Introduction to Innovation Policy in Developing Countries

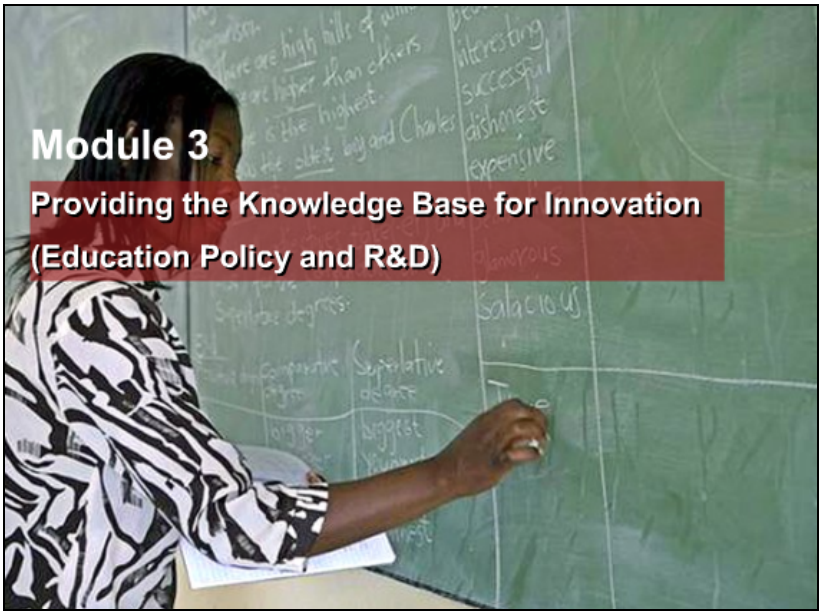
Module 03

Providing the Knowledge Base for Innovation (Education Policy and R&D)

World Bank Institute

Presentation Script

Providing the Knowledge Base for Innovation (Education Policy and R&D)

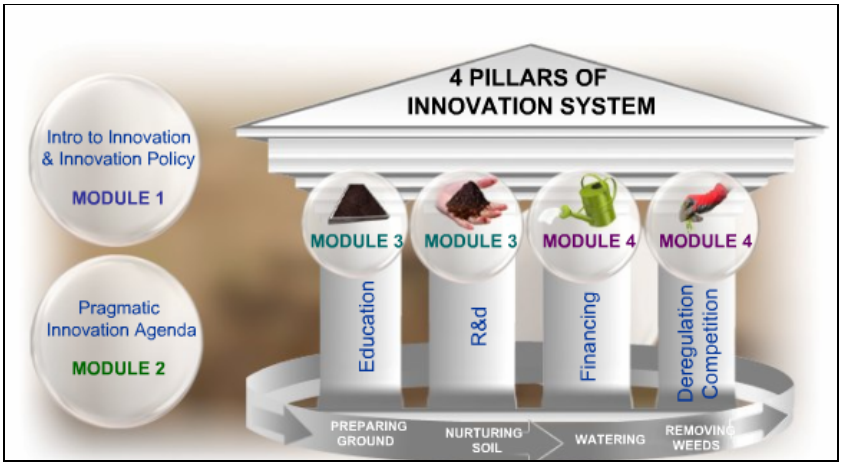


Preparing the ground and nurturing the soil

Invoking our metaphor of government as a gardener, we now look at its role in preparing the ground through education policy and nurturing the soil through research and development. As the metaphor implies, they are the foundation stone of the innovation system without which entrepreneurship cannot flower.

High-level Overview

Recalling the course module structure that we have seen in the first module, we are proceeding to Module 3 which covers two of four pillars of Innovation System: Education and R&D



Topics

We will start this module with the first topic "Education and Skills: Role in Innovation and Growth"

Role of Education

As we saw earlier, Education and Research and Development (R&D) make up two of the four components of the innovation system, and are important parts of the overall pragmatic innovation agenda. We begin with education.

Education matters to innovation and growth for a number of reasons. It enables individuals to work more effectively, adapt to change and carry out more complex higher value-added tasks. Skilled individuals also complement investment and facilitate the introduction of new ideas and technologies.

For resource-poor developing countries, education may relax natural resource constraints, allowing them to move into higher value industries and which are less dependent on scarce inputs.

Role of Technological change

The introduction of ICT in a variety of activities has raised the demand for more highly skilled labour. Jobs that rely on simple rules and sequential thinking are much more amenable to automation; but ICT has not been able to replace the human interaction required for more sophisticated activities. The demand for skills sharply increased in the 1980s and 1990s in middle income countries as a result of upgrading within industries.

Theoretical predictions that globalization would reduce the wage premium to education in developing countries as countries specialized in activities in which they had a comparative advantage, increasing the demand for skilled labour in industrial countries and increasing the demand for unskilled labour in developing countries have not materialized. Not only have wage differentials between skilled and unskilled workers increased in many developing regions; but the growth of highly-skilled occupations has outpaced the growth of less skills, a trend reinforced by foreign direct investment and resulting increase in the capital stock of developing countries.

Demand for New Skills

Successfully delivering education for innovation will depend not only on producing the right number of skilled workers, but also on the system supplying workers with the right knowledge, competencies, and qualities.

We can divide these skills along a number of dimensions.

First, there is a need to prepare the workforce with generic skills and key competencies. While there is a demand in the workplace for specialized tasks and jobs, there isn't a demand for specialized people. The division of labor has become more fuzzy. There is an expectation that employees will contribute to teams by integrating their knowledge with that of colleagues. They must be comfortable working across different boundaries. The trend towards product customization also encourages individuals to think in terms of short-term specialization based on demand. Generic skills also allow individuals to change jobs over time, provide a foundation upon which additional skills can be overlaid. They are less likely to be rendered obsolescent by technological and economic change, lowering the costs of retraining.

Within generic skills, we can further distinguish between cognitive and non cognitive skills. The former relates to basic analytical skills, including numeracy and literacy as well as the ability to think critically and solve problems. The latter refers to social and interpersonal skills:

the ability to communicate and work well in a team as well as a strong work ethic and self-discipline– skills that are needed in rapidly changing work environments where individuals must work with different colleagues and partners and where loosening organizational ties place greater emphasis on individuals' capacity for self-management.

These 'softer' skills tend to be underestimated by policy makers but occur frequently in employer surveys and interviews as a weakness in the curriculum.

There is also a need for more job- or industry- specific skills whether it is knowledge in assembly line management or fluency in a particular computer programming language. These skills give firms the day-to-day knowledge needed to be productive and competitive in their respective industries.

Finally, there is a need to develop better management skills. Studies show that better management practices are strongly associated with higher firm-level productivity, profitability, and survival, suggesting that they also account for differences in country-level productivity. Management skills are particularly important in the context of innovation where many different inputs inside and outside the organization need to be integrated and managers have to be able to 'read' market trends and needs which are often hazy and uncertain.

Topics

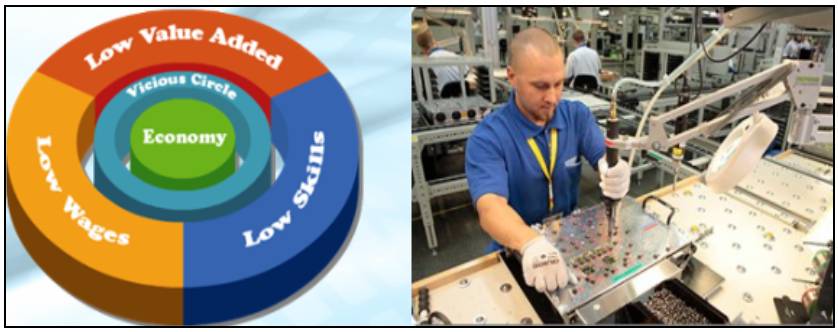
And now we'll proceed to our next topic "Education Policy Objectives and Principles"

Education Policy Principles

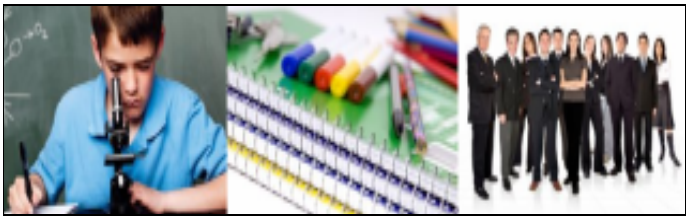
When we think about education policies for innovation, developing countries should keep in mind that education and innovation should be demand led.

This has two implications. First, it means that education systems should provide skills that are economically relevant to firms. However, firms also need to be demanding in terms of the skills they require. A danger is that an economy becomes trapped in a vicious circle of low value added, low skills and low wages. Because of wider market and institutional failures, firms may not always pursue high-value added strategies. These choices, in turn, shape the willingness of individuals to acquire high-level skills. Because of the interdependencies between firms product strategies and education and training, policymakers need ensure that the wider regulatory and investment environment provides the right signals for both firms to engage in innovation – and consequently for individuals to invest in skills.

It is also important that education systems do not just develop elite scientific and analytical skills but cater to the skills of the entire workforce. For instance, many developing countries lack an adequate supply of personnel equipped for mid-level craft tasks from repairing and maintaining electrical appliances to designing and constructing facilities such as rainwater harvesting systems or schools.



It is also increasingly understood that firms are collaborative in nature and depend on employees at all levels to be successful. New theories, informed by the success of companies like Toyota, argue that innovation has become open and democratized, emphasising how frontline workers are a powerful source of ideas as they can identify opportunities and constraints which researchers and managers who are further removed from day to day operations often cannot.



Education Policy Objectives: Access, Quality and Relevance

Education policies should marry three objectives:

Access and making sure that education is widely available across the population and at different stages in learners lives; ensuring that **quality** is preserved as education participation grows so rapidly; and **relevance** to market needs as they change over time.

Education Policies: Access (1/2)

First, let us examine the policies concerning access, which expand educational opportunities to all individuals.

This policy challenge has two aspects – first there is a need to expand access to traditionally under-served groups, notably females, ethnic minorities and rural populations. In many countries, socioeconomic background still has a major bearing on educational and labor market outcomes. **The result is to artificially limit the pool of skilled workers and entrepreneurs that can contribute to innovation**. A common problem is that students are forced to repeat or drop out of education as families cannot forego the loss of domestic and wage labour while children are in education. Cultural and social factors, notably stereotyping also lead to distortions.

Conditional cash transfers to families and students; grants for schools that increase enrolment and achievement among disadvantaged groups; the more extensive use of community-school partnerships and greater outreach; public information campaigns about the long-run benefits of education; special assistance to disadvantaged students with university application process and to a lesser extent special admission criteria may have a role to play in widening access.

Education Policies: Access (2/2)

A pragmatic innovation agenda is also premised on investment in vocational education and training and a lifelong learning infrastructure. In many countries, there has been a focus on expanding general education and academic pathways but to the exclusion of non-traditional routes. This is a problem because vocational education and training are better able to respond to the labour market and often have stronger institutional links with the market.

In developing countries with large informal sectors, traditional apprenticeships have performed a valuable function; in some African countries, 80-90 per cent of all basic skills training come from such apprenticeships, compared with 5-10 per cent from public training institutions and 10-15 per cent from NGO providers. They practically-oriented and are self-regulating and self-financing; on the other hand, they risk perpetuating obsolete technologies and lack standards and quality assurance. To this extent, an integrated approach which work with traditional apprenticeships but improves on them is preferable.

Elsewhere the coverage of in-service training can be patchy, especially among small and medium enterprises. High turnover of staff in more volatile environments may prevent firms from recouping the costs of training employees while for many training may be

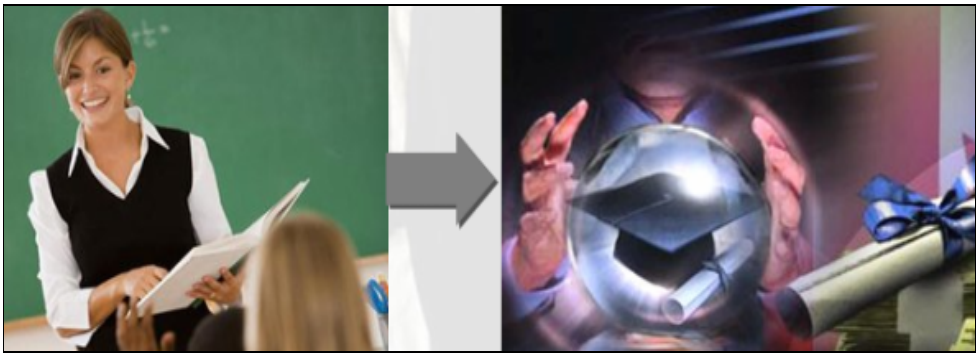
unaffordable, suggesting financial market deficiencies. **Policy can increase** provision through tax incentives,

cost-sharing schemes or more directly through levies; however, while prior skills levels in the workforce are low, firm demand for training is likely to remain weak.

Education Policies: Quality

Education policy is an important part of the innovation landscape but we must not confuse quantity with effectiveness.

Teachers are building blocks of any education system and research shows that they have disproportionate impact on student achievement. The most successful systems around the world have succeeded insofar as they have got the ablest graduates to become teachers; developed them into effective teachers through proper training and development and intervened when students have fallen behind. Elevating the status of the teaching profession has been a challenge for many developing countries, as evidenced by retention and recruitment difficulties.



Rote learning and the memorisation of procedural facts, sometimes combined with high stakes public examinations, have formed the backbone of many education systems. To meet the evolving needs of learners, **there is a need for new curricula and teaching methods** that are better adapted to the way in which people learn. These incorporate a number of ideas: that learning is **an active, social process; that motivation is crucial to effective learning; that learners have different levels of**

prior knowledge and follow different routes to the same learning outcome; and that some degree of structure is beneficial.

Quality: the path to excellence in higher education

Raising quality in the university sector is a particular challenge, especially as it is having to cope with an unprecedented expansion in demand in many parts of the world. Successful universities typically possess a number of complementary assets: **high concentrations of talent, abundance of resources, and flexible governance arrangements**. There is no model for getting to the top: policy makers may seek to upgrade one or two existing institutions with potential for excellence or they may seek to merge institutions, exploiting economies of scale and scope or create entirely brand new universities.

For developing countries, it is not appropriate to aim for world-class status; a more **realistic target is to develop the best national universities possible**, looking perhaps at successful precedents such as the land-grant institutions in the US in the nineteenth century or the polytechnic universities in Germany and Canada.

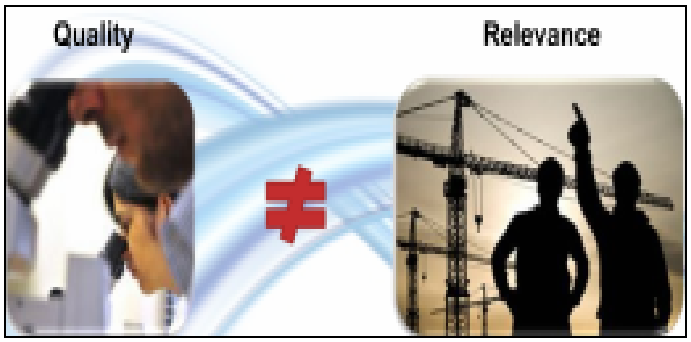
Encouraging diversification, choice and competition through private provision may be another mechanism to raise standards at all levels; however they must be

embedded within an appropriate **regulatory framework that safeguards quality and transparency**.

Rigorous benchmarking is another option. This allows administrators to evaluate the performance of their education systems against international competitors and identify effective practices. By implication, finding suitable comparable targets and making adjustments based on comparisons is an important element of successful reform – challenges which are discussed further in module

Education Policies: Relevance

In the past, there was a tendency to treat educational quality and relevance as interchangeable; providing a good education was by extension a relevant education. However a high-quality education may not necessarily be aligned with local development needs. Irrelevant education can contribute to high levels of unemployment, even among graduates from top national universities; indeed, in some African countries, unemployment appears to rise with the level of education.



To improve the relevance of education, policy makers can deepen linkages between education providers and employers. This can be done by expanding the role of vocational education and opportunities for work-based learning, as the German and Korean systems have successfully done and introducing youth entrepreneurship programs that give young people a taste of starting businesses and applying entrepreneurial skills.

Other options include increasing private sector representation on the boards of higher education institutions – and more radically giving employers a commissioning role in university funding. More generally, policy makers should seek to improve data collection and transparency about the earnings potential of different courses contributing to more informed choice on the part of learners.

While relevance is an important goal, a balance must nonetheless be struck. An overemphasis on industry's current needs may not always be the same as the long-term, dynamic needs of the rest of the economy.

Topics

Now we'll proceed to our next topic "Education Policy: Aspects of Implementation"

1. Education and Skills: Role in Innovation and Growth
2. Education Policy: Objectives and Principles
3. Education Policy: Aspects of Implementation
4. International Mobility of Talent: Opportunities and Challenges
5. Research and Development (R&D): Concepts and Trends
6. Policies to promote R&D

Education Policy: Aspects of Implementation (1/2)

Given limited public resources, there may be a need to target resources where benefits or spillovers to the public are greatest.

From the perspective of economic theory, this implies a focus on primary and secondary education which are assumed to have the highest social returns; by contrast, tertiary and technical and vocational education and on-the-job training are seen to lend themselves better to private provision. Because these activities are largely undertaken in preparation for formal work, individuals are more likely to capture most, if not, all the benefits in the form of higher wages – and so markets are likely to be more efficient.

However, where to target public money should be assessed on a case-by-case basis and should take account of equity as well as efficiency considerations. Moreover, it does not exclude other forms of assistance such as better access to student grants and loans for individuals to finance their education as well as the development of risk-sharing mechanisms and secondary markets that allow lenders to securitize their loans and issue bonds for student debt, creating more liquidity to originate more student loans.

Education Policy: Aspects of Implementation (2/2)

Another issue is sequencing. There is a growing view that the further away a country is from the technological frontier, the more growth rests on decent primary and secondary education rather than university degrees as implementing existing technologies is more important to growth than making cutting-edge innovations. In some circumstances, a singular focus on higher education can actually impede growth. Insights from neuroscience indicate that people self-identify as learners when they are young and that interventions during early childhood have long-term impacts on academic outcomes and job earnings. Waiting until further down the line say until secondary or tertiary education- may be too late to intervene and the costs of remedial training prohibitively expensive.

Topics

Now let's proceed to our next topic "International Mobility of Talent: Opportunities and Challenges

1. Education and Skills: Role in Innovation and Growth
2. Education Policy: Objectives and Principles
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International Mobility of Talent: Opportunities and Challenges

In developing countries where resources are limited, and the opportunity cost of investing in human capital is high, retaining skilled workers is an important priority of innovation policy.

The most visible manifestation of this dilemma is the **'brain drain',** where highly trained workers leave for advanced countries to seek out better opportunities. For instance, emigration rates for **scientists, engineers, and members** of the medical profession **–key actors in the innovation- are typically higher** than for the general university-educated population.

The risk of brain drain is most pronounced in small countries which lack a critical mass of skilled individuals and where a trickle of talent outwards can quickly a torrent. One study of 46 small states with populations of less than 1.5 million found that nearly 3 out of every 7 individuals with university education resided outside their country of Origin

International Mobility of Talent: Opportunities and Challenges (2/2)

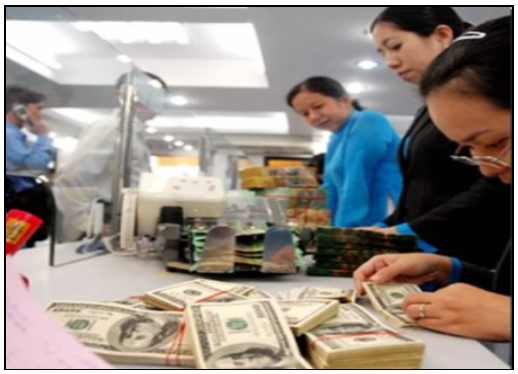
However, there are clear benefits to more moderates levels of movement, especially if diasporas gain valuable experience overseas and subsequently return home. In this respect, mobility can be a significant source of entrepreneurship, technology, marketing knowledge, networks and contacts and investment capital. Most significantly, they can become champions for extensive institutional reform.

Even if diasporas stay abroad, they provide remittances that, in theory, promote the diffusion of technology at home by encouraging investment and entrepreneurship, though, in reality, most of these only support the consumption of receiving families.

Whether or not diasporas stay away or return home depends on a number of factors: relative income levels, quality of living and research facilities, the size of the existing diaspora and the density of research networks may induce diasporas to stay abroad; while proximity to family, cultural affinities, and the desire to make a difference to technological progress in their home country may increase return rates.

Policy has had mixed and sometimes limited success in raising the return rate of the diaspora; as such, there is considerable scope to do more. Relying only on monetary incentives is likely to prove insufficient as a strategy. Moreover, there needs to be a

greater acknowledgment that different strategies will be necessary to recruit different skills.



Topics

Now let's deal with our next topic "Research and Development (R&D): Concepts and Trends

Research and Development (R&D)

The second component of the knowledge base is research and development – or scientific R&D which creates the knowledge and technology that can be put to work by firms and economies. For many developing countries, the key question is where it should direct and concentrate its efforts and how governments should share the burden of investments and risks with the private sector and the scale and range of incentives it should offer.

Research and Development (R&D): Types

To help frame our discussion, it is worth differentiating between different types of R&D. No typology is perfect or comprehensive; but we can think of the following activities:

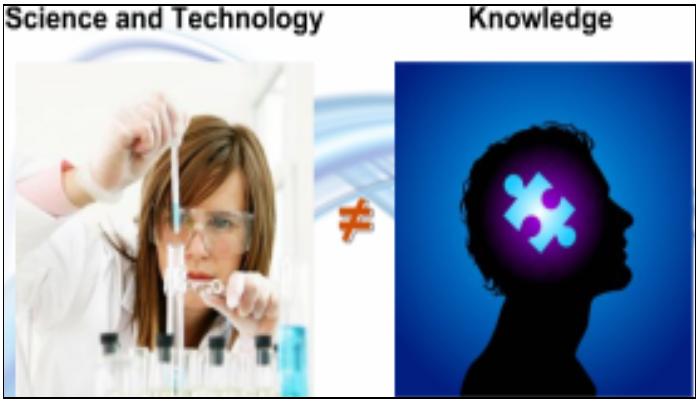
First, there is **basic research**. This refers to the generation of fundamentally new knowledge without any particular application in mind. Second, there is **applied research**. This refers to the generation of new knowledge but is guided by a specific practical aim; and third there is **experimental or advanced development** which draws on existing technologies and is directed toward producing improved products or processes.

Different types of research yield different outputs, involve different time horizons and risks and demand different skills and qualifications. The insights generated by **basic research potentially the most transformative** –think of Watson and Crick's discovery of the structure of DNA; but path they follow from the laboratory to the marketplace is long, winding and uncertain. As we move to more **applied forms of research**, so outputs become more practical and incremental, time horizons shorten and are easier to predict and advanced skills and qualifications become less important.

Research and Development (R&D): aspects of harnessing knowledge

While science and technology are important sources of knowledge, they are not synonymous with it. While our current focus is on research, we should be mindful that new ideas derive increasingly from the organisational and social sciences, design and the arts and even satisfying consumer needs. As such, a much wider range of players from customers to suppliers are important to knowledge creation than is conventionally assumed.

We should also bear in mind that the strength of an innovation system depends not only on the amount of knowledge it creates, but on the effectiveness of institutions for storing knowledge, the costs of accessing knowledge -not to mention the ability of actors to absorb the knowledge. Most important, there must exist mechanisms for commercializing knowledge**.**



Research and Development (R&D): a role for government

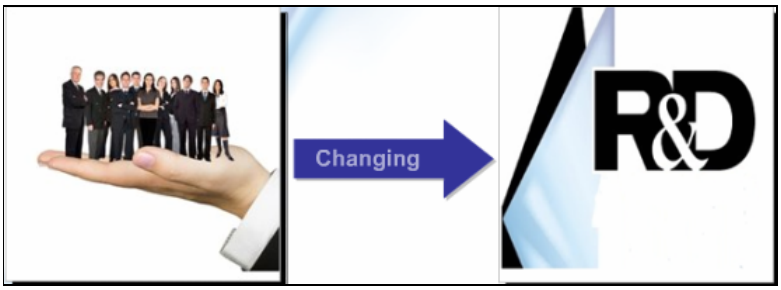
The government has a role to play in generating knowledge produced by research which is a classic public goods: the value of its benefits cannot be completely captured by whoever produces it but spills over into the rest of society. Private firms alone, in seeking to maximise their returns, will undertake less research than is socially desirable. This is most true of basic research which involves exploring fundamentally new areas with potentially economy-wide benefits

Contemporary Trends in R&D: Global Context

With these basic concepts and themes in mind, let us examine the wider backdrop against which **developing countries** are investing in and carrying out R&D.

In recent decades, by far the most significant development has been the **globalization of R&D**. **Increasing economic activity, deepening levels of scientific and human capital**, **falling communication and coordination costs** as a result of information technology and generous tax policies have encouraged R&D to go global, including to some developing countries.

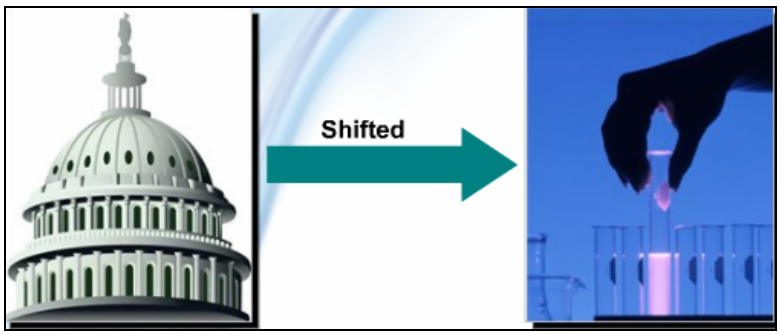
The main actors funding and carrying out R&D are also changing: government spending has relatively declined, and the **business sector is now the largest performer of R&D**, though reported figures do not include the value of incentives such as **R&D tax credits**. Government support itself has shifted to funding university R&D which typically carries out more radical and basic research relative to the private sector, though spending constraints now mean that universities face tighter forms accountability and are under greater pressure to demonstrate impact. Public resources are also increasingly channeled through research councils which provide more strategic or thematic focus than other public actors.



Knowledge no longer resides in one country or set of countries, but in all parts of the world. No single actor can do it alone – a realisation that has driven the popularity of **collaborations**, as demonstrated and one way to coping mechanism has been

collaboration, as reflected by an increasing share of **patents with co-inventors** in two or more countries or the increasing international co-authorship of scientific publications.

Finally, this **knowledge explosion** is tipping over into new areas, ranging from biotechnology, ICT and genetic engineering to nanotechnology and the environment – many of which have relevance for developing countries who confront severe natural resource and environmental challenges.



Research and Development (R&D) in Developing Countries

How do developing countries prosper in this environment? For most developing countries, the initial priority should be to scan relevant global knowledge and acquire and adapt it to local conditions. For example, a largely agrarian economy will need knowledge on various soils, climates, weather, pests and tastes. This does not rule out developing countries doing some basic research: this allows countries to understand global technological trends, providing a foundation for later upgrading and is often a precondition to participating in international research networks. But it should not be the overriding goal in the short to medium term.

Even when no formal research is being undertaken, developing countries can benefit from global flows of knowledge –whether through the import of capital goods that embody technology, participation in research consortia or opening up to foreign

direct investment that permits firms to observe the actions of foreign firms and learn about new products, marketing techniques and management practices.

These benefits should be assessed alongside the broader set of considerations and trade-offs, such as nurturing infant industries that may be hurt when a country reforms its trade regime. On the other hand, adds to the weight of arguments in favour of greater liberalization, not least because many tariffs escalate with the degree of product processing, a barrier which makes it difficult for developing countries to climb the value chain in certain markets.

Topics

Now let's proceed to our last topic "**Policies to promote R&D**

R&D Framework Conditions

Policymakers should bear in the mind the broader set of factors that affect firms decision to undertake R&D: the large majority of firms are **too small to have the resources** to make such investments or the skilled personnel to absorb their results; the **cost of capital is often too high**; **the macroeconomic environment is often unstable and unfavourable to conducting lengthy R&D**; **high entry and exit barriers** might reduce competitive pressures on firms to become more productive through

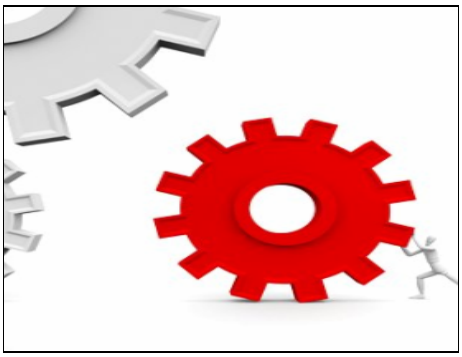
innovation; **intellectual property rights** that allow innovators to capture the rewards of R&D are often less developed.

In most cases, the firms that undertake **R&D will be large enterprises –whether publicly owned or conglomerates**. Policymakers should attempt to deepen these linkages in addition to addressing broader framework conditions, a task explored in the next module.

Policies to promote R&D

But how? Policy can encourage R&D in a number of ways. Direct measures include **tax incentives, grants, accelerated depreciation on R&D equipment, duty exemptions on imported equipment and other research inputs**.

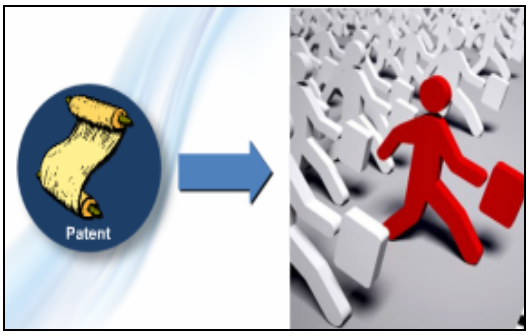
No instrument is perfect: for instance, accelerated depreciation for R&D equipment will not provide incentives to other inputs that are crucial to the innovation process, notably **training and marketing**. In general, there has been a **shift away from grants to tax incentives which avoid picking winners or targeting particular firms or sectors**. Tax incentives also require less bureaucracy to administer, though they may not be appropriate for all firms. Notably, most start-ups do not make taxable profits in their early years and consequently tax incentives may be less relevant.



Along with incentives to increase private R&D, policy can further strengthen the R&D by **increasing the skills of the population to absorb technology and promoting links between universities and firms**.

Intellectual Property (IP)

Intellectual property rights**–patent, copyright, trademark and allied rights** – which grant entrepreneurs temporary monopolies over the use and development of their ideas may be another spur to investment in R&D. The tension is that strong protection may slow down the diffusion of knowledge to follow-on innovation.



The importance of intellectual property (IP) varies from sector to sector since the rate of technological change is not uniform; meanwhile, there exist other mechanisms such as **secrecy, learning curve and lead time advantages and complementary manufacturing** that allow entrepreneurs to appropriate the benefits of their innovations. IP protection is most conducive to innovation where industry is characterized by the following features: a) research and development costs are high; b) there are high levels of uncertainty as to which lines of enquiry will bear fruit; and c) competitors can ascertain and mimic the content of technological advances cheaply and rapidly.

In contrast, IP will impede innovation when the following conditions are present: a) alternative mechanisms such as secrecy, lead-time and learning-curve advantages already provide creators adequate protection; b) innovation in the field tends to be highly cumulative; c) non-monetary incentives are important sources of motivation; and d) there are benefits from adopting and using common standards – so called network externalities.

The importance of **intellectual property rights also rises with economic development** –much inclusive innovation which involves adaptation and tinkering is unlikely to be patentable. Developing countries that toughen their IP laws often lack qualified examiners to handle the

avalanche of patent applications, creating legal uncertainties and concerns about the quality of awards. As **such developing countries need to think carefully about what level of protection is most appropriate** for them and how they navigate provisions in international agreements.

Improving system linkages between different R&D players

Earlier on, we explored the key role that universities play in equipping workers with skills to contribute to innovation; but **universities are also powerful engines of knowledge creation**. As with skills, though, there is a concern that research is not sufficiently relevant to the needs of industry and the economy.

A related problem has been the lack of interaction between universities and the private sector – each tending to occupy and operate in separate universes. Cumbersome regulations and incentive arrangements that link tenure and promotion only to academic publications have reinforced this isolation.

There are a number of measures to stimulate a more fruitful dialogue between sectors and the commercialization of R&D, including the **establishment of technology transfer offices, science parks and business incubators; the provision of innovation vouchers to enable firms to access research and expertise in universities; and greater opportunities for networking and interaction**, so that trust and understanding can emerge between universities and industry and opportunities for technological collaboration identified.

Deepening linkages between universities and regions and surrounding communities confronts policymakers with particular **challenges**. Often regional universities incur **additional costs because of their location, find it more difficult to achieve economies of scale** and are more remote from industry support and funding.

Still there is a tightrope to be walked in allowing universities to increase their commercial focus, especially if it diverts them from their core role of training skilled workers and restricts their freedom to explore and experiment with solutions that potentially have huge payoffs.

Final Thoughts

In this module, we were introduced to the following themes:

- Education and skills and their role in innovation and growth
- Education and skills are demand-led and the need to make broad investments which are properly sequenced
- The importance of access, quality and relevance to education policy
- The opportunities and challenges of migration
- Trends in research and development and the implications for developing countries
- How to strengthen the research and development base