sectors and M_s firms within each of the S industries. The total final output in sector $s\,(Y_s)$, is a Dixit–Stiglitz aggregator of the output produced by each firm (Y_{si}):

$$Y_s = \left(\sum_{i=1}^{M_s} Y_{si}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \tag{1}$$

where σ is the elasticity of substitution between varieties. Each firm's production function is given by a Cobb–Douglas aggregator of capital (K) and labor (L), with individual firm's TFP given by A_{si}:[2]

$$Y_{si} = A_{si} K_{si}^{\alpha_s} L_{si}^{1-\alpha_s} \tag{2}$$

There are two distortions or wedges affecting firms. One that affects output or firm size $(\tau_{y,si})$, and another that affects relative factor inputs $(\tau_{k,si})$. Since it is not possible to separately identify wedges that affect capital and labor, we choose to impose the wedge on capital, but this is to be interpreted as a distortion that affects the relative price of capital and labor. As these wedges are firm specific, they will not affect all firms the same way, thus generating differences in capital–labor ratios between firms. With these wedges, the problem of the firm is to choose between K and L to maximize profits (π_{si}):

$$\pi_{si} = \max_{K,L}[(1-\tau_{y,si})P_{si}Y_{si} - wL_{si} - (1+\tau_{k,si})RK_{si}] \tag{3}$$

where P is the price of the final good, w is the wage rate, and R is the rental price of capital. Since factor markets are competitive, all firms face the same factor prices.

Using the first-order conditions for capital and labor, substituting them in the production function and finding the optimal price for each variety yields the standard result that price is a markup over marginal costs: $P_{si} = \frac{\sigma}{1-\sigma}\left(\frac{R}{\alpha_s}\right)^{\alpha}\left(\frac{w}{1-\alpha_s}\right)^{1-\alpha}\frac{(1+\tau_{k,si})^{\alpha}}{A_{si}(1-\tau_{y,si})}$. With this pricing rule, the quantities of labor demanded and the quantity of output produced by each firm are proportional to their individual TFP and the idiosyncratic distortions or wedges they face. In the absence of distortions, firms' relative shares

[2]The Cobb–Douglas assumption is not innocuous. If the elasticity of substitution between capital and labor differs from 1, then the dispersion of the marginal product of capital, and hence the gains from reallocation, can change substantially. The more that capital and labor are substitutes for one another, the more technologically similar they are and the less important relative factor market distortions will be. Recent evidence suggests that this elasticity significantly differs from unity (see, for example, León–Ledesma, McAdam, and Willman 2010, 2015).

of output and labor would just be a function of A_i. The capital–labor ratio is given by

$$\frac{K_{si}}{L_{si}} = \frac{\alpha_s}{1-\alpha_s}\frac{w}{R}\frac{1}{1+\tau_{k,si}} \tag{4}$$

which implies that the idiosyncratic factor market distortion prevents firms from equalizing their capital–labor ratios.

The marginal revenue product of capital is given by $MRPK_{si} = P_{si}MPK_{si}$. Given the definition of MPK, we obtain

$$MRPK_{si} = \alpha_s\frac{\sigma-1}{\sigma}\frac{P_{si}Y_{si}}{K_{si}} = R\frac{1+\tau_{k,si}}{1-\tau_{y,si}} \tag{5}$$

Likewise, TFP revenue (TFPR) is defined as $TFPR_{si} = P_{si}A_{si}$, which, using the definition of prices, yields

$$TFPR_{si} = \frac{\sigma}{\sigma-1}\left(\frac{R}{\alpha_s}\right)^{\alpha_s}\left(\frac{w}{1-\alpha_s}\right)^{1-\alpha_s}\frac{(1+\tau_{k,si})^{\alpha}}{\left(1-\tau_{y,si}\right)} \tag{6}$$

From equations (5) and (6) above, it is clear that, in the absence of distortions, marginal revenue products of capital and $TFPR_{si}$ would equalize across firms. If a firm has a relatively high A_i, it will attract more capital and labor, until its price falls such that its $TFPR_{si}$ equalizes with that of lower productivity firms. Thus, as discussed below, the dispersion of $MRPK_{si}$ and/or $TFPR_{si}$ is a measure of idiosyncratic distortions affecting firm sizes.

It is also possible to obtain independent measures of size and factor market distortions, which are the ones we will work with as they allow us to separate the effects of access to finance and public credit by type of distortion. From equation (4), we get

$$1+\tau_{k,si} = \frac{\alpha_s}{1-\alpha_s}\frac{wL_{si}}{RK_{si}} \tag{7}$$

and combining this with (5), we find

$$1-\tau_{y,si} = \frac{\sigma}{\sigma-1}\frac{wL_{si}}{(1-\alpha_s)\,P_{si}Y_{si}} \tag{8}$$

Thus, the factor market distortion measures the firm's relative cost share of labor and capital relative to that for the sector represented by $\alpha_s/(1-\alpha_s)$. The size distortion measures the cost share of labor for the firm relative to that for the sector given by $(1-\alpha_s)$.

What we observe in the data are the $MRPK_{si}$ and $TFPR_{si}$ (and not the MPK_{si} and TFP_{si}) for every firm as we do not observe individual firm prices. This is why Hsieh and Klenow (2009) make an assumption about market structure to infer prices as a function of firm productivity and distortions.

Aggregate TFP in any sector s is defined as TFPR over aggregate prices. Using the final product aggregator, we obtain

$$TFP_s = \frac{TFPR_s}{P_s} = \left[\sum_{i=1}^{M_s} \left(A_{si} \frac{\overline{TFPR_s}}{TFPR_{si}} \right)^{\sigma-1} \right]^{\frac{1}{\sigma-1}} \tag{9}$$

where $\overline{TFPR}$ is the weighted average of TFPR for all firms in the sector. If all firms were the same (no heterogeneity), the ratio in brackets would disappear. At this point, sectoral (and aggregate) TFP is maximized.[3] That is, aggregate TFP is maximized when there is no dispersion in $TFPR_{si}$. Since by equation (6) the dispersion of TFPR is driven by the dispersion of distortions, then zero dispersion in both factor market and size distortions would imply maximum sectoral TFP.

III. Methodology

Our aim is to uncover the effect of financial access and access to public and private credit on the two measures of firm-level distortions derived from the model used by Hsieh and Klenow (2009): $\log(1 + \tau_{k,si})$, and $\log(1 - \tau_{y,si})$.[4] Since misallocation depends on the distribution of these measures, we are also interested in uncovering the effect of these variables on their dispersion. To do so, we proceed as follows. We first regress the two measures of distortions on variables measuring financial access, variables measuring access to public credit and private credit, and a set of controls. We will also interact the credit variables with the access-to-finance variables to show whether public and private credit have a different effect for firms that face financial access difficulties. If these variables are not important in affecting the distribution of distortions, they will not be significant. In order to measure whether the different variables increase or decrease the dispersion of distortions, we then use a Fields (2003) decomposition, which we explain below in more detail. This decomposition also allows us to understand better the role of financial variables as some coefficients are not directly interpretable in the initial regressions when we use an instrumental variables approach.

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[3] In Hsieh and Klenow (2009), the final economy's output is a Cobb–Douglas aggregator of sectoral outputs $Y = \prod_S Y_s^{\theta_S}$, where θ_S represents sector shares.

[4] In equation (12), we ignore the first term driven by the demand elasticity for the different varieties as it drops as a constant.

Specifically, for the more general case with interaction terms, we run the following cross-sectional regression:

$$\log D_i = \beta_0 + \beta_1 FA_i + \beta_2 PUB_i + \beta_3 PRIV_i + \beta_4 FA_i \times PUB_i + \beta_5 FA_i \times PRIV_i + X_i B + \varepsilon_i \quad (10)$$

where D_i represents the distortion of interest; FA_i is a self-reported financial access difficulty binary variable taking the value of 1 if the firm faces financial obstacles and zero otherwise; PUB_i is a binary variable taking the value of 1 if the firm has access to public credit and zero otherwise; $PRIV_i$ is, similarly, a binary variable for private credit; and X_i is a vector of control variables that includes economy and sector dummies, and other variables.[5] The coefficients β_1 to β_3 give us the direct effect of financial variables, while β_4 and β_5 show how the effect of public and private credit changes when the firm faces financial obstacles. A positive coefficient for the factor market distortion implies that the wedge increases for capital relative to labor. For the size distortion, a positive coefficient implies that the variable reduces the wedge and acts as a size subsidy in the sense that the firm's labor share is higher than the average for its sector. Financial constraints can have either positive or negative effects on size distortions depending on how they affect the activities of the firm. Financial constraints may lead to lower labor costs if firms need working capital to pay wages, or to higher costs if they distort the relative use of capital and labor in the firm given an elasticity of substitution between them.

As explained above, if these variables appear to be significant, then they are drivers of misallocation. However, looking at the coefficients by themselves does not inform us whether these variables lead to an increase or a decrease in the dispersion of distortions. To do so, we look at the Fields (2003) decomposition, which is based on previous contributions by Shorrocks (1982). This decomposition has been used widely in the labor literature to analyze the dispersion of outcome variables such as wages and earnings that can be explained by regressor variables such as education, age, and gender. In our case, we analyze the effect of the different financial variables on the dispersion of the explained part of distortions. We can estimate equation (10) by using ordinary least squares (OLS) or instrumental variable (IV). The resulting predicted distortion can be written as a factor model:

$$\log \widehat{D_i} = \beta_0 + \hat{z}_1 + \hat{z}_2 + \cdots + \hat{z}_k \quad (11)$$

where a hat over a variable denotes its predicted value and $\hat{z}_j = \hat{\beta}_j X_j$ for $j = 1, \ldots,$ k regressors. The Fields (2003) decomposition exploits this factor structure to study the effect of the composite variables $\hat{z}_j$ on the dispersion of the explained part of the

[5]We also experimented using year dummies to control for the year the survey was implemented. The results, however, were not affected by their inclusion.

distortion. That is, it will tell us the percentage increase or decrease in the dispersion of the predicted distortion that is explained by each of the regressors. This allows us to assess the effect of financial variables on misallocation directly.

The main problem with estimating equation (10) by OLS is that access to public or private credit may not be an exogenous treatment. Receiving credit from both types of institutions may depend on unobserved factors that also affect observed distortions, leading to correlation between the credit variables and the error term. For this reason, we also run regressions instrumentalizing both the PUB_i and $PRIV_i$ binary variables.[6] In order to do so, we first run a probit model where we project the variables on a set of instruments plus the controls. We cannot, however, use the fitted values of this regression on a second stage due to the problem of "forbidden regression" as explained by Angrist and Pischke (2009). This happens because the conditional expectation function of the first stage is nonlinear. To get around this problem, we follow Wooldridge (2010) and proceed using the following steps:

(i) Estimate a probit of the determinants of the credit variables using a set of instruments h_i and the control variables X_i. Obtain the fitted values $\widehat{P_i}$.

(ii) Regress P_i on $\widehat{P_i}$ and the control variables X_i, not on the instruments. Obtain the second-stage fitted values $\widehat{\widehat{P}}$.

(iii) Regress D_i on X_i and the second-stage fitted values $\widehat{\widehat{P_i}}$.

Since $\widehat{\widehat{P}}$ now comes from an OLS regression, the problem of the nonlinear conditional expectation function has been eliminated. In our case, however, we also have interaction terms between FA_i and the two instrumentalized credit variables. Interaction variables also suffer from the same forbidden regression problem mentioned above. In order to address this, we follow a similar procedure. We run a first-stage probit and obtain $\widehat{P_i}$. We then calculate $\widehat{P_i} \times FA_i$. We regress $P_i \times FA_i$ on $\widehat{P_i} \times FA_i$ and the exogenous controls to obtain $\widehat{\widehat{P_i} \times FA_i}$. We then regress the distortion variables on $\widehat{\widehat{P_i}}$, $\widehat{\widehat{P_i} \times FA_i}$, and the other controls. This gives us consistent standard errors and unbiased estimates and allows us to carry out the Fields (2003) decomposition. The coefficients on the instrumentalized variables cannot be interpreted the same way as the coefficients of the original binary variables since they are now continuous. However, the decomposition of the dispersion of the distortions still has the same interpretation. This is the added advantage of this decomposition.

[6] The financial access variable is a self-declared variable in the survey. Since there is no a priori reason for firms to declare financial access difficulties to surveyors, we believe it is safe to treat it as exogenous.

IV. Data and Descriptive Statistics

We use firm-level survey data from the World Bank's Enterprise Surveys for the period 2006–2014. This is a stratified survey of firms containing financial and business environment information. The data are purely cross-sectional. Some economies have been surveyed more than once during the review period, so we keep the data for the survey year with more available observations in order not to bias the results by weighting some economies twice. The original data contains results from 134 surveys and a total of 61,669 firms. However, this number was considerably reduced in the data-cleaning process (described below) and because of the lack of availability of some of the credit variables required in the analysis. Since we do not have price data for each firm, we are working with revenue-based measures as discussed in the model used by Hsieh and Klenow (2009). Data are in local currency units for the survey year. We do not transform them into a common currency since the measures we use are ratios and shares rather than absolute values. We calculate the variables of interest as follows:

(i) Output is measured as value added (VA). This is calculated as total annual sales minus the cost of raw materials and intermediate goods.

(ii) The number of workers (L) is the total number of full-time employees adjusted for temporary workers.

(iii) Capital (K) is defined as the net book value of machinery, equipment, land, and buildings.

(iv) Total wage bill (WTOT) corresponds to total wages, salaries, and bonuses paid.

(v) Labor productivity is VA/L.

We drop firms for which either VA, K, or WTOT are negative. We are then left with 23,023 firms and 45 economies. We also dropped any economy for which there are less than 150 firms in the sample. In many of the specifications used below, however, the lack of availability of some of the credit variables and variables used as instruments in the first-stage probit regressions leaves us with approximately 14,800 firms.

Table 1 presents the list of economies, the number of firms, and their distribution by size when we use the sample of 23,023 firms for 45 economies. Size is defined as "small" for firms with fewer than 20 employees, "medium" for firms with between 20 and 99 employees, and "large" for firms with more than 100

Table 1. **Number of Firms and Size Distribution**

		Distribution by Number of Employees (ratio)					**Distribution by Number of Employees (ratio)**		
	No.	**Small (<20)**	**Medium (20−100)**	**Large (>100)**		**No.**	**Small (<20)**	**Medium (20−100)**	**Large (>100)**
Angola	173	0.85	0.13	0.02	Mali	247	0.79	0.19	0.02
Argentina	532	0.25	0.40	0.35	Mexico	965	0.33	0.34	0.33
Bangladesh	1,039	0.28	0.38	0.35	Mozambique	272	0.63	0.31	0.06
Bolivia	198	0.47	0.37	0.15	Nepal	172	0.32	0.47	0.21
Brazil	925	0.34	0.45	0.21	Nicaragua	197	0.59	0.34	0.07
Bulgaria	362	0.31	0.47	0.22	Nigeria	875	0.68	0.28	0.04
Chile	572	0.30	0.41	0.30	Peru	472	0.24	0.40	0.36
PRC	1,327	0.13	0.43	0.44	Philippines	401	0.22	0.47	0.31
Colombia	545	0.33	0.36	0.31	Russian Federation	438	0.36	0.41	0.23
Costa Rica	172	0.34	0.44	0.22					
Croatia	209	0.34	0.33	0.33	Senegal	209	0.76	0.17	0.07
Ecuador	222	0.41	0.37	0.22	South Africa	644	0.34	0.40	0.26
Egypt	1,299	0.38	0.40	0.22	Sri Lanka	231	0.51	0.29	0.20
El Salvador	282	0.35	0.37	0.28	Sweden	228	0.28	0.52	0.21
Ghana	261	0.64	0.26	0.11	Tanzania	236	0.49	0.35	0.17
Guatemala	244	0.40	0.37	0.23	Tunisia	265	0.18	0.45	0.37
Honduras	184	0.52	0.30	0.18	Turkey	424	0.23	0.41	0.36
India	4,586	0.29	0.46	0.25	Uganda	253	0.58	0.35	0.07
Indonesia	536	0.46	0.29	0.25	Ukraine	245	0.47	0.35	0.18
Iraq	452	0.76	0.23	0.01	Uruguay	159	0.45	0.45	0.10
Jordan	234	0.39	0.33	0.28	Viet Nam	595	0.14	0.41	0.45
Kenya	208	0.27	0.38	0.36	Zambia	279	0.46	0.37	0.17
Lao PDR	311	0.47	0.36	0.17	Zimbabwe	343	0.35	0.38	0.27
					Total	**23,023**	**0.36**	**0.39**	**0.25**

Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Authors' compilation.

employees. There are nine Asian economies in the sample. The sample is dominated by Bangladesh, the PRC, Egypt, and India. While the sample mainly comprises small and medium firms, large firms represent a sizable 25% of the total. Given the prevalence of small firms in these economies, large firms may be overrepresented. The World Bank argues that this is the case since larger firms tend to have a larger impact on employment creation.

The credit and access-to-finance variables also come from the surveys. Firms were asked to answer the following question: "How much of an obstacle is financial access for the operation of the firm?" Firms then choose between "no obstacle," "minor obstacle," "moderate obstacle," "major obstacle," and "very severe obstacle." We translate these into a numeric, binomial variable taking the value of zero for no obstacle, minor, and moderate obstacle; and 1 for major and very severe obstacle. We also do a robustness check by classifying moderate obstacle as 1 rather than zero. This variable is used as a measure of financial access obstacles (FA_i), which will then be interacted with indicators of the type of credit available.

Firms were also asked whether they currently have a line of credit. If so, they were asked the following question: "Is this credit provided by a state-owned bank or a private credit bank?" We use these variables as a proxy for access to public and private credit, which are our PUB_i and $PRIV_i$ variables, respectively. Ideally, such variable should account for the amount of the firm's capital financed by both types of institutions. However, this measure is only available for a very small number of firms. Thus, this variable is taken as a proxy for being able to access either type of credit. The variables public credit (PUB_i) and private credit ($PRIV_i$) are binary variables that take the value of 1 if firms have access to a public or a private line of credit and zero otherwise.

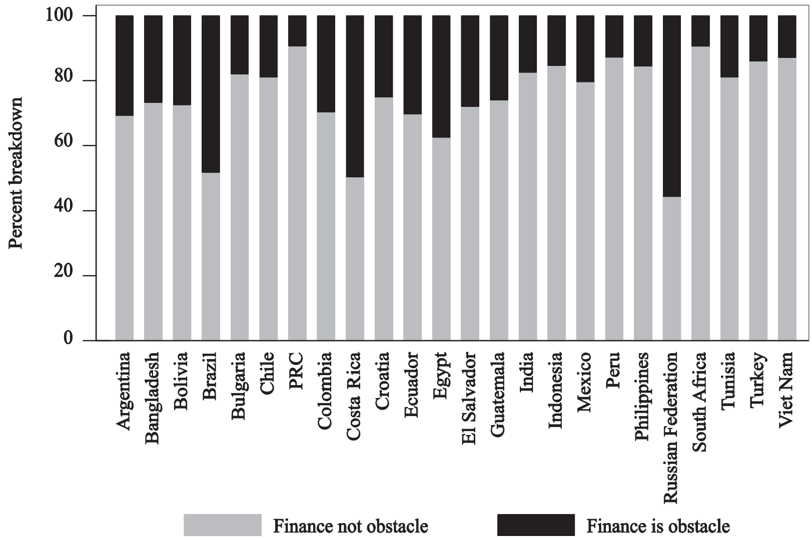
We also use a set of control variables related to other types of obstacles to the operation of firms. These obstacles are measured as binary variables just like the access-to-credit variable. These obstacles can be classified into the following categories: infrastructure (transportation, electricity); goods markets (trade regulations, informal sector); taxation and licensing; insecurity (political instability, corruption, theft, corruption, and courts); and labor markets (regulations and skill inadequacy). These obstacles can affect the optimal size of firms, and hence the dispersion of their marginal products, and can affect different firms heterogeneously and act as wedges that prevent firms from growing to their optimal size.[7]

Finally, we make use of a set of instruments for the first stage of the IV regressions. These include (i) a set of five dummies for the size of the city where the firm operates (each dummy takes the value of 1 for a particular population size range), (ii) the percentage of foreign ownership of the firm, and (iii) the percentage of sales of the firm going to foreign markets. We also experimented with other potential instruments including firm age, legal status of the firm, and percentage of capital held by the main owner of the firm, among others. However, none of these appeared to be significant in the first stage. We will explain below the instruments used for each of the public and private credit binary variables.

Figure 1 shows the percentage of firms in each economy that declare that finance is an obstacle. The economies where firms most commonly declare financial access problems are mainly African economies with a lower level of financial development, followed by mainly Latin American economies. In economies like the PRC and India, the share declaring financial access problems is much lower, which is generally also true for all other Asian economies in the sample with the exception of Bangladesh and Nepal. Figure 2 shows the shares of firms in each economy that receive a credit line from either public or private institutions. The sum of PUB_i and $PRIV_i$ does not cover all firms in the sample since a sizable proportion of them do not have a credit line. The PRC, India, the Lao People's Democratic Republic, and Viet Nam are the economies with the largest shares of firms with access to public credit lines. In general, Asian economies tend to have

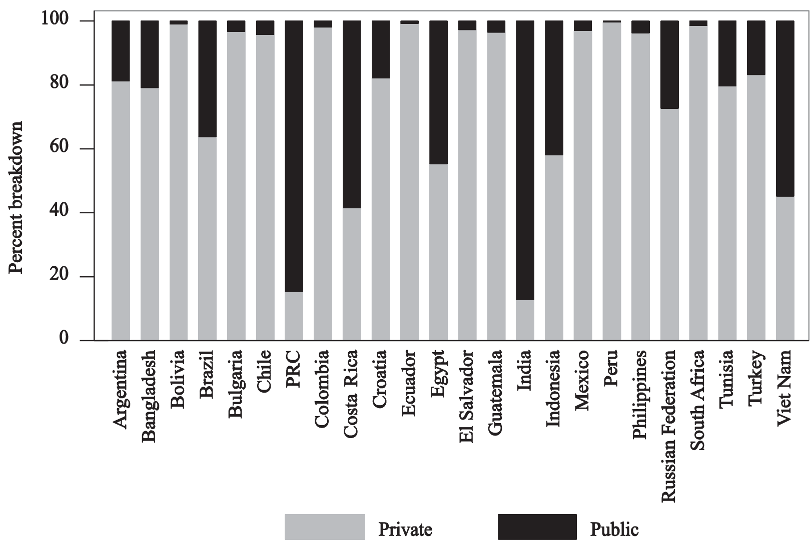
[7]See León–Ledesma (2016) for a detailed analysis of the role of these obstacles in driving misallocation.

Figure 1. **Percentage of Firms Declaring Finance is an Obstacle to Operations**



PRC = People's Republic of China.
Source: Authors' calculations based on data from World Bank. Enterprise Surveys and Indicator Surveys Sampling Methodology. www.enterprisesurveys.org

Figure 2. **Percentage of Firms Receiving Loan from Public Institutions**



PRC = People's Republic of China.
Source: Authors' calculations based on data from World Bank. Enterprise Surveys and Indicator Surveys Sampling Methodology. www.enterprisesurveys.org

a larger proportion of firms with access to public credit, which is consistent with the presence of directed credit institutions. Outside this group, economies such as Brazil, Egypt, and Russian Federation have a large proportion of firms with access to public credit as well, which is (again) consistent with the existence of state-owned lenders in the market.

Table 2 shows the distribution of public credit by firm size in each economy.[8] On average, it appears that public credit is slightly biased toward medium and large firms, and against small firms, when compared to the distribution of all firms in Table 1. This varies substantially by economy, but it is evident for large economies with an important element of public lending such as the PRC, India, and Russian Federation. For economies with a low prevalence of public credit lines, all public credit appears concentrated in a single size category.

Table 3 shows how the three possible credit outcomes (public, private, or no credit) are distributed in each economy for firms that face financial obstacles and those that do not. It is quite striking that, on average, the proportions are almost the same for both categories of firms. Neither public nor private credit appears to be more prevalent for firms that do not face financial obstacles. Of course, this result compounds demand and supply effects, so we cannot extract meaningful structural interpretations. Interestingly, this appears to be the case for most economies in the sample.

V. Results

We now proceed to analyze the regression results. The dependent variables measuring distortions were calculated in equations (7) and (8) and then logged. To calculate α_s, we averaged the capital share for firms by economy and sector, and trimmed the upper and lower 5% to smooth out the effect of outliers. Unfortunately, we only know a firm's sector at a high level of aggregation; there are a total of 15 sectors for both industry and services, with agricultural firms being excluded. Although it would be desirable to obtain capital shares for a larger number of sectors to obtain measures of misallocation, this will not affect the regression results as we include sector dummies that capture sector fixed effects. We then obtain the standard deviation of the two distortions for each sector and average them by economy. The average results for all economies are displayed in Table 4. The results show a high level of dispersion for both measures. Consistent with other studies—such as Hsieh and Klenow (2009) and Ha, Kiyota, and Yamanouchi (2016)—the factor market distortion is larger than the size distortion. There is also wide variability between economies. Angola displays the lowest size distortion and the Philippines displays the largest. For factor market distortions, South Africa displays the lowest and Sri Lanka displays the largest dispersions.

[8]There are only 39 economies out of the 45-economy sample for which public credit information is available.

Table 2. **Size Distribution of Firms Receiving Public Credit**

	Size Distribution by Number of Employees		
	Small (<20)	**Medium (20–100)**	**Large (>100)**
Argentina	16%	44%	41%
Bangladesh	23%	40%	36%
Bolivia	100%	0%	0%
Brazil	37%	44%	19%
Bulgaria	20%	60%	20%
Chile	42%	32%	26%
PRC	4%	35%	61%
Colombia	25%	63%	13%
Costa Rica	35%	58%	6%
Croatia	26%	26%	48%
Ecuador	0%	100%	0%
Egypt	29%	39%	32%
El Salvador	60%	20%	20%
Ghana	32%	37%	32%
Guatemala	50%	50%	0%
Honduras	100%	0%	0%
India	23%	49%	28%
Indonesia	35%	29%	36%
Iraq	70%	20%	10%
Kenya	13%	38%	50%
Lao PDR	38%	38%	24%
Mali	0%	100%	0%
Mexico	64%	29%	7%
Mozambique	0%	100%	0%
Nepal	45%	45%	9%
Peru	100%	0%	0%
Philippines	33%	67%	0%
Russian Federation	18%	42%	40%
South Africa	0%	0%	100%
Sri Lanka	46%	21%	33%
Sweden	50%	33%	17%
Tanzania	45%	27%	27%
Tunisia	20%	43%	37%
Turkey	25%	60%	15%
Ukraine	33%	33%	33%
Uruguay	42%	46%	13%
Viet Nam	12%	38%	50%
Zambia	29%	43%	29%
Zimbabwe	33%	33%	33%
Total	**23%**	**44%**	**33%**

Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Authors' compilation.

The results of the regression analysis are presented in Tables 5 and 6 for τ_k and τ_y, respectively. We use as controls the economy and sector dummies, as well as a set of other binary obstacle variables that were explained in the previous section. The tables present the results with and without interaction terms for the OLS and IV regressions.

Table 3. **Allocation of Public and Private Loans by Financial Obstacles**

	If credit is an obstacle, do you have. . .?			If credit is not an obstacle, do you have. . .?		
	Private Credit	**Public Credit**	**No Credit**	**Private Credit**	**Public Credit**	**No Credit**
Angola	4%	0%	96%	0%	0%	100%
Argentina	46%	11%	43%	56%	12%	32%
Bangladesh	35%	14%	52%	37%	8%	55%
Bolivia	53%	0%	47%	55%	1%	44%
Brazil	42%	23%	36%	44%	26%	30%
Bulgaria	46%	0%	54%	41%	2%	57%
Chile	74%	3%	23%	77%	3%	19%
PRC	7%	58%	36%	5%	25%	71%
Colombia	72%	2%	26%	78%	1%	21%
Costa Rica	24%	39%	37%	27%	33%	40%
Croatia	69%	17%	14%	57%	12%	31%
Ecuador	64%	0%	36%	56%	1%	44%
Egypt	6%	8%	86%	6%	3%	91%
El Salvador	59%	5%	36%	68%	1%	32%
Ghana	11%	6%	83%	9%	11%	80%
Guatemala	48%	2%	50%	46%	2%	52%
Honduras	48%	0%	52%	51%	1%	47%
India	4%	35%	61%	4%	28%	68%
Indonesia	17%	17%	66%	19%	13%	68%
Iraq	3%	2%	95%	2%	2%	95%
Jordan	19%	0%	81%	30%	0%	70%
Kenya	43%	4%	52%	43%	4%	54%
Lao PDR	15%	25%	60%	3%	6%	91%
Mali	2%	1%	97%	7%	2%	91%
Mexico	44%	2%	54%	51%	1%	48%
Mozambique	7%	1%	92%	8%	0%	92%
Nepal	39%	15%	46%	31%	3%	67%
Nicaragua	31%	0%	69%	37%	0%	63%
Peru	72%	1%	26%	87%	0%	13%
Philippines	51%	2%	47%	37%	1%	61%
Russian Federation	23%	12%	65%	20%	11%	69%
Senegal	13%	0%	87%	10%	0%	90%
South Africa	22%	0%	78%	34%	1%	65%
Sri Lanka	31%	11%	58%	32%	10%	58%
Sweden	33%	0%	67%	27%	3%	70%
Tanzania	18%	5%	76%	19%	4%	77%
Tunisia	45%	15%	40%	44%	11%	45%
Turkey	69%	12%	18%	55%	11%	34%
Uganda	13%	0%	87%	20%	0%	80%
Ukraine	15%	0%	85%	20%	2%	78%
Uruguay	33%	21%	47%	35%	13%	52%
Viet Nam	30%	30%	40%	31%	38%	32%
Zambia	15%	2%	83%	13%	3%	85%
Zimbabwe	18%	1%	81%	9%	1%	90%
Total	**26%**	**12%**	**62%**	**27%**	**13%**	**60%**

Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Authors' compilation.

Table 4. **Misallocation Measures: Dispersion of Distortions**

Variable	Mean	Standard Deviation	Min	Max
StDev(τ_y)	0.902	0.184	0.478	1.255
StDev(τ_k)	1.252	0.190	0.843	1.604

Source: Authors' calculations.

The instruments used for the first-stage probit for the public credit variable are as follows. First, a set of dummies is created for the city in which the firm is located, taking the value of 1 for a particular city size and zero otherwise. The sizes are "capital city," "more than 1 million," "between 250,000 and 1 million," "between 50,000 and 250,000," and "less than 50,000." The second instrument used is a variable measuring the percentage of foreign ownership in the firm. Finally, we use the rest of the control variables included in the regression. The set of city dummies are undoubtedly exogenous and unlikely to be correlated with determinants of distortions other than access to infrastructure, which we control for. We would also expect foreign ownership to reduce access to public credit as local firms are normally given preferential treatment.

For the first-stage probit for the private credit variable, we use the same city-size dummies plus a variable measuring the percentage of sales going to international markets (exports). It is likely that firms located closer to financial centers and with more diversified and/or larger markets (exporters) will have better access to private credit. Our first-stage probits, which are available upon request, show that all the instruments are significant, the sign of their coefficients are as expected, and the regression is well behaved in general. We also experimented with a wider set of instruments, but their correlation with the endogenous variables proved to be too weak to identify a causal effect.

The results in Table 5 show that several variables are significant drivers of the factor market distortion τ_k. This is especially the case for our finance-related variables. The first result is that financial obstacles appear to increase the relative cost of capital by close to 18% in all specifications as expected. This is also a very significant effect. In the OLS regressions, access to both private and public loans appears to significantly reduce the distortion. The interaction term appears to be insignificant for private credit but significant for public credit. The negative effect of public credit on the distortion appears to be stronger for firms that face financial obstacles than for those that do not. However, as seen in Table 3, the distribution of public credit does not appear to change significantly between these two types of firms. Therefore, the total effect on the distribution of the distortion can only be inferred from the Fields (2003) decomposition. The IV regressions, however, tell a slightly different story. The interpretation of the public and private loan variables cannot be done the same way since the variables are now continuous. In the specification with no interactions, having access to a private credit line reduces the distortion, while the effect of the public credit variable is not significant. The interaction variables

Table 5. **Regression Results for Factor Market Distortions (τ_k)**

	OLS Regressions		IV Regressions	
	(1)	**(2)**	**(3)**	**(4)**
Access to finance	0.184*	0.206*	0.175*	0.175**
	(7.36)	(6.68)	(6.27)	(3.13)
Private loan (yes = 1)	−0.120*	−0.125*	−2.418*	−2.540*
	(−4.30)	(−3.97)	(−4.51)	(−4.71)
Public loan (yes = 1)	−0.113*	−0.0693***	0.497	0.608***
	(−3.66)	(−2.11)	(1.82)	(2.20)
Access to finance × Private loan		0.00938		0.234***
		(0.18)		(2.00)
Access to finance × Public loan		−0.200**		−0.415***
		(−2.70)		(−2.16)
Electricity	−0.0335	−0.0334	−0.0186	−0.0186
	(−1.40)	(−1.40)	(−0.71)	(−0.72)
Transportation	−0.0231	−0.0231	0.00365	0.00375
	(−0.82)	(−0.82)	(0.11)	(0.11)
Customs and trade regulations	−0.0982**	−0.0972**	0.0131	0.0158
	(−2.97)	(−2.94)	(0.29)	(0.35)
Informal sector	0.0679**	0.0675**	0.0364	0.0359
	(2.69)	(2.68)	(1.32)	(1.30)
Access to land	0.00510	0.00663	−0.0754***	−0.0665
	(0.17)	(0.22)	(−2.17)	(−1.91)
Crime, theft	−0.0367	−0.0372	−0.0622	−0.0641
	(−1.18)	(−1.19)	(−1.77)	(−1.82)
Tax rates	−0.0465	−0.0468	−0.0659***	−0.0670***
	(−1.85)	(−1.86)	(−2.25)	(−2.29)
Tax administration	0.0525	0.0530	0.0805***	0.0830***
	(1.77)	(1.78)	(2.35)	(2.42)
Business licensing	−0.0326	−0.0327	−0.0927***	−0.0917***
	(−1.06)	(−1.06)	(−2.50)	(−2.47)
Political instability	0.0176	0.0183	−0.0190	−0.0175
	(0.59)	(0.61)	(−0.59)	(−0.54)
Corruption	−0.0371	−0.0380	−0.0184	−0.0186
	(−1.44)	(−1.47)	(−0.60)	(−0.61)
Courts	0.0808***	0.0810***	0.0875***	0.0826***
	(2.45)	(2.45)	(2.31)	(2.18)
Labor regulations	0.0178	0.0181	0.105**	0.104**
	(0.54)	(0.55)	(2.79)	(2.75)
Inadequate education workers	0.0328	0.0321	0.110**	0.108**
	(1.12)	(1.10)	(3.10)	(3.04)
Country dummies	YES	YES	YES	YES
Sector dummies	YES	YES	YES	YES
Constant	−0.539***	−0.547***	0.0451	0.0577
	(−2.03)	(−2.05)	(0.24)	(0.31)
N	18,025	18,025	14,828	14,828
R^2	0.014	0.015	0.013	0.014

IV = instrumental variable, OLS = ordinary least squares.
Notes: *** = 10% level of significance, ** = 5% level of significance, * = 1% level of significance. t statistics in parentheses. Heteroscedasticity-consistent standard errors. See text for the IV procedure implemented using a first-stage probit for public and private credit.
Source: Authors' calculations.

Table 6. **Regression Results for Factor Market Distortions (τ_y)**

	OLS Regressions		IV Regressions	
	(1)	**(2)**	**(3)**	**(4)**
Access to finance	0.133*	0.146*	0.125*	0.104***
	(7.27)	(6.58)	(6.08)	(2.51)
Private loan (yes = 1)	−0.083*	−0.086*	−1.720*	−1.802*
	(−3.97)	(−3.70)	(−4.35)	(−4.54)
Public loan (yes = 1)	−0.0728**	−0.0455	0.326	0.367
	(−3.11)	(−1.85)	(1.63)	(1.80)
Access to finance × Private loan		0.00946		0.166
		(0.25)		(1.93)
Access to finance × Public loan		−0.126***		−0.152
		(−2.18)		(−1.07)
Electricity	−0.0220	−0.0220	−0.0128	−0.0129
	(−1.25)	(−1.25)	(−0.67)	(−0.67)
Transportation	−0.00757	−0.00755	0.0186	0.0188
	(−0.37)	(−0.37)	(0.75)	(0.76)
Customs and trade regulations	−0.0716**	−0.0710**	0.00625	0.00707
	(−2.87)	(−2.85)	(0.19)	(0.21)
Informal sector	0.0453***	0.0451***	0.0224	0.0224
	(2.50)	(2.49)	(1.11)	(1.11)
Access to land	0.00463	0.00567	−0.0537***	−0.0480
	(0.21)	(0.26)	(−2.10)	(−1.87)
Crime, theft	−0.0325	−0.0328	−0.0530***	−0.0538***
	(−1.40)	(−1.42)	(−2.04)	(−2.08)
Tax rates	−0.0221	−0.0223	−0.0376	−0.0384
	(−1.17)	(−1.17)	(−1.75)	(−1.78)
Tax administration	0.0346	0.0349	0.0520***	0.0531***
	(1.55)	(1.57)	(2.06)	(2.10)
Business licensing	−0.0293	−0.0293	−0.0737**	−0.0728**
	(−1.27)	(−1.27)	(−2.70)	(−2.67)
Political instability	0.00970	0.0101	−0.0188	−0.0185
	(0.42)	(0.44)	(−0.79)	(−0.78)
Corruption	−0.0362	−0.0367	−0.0192	−0.0187
	(−1.89)	(−1.92)	(−0.86)	(−0.83)
Courts	0.0694**	0.0695**	0.0739**	0.0707***
	(2.86)	(2.86)	(2.65)	(2.54)
Labor regulations	0.0125	0.0126	0.0728**	0.0718**
	(0.51)	(0.52)	(2.63)	(2.59)
Inadequate education workers	0.0264	0.0259	0.0784**	0.0773**
	(1.21)	(1.19)	(3.01)	(2.96)
Country dummies	YES	YES	YES	YES
Sector dummies	YES	YES	YES	YES
Constant	−0.379***	−0.383***	−0.05	−0.04
	(−2.20)	(−2.22)	(−0.39)	(−0.30)
N	18,027	18,027	14,828	14,828
R^2	0.02	0.02	0.02	0.02

IV = instrumental variable, OLS = ordinary least squares.
Notes: *** = 10% level of significance, ** = 5% level of significance, * = 1% level of significance. t statistics in parentheses. Heteroscedasticity-consistent standard errors. See text for the IV procedure implemented using a first-stage probit for public and private credit.
Source: Authors' calculations.

in column (4) show that public credit now reduces the distortion for firms that face financial obstacles. The total effect for these firms is, however, still negative. For private loans, the effect is the opposite; it reduces the distortion more for firms that do not report financial obstacles. Overall, the regression is jointly significant. However, the variables explain only a small part of the variation of the endogenous variable as shown by the R^2 coefficient.

For the size distortion, the results are presented in Table 6. Lack of access to finance acts as a size subsidy in the sense that it increases the cost share of labor in value added. This, however, may well be the consequence of a lack of access to finance leading to higher labor intensity due to a lack of access to capital. Public and private credit have the opposite effects as were expected from the OLS regressions. The significant result for the public credit variable disappears when we introduce the interaction with financial access in the IV regressions. However, in the OLS regression, access to a public loan for firms that face financial difficulties has a significantly negative effect; it acts as a size tax. Turning to the IV regressions, the only variable that appears to be significant is access to private credit, which reduces the cost share of labor. Public credit has a positive effect, but it is not significantly different from zero. The interaction terms are not significant either. Hence, being the recipient of a public or a private loan when the firm faces financial obstacles does not appear to be significantly different from when they do not face financial obstacles. Overall, the results are not very conclusive beyond the fact that obstacles to finance and accessing a private loan are significant drivers of size distortions.

Finally, we turn to the Fields (2003) decompositions for both distortions in Tables 7 and 8. The results show the percentage of the explained part of the dispersion of distortions to which each variable contributes. This contribution can be positive if the variable increases the dispersion of the distortion, or negative if it reduces it. These results should be seen in conjunction with the regression results to analyze whether these effects are significant. The sum of the contributions of the variables, including economy and sector dummies, is 100 as we are looking at the explained part. We focus here on the IV regression results in columns (3) and (4), although we also present the results from the OLS regressions.

For the factor market distortion, all obstacles explain almost half of the dispersion of the distortion, the other half is explained mainly by economy dummies. Of the obstacles, the main driver is access to finance. Financial obstacles increase the dispersion of τ_k, leading to misallocation. Being the recipient of a public loan has a small positive effect on dispersion as well. For firms facing financial obstacles, the effect is negative. However, the magnitude of the effect is very small in comparison with not having a loan. For private loans, the effect is positive. The effect of having a private loan for firms that face financial obstacles is positive and sizable. Private loans appear to increase the dispersion of the distortion, thus their allocation across firms increases allocative inefficiency. This is indicative of possible distortions in private credit markets. Public credit, which is designed to allow firms with viable investment

Table 7. **Contribution of Variables to the Explained Dispersion of τ_k (%)**

	OLS Regressions		**IV Regressions**	
	(1)	**(2)**	**(3)**	**(4)**
Access to finance	24.36	26.35	21.68	20.37
Private loan (yes = 1)	7.45	7.47	7.97	7.86
Public loan (yes = 1)	3.55	2.11	0.20	0.23
Access to finance × Private loan		0.20		8.89
Access to finance × Public loan		1.59		−3.70
Electricity	0.48	0.46	0.23	0.22
Transportation	0.13	0.12	−0.04	−0.04
Customs and trade regulations	3.40	3.26	−0.51	−0.57
Informal sector	4.00	3.85	1.73	1.60
Access to land	0.10	0.12	−0.12	−0.10
Crime, theft	0.15	0.15	0.62	0.60
Tax rates	0.98	0.95	1.80	1.72
Tax administration	0.89	0.87	0.81	0.79
Business licensing	0.19	0.18	1.51	1.40
Political instability	−0.35	−0.35	0.47	0.40
Corruption	0.40	0.39	0.36	0.34
Courts	2.55	2.47	3.70	3.28
Labor regulations	0.29	0.28	2.07	1.92
Inadequate education workers	0.73	0.70	2.25	2.07
All obstacles	49.29	51.19	44.74	47.26
Country dummies	48.17	46.41	55.50	53.14
Sector dummies	2.54	2.40	−0.24	−0.41
Total	**100**	**100**	**100**	**100**

IV = instrumental variable, OLS = ordinary least squares.
Source: Authors' calculations.

projects to bypass financial constraints, only reduces the allocative inefficiency of factors of production by a small amount for all firms. It even increases it marginally for firms that do not report facing financial obstacles. Overall, however, the role of public credit in improving aggregate TFP through improved allocation of capital and labor is almost negligible.

A very similar picture arises from the decomposition of τ_y. In this case, access to finance has a smaller effect, and it is being a recipient of a private loan that seems to dominate by increasing substantially the dispersion of the size distortion. Public credit also increases this dispersion, except for firms that face financial obstacles. However, the effect of these interaction variables and the direct effect of public credit is not significant when we look at the regression results. In fact, not having a credit line at all while facing financial obstacles appears to lead to a smaller dispersion of distortions than having a credit line.

Distortions that affect firms in an idiosyncratic way lead to an inefficient allocation of capital and labor, and firm sizes. These distortions, whether generated by market or government failures, may be caused by an inefficient allocation of credit. Our evidence shows that the allocation of both private and public credit leads to an increase in the dispersion of distortions. Public credit only reduces

Table 8. **Contribution of Variables to the Explained Dispersion of τ_y (%)**

	OLS Regressions		IV Regressions	
	(1)	(2)	(3)	(4)
Access to finance	17.71	19.03	15.17	12.25
Private loan (yes = 1)	5.79	5.93	24.96	25.44
Public loan (yes = 1)	1.71	1.05	1.27	1.39
Access to finance × Private loan		0.19		5.81
Access to finance × Public loan		0.79		−1.64
Electricity	0.46	0.45	0.21	0.21
Transportation	0.02	0.02	−0.15	−0.15
Customs and trade regulations	2.65	2.58	−0.29	−0.32
Informal sector	2.40	2.34	0.82	0.80
Access to land	0.08	0.10	0.29	0.25
Crime, theft	0.34	0.33	1.09	1.07
Tax rates	0.44	0.43	1.15	1.14
Tax administration	0.51	0.51	0.09	0.09
Business licensing	0.33	0.32	2.17	2.08
Political instability	−0.41	−0.42	0.96	0.92
Corruption	0.84	0.84	0.61	0.58
Courts	2.28	2.24	3.13	2.92
Labor regulations	0.20	0.20	1.13	1.08
Inadequate education workers	0.48	0.47	0.75	0.72
All obstacles	35.82	37.38	53.36	54.63
Country dummies	61.27	59.83	45.22	44.09
Sector dummies	2.91	2.80	1.42	1.27
Total	**100**	**100**	**100**	**100**

IV = instrumental variable, OLS = ordinary least squares.
Source: Authors' calculations.

this dispersion for firms that face (self-declared) financial obstacles. It is clear that public credit does not appear to compensate for the distortions that exist in private credit markets. However, the bulk of the dispersion of these distortions remains unexplained. Finance appears to be important only when we look at the part of the distortions that we are able to explain with observations. In that sense, our results are consistent with several results in the literature that attribute a minor role to financial access in explaining misallocation.

VI. Conclusions

Misallocation implies that, with the same amount of capital, labor, and firm-level TFP, aggregate TFP can be higher if factors of production were reallocated between firms. Distortions that affect firms in a heterogeneous way lead to suboptimal capital–labor ratios at the firm level and a distribution of firm sizes that is not consistent with the distribution of their TFP. One of the factors that may drive these distortions are financial frictions that prevent viable projects from being financed and allow unviable projects to be financed.

We have studied quantitatively the effect of access to finance to explain the dispersion of factor market and size distortions that drive misallocation. Our focus is not only on the effect of financial obstacles, but also on whether public credit has a significant effect in improving allocation. Directed credit policies through government-owned institutions are very common in many emerging markets and have gained importance in recent decades. Thus, it is important to understand whether government credit has any positive effect on aggregate TFP, and hence per capita income, through an improved allocation of resources.

We use a database of close to 23,000 firms in 45 economies and derive two measures of distortions from the Hsieh and Klenow (2009) model. The first measures factor market distortions that prevent firms from achieving their optimal capital–labor ratio. The second measures size distortions that prevent firms from achieving their optimal size as dictated by their TFP. We then use a regression approach to measure the effect of self-declared access-to-finance obstacles, access to a government-owned bank credit line, and access to a private-owned bank credit line on these two measures of distortions. We instrumentalize the public and private credit line variables to isolate their treatment effect. We then use a regression-based decomposition that allows us to see whether these variables increase or decrease the dispersion of distortions across firms.

Our results show that access-to-finance obstacles increase the dispersion of both factor market distortions and size distortions. Private credit increases the dispersion of both distortions, especially the size distortion. This is not surprising given that it is the existence of informational asymmetries together with underdeveloped financial markets that can lead to an inefficient allocation of private credit. Public credit, on the other hand, has a very small effect. For firms that do not face financial obstacles, it increases slightly the dispersion of both distortions. For firms that face financial obstacles, it decreases slightly the dispersion, but it is not significant in the case of size distortions. However, public credit does not appear to compensate for the distortions that exist in the private credit markets. We thus conclude that public credit does not appear to improve significantly the informational and regulatory frictions that exist in credit markets even among our sample that is dominated by developing economies with lower levels of financial depth. The majority of the dispersion of these distortions remains unexplained. Financial variables appear only to be important in driving the explained part of these distortions and are significant. However, they cannot explain a sizable enough part of them to be considered as the key drivers of misallocation.

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Sectoral Infrastructure Investments in an Unbalanced Growing Economy: The Case of Potential Growth in India

CHETAN GHATE, GERHARD GLOMM, AND JIALU LIU STREETER*

We construct a two-sector (agriculture and modern) overlapping generations growth model calibrated to India to study the effects of sectoral tax rates, sectoral infrastructure investments, and labor market frictions on potential growth in India. Our model is motivated by the idea that because misallocation depends on distortions, policies that reduce distortions raise potential growth. We show that the positive effect of a variety of policy reforms on potential growth depends on the extent to which public and private capital are complements or substitutes. We also show that funding more infrastructure investments in both sectors by raising labor income taxes in the agriculture sector raises potential growth.

Keywords: Indian economic growth, misallocation, public capital, structural transformation, two-sector OLG growth models, unbalanced growth
JEL codes: H21, O11, O20, O41

I. Introduction

How do sectoral tax policies and labor laws distort the sectoral allocation of labor and capital to prevent developing economies from realizing their growth potential? Lewis (1954) famously argued that economic development means growth of the modern sector. If so, what prevents the development and expansion of the modern sector in growing economies? What are the impediments to the reallocation of labor to sectors of high productivity? Will a tax on agriculture income that funds higher public investment inhibit the rise of the modern sector? These questions have policy importance as distortions in the agriculture and the nonagriculture (modern) sectors constrain growth in developing economies by preventing the full productivity effect of factor reallocation.

*Chetan Ghate (corresponding author): Economics and Planning Unit, Indian Statistical Institute Delhi. E-mail: cghate@isid.ac.in; Gerhard Glomm: Department of Economics, Indiana University, Indiana. E-mail: gglomm@indiana.edu; Jialu Liu Streeter: Department of Economics, Allegheny College, Pennsylvania. E-mail: jstreeter@allegheny.edu. The authors would like to thank Partha Sen, K. P. Krishnan, Pawan Gopalakrishnan, Pedro de Araujo, participants at the Asian Development Outlook–Asian Development Review Conference held in Seoul in November 2015, the managing editor, and an anonymous referee for helpful comments. Gerhard Glomm gratefully acknowledges very generous hospitality from the Indian Statistical Institute Delhi, especially the Policy and Planning Research Unit for financial assistance related to this project. The usual disclaimer applies.

We address these questions within the context of an unbalanced growing economy, India, that is undergoing fundamental changes in the structure of production and employment. We build a two-sector overlapping generations (OLG) neoclassical growth model calibrated to India. The two sectors are an agriculture sector and a modern (nonagriculture) sector that merges the manufacturing and service sectors together.[1] In our model, all individuals work when young and retire when old. Individuals pay taxes on their labor income in both sectors, and receive an excise subsidy for the consumption of agriculture products. The remaining tax revenues are allocated as infrastructure investments across both sectors. In each sectoral production technology, the stock of public infrastructure is a productive input, and is combined with sector specific capital and labor in accordance with a constant elasticity of scale (CES) production function. Public and private capital can be complements or substitutes. To incorporate the drag on modern sector output because of the presence of labor laws, we subtract a term that increases proportionately with the amount of labor employed in the modern sector. We think of this loss occurring because of bureaucratic problems related to a large labor force in the modern sector. Labor and capital are assumed to be perfectly mobile across sectors.

Given this setup, we show that exogenous fiscal policies (sectoral taxes and subsidies) and labor market frictions can play an important role in misallocating factors of production, which affects potential growth. Since less misallocation would suggest that the economy can produce more with the same factors of production and production technology, policy reforms that induce greater efficiency are key to understanding India's growth and growth potential.

A. India's Pattern of Structural Transformation

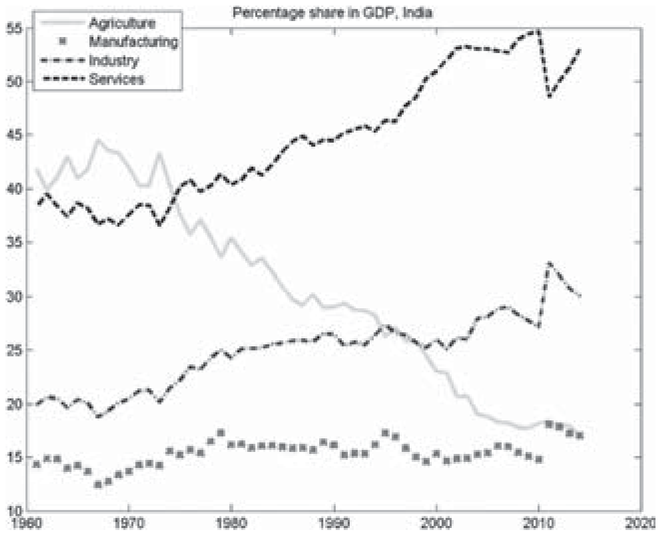
Most economies have undergone substantial structural changes that involved shifts of resources across the agriculture, manufacturing, and service sectors, and very large changes in the capital–output ratios of all three sectors. In the context of the development process, India stands out for three reasons.[2] As can be seen from Figure 1, India's service sector has grown rapidly in the last 3 decades, constituting 55% of the gross domestic product (GDP) in 2010, with a share close to 53% in 2015.[3] The large size of the service sector in India is comparable to the size of the service sector in developed economies where services often provide more than 60% of total output and an even larger share of employment. Since many components

[1] This identification is not necessary as we just need two sectors whose output and employment shares in the total economy rise and fall, respectively, and whose capital–output ratios are not constant over relatively long time horizons.

[2] These structural shifts are documented in Verma (2012).

[3] Industry comprises value added in mining, manufacturing, construction, electricity, and water and gas. In 2014, value added in industry was 30% of GDP. Manufacturing value added was 17% of GDP, comprising approximately 57% of industry's share.

Figure 1. **Structural Transformations in India**



GDP = gross domestic product.
Source: World Bank. World Development Indicators. http://data.worldbank.org/indicator/

of services (e.g., financial services, business services, hotels, and restaurants) are income related and increase only after a certain stage of development, the fact that India's service sector is very large relative to its level of development is puzzling.

Second, the entire decline in the share of agriculture in India's GDP in the last 2 decades has been accounted for by an expanding service sector. The manufacturing sector's share of GDP has stayed constant at around 15% of GDP over the past 30 years.[4] In general, such a trend is experienced by high-income economies and not by developing economies. In developing economies, the typical pattern is for the manufacturing sector to replace the agriculture sector's declining share of GDP initially. Only at higher levels of aggregate income does the service sector play an increasingly large role. In addition, in spite of the rising share of services in both GDP and trade, there has not been a corresponding rise in the share of services in India's total employment. In other words, India's service sector has not been sufficiently employment generating.[5]

[4]In comparison, in 2010, manufacturing value added as a percentage of GDP was 29.5% in the People's Republic of China, 24.8% in Indonesia, 24.5% in Malaysia, and 33.6% in Thailand (UN National Account Statistics 2015). Gupta and Kumar (2012) provide a comprehensive review of the factors inhibiting India's manufacturing sector in the postreform period. Hsieh and Klenow (2009) show that firm heterogeneity in productivity and distortions have led to misallocation in Indian firms.

[5]While there will always be issues with modeling three disparate sectors such as services, manufacturing, and agriculture, one can think of agriculture in our model—and other models of economic transformation—as being the one truly traditional sector and the rest of the economy as the more modern sector. These models typically capture the shrinking of the agriculture sector as the economy develops.

Table 1. **Data on Structural Transformation in India, 1970–2000**

Variable	Agriculture 1970	Agriculture 2000	Manufacturing 1970	Manufacturing 2000	Services 1970	Services 2000
$\frac{Employment}{Share}$	77%	62%	12%	19%	12%	20%
$\frac{GDP}{Share}$	48%	25%	23%	27%	29%	48%
K/Y Ratio	3.3	0.9	0.6	4.3	11.0	1.8
$\frac{Gross}{Capital\ Formation}$	18%	9%	33%	30%	49%	61%

GDP = gross domestic product.
Note: "K/Y Ratio" refers to the capital–output ratio.
Source: Verma. 2012. Structural Transformation and Jobless Growth in the Indian Economy. In C. Ghate, ed. *The Oxford Handbook of the Indian Economy*. Oxford University Press: New York.

Third, unlike the case of aggregate data in advanced economies where capital–output ratios are often constant over time, the sectoral capital–output ratios in India exhibit large changes over time (Table 1).[6] While agriculture's capital–output ratio fell from 3.3 to 0.9 between 1970 and 2000, the manufacturing sector's capital–output ratio rose from 0.6 to 4, and the service sector's capital–output ratio fell from 11 to 1.8.

Figure 2 shows agriculture employment in Brazil, the People's Republic of China, and India during 1980–2015. What is apparent is that the relative decline of agriculture's share of employment is slower in India than in these economies. Taking Figure 1 and Figure 2 together, what stands out is that the changes in India's GDP structure are asymmetric to its sectoral employment intensity.

Figure 3 shows that when measured in constant 2005 United States dollars, the growth of India's GDP has risen persistently since 1980.

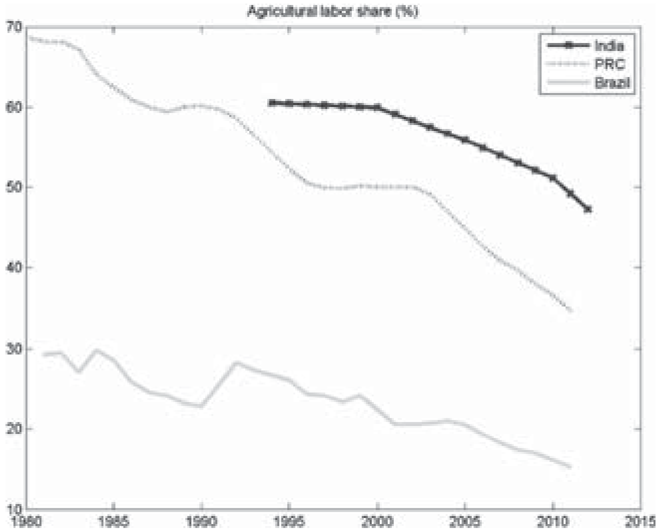
B. Description of the Main Results

The observations in the previous section suggest that, in the context of India over the last 50 years, the balanced growth assumption does not seem appropriate. First, the growth rate of GDP seems to be increasing over the sample period. Moreover, the transition out of agriculture seems to have accelerated after 1975. We therefore abandoned the strategy of balanced growth and instead pursued a strategy of matching the transition out of agriculture with growth in the modern sector (manufacturing and services).[7] In our model, growth will not be balanced since the production technologies do not exhibit constant returns in all the augmentable

[6]See Verma (2012).

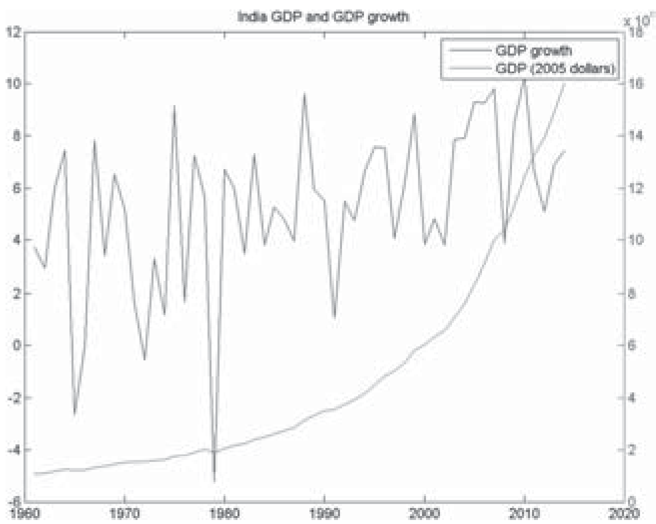
[7]In models of capital accumulation, balanced growth typically prevails when there are constant returns to all augmentable factors. In such a case, all variables that can grow will grow at the same constant rate forever, and all variables that are bounded are constant over time. In growth models of structural transformation such as Gollin, Parente, and Rogerson (2002), balanced growth in the sense defined above typically is not obtained since the perpetual shifting of resources from the traditional to the modern sector prevents the growth rate of GDP from being constant over time. It is still possible, however, to define something like balanced growth in terms of a constant rate of labor migration from the traditional to the modern sector.

Figure 2. **Agriculture Employment in Select Emerging Market Economies**



PRC = People's Republic of China.
Source: World Bank. World Development Indicators. http://data.worldbank.org/indicator/

Figure 3. **Indian GDP and GDP Growth (Constant 2005 Prices)**



GDP = gross domestic product.
Source: World Bank. World Development Indicators. http://data.worldbank.org/indicator/

factors. In our model, both physical and infrastructure capital are augmentable. The labor's share of value added differs across the two sectors, so the returns to the two augmentable factors differ across the two sectors as well. It is this difference in the returns to augmentable factors that helps us match the transition out of agriculture into the modern sector. This transition will generally be neither constant nor balanced.

Our baseline calibrations capture some of the observations discussed in Figures 1–3 for India fairly closely over a 30-year period. For instance, GDP per capita increases persistently, as is shown in Figure 3. Second, consistent with the observations in Table 1, the agriculture sector is shrinking over time: its employment share drops from 67% to 40%. The drop in agriculture's share of GDP is relatively larger from 56% to 30%. These drops are largely consistent with the asymmetry in the data in Table 1, which show that agriculture's share of GDP in the Indian data falls more rapidly than its employment share.

Given that the baseline model captures unbalanced growth in India qualitatively, we use the calibrated version of the model to conduct a variety of counterfactual policy experiments on (i) the sectoral allocation of public infrastructure investment between the agriculture and modern sectors, (ii) changes in sectoral tax rates and subsidies, and (iii) changes in the drag created by labor market friction to increase potential growth. Our first result addresses how public capital should be allocated between the agriculture and modern sectors to influence India's growth potential. We show that a major policy reform that increases the sectoral allocation of public capital to the agriculture sector leads to smaller effects on overall GDP when public and private capital are substitutes, rather than complements. When public and private capital are substitutes, an increase (decrease) in public capital is followed by a decrease (increase) in private capital, thus undoing the effects of policy change. In the case of complements, a reinforcing effect takes place that magnifies the policy effects.

Second, we show that increasing the agricultural income tax rate and using the extra tax revenue to fund increased investment in infrastructure in both sectors leads to a large and persistent increase in GDP. When the same experiment is conducted with an identical rise in the modern sector's tax rate, the substitutability between private and public capital induces larger shifts in labor across the sectors, which translates into a larger decline in modern sector output, which in turn, causes a larger decline in overall GDP.

Third, we find that an increase in the subsidies for the agriculture goods shifts demand away from the modern sector to the agriculture sector. This shift drags down potential growth and decreases overall GDP.

To incorporate the drag on the modern sector's output caused by the presence of labor laws, following Das and Saha (2015), we subtract a term that increases proportionately with the amount of labor employed in the modern sector. We think of this loss occurring because of bureaucratic problems related to a large labor force in the modern sector. We show that increasing the regulatory drag—or labor market frictions—decreases wages in the modern sector and this shifts employment to agriculture. There is a drop in output in both the modern and the agriculture sectors, with the drop in the modern sector being larger. Since both sectoral outputs decline, overall GDP declines as well. These results are very similar when public and private capital are substitutes. This is a new interpretation of the effect of labor market frictions on sectoral infrastructure investments. Typically in the literature, labor market frictions are seen to employ inefficient labor in the modern sector (see, for example, Gupta and Kumar 2012) or to constrain growth by deterring entry and skewing firm-size distribution (see, for example, Alfaro and Chari 2014). In our model, labor market frictions depress potential output by pulling productive resources out of the modern sector. A lower value of the labor market friction parameter leads to higher efficiency, suggesting that policies that diminish labor market distortions can affect potential growth.

C. Literature Review

Our paper builds on the literature in the field of growth and development. There is a large body of literature that studies how structural change and growth are related in the development process, including Caselli and Coleman (2001); Glomm (1992); Gollin, Parente, and Rogerson (2002); Laitner (2000); and Lucas (2004). However, there has been relatively little work within this literature focusing on developing economies in general and India in particular.

There is also a large body of literature studying the effects of infrastructure investment on economic growth. Usually these types of analyses are carried out in a one-sector growth model with an aggregate production function, often of the Cobb–Douglas kind. Examples here include Barro (1990); Turnovsky and Fischer (1995); Turnovsky (1996); Glomm and Ravikumar (1994, 1997); Eicher (2000); Agénor and Moreno-Dodson (2006); Agénor (2008); Ott and Turnovsky (2006); and Angelopoulos, Economides, and Kammas (2007); among others. There are also many empirical studies to go along with the above theoretical investigations. Examples of such empirical papers include Barro (1990), Ai and Cassou (1995), Holtz-Eakin (1994), and Lynde and Richmond (1992).[8] To the extent that infrastructure is often seen as being strategic to development, these papers do not discuss how infrastructure spending should be financed across sectors or whether the agriculture sector should be taxed.

II. The Model

The economy in our model is populated by an infinite number of generations. Each generation is alive for two periods, young age and old age, and each accounts for

[8]Combining these two areas of growth and development research, there is a smaller body of literature that analyzes the effects of infrastructure investment in economies undergoing structural changes such as large shifts of productive activity from agriculture to manufacturing and then to services. Examples include Arcalean, Glomm, and Schiopu (2012); Carrera, Freire-Seren, and Manzano (2009); de la Fuente et al. (1995); Caminal (2004); and Ott and Soretz (2010).

25 years. All individuals work when young and retire when old. Within a generation, all individuals are identical. For simplicity, we assume that all individuals consume only in the second period of life.[9] Thus, all income from the first period is saved for consumption when old. There are two sectors: one we call "agriculture" and a second sector we call "modern," although the names are not crucial. What is crucial is that there are two sectors, with one sector declining and one sector increasing along the development path. The utility function for all households is given below:

$$u(c_{m,t+1}, c_{a,t+1}) = lnc_{m,t+1} + \phi lnc_{a,t+1}, \quad \phi > 0 \tag{1}$$

where $c_{m,t+1}$ denotes household consumption of the modern sector good and $c_{a,t+1}$ the consumption of the agriculture good.

Households working in the agriculture and modern sectors solve the following problem:

$$\begin{aligned} \max_{c_m, c_a} \quad & lnc_{m,t+1} + \phi lnc_{a,t+1} \\ s.t. \quad & c_{m,t+1} + (1-\xi)p_{t+1}c_{a,t+1} = (1-\tau_a)w_{a,t}(r_t + 1 - d) \quad \text{Agriculture} \\ & c_{m,t+1} + (1-\xi)p_{t+1}c_{a,t+1} = (1-\tau_m)w_{m,t}(r_t + 1 - d) \quad \text{Modern} \end{aligned} \tag{2}$$

where $0 < \xi < 1$ is a government subsidy on agriculture goods consumption and $\tau_a \in [0, 1]$ and $\tau_m \in [0, 1]$ are tax rates levied on labor income in the agriculture and modern sectors, respectively. r_t represents the rental price of capital. d is the depreciation rate of capital, $w_{a,t}$ is the wage rate in the agriculture sector, and $w_{m,t}$ is the wage rate in the modern sector. We assume that the modern sector good is the numeraire, and so p_t denotes the relative price of the agriculture good relative to the modern sector good.[10] Since households only consume in the second period, aggregate consumption for the agriculture good, $c_{a,t+1}$, and the modern sector good, $c_{m,t+1}$, satisfies

$$\frac{c_{a,t+1}}{c_{m,t+1}} = \frac{\phi}{(1-\xi)p_{t+1}} \tag{3}$$

Following Getachew and Turnovsky (2015), we assume output in each sector is produced by the production functions specified in equations (4) and (5), in

[9] We make the assumption that consumption only takes place when individuals are old. In that case, all income earned by the young is saved. This assumption generates results that are very similar to more general models where utility is derived from consumption in both periods of life, preferences are homothetic, and, as a result, savings are a constant fraction of income. With our assumption, the savings rate happens to be constant at 100%.

[10] We assume that $w_{a,t}$ is inclusive of the relative price, p_t, as shown in equation (10).

which private capital and public capital are combined in accordance with the CES production function, with elasticity of substitution being $\epsilon = 1/(1-\rho)$:

$$Y_{a,t} = A_{a,t}[a_1 K_{at}^{\rho_a} + (1-a_1)G_a^{\rho_a}]^{\theta_a/\rho_a} L_{at}^{1-\theta_a} \qquad 0 < a_1 < 1 \tag{4}$$

$$Y_{m,t} = A_{m,t}[a_2 K_{mt}^{\rho_m} + (1-a_2)G_{mt}^{\rho_m}]^{\theta_m/\rho_m} L_{mt}^{1-\theta_m} - \gamma L_{m,t} \qquad 0 < a_2 < 1 \tag{5}$$

$$Y_t = Y_{a,t} p_t + Y_{m,t} \tag{6}$$

Here, $A_{a,t}$ and $A_{m,t}$ are total factor productivity (TFP) in the agriculture and modern sectors, respectively. $K_{a,t}$ and $K_{m,t}$ are the total amount of physical capital used in each sector, respectively, and $L_{a,t}$ and $L_{m,t}$ stand for the total amount of labor employed in each of the two sectors. $G_{a,t}$ and $G_{m,t}$ denote the stock of public capital in the agriculture and modern sectors, respectively. γL_{mt} represents the labor friction in the modern sector: we subtract a term that increases proportionately with the size of labor employed in the modern sector. We think of this loss occurring because of bureaucratic problems related to a large labor force in the modern sector. This specification follows Das and Saha (2015).

We assume that investments in public infrastructure can be financed by a tax on (i) labor income in the modern sector, (ii) labor income in the agriculture sector, or (iii) both. In addition to financing the public good investment, the government also subsidizes consumption of agricultural products. The government budget constraint can be written as

$$G_{a,t} + G_{m,t} + \xi p_t c_{a,t} = \tau_a w_{a,t} L_{a,t} + \tau_m w_{m,t} L_{m,t} \tag{7}$$

where ξ is the subsidy for the consumption of the agriculture good. We do not allow public debt in our model. Letting $\delta_a \in [0, 1]$ denote the fraction of government revenue allocated to agricultural infrastructure, we can write

$$G_{a,t} = \delta_a[\tau_a w_{a,t} L_{a,t} + \tau_m w_{m,t} L_{m,t} - \xi p_t c_{a,t}] \tag{8}$$

$$G_{m,t} = (1-\delta_a)[\tau_a w_{a,t} L_{a,t} + \tau_m w_{m,t} L_{m,t} - \xi p_t c_{a,t}] \tag{9}$$

The returns to factors in the two sectors are

$$w_{a,t} = p_t A_{at}[a_1 K_{at}^{\rho_a} + (1-a_1)G_{at}^{\rho_a}]^{\theta_a/\rho_a}(1-\theta_a)L_{at}^{-\theta_a} \tag{10}$$

$$w_{m,t} = A_{at}[a_2 K_{mt}^{\rho_m} + (1-a_2)G_{mt}^{\rho_m}]^{\theta_m/\rho_m}(1-\theta_m)L_{mt}^{-\theta_m} - \gamma \tag{11}$$

$$r_{a,t} = p_t A_{at}\theta_a[a_1 K_{at}^{\rho_a} + (1-a_1) * G_{at}^{\rho_a})^{\theta_a/\rho_a - 1} a_1 K_{at}^{\rho_a - 1} L_{at}^{1-\theta_a} \tag{12}$$

$$r_{m,t} = A_{at}\theta_m[a_2 K_{mt}^{\rho_m} + (1-a_2) * G_{mt}^{\rho_m})^{\theta_m/\rho_m - 1} a_2 K_{mt}^{\rho_m - 1} L_{mt}^{1-\theta_m} \tag{13}$$

Assuming costless mobility of labor, we can equate the after tax wage rates across the two sectors

$$(1-\tau_a)w_{a,t} = w_{m,t}(1-\tau_m) \tag{14}$$

Similarly, we also assume perfect capital mobility, which implies

$$r_{a,t} = r_{m,t} = r_t \tag{15}$$

For capital and labor markets, the aggregate capital K_t and aggregate labor L_t are both known at the beginning of time t:

$$\begin{aligned} K_{at} + K_{mt} &= K_t \\ L_{at} + L_{mt} &= L_t \end{aligned} \tag{16}$$

There is no population growth in the model: $L_t = L_{t+1}$. All income is saved and funds the future capital stock:

$$K_{t+1} = (1-\tau_a)p_t w_{a,t} L_{a,t} + (1-\tau_m)w_{m,t} L_{m,t}$$

For the two goods market, agriculture goods can only be used for consumption. Modern sector goods can be used as consumption or investment (see, for example, Cheremukhin et al. 2014). The market clearing condition for the two goods are

$$\begin{aligned} c_{at} L_t &= Y_{at} \\ c_{mt} L_t + K_{t+1} - (1-d)K_t + G_{t+1} &= Y_{mt} \end{aligned} \tag{17}$$

Finally, both sectors have no direct interaction with one another, the economy is closed, and prices are determined fully by domestic production.

III. Calibration Parameters

This section describes the parameters used in our calibration exercises. Our calibration strategy is to match the initial shares of sectoral employment rates, sectoral capital–output ratios, and sectoral GDP ratios; and the rate of decline (increase) of these shares over a 30-year period, as depicted in Table 1.

The initial TFP in the agriculture sector (A_a) is set at 2, while that in the modern sector (A_m) is set at 1. The growth rate of agricultural TFP is 1.4, equivalent to 1.4% annual growth; the growth rate of modern TFP is 1.3, equivalent to 1.3% annual growth. This reflects that average annual TFP growth was lower in the modern sector in India in its earlier stages of development (Verma 2012). In the agriculture production function, a_1 represents the weight of private capital when combined with public capital, and is set at 0.8. Similarly, a_2 is also set at 0.8. This reflects the common observation that private capital is more important than public capital in final goods production. The CES parameters, ρ_a and ρ_m, each assume two values: 0.6 and -0.3. If $\rho = 0.6$, then private capital and public capital are substitutes; if $\rho = -0.3$, then private and public capital are complements. In the production function, labor has a power parameter $(1 - \theta)$. The crucial distinction in our model between the two sectors is capital intensity. In all the experiments below, we assume that the modern sector is more capital intensive than the agriculture sector: $\theta_m = 0.5 > \theta_a = 0.3$.

We now describe the policy parameters. The government funding share for agricultural infrastructure, δ_a, is set at 0.5 in the baseline model and assumes values from 0.2 to 0.55 in the experiment. The tax rate of agricultural income, τ_a, is 0.2 in the baseline and varies from 0.1 to 0.4 in the experiment. Similarly, the tax rate on modern sector income, τ_m, is 0.3 in the baseline, and varies from 0.1 to 0.4 in the experiment. Government subsidies of agriculture goods prices, ξ, are set at 0.1 in the baseline and range from 0.01 to 0.15 in the experiment. Lastly, the labor friction parameter, γ, is set at zero in the baseline, and varies from zero to 0.1 in the experiment. These values are summarized in Table 2.

IV. Policy Experiments

Figure 4 depicts our calibration to Indian data, assuming no labor market frictions and no subsidies. We refer to this as the baseline model. The dashed lines show the results for the complementarity assumption.[11] We assume that public capital is split evenly between the two sectors. For the calibrated version with the parameter values from Table 2, we obtain the following results. First, GDP per capita grows persistently, as shown in Figure 3. Second, consistent with the observations in Table 1, the agriculture sector is shrinking over time: its employment share drops from 67% to 40%. The decline in agriculture's share of GDP is even larger proportionately, dropping from 56% to 30%. These declines are largely consistent with the asymmetry in the data in Table 1, which show that agriculture's share of GDP falls more rapidly than its employment share. The sizes of these relative drops are maintained if public and private capital are substitutes, rather than complements. The reason why overall GDP is lower when public and private capital are complements is that a limited amount of G constrains total output as this constrains the productivity of K. As a result, overall output is less than the case where K and G are substitutes.[12]

[11] In each experiment, we show two technological cases: (i) the case of private capital and public capital being complements, which we take to be the empirically valid assumption, and (ii) the case where they are substitutes.

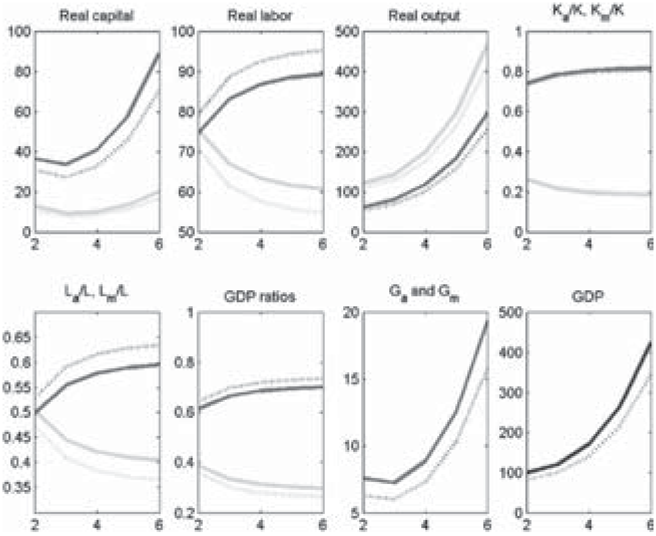
[12] An example of substitutes is government-owned machinery versus privately owned machinery. An example of complements is private factories that rely on public infrastructure to deliver products.

Table 2. **Calibration Parameters**

Parameter	Definition	Baseline Value	Experiments
ϕ	Parameter in Utility	1	
A_a	Initial TFP in Agriculture	2	
A_m	Initial TFP in Manufacturing	1	
g_a	Growth Rate of Agricultural TFP (20 years)	1.4	
g_m	Growth Rate of Manufacturing TFP (20 years)	1.3	
a_1	Capital Parameter in Agriculture Production	.8	
a_2	Capital Parameter in Manufacturing Production	.8	
ρ_a	CES Parameter in Agriculture Production	.6, −.3	
ρ_m	CES Parameter in Manufacturing Production	.6, −.3	
θ_a	Parameter in Agriculture Production	.3	
θ_m	Parameter in Manufacturing Production	.5	
Fiscal Policy			
δ_a	Government Infrastructure Share in Agriculture	.5	$\{0.2, .55\}$
τ_a	Tax Rate on Agriculture Income	.2	$\{0.1, 0.4\}$
τ_m	Tax Rate on Manufacturing Income	.3	$\{0.1, 0.4\}$
ξ	Government Subsidy on Agriculture Prices	.1	$\{0.01, 0.15\}$
Labor Market			
γ	Labor Market Friction	0	$\{0, 0.1\}$

CES = constant elasticity of substitution, TFP = total factor productivity.
Source: Authors' calculations.

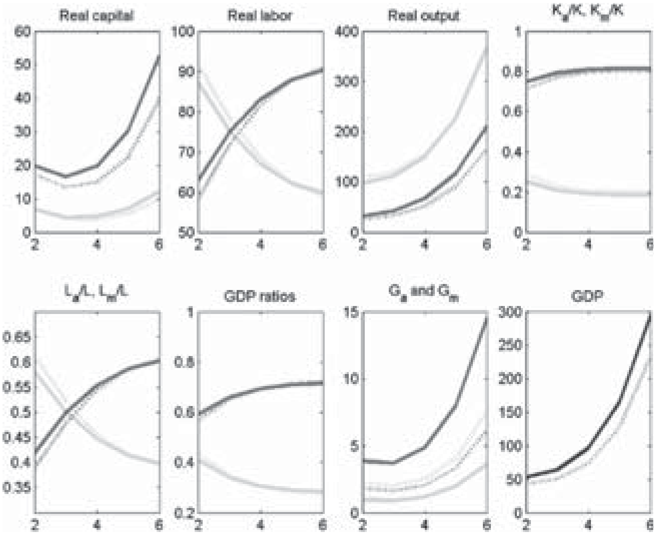
Figure 4. **Baseline Model: No Labor Market Frictions, No Subsidies**



GDP = gross domestic product.
Notes: Solid lines denote the period before the policy experiment; dashed lines denote the period after the policy experiment. Medium-shaded lines denote the modern sector; light-shaded lines denote the agriculture sector; dark-shaded lines denote overall GDP.
Source: Authors' calculations.

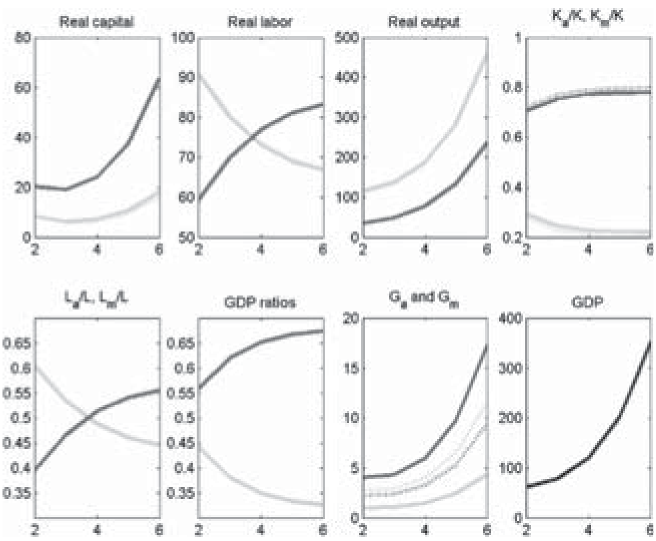
One important policy issue that can fundamentally influence the growth potential relates to how public capital should be allocated between the agriculture and modern sectors. It is expected that increasing the share of public capital going to agriculture will increase agricultural output, the question is by how much. In the first policy experiment (Figure 5), we increase agriculture's share of infrastructure, δ_a, from 0.2 to 0.6. This represents a very significant policy reform. An immediate impact of an increase in the share of infrastructure in agriculture is that G_a increases and G_m falls. Because G and K are assumed to be complements, K_m also falls. Figure 6 reveals that GDP growth declines as more public capital is allocated to agriculture. This is true simply because of the higher capital intensity (private and public) of the modern sector relative to agriculture. As expected (because L_a also increases), the relative size of the agriculture sector increases, both measured in terms of employment and GDP share, although the effect on the labor share seems to be larger than on the GDP share. The effect on the level of overall GDP is persistent, while the magnitude of the effects on agriculture's labor share and GDP share declines over time. Finally, the effect on overall GDP is far smaller when public and private capital are substitutes. This makes sense; when public and private capital are substitutes, an increase (decrease) in public capital is followed by a decrease (increase) in private capital, thus undoing the effect of policy change. In the case of complements, a reinforcing effect occurs that magnifies the policy effect.

Figure 5. **Policy Experiment: Increase δ_a from 0.2 to 0.6; *K* and *G* complements**



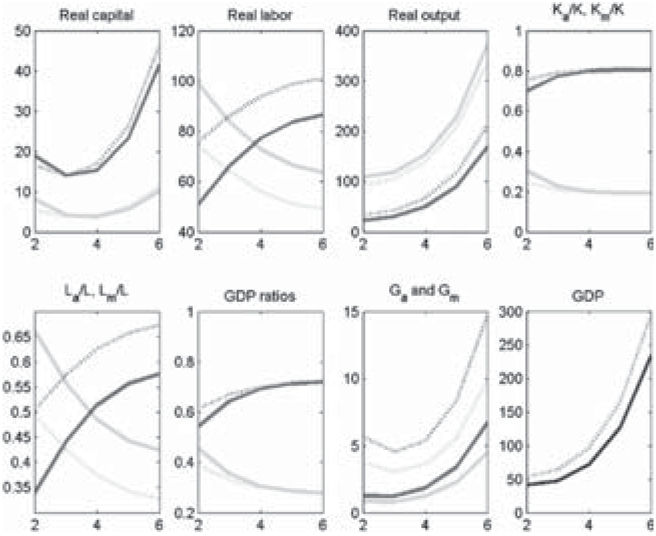
GDP = gross domestic product.
Notes: Solid lines denote the period before the policy experiment; dashed lines denote the period after the policy experiment. Medium-shaded lines denote the modern sector; light-shaded lines denote the agriculture sector; dark-shaded lines denote overall GDP.
Source: Authors' calculations.

Figure 6. **Policy Experiment: Increase δ_a from 0.2 to 0.6; *K* and *G* substitutes**



GDP = gross domestic product.
Notes: Solid lines denote the period before the policy experiment; dashed lines denote the period after the policy experiment. Medium-shaded lines denote the modern sector; light-shaded lines denote the agriculture sector; dark-shaded lines denote overall GDP.
Source:Authors' calculations.

Figure 7. **Policy Experiment: Increase τ_a from 0.1 to 0.4; increase government expenditure proportionately in both sectors; *K* and *G* complements**

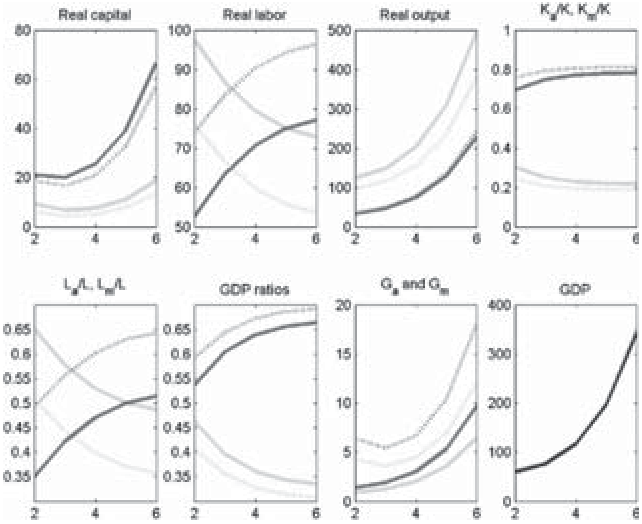


GDP = gross domestic product.
Notes: Solid lines denote the period before the policy experiment; dashed lines denote the period after the policy experiment. Medium-shaded lines denote the modern sector; light-shaded lines denote the agriculture sector; dark-shaded lines denote overall GDP.
Source: Authors' calculations.

In the next policy experiment, we increase the agricultural income tax rate, τ_a, from 10% to 40% and use the extra tax revenue to fund increased investment (proportionately) in both types of infrastructure. We first consider the case of complements (Figure 7). This policy leads to a large and persistent increase in GDP for two reasons. First, the tax increase in the agriculture sector induces a large shift of labor (because of the reduction in the after-tax wage) out of agriculture and into the more capital-intensive modern sector. Second, the increased stock of infrastructure in both sectors increases output directly, as well as indirectly through the productivity of capital (an augmentable factor) and labor. Of course, the last effect is not there, or is at least smaller, when public and private capital are substitutes (Figure 8). The massive shift of labor from agriculture to the modern sector increases output in the modern sector and decreases output in agriculture. But the associated change in agriculture's share of GDP is relatively small and declines over time.

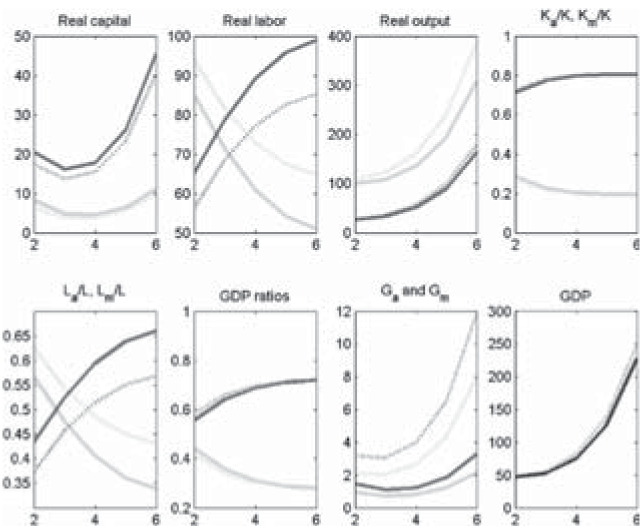
Alternatively to financing additional investment in public infrastructure, the government could raise taxes on income, τ_m, in the modern sector instead. In Figure 9, we illustrate the economic effects of raising the income tax in the modern sector from 10% to 40% (an identical increase compared to τ_a in the previous case) and use the extra revenue to finance infrastructure investment proportionately in both sectors. Once again, an immediate impact of an increase in τ_m is that G_a and G_m

Figure 8. **Policy Experiment: Increase τ_a from 0.1 to 0.4; increase government expenditure proportionately in both sectors; *K* and *G* substitutes**



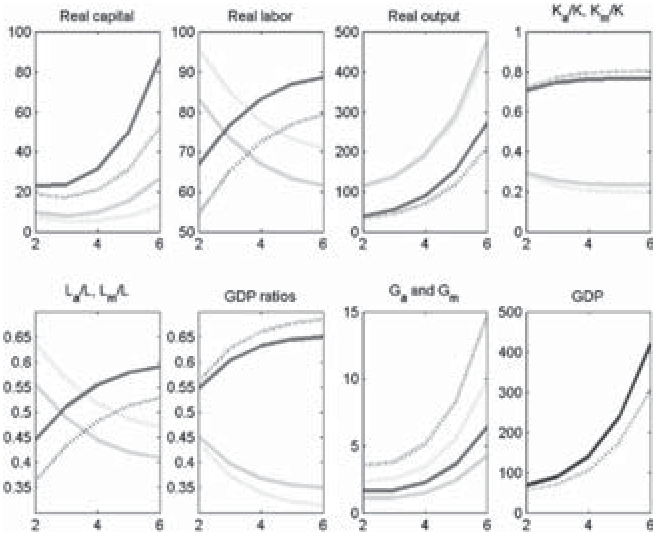
GDP = gross domestic product.
Notes: Solid lines denote the period before the policy experiment; dashed lines denote the period after the policy experiment. Medium-shaded lines denote the modern sector; light-shaded lines denote the agriculture sector; dark-shaded lines denote overall GDP.
Source: Authors' calculations.

Figure 9. **Policy Experiment: Increase τ_m from 0.1 to 0.4; increase government expenditure proportionately in both sectors; *K* and *G* complements**



GDP = gross domestic product.
Notes: Solid lines denote the period before the policy experiment; dashed lines denote the period after the policy experiment. Medium-shaded lines denote the modern sector; light-shaded lines denote the agriculture sector; dark-shaded lines denote overall GDP.
Source: Authors' calculations.

Figure 10. **Policy Experiment: Increase τ_m from 0.1 to 0.4; increase government expenditure proportionately in both sectors; *K* and *G* substitutes**



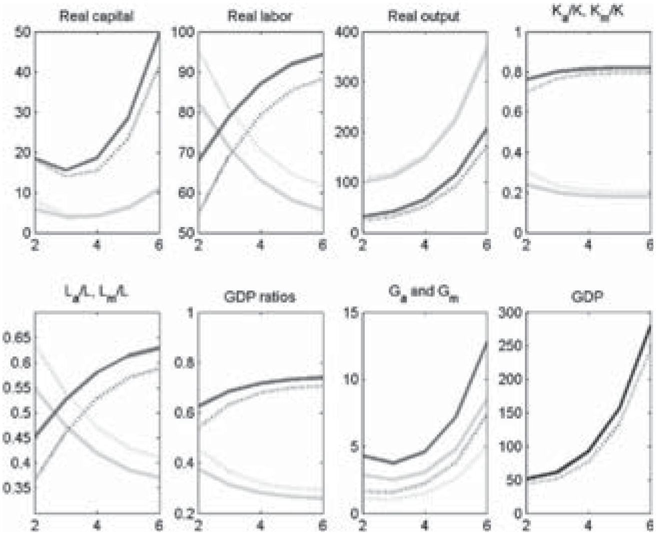
GDP = gross domestic product.
Notes: Solid lines denote the period before the policy experiment; dashed lines denote the period after the policy experiment. Medium-shaded lines denote the modern sector; light-shaded lines denote the agriculture sector; dark-shaded lines denote overall GDP.
Source: Authors' calculations.

increase. However, there is one basic benefit and one basic cost associated with this policy. The cost is a shift of labor to agriculture with its lower capital productivity. The benefit is the extra infrastructure capital. Therefore, when public and private capital are complements, these two effects roughly cancel each other out and, as a consequence, the effects on overall GDP are small; when public and private capital are substitutes, the effect on overall GDP is negative. The substitutability induces larger shifts in labor across the sectors, which translates into a larger decline in modern sector output, which in turn causes a larger decline in overall GDP. These results also show that funding more infrastructure investments in both sectors by raising labor income taxes in the agriculture sector raises potential growth.

Many poor economies maintain subsidies for agricultural products, such as food, and India is no exception in this regard. In Figure 11, we illustrate the effect of increasing such a subsidy. As expected, we find that a higher subsidy, or an increase in ξ, leads to a reduction in G_a and G_m. We also find that (i) the subsidy for the agriculture good shifts demand away from the modern sector to the agriculture sector, and (ii) this shift drags down potential growth and decreases overall GDP.

There are many reasons to believe that various regulations and labor practices in manufacturing and the service sector (modern sector) hold back productivity at unnecessarily low levels. We model this in the production function as a subtraction from output by the amount, γL_m. So far, we have assumed in all computations

Figure 11. **Policy Experiment: Increase ξ from 0.01 to 0.15; *K* and *G* complements**

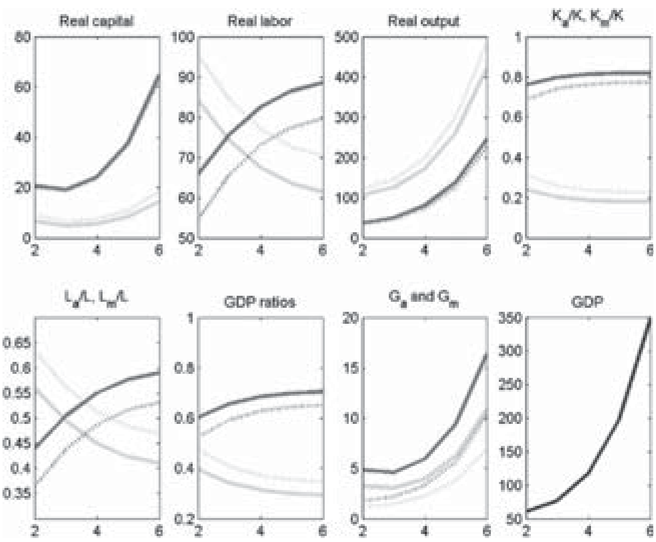


GDP = gross domestic product.

Notes: Solid lines denote the period before the policy experiment; dashed lines denote the period after the policy experiment. Medium-shaded lines denote the modern sector; light-shaded lines denote the agriculture sector; dark-shaded lines denote overall GDP.

Source: Authors' calculations.

Figure 12. **Policy Experiment: Increase ξ from 0.01 to 0.15; *K* and *G* substitutes**

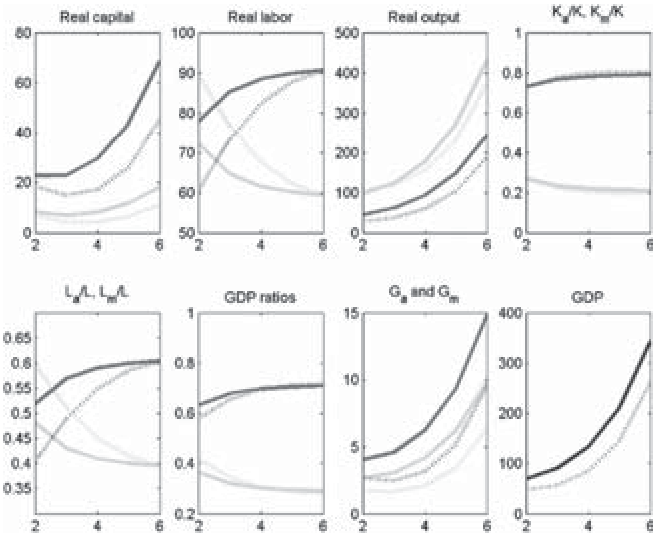


GDP = gross domestic product.

Notes: Solid lines denote the period before the policy experiment; dashed lines denote the period after the policy experiment. Medium-shaded lines denote the modern sector; light-shaded lines denote the agriculture sector; dark-shaded lines denote overall GDP.

Source: Authors' calculations.

Figure 13. **Policy Experiment: Increase γ from 0.0 to 0.1; *K* and *G* complements**



GDP = gross domestic product.
Notes: Solid lines denote the period before the policy experiment; dashed lines denote the period after the policy experiment. Medium-shaded lines denote the modern sector; light-shaded lines denote the agriculture sector; dark-shaded lines denote overall GDP.
Source: Authors' calculations.

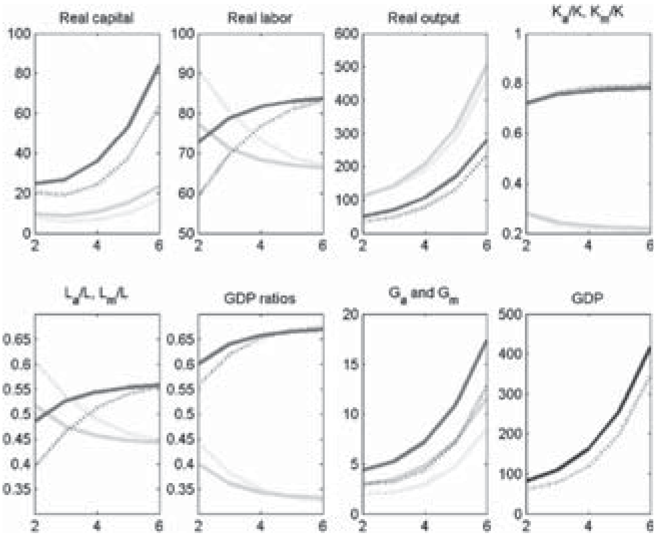
that this drag is zero. To investigate the effect of this regulatory drag on economic growth, we increase γ in equation (5) from zero to 0.1. Figure 13 shows that increasing the regulatory drag decreases wages in the modern sector, shifting employment to agriculture. Because γ increases, modern sector GDP, Y_m, also falls, which leads to a reduction in G_a and G_m. This is a new interpretation of the effect of labor market frictions on sectoral infrastructure investments. Labor market frictions are typically seen to employ inefficient labor in the modern sector (see, for example, Gupta and Kumar 2012) or constrain growth by deterring entry and skewing firm-size distribution (see, for example, Alfaro and Chari 2014). In our model, labor market frictions depress potential output by pulling productive resources out of the modern sector.

We also find that there is a drop in output in both the modern and agriculture sectors, with the drop in the modern sector being larger. Since both sectoral outputs decline, overall GDP declines as well. These results are very similar when public and private capital are substitutes.

A. Robustness

A feature of our model described in equations (1)–(17) is that the relative price of the agriculture good falls steadily. The drop in price is a function of the Cobb–Douglas specification, which has been used in many similar models. In effect,

Figure 14. **Policy Experiment: Increase γ from 0.0 to 0.1; K and G substitutes**



GDP = gross domestic product.
Notes: Solid lines denote the period before the policy experiment; dashed lines denote the period after the policy experiment. Medium-shaded lines denote the modern sector; light-shaded lines denote the agriculture sector; dark-shaded lines denote overall GDP.
Source: Authors' calculations.

as the TFP of the agriculture sector increases, the price of the agriculture product decreases. This offsets the increase in the agricultural product, $Y_{a,t}$. To adjust for this, instead of equation (6) we define output in constant prices, which holds the agriculture price from the first period fixed:

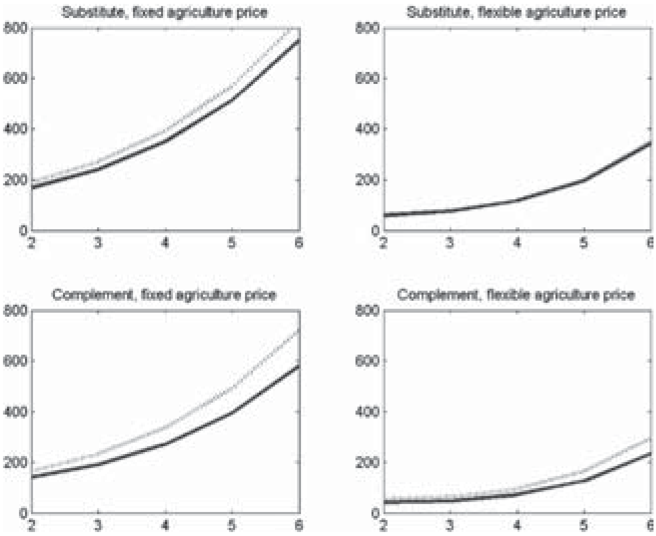
$$Y_t = p_0 Y_{a,t} + Y_{m,t} \tag{18}$$

p_0 is endogenously determined from the system. In subsequent periods, it is kept fixed.[13] We consider one key policy experiment: an increase in agriculture income taxation. In the first period, zero, Figure 15 shows that the overall GDP level defined by equation (18) is higher than the corresponding level of GDP from equation (6). Under the fixed-price definition of GDP, the relative price of the agriculture good is invariant with respect to changes in agricultural productivity. When the relative price is flexible, it declines over time.[14]

[13]Because of parameter sensitivity, in the fixed-price definition of GDP, we change the following parameter values in Table 2: (i) initial agricultural TFP, A_a, is set to 3; (ii) initial manufacturing TFP, A_m, is set to 1; (iii) agricultural TFP growth is set to 1.3%; and (iv) manufacturing TFP growth is set to 1.2%. To facilitate the GDP comparison, we apply this subset of parameters for the calculation of flexible-price GDP as well.

[14]The comparisons between flexible-price and fixed-price GDP for the other policy experiments are available from the authors upon request. In these, we see that the ordering of the policies that we consider by their effects on growth are invariant to the definition we use.

Figure 15. **Comparison between fixed-price GDP from equation (18) (dark-shaded line) and flexible-price GDP from equation (6) (dashed medium-shaded line) after τ_a increases from 0.1 to 0.4**



GDP = gross domestic product.
Notes: Graphs in top row correspond to K and G being substitutes; graphs in bottom row correspond to K and G being complements.
Source: Authors' calculations.

V. Conclusion and Policy Implications

We build a two-sector (agriculture and modern) OLG growth model calibrated to India to examine the effects of sectoral tax policies, sectoral infrastructure investments, and labor market frictions on the sectoral allocation of labor and capital in the Indian economy. Our paper hopes to address two broad issues. First, how do sectoral tax rates and labor market frictions prevent developing economies like India from realizing their growth potential? Second, what prevents the development and expansion of the modern sector in a growing economy like India? These questions have policy implications as distortions in the agriculture and modern sectors have constrained growth in India by limiting the full productivity effect of factor reallocation.

The calibrated model yields several policy implications. We show that a major policy reform that increases the sectoral allocation of public capital to the agriculture sector leads to a smaller effect on overall GDP when public and private capital are substitutes rather than complements. When public and private capital are substitutes, an increase (decrease) in public capital is followed by a decrease (increase) in private capital, thus undoing the effect of the policy change. In the case of complements, a reinforcing effect takes place that magnifies the policy effect. We also show that funding more infrastructure investment in both sectors by raising labor income taxes in the agriculture sector raises potential growth. If the same policy reform is enacted by taxing labor income in the modern sector, potential growth increases by much less.

Finally, increasing the regulatory drag—or labor market friction—decreases wages in the modern sector and shifts employment to agriculture. This leads to a drop in output in both the modern and agriculture sector, with the drop in the modern sector being larger. Since both sectoral outputs decline, overall GDP declines as well. These results are very similar when public and private capital are substitutes.

In sum, policy reforms relating to sectoral tax rates, sectoral infrastructure investments, and labor market frictions can have a sizable effect on growth and potential growth in the Indian context.

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The Political Economy of the Middle-Income Trap: Implications for Potential Growth

YIKAI WANG*

Why do some middle-income economies implement policies to achieve sustainable growth driven by innovation, while others fail to do so? In this paper, I propose a politico-economic explanation: innovation leads to the creative destruction of existing technology that can harm the interests of the pivotal policy maker. Therefore, the pivotal policy maker may implement policies that prevent innovation and harm potential growth in order to protect its own interests. Political institutions, which are endogenously determined by fundamentals of the economy such as state capacity, shape policy maker decisions. This paper studies the relationship between growth, policies, institutions, and fundamentals. Understanding the relationship allows for the design of more efficient aid programs to help the growth of middle-income economies, especially in the long run.

Keywords: middle-income trap, political institution, potential growth, rule of law, state capacity
JEL codes: O43, P16

I. Introduction

Many Asian economies successfully grew out of poverty after the Second World War. Some, such as the Republic of Korea, kept growing at a rapid pace and eventually became rich. Others, such as Indonesia and the Philippines, experienced a slowdown in growth and have remained in the middle-income grouping of economies for many years. The "middle-income trap" is a term used to describe the phenomenon in which an economy gets stuck at middle-income status because it is unable to achieve a high enough growth rate to join the club of rich economies.

Why does a middle-income economy grow slowly following a period of rapid growth that brought it out of poverty? The answer is that the main contributors to growth change as the economy enters a new stage of development. When an economy is poor, capital deepening largely contributes to growth. Once it has become a middle-income economy, growth in total factor productivity is more important

*Yikai Wang: Assistant Professor, University of Oslo, Department of Economics, Oslo, Norway. E-mail: yikai.wang@econ.uio.no. The author would like to thank the participants at the Asian Development Outlook–Asian Development Review Conference held in Seoul in November 2015, the managing editor, and an anonymous referee for helpful comments. The usual disclaimer applies.

(see, for example, Bulman, Eden, and Nguyen 2014). This means that once a poor economy grows itself out of poverty, in order to keep growing fast it needs to change its growth pattern and economic system from one that accumulates production factors to one that improves factor productivities. Therefore, the government needs to implement the right policies and provide the necessary conditions for continued rapid growth as an economy's stage of development changes. Han and Wei (2015) find that some of the crucial conditions for achieving rapid growth in a low-income economy, such as good transport infrastructure, are replaced in terms of importance when an economy attains middle-income status by other conditions such as openness to foreign direct investment.

If the right policies and conditions can help an economy escape the middle-income trap, why do some economies fail to provide them? This is puzzling, especially given that there is evidence of the most effective policies to adopt based on the experience of economies such as the Republic of Korea that have implemented policies which led to innovation and sustainable growth. One important reason for this failure lies in the political economy: the new policies that an economy needs as its stage of development changes may lead to creative destruction that harms the existing interests of the pivotal policy maker. Even if growth can lead to a larger pie, the government as the pivotal policy maker may not desire this outcome if the new policies required for such growth imply that it must settle for a smaller piece of the pie.

Let us consider a case in which an economy has advanced from low-income to middle-income status by relying on government-led capital deepening in low-value-added industries. As innovation becomes more important for sustainable growth at the middle-income level, the government as the pivotal policy maker needs to change its policies to incentivize entrepreneurs, the pivotal economic agents, to invest in innovative firms if it wants to achieve the rapid growth needed to escape the middle-income trap.

There are many cases in which policy makers do not implement the most socially beneficial policies. One example is when the government's capacity to tax is too low and it cannot claim a sufficiently large share of output through a tax on entrepreneurs that makes it better off under a new economic system that encourages innovation. Therefore, it prefers to continue promoting low-value-added firms rather than switch to innovation-driven growth. In another example, the government has sufficient capacity to tax and redistribute, but another problem arises: entrepreneurs fear overtaxation or even expropriation and so they are not willing to invest in innovation. Therefore, the government needs to commit to a low enough tax rate so that entrepreneurs expect to benefit from innovation. To provide this commitment, the government may need to firmly establish the rule of law and/or share political power with entrepreneurs through democratization. Eventually, an economy's political institutions will determine whether the pivotal policy maker and pivotal economic agents are able to agree on switching to a new economic structure and growth pattern.

Escaping the middle-income trap requires adopting new policies that change the growth pattern to one that is driven by innovation. Whether the government is willing to pursue reforms and whether these policies will be effective depends on political institutions allowing for a scheme in which output is shared between the pivotal policy maker and the pivotal economic agents. Political institutions are partly endogenous in terms of whether or not to implement the rule of law or to democratize. Eventually, the fundamentals of an economy will determine the evolution of its political institutions, economic policies, and whether or not it can escape the middle-income trap.

In this paper, I propose a theory to study how economic policies and political institutions are determined in an emerging economy that has attained middle-income status. This theory examines how institutions and growth are determined by an economy's fundamentals, including the government's capacities. With the aid of this theory, I assess under which conditions an economy can make the reforms to political institutions and (subsequently) economic policies that are needed to escape the middle-income trap.

Knowing these conditions allows for a discussion of how foreign aid can alter the choices that a government makes about its political institutions and economic policies, which can ultimately help an economy escape the middle-income trap. Many studies on foreign aid only focus on its immediate effects on economic outcomes, while ignoring the response of political institutions and the long-run economic consequences. The model in this paper takes into account the political response to foreign aid and demonstrates that not doing so can lead to a misunderstanding of the impacts of such aid, especially in the long run. Certain types of foreign aid that help an economy's short-run growth may be harmful to long-run growth by affecting the interests of the pivotal policy maker and possibly hindering political development and economic reform in the long run. Foreign aid that encourages capital deepening in low-value-added industries can discourage the government from promoting innovation. At the same time, some types of foreign aid without any significant positive impact in the short run might benefit an economy's long-run political development and growth. For example, in the early stage of development when innovation is not critical and the government is most adept at supporting large firms that rely on imitation, foreign aid that encourages political power sharing between the government and entrepreneurs through democratization may appear to be meaningless in the short run. However, as the economy enters a more advanced stage of development in which innovative firms run by entrepreneurs are crucial, the prior establishment of political institutions that protect entrepreneurs can make them feel secure enough to invest in the innovation needed for sustainable growth. Interventions at the early stage of development may even be cheaper for international organizations seeking to promote long-run growth. In summary, foreign aid that aims to help economies avoid the middle-income trap must take into account the political environment and long-run impacts of such assistance. Furthermore, foreign aid should be conditional on economic policies and political choices in order to incentivize the government to implement policies that are beneficial in the long run.

The rest of the paper is organized as follows. Section II presents the benchmark politico-economic model. In section III, the model is extended to allow for discussions of the impacts of foreign aid on short-run growth, political developments, and long-run growth. Section IV concludes.

II. The Model

This section presents a politico-economic model to study the growth of middle-income economies. It emphasizes how potentially conflicting interests between the pivotal policy maker and the pivotal economic agents shape political institutions, economic policies, and growth.

A. Preferences, Technology, and Markets

The time span of the model comprises two periods, $t = 1$ and $t = 2$, representing the two stages of an economy's development. The model economy is populated by two classes of agents: an elite (e) and private entrepreneurs (p). Both of them live for two periods. Each class consists of infinitely many members and the population size of entrepreneurs is larger than that of the elite. For each class, the agents' behavior is captured by a representative agent, who maximizes his or her lifetime utility, $u(c_1^i) + \beta u(c_2^i) = \log c_1^i + \beta \log c_2^i$, where $i \in \{e, p\}$.

There is one final output that can be produced by two types of neoclassic firms. An imitative firm (M firm) produces it with technology, Z_t^m, that is an imitation of the world technology frontier, Z_{t-1}. Assume that the imitation efficiency is η, then $Z_t^m = \eta Z_{t-1}$. An innovative firm (N firm) improves on the existing technology in the economy in the previous period and produces $Z_t^n = \nu Z_{t-1}$, where Z_{t-1} is the technology level on which the innovation is based (technology used in the last period), which can be either imitative or innovative. We assume that in period 1, imitative technology is more productive because the existing technology in the economy is far removed from the world technology frontier. In period 2, innovative technology is more productive, given that the existing technology is sufficient in period 2. The assumption is formalized as follows in assumption (1).

$$Z_1^m = \eta Z_0 > \nu Z_0 = Z_1^n . Z_1^m < Z_2^m = \eta Z_1 < \nu Z_1 = Z_2^n \tag{1}$$

There are an infinite number of firms and therefore each firm takes prices as given. A representative firm for each type of firm is sufficient to capture the behavior of all firms. To keep the benchmark model simple, I assume that production only requires technology and not other resources such as capital or labor. Therefore, the production function is simply $Y_t = Z_t$. Because there is no labor, workers are also not modeled. In addition to their use of technology, the two types of firms are also different in terms of ownership: M firms can only be run by the elite, while N firms can only be run by the entrepreneurs. This assumption means that the elite have the capacity of putting resources together to run the imitative firms, while entrepreneurship is necessary for running innovative firms. The startup cost for both types of firms is $C \in (Z_1^n, Z_1^m)$. The startup cost makes running N firms at $t = 1$ unprofitable, but the cost is always smaller than output in the other three cases (running M firms at t = 1 and running M and N firms at t = 2).

In the goods market, a firm's output goes to the owner of the firm. Specifically, the output of M firms becomes the income of the elite, and the output of N firms is the income of the representative entrepreneur. Each agent can save in the international financial market and can get an exogenous return, r, in the next period.

B. Political Systems

In this model, there are two types of political regimes: democracy and oligarchy. In a democracy, given majority voting and the larger population size of entrepreneurs, the representative entrepreneur runs the government; in an oligarchy, the elite do.

In a democracy, the outcome is assumed to be the laissez-faire competitive equilibrium. Once a democracy is established at $t = 1$, it is consolidated at $t = 2$.

In an oligarchy, the policy maker can decide either to democratize or to sustain an oligarchy after paying the cost of repression. The government, as the pivotal policy maker, can do two things. First, it can decide to allow for one type of firm to operate—either M firms or N firms. We can think of this as the government needing to provide the necessary environment (regulations and laws) for either of the two types of firm, with only enough capacity to provide for one. Second, after production occurs, the government can tax the other group of agents and transfer the revenue to the ruling group, subject to a constraint on the upper bound of the tax rate. This represents so-called state capacity as described by Besley and Persson (2009).

C. Equilibrium

In this subsection, I first solve for the optimal behaviors of agents and then summarize the equilibrium outcome in both a democracy and an oligarchy.

Each agent maximizes his or her lifetime utility. Given the exogenous interest rate, r, this is equivalent to maximizing the lifetime income, $y_1^i + (1)/(1+r)y_2^i$, discounted by r and then using savings to smooth consumption in order to maximize

Table 1. **Outcome in a Democracy**

Democracy	Elite Income	Entrepreneur Income	Output
$t = 1$	$Z_1^m - C$	0	Z_1^m
$t = 2$	0	$Z_2^n - C$	Z_2^n

Source: Author's compilation.

the lifetime utility. Given the log utility, the consumption in period 1 is simply a fraction of lifetime income calculated as $1/(1+\beta)$). (For more details, see the Appendix.)

In the following discussion, we can think of the agents as lifetime income maximizers. In a democracy, I assume that the equilibrium outcome is the efficient competitive equilibrium; that is, in period 1 the government allows M firms to operate, given that they are more productive than N firms, while in period 2 the representative entrepreneur, being also the pivotal policy maker and the pivotal economic agent, chooses to allow the more productive N firms to operate. This assumption is made to simplify the discussion with regard to a democracy and focus on growth in an oligarchy, which is crucial for this paper and more relevant for discussions on the development of most middle-income economies. This assumption is without loss of generality and the conditions that guarantee it are quite natural and will be discussed in section III. The outcomes in a democracy can be summarized in Table 1.

In an oligarchy, the timing of events is as follows:

(i) At $t = 1$, the elite decide whether to democratize or not.

   (a) If yes, the economy enters equilibrium in a democracy and the elite receive an additional reward, R_1.[1]

   (b) If no, the elite pays a cost, C_1^o, to defend the oligarchy. Then the events described in the steps below will happen.

(ii) The elite decide whether to allow M firms or N firms to operate.

(iii) The elite decide whether or not to implement the rule of law and to commit to a tax rate, τ_1.

(iv) Owners of firms decide whether to produce or not.

   (a) If M firms are allowed to operate, the elite decide whether to produce or not.

[1] R_1 can be considered as a reputational reward or an income reward from the outside world (e.g., other economies and/or international organizations that encourage democratization).

(b) If N firms are allowed, entrepreneurs decide whether to produce or not.

(v) The elite tax entrepreneurs and transfer the tax revenue to themselves.

(a) If the elite commit to a tax rate in step (iii), the tax rate is τ_1.

(b) If not, the elite now set the tax rate at τ_1.[2]

(vi) If the economy is still an oligarchy at $t = 2$, then the same events occur as in $t = 1$.

The optimal actions of all agents can be solved by backward induction. Since events in period 2 are the same as events in period 1, we can also use steps (i)–(v) to denote the events in period 2. Of course, the notations have to be changed accordingly so that the subscript of time-dependent variables represents period 2 (e.g., R_2, τ_2, and C_2^o).

In step (v) of period 2, if the rule of law has been established and there is a committed tax rate, then the elite simply tax entrepreneurs at the rate τ_2; if there is no rule of law, the elite can tax or expropriate the property of entrepreneurs at the rate they choose. I assume that there is an upper bound of the tax rate, denoted as $\overline{\tau}$, subject to the state's capacity as defined by Besley and Persson (2009). Meanwhile, there is a lower bound of the tax rate that the elite can commit to, denoted as $\underline{\tau}$, in order to model the limited commitment ability. This assumption applies to both periods and is formally stated below as assumption (2). τ_t is the final tax rate, so it can represent the committed tax rate and also the reset tax rate.

$$\tau_t \in [\underline{\tau}, \overline{\tau}] \tag{2}$$

In period 2, given the expected tax rate, τ_2, if N firms are allowed to operate, entrepreneurs can pay a startup cost, C, to produce. If they produce, their expected income is $(1 - \tau_2)\, Z_2^n - C$; if not, their income is zero. If M firms are allowed to operate, the elite's expected income is $Z_2^m - C$ if they produce and zero if they do not. Given the assumption that C is small enough in period 2 when M firms are allowed, the elite always wants to produce. In comparison, when N firms are allowed, entrepreneurs only want to produce if they expect the tax rate to be low enough; that is, $\tau_2 \leq 1 - C/Z_2^n$, which leads to $(1 - \tau_2)Z_2^n - C \geq 0$. Obviously, allowing N firms to operate without incentivizing entrepreneurs to produce leaves everyone without income, which is never optimal. Either the elite is able to commit to a low

[2] τ_t is used to indicate both the committed tax rate set in step (iii) and the tax rate reset in step (v) when there is no commitment. Though these are two tax rates, they never appear at the same time; either the committed tax rate or the reset tax rate exists and becomes the final tax rate that entrepreneurs pay. Therefore, using τ_t to denote the final tax rate on entrepreneurs—either the committed rate or the reset rate—should not create confusion.

Table 2. **Outcome in the Oligarchy in Period 2**

	Elite Income	Entrepreneur Income	Output
Democratization	R_2	$Z_2^n - C$	Z_2^n
Oligarchy with innovation	$\tau_2 Z_2^n - C_2^o$	$(1 - \tau_2) Z_2^n - C$	Z_2^n
Oligarchy without innovation	$Z_2^m - C - C_2^o$	0	Z_2^m

Source: Authors' compilation.

Table 3. **Optimal Choice in Period 2**

Condition	Choice	Elite Income
$C_2^o + R_2 > \max\{\tau Z_2^n, Z_2^m - C\}$	Democratization	R_2
$\tau_2 Z_2^n > \max\{C_2^o + R_2, Z_2^m - C\}$	Oligarchy with innovation	$\tau_2 Z_2^n - C_2^o$
$Z_2^m > \max\{C_2^o + R_2, \tau Z_2^n\}$	Oligarchy without innovation	$Z_2^m - C_2^o$

Source: Author's compilation.

enough tax rate to incentivize entrepreneurs or it chooses to operate M firms itself. There are two ways to commit to a low enough tax rate on entrepreneurs. The first is to implement the rule of law and set τ_2 as in step (iii) of period 2. The second way, though not obvious, is to democratize in step (i) of period 2. After democratization, entrepreneurs know that they will run the government and therefore will not be taxed. In short, there are three possible outcomes in period 2, which are summarized in Table 2.

Under which conditions do the elite choose democratization? Under which alternatives do the elite choose to stay in an oligarchy but allow for innovation? First, an oligarchy with innovation is not always an available choice, while democratization and an oligarchy without innovation are always possible choices. To choose an oligarchy with innovation, it must be that $\tau_2 \leq 1 - C/Z_2^n$. Remember that assumption (2) says that $\tau_2 \geq \underline{\tau}$. Only if $\underline{\tau} \leq 1 - C/Z_2^n$ is it possible to commit to a tax rate, τ_2, that is low enough to incentivize entrepreneurs to produce, but not so low as to make the commitment impossible. In this case, the highest tax rate that both satisfies the state capacity constraint and is compatible with the incentive constraint, $\tau_2 = \min(\overline{\tau}, 1 - C/Z_2^n)$, is the optimal tax rate for the elite. Second, when all three choices are possible, the one that gives the elite the highest final income is chosen. The choice depends on parameters such as C_2^o and R_2.The different cases are summarized in Table 3.

Intuitively, when the return on democratization and the cost of defending an oligarchy are high enough, democratization is the optimal choice of the elite. Otherwise, an oligarchy is maintained. In this situation, if output from innovation and tax capacity are high enough, an oligarchy with the rule of law is chosen and innovation occurs. This is also conditional on being able to commit to a low enough tax rate. The final case, an oligarchy without innovation, is chosen when the conditions for the above two cases are not satisfied, or equivalently, when the return from imitation is high for the elite (though not for society as a whole). The elite

Table 4. **Outcome in the Oligarchy in Period 1**

	Elite Income	Entrepreneur Income	Output
Democratization	$Z_1^m - C + R_1$	0	Z_1^m
Oligarchy	$Z_1^m - C - C_1^o$	0	Z_1^m

Source: Author's compilation.

Table 5. **Elite Income**

Elite Income	t = 1	t = 2	Lifetime
Democratization	$Z_1^m - C + R_1$	0	$Z_1^m - C + R_1$
Oligarchy	$Z_1^m - C - C_1^o$	y_2^o	$Z_1^m - C - C_1^o + 1/(1+r)y_2^o$

Source: Author's compilation.

choose to allow only M firms to produce and do not need to establish the rule of law or commit to a tax rate—expropriation is optimal for the elite (in the off-equilibrium path) if an entrepreneur produces.

In period 1, given the same sequence of events as in period 2, the potential different choices and outcomes are similar. One simplification to the cases in period 1 is that imitation is always better than innovation, both for total output and the elite's income, given the assumption $Z_1^m > Z_1^n$. The elite never choose to allow for N firms to operate because operating M firms is always more productive and implies more income for the elite. The reason that in period 2 the elite may choose to forbid the more efficient N firms from producing is because the elite only claim a fraction of the N firms' output, while in period 1, the elite claim all of the output of the more efficient M firms. There will be no innovation and the two possible outcomes are summarized in Table 4.

The income in period 1 is always higher if the elite choose democratization, given that there is a reward for democratization and a cost to defending an oligarchy. However, the continuation value from period 2 once democratization is chosen in period 1 is simply zero, and the continuation value from maintaining an oligarchy, $y_2{}^o$, is larger. The optimal choice of the elite in period 1 should be to maximize the elite's lifetime income, which is the sum of income in period 1 and the discounted income from period 2. The income of the elite is summarized in Table 5. If the return from democratization and the cost of defending an oligarchy in period 1 is large enough, in terms of $R_1 + C_1^o \geq 1/(1+r)y_2^o$, then democratization happens in period 1. Otherwise, an oligarchy will persist.

The output in both cases is the same in period 1 as democracy does not lead to increased output in the early stage of development. When an oligarchy is sustained until period 2, three cases—with or without democratization, or the rule of law—may emerge in period 2, depending on the conditions discussed above. However, in the long run, democracy leads to higher output. The different cases and corresponding conditions are summarized in Table 6.

Table 6. **Summary of All Cases**

Conditions			$t = 1$	$t = 2$
$C_1^o + R_1$ large			Democracy, Z_1^m	Democracy, Z_2^n
$C_1^o + R_1$ small	$C_2^o + R_2$ large		Oligarchy, Z_1^m	Democracy, Z_2^n
	$C_2^o + R_2$ small	$\bar{\tau}$ large and $\underline{\tau}$ small	Oligarchy, Z_1^m	Oligarchy with innovation, Z_2^n
		$\bar{\tau}$ small or $\underline{\tau}$ large	Oligarchy, Z_1^m	Oligarchy without innovation, Z_2^m

Source: Author's compilation.

D. Implications for the Middle-Income Trap

In the model, the middle-income trap corresponds to the case of an economy growing in period 1 through imitation but failing to switch to innovation in period 2. This happens in an oligarchy when the state's tax capacity is too low for the elite to benefit from switching to innovation-based growth, or the commitment to a low enough tax rate to incentivize entrepreneurs to innovate does not exist even though the elite want to switch to innovation.

To escape the middle-income trap, several policies are necessary. First, the government needs to create an environment that facilitates the operation of innovative firms. This includes the protection of intellectual property and equality between the rights of firms that are politically connected to the government and private innovative firms. In the model, this corresponds to the elite choosing to allow for N firms to produce in step (ii) of period 2. Second, the government has to guarantee that entrepreneurs will receive a large enough return on their investment in innovation without being taxed too heavily or having property expropriated. This requires policies such as a stable and reasonable tax rate, and the protection of property rights. Moreover, it requires the government's commitment to such policies.

Whether the government is willing and able to pursue the right policies to escape the middle-income trap depends on the status of its political institutions. For example, the second condition described above, the guarantee of an entrepreneur's return on innovation, does not exist in cases when an oligarchic government fails to implement the rule of law. On the other hand, it does exist when the rule of law is implemented in an oligarchy, as occurred in Hong Kong, China and Singapore, or when there is democratization, as occurred in the Republic of Korea. In the former case, the rule of law guarantees a reasonable tax rate and protects the property rights of private entrepreneurs. In the latter case, political power is shared with entrepreneurs following democratization so that the government represents entrepreneurs' interests and provides the necessary protection for innovation.

Why do some economies implement the rule of law in an oligarchy and some economies democratize and eventually become rich, while others do not and ultimately fail to escape from the middle-income trap? These choices are determined by the fundamentals of different economies that can lead to divergence in political development and, eventually, economic growth. One such fundamental is state capacity. When state capacity is low, the elite do not benefit enough from innovation. Therefore, the elite have no incentive to implement the rule of law and other policies that encourage innovation since this would harm their existing interest in imitative production. This corresponds with so-called "weak states" in which the government lacks the power to tax and regulate the economy (Besley and Persson 2009). This problem hinders growth in poor economies as well as in middle-income economies.

The second fundamental is the ability of a government to commit. In the model, if the government implements the rule of law to commit to a tax rate, there is a lower bound to the tax rate. In reality, the government's ability to commit depends on the trust of the citizens in the government. It takes time for a government to establish a good reputation with its citizens. If the government has implemented promised policies in the past, then citizens will be more likely to believe that the government will not increase the tax rate when output increases. Moreover, the ability to commit also depends on the cost of reneging. If the cost is high, then citizens are able to punish the policy maker for reneging. Punishment is more likely to happen when citizens hold sufficient political power. For example, in a democratic society, citizens may be able to replace the policy maker when it reneges on its promises. In economies where the cost of reneging is low, either because there is no way to punish the policy maker or because its reputation has not been firmly established, the policy maker may not be able to credibly commit to a low enough tax rate. Entrepreneurs will then rationally expect that the tax rate and/or probability of expropriation will be high and they will not invest in innovative production.

The third fundamental is the existing interest of the elite in imitative technology. If their interest is high, it is more likely that the elite will decide to maintain the political institutions and policies that favor their own businesses and prevent more productive and innovative firms from entering the market and reducing their economic rent.

In summary, the model illustrates which policies are crucial for escaping the middle-income trap and shows whether these policies can or will be implemented depending on the status of an economy's political institutions. Political institutions, which are partly endogenous, are determined by fundamentals such as state capacity, the government's commitment ability, and the elite's existing interest. At the same time, these fundamentals and policy-making incentives can be changed through targeted foreign aid. Therefore, it is possible that international organizations can provide the right type of assistance to help an economy escape the middle-income trap. Foreign aid that focuses on short-run growth without taking into account related political developments and long-run impacts may be detrimental to an economy's long-run growth. In section III, I will extend the model to allow for discussions of the impacts of foreign aid on short-run growth, political developments, and long-run growth.

III. Extension of the Model

In this section, the benchmark model is extended to study the impact of foreign aid, including which types of foreign aid can be helpful for an economy seeking to escape the middle-income trap. The robustness of the model is also discussed. Assumptions in the benchmark model are also discussed and the consequences of relaxing them or using alternative settings are considered.

A. Foreign Aid

Unconditional foreign aid may increase the total income in an economy while not changing the incentives that make the policy maker adopt the right policies and political institutions that will eventually lead to sustainable growth. On the other hand, foreign aid that is conditional on policies, political choices, and fundamentals may change the equilibrium outcome and the development path.

Foreign aid can be made conditional on the adoption of policies that encourage innovation and opening, such as conditional policy loans to promote an open capital market and the relaxation of restrictions on foreign direct investment. If more innovative firms (and perhaps international firms) are allowed to enter the market, then the technological progress and growth of middle-income economies will accelerate (see, for example, Bulman, Eden, and Nguyen 2014; and Han and Wei 2015). In the model, this corresponds to adding an extra return, R^N, in the step allowing for N firms to operate.

In addition to directly changing incentives for policy making, it is also possible to influence the incentives of political choices that, in turn, affect policies. In the model, this corresponds to increasing the return on democratization, R_t, and raising the cost of defending an oligarchy, C_t^o. Foreign aid that strengthens civil society and democratic activities, or puts pressure on nondemocratic regimes, may not have a direct positive effect on short-run growth but may lead to political developments that allow for a more equal sharing of growth resulting from innovation. This can facilitate long-run technological progress and growth.

Finally, interventions that seek to change crucial fundamentals can also lead to the favored outcome. If the lack of state capacity is the problem, foreign aid that strengthens the tax regime or develops a formal sector that allows for more efficient taxation can be the solution. If the interest of the elite in maintaining inefficient industries is the reason for the prevention of innovation, free entry, and creative destruction, then foreign aid that seeks to reduce the interest of the elite in sustaining these industries can be effective. In contrast, interventions that help such industries increase short-run output may harm long-run political and economic developments, as shown in the following example.

In the early stage of development, an international organization decides to provide aid for imitative firms through loans designed to increase its capital and/or improve its technology. This may increase short-run output, which implies that there is an interest among the elite in keeping in place policies that protect imitative firms. This can result in period 2 in the elite deciding not to encourage innovation, while absent any such foreign aid the elite might have chosen to replace imitative firms with innovative firms. The consequence of such aid is higher short-run output with lower long-run output. Mapping this into the model, let us consider an increase of Z_1^m and Z_2^m to $Z_1^m + \delta$ and $Z_2^m + \delta < Z_2^n$, without changing $Z_2{}^n$. The equilibrium outcome without the aid is an oligarchy with the rule of law in period 2, since allowing N firms to produce is the same for the elite as keeping production with M firms ($\tau_2 Z_2^n = Z_2^m - C$). With the foreign aid, $\tau_2 Z_2^n < Z_2^m + \delta - C$, an oligarchy without innovation is preferred by the elite and the final output decreases from Z_2^n to $Z_2^m + \delta$. The aid only improves output if the political institutions and policies are held constant. However, it changes the incentives and the pivotal policy maker's political choice. Eventually, providing aid to imitative firms in the early stage of development has a negative impact on long-run output.

Understanding the difference between short-run and long-run consequences also allows for providing more efficient aid at a cheaper price. For example, aid that encourages the government to democratize in the early stage of the development may not have an immediate impact on growth, but it can have an impact in the later stage of development. Naturally, one may argue that since democratization does not improve output in the early stage of development, foreign aid can wait until the economy enters the advanced stage of development. This logic is incorrect, however, because the cost of intervention in the later stage can be higher. Consider the following extension of the model. Suppose that without foreign aid, there is no reward for democratization, $R_1 = R_2 = 0$, and at $t = 2$ the optimal choice of the elite without the aid is an oligarchy without the rule of law. To help an economy democratize and eventually achieve innovation-driven growth, aid that is conditional on democratization, if provided at $t = 2$, has to increase R_2 to at least $Z_2^m - C - C_2^o$. If the aid is provided at $t = 1$, the following condition has to be satisfied, $R_1 \geq -C_1^o + 1/(1+r)(Z_2^m - C - C_2^o)$, which makes democratization attractive to the elite. If the aid provider discounts the cash flow with interest rate r', then its cost of providing the aid at $t = 2$ is $1/(1+r')(Z_2^m - C - C_2^o)$ and at $t = 1$ is $-C_1^o + 1/(1+r)(Z_2^m - C - C_2^o)$. As long as r' is not too large, it is cheaper to provide aid at $t = 1$, though it does not immediately help growth. For example, $r' = r$ is a sufficient condition. In fact, even if r' is slightly bigger than r, it may still be optimal to incentivize democratization in period 1 as it saves the elite from paying the repression cost in period 1.

In summary, taking into account the political response and policy changes is important to analyze the impacts of foreign aid. This knowledge allows international organizations to design better aid programs that promote the growth of middle-income economies and helps to avoid interventions that focus only on the short run while leading to negative long-run outcomes.

B. Assumptions about Democracy

In section II, I assume that democracy leads to the laissez-faire competitive equilibrium in which the more productive firms (M firms at $t = 1$ and N firms at $t = 2$) operate and there is no tax. It seems reasonable to assume that in a democracy, though the elite are no longer the pivotal policy maker, they still enjoy a high level of status and their property has not been expropriated by entrepreneurs. That said, it is interesting to think about what happens if entrepreneurs could expropriate the elite's property in a democracy. At $t = 2$, the elite receive no income from production since only N firms operate; thus, there is nothing to expropriate or tax. At $t = 1$, the entrepreneur taxes the elite to the highest level such that the elite are still willing to invest in M firms, subject to the state capacity constraint, which is $\min(1 - C/Z_1^m, \overline{\tau})$. Given $C > Z_1^n$, it is never profitable to run N firms at $t = 1$, so we do not need to consider a case in which the representative entrepreneur forbids the elite from running M firms and decides to run N firms. If we drop the assumption in the benchmark model about democracy and allow for a tax, then in period 2 there will be no difference, while in period 1 the elite's income is lower. Thus, the qualitative structure of the paper does not change.

C. Uncertainty

In the benchmark model, there is no uncertainty. All agents have perfect foresight. It is reasonable to think that in reality there may be political uncertainty and risks in pursuing innovation. Given the linear feature of the model with regard to the production functions and the agent's maximization problem, introducing uncertainties would change the model. The only difference is that the period 2 variables now represent their expected values, taking into account all possible realizations. Of course, if we introduce some curvature to the agent's maximization problem, the results will be quantitatively different. However, the main results should stay the same if these changes do not affect the key assumptions; that is, innovation is still more attractive in period 2 when taking into account the risk aversion of entrepreneurs.

IV. Conclusion

This paper proposes a politico-economic theory for the middle-income trap. It studies the policies that help a middle-income economy switch to technological progress and sustainable growth led by innovation. It also analyzes the political institutions that allow for these policies. It discusses the fundamentals of an economy, including state capacity and the government's commitment ability, that determine which political institutions endogenously emerge and whether an economy will implement the right policies to escape the middle-income trap.

This theory is also useful for studying the impacts of foreign aid not only on output in the short run, but also with regard to the political response of the government and the long-run impacts on political and economic developments. This can help international organizations to design efficient and low-cost aid programs, and identify those interventions that provide only short-term benefits while harming long-run development.

Many simplifications have been made in this paper in order to emphasize the primary logic and key message of the theory. For example, the outcome in a democracy is simply assumed to be the efficient competitive equilibrium. Future research is needed to make the theoretical model more realistic and to answer important real-world questions.

Moreover, the government's commitment problem in an oligarchy is represented by a reduced-form parameter. It would be useful to properly model and study the commitment problem in order to better understand how the government can solve the problem and implement the rule of law, and how the rule of law as one commitment device interacts with democratization as the other commitment device.

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Appendix: Maximization of Lifetime Utility

An agent, *i,* maximizes the lifetime utility, subject to the lifetime budget constraint as follows:

$$\max_{c_1^i, c_2^i, p} \log c_1^i + \beta \log c_2^i, \text{ s.t. } c_1^i + 1/(1+r)c_2^i = y_1^i(p) + 1/(1+r)y_2^i(p)$$

where p represents choice variables other than consumption, which include policies and political choices when the agent is the pivotal policy maker, and the investment decisions when it is the pivotal economic agent. Obviously, the optimal solution to the above problem $\{c_1^*, c_2^*, p^*\}$ contains p^* that maximizes $y_1^i(p) + 1/(1+r)y_2^i(p)$ because it gives the highest lifetime budget and therefore gives the largest choice set of $\{c_1^i, c_2^i\}$. To know more about p^*, we can focus on the following problem:

$$\max y_1^i(p) + 1/(1+r)y_2^i(p)$$

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