

## R&D and Productivity

On 2003-02-18, Tuesday, José Tribolet, president of INESC, while speaking at the Cordoaria Nacional (Engenho & Obra expo, Lisbon) about the past, the present, and the future of his organization, made it clear how important the contact with other countries' organizations is and will (increasingly) be, for INESC, for Portugal and for any other nation...

We truly live in a globalized economy: the world, as we know it, wouldn't be possible at all, if it wasn't for the entanglement of today's reality, largely based on an unprecedented cultural openness. Most interestingly, there is data suggesting that the world would be different, for worst, from an economical point of view, if it wasn't for the internationalization of many phenomena, from the Internet to Multi National Enterprises (MNEs).

This document comments the papers "R&D and Productivity: the international connection", by Helpman, E. (1997), and "Multinational Enterprises, Technology Diffusion and Host Country Productivity Growth", by Xu, B. (2000). These papers focus on the effects that a country can have on another's economy, namely via international trade (ITR), foreign direct investment (FDI), and MNE affiliates.

Research & Development (R&D) is a tremendously important activity for economic growth. Helpman's paper refers that one can find evidence of such importance, by (1) observing the long run consequences of many innovations and inventions, (2) checking studies that measure very high rates of return for the investment on R&D, mainly after World War II; and (3) by checking studies that measure R&D as having a strong contribute to Total Factor Productivity (TFP), be it from an enterprise or nation's perspective.

A superb example of (1) is the invention of the microprocessor. It's really hard to think of something else having a deeper and wider impact on the society... Surely the microprocessor was only possible because many other previous inventions, like electricity, but if one manages to think strictly forward, it probably won't find anything else as omnipresent.

The microprocessor is also an appropriate example of (2), for that despite the ever heavier investments required to miniaturized it further, to improve its performance yet another step, and to lower its power consumption, the large millions of appliances that it will have, will most likely translate to high returns.

More importantly, the microprocessor has huge sectorial and social benefits that if considered, will compute even higher returns on investment. The social benefits include higher productivity on other activities, from teaching to agriculture, hence its weight on TFP (3).

The Intel 4004 (1971) is usually mentioned as the first microprocessor, so it is an American invention. However, there probably isn't a single country not having benefited from it...

Helpman's paper tries to understand how a country's investment on R&D affects other countries' economies. The paper identifies ITR and FDI as being

two diffusion channels of technology. ITR and FDI make possible goods and services that embody Science, Technology, R&D and know-how from a source [nation] to a destination [nation]; and once available on the destination will contribute to the destination's own goods and services.

This contribution can take many forms, such as when a country gets access to foreign inputs, which weren't locally available on enough quantities or with the desired quality; or when a country gets the opportunity to learn the production techniques, the organization methods, and the market's *modus operandi* of its commercial partner; or just by providing the opportunity to imitate, although imitation can be expensive, as in the reverse engineering of complex technological goods.

This means that a country's R&D will benefit not only its own TFP, but also the TFP of the countries with which it has international relations, by trade and by direct investment – these are called spillovers.

Helpman uses the values of Import Share (IS), School Enrollment Ratio (SER), and elasticity of TFP (eTFP), from a set of countries, 20 of them industrialized (including all the G7) and the remaining developing, to observe how the spillovers happen.

Let RDE be the stock of foreign R&D – that is the sum of foreign investments on R&D, weighted by IS –, and let RDI be the stock of domestic R&D – that is the investments a country does on R&D, which is 1.5% to 3% of GDP for the G7 countries –, then Helpman finds that for all countries, eTFP relative to RDE is proportional to IS, meaning that the more a country imports from another (the greater IS), then the more embodied foreign R&D it imports (the greater RDE is), then the greater should be its TFP.

The same is true for eTFP relative to RDI, meaning that the more a country invests on [domestic] R&D, the greater TFP is, with the higher values of elasticity corresponding to the more developed countries, which are then more sensitive to knowledge, hence the expression “knowledge based economies”, for such nations.

While Helpman's paper believes that ITR and FDI, both always contribute to TFP, Xu's paper studies MNEs and finds no clear evidence that FDI can, unconditionally, increase productivity per capita (PPC).

There are always technological spillovers from trade, but FDI is only expected to have a clear impact on productivity, when the hosting country human resources have a certain degree of education.

Xu exemplifies with (Australia, Canada and Mexico) versus (Venezuela and Morocco). The first group is countries which showed gains of productivity, following FDI by MNEs; the second group is countries which also had FDI by MNEs, but showed no gains of productivity.

Xu finds that, for developed countries (DCs), the importance of MNEs for gains of productivity is nearly as high as ITR. Together, ITR and MNEs represented a 1.34% boost on TFP, 40% of which due to MNEs.

For less developed countries (LDC), the presence of MNEs also raises productivity, but such gains might have origin on factors other than technological spillovers, such as the increased competition. According to Xu's study, LDCs might not have the human resources capable of absorbing the spillovers that come with the MNE affiliates, establishing a threshold below which the hosting nation won't regard the MNE as a diffusion channel of technology.