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UNIDO RESEARCH PROGRAMME

COMBATING MARGINALIZATION AND POVERTY THROUGH INDUSTRIAL DEVELOPMENT ‹COMPID›

Technological development in low-income countries: **policy options for sustainable growth**

Summary

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≪COMPID≫

COMBATING MARGINALIZATION AND POVERTY
THROUGH INDUSTRIAL DEVELOPMENT

Technological development in low-income countries: policy options for sustainable growth

Summary

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Contents

OVERVIEW

The report *Technological development in low-income economies: policy options for sustainable growth* is part of the broader research programme on Combating Marginalization and Poverty through Industrial Development (COMPID) of the United Nations Industrial Development Organization (UNIDO).[1] The main purpose of the report is to present a conceptual framework that can be used as a guide, not a blueprint, by UNIDO to assist its client governments and the private sector in low-income countries in designing and implementing technology strategies for industry that are environmentally sound. Based upon this conceptual framework, a second objective is to derive implications for UNIDO's technology-related policy advisory and institutional capacity-building services.

[1]COMPID includes the following five projects: *(a)* Supporting industrial development: overcoming market failures and providing public goods; *(b)* Technological development in low-income countries: policy options for sustainable growth; *(c)* Industrialization and poverty alleviation: pro-poor industrialization strategies revisited; *(d)* Productivity enhancement and equitable development: challenges for SME development; and *(e)* Social capital for industrial development: operationalizing the concept.

I. A CONCEPTUAL FRAMEWORK FOR POLICY FORMULATION

The conceptual framework developed in chapter I of the report draws extensively from the successful experiences with environmentally sound technological development in industry in a small group of East Asian newly industrializing countries or regions. The report begins by focusing on lessons learned from efforts by governments and firms in these countries or regions to building technological capability. The report then turns to the lessons learned from efforts within these countries or regions to improve the environmental performance of industrial firms. Lessons learned in both arenas are then used to develop a conceptual framework matrix. This matrix identifies concrete and specific pathways to environmentally sound technological development in industry, relates these to four other core elements of environmentally sound technology, namely, enabling conditions, the policy process and technology infrastructure, technology support institutions and policy integration.

A. TECHNOLOGICAL DEVELOPMENT: EXPERIENCES OF EAST ASIA

Based on the experience of East Asian countries and technology strategies, policies and institutions, the literature on technology and development, as well as on the rationale for a focus on technological learning and upgrading set out in UNIDO's *Industrial Development Report 2002/2003,* the report recognizes that conscious effort by both individual firms and governments is necessary for building technological capabilities of indigenous industrial firms in developing countries. Such efforts will enable developing countries to produce efficiently, thrive and grow, provide numerous well-paid jobs, link and export to, as well as compete in, the global economy (Lall [1992]).

Technological development is primarily a firm-level effort. It involves trial and error and gaining tacit experience with particular technologies (Lall [1992] p. 166). As is presently known, there are significant differences in the willingness of firms to undertake and succeed in these tasks. If this were not the case, productivity and efficiency differences between firms using the same technology in the same industry, both within and between countries, would be less than those observed (Tybout [1996] pp. 43-72). In the same vein, differences in the degree to which firms in the same industry in the same country (or region) adapt and improve existing industrial technologies to new needs or create new comparative advantages in increasingly technology-intensive sectors would also be smaller than observed (Bell and Pavitt [1992] p. 257).

To begin with, they must match their choice of foreign technology to local needs, conditions and constraints (Dahlman, Ross-Larson and Westphal [1987] p. 762). Doing so requires firms to scan the technological horizon to identify and assess the technological possibilities open to them. This is both a time-consuming and costly endeavour. Moreover, for each possible choice,

firms must assess the costs and benefits of that choice. This includes assessing the possibilities that each distinct technology holds for acquiring additional capabilities. Since it is difficult for firms to learn across diverse technological dimensions, particular technology choices also tend to move firms along particular technology trajectories.

After firms have narrowed their search to particular technologies, they must decide precisely how to acquire all the elements—information, means and understanding—associated with their technology choices. Options include relying on foreign direct investment, licensing agreements, turnkey projects, purchase of individual pieces of capital equipment, and/or acquiring technological capabilities through technical assistance (Dahlman, Ross-Larson and Westphal [1987] pp. 767-769). Having settled on technology choices and options for acquiring all the elements associated with particular technologies, firms must then invest in the arduous tasks of acquiring the investment, production and linkage capabilities offered by the technologies they have chosen. With respect to investment capabilities, firms must learn how to organize and oversee all activities associated with establishing and/or expanding a given factory (Lall [1992] p. 171).

Once the technology is installed, emphasis shifts to acquiring production capabilities, or the capability to improve the operation of a factory, to learn how to optimize the operation of facilities, including raw material control, production scheduling, quality control, troubleshooting, adapting processes and products to changing circumstances, and to repair and maintain equipment as needed (Lall [1992] p. 171). Finally, firms must develop linkage capabilities that enable them to transmit information, skills and technology to, and receive information, skills technology and other inputs, from component and raw material suppliers, subcontractors and technology institutes (ibid.).

As all firms are embedded in a larger socio-economic and political environment, governments' industrial development strategies, policies and institutions have an enormous impact on whether firms invest in building their technological capabilities, how much they invest and how successful they are in building these capabilities. To begin with, governments must provide minimal non-technological *enabling conditions* to enable firms to lengthen their time horizons. This means that governments must provide sufficient political stability so that firms can reap the gains from long-term investments in building their technological capabilities (Barro [1991]). Maintaining macroeconomic stability—a competitive exchange rate, relatively low inflation and sustainable fiscal and current account deficits—is equally important, as is providing sufficient and reliable infrastructure, an educated workforce and opening the economy to trade and foreign investment (World Bank [1993]).[2]

Governments must also establish a *policy process* (Rodrik [2004]) centred on embedded autonomy (Evans [1995]) with the private sector, to design and implement technology strategies that take advantage of markets and the global economy. In addition, governments must provide or support the development of a *technological infrastructure*. Developing this infrastructure has to be guided by a market-building perspective, and governments must ensure that it is externally oriented and meets the real needs of firms. Doing so requires that the policy process be adapted to account for the role of a competent environmental regulatory agency that is linked to the institutions of industrial policy through policy integration (Angel and Rock [2003]).

[2]How they do so matters, see, for example, Amsden [1989]; Wade [1990]; Huff [1990]; Mardon [1990]; Rhee and others [1984] and Rock [1999] and [2000].

The successful industrializers in the East Asian newly industrializing countries (or regions) met these relatively stringent requirements for successful technological upgrading by linking the four dimensions of public policy—enabling conditions, the policy process, technological infrastructure and policy integration—to one of three *specific and concrete pathways*[3] leading to capabilities-building. These pathways, however, extended well beyond identifying routes to upgrading, based on serving the local market, exporting manufactures or developing linkages with the global economy and/or multinational corporations. In each instance, the concrete and specific pathway chosen was deeply rooted in domestic politics (Wade [1990]) and had important implications for the subsequent size distribution of firms (ibid.; Amsden [1989]; Rock [1989] and [2000]), as well as for the precise ways governments developed embedded autonomy with the private sector.

The first pathway to technological development, followed primarily by Taiwan Province of China, focused on the public sector institutions of a *national technology and innovation system* that were tightly linked through embedded autonomy to the Province's small and medium enterprises and the global economy (Wade [1990]). A public sector investment promotion agency identified industries and technologies that were thought to be most applicable to each stage of industrial development. A quasi-public/quasi-private sector science and technology institute acquired these technologies, reverse engineered them, spun them off and diffused them to the region's numerous small and medium enterprises. A public sector export-marketing agency helped these firms to overcome information failures associated with serving markets of developed countries or regions. Another public sector agency linked the Province's larger firms to clusters of smaller firms that ultimately became suppliers to these larger firms. Besides, in numerous instances, State-owned enterprises in upstream industries were used to acquire technological capabilities in scale intensive industries and to supply downstream users with high quality and competitively priced intermediate inputs.

In the second pathway, which was followed by the Government of the Republic of Korea (Amsden [1989]) and, to a lesser extent, by the Governments of Indonesia (Rock [1999]) and Thailand (Rock [2000]), the policy process focused on *building a relatively small number of large indigenous national firms*. The approach of the Republic of Korea to building technologically competent national firms was rooted in a unique institutional framework that enabled the Government, again through embedded autonomy, to allocate performance-based promotional privileges—primarily subsidized credit from State-owned banks—to a small number of what turned out to be very large conglomerates (Rhee and others [1984]). Those firms also relied heavily on the Government's rather severe restrictions on foreign capital to ensure that foreign direct investment, licensing agreements and technical assistance agreements hastened the building of firm-level technological capabilities (Mardon [1990]).

[3]It is important to note that each of the East Asian newly industrializing countries (or regions) often used more than one pathway to technological upgrading. For example, Taiwan Province of China followed a national innovation strategy and a big firm State-owned enterprise strategy (Wade [1990]). Thailand followed a large firm strategy, but it also invested in upgrading of small and medium enterprises. The point here is not that each country (or region) only followed one strategy, but that there was a dominant strategy in each country. The focus is on this dominant strategy.

Governments in Indonesia and Thailand, for their part, were less capable than their counterparts in the Republic of Korea and government–business relationships were more prone to rent-seeking activities (Rock [1999] and [2000]). Governments in both countries were also more open to foreign direct investment. Because of this, promotional privileges tended to be somewhat less performance based. Despite this, Governments in both countries targeted promotional privileges to a relative few in what turned out to be *very large national firms that engaged in joint ventures with large multinational corporations of developed countries.* As in the Republic of Korea, those firms dominated the industrial economy. Initially, a large number of the joint ventures between these large national firms and multinational corporations served local rather than export markets. Over time, however, promotional privileges shifted to encourage the export of manufactures.

The last pathway, followed by the Governments of Malaysia (Felker [2001]; Raisah [2001]; Churchill [1995]) and Singapore (Huff [1999]), initially focused on a policy process that fostered the development of infrastructure facilities, the human capital base, an incentive system, as well as an institutional framework, necessary to attract multinational corporations of developed countries. In both countries, core government agencies—in particular investment promotion agencies and agencies responsible for industrial estates, export processing zones and licensed manufacturing warehouses—enjoyed substantial embedded autonomy with multinational corporations. This enabled premier investment promotion agencies to scour the globe for firms and industries. It also enabled those responsible for those agencies to build and sustain Organisation for Economic Co-operation and Development-style industrial parks, export processing zones and licensed manufacturing warehouses that met foreign investors' needs for reliable, high quality and reasonably priced infrastructure services. Both countries also invested in skilled labour. They controlled wage rates and severely restricted workers' rights to unionize and strike (Haggard [1990]).

At the outset, this approach to industrial development did not assume the necessity of creating an indigenously-owned industrial base, an indigenous class of entrepreneurs, or the building of technological capabilities in indigenous firms. At a later stage, however, the Governments of Malaysia and Singapore extended this model to include capabilities-building in indigenous firms by restructuring the policy process to promote the *participation of indigenous small and medium enterprises in the global value chains of multinational corporations* located in each country. In both, this was accomplished primarily through domestic industry upgrading programmes or vendor development programmes. The programmes linked investment promotion agencies, industrial estate authorities, multinational corporations and local-supplying small and medium enterprises in long-term relationships that enabled local-supplying firms to meet the quality, price, on-time delivery and environmental specifications of their multinational buyers (Battat and others [1996]; Churchill [1995]).

In each of these cases, the Governments were staffed by increasingly capable and autonomous bureaucracies that enjoyed substantial "embeddedness"—a government's institutionalized links with the private sector. Embedded autonomy also enabled bureaucrats in core agencies to get the policy process right by adopting shared (with the private sector) long-term technological upgrading visions of industrial growth. Whereas "embeddedness" enabled these Governments to better understand the real problems faced by firms, autonomy enabled them to hold firms accountable for their performance while minimizing the risks of capture, rent-seeking and corruption (Rodrik [2004]). In each instance, however, none of this was easy to achieve. Capable

government bureaucracies with embedded autonomy had to be created and sustained. Simultaneous with the development of bureaucratic capabilities, the Governments learned, through their "embeddedness" with the private sector in long, pragmatic, often tortuous, trial and error processes, how to deal with these as well as other issues required for them to meet their industrial development aspirations. In no case did the Governments develop and follow a well defined blueprint, such as the Washington Consensus.

B. FROM TECHNOLOGICAL DEVELOPMENT TO INDUSTRIAL ENVIRONMENTAL IMPROVEMENT

Governments in several rapidly industrializing East Asian countries also learned how to integrate industrial environmental management strategies into their technological capability-building programmes. The first step in this process was *building and strengthening the traditional command and control environmental regulatory systems* (Rock [2002]). These agencies adopted *aggressive performance goals and clear performance expectations* that were consistently pursued and implemented. The most effective environmental regulatory agencies in East Asia had *capacities to learn and adapt to change.* They were pragmatic, opportunistic, had flexibility of response, coordination across scales, the capacity to learn from experiences, and to adapt to changing economic and political circumstances. They also developed regulatory systems that were *innovative and rich in information.* Importantly, however, governments went beyond this—they integrated new environmental agencies, through policy integration, with core industrial development agencies.

Integration of environmental considerations into the institutions of industrial policy followed somewhat different pathways in different countries in East Asia, but they all depended on three dimensions of policy integration: *forging relations with powerful state institutions of industrial development*; identifying cost-effective technological options for *reducing abatement costs;* and *adopting an information-driven approach* to promote demand for environmental improvement (Angel and Rock [2003]). Close relations with industrial development agencies proved critical for gaining support for environmental improvement in government and business, in identifying cost-effective abatement options, as well as opportunities for lowering the energy, water and material intensities of production.

Case evidence cited in the report suggests that linking new environmental agencies with more powerful economic development and industrial policy agencies in East Asia helped to gain critical support for environmental improvement within government and from business. It fostered trust and confidence between environmental agencies, economic development and industrial policy agencies and the business community over a shared need to preserve environmental quality, particularly because this objective was pursued without imposing excessive costs on firms which would have endangered their profitability, growth and export potential. The involvement of economic development agencies was a strong sign to the business community of the seriousness of the governments' commitment to the goal of environmental improvement, as well as to finding solutions that did not impose unreasonable costs on firms and industries.

C. THE CONCEPTUAL FRAMEWORK MATRIX

The report, as mentioned earlier, uses the insights gained from the successful experiences in East Asia with environmentally sound technological upgrading in industry to develop a conceptual framework that can be used as a guide, not a blueprint, by UNIDO to design and implement technological development strategies and policies, which are environmentally sound, in low-income countries (or regions). The conceptual framework is presented in a conceptual framework matrix that is built around the following five principles:

- Enabling conditions;
- Policy process;
- Technological infrastructure;
- Policy integration;
- Concrete and specific pathways to technological development.

Those principles are distilled from the successful experiences of environmentally sound technological upgrading in the East Asian newly industrializing countries (or regions).

To begin with, the conceptual framework matrix recognizes that each of the East Asian newly industrializing countries (or regions) relied on one of three *specific* and *distinct upgrading pathways* to enhance the technological capabilities of indigenous firms. The following are the pathways:

- Building a national technology and innovation system linked to a large number of small and medium enterprises;
- Supporting the development of a small number of large firms linked to multinational corporations and the global economy;
- Linking a large number of small and medium enterprises to the global value chains of OECD multinationals.

The conceptual framework matrix further recognizes that there are a significant number of non-technological *enabling conditions*, namely, political stability, macroeconomic stability, openness to trade and investment, adequate, reliable and reasonably priced infrastructural services, and a well educated and trained labour force alongside flexible factor markets. Such conditions must be in place and sustained, or must be set in place within a reasonably short period (and sustained) after the government has launched its upgrading strategy. The report argues that since these non-technological policies and institutions are so important to the pace and scale of technological development, not a single developing country has been able to achieve substantial long-term technological capabilities-building in indigenous firms without establishing and maintaining these non-technological enabling conditions.

As the conceptual framework matrix also recognizes that technological development is inherently a costly, risky and uncertain endeavour that firms are unlikely to undertake without a supportive policy environment structured by governments, a *policy process*, rather than specific

policies, is placed at the centre of the conceptual framework matrix. The report identifies the following four key elements of this policy process:

- Making use of a stakeholder-based, consensus-building process between government and business to create agreement on a coherent national strategy of industrial development;
- Relying on the principle of embedded autonomy between governments and firms;
- Being market-building in its orientation;
- Promoting links to the global economy for services and technological know-how;
- Engaging in policy integration.

The report and the conceptual framework matrix argue that the importance lies as much in adopting the right policy process as it does in selecting the right individual policies and institutions. In fact, the experiences of the East Asian newly industrializing countries (and regions) reveal that government emphasis on getting the policy process right—particularly through embedded autonomy—supported a pragmatic trial and error search for the most effective policies and institutions. Owing to this, governments were constantly shuffling between policies and institutions, weeding out those perceived as ineffective and strengthening and reforming those that worked. This would have been impossible without recognizing that it was just as important to get the policy process right as it was to get individual policies right. It would also have been impossible without embedded autonomy. "Embeddedness" was critical to a government being able to understand the real constraints to upgrading faced by firms. Autonomy was equally crucial because it insulated those in core government technology upgrading agencies from falling prey to private sector clients, and from corruption and rent-seeking. Taken together, embedded autonomy would enable governments to understand better the problems faced by private firms and hold firms accountable for their performance.

Once the non-technological enabling conditions reach some minimal value and government launches a policy process based on a national industrial development strategy arrived at through the government's embedded autonomy with the private sector, a market-building and internationally focused approach must be adopted to ensure the provision of a *technology infrastructure* and technology support services (Teubal [1996]). What this means is that governments must design and implement technology policies which aim at stimulating the supply of technological services while promoting the articulation of their demand. Public sector technology support institutions must be market-demand driven, they must "leverage" knowledge through participation in the global economy, and ensure that public sector technology support institutions are fine-tuned to the particular situation of firms and industries in the country (or region). The conceptual framework matrix presumes that none of this is possible unless public sector technology support institutions provide high quality services to private sector clients who are willing to pay for at least some of those services, and unless public sector technology support institutions enjoy embedded autonomy with their private sector clients.

A fifth element of the conceptual framework matrix concerns environmentally sound industrial growth. Once governments and firms focus on improving the ambient environmental quality and the environmental performance of firms, governments must create capable and well resourced command and control environmental agencies. They should also make every effort

to link these agencies to industrial policy institutions through *policy integration*. A conceptual framework matrix embodying these five principles appears in the table. It outlines policy profiles for each technological development pathway. One final comment on these policy profiles and the conceptual framework underlying them deserves mention. With limited exception, the key elements of the policy process and the technological infrastructure supporting it can be, and have been, used in each of the pathways to technological upgrading. Thus, what distinguishes the use of a particular policy process or support institution is not whether the policy process or institution is used, but whether its targeted focus is on a particular pathway. For example, the Government of the Republic of Korea and, to a lesser extent, the Governments of Indonesia and Thailand, used their policy process and technological infrastructure to promote high-speed technological learning in large-scale indigenous conglomerates. Taiwan Province of China used its policy process to link its technological infrastructure to technological changes occurring in the global economy and to the large number of indigenous and export-oriented small and medium enterprises extant in Taiwan Province of China. In Malaysia and Singapore, the Governments used their policy processes and their technological infrastructures to promote linkages between indigenous small and medium enterprises and the global value chains of OECD-based multinational corporations.

Conceptual framework matrix

Pathways to technological development and capabilities-building	*Through the development of national technology systems*	*Through linked learning in joint ventures and licensing agreements between large domestic firms and large multinational companies*	*Through linked learning of small firms participating in global value chains*
Core elements		*Conditions*	
Political stability	Must be high	Must be high	Must be high
Macroeconomic stability	Dollar index, inflation and fiscal deficits should be low	Dollar index, inflation and fiscal deficits should be low	Dollar index, inflation and fiscal deficits should be low
Openness to trade and investment	Can start low	Must be high	Must be high
Physical infrastructure	Must be well developed	Must be well developed particularly in industrial estates, export processing zones and licensed manufacturing warehouses	Must be well developed particularly in industrial estates, export processing zones and licensed manufacturing warehouses
Labour force	Must be well educated, particularly need a large number of well trained engineers	Must be well educated, particularly need a large number of well trained engineers	Must have a literate labour force that can work in factories
Policy process			
Industrial development strategy	Government and business stakeholders must agree on a long-term industrial development strategy	Government and business stakeholders must agree on a long-term industrial development strategy	Government and business stakeholders must agree on a long-term industrial development strategy
Embedded autonomy	Must be high	Can be limited to pockets of efficiency in investment promotion agencies, industrial estates, export processing zones, and licensed manufacturing warehouse authorities	Can be limited to pockets of efficiency in investment promotion agencies and in agencies serving the needs of small local firms
Bureaucratic competence in public sector bureaucracy—supporting embedded autonomy	Must be high, particularly in peak pilot institutions that establish a national vision for industrial development and coordinate policy across an array of public and private sector actors	Can be limited to pockets of efficiency in peak pilot institutions that establish a vision for industrial development and coordinate policy across a small number of public sector agencies	Can be limited to pockets of efficiency needed to serve small local firms
Government–business networks	Must be dense and limited to clear performance goals that are monitored	Must be dense and limited to clear performance goals in a small number of public sector agencies and a similarly small number of large domestic firms that are promoted by government policies	Can be limited to a small number of industry associations in promoted industries, initially focused on entry-level capabilities-building in resource-based and labour-intensive manufactures
Technological infrastructure and technology support institutions	Must be market driven, externally (internationally) oriented, and focus on the real needs of the private sector	Must be market driven, externally (internationally) oriented, and focus on the real needs of the private sector	Must be market driven, externally (internationally) oriented, and focus on the real needs of the private sector
Policy integration linking the environmental regulatory agency to institutions of industrial policy	Must be high	Can be limited to links to large national firms and multinational corporations	Can be limited to linkages between multinational corporations and the local SMEs that supply them
Environmental regulatory agency	Must be competent and capable of setting, monitoring and enforcing realistic emissions standards	Must be competent and capable of setting, monitoring and enforcing realistic emissions standards	Must be competent and capable of setting, monitoring and enforcing realistic emissions standards
Regulatory stringency	Must be high	Must be high	Must be high
Energy prices	Should be market based	Should be market based	Should be market based

II. APPLYING THE CONCEPTUAL POLICY FRAMEWORK TO LOW-INCOME COUNTRIES

This chapter assesses the adequacy of the conceptual framework matrix in a three-step process. The first step relies on published data to assess the degree to which different groups of low-income countries (or regions) meet minimal enabling conditions. As published data are not detailed enough to make sufficiently informed judgements about the strengths and weaknesses in the policy process and in the technological infrastructure in individual countries, the second step involves collecting, through a rapid appraisal survey instrument, more detailed empirical measures of countries' policy processes and their technological infrastructures. The final step involves an in-depth country case study to verify the findings derived from the rapid appraisal survey instrument.

A. PUBLISHED DATA

With respect to the status of the *enabling conditions* for each upgrading pathway, the report finds that data on the status of enabling conditions (political stability, macroeconomic stability, openness to the global economy, physical infrastructure development and human skills base) in most low-income countries (or regions) are far removed from meeting the minimal conditions for any environmentally sound upgrading strategy. It is, therefore, doubtful that any upgrading strategy would work. Low-income countries suffer from a number of pathologies—they have substantially more political instability, more macroeconomic instability and are less connected to the global economy than other developing countries. They also have weak human skills bases and limited and unreliable physical infrastructures.

B. RAPID APPRAISAL SURVEY DATA

Published data are often not detailed enough to identify critical elements in the policy process or the underlying technological infrastructure that are sufficient for use in policy analysis and programme development. The report, therefore, uses a rapid appraisal survey instrument to collect primary data on the presence and effectiveness of strategies, institutions and policies supporting technological and environmental upgrading among a sample of low-income countries. The survey instrument contains questions on the following three main areas:

- The industrial development vision and industrial development strategy (upgrading pathways);
- The policy process meant to support a technological development strategy;
- Technology support institutions.

In each country (or region) surveyed, a set of knowledgeable individuals were asked to rate, on a Likert scale, the degree to which the country (or region) in question had a clearly identified vision and strategy for technology upgrading; whether the policy process supporting the strategy was sufficient to do so; and whether the technological infrastructure and technology support institutions were demand-driven and externally focused.

The report uses the survey data from a sample of 27 countries to identify clusters of high and low performance in countries (or regions) based on three criteria:

- The choice of pathways to technological upgrading;
- The adequacy of the policy process and incentive structures (are they sufficient to entice firms to enhance their technological capabilities?);
- The focus of technology support institutions (are they demand-driven and externally focused?).

Of the 27 countries surveyed, 11 were identified as having a strategy, a policy process and technology support institutions supportive of building a national technology and innovation system. Ten of the 27 countries were identified as having a strategy, a policy process and technology support institutions supportive of the second pathway, that is, through joint ventures between large domestic firms and multinational corporations, and 15 were assigned to the relatively high performing cluster of countries aligned with the technology upgrading pathway focused on *linking small and medium enterprises to global value chains of multinational corporations.*[4]

The report cross-references the base country high performing clusters against necessary conditions for each of the pathways. When minimally acceptable (cut-off) values for these conditions were applied to the high performing countries in each cluster pathway, *no country* in the high performing national technology and innovation system cluster meets the necessary conditions.[5] However, five countries in the high performing category that build large national firms linked to the global economy cluster actually met the required conditions, and 16 of the 18 countries in the high performing category that link small and medium enterprises to global value chains of multinational corporations met the conditions relevant to this pathway.

The report also conducts a sensitivity analysis of these results[6] to illustrate the position of countries relative to an initial baseline of required conditions. The sensitivity analysis indicates that the biggest changes in cluster group membership occur, not surprisingly, when the cut-off values for the baseline conditions are adjusted downward. *In other words, many of the surveyed countries are positioned somewhat below the original baseline, in terms of necessary enabling conditions for pursuing one or more pathways for technological upgrading.* The policy implication is that it is important for these low-income countries to continue their efforts to improve these necessary conditions as part of their industrial development strategy.

[4]Seven of the 27 low-income countries were not assigned to the grouping of any of the three technology upgrading pathways. All seven countries rank very low on the UNIDO Competitive Industrial Performance Index.

[5]Given the demands of this pathway to upgrading, this finding is not particularly surprising.

[6]A sensitivity analysis was carried out by raising and lowering critical values on the set of six enabling conditions, one variable on firm-level capability and two on government effectiveness.

C. GAP ANALYSIS FOR ONE COUNTRY: GHANA

The report then turns to using the survey results to conduct a gap analysis for one low-income country, namely, Ghana. The gap analysis is aimed at providing a more fine-grained analysis of where a country's institutions and policies might be strengthened. The results of gap analysis are then examined in a series of in-depth interviews in the country. The survey data suggests that the Government of Ghana is considered "somewhat effective" in attracting foreign investment, in promoting exports and in identifying priority industries based on market opportunity. The survey data also suggests that the Government is viewed as "somewhat less" successful in targeting technological upgrading as the key for industrial development.

These initial findings from the gap analysis prompted an in-depth, field-based examination of whether technological upgrading receives sufficient attention in the Government's industrial development strategy and whether the policy process and technology support institutions needed to support technological upgrading are effective. Interviews in Ghana confirmed that the *Government strategy focuses more on promoting private investment and exports than on technology upgrading of industry.* Those interviews also confirmed that the *policy process* and the institutions supporting technology upgrading are weaker than those that support the promotion of investment and exports.

Having gone through the three-step empirical process to assess the adequacy of the conceptual framework matrix, the report confirms the utility of the conceptual framework matrix as a *diagnostic and programming tool.* The testing of the framework against published data for a sample of low-income countries reveals that most of them fail to meet even the absolute minimal enabling conditions necessary for launching any technology-upgrading strategy rooted in exporting, linking and learning from the global economy. These countries can be served best by assisting them in improving the enabling conditions and by being *opportunistic* enough to take advantage of the unique (and unexpected) opportunities for at least some firms in some industries to start learning how to technologically upgrade by simply increasing their exposure to the global economy.

Using the rapid appraisal survey provides a more detailed empirical assessment of the state of individual countries' technology *strategies* and the *policy process* and *technology support institutions* designed to support those strategies. The report argues that this more detailed empirical assessment can also be used as a diagnostic tool to carry out an initial gap analysis to identify weaknesses in government strategy, policy process and institutions. In sum, the report concludes that the conceptual framework matrix is a useful diagnostic and programming tool, if published data are combined with the more detailed rapid appraisal survey data and in-depth country analyses.

III. IMPLICATIONS FOR UNIDO

The implications of the report for UNIDO's operations (UNIDO [2004a]) are organized in two broad categories in chapter III. First, the conceptual framework and associated empirical work has overarching implications for the process and approach that UNIDO takes for promoting productivity enhancement. The report identifies three elements that deserve particular attention:

- Policy process;
- Diagnostics;
- Policy integration.

Secondly, the report has specific implications for certain UNIDO service modules, in particular, investment and technology promotion, industrial competitiveness and trade, private sector development and environmental management.

A. OVERARCHING IMPLICATIONS

As mentioned earlier, the conceptual policy framework developed in the report identifies five core elements of an effective policy process to promote technological capability-building and environmental improvement as follows:

- Enabling conditions;
- Policy process;
- Technology infrastructure;
- Policy integration;
- Technological development pathways.

The empirical analysis in chapter II clearly demonstrates that one of the major challenges facing low-income countries is their weak position with respect to many basic enabling conditions, which are necessary for the successful promotion of technological capability-building by firms. While it is well understood, it is nonetheless worth emphasising that efforts by UNIDO to promote technological development need to be coordinated with broader development initiatives to strengthen the underlying enabling conditions for private sector development in low-income countries.

In addition to the emphasis on enabling conditions, the policy framework developed in the report identifies the five critical elements of policy process that contribute to successful technological capability-building. The analysis suggests that successful technological development in low-income

countries requires the adoption of a policy process marked by a national strategy of industrial development, centred on a principle of embedded autonomy between firms and governments, which is market-building in its orientation and which promotes links to the global economy for services and technological know-how. In order to ensure environmentally sound industrial development, the policy process should be characterized by a commitment to policy integration. These broad principles need to guide the shape of institutional development promoted by UNIDO. While UNIDO has made a strong commitment to shifting toward a demand-oriented policy process (UNIDO [2004a]), there remains a continuing legacy of supply-driven initiatives. Given UNIDO's expertise and strategic focus and the situation of most low-income countries, with respect to enabling conditions and policy process, the following three areas represent particular opportunities for UNIDO to provide important value-added to the industrial development process in low-income countries: *(a)* strengthening the policy process; *(b)* refining the diagnostic tools and associated integrated country planning; and *(c)* developing policy integration initiatives to promote environmentally sustainable industrialization in low-income countries.

1. Policy process

UNIDO is often requested to provide advice on the policy process. Given the range of needs of low-income countries, what should countries focus on first, in terms of policies and institutions? Are there particular policy instruments that should be developed and deployed? Are there appropriate ways to identify priority industrial sectors for development? The conceptual framework matrix developed in the report suggests that unless countries develop a policy process that is based on the principles articulated above, the returns on investment in particular policy instruments, support institutions or sectors, are likely to be constrained. In other words, the first priority is to put in place the enabling conditions and policy process, both of which are conducive to technological upgrading. Once such an institutional framework is in place, the relationship of embedded autonomy between a competent government bureaucracy and firms secures the information flow needed to foster the demand for services that enhance technological capability-building. The clear implication for UNIDO's services in low-income countries is the need to focus greater attention on creating or institutionalizing an appropriate policy process, or institutional setting, for future private sector technological capability-building.

2. Diagnostic tools and integrated country planning

The analysis presented in the report indicates that opportunities for successful technological development in low-income countries are likely to be very limited because the underlying enabling conditions limit firms' demands for new capabilities. For this reason, effective diagnostic tools and an effective diagnostic process are of particular importance. UNIDO is increasingly engaged in developing methodologies for industrial diagnosis and country planning. Within the Strategic Research and Economics Branch, an initiative is underway to provide a comprehensive "action and policy oriented" industrial diagnosis for developing countries. This initiative, like the report, is linked to the *Industrial Development Reports* (UNIDO [2002] and [2004b]) and to the use of the Competitive Industrial Performance Index (UNIDO [2002]) as an aggregate performance index.

Conceptually, this diagnostic tool builds on a concept of industry as an innovation and learning system that is supported by institutions, framework conditions and industrial governance. This concept of an innovation and learning system is largely consistent with the framework

presented in the report. It is important to note that this innovation and learning system is a broader concept than the notion of a technology upgrading pathway based on a national technology and innovation system. The innovation and learning system is an approach applicable to countries at all stages of industrial development, no matter what pathway to technology upgrading is chosen.

The comprehensive industrial diagnostic tool being developed by UNIDO contains both quantitative and qualitative indicators for industrial capabilities and support systems. Presently, the tool relies mainly on published data. The opportunity exists, therefore, to make use of the rapid appraisal survey tool, presented in the report, to collect information on institutions and policies in a particular country as one part of the comprehensive diagnosis. *The use of the survey tool would enhance this effort to develop a comprehensive industrial diagnosis in three ways: first, it provides information on the soft institutional features of countries' upgrading strategies, policy process and technology support institutions; secondly, by focusing attention on alternative pathways to upgrading, it disaggregates the concept of industrial innovation and learning systems into one of three concrete and specific pathways, thereby enriching the concept; and thirdly, it enables UNIDO to undertake systematic gap analyses needed to identify intervention opportunities.*

In addition to the efforts made to develop a comprehensive diagnostic tool, various Branches of UNIDO are engaged, on a continuing basis, in assessment activities in support of country planning. For example, a project to implement a technology needs assessment within low-income countries has recently been approved. The appraisal tool approach developed in the report can be used effectively in such a national technology needs assessment. In the implementation of this approach, UNIDO could consider developing a modified version of the survey tool, presented in the report, for facilitating stakeholders' discussions on strategies, policies and institutions—rather than as a direct assessment tool. In other words, the survey results are best used not as a free-standing assessment, but as the basis for a *stakeholders' dialogue* in which the effectiveness of strategies, policies and institutions is discussed, and priorities for steps to be taken to strengthen effectiveness are identified.

The report encourages UNIDO to consider possible funding sources for such a policy dialogue among key stakeholders and to pilot test such an approach in Ghana and other low-income countries in Africa. The field analysis in Ghana, undertaken for the report, confirmed that the availability of the rapid appraisal results provides a focus for stakeholder discussion that is not available elsewhere. It certainly facilitates discussion on opportunities to strengthen policy and institutional interventions, which would assist in promoting sustainable technology upgrading and poverty-reducing growth. If UNIDO is able to successfully link its strategic industrial diagnosis tools to the rapid appraisal survey and combine both with stakeholders' dialogues in assisted countries, it should be possible to link more systematically each of UNIDO's service modules and UNIDO's overall assistance to a more strategic, demand-driven and internationally focused assistance strategy.

3. Policy integration

The tools identified in the report—policy profiles, rapid appraisal survey and stakeholders' dialogues—can be extended to the environmental sustainability of industry. As is argued in chapter I of the report, ensuring the environmental sustainability of industry entails building a competent, capable and well financed environmental regulatory agency. It also requires the use

of appropriate policy tools, a capacity in regulatory agencies to learn and adapt, and the integration of industrial environmental improvement goals into more traditional industrial development agencies.

How can UNIDO use what is learned in the report on the efficacy of policy integration to assist governments and the private sector in low-income countries to improve the environmental performance of those firms and industries engaged in long-term technological capabilities strategies? There are numerous answers to this question. First, UNIDO could conduct short-term training programmes and organize specialized field visits of key government officials and private sector actors from low-income countries to provide first hand exposure to concrete real life examples of how technological development has moved in parallel with environmental improvement in East Asia.

These programmes could include, for example, visits to one or more of Malaysia's profitable, export-oriented palm oil processing facilities, which are environmentally sound. It could include visits to first and second tier suppliers of electronics in the Malaysian state of Penang to demonstrate how these suppliers are being assisted by their multinational corporation buyers, who are developing firm-based environmental standards, to increase the recycling ability of the parts they supply to electronics firms of multinational corporations while reducing the toxicity of those parts. It could also include visits to one or more multinational corporations, such as Holcim, Inc. and its large Thai subsidiary, Siam City Cement, to learn how Holcim's corporate and internal industrial environmental benchmarking programme is linked to technological upgrading in Holcim's subsidiaries. It could also include visits to the Industrial Development Bureau in the Ministry of Economic Affairs and the Industrial Technology Research Institute—two institutions in the national technology system in Taiwan Province of China—engaged in activities to help local Taiwanese firms meet international best practice in energy, materials and water pollution intensities.

Such workshops and study trips could also expose government officials and private sector actors to one or more examples of new governmental environmental initiatives. Such initiatives include the European Union's Reduction of Hazardous Wastes and Waste Electrical and Electronic Equipment that, as the report's case study on multinational corporations, local supply chains in Penang, Malaysia, demonstrated, are affecting the environmental behaviour of multinational firms and their suppliers in developing countries. In addition to these two recommendations, UNIDO should consider developing a more refined rapid assessment survey instrument, similar to that developed in the report for technological upgrading, that focuses on industrial–environmental improvement. As with the survey instrument developed for technological upgrading, this instrument should focus on alternative pathways to industrial environmental management that are linked to the three pathways to technological upgrading identified in the report.

The survey instrument could be pilot tested in three or four countries and then administered in approximately 25 low-income countries. As with the rapid assessment instrument for technological upgrading, the strategies, policy process and institutions for environmental improvement must be cross-mapped against the policy profiles and the enabling conditions identified in the report for any environmental improvement strategy to be successful. To integrate environmental considerations into the institutions of economic and industrial policy and into

UNIDO's thinking and actions, the organizational unit responsible for the service module on industrial governance and statistics should organize workshops to promote, encourage and manage stakeholders' industrial–environmental dialogues, in particular, in low-income countries that review the findings from the industry and environment rapid appraisal survey. Individuals from prominent economic and industrial development agencies and institutions, along with representatives from environmental regulatory agencies and cleaner production agencies should be encouraged to attend such workshops. The outcome of such stakeholders' workshops could lead to an agreement on a strategy for improving the industrial–environmental outcome and contribute to strengthening a set of policies, institutions and initial conditions to ensure that the strategy can work.

The major advantage of this approach is that it creates embedded autonomy by linking industrial plants and firms to technology upgrading institutions and environmental management institutions and agencies. Assuming that the relevant organizational units are involved in the diagnostic exercise and the stakeholders' dialogue, one or more of those units could offer assistance for an upgrading strategy that could include a vital environmental dimension. This could provide an important opportunity for UNIDO to begin practising policy integration.

B. Implications for UNIDO service modules

Currently, UNIDO offers eight service modules[7] that are linked through integrated programmes and/or country service frameworks. The recent shift to integrated programmes and country service frameworks as a vehicle for providing UNIDO assistance marks an important step in linking UNIDO's service modules to an integrated country-level approach to assistance, to each other, and to the real upgrading and environmental needs of governments and the private sector in low-income countries. The report and concomitant conceptual framework matrix bear some relevance to four service modules of UNIDO, namely, investment and technology promotion, industrial competitiveness and trade, private sector development, and environmental management. The emphasis of the report on enabling conditions, policy process and technology support institutions are likely to be particularly important for each of these modules.

1. Service module 2: Investment and technology promotion

The technical assistance programmes of service module 2 are central to initiatives to promote technological development in low-income countries. The two primary areas of focus in this service module are investment promotion and technology promotion. In both areas, UNIDO identifies government and market failures and weaknesses in institutional capacity as the critical problems to be addressed. The technical assistance programmes of UNIDO in this area include strategy and policy advice, technology foresight analysis, needs assessment, training in policy tools and approaches and institutional capacity-building. The programmes within this module reflect many elements of the conceptual framework outlined in the report. UNIDO has also taken the right decision to shift towards a demand-driven and market-centred policy

[7]The eight service modules comprise: Industrial Governance and Statistics; Investment and Technology Promotion; Industrial Competitiveness and Trade; Private Sector Development; Agro-industries; Sustainable Energy and Climate Change; Montreal Protocol; and Environmental Management (http://www.unido.org/).

process that seeks to forge effective close ties between technology support institutions, domestic firms and investors in multinational corporations. This provides an opportunity for UNIDO in this service module to take further steps along the path from supply-driven to market-centred policy intervention.

The report makes two specific recommendations to enhance this shift. First, much of the analytical foundation of service module 2 continues to rest on the concept of market failure, but, as indicated in the conceptual framework, once the analytical framework shifts from that of market failure to one of embedded autonomy, there is a greater opportunity to shape a policy process that stimulates sustained demand for technological capability-building on the part of firms and institutions. So, the first recommendation is to focus greater attention on cultivating a policy process, as described in the report, rather than on responding to perceived market failures. Secondly, service module 2 includes both investment promotion and technology promotion. The empirical analyses and case studies presented in the report suggest that the basic tools for investment promotion are far better understood than are approaches to technology promotion and technological capability-building. UNIDO is uniquely positioned to focus on technology capability-building rather than investment promotion. For this reason, the report recommends that UNIDO consider concentrating programme emphasis in service module 2 on technological capability-building.

2. Service module 3: Industrial competitiveness and trade

Service module 3 supports technical assistance projects in areas of standards, metrology and accreditation and that of supply chain development through networks and partnerships. Both areas are crucial to technological upgrading and capability-building in low-income countries. The first area of standards, metrology and accreditation is a critical "market-building" resource to the extent that these services create a framework within which the market for products and services is created and "trading" can take place. Standards are also a contested topic among countries—with developing countries fearing that standards are nothing more than barriers to trade. The report argues that there is little doubt that there is a great need for institutional capacity-building in this area and that UNIDO is well placed to provide such support.

The report, however, expresses one concern. If governments lack a clear policy process to industrial technology development, they are likely to focus efforts in cooperation with standards agencies, metrology capabilities and testing laboratories on strengthening across the board capabilities. This is likely to extend beyond UNIDO's and most low-income countries' resources and capabilities. Part of the demand of local firms for these types of services can probably be met by the international private sector. Nevertheless, other private sector demand for such services is likely to be limited to a few product lines or industries, in particular in the early stages of technological development. Moreover, building capabilities across the board is likely to be prohibitively expensive, possibly unwarranted and beyond the means of low-income countries. With a clearer strategy and a policy process that emphasises embedded autonomy, governments and UNIDO could target their efforts in this area on those activities that meet the real demands of private sector firms. Alternatively, UNIDO might consider positioning its interventions as a facilitator rather than as a direct supplier of services for building capability in this area.

In the second area of supply chain assistance, UNIDO supports a network of subcontracting and partnership exchange. The subcontracting and partnership exchange serves, in part, as a

clearing house that helps to link small and medium enterprises to global value chains. The key characteristic of these subcontracting and partnership exchanges, from the perspective of the conceptual framework, is that they are self-financing. The principal of self-financing of technical assistance services is fully consistent with the concept of embedded autonomy—the value of these services on subcontracting and partnership exchange is determined in the marketplace.

3. Service module 4: Private sector development

The service module on private sector development covers a variety of technical assistance programmes designed to promote private sector development, especially that of small and medium enterprises. Specific programme focuses include access to information technology, promoting sector-based business partnerships, small and medium enterprises cluster and networking development, as well as the role of women in entrepreneurship. The activities covered under this service module are discussed extensively in another COMPID project that focuses on small and medium enterprises development. Accordingly, the report is limited to underlining UNIDO's accepted role as a catalyst for private sector development, including small and medium enterprises. The tendency to be resisted is evident, with regard to engaging in direct technical assistance to small and medium enterprises. UNIDO can best make a catalytic contribution to the development of small and medium enterprises by creating an overall policy process, consistent with the conceptual framework, within which small and medium enterprises can grow and develop in low-income countries.

4. Service module 8: Environment management

Service module 8 links issues of technological development to environmental management and sustainability. Three major focal areas are identified:

- Cleaner production;
- Water management;
- Treatment of persistent organic pollutants and persistent toxic substances.

The report's overarching recommendations traced out some of the implications of policy integration for UNIDO operations. Here the report focuses more narrowly on the work of the national cleaner production centres. These centres have been an important part of UNIDO's environmental management technical assistance programmes. Indeed, it is fair to say that UNIDO has played a leading role in the multilateral arena in promoting cleaner production initiatives. Technical assistance programmes focus on eco-efficiency and the transfer and adoption of environmentally sound technology.

Most government-led initiatives that seek to promote cleaner production are supply-driven. The typical profile of a cleaner production initiative is one in which firms engage in recommended activities while the programme is in place. But there is little diffusion of best practice beyond the participating firms, and once the programme is completed, only modest commitments to continuation are made by participating firms. While these cleaner production programmes can be justified in terms of their immediate impact, they rarely have the downstream multiplier effects that policy makers desire. UNIDO's assessment of the programme on national cleaner production centres is consistent with this pattern. Cleaner production initiatives are, in short, a classic example of the limits to supply-driven initiatives. Because the UNIDO

network of national cleaner production centres is an important development resource, the report recommends that the programme focus more on shifting the thrust of national cleaner production centres towards interventions that promote the demand for cleaner production. In line with the analysis of supply chain management presented in chapter II, the report suggests that one way this could be done is by linking national cleaner production centres to the growing importance of firm-based standards and supply chain requirements as a driver of cleaner production.

IV. CONCLUSIONS

The report reviews the technological capabilities-building experiences in new productive, including new environmental, activities by private sector firms in industry in a small group of the East Asian newly industrializing countries (or regions)[8] for guidance in developing a conceptual framework that UNIDO could use for programming purposes. The report does so because firms must be at the centre of any upgrading strategy and because private sector firms in these countries (or regions) have been particularly successful in building their technological capabilities in new activities in industry, including new environmental activities. Since all firms are enmeshed in particular socio-economic and political environments, the report and conceptual framework recognized that the public sector in the East Asian newly industrializing countries (or regions) played central roles in enticing and assisting firms in these areas to engage in the risky, costly, uncertain and difficult task of building their technological capabilities in new activities. They provided the necessary enabling conditions, the right policy process, the technological infrastructure and technology support institutions leading to a concrete and specific upgrading pathway.

The conceptual framework presented in the report was developed on the basis of a conceptual framework matrix. This matrix identifies three *specific* and *concrete* upgrading pathways, which go beyond merely promoting the export of manufactures or linking local firms to the global economy. It also identifies four core elements for promoting environmentally sound technological development:

- Enabling conditions;
- Policy process;
- Technological infrastructure;
- Policy integration.

For each of these core elements, the conceptual framework matrix specifies relevant conditions for each of the three pathways. The adequacy of the conceptual framework matrix was assessed by subjecting it to several empirical tests. Results showed that the conceptual framework matrix can be used to categorize countries' (or regions') industrial development strategies, evaluate shortfalls in enabling conditions, and identify critical gaps in the policy process and in the technological infrastructure that need to be filled. An in-depth case study on one country suggests that the conceptual framework matrix can also be used as a country-level diagnostic tool, which is particularly useful when combined with an in-country stakeholder process between government and business centred on building a consensus over industrial development strategy.

[7]The report focuses on the Republic of Korea and Taiwan Province of China in North-East Asia, and Indonesia, Malaysia, Singapore and Thailand in South-East Asia.

The conceptual framework matrix and its limited application undertaken for the report have several important implications for UNIDO. To begin with, the conceptual framework matrix and associated empirical work have several overarching implications for the process and the approach that UNIDO takes to promote environmentally sound productivity enhancement in industry in the low-income countries. Given the critical importance of the non-technological enabling conditions identified in the report, it is clear that UNIDO's upgrading efforts need to be coordinated with broader development initiatives to strengthen the underlying enabling conditions. UNIDO's efforts also need to be part of a well defined, in-country policy process that is marked by a clear national strategy of industrial development, centred on a principle of embedded autonomy between firms and government, and that is market-building in its orientation by, among other things, promoting firm-level links to the global economy. The report argues that these broad principles should guide the shape of institutional development supported by UNIDO and suggests that UNIDO consider strengthening the policy process and refining its diagnostic tools to take into account these principles.

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GLOSSARY

Ambient standards	Ambient standards refer to air or water quality standards.
East Asian newly industrializing countries or regions	The East Asian newly industrializing countries or regions referred to in the report include Indonesia, Malaysia, Republic of Korea, Singapore, Taiwan Province of China and Thailand.
Embedded autonomy	Embedded autonomy is a key element of the policy process. "Embeddedness"—referring to the institutionalized links of communication with the private sector—is essential for governments to understand better the real constraints that firms face as they attempt to upgrade their technological capabilities. Autonomy refers to the independence government has from the private sector. Autonomy is important because it enables the government to protect itself from capture, rent-seeking and corruption while holding the private sector accountable for its performance.
"Embeddedness"	"Embeddedness" refers to the institutionalized links of communication with the private sector.
Emissions standards	Emissions standards refer to pollutant loads in water or air quality emitted from particular factories.
Enabling conditions	Enabling conditions, in the report, refer to political stability, macroeconomic stability (a competitive exchange rate, low inflation, and sustainable fiscal and current account deficits), physical infrastructure (roads, ports, railways, airports, communications and power), openness to trade and investment, and the human capital base.
Institutions	Two definitions of institutions are used in the report. On the one hand, the term "institutions" is used to refer to a set of formal and informal rules of conduct that facilitate coordination or govern relationships between individual actors. Under this definition, embedded autonomy can be considered as an institution. On the other hand, it is common to refer to particular private or public sector agencies as institutions. Under this definition of institutions, a government standards and metrology agency can be referred to as an institution.
Market-building technology policies	Market-building technology policies refer to policies that aim at stimulating the supply of technological services while promoting the articulation of their demand.

National technology and innovation system	A national technology and innovation system, as used in the report, refers to the public sector and quasi-public sector institutions that support technology and innovation—institutions which, importantly, are linked through embedded autonomy, to the real needs of firms.
Policy integration	Policy integration refers to a policy process that seeks to manage levels of industrial pollution and environmental intensities (such as the energy intensity of value-added) by linking environmental regulatory agencies to the core agencies responsible for industrial development, that is, those responsible for policy design and implementation, including technological support institutions.
Policy process	The policy process, as discussed in the report, refers to the institutional setting for policy formulation and implementation. See embedded autonomy.
Technological capability	Technological capability comprises the ability to operate productive facilities competitively, raise quality, introduce new products, upgrade productive and environmental practices, diversify into higher value-added activities and, more broadly, develop the skills, knowledge and institutions required for economic development.
Technological capability-building	Technological capability-building is the activity of allocating resources to create and develop such capability. This definition is intended, mutatis mutandis, as much for firms as for aggregate levels.
Technological development	Technological development is the improvement in productive practices that results from engaging technological capability in innovative activity which translates into enhanced productivity and social welfare (technological development and technological upgrading are used interchangeably in the report).
Technological development pathways	Technological development pathways refer to the concrete and specific pathways used by governments in the East Asian newly industrializing countries or regions to link governments and firms in a policy process designed to strengthen the technological capabilities of firms. These pathways—building of a national technology and innovation system linked to small and medium firms, promoting the development of a small number of large firms linked to the international economy, and linking small and medium firms to the global value chains of multinational corporations—have important implications for the subsequent size distribution of firms within an economy and for the precise ways governments build embedded autonomy with the private sector.
Technological infrastructure and technology support institutions	Technological infrastructure and technology support institutions refer to the panoply of public and quasi-public sector agencies: investment promotion agencies, standards and metrology agencies,

industrial estate and export processing zone authorities, export marketing institutions, productivity centres, science and technology institutes, environmental regulatory agencies and national centres of cleaner production.

Technology strategy

Technology strategy refers to the outlines of a government's approach to fostering technological development.

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