Faster growth in productivity will be the key driver of economic growth in East Asia, especially as demographics become less favorable. Innovation, that is the transmission, absorption and commercialization of ideas and technologies, will be crucial for this productivity growth. Low-income countries will need to educate more workers, and continue adopting existing technologies. Middle-income countries have successfully exploited a model of high volume, low value added assembly operations, mainly through adoption of existing technologies. For these countries now, sustaining rapid growth will depend more on the ability of private sectors to innovate closer to the frontier and to move up the value chains. To innovate, firms need adequately educated and skilled workers, who can absorb and use innovative knowledge and processes. As cities become the crucibles of innovation, conditions need to be created to exploit the proximity of companies and workers, so that they can act as knowledge exchanges as well as provide capital for the more risky innovative projects.

Productivity growth is lagging in most countries in the region

The middle-income countries of East Asia other than China, have recorded slower productivity growth than countries with similar incomes in other regions. This slowdown appears to have accelerated since the 1997–98 Asian financial crisis (Figure 1). Boosting the pace of productivity growth will be crucial for the middle-income countries to move to high-income status and to prosper in the increasingly more competitive world (Figure 2). Productivity growth will be especially relevant because most countries in the region are expected to lose demographic benefit they have been enjoying recently.¹

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¹ Bloom and Finlay (2009), see also East Asia and Pacific Economic Update (April 2011).
Aggregate figures hide a substantial diversity in firm-level productivity across and within countries and industries. Gaps between leading firms and the least productive firms are wide in East Asia: in some industries, total factor productivity (TFP) of the top firms is 20 times higher than that of the least productive firms (Figure 3). There is also geographical diversity, both between and within countries. For example, total factor productivity in Thailand’s electronics industry varies between 110 percent that of an average Chinese firm in the same sector in Lower North East region and only half that in the Upper North East; large productivity differentials are also present in Malaysia, the Philippines, and Vietnam (Figure 5). This diversity in total factor productivity reflects a variety of factors, both firm-specific and related to the existing climate for innovation.

Among firm-specific factors, the level of innovation efforts a firm undertakes is the most important determinant of total factor productivity. Empirical evidence confirms that firms that do R&D have approximately 18 percent higher TFP than firms that do not, and product innovation is associated with 6 percent higher TFP (Figure 4). Indicators of access to more advanced technology—such as having internationally-recognized quality certifications or using foreign-licensed technology—similarly show higher TFP for more advanced firms (22 and 18 percent, respectively).

Falling behind on frontier innovation?

Most of East Asia’s middle-income countries have absorbed foreign knowledge and improved their production capabilities in the process. Production capabilities, or the level of sophistication of the country’s companies to produce diverse products, have grown rapidly in East Asia in large part through participation in global or regional production networks and the accompanying technology transfers.2 Even though some countries, such as Indonesia, Malaysia, or Thailand, have significantly increased sophistication of their products, they have not been able to move high enough in the value chains to catch up with Korea or Singapore (Figure 6).

East Asia lags behind other regions on firm-level innovation, especially in the middle-income countries other than China (Figure 7). China is building up its technological capacity, as reflected in the fast growing number of patents issued by U.S. Patent Office (USPTO), and is now above average for its income per capita. But Thailand and Malaysia are below average for their income group, and are far below Korea during its take off (Figure 8). The middle-income countries of East Asia have made remarkable progress exploiting a model of high volume, low value added assembly operations for exports. Moving up the value chains will require that companies become more innovative at introducing new or improved goods and services, developing or adopting innovative production processes and better modes of business operation (see Box 1).

**Figure 6.** Change in the number of “capabilities” to produce new products, 1975 to 2005
change and level of the capabilities ranking, 0–100; higher is more capabilities

Source: Calculations based on Hidalgo (2009).

**Figure 7.** Firms in East Asia innovate less on some measures


**Figure 8.** Number of patents per capita in Thailand and Malaysia is lower than in Korea during its take-off

Source: Regression relation between patents and per capita income

**Box 1. What is an innovation framework?**

Innovation includes activities that advance the technological frontier and adoption of existing knowledge and production processes—sometimes in a better way. Innovating at the frontier requires sophisticated education, continuous investments in research and development, and property rights, while benefits may accrue only after a substantial period of time.

Most companies in developing countries—including in middle-income East Asia, by contrast, are innovating inside the frontier by absorbing knowledge, typically from abroad, through international transfers and spillovers. Even the simple use of existing knowledge can be innovation, from a perspective of a company (that adopts a new product line, for example) or a grass-roots entrepreneur (who starts using a phone for a financial transaction). The most productive and inclusive kind of innovation seems to be in the middle when firms can be *piggyfrogging* through technological change: leapfrogging to wide use of new technologies by piggybacking on the existing knowledge and patent base.

Building of the policy framework for innovation requires action in several policy areas: education, trade, investment, finance, and decentralization. A “gardening” analogy for innovation policy framework encourages promotion of policies that are aimed at: (1) preparing a fertile ground for innovation (education), (2) nurturing the soil (research and development, information transmission and connectivity), (3) removing weeds (competition and regulation policy), and (4) watering (finance, and other support for innovators).

For the transition to high-income status, more needs to be done on the agenda for facilitating innovation in the MICs. Along with larger government outlays, the need for stable and enhanced foreign capital inflows is crucial, as these bring along knowledge and management expertise. Components of good innovation policy are the following four agendas: creating incentives for productive entrepreneurship, providing adequate skills to the workforce, ensuring good transmission of information and ideas, and making sure financing is available for start-ups, upgrades and commercialization.³

Education is the key constraint to more innovation in the majority of middle income countries in EAP. Based on the surveys of entrepreneurs, binding constraints to innovation differ by country and include: education of workers, the investment climate, availability and accessibility of financing (especially for smaller firms), and regulations creating a competitive environment. Education of the workforce is the key constraint to innovation in most countries (Figure 9 and Figure 10). The next section looks into this in more detail and shows that quality of education is an issue in most middle-income countries, while quantity is a binding constraint to innovation in the low income bracket.

**Figure 9.** Firms in middle-income countries are constrained by different factors in their innovation efforts

<table>
<thead>
<tr>
<th>Composite index of the constraints, from the most severe (0) to the least severe (10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>Constraints</td>
</tr>
<tr>
<td>More binding constraints</td>
</tr>
<tr>
<td>Less binding constraints</td>
</tr>
<tr>
<td>Entrepreneural</td>
</tr>
</tbody>
</table>

Note: Index is scaled by maximum and minimum in the region.

**Figure 10.** Firm-level innovation is heavily dependent on knowledge spillovers and education...

<table>
<thead>
<tr>
<th>Cumulative absolute percentage impact on innovation by firm size, percent change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro (1–10 employees)</td>
</tr>
<tr>
<td>Regs &amp; Corruption</td>
</tr>
</tbody>
</table>

Sources: Enterprise Surveys and Dutz and O’Connel (2011).

**Figure 11.** Innovators hire more tertiary educated workers

<table>
<thead>
<tr>
<th>Share of workers with higher education, in percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>IDN</td>
</tr>
</tbody>
</table>


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³ Canuto et al. (2010).
⁴ Vandenbussche, Aghion and Meghir (2006) draw attention to the greater returns from investment in skills and research as a country approaches the technological frontier.
⁵ This section draws on World Bank (forthcoming) Flagship on Tertiary Education in East Asia and Pacific, and Yusuf and Nabeshima (2010c).
with gradually increasing ratios of tertiary education workers, indicates growing demand for skilled labor (Figure 13). However, quantity of educated workers is an important issue only in low-income countries and in selected sectors in other countries.

**Quality of education has been identified as the main constraint to more innovation in the middle income countries.** Compared to countries in the South Asia region, for example, India has the highest enrollment rate at 12 percent, while it is 93 percent in Korea, 46 percent in Thailand, and 17 on average in other East Asian countries. However, in the middle-income countries, it is increasingly harder to find graduates who fit the job, and vacancies stay empty while many graduates are unemployed (Figure 14, Figure 15). Another indicator that points at poor quality is science scores which are lower than world average (Figure 12).

Challenges with *quality* of education to deliver specific skills needed are also more severe in some industries, especially *manufacturing*. Poor technical skills are a particularly critical issue for engineering graduates. Firms also mention managerial capability, IT, English skills, and behavioral skills as problematic. A survey of foreign employers in China concluded that only 10 percent of science and engineering graduates made the cut. It also found that 44 percent of executives cited insufficient talent as their main challenge for reaching global ambitions. Furthermore, China has seen a widening gap in the skills mismatch between its firms and employees at all employment levels. Finally, the need for re-training also points to critical gaps in tertiary education in Vietnam, the Philippines, and Indonesia.
Innovation happens in cities

Strong economic growth in East Asia has been accompanied by rapid urbanization and industrial development in cities. The employment share in manufacturing, urban clustering, and access to international market are highly correlated with urban productivity.  

Urbanization facilitates knowledge exchange and spillovers. Without interaction, firm-level innovation by large firms would have been 40 percent lower, and in the absence of knowledge transfers through trade, it would have been 10 percent lower. Larger firms are better able to benefit from access to global knowledge, while smaller firms needed to locate close to large firms to catch up. For example, for small firms the use of information and telecommunications technology in their vicinity is more important than their own efforts.  

The technology nexus supported by strong linkages between industry and universities is an essential part of a modern innovation framework, as outlined in Box 1. Such nexus rests in relatively high quality of universities that are able to provide practical skills that are required by the industry, as well as in linkages between firms and universities. While large firms depend mostly on their on R&D for innovative activities, small and medium firms exploit knowledge created in the industry including that of the large firms and in universities.  

Improving quality of universities can increase absorptive capacity of the entrepreneurs and strengthen innovation frameworks, especially in the middle-income countries. Only 9 out of the 50 best universities are from East Asia. Only Korea, Singapore and Japan have numbers of scientific articles per capita that are comparable to those of industrialized countries. The middle income countries in the region, with exception of China (which is at par with Mexico and higher than India) have much less published scientific articles per capita than comparable countries in other regions, such as Mexico, Brazil, or South Africa. 

The geographic coincidence of universities and corporate research is important, but once it is established the curricula need to also be tailored to the industry needs. There are several ways by which universities can influence innovative capacity of firms (Table 1), in addition to educating and encouraging entrepreneurship (like the National University of Singapore program has done). 

| Licensing | Spin-offs | Technology transfer offices |
| Technology brokers | Science parks | Incubators |
| Support for graduate entrepreneurship | Research contracts and consultancy | Collaborative research |
| External training | Mobility programs for research staff | Student placement in enterprises |
| Technology centers | Technology networks | Venture capital funds |
| Cluster initiatives |  |

Table 1. Countries at risk from climate change effects


Firms that face strong competitive pressure are more likely to innovate than those reporting no such pressure. Innovative activity of small- and medium-sized firms tends to be greater where there is a strong presence of knowledge spillovers. Clusters are formed by entrepreneurs, and so positive economic returns must be linked to entrepreneurial activity. Entrepreneurial activity is determined by the number of startup rates (especially for SMEs), population density, population growth, skill and human capital levels of the labor force (high share of skilled workers), low unemployment, and the average establishment size has negative impact on startup rates. Start-up rates and exit rates have been shown to contribute positively to productivity growth, controlling for imperfect competition and extent of scale economies. Reflected in the number of procedures required to start a business, firms in East Asian countries are facing better competition now than in 2004.

7 Based on calculations on Enterprise Surveys (ES) data, see Dutz and O’Connell (2011).
9 According to the Times Higher Education Supplement.
Finance is necessary to commercialize ideas

Investment does not only drive growth, it also transmits knowledge that is essential for innovation. Even though total investments remained subdued, apart from China (East Asia and Pacific Update October 2010), inward FDI in East Asia and Pacific shot up exponentially after the Asian crisis (see Chapter 1). At firm level, firms that are able to reinvest a higher percentage of profits were more productive. FDI is also a significant source of R&D financing, especially in the low income countries in the region.

Apart from FDI, investments in research and development (R&D) are the most widespread source of innovation financing. Countries with R&D spending below 0.5 percent of GDP are much less likely to cross the middle-income threshold (Figure 17). Doubling R&D spending over a decade—along with maintaining other supportive factors, such as human capital and innovation institutions—can lead to a technological take off of a country. Korea, Singapore and Japan all have R&D intensive growth, while Thailand and Malaysia do less R&D than countries in their income group (Figure 18). China increased its R&D spending from 0.6 in 1999 to 1.4 in 2008, having positioned itself for growth through productivity increases.

But presence of countries with high R&D spending and lower growth suggests that more efficient utilization of funds is key to success. Private capital has been shown to be more effective for innovation financing (Figure 19). East Asian countries have room from improvement on the levels of R&D, but they do have one of the highest private sector participation in R&D.
Given that innovation is riskier than normal investments, venture capital has recently become a key means of financing of innovation in many industries. Consistent with the analysis above, venture capital tends to appear and proliferate in the cities where demand is highest due to high density of firms, and in cities with high share of military or other research (Figure 20). A gravity analysis indicates that distance, common language, and colonial ties are significant factors in directing these flows. Additionally, the presence of high-end human capital, a better business environment, high levels of military expenditure, and deeper financial markets are important local factors that attract international venture capital. There is also evidence of path dependency and persistence in venture capital flows, indicating network effects and fixed costs of entry may be at work.

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