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Human capital, R&D, trade, and long-run productivity. Testing the technological absorption hypothesis for the Portuguese economy, 1960–2001

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ABSTRACT

An important characteristic of the role of foreign trade in the technological catch-up of countries is the complementary nature with technological change, human capital development and local R&D efforts. Using cointegration techniques, evidence based on Portuguese long-run growth suggests that by investing in certain capacity-building activities, namely human capital and local R&D efforts, countries can improve their ability to identify, value, assimilate, and apply (or exploit) knowledge that is developed in other (more developed) countries. Although human capital has a stronger direct impact on total factor productivity than internal R&D efforts, the latter's indirect impact, by means of machinery and equipment imports, is tremendous. Trade also emerges as a powerful direct contributor to long-term total factor productivity, especially in its embodied form, through the acquisition of advanced machinery and equipment from more developed countries. The (smaller) productivity enhancing effect of licenses and FDI seems to be strongly dependent on institutional circumstances, namely those related to human capital investments and incentives.

1. Introduction

A number of studies have identified channels through which productivity levels of countries are interrelated, emphasizing the role of international trade (Xu and Chiang, 2005). The primary channels for international technology transfer during the post-war period were trade of capital goods, foreign direct investment (FDI), and licensing (Mowery and Oxley, 1995). Understanding the effective channels of technology diffusion is essential for policymakers in the face of expanding globalization (Zhu and Jeon, 2007).

The possibility of technological transfer is influenced by several factors, namely the social capability of an economy (Abramovitz, 1986), which involves "... various efforts and capabilities that developing countries have to develop in order to catch-up, such as improving education, infrastructures, and, more generally technological capabilities" (Fagerberg and Godinho, 2005: 523). The theory predicts that there may be important interactions between technology imports (in its various forms) and capacity-building activities, such as educational attainment and local R&D efforts, because technology imports boost productivity only when an economy has a threshold level, in terms of educational attainment or local R&D effort, that is high enough to allow for the efficient use of the imported technology (Mayer, 2001).

A better understanding of a country's real sources of growth requires examining the human capital–R&D–trade–growth nexus. One of the main problems with empirical studies in this domain is that they do not clearly test the mechanisms through which trade affects total factor productivity. When commenting on the paucity of systematic testing within endogenous growth theory Pack (1994) stressed that using cross-country regressions to explain growth produces irregular orders of magnitude and indications of where to search for explanations of growth, without exploring the connection between factor accumulation and economic growth. In his opinion, "[t]he challenge for empirical work is to test the implications of the ... theory more directly, [i.e.] testing its insights against the economic evolution of individual countries using time series data" (Pack, 1994: 70).

The interrelationship between trade, human capital, local R&D efforts and growth is likely to be a major issue for Portugal. First, the escalating openness to international trade following World War II is considered an 'inescapable feature' in the development of the Portuguese economy (Barros and Garoupa, 1996). Second, in the same period, the structure of imports changed, revealing a steady upward trend in investment goods (Courakis et al., 1990). These were considered decisive to industrialization both as providers of inputs and as a channel of technological transfer (Afonso and Aguiar, 2005). The other two channels for international technology transfer (FDI and acquisition of foreign licenses) are not as con-

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sensual as to their impact (FDI) nor do they attract much attention (foreign licensing). Resorting to cointegration techniques, in the present paper, we estimate the relative importance of trade, human capital and R&D (as well as the interaction between the first and the two latter, i.e., the technological absorption hypothesis) on Portuguese long-run growth.

The paper is organized as follows. The next section discusses the theory and empirical literature discussing the potential role of technology imports and the importance of human capital and local R&D efforts on the economic performance of countries. Section 3 provides some background on the dynamics of Portuguese technology imports and economic growth, and Section 4 discusses the data sources and proxies for the relevant variables. Section 5 highlights our econometric specification and the estimation results, and Section 6 discusses the main conclusions.

2. Trade, technological change, human capital, and economic growth: a review

Early catching-up literature, anchored in the neoclassical growth model, suggests that technological transfer is an important source of technological advancement for poor economies (Nelson and Phelps, 1966; Abramovitz, 1986). Advances in the theory of endogenous technological progress have led to a renewed interest in the relationship between trade, technological change, human capital and economic growth. As argued in modern trade literature and integration theory, trade triggers important supply-side effects, which induce efficiency improvements in the enterprise sector and finally lead to additional growth (Grossman and Helpman, 1991). In this context, economies importing goods from other countries with a higher technological level can import technological progress and may be able to renounce their own innovation activity (Rivera-Batiz et al., 1993). Empirically, a number of studies for different set of countries have shown that foreign trade is promoting growth (e.g., Dollar, 1992; Ben-David, 1996). Coe and Helpman (1995) and Coe et al. (1997) consider foreign trade a carrier of knowledge and assess the importance of imports in introducing foreign technology into domestic production and spurring total factor productivity. They assume that a country that is more open to technology imports derives greater benefits from foreign R&D, and show empirically that the countries which have experienced faster growth in TFP have imported more from the world's technology leaders.[1]

Developed countries in general are the global technological leaders. Therefore, imports from these countries are much more likely to embody advanced technology, in particular technology unavailable to firms in less developed countries, than imports from other countries. The contribution of capital goods and imports from developed countries is largely operated through technology transfer effects. According to Lawrence and Weinstein (1999), the role of imports in boosting productivity has been largely ignored due to an excessive focus on the export growth relationship by world authorities (e.g., World Bank). Kim et al. (2009) further assert that with respect to the impact of imports on growth, empirical literature is lagging far behind the theoretical one.

Regarding FDI, a number of studies (e.g., Grossman and Helpman, 1991; Hermes and Lensink, 2003; Batten and Vo, 2009) suggest that it plays an important role in modernizing the economy and promoting economic growth in host countries, especially in developing countries. Since a large share of global R&D is undertaken by multinational corporations, FDI by these firms is considered a potential channel providing access to advanced technologies available on the global marketplace (Zhu and Jeon, 2007). Theoretically, FDI has been shown to boost economic growth through technology transfer and diffusion (Wang and Blomström, 1992), spillover effects (Wang and Yu, 2007), productivity gains, and the introduction of new processes, managerial skills and know-how in host countries (Girma, 2005), labour turnover (Gershenberg, 1987), or backward and forward production linkages (Markusen and Venables, 1999). Although theoretical models for FDI and technology transfer are well developed (Glass and Saggi, 1998), empirical studies have yielded mixed results (some positive results: Zhu and Jeon, 2007; no evidence: Xu and Wang, 2000). Several empirical studies indicate that the growth effect of FDI is strongly dependent on the institutional circumstances of the host or receiving countries (Hermes and Lensink, 2003); specifically, they find that FDI inflow is positively associated with economic growth only when countries have previously achieved a certain level of wealth, financial development or educational attainment (Borensztein et al., 1998; Alfaro et al., 2004).

The relationship between FDI and human capital is complex and extremely non-linear (Blomström et al., 2001). Without properly trained or educated human resources, these processes of technology/knowledge transfer and creation, reactive or proactive, cannot occur effectively (Haddad and Harrison, 1993). Borensztein et al. (1998) found a positive link between FDI and growth but only provided that a minimum threshold of human capital has been achieved, corroborating the "absorptive capacity" hypothesis (Cohen and Levinthal, 1989). In line with Borensztein et al.'s (1998) idea of a minimum threshold of human capital, Xu (2000) found that, in the absence of adequate human capital, spillovers (namely of a technological nature, and productivity spillovers) may simply be unfeasible. Therefore, human capital is crucial to enable the spillovers that underpin economic growth. Using a comprehensive panel data set of 79 countries and covering a longer period (1980–2003), Batten and Vo (2009) demonstrate that FDI does in fact have a stronger positive impact on economic growth in countries with a higher level of educational attainment.

Athreye and Cantwell's (2007) findings are consistent with the view that multinationals require the presence of local capabilities and infrastructure before they invest, and that, in more recent times, they tend to follow knowledge-based asset-seeking strategies to reinforce their competitive strengths, as argued by authors such as Cantwell (1989) and Pearce (1999). Competence-creating subsidiaries need to be more closely embedded within local networks (Birkinshaw et al., 1998), and an increased intensity of knowledge exchanges between local actors in these networks tends to create a virtuous cycle of growth in innovation in those favoured locations that have attracted high-quality FDI. Athreye and Cantwell (2007) argue that the international knowledge connections provided by FDI tend to precede and thus facilitate catching-up at higher levels of technological sophistication—FDI promotes technological catch-up among countries that have already acquired sufficient absorptive capacity for higher-order types of innovative activity to take off locally; nevertheless, on average, it tends to have little impact on catching-up in earlier stages of development.

One of the few existing studies relating disembodied technology trade (including patents, licenses for patents, know-how (unpatented knowledge), models and designs, trademarks (including franchising), technical services, and funding of industrial R&D

[1] Imported technology is expected to have a positive effect on the host country's productivity for several reasons. An important channel by which better-quality technology is obtained is through imported goods, which embody advanced technology (Mendi, 2007; Kim et al., 2009). Thus, total factor productivity (TFP) may increase simply because firms using more advanced technologies raise average productivity; these firms may foster competition among domestic firms, leading to the survival of the fittest; and imported technology may be imitated by local competitors, or even by the licensee, once the licensing contract expires.