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Abstract

While developing Asia has recovered strongly from the global crisis, the region faces the medium- and long-term challenge of sustaining growth beyond the crisis. The central objective of this paper is to empirically investigate the sources of economic growth in 12 developing Asian economies during 1992–2007 via a two-stage analysis. In the first stage, we estimate total factor productivity growth (TFPG) and account for the relative importance of labor, capital, and TFPG in growth. In the second stage, we examine the effect of fundamental determinants of growth such as human capital on both economic growth and TFPG. Our most significant finding is that TFPG is becoming relatively more important as a source of developing Asia's growth. Our results also confirm the relevance of supply-side factors, in particular human capital and openness to trade, for developing Asia's medium- and long-term growth. The overarching implication for policy makers is that supply-side policies that foster productivity growth will be vital for sustaining developing Asia's future growth in the postcrisis period.

I. Introduction: Sustaining Developing Asia's Growth Beyond the Global Crisis

During 2008–2009, developing Asia was fully preoccupied with overcoming the adverse impact of the global financial and economic crisis. The collapse of global trade brought about by the compression of demand in industrialized countries climaxed during the fourth quarter of 2008 and first quarter of 2009, with predictably dire consequences for the region's exports and growth. During those two quarters there were widespread concerns that the export-dependent region would suffer a deep and protracted recession. Fortunately, however, the region has staged a stunning V-shaped recovery that has surpassed all expectations. While the region's gross domestic product (GDP) growth rate slipped from an average of 8.83% during 2005–2007 to 6.6% in 2008 and further to 5.2% in 2009, it is projected to rebound strongly to 7.5% in 2010 and 7.3% in 2011. Understandably and appropriately, the overriding priority of developing Asian governments in 2008–2009 lay in mitigating the impact of the global crisis on domestic economic activity. The region's countries quickly and decisively implemented countercyclical fiscal and monetary stimulus programs to support aggregate demand in the face of plummeting exports and feeble private consumption and investment. As the crisis recedes and recovery gathers momentum, however, short-run output stabilization will give way to long-run output growth as the top priority of developing Asia's policy makers. It is true that there is no clear-cut dichotomy between short-run stabilization and long-run growth, and the former can pave the way for the latter. If developing Asia had suffered a much more pronounced impact from the global crisis, the region would have been in a far worse position for medium-term growth in the postcrisis period. Nevertheless, the distinction matters because short-run output fluctuations are more influenced by aggregate demand, whereas long-run growth depends more on supply-side factors that augment an economy's productive capacity. Therefore, policies that reduce short-term output volatility are targeted toward aggregate demand whereas policies that foster long-term growth are targeted toward boosting the supply of productive factors and their productivity. While developing Asia has surpassed all expectations in weathering and recovering from a once-in-a-lifetime external shock, the key question now becomes whether the region can sustain rapid growth beyond the recovery. That is, what are the major obstacles to long-term growth in the postcrisis world and what must the region do to successfully overcome them?

For developing Asia, sustaining growth in the medium and long run matters, and matters hugely for a number of reasons. Above all, for all its sustained rapid growth in the decades prior to the global crisis and its remarkable resilience during the global crisis, developing Asia remains by and large a poor region. The region remains home to two thirds of the world's poor despite the massive reduction of poverty that has accompanied the region's rapid growth. One has to remember the very low initial base (i.e., very low per capita income levels and correspondingly high poverty rates) from which the region began its economic ascent. There is undoubtedly an element of truth in the countless news headlines proclaiming the dawn of the Asian century, and a seismic shift in the global balance of economic power from the West to the East. However, such headlines should not detract from the fundamental fact that the region still lags far behind the industrialized countries in terms of living standards, and hundreds of millions of its citizens still live below the poverty line. Furthermore, there is no guarantee that the stellar growth of the precrisis period will automatically carry over into the postcrisis period. There is also an unfortunate tendency in the mass media to highlight GDP, e.g., "the People's Republic of China [PRC] set to become the world's second biggest economy", and neglect GDP per capita, which is much more relevant for living standards. In short, sustaining long-run growth in the postcrisis period is important both for lifting general living standards and making a further dent on still-widespread poverty.

Sustaining growth in the postcrisis world will be more challenging in many ways than in the precrisis world because the external environment is likely to be less benign. In particular, the global crisis could have far-reaching ramifications for the region's export-led growth paradigm. In striking contrast to most previous financial crises, the current global crisis originated in industrialized countries. As a result, the global crisis has hit industrialized countries much harder than developing countries and recovery has been noticeably quicker and more robust in the latter group of countries. This asymmetry marks a continuation and intensification of a gradual but secular rise in the relative importance of developing countries in the world economy. Part of the burden of unwinding the global current account imbalances that contributed to the global crisis will fall on the deficit countries, in particular the United States (US). The projected decline in US consumption and rise in US savings is desirable for global stability but will adversely affect developing Asia's export and growth prospects in the short run. Likewise, the general weakening of European economies reeling from fiscal problems does not bode well for their revival as dynamic markets for Asian exporters. The postcrisis world is also likely to be more volatile since industrialized countries—the bedrocks of stability prior to the crisis—have become potential sources of volatility since the crisis. Instability emanating from industrialized countries will have a proportionately bigger impact on global stability, as the 2008–2009 global crisis painfully illustrated.

As developing Asia's recovery consolidates and gains a firmer footing, medium- and long-run growth will reassert themselves as the region's top priorities. The global crisis has highlighted the feasibility and desirability of short-run output stabilization in the face

of a severe external shock to a region unaccustomed to using fiscal and monetary policy for countercyclical purposes. However, over a longer time horizon, the still-low average per capita incomes and still-large poor population of the region means that medium- and long-run growth overshadow short run stability as the overall macroeconomic objective. An important question that arises in connection with maximizing the region's medium- and long-run growth is whether there needs to be a fundamental rethinking of the Asian growth model. What has made this question all the more relevant is the changes to the global economic environment, which may call for adjustments to the precrisis growth model. All in all, the global crisis provides an opportune time for taking stock of the region's sustained rapid growth in the precrisis period, as well as thinking about effective ways to cope with constraints to growth in the postcrisis period.

II. Toward a New Asian Growth Paradigm?

Many observers might find it puzzling as to why we are even posing the question of whether developing Asia needs a new model in order to sustain growth beyond the crisis. After all, the region has stood out for its sustained rapid growth, and had easily outperformed the rest of the world for decades. As a result of its strong fundamentals, developing Asia is also recovering more quickly and strongly than other regions and is leading the world out of recession. Therefore, it may seem an odd time to reexamine the appropriateness of Asia's time-tested growth model. Indeed many elements that contributed to the region's superior long-run performance in the precrisis period will continue to serve it well in the postcrisis period. For example, developing Asia's prudent fiscal and monetary policy laid the foundation for macroeconomic stability that enabled the region's firms and households to plan for the long term. Fiscal and monetary policies fostering macroeconomic stability will remain highly relevant for long-run growth in the postcrisis world. Another example of a timeless ingredient of the Asian miracles is openness to foreign trade and technology. An outward-looking growth strategy that reinforces the region's vital links with the outside world will continue to deliver huge benefits for the region's growth and welfare in the postcrisis period. High savings and investment rates that enabled a rapid build-up of the region's physical capital stock in the precrisis period will do so beyond the crisis as well. In short, many ingredients of the recipe for precrisis success remain valid for postcrisis success.

The one ingredient of the region's precrisis growth paradigm that has been called into question by the global crisis is the region's export-oriented growth. However, developing Asia's experience during the global crisis does not invalidate developing Asia's export-led growth strategy. Exports enabled Asian producers to overcome the limitations of small domestic markets and forced them to become more efficient in order to compete successfully in highly competitive foreign markets. What the global crisis highlights is not so much the risks of growing via integration into the world economy, but rather, the costs

of neglecting the potential contribution of domestic demand to growth. To the extent that various structural distortions impede domestic demand and production for the domestic market, removing such distortions can provide the economy with an additional source of growth and dynamism (ADB 2009a). In fact, rebalancing Asia's growth toward domestic sources has become a policy priority in many Asian countries, most notably in the PRC. Rebalancing involves not only demand-side measures aimed at strengthening domestic demand (such as social protection) but also supply-side measures that boost industries and firms catering to domestic demand (such as services). A natural consequence of stronger domestic economies would be stronger intraregional trade that would enable regional countries to exploit hitherto underexploited gains from trade with their neighbors (ADB 2009b). Rebalancing and intraregional trade are thus two new and distinctive elements of the postcrisis Asian growth paradigm.

While a greater role for domestic demand and intra-Asian trade will be important elements of developing Asia's postcrisis economic landscape, in this paper we want to instead explore the supply side factors that have become more influential over a longer time horizon. In the long run, an economy's growth is determined primarily by supply side factors, in particular the accumulation of factors of production—capital and labor—and their productivity. Those factors are likely to overshadow the structure of demand as the determinants of developing Asia's long-run growth performance. There is a long-running debate on whether developing Asia's growth was driven by factor accumulation or productivity gains. The balance of evidence suggests that in the past the region's sustained rapid growth was driven primarily by factor accumulation. Yet there are good reasons to believe that the relative importance of productivity gains will rise in the postglobal crisis period. Above all, according to the law of diminishing marginal returns to capital, the high-savings, high-investment paradigm of the precrisis period will yield smaller benefits as the size of the physical capital stock increases. Many East and Southeast Asian countries have built up a large stock of physical capital as a result of their high-saving, high-investment growth pattern. In addition to a less benign external environment arising from weaker demand and greater volatility in industrialized countries, developing Asia also faces a number of homegrown structural shifts impinging upon the region's long-run growth. In particular, the region is in the midst of a rapid demographic transition toward older populations.

The most fundamental reason for taking a closer look at developing Asia's growth paradigm as we move into the postglobal crisis world is that the region's past success has fundamentally transformed it. Today's Asia is far different from yesterday's Asia. It should be emphasized that many of the elements of the Asian growth paradigm that had served the region well before the global crisis (for example, macroeconomic stability and openness to trade) will continue to serve it well beyond the crisis. The region did so well because it got many of the fundamentals "right" and there is no compelling reason to move away from those fundamentals. This means that some of the ingredients of Asia's spectacularly successful recipe for growth are less relevant for today's industrialized,

middle-income Asia than they were for yesterday's agricultural, low-income Asia. In particular, productivity growth will become a relatively more important source of growth than reallocation of surplus rural labor and rapid accumulation of physical capital. The key to sustaining rapid growth beyond the global crisis thus lies in improving the productivity of labor and capital on a sustained basis.

Mapping out the region's future growth requires a basic understanding of the region's past growth. In this connection, the key question is "What have been the drivers of the region's growth in the past?" A related question is "Has the relative importance of the different growth drivers changed over time?" This evolution in the sources of growth over time holds telling clues about the likely sources of future growth. Above all, any shift in the relative importance of growth drivers—given that some drivers are becoming more important while other drivers are becoming less important—in the precrisis period can inform us about the likely structure and direction of growth in the postcrisis period. This, in turn, can inform policy makers about the major constraints to growth that have to be addressed and, more broadly, the kinds of policies that they need to put into place in order to sustain growth beyond the crisis. The next two sections describe the empirical analysis of developing Asia's growth drivers during 1992–2007, and report and discuss the main findings from the analysis.

III. Recent Patterns of Growth in Developing Asia: Growth Accounting

In this section, we examine recent patterns of growth in developing Asia. More specifically, we examine the relative importance of capital, labor, and total factor productivity (TFP) in explaining the region's economic growth during 1992–2007. As explained earlier, the two primary sources of growth are the accumulation of factors, i.e., growth in the quantity of capital and labor; and TFP growth. Although labor productivity growth, or the increase in output produced by one unit of labor, is also a widely used indicator of productivity, TFP growth is a more accurate indicator of productivity improvements since it indicates improvement in the efficiency in production, controlling for the contribution of all factors of production that are used. In addition, in the case of developing Asia, the key question regarding growth has always been the relative importance of capital accumulation versus productivity growth, and this can be better resolved by looking at TFP rather than labor productivity.

A. Empirical Framework and Data

The 12 Asian developing economies (ADEs) in our sample are the PRC; Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; Pakistan; the Philippines;

Singapore; Taipei,China; Thailand; and Viet Nam. The 12 economies are divided into three groups:

(i) the PRC

(ii) four newly industrializing economies (NIEs): Hong Kong, China; the Republic of Korea; Singapore; Taipei,China

(iii) seven ADEs: India, Indonesia, Malaysia, Pakistan, the Philippines, Thailand, Viet Nam

The PRC is treated as a separate group in light of its size, exceptional growth, and unique structural characteristics. For comparative purposes, we also include the G5, which we divide into Japan and non-Asian G5, i.e., France, Germany, the United Kingdom, and the US. We divide our sample period (1992–2007) into three distinct subperiods with different structural characteristics:

(i) 1992–1997 marks the pre-Asian crisis period characterized by imbalances that brought about the crisis

(ii) 1997–2002 marks the immediate post-Asian crisis period characterized by restructuring and reform

(iii) 2002–2007 marks the most recent subperiod characterized by rapid pre-global crisis growth

In calculating TFP growth, we assume a two-input neoclassical production function with constant returns to scale. TFP growth is calculated based on the following equation.

$$\Delta \ln(TFP) = \Delta \ln(Y) - (1 - \alpha_L)\Delta \ln(K) - \alpha_L \Delta \ln(L) \quad (1)$$

where *Y* is GDP, *K* is capital stock, and *L* is labor.

This basic formula uses a labor input without quality adjustment for human capital differences. The parameter α_L is the output elasticity with respect to labor. In most growth accounting literature, it is common to assume competitive labor markets under which output elasticity with respect to labor is equal to the labor shares of GDP. Data on labor compensation is available in the *National Accounts Statistics* of the United Nations. However, for the 12 Asian economies in question, the data on labor compensation is available for only limited countries and for only limited periods. Therefore, we have chosen to produce TFP growth based on two different methods. First, we have calculated labor shares for the Asian economies with labor compensation data. For the countries without labor share data, we have borrowed and applied those of the Asian economies

with labor share data. Second, we followed the study of Fischer (1993) and have assumed a common labor share to be 0.6.

Labor is usually considered to be augmented by enhancements in human capital. Since formal education is a major source of human capital enhancement, we incorporate average educational attainment years of the population (*h*) of each country to augment labor.

Here, we consider two types of labor quality adjustments. First, labor (*L*) is linearly adjusted by human capital (*h*): *hL*. The TFP growth estimates is calculated based on the following equation.

$$\Delta \ln(TFP) = \Delta \ln(Y) - (1 - \alpha_L)\Delta \ln(K) - \alpha_L[\Delta \ln(L) + \Delta \ln(h)] \quad (2)$$

Second, labor is exponentially adjusted by human capital: exp*(0.08*h)L*. This adjustment method is taken from Barro and Lee (2010). The TFP growth estimates is calculated based on the following equation.

$$\Delta \ln(TFP) = \Delta \ln(Y) - (1 - \alpha_L)\Delta \ln(K) - \alpha_L[\Delta \ln(L) + 0.08\Delta h] \quad (3)$$

B. Empirical Results

In this subsection, we report and discuss the results of the empirical analysis described in the preceding subsection. Table 1 reports the TFP estimates calculated for 1992–1997 on the basis of equation (1) without any adjustment for human capital. The first three rows of Table 1 report the average growth in output, capital, and labor during 1992–1997 for each of our country groups (four non-Asian G5 countries, Japan, four NIEs, the PRC, and seven ADEs). The next three rows report the respective contribution of capital, labor, and TFP to output growth under the assumption that labor share is equal to actual share of labor in national income. This assumption is denoted as C1. Contribution of capital is the percentage point of the output growth that is explained by the growth in capital (= $(1 - \alpha_L)\Delta \ln(K)$). Contribution of labor is the percentage point of the output growth that is explained by the growth in labor (= $\alpha_L \Delta \ln(L)$). Contribution of TFP is the percentage point of output growth (= $\Delta \ln(y)$) that is explained by the TFP growth (= Δ ln(TFP)). The next row reports the relative portion of output growth that is explained by the TFP growth (= $\Delta \ln(TFP)/\Delta \ln(y)$). For example, for the non-Asian G5, since the contribution of TFP growth to output growth is 1.04% and output growth is 2.35%, the relative contribution of TFP growth is 44% (= 1.04/2.35). The next four rows report the results of the identical growth accounting exercise under an alternative assumption about the share of labor, which is assumed to be 0.6 as in Fischer (1993). This alternative assumption is denoted as C2. Tables 2 and 3 report the results of the identical empirical analysis for 1997–2002 and 2002–2007, respectively.

Table 1: Contribution of Capital, Labor, and TFP to Output Growth, 1992–1997 (percent)

	Non-Asian G5	Japan	Four NIEs	China, People's Rep. of	7 ADEs
Growth in					
Output	2.35	1.26	6.99	9.79	5.64
Capital	2.50	3.29	8.72	11.45	8.04
Labor	0.50	0.61	2.14	1.17	2.33
C1. labor share = actual					
Contribution of					
Capital	1.03	1.63	4.42	5.39	5.57
Labor	0.29	0.31	1.03	0.62	0.70
TFP	1.04	-0.68	1.55	3.78	-0.63
(Relative contribution of TFP)	44.00	-53.52	22.18	38.63	-11.24
C2. labor share = 0.6					
Contribution of					
Capital	1.00	1.32	3.49	4.58	3.21
Labor	0.30	0.37	1.28	0.70	1.40
TFP	1.06	-0.42	2.22	4.51	1.03%
(Relative contribution of TFP)	44.90	-33.20	31.77	46.10	18.26
lsh1992	60.00	60.00	60.00	60.00	60.00
labsh1992	60.06	49.12	49.71	52.33	30.06

ADE = Asian developing economy, NIE = newly industrializing economy, TFP = total factor productivity.
Note: Labor quality not adjusted for human capital.
Source: Authors' estimates.

The most striking result from Tables 1, 2, and 3 is that there has been a clear shift in the sources of growth from physical capital accumulation to TFP in ADEs. Prior to 2002, the expansion of the capital stock was the main source of output growth in the region, but after 2002, TFP growth accounted for a much larger share of growth. Throughout the entire sample period, the contribution of labor was minimal for all Asian economies. The contribution of TFP growth for the Asian economies is lower when actual labor shares are used, since their actual labor shares are typically less than 0.6. As a result, higher weights are applied to capital stock growth, which was very high. The relative contribution of TFP was lower than for the non-Asian G5 until 2002. However, estimates and contributions of TFP growth have increased significantly in the period 2002–2007 for the four NIEs and seven ADEs. The TFP growth estimates for the 11 Asian economies for this subperiod are even higher than those of the non-Asian G5. The estimates and contribution of the PRC's TFP growth are strongly positive throughout the entire sample period, showing a very different pattern compared to those of the Asian economies at a similar developmental stage.

Table 2: Contribution of Capital, Labor, and TFP to Output Growth, 1997–2002 (percent)

	Non-Asian G5	Japan	Four NIEs	China, People's Rep. of	7 ADEs
Growth in					
Output	2.58	-0.19	2.57	7.69	3.16
Capital	3.23	1.59	4.95	8.74	3.92
Labor	0.66	-0.30	1.49	0.96	2.46
C1. labor share = actual					
Contribution of					
Capital	1.33	0.78	2.43	4.10	2.75
Labor	0.38	-0.15	0.75	0.51	0.76
TFP	0.86	-0.81	-0.61	3.08	-0.34
(Relative contribution of TFP)	33.38	431.85	-23.75	40.10	-10.71
C2. labor share = 0.6					
Contribution of					
Capital	1.29	0.64	1.98	3.50	1.57
Labor	0.39	-0.18	0.89	0.58	1.47
TFP	0.90	-0.65	-0.30	3.62	0.12
(Relative contribution of TFP)	34.73	344.17	-11.74	47.07	3.77
lsh1992	60.00	60.00	60.00	60.00	60.00
labsh1992	57.89	50.77	50.20	53.11	30.68

ADE = Asian developing economy, NIE = newly industrializing economy, TFP = total factor productivity.
Note: Labor quality not adjusted for human capital.
Source: Authors' estimates.

Table 3: Contribution of Capital, Labor, and TFP to Output Growth, 2002–2007 (percent)

	Non-Asian G5	Japan	Four NIEs	China, People's Rep. of	7 ADEs
Growth in					
Output	2.32	1.73	5.48	12.20	6.58
Capital	2.78	1.10	3.74	10.63	4.92
Labor	0.77	-0.07	1.46	0.85	2.25
C1. labor share = actual					
Contribution of					
Capital	1.16	0.55	1.84	4.98	3.44
Labor	0.44	-0.04	0.72	0.45	0.69
TFP	0.72	1.22	2.91	6.76	2.45
(Relative contribution of TFP)	31.06	70.46	53.11	55.44	37.25
C2. labor share = 0.6					
Contribution of					
Capital	1.11	0.44	1.49	4.25	1.97
Labor	0.46	-0.04	0.87	0.51	1.35
TFP	0.74	1.33	3.11	7.44	3.26
(Relative contribution of TFP)	32.10	77.12	56.74	60.96	49.53
lsh1992	60.00	60.00	60.00	60.00	60.00
labsh1992	59.05	50.97	51.46	53.11	30.55

ADE = Asian developing economy, NIE = newly industrializing economy, TFP = total factor productivity.
Note; Labor not adjusted for human capital.
Source: Authors' estimates.

Table 4 reports the TFP estimates calculated for 1992–1997 on the basis of equations (2) and (3) to adjust labor for human capital. In addition to the average growth in output, capital, and labor during 1992–1997, we also report the average growth in the two alternative definitions of human capital: human1 = *h* and human2 = *exp(0.08*h)*. We report the contribution of capital, labor, TFP, and human capital to output growth. The contribution of human capital is the percentage point of output growth (= Δln(y)) that is explained by the growth in human1 (= $\alpha_L \Delta$ln(human1)) and human2 (= $\alpha_L \Delta$ln(human2)). C3 denotes the results for linearly adjusting labor for human capital (*human1*) while C4 denotes the results for exponential adjustment (*human2*). Tables 5 and 6 report the results of the identical growth accounting exercise for 1997–2002 and 2002–2007, respectively. Labor shares are assumed to be 0.60 in all three tables.

Table 4: Contribution of Capital, Labor, and TFP to Output Growth, 1992–1997 (percent)

	Non-Asian G5	Japan	Four NIEs	China, People's Rep. of	7 ADEs
Growth in					
Output	2.35	1.26	6.99	9.79	5.64
Capital	2.50	3.29	8.72	11.45	8.04
Labor	0.50	0.61	2.14	1.17	2.33
Human1	1.43	0.96	0.86	2.36	1.81
Human2	0.88	0.68	0.49	1.00	0.64
C3. linear labor-quality adjustment					
Contribution of					
Capital	1.00	1.32	3.49	4.58	3.21
Labor	0.30	0.37	1.28	0.70	1.40
Human1	0.85	0.48	0.40	1.25	0.56
TFP	0.20	-0.99	1.71	3.10	-0.05
(Relative contribution of TFP)	8.37	-78.65	24.39	31.66	-0.97
C4. exponential labor-quality adjustment					
Contribution of					
Capital	1.00	1.32	3.49	4.58	3.21
Labor	0.30	0.37	1.28	0.70	1.40
Human2	0.53	0.41	0.29	0.60	0.38
TFP	0.53	-0.83	1.93	3.91	0.65
(Relative contribution of TFP)	22.38	-65.37	27.60	39.96	11.46
lsh1992	60.00	60.00	60.00	60.00	60.00
labsh1992	60.06	49.12	49.71	52.33	30.06

ADE = Asian developing economy, NIE = newly industrializing economy, TFP = total factor productivity.
Note: Labor quality adjusted for human capital.
Source: Authors' estimates.

Table 5: Contribution of Capital, Labor, and TFP to Output Growth, 1997–2002 (percent)

	Non-Asian G5	Japan	Four NIEs	China, People's Rep. of	7 ADEs
Growth in					
Output	2.58	-0.19	2.57	7.69	3.16
Capital	3.23	1.59	4.95	8.74	3.92
Labor	0.66	-0.30	1.49	0.96	2.46
Human1	1.22	0.65	1.06	1.87	2.00
Human2	0.80	0.48	0.67	0.88	0.71
C3. linear labor-quality adjustment					
Contribution of					
Capital	1.29	0.64	1.98	3.50	1.57
Labor	0.39	-0.18	0.89	0.58	1.47
Human1	0.71	0.33	0.54	0.99	0.61
TFP	0.17	-1.04	-0.94	2.50	-1.08
(Relative contribution of TFP)	6.46	550.92	-36.54	32.50	-34.10
C4. exponential labor-quality adjustment					
Contribution of					
Capital	1.29	0.64	1.98	3.50	1.57
Labor	0.39	-0.18	0.89	0.58	1.47
Human2	0.48	0.29	0.40	0.53	0.43
TFP	0.41	-0.94	-0.71	3.09	-0.31
(Relative contribution of TFP)	16.06	496.47	-27.41	40.19	-9.78
lsh1992	60.00	60.00	60.00	60.00	60.00
labsh1992	57.89	50.77	50.20	53.11	30.68

ADE = Asian developing economy, NIE = newly industrializing economy, TFP = total factor productivity.
Note: Labor quality adjusted for human capital.
Source: Authors' estimates.

As was the case when we did not adjust labor quality for human capital, the most striking result is the shift in the source of growth from physical capital accumulation to TFP after 2002. Although additions to the capital stock were the main driver of growth until 2002, the relative importance of TFP rose noticeably after 2002. For the four NIEs, the relative contribution of TFP growth was sizeable in 1992–1997 but dropped during 1997–2002. However, the absolute size and relative contribution of TFP growth became dominant after 2002. For the seven ADEs, TFP growth was either negative or marginal until 2002, but became the dominant driver of growth after 2002. The estimate of TFP growth and its contribution to output growth increased significantly in the period 2002–2007 for both NIEs and ADEs. The TFP growth estimates for the 11 Asian economies for this subperiod are even higher than those of the non-Asian G5. The contribution of TFP growth is lower for Asian economies when labor is adjusted linearly for human capital. Throughout the whole sample period, the contribution of labor was minimal for all Asian economies. Growth in human capital for the four NIEs was lower than in the G5 until 2002 but turned higher afterward. For the 7 ADEs, the growth in human capital was higher than all other groups except the PRC for all periods. The estimate of the PRC's TFP growth and its

contribution to the PRC's output growth remain strongly positive throughout the entire sample period.

Table 6: Contribution of Capital, Labor, and TFP to Output Growth, 2002–2007 (percent)

	Non-Asian G5	Japan	Four NIEs	China, People's Rep. of	7 ADEs
Growth in					
Output	2.32	1.73	5.48	12.20	6.58
Capital	2.78	1.10	3.74	10.63	4.92
Labor	0.77	-0.07	1.46	0.85	2.25
Human1	0.69	0.58	1.22	1.39	2.13
Human2	0.47	0.45	0.82	0.72	0.84
C3. linear labor-quality adjustment					
Contribution of:					
Capital	1.11	0.44	1.49	4.25	1.97
Labor	0.46	-0.04	0.87	0.51	1.35
Human1	0.40	0.29	0.62	0.74	0.64
TFP	0.31	0.98	2.35	6.60	1.93
(Relative contribution of TFP)	13.49	56.63	42.88	54.11	29.34
C4. exponential labor-quality adjustment					
Contribution of:					
Capital	1.11	0.44	1.49	4.25	1.97
Labor	0.46	-0.04	0.87	0.51	1.35
Human2	0.28	0.27	0.49	0.43	0.51
TFP	0.45	1.06	2.60	7.01	2.74
(Relative contribution of TFP)	19.53	61.55	47.47	57.45	41.62
lsh1992	60.00	60.00	60.00	60.00	60.00
labsh1992	59.05	50.97	51.46	53.11	30.55

ADE = Asian developing economy, NIE = newly industrializing economy, TFP = total factor productivity.
Note: Labor quality adjusted for human capital.
Source: Authors' estimates.

Most other growth accounting studies for Asian economies look at the pre-1990 period. Collins and Bosworth (1997) performed growth accounting for 1960–1994 period, but this still does not overlap much with our sample period. Their sample included three NIEs and four Association of Southeast Asian (ASEAN) countries. Other studies include Young (1994 and 1995) and World Bank (1993), both of which look at four NIEs and three ASEAN countries. Interestingly and significantly, previous growth accounting studies based on the pre-1990 period have found that capital accumulation, or more broadly, input-based growth, was the main source of growth in Asian economies. Our study finds that this growth pattern continued up to 2002, but TFP growth emerged as a relatively more important growth driver since then. Taken together, the evidence from our study and existing studies suggests that factor accumulation, in particular capital accumulation, drove the region's growth for an extended period of time but the growth paradigm is recently shifting toward one in which productivity plays a bigger role.

The consistently large size of the PRC's TFP estimate and its large influence on output growth is something of a puzzle in light of the widespread perception that high savings and high investment underlie the country's exceptionally rapid growth. There are a number of possible explanations for our finding of an oversized role of TFP growth in the PRC's growth. First, capital stock may be underestimated, in which case TFP growth will be overestimated. Second, the PRC's huge TFP growth may reflect to extensive, economywide reallocation of resources from low-productivity areas to high-productivity sectors, i.e., from rural to urban, from agriculture to manufacturing. However, this type of reallocation of resources across sectors also happened in the Republic of Korea and other Asian countries in the 1970s and 1980s, but these countries did not experience such spectacular TFP gains. A third explanation has to do with the PRC's transition from a centrally planned economy to a market-oriented economy, and the consequent removal of pricing and other distortions. According to this view, the jump in TFP is a consequence of getting prices right, establishing private property rights, opening up to foreign trade, and other efficiency-promoting structural changes.

To sum up the results of our growth accounting exercise, which sought to assess the relative importance of capital, labor, and TFP in developing Asia's economic growth during 1992–2007, the source of growth seems to be shifting from capital accumulation to TFP growth since 2002. Prior to 2002, capital accumulation was the dominant source of growth prior to 2002, and this result is consistent with the evidence from the existing literature. While the existing literature looks largely at data prior to 1990, our evidence indicates that the capital-led pattern of growth persisted until 2002. Our central finding that the emergence of TFP growth is an important source of growth since 2002 holds for both NIEs and developing countries. Furthermore, the finding is robust and consistent across different specifications, including different adjustments for human capital. Overall our evidence suggests that fostering TFP growth holds the key to sustaining the region's growth, although capital accumulation will continue to contribute substantially.

IV. Explaining Output Growth and TFP Growth: Estimation of Growth Equations

In this section, we attempt to explain output growth and TFP growth through a number of explanatory variables widely used in the standard empirical literature on growth. The growth accounting exercise of the previous section attributed economic growth to two broad sources—growth in the supply of productive factors and TFP growth. In this section, we incorporate a much larger number of explanatory variables in order to identify more specific sources of growth. Following most of the literature, we define output growth as the growth rate of GDP per worker. In light of our key finding of the growing importance of TFP growth in output growth in developing Asia since 2002, we

also seek to explain TFP growth, estimated in the previous section, with the same set of explanatory variables. Therefore, we look at two dependent variables, output growth and TFP growth. The explanatory variables include growth of capital stock per worker, per capita GDP relative to the US to incorporate the catch-up effect, life expectancy, human capital, population size, percentage of tropical area, openness, and inflation. Four additional explanatory variables are related to various aspects of governance, namely, government effectiveness, rule of law, control of corruption, and regulatory quality.

A. Empirical Framework and Data

The production function we use is basically the Cobb-Douglas specification. Human capital is assumed to improve the quality of labor exponentially: *exp(0.08*h)L*. The level of technology (*A*) depends on catch-up effect, human capital, and other country-characteristics. Human capital therefore affects output through two channels. It is a factor of production and also a contributor to the technological level.

$$\begin{aligned} &Y = AF(K, HL) \\ &Y = AK^{1-a_L}(HL)^{a_L} \\ &\dot{A}/A = F(\text{catch-up effect, human capital, other determinants}) \end{aligned} \tag{4}$$

In order to identify determinants of the per worker GDP and TFP growth, we adopt the following empirical models from Bosworth and Collins (2003) based on conditional convergence theory (or catch-up effect): a country with a low initial income per capita relative to its own long-run (or steady-state) potential level of income per capita will grow faster than a country that is already closer to its long-run potential level of output per capita. In their study, catch-up effect, openness, geographical factors, and institutional quality are shown to be influential in GDP and TFP growth.

Studies such as Benhabib and Spiegel (1994); Dinopoulos and Thompson (2000); Bils and Klenow (2000); and Sachs, Radelet, and Lee (2001) have adopted models where "level of human capital" influences productivity growth. Thus, we have augmented the model to additionally reflect the role of human capital level in determining the per worker GDP growth and TFP growth. We will use a comprehensive international country-level panel data to estimate the main determinants. The specification is as follows:

$$\begin{aligned} \Delta\ln(Y/L)_{it} &= \beta_0 + \beta_1\Delta\ln(K/L)_{it} + \beta_2\ln\left(\frac{Y_{i0}}{Y_{us,0}}\right) + \beta_3 human + \gamma' Z + dum\_yr_t + \varepsilon_{it} \\ \Delta\ln(TFP)_{it} &= \beta_0 + \beta_1\ln\left(\frac{Y_{i0}}{Y_{us,0}}\right) + \beta_2 human + \gamma' Z + dum\_yr_t + \varepsilon_{it} \end{aligned} \tag{5}$$

where Y = output, L = labor, K = capital sock, Y_{i0} = country i's initial per capita income, Y_{US0} = the US's initial per capita income, *human* = human capital, Z = vector of control variables, and dum_{yr} is dummy variable for time periods.

The base model equation includes initial conditions such as initial income per capita(-) relative to the US level ($\frac{Y_{i0}}{Y_{us,0}}$); educational attainment level (*human*) as the level of human capital; and other potential determinants. The latter includes the following variables: (i) initial life expectancy relative to the initial health condition and initial population of the US; (ii) trade instrument such as openness variable from Penn-World Tables (PWT); (iii) geographical factor such as composite average of the number of frost days and tropical area; (iv) policy variables such as inflation rates and current account balance relative to GDP; and (v) institutional factors such as rule of law, government effectiveness, control of corruption, or regulatory quality. We also include time period dummies for the first two 5-year periods (1992–1997 and 1997–2002). The only difference between the equation for output per worker growth and TFP growth is that the former includes capital stock per worker as an explanatory variable.

We use an unbalanced international country-level panel data set from 1992 to 2007.[1] The data set includes 125 developing and developed countries.[2] Appendix 1 lists the countries in our sample. Appendix 2 shows the definitions of all dependent and independent variables, along with their data sources. Since the annual variation of TFP growth is usually governed by noise, we construct a "5-year interval data set" consisting of average or initial values of variables from each 5-year, nonoverlapping interval within the full sample.[3] Initial values of each respective interval are considered for the variables representing initial conditions such as initial income per capita relative to the US level, initial life expectancy relative to the US, and initial population. To control for the omitted time effect of each 5-year interval, panel regression with period-fixed effect is performed on the 5-year interval panel data set.

B. Empirical Results: Output per Worker Growth Equation Estimation

Table 7 reports the results of regressing the 5-year average growth rate of output per worker on the explanatory variables. The following explanatory variables seemed to be significant: growth in capital stock per worker (*mdkkl*); initial conditions: log of the per capita GDP relative to that of the US in the initial year of each respective 5-year interval (catch-up effect, *lny_us*); initial population size (*lnpop*); human capital: 5-year averages of educational attainment level (*mhuman*); geographical factor: percentage tropical area (*mtropic*); openness: log of openness index from PWT (*mopenc*); and government effectiveness (from World Bank, World Governance Indicator, *mgoveff*). Growth in capital stock per worker, population size, human capital, openness, and government effectiveness positively contributed to the growth in GDP per worker. Lower initial per

[1] The ending year is set at 2007 due to the limited data availability of PWT.
[2] We have excluded extreme data points where average annual TFP growth, per worker GDP growth, or per worker capital stock growth is greater than 20% or less than –20%.
[3] More specifically, the 5-year intervals considered are 1992–1997, 1997–2002, and 2002–2007.

capita GDP relative to the US and relatively small tropical area also had a positive effect. Variables that were not significant were life expectancy, inflation rate, and current account balance relative to GDP.

Table 7: Output per Worker Growth Equation (dependent variable = dln(Y/L))

Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Variables	**a1**	**a2**	**a3**	**a4**	**a5**	**a6**
mdkkl	0.448***	0.428***	0.428***	0.429***	0.403***	0.404***
	(12.23)	(11.26)	(11.23)	(11.08)	(10.06)	(10.14)
lny_us	-0.010***	-0.010***	-0.010***	-0.010***	-0.014***	-0.013***
	(-5.186)	(-5.396)	(-4.749)	(-4.231)	(-4.748)	(-5.040)
lnlifes			-0.000	-0.001	0.005	
			(-0.00995)	(-0.0634)	(0.440)	
mhuman	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***
	(5.030)	(5.158)	(5.028)	(4.811)	(4.498)	(4.764)
lnpop		0.002*	0.002*	0.002*	0.002	0.002*
		(1.855)	(1.813)	(1.788)	(1.590)	(1.787)
mtropic	-0.010***	-0.009***	-0.009***	-0.009***	-0.008**	-0.008**
	(-2.910)	(-2.836)	(-2.808)	(-2.850)	(-2.385)	(-2.449)
mopenc	0.005**	0.009***	0.009***	0.009***	0.008**	0.008**
	(2.134)	(2.817)	(2.754)	(2.834)	(2.453)	(2.533)
minflat_cpi				0.000	0.000	
				(1.007)	(1.228)	
mca_gdp				-0.000	-0.000	-0.000
				(-0.158)	(-0.00117)	(-0.0113)
mgoveff					0.006**	0.005**
					(2.271)	(2.109)
_lyear_1992	-0.004	-0.003	-0.003	-0.003	-0.004	-0.004
	(-1.107)	(-0.843)	(-0.837)	(-0.949)	(-1.259)	(-1.077)
_lyear_1997	-0.010***	-0.009***	-0.009***	-0.010***	-0.010***	-0.010***
	(-3.228)	(-3.124)	(-3.107)	(-3.096)	(-3.294)	(-3.246)
Constant	-0.047***	-0.081***	-0.081***	-0.083***	-0.082***	-0.083***
	(-3.521)	(-3.575)	(-3.451)	(-3.493)	(-3.464)	(-3.655)
Observations	315	315	315	315	315	315
Adjusted R-squared	0.450	0.455	0.453	0.451	0.459	0.459

*** p<0.01, ** p<0.05, * p<0.1.
Note: t-statistics in parentheses.
Source: Authors' estimates.

Table 8 augments the analysis of Table 7 by incorporating four different indicators of governance indicators—rule of law, government effectiveness, control of corruption, regulatory quality—into the growth regression. Among the four governance indicators, government effectiveness and control of corruption were shown to be significant in the regression. Model 6 includes two interaction terms: *mgoveff_a* (= *mgoveff * dummy_asia12*) to gauge the differential impact of government effectiveness for ADEs and *mgoveff_o* (= *mgoveff * dummy_oecd*) to do the same for economies of the Organisation for Economic Co-operation and Development (OECD). In Model 6, the coefficient for the *mgoveff* rises and the coefficient for interaction term with OECD dummy is significantly

negative. This implies that the government effectiveness is more important in GDP growth per worker for the non-OECD (developing) economies.

Table 8: Output per Worker Growth Equation, Governance Indicators Included (dependent variable = dln(Y/L))

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**a1**	**a2**	**a3**	**a4**	**a5**	**a6**
mdkkl	0.419***	0.417***	0.404***	0.410***	0.400***	0.386***
	(10.73)	(10.64)	(10.25)	(10.56)	(10.00)	(9.594)
lny_us	-0.011***	-0.011***	-0.013***	-0.013***	-0.013***	-0.014***
	(-4.927)	(-5.255)	(-5.559)	(-5.470)	(-5.496)	(-5.925)
mhuman	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***
	(5.058)	(4.588)	(4.935)	(5.015)	(4.748)	(5.087)
lnpop	0.002*	0.002*	0.002*	0.002*	0.002	0.002
	(1.896)	(1.838)	(1.798)	(1.896)	(1.549)	(1.557)
mtropic	-0.008**	-0.010***	-0.008**	-0.008**	-0.008**	-0.009***
	(-2.484)	(-2.930)	(-2.456)	(-2.249)	(-2.285)	(-2.740)
mopenc	0.008***	0.008***	0.008**	0.007**	0.007**	0.005
	(2.715)	(2.699)	(2.573)	(2.464)	(2.248)	(1.496)
mlaw	0.002					
	(0.962)					
mregq		0.003				
		(1.129)				
mgoveff			0.005**		0.005	0.010***
			(2.118)		(0.912)	(2.605)
mcontrolcorr				0.004*	0.001	
				(1.912)	(0.151)	
mgoveff_a						0.004
						(0.720)
mgoveff_o						-0.007*
						(-1.896)
_lyear_1992	-0.003	-0.003	-0.004	-0.003	-0.003	-0.004
	(-0.947)	(-0.958)	(-1.102)	(-0.887)	(-0.979)	(-1.344)
_lyear_1997	-0.010***	-0.010***	-0.010***	-0.010***	-0.010***	-0.010***
	(-3.194)	(-3.235)	(-3.286)	(-3.321)	(-3.367)	(-3.485)
Constant	-0.083***	-0.080***	-0.083***	-0.082***	-0.077***	-0.068***
	(-3.634)	(-3.515)	(-3.661)	(-3.546)	(-3.253)	(-2.902)
Observations	315	315	315	309	309	315
Adjusted R-squared	0.455	0.455	0.461	0.446	0.446	0.469

*** p<0.01, ** p<0.05, * p<0.1
Note: t-statistics in parentheses.
Source: Authors' estimates.

To sum up our empirical evidence for GDP per worker growth regressions, the following results were robust. The level of human capital was found to contribute to growth. Furthermore, growth is higher when the country is more open in terms of trade. Government effectiveness also contributes to growth. Nontropical countries and countries with larger populations grow faster. There is some evidence of convergence, or the catch-up effect. Among four different measures of governance indicators (rule

of law, government effectiveness, control of corruption, regulatory quality) government effectiveness and control of corruption were shown to be significant in the regression. Finally, the role of government effectiveness was greater for the non-OECD countries

C. Empirical Results: TFP Growth Equation Estimation

Output per worker can be decomposed into growth in capital stock per worker and TFP growth. TFP growth is of particular interest to us since the growth accounting analysis in Section III indicated that its relative importance as a source of growth was rising. Table 9 reports the results of regressing the 5-year average growth rate of output per worker on the explanatory variables. The following explanatory variables seemed to be significant

(i) initial conditions: log of per capita GDP relative to that of the US in the initial year of each respective 5-year interval (catch-up effect, *lny_us*)

(ii) human capital: 5-year averages of educational attainment level (*mhuman*)

(iii) geographical factor: percentage tropical area (*mtropic*)

(iv) openness: log of openness index from PWT (*mopenc*)

(v) government effectiveness: government effectiveness (from World Bank, World Governance Indicators, *mgoveff*).

Human capital, openness, and government effectiveness positively contributed to TFP growth. A lower initial per capita GDP relative to the US and a relatively smaller tropical area also had a positive effect. Variables that were not significant were life expectancy, population size, inflation rate, and current account balance relative to GDP.

In Table 10, we investigate whether determinants that have shown significance in Table 9 have differential impact in three different groups of countries: OECD, 12 Asian countries, and the rest of the world. We will consider interaction terms for three variables: human capital (*mhuman*), openness (*mopenc*), and government effectiveness (*mgoveff*). Model 2 includes the following interaction terms: *mhuman_a* (= *mhuman* * *dummy_asia12*) and *mhuman_o* (= *mhuman* * *dummy_oecd*). In Model 2, the coefficient for *mhuman_a* is positive and significant, but *mhuman_o* is not significant. These interaction terms are additive to *mhuman*. This implies that the role of human capital is greater in the 12 Asian economies than in other countries. Model 3 includes the following interaction terms: *mopenc_a* (= *mopenc* * *dummy_asia12*) and *mopenc_o* (= *mopenc* * *dummy_oecd*). In Model 3, the coefficient for *mopenc_a* is positive and significant, but *mopenc_o* is not significant. These interaction terms are additive to *mopenc*. This implies that the role of openness is greater in the 12 Asian economies than other countries. Model 4 includes the following interaction terms: *mgoveff_a* (= *mgoveff* * *dummy_asia12*) and

mgoveff_o (= *mgoveff * dummy_oecd*). In Model 4, the coefficient for *mgoveff_a* is not significant, but *mgoveff_o* is not negatively significant. These interaction terms are additive to *mgoveff*. This implies that the role of government effectiveness is greater for the non-OECD economies compared to the OECD economies. Model 5 includes all interaction terms considered in Models 2–4. In Model 5, the differential effects that we saw in Models 2–4 all disappear. This may be due to multicolinearity problem due to inclusion of so many interaction terms.

Table 9: TFP Growth Equation (dependent variable = dlnTFP)

	(1)	(2)	(3)	(4)	(5)
Variables	**a1**	**a2**	**a3**	**a4**	**a5**
lny_us	-0.010***	-0.014***	-0.015***	-0.014***	-0.012***
	(-5.536)	(-5.895)	(-5.373)	(-4.882)	(-4.282)
lnlifes			0.005	0.005	-0.009
			(0.429)	(0.396)	(-0.693)
mhuman	0.004***	0.004***	0.004***	0.004***	0.004***
	(5.291)	(5.045)	(4.860)	(4.645)	(4.975)
lnpop			0.001	0.001	0.002
			(1.163)	(1.142)	(1.603)
mtropic	-0.011***	-0.009***	-0.009***	-0.009***	-0.009***
	(-3.325)	(-2.849)	(-2.676)	(-2.703)	(-2.662)
mopenc	0.006**	0.005**	0.007**	0.007**	0.008**
	(2.346)	(2.048)	(2.248)	(2.338)	(2.537)
minflat_cpi				0.000	0.000
				(1.011)	(0.829)
mca_gdp				-0.000	-0.000
				(-0.207)	(-0.237)
mgoveff		0.006**	0.006**	0.006**	
		(2.414)	(2.288)	(2.342)	
mcontrolcorr					0.004**
					(1.994)
_lyear_1992	-0.004	-0.004	-0.004	-0.004	-0.003
	(-1.180)	(-1.354)	(-1.127)	(-1.258)	(-0.905)
_lyear_1997	-0.010***	-0.010***	-0.009***	-0.010***	-0.009***
	(-3.207)	(-3.272)	(-3.136)	(-3.152)	(-3.115)
Constant	-0.055***	-0.059***	-0.080***	-0.081***	-0.087***
	(-4.078)	(-4.335)	(-3.392)	(-3.430)	(-3.696)
Observations	315	315	315	315	309
Adjusted R-squared	0.186	0.199	0.198	0.196	0.183

*** p<0.01, ** p<0.05, * p<0.1.
Note: t-statistics in parentheses.
Source: Authors' estimates.

Table 10: TFP Growth Equation, Differential Impact on OECD and 12 Asian Countries (dependent variable = dlnTFP)

	(1)	(2)	(3)	(4)	(5)
Variables	**a1**	**A2**	**a3**	**a4**	**a5**
lny_us	-0.014***	-0.014***	-0.014***	-0.015***	-0.015***
	(-5.895)	(-6.036)	(-6.071)	(-6.198)	(-6.432)
mhuman	0.004***	0.004***	0.004***	0.004***	0.005***
	(5.045)	(5.141)	(5.267)	(5.219)	(5.217)
mhuman_a		0.001*			-0.003
		(1.822)			(-1.205)
mhuman_o		-0.000			-0.001
		(-0.592)			(-0.743)
mtropic	-0.009***	-0.011***	-0.011***	-0.011***	-0.011***
	(-2.849)	(-3.235)	(-3.281)	(-3.120)	(-2.992)
mopenc	0.005**	0.004	0.004	0.003	0.001
	(2.048)	(1.400)	(1.444)	(0.979)	(0.295)
mopenc_a			0.002**		0.006
			(2.299)		(1.640)
mopenc_o			-0.000		0.004
			(-0.152)		(1.193)
mgoveff	0.006**	0.006**	0.005**	0.009***	0.008**
	(2.414)	(2.249)	(1.986)	(2.716)	(2.284)
mgoveff_a				0.004	0.005
				(0.816)	(0.833)
mgoveff_o				-0.006*	-0.007
				(-1.817)	(-1.415)
_Iyear_1992	-0.004	-0.004	-0.004	-0.005	-0.005
	(-1.354)	(-1.399)	(-1.370)	(-1.473)	(-1.446)
_Iyear_1997	-0.010***	-0.010***	-0.010***	-0.010***	-0.010***
	(-3.272)	(-3.325)	(-3.323)	(-3.366)	(-3.413)
Constant	-0.059***	-0.053***	-0.054***	-0.048***	-0.047***
	(-4.335)	(-3.824)	(-3.951)	(-3.401)	(-3.300)
Observations	315	315	315	315	315
Adjusted R-squared	0.199	0.206	0.209	0.210	0.215

*** p<0.01, ** p<0.05, * p<0.1.
Note: t-statistics in parentheses.
Source: Authors' estimates.

To sum up our empirical evidence for TFP growth regressions, human capital and openness seem to have a positive significant effect on TFP growth. Government effectiveness also seems to benefit TFP growth. Taken together, these results indicate that countries that invest more in human capital have higher levels of integration into the world economy, enjoy stronger governance, and have institutions that will enjoy more rapid TFP growth. We also find that favorable geography has a positive effect on TFP growth. Our results lend support to convergence or the catch-up effect. Interestingly, we find that human capital and openness play a bigger role in the TFP growth in the 12 Asian countries than elsewhere. The role of government effectiveness was larger for non-OECD countries, which implies that governance matters more for TFP growth in developing countries than in developed countries.

V. Concluding Observations and Policy Implications

The single most interesting and significant finding emerging from our empirical analysis is that the primary source of developing Asia's economic growth is shifting from accumulation of physical capital to TFP growth. This is consistent with the region's transition from a low-income, capital-deficient region to an increasingly middle-income, capital-abundant region, and hence the setting in of diminishing marginal returns to capital. Our evidence is hardly definitive and subject to the usual criticism about the inadequacy of using residuals, i.e., output growth that cannot be explained by capital and labor, to measure productivity growth. The inclusion of the Asian crisis period is also problematic since the contraction of output that occurred heavily influences and distorts the results. Nevertheless, our evidence is largely consistent with the empirical literature on developing Asia's growth, which finds that capital accumulation drove the region's growth prior to 1990. According to our evidence, this pattern of growth continued until around 2002. Our empirical evidence suggests that there has been a major structural shift in the pattern of developing Asia's economic growth around 2002. More specifically, we find that TFP begins to play a much larger role in the region's growth. The primary policy implication arising from our main finding—the growing relative importance of TFP growth in developing Asia's economic growth—is that governments around the region should more forcefully pursue policies that foster higher productivity. Given that the source of the region's economic growth is shifting from factor accumulation to productivity growth, policies that promote the productivity of all inputs will hold the key to sustaining growth beyond the global crisis. Total factor productivity growth consists of two components, technological progress (TP) and technical efficiency change (TEC). TEC refers to narrowing the gap between potential and actual output or, equivalently, moving from inside the production frontier toward the frontier. For example, at a micro level, better management enables a firm to be more productive with the same level of inputs and technology. An economywide example is more flexible labor markets, which result in a more efficient allocation of labor across firms and industries. On the other hand, TP refers to shifting out of the production frontier due to technological innovation. For the more advanced countries, technological progress will involve investment in research and development (R&D) and knowledge-creating activities. For the less advanced economies, TP will largely involve the adoption of new and existing technologies created by countries closer to the world technology frontier.

There are a number of specific areas in which developing Asia's governments can foster higher productivity. For example, better transport, communication, energy, and other infrastructure improve the productivity of all firms and industries. Although some parts of the region's infrastructure are among the best in the world, the region's very success is creating new demands for more and better infrastructure. It is estimated that between 2010 and 2020, developing Asia needs to invest a staggering total of US$8 trillion in infrastructure. Another area where effective policies are required to foster productivity growth is human capital. While developing Asia has traditionally invested heavily in

education, the region has to do a better job of producing workers with the "right" skills needed by employers. Shortage of skills in key areas can become a bottleneck to growth. For example, for all the success in its world-class, export-oriented information technology (IT) services sector and its large and growing army of university graduates, one of the key constraints to further growth of the sector is the shortage of workers with the required skills. A third area relevant for speeding up developing Asia's transition to productivity-led growth is financial development. While the region's financial systems have become noticeably stronger and more efficient since the Asian crisis, they still lag behind the region's dynamic, world-class manufacturing sector. Yet sustaining growth postcrisis will depend more on the efficiency of investment and less on the quantity of investment, which means that financial systems will have to do a better job of allocating capital to its most productive uses. A fourth area for promoting productivity is international trade and, more generally, openness. Developing Asia's remarkable economic success in the past closely paralleled its growing integration into the world economy. In addition to static welfare gains based on comparative advantage, trade delivers substantial dynamic efficiency gains. In particular, globalization forces firms and industries to raise their game to survive competition in both domestic and foreign markets.

At a broader level, our empirical evidence strongly reconfirms the relevance of supply-side factors for developing Asia's medium- and long-term growth. The explanatory supply-side variables drawn from the standard empirical literature do a reasonably good job of explaining growth in a panel of 125 countries during 1992–2007. Interestingly and significantly, we find that human capital and economic openness, both of which were significant, played an especially significant role in the growth of developing Asian countries. This makes sense in light of the region's traditional high priority on investment and outward-looking export-oriented growth strategy. The overarching implication for policy makers is that supply-side policies that augment productive capacity by fostering higher productivity will be vital for sustaining developing Asia's future growth in the postcrisis period. More robust domestic demand and intra-Asian trade can help absorb the additional output.

Developing Asia has recovered from the global crisis with remarkable speed and vigor. Despite the region's robust recovery and its track record of superior sustained growth performance in the pre-global crisis period, now is a good time to take stock of Asia's medium- and long-term growth and policies for growth for at least a couple of reasons. First, the postcrisis world is likely to present a less benign global environment. Second, and much more fundamentally, some of the ingredients appropriate for yesterday's Asia will be less relevant for today's Asia, because the region's very success has transformed it from a low-income, capital-deficient region to a middle-income capital-abundant region. In particular, for the region as a whole, the source of growth will shift further from factor accumulation to TFP growth, a trend that has already begun according to our empirical analysis. Therefore, supply-side policies that promote productivity growth hold the key to sustaining the region's medium- and long-term growth.

Appendix

Appendix 1: List of Economies

Albania
Argentina
Armenia
Australia
Austria

Bahrain
Bangladesh
Barbados
Belgium
Belize
Benin
Bolivia
Botswana
Brazil
Bulgaria
Burundi

Cambodia
Cameroon
Canada
Central African Republic
Chile
China, People's Republic of
Colombia
Congo, Republic of
Costa Rica
Cote d'Ivoire
Cyprus
Czech Republic
Denmark

Ecuador
Egypt
El Salvador

Fiji Islands
Finland
France

Gabon
Gambia
Germany
Ghana
Greece
Guatemala
Guyana

Haiti
Honduras
Hong Kong, China
Hungary
Iceland
India
Indonesia
Iran
Ireland
Israel
Italy

Jamaica
Japan
Jordan

Kenya
Korea, Republic of
Kuwait
Kyrgyz Republic

Lao People's Democratic Republic
Latvia
Lesotho
Libya
Lithuania
Luxembourg

Macao, China
Malawi
Malaysia
Maldives
Mali
Malta
Mauritania
Mauritius
Mexico
Mongolia
Morocco
Mozambique

Namibia
Nepal
Netherlands
New Zealand
Nicaragua
Nigeria
Norway

Pakistan
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Poland
Portugal
Romania
Rwanda

Saudi Arabia
Senegal
Sierra Leone
Singapore
Slovak Republic
Slovenia
South Africa
Spain
Sri Lanka
Sudan
Swaziland
Sweden
Switzerland
Syria

Tanzania
Thailand
Togo
Tonga
Trinidad and Tobago
Tunisia
Turkey

Uganda
United Kingdom
United States
Uruguay

Venezuela
Viet Nam

Yemen

Zambia
Zimbabwe

Appendix 2: Definitions of Variables and Their Data Sources

Variables	Definitions	Sources
Dependent Variables		
dlnTFP	5-year average growth rate of TFP. TFP growth is derived from equation (3)	
dln(Y/L)	Five-year average growth rate of GDP per worker (Y/L)	PWT
Independent Variables		
dln(K/L)	5-year average growth rate of capital stock per worker (K/L); capital stock (K) series are estimates from Lee (2010) based on the PWT investment series	PWT
lny_us	Log of the per capita GDP relative to that of the US in the initial year of each respective 5-year interval	PWT
lnlifes	Log of initial life expectancy relative to that of the US in the initial year of each respective 5-year interval	WDI
mhuman	5-year averages of educational attainment level (human) from Barro-Lee data set	Barro and Lee (2010)
lnpop	Log of population in the initial year of each respective 5-year interval	PWT
mtropic	Percentage tropical area	Gallup and Sachs (1998)
mopenc	Log of openness index from PWT	PWT
minflat_cpi	5-year average inflation rate (CPI)	WDI
mca_gdp	5-year average of current account deficit relative to GDP	WDI
mdrk_l2	5-year average growth rate of R&D stock per worker; real R&D stocks were constructed on the basis of R&D to GDP ratios	WDI and Main Science and Technology Indicators
mlaw	Rule of law (from World Bank, World Governance Indicators)	WGI
mgoveff	Government effectiveness (from World Bank, World Governance Indicators)	WGI
mcontrolcorr	Control of corruption (from World Bank, World Governance Indicators)	WGI
mregq	Regulatory quality (from World Bank, World Governance Indicators)	WGI
_lyear_1992	Dummy variable for the 1992–1997 period	
_lyear_1997	Dummy variable for the 1997–2002 period	

CPI = consumer price index, PWT = Penn World Tables Version 6.3 (Heston et al. 2009), WDI = World Development Indicators, WGI = World Governance Indicators.
Sources: Heston et al. (2009), OECD (2010), World Bank (2010).

Appendix 3: Summary Statistics of Variables

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
mdyyl	350	0.017	0.028	-0.125	0.122
mdtfp2	350	0.007	0.024	-0.113	0.098
mdkkl	350	0.015	0.033	-0.139	0.152
lny_us	350	-1.737	1.126	-4.008	0.466
lnlifes	350	-0.143	0.177	-1.163	0.055
mhuman	350	7.260	2.768	0.629	12.796
lnpop	350	9.127	1.696	4.523	14.066
mtropic	315	0.495	0.476	0.000	1.000
mopenc	350	84.079	52.350	16.936	418.998
minflat_cpi	350	13.067	56.667	-1.756	1007.457
mca_gdp	350	-1.729	6.954	-27.920	34.857
mdrk_l2	214	0.539	0.050	-0.108	0.208
mlaw	349	0.146	0.989	-1.850	2.058
mgoveff	349	0.225	1.007	-1.592	2.636
mcontrolcorr	339	0.177	1.049	-1.757	2.468
mregq	350	0.233	0.862	-2.104	1.992

Sources: Heston et al. (2009), OECD (2010), World Bank (2010).

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About the Paper

Donghyun Park and Jungsoo Park examine the sources of economic growth in 12 developing Asian countries during 1992–2007. They find that total factor productivity growth has begun to play a bigger role in the region's growth since 2002. The key implication for Asian policy makers is that they should prioritize areas that have a positive effect on productivity growth in order to sustain growth in the long term.

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