# 4. ADDRESSING SKILLED LABOR SHORTAGES AND FOSTERING SCIENCE AND INNOVATION

88. For more than 25 years since 1950, Thailand is one of the 13 economies in the world that have grown at an annual rate of more than 7 percent.[49] Six of these sustained high growth economies – Hong Kong (China), Japan, Korea, Malta, Singapore, and Taiwan (China) – now enjoy high-income levels. The others, especially Thailand, Malaysia, Indonesia, and Brazil, reached middle-income status and have experienced less impressive growth.

89. The growth model of Thailand and of other latecomers—such as Malaysia and Indonesia—differs from that of the early East-Asian "Tigers" (South Korea, Taiwan, Singapore, and Hong Kong). "Learning by exporting" has been a major vehicle of productivity growth for Thailand. Through intermediate linkages, the export sectors have had productivity effects on the rest of economy, and advanced technology or high skill intensity have had a much more limited role on productivity.[50] Economic growth in Thailand has been, to a large extent, driven by investments and between-sector productivity growth. To the extent that Thailand has experienced productivity improvements, they have been associated with international spillovers and have been the result of a broad learning process rather than innovation and high-tech production.

90. Reallocation of resources from lower productivity to higher productivity sectors has largely contributed to total factor productivity growth in Thailand in the past decade. In the past five years, principal manufacturing products have represented over three-fourths of total exports. Agricultural and agro-industrial products have been declining as a share of total exports, representing only 10 and 6 percent, respectively, in 2007 (Figure 31). Some traditional export products, such as garments, have also seen their share in total export decline. The top three exports in the past five years have been more high-tech products: computers and parts, automobiles and parts, and integrated circuits (I.C.) (Figure 32). They account for over 50 percent of the total value of the top 10 exports.

91. Although a large part of the value-added by Thai firms may come from assembly, the fact that high tech products account for a growing share of exports indicates that the production structure in Thailand is moving from labor-intensive to more technology-intensive. These three high-tech sectors all exhibit sizable scale economies. There may still be room for TFP growth from further shifting resources to these and other high-tech productive sectors.

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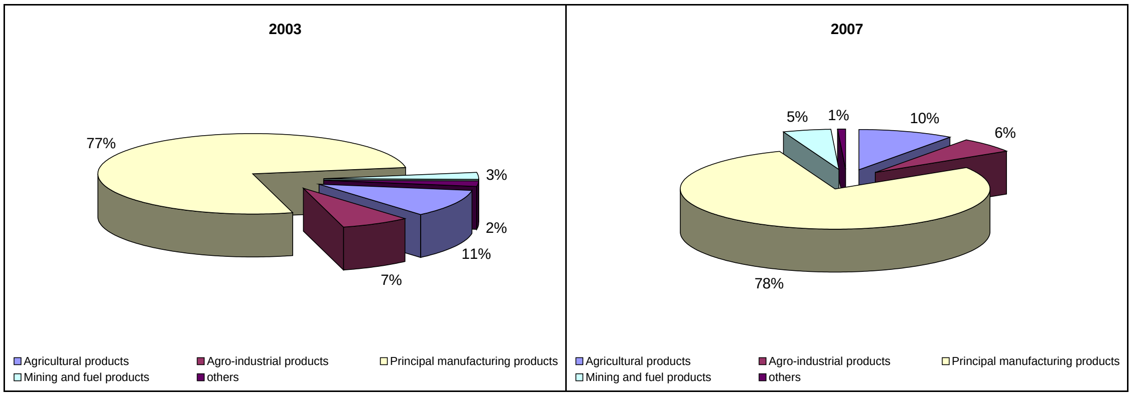
[49] See Commission on Growth and Development (2008)

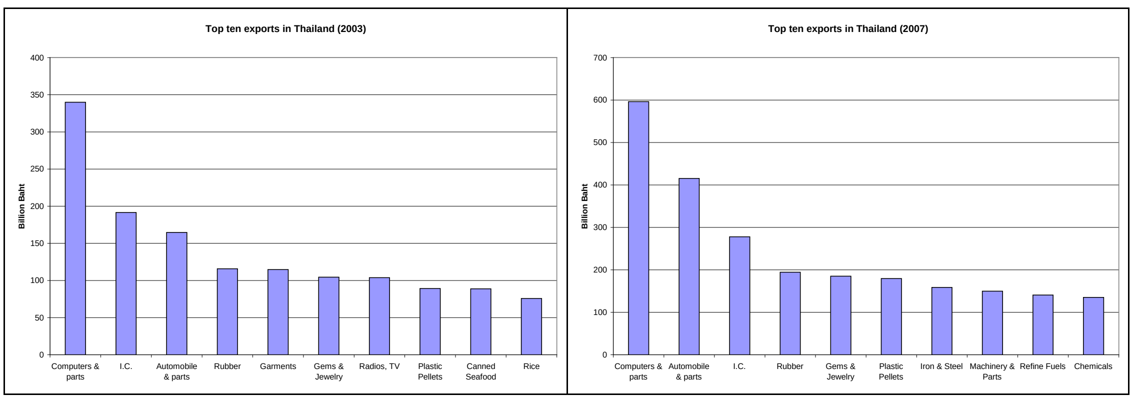
[50] See Diao, Rattso and Stokke (2006).

**Figure 31. Export Structure in Thailand, 2003 and 2007 (Percent)**




Source: Department of Trade Negotiation, Ministry of Commerce of Thailand

**Figure 32. Top Ten Exports in Thailand, 2003 and 2007**




Source: Department of Trade Negotiation, Ministry of Commerce of Thailand

92. Promoting innovations, moving toward the global technological frontier or moving the frontier to a more advanced level, to stimulate within-sector productivity growth is important, especially in the long run. The shortage of skilled labor and professionals, the low level of R&D, and the weak cooperation between research institutes and industrial sectors remain important constraints in Thailand. Many small or medium-size firms in Thailand do not have the capability and incentives to undertake R&D in house. Public investment in applied research is essential for their technological upgrading.

93. Acquisition of labor skills and knowledge is essential in the late stages of economic growth. The term "innovation" refers to significant changes leading to productivity increases that are fundamental sources of economic growth.[51] Innovation is not limited to (more easily observable) product innovation but it also includes process innovation, technological innovation, marketing innovation, and organizational innovation—which are all activities that expand the knowledge base. In high-income East Asian economies like Taiwan (China), Singapore, Hong Kong, and Korea, knowledge—as opposed to labor and capital accumulation—increasingly becomes the main engine of

[51] See Baumol (2002).

growth. Moving toward a knowledge-based economy requires four conditions: (i) a skilled labor force; (ii) an effective innovation system; (iii) a modern information infrastructure; and (iv) a supportive institutional regime.[52] The latter—which includes a range of institutional features (macroeconomic framework, trade regime, and regulatory framework) providing economic incentives for the creation, diffusion, and effective use of knowledge—determines the effectiveness of the other three conditions. A "Knowledge Economy Index" (KEI) has been created to measure a country's ability to generate, adopt, and disseminate knowledge.[53] The KEI values for selected countries are shown in Table 3.

**Table 3. Knowledge Economy Index for Selected Countries**

| Rank in 2008 | Change in rank from 1995 | Country | KEI in 2008 or most recent year | Change from KEI in 1995 |
|---|---|---|---|---|
| 1 | 0 | Denmark | 9.6 | 0.0 |
| 17 | + 7 | Taiwan (China) | 8.7 | + 0.5 |
| 19 | - 2 | Japan | 8.5 | - 0.3 |
| 21 | 0 | Singapore | 8.4 | 0.0 |
| 26 | - 3 | Hong Kong (China) | 8.2 | - 0.1 |
| 31 | - 3 | Korea | 7.7 | - 0.2 |
| 46 | + 1 | Malaysia | 6.2 | + 0.1 |
| 55 | + 11 | Brazil | 5.5 | + 0.5 |
| **63** | **- 10** | **Thailand** | **5.3** | **- 0.3** |
| 77 | + 18 | China | 4.4 | + 0.9 |
| 93 | + 3 | Indonesia | 3.3 | - 0.2 |
| 96 | + 12 | Vietnam | 3.2 | + 0.6 |
| 100 | + 4 | India | 3.0 | - 0.1 |

Source: World Bank (2007).

94. The five East Asian economies with a high-income level perform well on the KEI. Malaysia, Brazil, and Indonesia improved their position compared to 1995 but lag behind the richer East Asian economies. Thailand, which ranks 63rd out of 132 countries in 2008 (a drop from 53rd in 1995) is a more worrisome case. This low ranking is due to a poorer score and indicates that conditions that support the move toward a knowledge economy have worsened in Thailand. Unless the country significantly improves the quality of its labor force, information infrastructure, and related incentive mechanisms in the coming years, it may soon be overtaken by emerging economies such as China, Vietnam or India.

[52] See World Bank (2007).

[53] The index is a simple average of normalized performance scores on each of the four conditions. Each condition is measured by three variables so that there are 12 variables in total. For instance, countries with a favorable KEI score (such as Scandinavian countries) will have high adult literacy and school enrollment rates, numerous granted patent applications and scientific journal articles, adequate telephones, computers and Internet services, less distorted tariff and non-tariff barriers, and good regulatory quality and rule of law.

95. This chapter—which does not attempt to provide a comprehensive assessment of the subject—examines some dimensions of Thailand's labor force, innovation system, and information infrastructure using firm-level data from PICS.[54] PICS 2007 results for Thailand are compared with those in PICS 2004 and, to the extent possible, to results from other countries in 2002-2005. The chapter is organized as follows. Section 1 examines shortages and mismatches of labor skills in Thailand. Section 2 examines recent enterprise efforts to conduct innovative activities and assesses the effectiveness of the Research and Development (R&D) system and related government support. Section 3 briefly looks at the use of information technology by local manufacturing firms. Section 4 summarizes the key arguments and makes some policy remarks.

## SKILLS AND EDUCATION OF THE LABOR FORCE

96. Chapter 1 reported that nearly 40 percent of all firms in PICS 2007 cited shortage of skilled workers as one of the three most binding investment constraints they faced. A similar share of firms also viewed "skills and education of available workers" as a major or severe business obstacle. This problem was also emphasized in PICS 2004.

97. In the survey, the labor force is divided into three groups: professionals, skilled production workers, and unskilled production workers. Professionals include trained and certified specialists such as engineers, scientists, software programmers, lawyers, and other university graduates. Enterprise innovation efforts tend to rely heavily on the size and quality of this group. The category skilled production workers primarily refer to skilled technicians involved directly in the production process.

98. The shares of firms with vacancies in each worker group, and the time it took to fill the most recent vacancy are shown in Table 4. On average, firms took 7.4 weeks to find a suitable professional worker in 2007, a week longer than they did in 2004. For skilled technicians, the average time (5.2 weeks) was slightly less than the 2004 level. Despite this improvement, a shortage of skilled technicians is much more prevalent in Thailand than in other countries. Out of 64 countries for which similar data are available, Thailand ranks 53rd. On average, these countries took only 3.8 weeks to find skilled technicians, i.e., about 10 days less than Thailand. Figure 33 shows statistics for selected countries. The time it takes to find unskilled workers (2.2 weeks) remained unchanged in 2007. Thailand ranks 47th out of 66 countries; the average country spends half of a week less than Thailand to fill an unskilled worker position (see Figure 34). When skilled labor is hard to find, this is either because available workforce has poor skills (skill shortage) or workers sufficiently possess certain skills but these are not the skills required by firms (skill mismatch) or both.

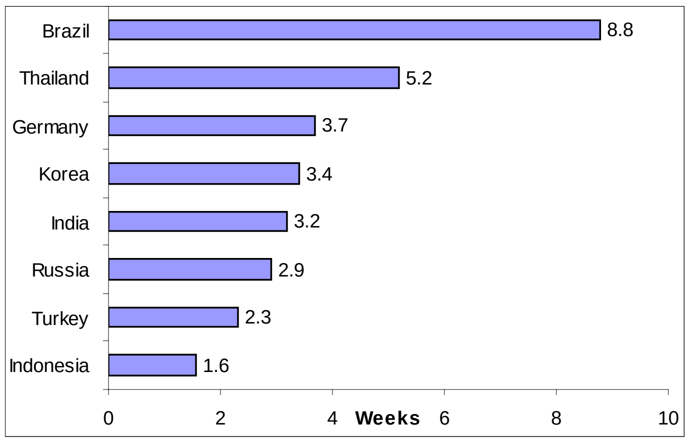
[54] This chapter adds information to the World Bank and NESDB report (2008) examining Thailand's transition towards a knowledge economy. It is based on country-level data and firm-level case studies.

**Table 4. Job Vacancies**

| | Professional worker | | Skilled production worker | | Unskilled production worker | |
|---|---|---|---|---|---|---|
| | PICS 2007 | Change from PICS 2004 | PICS 2007 | Change from PICS 2004 | PICS 2007 | Change from PICS 2004 |
| Share of firms with vacancies (%) | 20.4 | - 8.0 | 30.1 | + 0.8 | 48.0 | + 11.0 |
| Time to fill the most recent vacancy (weeks) | 7.4 | + 1.0 | 5.2 | - 0.7 | 2.2 | 0.0 |

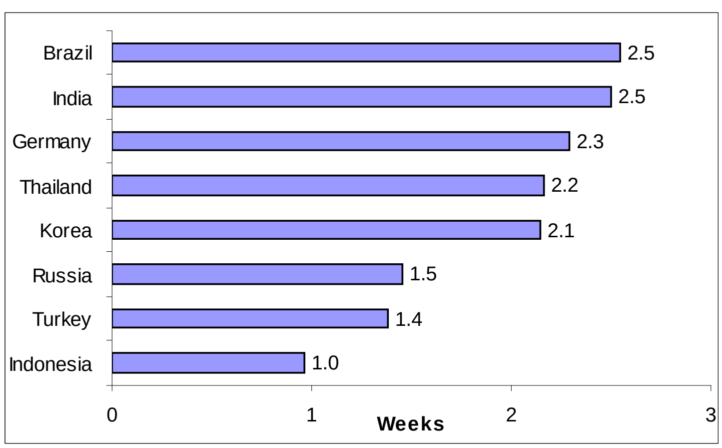
Source: Thailand PICS 2004 and 2007.

**Figure 33. Time Required to Fill the Most Recent Vacancy for Skilled Production Workers (Weeks)**




Source: Global PICS (2002-2005) and Thailand PICS 2007
Notes: The data are in 2002 for India; in 2003 for Brazil and Indonesia; in 2005 for Germany, Korea, Russia, and Turkey; and in 2007 for Thailand. The global sample has 66 countries.

**Figure 34. Time Required to Fill the Most Recent Vacancy for Unskilled Production Workers (Weeks)**




Source: Global PICS (2002-2005) and Thailand PICS 2007.
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99. Table 5 provides a disaggregated picture by region of the time it takes to fill the most recent vacancy for different worker groups. This largely reflects the composition of the manufacturing sector in each region. For example, qualified professional workers are particularly scarce in the Northeast (15.5 weeks compared to the national average of 7.4 weeks—this number is rising sharply compared to PICS 2004), where over half of firms are in the furniture/wood products and garments industries, the two industries that take the longest time to find professional workers. Similarly, skilled production workers are harder to find in the East due to the concentration of automotive parts and rubber and plastics firms, which suffers more from insufficient skilled workers than other industries. This job vacancy rate also applies to a large share of food processing establishments in the South (42 percent) in the case of unskilled production workers. Table 5 also shows that foreign firms take less time to fill job vacancies, most likely because foreign firms typically offer more generous salaries and benefits than domestic ones. Finally, the disparity across firm size and type is less systematic.

**Table 5. Time to Fill Job Vacancies in Thailand, by Region, Industry and Enterprise Type**

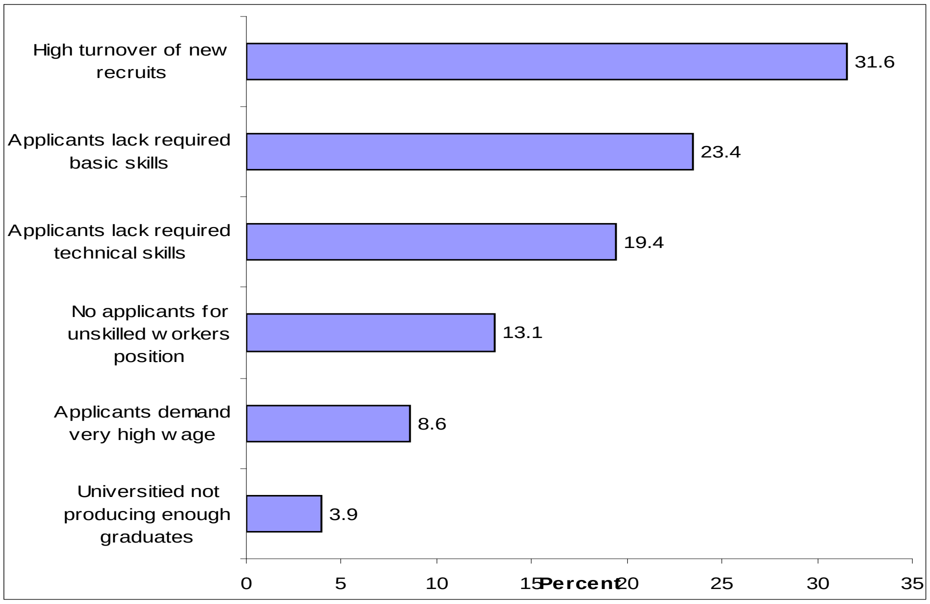
| | **Professional worker** | | **Skilled production worker** | | **Unskilled production worker** | |
|---|---|---|---|---|---|---|
| | PICS 2007 | Change from PICS 2004 | PICS 2007 | Change from PICS 2004 | PICS 2007 | Change from PICS 2004 |
| Thailand | 7.4 | + 1.0 | 5.2 | - 0.7 | 2.2 | 0.0 |
| Bangkok and vicinity | 7.7 | + 1.1 | 5.2 | - 1.7 | 2.0 | + 0.1 |
| Central | 6.3 | + 0.5 | 4.4 | - 0.7 | 2.0 | + 0.4 |
| East | 6.6 | + 0.3 | 7.0 | + 1.5 | 2.7 | + 0.7 |
| North | 6.0 | + 0.2 | 3.6 | - 0.3 | 2.6 | + 0.8 |
| Northeast | 15.5 | + 10.8 | 5.5 | - 2.8 | 1.7 | - 3.6 |
| South | 9.0 | + 1.2 | 5.5 | + 1.8 | 3.2 | - 0.3 |
| Auto components | 7.6 | + 0.5 | 6.0 | - 0.4 | 1.9 | + 0.1 |
| Electrical appliances | 7.1 | + 2.4 | 4.4 | + 0.8 | 2.1 | + 0.3 |
| Electronic components | 6.6 | + 1.6 | 3.8 | + 0.2 | 1.8 | + 0.1 |
| Food processing | 6.8 | + 0.8 | 4.0 | - 1.9 | 2.7 | - 1.6 |
| Furniture | 10.1 | + 2.9 | 5.1 | - 0.5 | 2.1 | + 0.4 |
| Garments | 8.2 | + 0.3 | 5.3 | - 6.7 | 2.2 | 0.0 |
| Machinery | 8.0 | + 0.8 | 5.3 | - 1.4 | 2.2 | + 0.1 |
| Rubber and plastics | 6.1 | - 0.5 | 5.5 | + 1.4 | 2.1 | + 0.5 |
| Textiles | 7.2 | + 1.5 | 5.4 | + 0.5 | 2.2 | + 0.3 |
| Small | 6.9 | + 0.5 | 5.4 | - 1.4 | 2.4 | + 0.3 |
| Medium | 7.9 | + 2.2 | 4.9 | - 0.3 | 2.0 | + 0.3 |
| Large | 7.0 | + 0.4 | 5.3 | - 0.8 | 2.0 | - 0.6 |
| Foreign | 5.5 | - 0.2 | 3.5 | - 1.8 | 1.3 | - 1.9 |
| Domestic | 7.7 | + 1.3 | 5.4 | - 0.6 | 3.3 | + 1.3 |
| Non-exporting | 6.6 | + 1.1 | 5.2 | + 0.1 | 2.3 | + 0.3 |
| Exporting | 7.9 | + 1.1 | 5.2 | - 1.3 | 2.0 | - 0.3 |

Source: Thailand PICS 2004 and PICS 2007.

100. The key reason for numerous job vacancies, many of which are hard to fill, is the poor quality of the labor force. Over 40 percent of firm managers mentioned that vacancies arise because many applicants lack the basic skills or technical skills that firms

require (Figure 35). At the professional level, the issue is obviously not quantity-related either. Only a small number of establishments indicate that the supply of university graduates falls short of their demand. At the unskilled worker level, however, labor shortages could be a serious problem, especially in labor-intensive industries such as food processing and garments where many vacancies result from too few applicants.

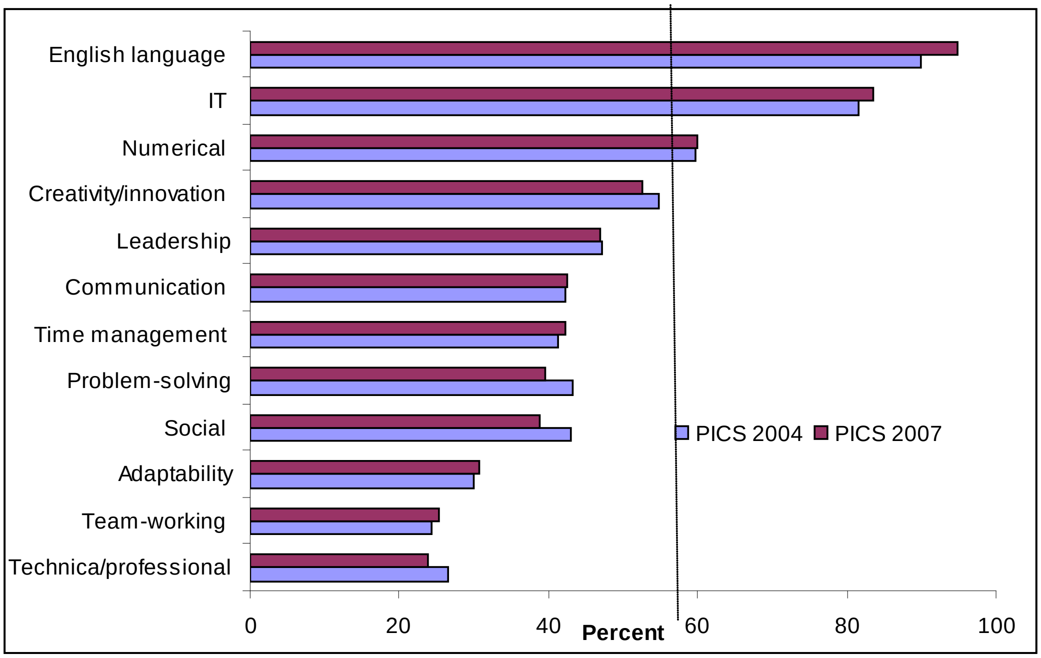
**Figure 35: Most Important Cause of Job Vacancies (Percent of Firms)**




Source: Thailand PICS 2007

101. There are several skills that firm managers feel their current workers do not possess at a satisfactory level. For instance, at least half of all firms rated the following skills of their local skilled technicians as poor or very poor: English, information technology (IT), numerical skills, and creativity/innovation skills (Figure 36). English proficiency and IT skills have in fact worsened since 2004. In general, the firms are much more positive about the quality of their professional staff, although two-thirds of them believe local professionals are not proficient in English.

**Figure 36. Percentage of Firms that Rate Certain Labor Skills as Poor or Very Poor**




Source: Thailand PICS 2004 and PICS 2007.

102. In addition to enhanced basic and technical skills, many firms look for loyalty in their employees. In fact, 15 percent of firms viewed loyalty as more valuable than common attributes such as education level and experience. Most of these are small, locally-owned firms, operating in the furniture, textiles, and garments industries. The importance of loyalty is understandable considering that job vacancies in about one-third of all firms arise because of high turnover of new recruits (see Figure 35 on the preceding page). This number could be higher in some industries—for example, 45 percent in the textiles industry. High staff turnover can be detrimental and discourages firms from providing in-house training, thus further weakening labor skills.[55]

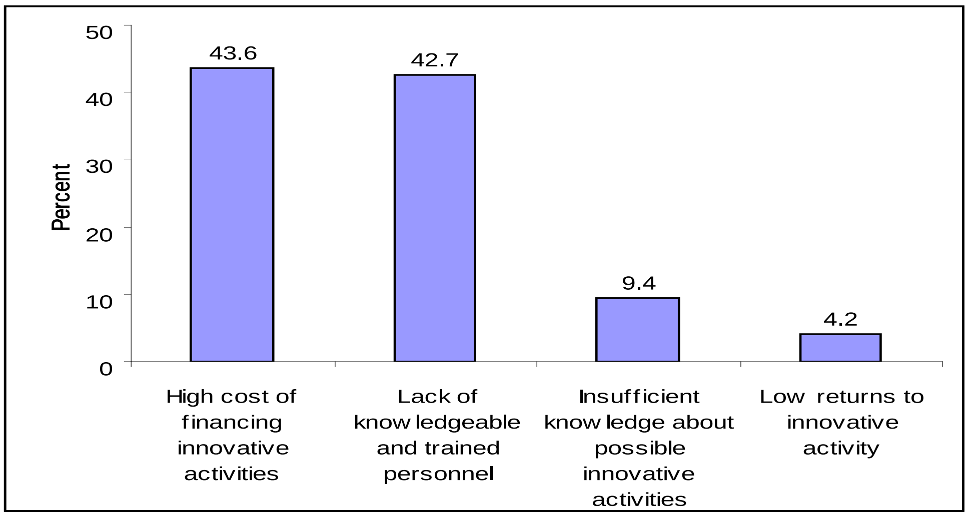
103. Given this general dissatisfaction with basic and technical worker skills and high employee turnover that discourages firms to offer their own training, effective and affordable skill-development support institutions could lessen the problem. Currently, such institutions are not common. The survey responses show that this is mainly because available skill-development services are not relevant for firms. A large number of firms are also unsure how to contact these institutions or are unaware of them. Skill-development support agencies, both private and public, will therefore need to improve their outreach activities and interact more with manufacturing firms on how to design training and other services.

104. Shortages of capable staff can have both short and long-term effects on economic activity. In the short term, firms could operate below full capacity because they cannot find enough competent and experienced workers. In fact, nearly 20 percent of firms in the

[55] An interview with a leading Thai automotive parts company reveals that competition for talented, newly-trained workers is intense. It has forced firms to reconsider the size of their in-house training programs.

garment and machinery and equipment industries cited this as a key reason for capacity underutilization. In the longer run, shortages of well-trained staff limit a firm's effort to enhance productivity. Nearly all firms believe investment in innovation activities yields high returns, however, they do not engage more in these activities for two reasons: they consider innovations to be financially costly and they lack knowledgeable and trained personnel (see Figure 37). As discussed in Chapter 1, shortage of skills is a key reason why firms, especially small and medium firms, do not use financial instruments to hedge against the risk of macro volatility.

**Figure 37. Reason Reported by Firms for not Engaging in Innovative Activities (Percentage of Firms)**

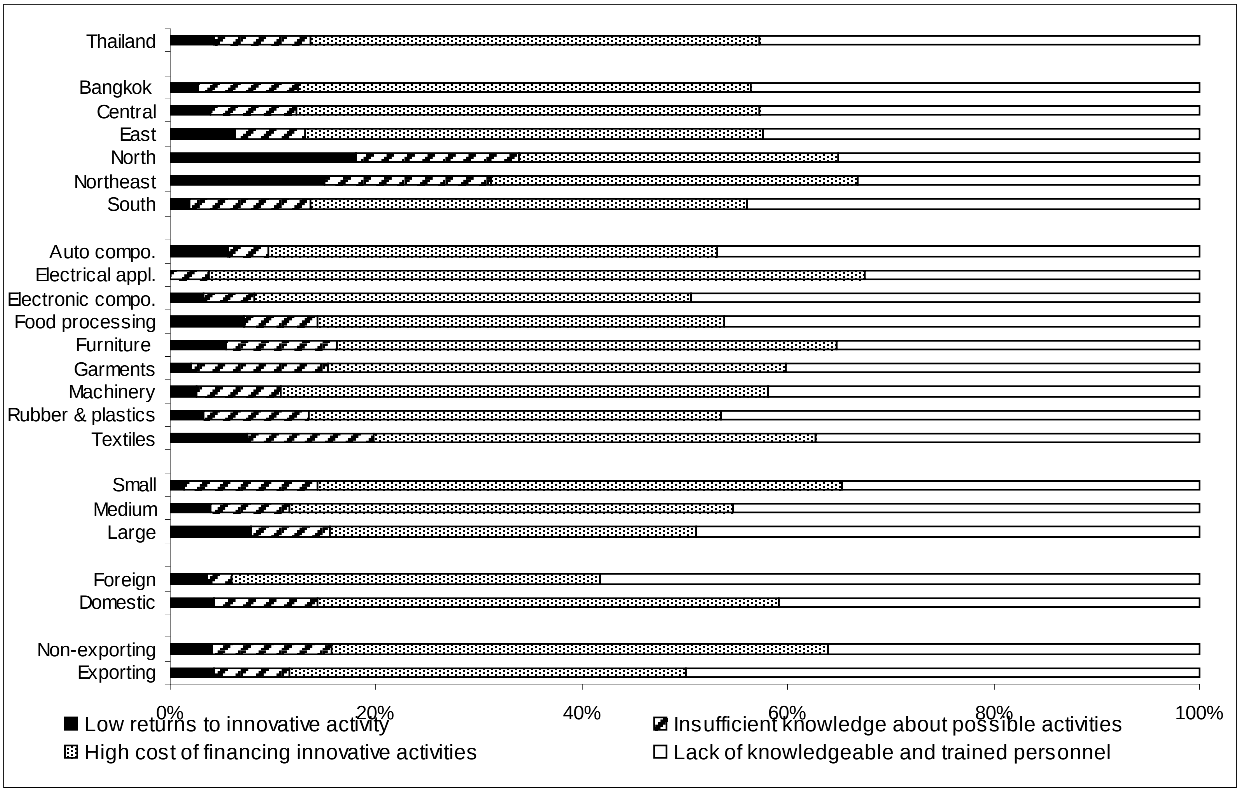



Source: Thailand PICS 2007

105. Figure 38 reveals that the lack of qualified staff who could contribute to innovative activities is more of an issue among large, foreign, and exporting firms.[56] This is rather puzzling, given the result previously reported that foreign firms can generally recruit professional workers quicker than domestic ones, and the fact that large firms do not suffer more than smaller ones from skill shortages. An explanation could be that foreign and large firms are generally more dynamic than their counterparts in terms of innovative activities and hence are more aware of the problem. We will show below that foreign and large firms carried out more innovations such as developing a new major product line, introducing new, substantive technology, and filing patents and utility models relative to domestic and smaller firms. Moreover, foreign and large firms tend to have greater financial resources so that financing is less of a constraint and skill shortage is more binding.

[56] In PICS 2007, large and exporting firms are closely linked. While less than 8 percent of small and medium-sized firms are owned by foreign investors, roughly 22 percent of large firms are foreign-owned.

**Figure 38. Reason Reported by Firms for Not Engaging in Innovative Activities—Disaggregated Sample (Percent)**




Source: Thailand PICS 2007

106. The share of professional workers —the group most likely to contribute to innovation -- in the labor force is declining; it has become harder to find suitable professional workers. Engineers were on average only 1.1 percent of all staff in 2007, down from an already low 1.4 percent in 2004. The proportion of scientists and information technicians also dropped from 0.2 and 0.5 percent in 2004 to 0.1 and 0.2 percent in 2007, respectively.

## RESEARCH & DEVELOPMENT, TECHNOLOGY ACQUISITION AND RELATED SERVICES

107. This section reviews innovation activities that firms have recently undertaken, comparing Thailand with other countries, then examines four activities that facilitate innovations: R&D, channels to acquire technology, related business services, and government support. As stated earlier, innovative activities are not only new products (which are more easily observable) but include any business activities that expand the technology base. Table 6 presents the responses of firms regarding innovations undertaken in recent years. These activities include various dimensions of innovations: technological innovations (e.g., upgrading machinery and equipment), process-oriented innovations (e.g., introducing a new way the main product is produced), product innovations (e.g., developing a new product line) and commercial innovations (e.g., agreeing to a joint venture with a foreign partner).

**Table 6. Percentage of Firms That Undertook Innovative Activities in the Past Two Years**

| | PICS 2007 | Change from PICS 2004 |
|---|---|---|
| Upgrading machinery and equipment | 86.4 | + 18.0 |
| Upgrading existing product line | 80.3 | + 9.6 |
| Entering new markets due to process or product improvements in quality or cost | 57.6 | + 1.6 |
| Developing a major new product line | 49.3 | - 1.1 |
| Introducing new technology that substantially changed the way the main product is produced | 46.7 | - 4.8 |
| Filing patent/utility models or copyright protected materials | 9.1 | - 1.6 |
| Entering a joint venture agreement with a foreign partner | 2.5 | - 1.0 |

Source: Thailand PICS 2004 and PICS 2007.

108. When innovations are defined as broadly as is the case here, we find that a large share of the firms surveyed had "innovative" activities in recent years. For instance, at least 80 percent of all firms either upgraded their machinery and equipment or upgraded their existing product line. These are large improvements compared to results in PICS 2004.[57] However, when the innovative activities in question require greater resources and efforts (e.g., introducing new technology or a new product line), less than one-half of firms accomplished these. Less than 10 percent of the firms surveyed filed patents or copyrights. The share of firms that have their own brand (marketing innovation) fell from 51 percent in 2004 to 45 percent in 2007. Overall, the share of firms that did more sophisticated innovative activities dropped since 2004.

109. As shown in Table 7, large, foreign, and export-oriented firms had more innovative activities than their counterparts. Innovations are also more common in the food processing, automotive parts, electrical appliance, and electronic components industries, than in the textiles and rubber/plastics industries. The East has the strongest performance (since more automotive parts as well as large, and foreign companies are located in that region). These findings are hardly surprising. Large, foreign, and exporting firms tend to have more financial resources to fund innovative activities. They are also more likely to be under greater competitive pressure to differentiate their products.

[57] These activities are important to firms' performance. The empirical results in Chapter 3 show that firms with more new machinery and equipment tend to have higher productivity.

## Table 7. Percentage of Firms that Recently Undertook Certain Innovations by Subsamples

| | **Upgraded machinery and equipment** | | **Upgraded an existing product line** | | **Developed a major new product line** | | **Introduced new technology that substantially changed the way the main product is produced** | | **Filed any patent or utility models or copyright protected materials** | | **Entered a new joint venture agreement with a foreign partner** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PICS 2007 | Chg from PICS 04 | PICS 2007 | Chg from PICS 04 | PICS 2007 | Chg from PICS 04 | PICS 2007 | Chg from PICS 04 | PICS 2007 | Chg from PICS 04 | PICS 2007 | Chg from PICS 04 |
| Thailand | 86.4 | + 18.0 | 80.3 | + 9.6 | 49.3 | - 1.1 | 46.7 | - 4.8 | 9.1 | - 1.6 | 2.5 | - 1.0 |
| Bangkok and vicinity | 85.7 | + 13.2 | 80.1 | + 4.9 | 50.6 | - 0.6 | 46.7 | - 7.2 | 9.9 | - 2.7 | 2.3 | - 1.3 |
| Central | 89.4 | + 20.7 | 83.1 | + 14.7 | 50.3 | - 1.3 | 46.3 | - 7.7 | 7.9 | - 2.0 | 2.8 | - 0.8 |
| East | 91.1 | + 14.0 | 85.9 | + 8.8 | 51.0 | - 5.3 | 56.1 | - 3.3 | 10.7 | - 3.4 | 3.4 | + 0.2 |
| North | 62.0 | - 2.4 | 56.6 | - 14.7 | 41.8 | - 7.5 | 28.4 | - 23.7 | 3.9 | - 4.3 | 2.3 | - 3.2 |
| Northeast | 78.5 | + 25.8 | 70.6 | + 15.1 | 37.5 | - 12.5 | 43.4 | + 5.9 | 11.4 | + 7.2 | .. | .. |
| South | 88.3 | + 47.1 | 75.5 | + 25.9 | 37.5 | + 3.9 | 37.9 | + 12.7 | 2.8 | + 0.9 | 2.8 | - 0.9 |
| Auto components | 93.7 | + 13.7 | 81.3 | - 2.8 | 56.6 | - 10.3 | 61.4 | - 1.4 | 9.6 | - 6.9 | 0.8 | - 1.9 |
| Electrical appliances | 79.2 | + 13.3 | 91.0 | + 14.8 | 57.0 | + 5.8 | 38.2 | - 22.0 | 14.6 | - 3.6 | .. | .. |
| Electronic components | 90.1 | + 15.0 | 79.6 | - 3.2 | 53.3 | - 18.0 | 58.7 | - 13.9 | 10.9 | - 3.8 | 2.7 | - 2.5 |
| Food processing | 92.3 | + 20.3 | 88.4 | + 17.4 | 58.8 | + 10.8 | 53.3 | + 2.5 | 9.7 | - 0.4 | 2.7 | - 2.9 |
| Furniture | 78.0 | + 17.2 | 87.3 | + 26.5 | 58.4 | + 20.0 | 34.7 | + 1.1 | 9.2 | + 3.6 | 4.7 | + 3.9 |
| Garments | 82.5 | + 13.4 | 75.8 | + 8.5 | 52.1 | + 6.9 | 48.6 | + 2.2 | 11.6 | + 0.3 | 3.0 | - 1.8 |
| Machinery | 84.1 | + 10.1 | 87.1 | + 3.1 | 53.7 | - 6.3 | 40.8 | - 23.2 | 7.3 | - 1.7 | 4.7 | + 0.7 |
| Rubber and plastics | 90.0 | + 30.4 | 78.1 | + 18.6 | 41.5 | - 4.8 | 48.8 | + 10.5 | 7.6 | - 1.6 | 2.7 | - 0.7 |
| Textiles | 81.5 | + 17.6 | 70.8 | + 6.8 | 35.3 | + 0.3 | 34.0 | - 14.4 | 7.1 | + 1.7 | .. | .. |
| Small | 76.8 | + 28.4 | 78.4 | + 22.5 | 38.6 | + 4.1 | 32.6 | - 0.7 | 5.3 | + 0.0 | 1.0 | + 0.4 |
| Medium | 90.9 | + 24.6 | 78.1 | + 9.3 | 52.2 | + 4.3 | 46.9 | - 0.2 | 8.7 | - 1.6 | 3.1 | + 1.0 |
| Large | 92.3 | + 10.3 | 85.6 | + 4.5 | 58.9 | - 3.2 | 64.1 | - 2.2 | 14.3 | + 0.1 | 3.6 | - 3.0 |
| Foreign | 94.4 | + 13.9 | 86.6 | + 2.8 | 59.8 | - 13.7 | 70.2 | - 1.2 | 6.9 | - 7.7 | 7.8 | + 3.0 |
| Domestic | 85.3 | + 18.8 | 79.6 | + 11.0 | 51.7 | + 4.9 | 44.2 | - 4.2 | 9.4 | - 0.7 | 1.9 | - 1.4 |
| Non-exporting | 82.0 | + 21.0 | 75.8 | + 12.6 | 40.3 | - 1.7 | 37.9 | - 4.8 | 5.9 | - 1.3 | 0.7 | - 0.3 |
| Exporting | 91.2 | + 17.2 | 85.3 | + 8.9 | 59.2 | + 2.5 | 56.4 | - 1.7 | 12.5 | - 0.8 | 4.5 | - 0.9 |

Source: Thailand PICS 2004 and PICS 2007.

110. Across countries, firms in Thailand are relatively "innovative" as shown by the data in Table 8. More firms developed a new product type, upgraded existing product lines, and adopted new technology than in most other countries for which data are available. Joint venture agreements with foreign partners are more common in advanced economies like Korea and Ireland than in Thailand.[58] Enterprises in Brazil appear to perform very well in innovative activities.[59] This appears to reinforce the fact Brazil moved up quickly in the ranking of the Knowledge Economy Index.

**Table 8. International Comparison - Percentage of Firms that Undertook Innovative Activities in the Past Two Years**

| Developed a major new product line | | Upgraded an existing product line | | Introduced new technology that substantially changed the way the main product is produced | | Entered a new joint venture agreement with a foreign partner | |
|---|---|---|---|---|---|---|---|
| Brazil | 67.6 | Brazil | 94.6 | Brazil | 67.9 | Korea | 11.5 |
| Philippines | 49.4 | **Thailand** | **80.3** | **Thailand** | **46.7** | Ireland | 10.8 |
| **Thailand** | **49.3** | Indonesia | 68.2 | Vietnam | 45.1 | *World Average* | *6.3* |
| Vietnam | 43.8 | Vietnam | 65.9 | Philippines | 42.2 | Indonesia | 5.9 |
| *World Average* | *39.2* | Philippines | 64.2 | Ireland | 38.1 | Vietnam | 5.7 |
| Ireland | 38.5 | *World Average* | *56.1* | *World Average* | *36.6* | Philippines | 5.7 |
| Indonesia | 37.8 | Ireland | 54.7 | China | 33.4 | Brazil | 4.2 |
| Korea | 37.5 | Korea | 53.9 | Turkey | 30.5 | **Thailand** | **2.5** |
| Turkey | 28.9 | Germany | 45.4 | Germany | 23.2 | Turkey | 2.7 |
| China | 24.0 | China | 40.3 | Indonesia | 22.4 | Germany | 2.5 |
| Germany | 17.5 | Turkey | 37.0 | Korea | 16.2 | China | n/a |

Source: Global PICS (2002-2005) and Thailand PICS 2007.
Notes: The data are in 2003 for Brazil, China, Indonesia, and the Philippines; in 2005 for Germany, Ireland, Korea, Turkey, and Vietnam; and in 2007 for Thailand. The samples used to calculate the world means have 61-65 countries subject to the data availability of specific indicators.

## Research and Development

111. Table 9 presents data on research and development efforts by firms. The first row shows that one-fourth of firms hire staff exclusively for R&D or design purposes. This represents a marginal increase with respect to the 2004 level, and raises the average proportion of R&D and design staff to nearly 4 percent in 2007. Despite this, the share of overall R&D spending in operating revenue dropped from 0.5 percent in 2004 to 0.3 percent in 2007. This suggests that although firms on average spent more on R&D personnel, expenditure on other R&D items

[58] This hardly qualifies as an "innovation" but a shift in the management structure can lead to more innovations in the future.

[59] The figures in Table 8 should be viewed as suggestive, as they only show the shares of firms that carried out innovative activities, but not the intensity or complexity of such activities. For example, for Thailand, the number of product types introduced during 2004-2006 was up to one- quarter of the total number of product types manufactured in 2007. This is higher than 15 percent in Brazil, but the latter country reports higher share of firms developing a new product line in recent years. These shares of new products are the median values. The mean values are biased as they vary widely across firms.

decreased. Figure 39 shows that, compared with other countries, the share of R&D spending by firms in Thailand is very low. This low and decreasing expenditure share for research and development can perhaps explain why more sophisticated innovative activities, such as patents, are carried out by much fewer (and a declining number of) firms.

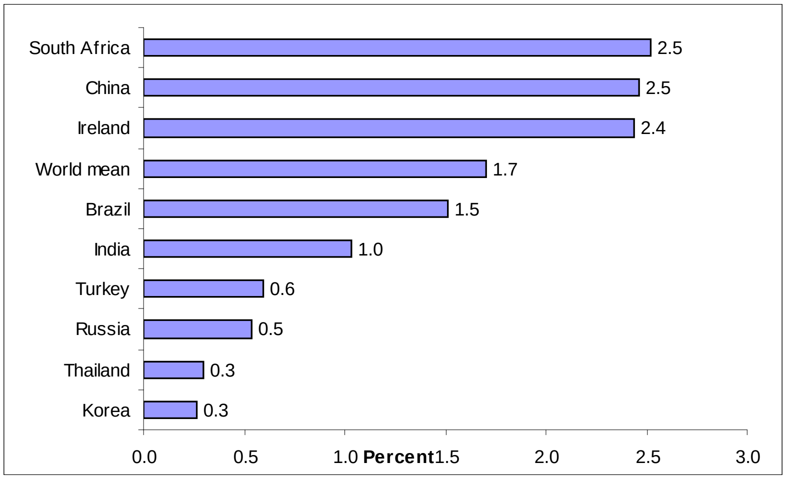
112. Finally, Table 9 shows that less than 10 percent of all firms subcontracted their R&D projects to other companies. Outsourcing of R&D activities tends to benefit firms because they can gain more from global knowledge and more qualified human resources available elsewhere. In many instances, this can also result in more efficient spending for research and development.

**Table 9. R&D Indicators**

| | **Share of firms employing staff exclusively for R&D or design** | | **Share of R&D/design staff in total staff** | | **R&D spending as a share of operating revenue (%)** | | **Share of firms subcontracting R&D projects to other companies** | |
|---|---|---|---|---|---|---|---|---|
| | PICS 2007 | Chg from PICS 04 | PICS 2007 | Chg from PICS 04 | PICS 2007 | Chg from PICS 04 | PICS 2007 | Chg from PICS 04 |
| Thailand | 22.4 | + 1.4 | 3.8 | + 1.2 | 0.3 | - 0.2 | 7.4 | + 0.1 |
| Bangkok and vicinity | 23.0 | - 0.5 | 4.5 | + 1.5 | 0.3 | - 0.4 | 8.0 | - 0.3 |
| Central | 22.6 | + 2.7 | 3.1 | + 1.0 | 0.4 | + 0.3 | 6.1 | 0.0 |
| East | 21.4 | - 0.5 | 3.7 | + 1.7 | 0.1 | - 0.5 | 5.5 | - 4.4 |
| North | 19.3 | - 4.0 | 1.7 | - 0.2 | 0.1 | 0.0 | 4.9 | + 2.2 |
| Northeast | 18.5 | + 3.3 | 1.7 | - 1.0 | 0.3 | + 0.1 | 7.8 | - 0.6 |
| South | 22.1 | + 10.9 | 1.7 | - 0.8 | 0.1 | + 0.1 | 17.3 | + 14.5 |
| Auto components | 22.3 | - 1.1 | 2.5 | + 0.1 | 0.3 | 0.0 | 12.4 | + 2.1 |
| Electrical appliances | 38.9 | + 2.5 | 3.4 | + 1.0 | 0.3 | - 0.9 | 5.6 | - 4.7 |
| Electronic components | 34.7 | + 8.6 | 7.2 | + 5.6 | 0.7 | + 0.5 | 10.8 | + 3.1 |
| Food processing | 24.4 | - 2.9 | 1.0 | - 0.1 | 0.1 | 0.0 | 16.7 | + 8.9 |
| Furniture | 29.4 | + 5.4 | 3.4 | + 0.4 | 0.5 | + 0.4 | 2.4 | - 1.6 |
| Garments | 19.6 | + 2.9 | 2.7 | + 0.6 | 0.3 | - 1.8 | 4.4 | - 2.7 |
| Machinery | 28.9 | + 4.9 | 5.8 | + 1.8 | 0.6 | + 0.4 | 11.5 | + 4.5 |
| Rubber and plastics | 18.2 | + 6.6 | 4.1 | + 0.6 | 0.2 | + 0.1 | 5.6 | - 1.9 |
| Textiles | 13.0 | - 1.0 | 3.3 | + 0.5 | 0.1 | - 0.1 | 3.3 | - 1.5 |
| Small | 13.1 | + 1.3 | 9.5 | + 2.6 | 0.4 | 0.0 | 4.4 | - 2.1 |
| Medium | 22.3 | + 4.5 | 3.3 | + 1.2 | 0.3 | - 0.5 | 7.2 | + 1.2 |
| Large | 34.0 | + 4.5 | 1.4 | + 1.0 | 0.2 | 0.0 | 11.4 | + 2.5 |
| Foreign | 30.6 | + 7.9 | 2.0 | + 0.7 | 0.2 | + 0.1 | 11.8 | + 4.3 |
| Domestic | 21.6 | + 0.8 | 4.0 | + 1.3 | 0.3 | - 0.2 | 7.0 | - 0.2 |
| Non-exporting | 13.8 | - 1.8 | 6.0 | + 2.0 | 0.2 | - 0.1 | 5.0 | - 0.2 |
| Exporting | 31.8 | + 6.7 | 2.7 | + 1.3 | 0.4 | - 0.2 | 10.1 | + 1.2 |

Source: Thailand PICS 2004 and PICS 2007.

**Figure 39. Share of R&D Spending in Total Sales (Percent)**




Source: Global PICS (2002-2005) and Thailand PICS 2007.
Notes: The data are in 2002 for India; in 2003 for Brazil, China, Indonesia, the Philippines, and South Africa; in 2005 for Ireland, Korea, Vietnam, Russia, and Turkey; and in 2007 for Thailand. The whole sample has 66 countries.

113. Across different samples Table 9 indicates that manufacturing firms in high-tech industries such as electronic components, electrical appliances, and machinery and equipment spend more in conducting R&D. At least one-third of firms that produce electronics and electrical goods employ staff exclusively for R&D or design activities, while electronics and machinery companies spent around 0.6-0.7 percent of their operating revenues on R&D (compared with the national average of 0.3 percent). In general, we see that large, foreign, and exporting firms engage more in R&D activities. Larger shares of these firms hire research and design staff. They also outsource more research projects, although the evidence on R&D spending is less strong. Greater effort has appeared to translate into more innovative activities carried out by these firms.

## Technology Acquisition

114. The channels that firms use to acquire technology can have a significant effect on their capacity to innovate. When high-quality affordable technology is already embodied in new machinery and equipment, whether local or imported, firms have weak incentives to innovate. This is also the case for subsidiaries acquiring ready-to-use technologies from their parent (mostly foreign) company. Over the long run, these conditions limit a firm's ability to adopt technological innovations.

115. Table 10 lists the leading ways that manufacturing firms in Thailand adopted to obtain new technology. Changes in the ranking of these channels between 2004 and 2007 are minor. The data show that 22 percent of firms acquire technology embodied in newly-acquired local or imported machinery and equipment. This reliance on imported machinery increased since 2004. As shown in Table 10, in 40 percent of the firms surveyed, technology was developed in-house, with clients or with machinery suppliers. It should however be noted that many of the firms reporting that they developed or adapted technology in-house could refer to minor adaptations of technology transferred from their parent company.

**Table 10. Main Channels Used by Firms in Thailand to Acquire Innovations**

| | PICS 2007 | Change from PICS 2004 |
|---|---|---|
| Embodied in new imported machinery or equipment | 22.4 | + 6.8 |
| Developed in cooperation with client firms | 18.0 | + 1.5 |
| Developed or adapted within the establishment locally | 14.5 | - 4.4 |
| Embodied in new local machinery or equipment | 12.8 | - 0.8 |
| Developed with equipment or machinery supplier | 8.2 | + 2.2 |
| Transferred from parent company | 8.1 | - 3.6 |
| Other channels | 6.6 | - 0.3 |
| From a business or industry association | 4.4 | + 0.4 |
| By hiring key personnel | 1.5 | - 1.5 |
| Consultants | 1.3 | + 0.7 |
| From universities, public institutions | 1.2 | + 0.3 |
| Licensing or turnkey operations from domestic sources | 0.5 | - 0.5 |
| Licensing or turnkey operations from international sources | 0.4 | - 0.7 |
| Mergers and acquisitions | 0.1 | - 0.1 |

Source: Thailand PICS 2004 and PICS 2007.

116. Technological innovations originating from universities and public institutions are used by 1 percent of surveyed firms only. This clearly reflects weak linkages between manufacturing firms and research centres or universities—institutions that are essential for the generation of new technology. The PICS data show that less than 7 percent of the firms that developed/adapted technology locally sought help from universities. The share of firms that collaborated with research institutions is much lower at 1.3 percent. Overall, less than 25 percent of all firms in PICS 2004 and 2007 ever worked with research or technology-support institutions. The services of these institutions are not widely used because their services are not well matched with firm needs. Most firms are unaware of or unsure how to contact these institutions—as was also the case with skills development-support institutions.

117. Table 10 also reveals that new technology acquisition channels relying directly on the availability of human resources (such as key personnel and consultants) are uncommon in Thailand. Recall that we indicated earlier that over 40 percent of firms reported that they did not innovate because they lacked skilled personnel.

118. Table 11 presents the data on technology acquisition by region, industry and ownership type of firm. Small, domestic, non-exporting firms adapt or develop technology in-house or with clients and machinery suppliers more than larger, foreign, and exporting firms—which rely on parent companies. The data indicates that firms in the automotive parts and electronic components sector (mostly subsidiaries of Japanese firms) rely heavily on their parent companies as a source of new technology. None of the electronics/electrical establishments in the survey gained new technology from local universities and public institutions.

**Table 11. Main Channels Used by Firms in Thailand to Acquire Technological Innovations, by Region, Industry and Enterprise Type**

| | Embodied in new local and imported machinery or equipment | | Developed or adapted within the establishment locally or with client firms or machinery suppliers | | Transferred from parent company | | By hiring key personnel and consultants | | From universities, public institutions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | PICS 2007 | Chg from PICS 04 | PICS 2007 | Chg from PICS 04 | PICS 2007 | Chg from PICS 04 | PICS 2007 | Chg from PICS 04 | PICS 2007 | Chg from PICS 04 |
| Thailand | 32.7 | + 3.5 | 37.8 | - 3.6 | 7.5 | - 4.1 | 2.6 | - 1.0 | 1.1 | + 0.3 |
| Bangkok and vicinity | 37.3 | + 10.6 | 39.7 | - 5.6 | 2.2 | - 6.1 | 2.8 | - 1.4 | 0.9 | + 0.3 |
| Central | 28.4 | - 7.4 | 41.8 | + 4.6 | 8.6 | - 4.0 | 1.6 | - 1.1 | 1.1 | + 0.3 |
| East | 23.8 | - 5.1 | 24.5 | - 10.2 | 25.0 | + 3.7 | 2.0 | - 0.9 | 1.9 | + 0.2 |
| North | 34.4 | + 9.0 | 31.4 | + 0.9 | 13.9 | - 6.4 | 3.1 | - 0.3 | 0.0 | - 1.7 |
| Northeast | 25.4 | + 3.8 | 32.2 | - 12.9 | 13.0 | + 5.2 | 2.4 | - 1.5 | 0.0 | + 0.0 |
| South | 35.1 | + 1.3 | 39.0 | - 10.4 | 2.5 | - 2.7 | 7.7 | + 3.8 | 3.8 | + 2.5 |
| Auto components | 27.3 | - 10.9 | 30.5 | + 3.3 | 27.7 | + 6.3 | 3.5 | - 0.2 | 2.0 | + 1.2 |
| Electrical appliances | 41.5 | + 21.7 | 39.3 | - 4.2 | 9.6 | - 12.7 | 3.0 | + 0.3 | 0.0 | - 1.3 |
| Electronic components | 15.8 | - 10.6 | 44.2 | + 7.4 | 24.1 | - 5.7 | 4.3 | + 2.2 | 0.0 | - 0.7 |
| Food processing | 36.9 | - 2.2 | 34.3 | + 1.2 | 8.2 | + 0.9 | 6.3 | + 1.6 | 0.5 | - 2.2 |
| Furniture | 30.9 | - 1.7 | 48.2 | - 1.3 | 1.0 | + 1.0 | 2.2 | - 0.1 | 2.4 | + 2.4 |
| Garments | 35.8 | + 8.4 | 35.9 | + 2.1 | 4.4 | + 1.5 | 0.8 | - 5.7 | 0.8 | + 0.8 |
| Machinery | 24.0 | + 19.7 | 44.2 | - 22.5 | 9.4 | - 4.6 | 2.4 | - 1.9 | 2.3 | + 1.2 |
| Rubber and plastics | 36.4 | + 5.1 | 34.8 | - 12.8 | 1.8 | - 0.4 | 2.5 | + 0.3 | 0.8 | + 0.3 |
| Textiles | 36.8 | + 4.9 | 38.1 | - 6.9 | 2.5 | - 7.0 | 0.6 | - 3.0 | 1.0 | + 0.2 |
| Small | 31.9 | + 4.5 | 44.0 | - 7.8 | 2.4 | - 0.7 | 2.4 | - 1.5 | 0.4 | + 0.0 |
| Medium | 31.9 | + 3.2 | 39.5 | - 2.8 | 5.2 | - 3.6 | 2.6 | - 0.2 | 1.6 | + 0.2 |
| Large | 34.8 | + 4.1 | 28.2 | - 7.5 | 16.6 | - 1.6 | 2.6 | - 1.4 | 1.3 | + 0.7 |
| Foreign | 32.0 | + 9.4 | 17.3 | - 2.4 | 47.7 | - 3.7 | 1.3 | + 0.7 | 0.0 | + 0.0 |
| Domestic | 33.0 | + 2.5 | 40.5 | - 4.7 | 2.3 | - 2.4 | 2.7 | - 1.4 | 1.2 | + 0.2 |
| Non-exporting | 32.0 | + 0.4 | 41.1 | - 5.2 | 2.6 | - 2.5 | 2.4 | - 1.1 | 0.5 | - 0.2 |
| Exporting | 33.5 | + 5.8 | 34.3 | - 3.9 | 12.7 | - 3.3 | 2.7 | - 0.9 | 1.8 | + 0.8 |

Source: Thailand PICS 2004 and PICS 2007.

119. Table 12 provides an international perspective on technology acquisition. Thailand has more firms developing technology in-house or with client firms or machinery suppliers than comparator countries. Thailand also relies less on technology embodied in new machinery and equipment. This data suggests that compared to other countries Thailand makes reasonable efforts to generate technological innovations. However, the role of Thailand's universities and research centers in generating new technology is more limited than in advanced economies such as Korea and Ireland. More firms acquired their technology from parent companies. Such technology transfer usually discourages local innovations if the technology transferred is ready to use but it helps local firms in building their technological capability.

**Table 12. Technology Acquisition in Selected Countries**

| | Thailand | Korea | Ireland | Brazil | Indonesia | Philippines | Vietnam |
|---|---|---|---|---|---|---|---|
| Embodied in new machinery or equipment | 33.1 | 40.4 | 59.7 | 45.8 | 48.7 | 43.0 | 69.2 |
| Developed or adapted within the establishment locally | 19.4 | 5.3 | 10.5 | 19.2 | 4.7 | 8.3 | 9.6 |
| Developed with client firms | 17.2 | 9.6 | 6.8 | 4.5 | 15.1 | 9.7 | 0.0 |
| Transferred from parent company | 11.8 | 4.3 | 2.6 | 3.1 | 2.7 | 4.3 | 1.6 |
| Developed with equipment or machinery supplier | 7.2 | 4.3 | 5.2 | 3.9 | 7.0 | 5.0 | 11.7 |
| From an industry association | 4.4 | 2.1 | 2.6 | 0.4 | 0.0 | 3.0 | 0.0 |
| By hiring key personnel | 3.0 | 21.3 | 8.9 | 12.5 | 17.9 | 14.2 | 2.3 |
| Licensing or turnkey operations from international sources | 1.2 | 6.4 | 0.5 | 0.6 | 2.3 | 1.3 | 3.3 |
| Licensing or turnkey operations from domestic sources | 1.1 | 4.3 | 1.6 | 0.4 | 1.6 | 0.2 | 2.3 |
| From universities, public institutions | 0.9 | 2.1 | 1.6 | 0.4 | 0.0 | 0.2 | 0.0 |
| Consultants | 0.7 | 0.0 | 0.0 | 2.6 | 0.0 | 4.5 | 0.0 |
| Trade Fairs and/or Study Tours | 0.0 | 0.0 | 0.0 | 6.6 | 0.0 | 6.4 | 0.0 |

Source: Global PICS (2002-2005). The data are for 2003 for Brazil, Indonesia, and the Philippines, 2004 for Thailand and 2005 for Ireland, Korea, and Vietnam.

120. Table 13 presents data on local innovations and technology transfers in Thailand. Over three quarters of firms that acquired new technology from a parent company view adaptation or local R&D to suit local conditions as necessary. This share fell by 10 percent with respect to 2004. Fewer firms also indicate that they learn about new technology from being a supplier to a multinational company (MNC). Half of the firms surveyed in PICS 2007 are MNC suppliers so this has an important effect on the overall innovative capability of Thailand. This evidence suggests a need to strengthen new local knowledge and technology.

**Table 13. Foreign Technology Transfers and Local Innovations**

| Share of firms viewing… | PICS 2007 | Change from PICS 2004 |
|---|---|---|
| Adaptation or R&D to suit local conditions is necessary if technology transferred from parent company | 77.6 | - 10.4 |
| Training of workers to implement technology is necessary if technology transferred from parent company | 94.1 | - 2.9 |
| They learn about new technology from being a supplier to Multinational Corporation | 43.4 | - 6.7 |

Source: Thailand PICS 2004 and PICS 2007.

### Business Services

121. Business services—engineering and design, information technology, management and marketing, and legal services—can support innovation. Engineering, design and IT services are especially important for product and process innovations, while management services can help to promote organizational innovation. Legal services become useful for intellectual property rights when firms need to register patents or copyrights. Business services that support innovation seem to have become more available in recent years. For example, firms with calibrating and testing services for machinery and equipment in their own region increased from 62 percent in 2004 to 80 percent in 2007. The increase was 30 percent in the Northeast, though it is still below the national average. In the North, only around 40 of all surveyed firms in the region had calibrating and testing services available nearby.

122. As shown in Table 14, business services are now much more affordable than a few years ago. All business services were perceived to be affordable by not more than 40 percent of all firms in 2004 but these numbers increased remarkably in 2007. There is no indication that the quality of innovation-related services has improved - except for engineering and design services. A small number of firms cited legal services as having poorer quality.

**Table 14. Percentage of Firms Reporting that Business Services are Affordable and of Good Quality**

| | Are affordable | | Have fairly or very good quality | |
|---|---|---|---|---|
| | PICS 2007 | Change from PICS 2004 | PICS 2007 | Change from PICS 2004 |
| Engineering and design | 79.6 | + 55.6 | 85.0 | + 6.5 |
| IT | 57.5 | + 27.6 | 77.7 | - 0.3 |
| Management and marketing | 89.7 | + 81.1 | 73.6 | - 0.6 |
| Legal | 57.0 | + 16.5 | 81.9 | - 2.3 |

Source: Thailand PICS 2004 and PICS 2007.

### Government Support

123. The PICS data on government support relate to public initiatives and projects that support firms to carry out innovative activities. The majority of enterprises innovate without incentives from government. In 2004, 12 percent of all surveyed firms

participated in government schemes to conduct R&D. This fell to 8 percent in 2007. Table 15 shows that a small number of firms participate in various types of incentive schemes. Between 40 and 60 percent of all firms surveyed reported that they had never heard about these schemes. In addition to the three schemes reported in Table 15, 1-4 percent of firms participated in other programs including the Industrial Technology Assistance Program (NSTDA), the Open Lab (NSTDA), the Skill, Technology and Innovation Promotion (BOI), and the R&D Investment Promotion (BOI). Incentives offered by the National Innovation Agency—such as funds for R&D and joint ventures for innovation—are used by only a small number of PICS 2007 firms.

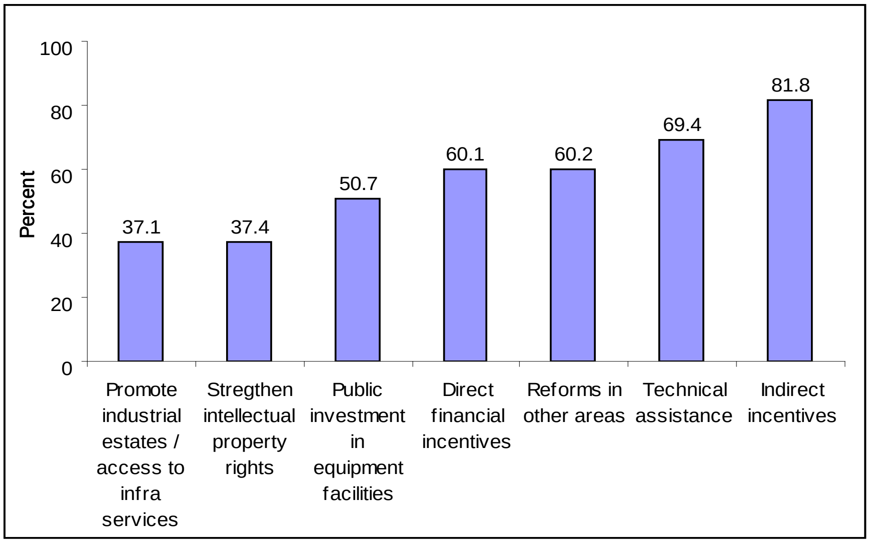
**Table 15. Share of Firms Benefiting from Government Initiatives to Promote Innovation (Percent)**

| | Benefitted from… | | Never heard of… | |
|---|---|---|---|---|
| | PICS 2007 | Change from PICS 2004 | PICS 2007 | Change from PICS 2004 |
| Science Park project (NSTDA) | 2.3 | + 1.3 | 41.2 | + 2.9 |
| Low interest loans for technological development in private sector (NSTDA) | 1.5 | 0.0 | 45.0 | + 17.4 |
| 200% Tax reduction for R&D expenditure (Revenue Department and NSTDA) | 1.1 | + 0.3 | 61.5 | + 18.3 |

Source: Thailand PICS 2004 and PICS 2007.

124. The Thailand PICS does not specifically ask firms why they do not use government schemes. But possible reasons are poor outreach program of existing government incentives, irrelevancy of incentives to firms' needs, and no demand for incentives. Figure 40 provides the frequency of response to the question "what government initiative do you view as important to promote your firm's innovation activities?" Over 80 percent of firms mentioned indirect incentives such as tax deductions; followed by technical assistance; reforms such as streamlining tax reporting processes and lifting restrictions on capacity expansion; and direct financial incentives such as subsidies and low-interest rate loans.

**Figure 40. Percentage of Firms Viewing Certain Government Initiatives as Very Important to Promote Innovation**



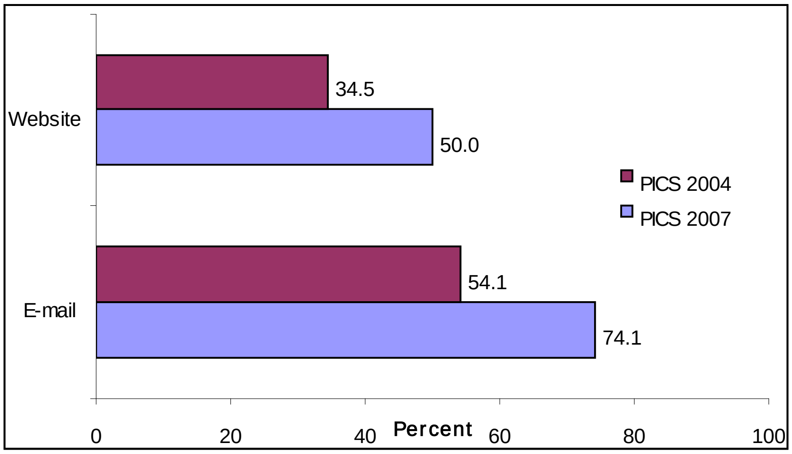

Source: Thailand PICS 2004 and PICS 2007.

### MODERN INFORMATION INFRASTRUCTURE

125. This section provides information on the use of information/communications infrastructure for the diffusion of knowledge by manufacturing firms in Thailand.[60] Figure 41 shows the percentage of firms that regularly use email and Internet to correspond with their customers and suppliers. By 2007, websites and e-mails were common in about 50 and 75 percent of the firms surveyed, respectively. This more widespread use of information technology reflects, among other factors, a noticeable increase in IT investment. Planned investments in IT increased from 9 percent of total investment in 2004 to 13.7 percent in 2007 (see Figure 42). In 2007, however, firms considerably reduced their planned investment in IT.

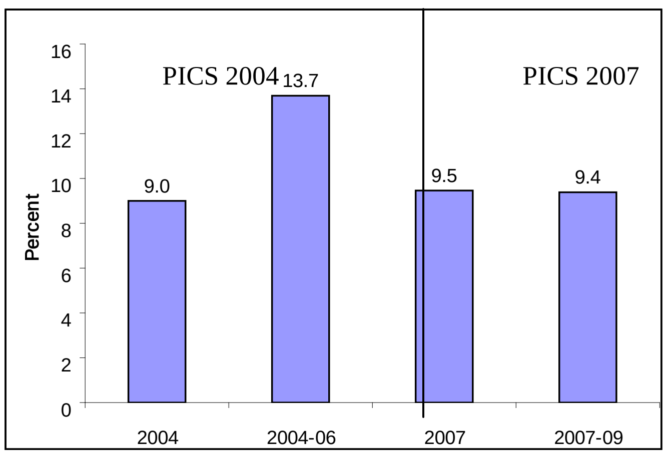
[60] The PICS contains less data on information and communications infrastructure in enterprises than on skilled labor and the innovation system.

**Figure 41. Percentage of Firms Regularly Using Emails and Website to Interact with Their Clients and Suppliers**




Source: Thailand PICS 2004 and PICS 2007.

**Figure 42. Share of Planned IT Investments in Total Investments for Current and Future Years**




Source: Thailand PICS 2004 and PICS 2007.

126. The correlation between types of firms that have extensive innovative activities—the large, foreign, and exporting firms and automotive parts, electrical appliances, and electronic components' industries which have higher-technology intensity —and those that invest in IT (Table 16) is high. Nonetheless, these enterprises planned a more moderate investment in IT in the coming years. Firms in the furniture industry generally have a very low share of IT investment. Email and Internet are not common in the textiles industry.

**Table 16. Use of IT and Planned Investments in IT, by Region, Industry and Enterprise Type**

| | Share of planned, current IT investment | | Share of planned, future IT investment | | Share of firms using e-mail regularly | | Share of firms using website regularly | |
|---|---|---|---|---|---|---|---|---|
| | PICS 2007 | Chg from PICS 04 | PICS 2007 | Chg from PICS 04 | PICS 2007 | Chg from PICS 04 | PICS 2007 | Chg from PICS 04 |
| Thailand | 9.5 | + 0.5 | 9.4 | - 4.4 | 74.1 | + 20.0 | 50.0 | + 15.5 |
| Bangkok and vicinity | 10.5 | - 1.1 | 11.6 | - 9.2 | 73.0 | + 14.9 | 47.6 | + 12.5 |
| Central | 9.8 | + 1.4 | 7.0 | + 0.2 | 75.4 | + 19.9 | 53.4 | + 17.6 |
| East | 7.9 | + 2.0 | 9.5 | - 1.8 | 87.2 | + 24.7 | 58.3 | + 15.0 |
| North | 5.9 | - 2.6 | 7.3 | - 1.8 | 48.2 | - 1.1 | 38.5 | + 4.3 |
| Northeast | 4.2 | - 1.9 | 3.6 | - 5.0 | 64.0 | + 33.5 | 47.1 | + 23.5 |
| South | 6.3 | + 4.1 | 1.8 | - 0.6 | 68.3 | + 37.4 | 44.0 | + 25.3 |
| Auto components | 14.6 | - 3.3 | 12.0 | + 3.8 | 93.3 | + 25.7 | 67.2 | + 23.1 |
| Electrical appliances | 25.8 | + 21.8 | 18.6 | - 4.8 | 69.5 | + 13.8 | 63.9 | + 20.7 |
| Electronic components | 22.2 | + 7.5 | 20.4 | + 13.5 | 91.7 | + 13.4 | 63.8 | + 12.9 |
| Food processing | 5.2 | + 0.9 | 6.8 | - 0.5 | 70.8 | + 16.6 | 55.5 | + 15.3 |
| Furniture | 3.5 | - 2.3 | 2.2 | - 7.9 | 75.9 | + 35.1 | 56.4 | + 37.2 |
| Garments | 9.6 | + 4.1 | 8.3 | - 2.6 | 69.1 | + 12.0 | 40.1 | + 10.3 |
| Machinery | 8.3 | + 2.6 | 15.4 | - 29.5 | 75.2 | + 17.2 | 51.8 | + 14.8 |
| Rubber and plastics | 6.1 | - 3.6 | 6.5 | - 5.8 | 76.8 | + 34.8 | 45.6 | + 16.5 |
| Textiles | 8.6 | + 5.3 | 8.0 | - 0.5 | 53.6 | + 11.7 | 38.0 | + 14.3 |
| Small | 6.9 | + 1.9 | 8.6 | - 19.1 | 61.6 | + 31.2 | 33.5 | + 17.4 |
| Medium | 9.8 | - 1.7 | 9.1 | - 5.3 | 75.0 | + 22.9 | 53.3 | + 22.5 |
| Large | 10.6 | + 2.1 | 10.3 | + 2.8 | 88.3 | + 18.6 | 66.2 | + 17.5 |
| Foreign | 16.2 | + 2.4 | 10.5 | + 3.6 | 92.9 | + 17.3 | 58.2 | + 6.8 |
| Domestic | 8.6 | + 0.7 | 9.2 | - 6.0 | 71.8 | + 21.0 | 48.9 | + 17.0 |
| Non-exporting | 8.7 | + 0.5 | 9.0 | - 5.7 | 59.1 | + 22.5 | 35.2 | + 16.0 |
| Exporting | 10.1 | + 0.6 | 9.6 | - 3.4 | 90.6 | + 23.2 | 66.2 | + 20.2 |

Source: Thailand PICS 2004 and PICS 2007.

127. In general, most managers think that IT investments yield reasonable rates of return and that adopting IT helps to enhance productivity. But they are reluctant or unable to introduce or expand IT usage. The main reasons are the high cost of IT equipment and maintenance and the lack of skilled human resources. Table 17 also shows that the percentage of firms viewing these constraints as very important increased significantly from 2004 to 2007. This could explain the declining share of IT investment planned for the future in PICS 2007.

**Table 17. Percentage of Firms Viewing Certain Constraints to Introducing or Expanding IT Use as Very Important**

| | PICS 2007 | Change from PICS 2004 |
|---|---|---|
| Lack of knowledgeable and trained IT personnel | 50.9 | + 14.8 |
| Lack of experienced consultants to provide or design IT-based solutions system | 49.1 | + 13.1 |
| High cost of IT equipment and maintenance | 44.3 | + 25.8 |
| Low returns to investments in IT | 23.8 | + 11.0 |
| IT-based systems do not improve productivity | 20.2 | + 5.4 |

Source: Thailand PICS 2004 and PICS 2007.

## CONCLUDING REMARKS

128. Shortage of skilled labor remains a key business constraint in Thailand. Qualified professionals are harder to find, and both skilled and unskilled production workers are scarce compared to countries with similar development level. The extent of shortages varies across industries but is less severe among foreign firms. Many job vacancies arise because applicants lack basic and technical skills that firms require. Managers are particularly dissatisfied with English proficiency and IT, numerical skills, and the creativity of their employees. There is a high turnover of new recruits and this discourages firms from providing training. The lack of skilled staff limits the efforts made by enterprises to innovate. The contribution of public and private institutions in skills development is marginal. Enterprises do not view existing services as relevant to their needs.

129. A large number of enterprises in Thailand, especially large and foreign firms and those in the high-tech industries, are innovating through activities such as upgrading machinery and existing product lines. In that regard, Thailand compares favorably with other counties. But more sophisticated activities such as introducing new technology or product type, are carried out by less firms. R&D spending is low by international standards. A large number of firms in Thailand develop technology in-house or with clients and machinery suppliers but manufacturing relies predominantly on technology embodied in imported machinery and equipment. Universities and public institutions play a more limited role in generating new technology in Thailand than in other comparable economies. Business services to support innovation, such as engineering, design, and IT services, are now widely available but their quality has not improved. Finally, only a limited number of firms benefit from government initiatives and other incentive schemes.

130. Information technology tools such as the email system and Internet are widely used, especially by large and foreign firms and firms in the high-tech industries, which are also firms that undertook more innovation. There was a large planned increase in IT investment in 2004 but not in 2007. Increasing staff skills and reducing IT costs are considered important to encourage more investment in IT.

131. The Thai government has introduced various initiatives to improve the quality of the labor force. At the secondary education level, it has allowed new school designs

including independent private schools; ICT schools integrating computers in teaching and learning; and bilingual schools. Recent measures have been adopted to upgrade teacher standards by focusing on education management and curriculum change, and to improve labor skills and vocational schools. It would be helpful to concentrate on further areas where improvements are needed (World Bank, 2006b). Instructional resources and teaching aids remain in short supply. The government should also consider strengthening internal and external quality assurance mechanisms in schools; decentralizing authority to schools to increase their accountability for student performance; and better targeting of student loan schemes. Many students in general have a strong preference for universities over vocational or technical schools; and university graduates are more valued, both socially and financially, in local labor markets. The government should create more career opportunities and paths in vocational schools.

132. The tertiary education level is where the main challenge lies. The cabinet has approved a 15-year tertiary education framework (2008-2022) focusing on knowledge and innovation. Thailand's government has been successful in designing and passing the regulations required to modernize its higher education system and make it more efficient. It now needs to focus on implementing these policies and on education the public, and the academic community, about the advantages of a more decentralized and autonomous system. These advantages include having the potential to engage in fruitful collaboration with industry, encouraging entrepreneurial endeavours from faculty to attract external funding, and promoting cross-institutional, cross-border, and interdisciplinary partnerships from maximizing outputs.

133. The Government has made many efforts to enhance science and technology in Thailand. First, the government recently adopted a proposal by the National Research Council of Thailand (NRCT) to reform the national research system. This proposal uses a national research project management approach for the management of public research budgets; it strengthens the cooperation between NRCT and other public research funds; it introduces a 'dominant player model' in which only one public agency coordinates research efforts in the public sector and it changes the role of public units from conducting to facilitating research done by other parties. Second, the Cabinet also approved a draft law on science and technology which will set up an institution that will coordinate local and foreign science and technology agencies. Third, the Cabinet also recently approved a promotion plan for 2007-2011 for small and medium-sized enterprises (SMEs) to provide incentives to move toward knowledge-based business; it adopted a five-year strategy to develop robotic technology and automation systems; it established an excellence centre in Physics, and has a project to enhance technological capabilities in the electronics industry. More emphasis is placed on attracting foreign investment to transfer knowledge locally. A decision on a new Board of Knowledge Investment (or on broadening the existing functions of the Board of Investment to include knowledge-based investments) is under review.

134. The government could usefully examine what other countries such as South Korea or Finland have achieved. The South Korean three-year plan has five parts: expanding human resources, enhancing science and technology, developing information infrastructure, developing knowledge-based industry, and eliminating the digital divide.

To achieve these goals, five working groups were established. They involve 19 ministries and 17 research institutes. In Finland, the government clearly stated that it would fund basic and applied research while the private sector should be more involved at the commercialization stage. R&D was first developed through government institutes; the aim was to adapt imported technology to local needs. More R&D is performed by the business sector as the industrial sector expands.

135. In Thailand, at the supra-ministerial level, the National Research Council of Thailand (NRCT) and the National Science and Technology Policy Committee (NSTC), are responsible for the coordination of all national technology policies. These two agencies are not seen as effective in coordinating innovation policies and at providing a vision for innovation and technology (World Bank and NESDB, 2008). This is partly because the private sector is not sufficiently involved in the formulation of policy. This is in contrast to Finland's Science and Technology Policy Council, which is chaired by the prime minister and comprises of representatives from key ministers and the business community, trade unions, and civil society. Such coordinating agencies should be well funded, flexible and focuses entirely on supporting innovation-related projects (World Bank 2007).

136. There are close to 50 fiscal incentives from the Thai government to promote innovations in enterprises. However, their collective impact is rather disappointing because these schemes are uncoordinated. They are designed and provided by different ministries, each with own mission and objectives. In some cases, these incentive schemes are too narrowly defined and benefit only a small number of firms. In other cases, collaterals are required by many loan schemes and limit access for start-up enterprises. The government could study the Finnish, South Korean and other systems to coordinate science and technology policy and increase the impact of its support of innovation.[61]

137. Effective innovation systems generally rely on close collaboration between universities, research institutes and manufacturing firms. To strengthen these linkages, the government could study several measures such as giving greater authority to universities to manage their personnel policies (so they can compete for high-quality students and staff); providing funding for basic research to leading universities; establish science parks and incubators adjacent to universities; create intermediary organizations with representatives from universities, the private sector, and government to help bridge the information gaps between users and developers of technology; or offering matching funds, as in Finland, for universities and companies that work together on specific research and technology projects (World Bank, 2007).[62]

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[61] See in particular, Hatakenaka (2008).

[62] World Bank and NESDB (2008) describes in more detail how successful intermediaries are set up, managed, and financed in the US, UK, Canada, and Japan.