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Technology and costs in international competitiveness: From countries and sectors to firms

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ABSTRACT

This paper examines the microfoundations of the determinants of international competitiveness. It does so within the broader "technology gap" perspective whereby wide technological and organizational differences ultimately shape the patterns of trade within sectors across countries and their dynamics. First, we take stock of the incumbent evidence on the relation between cost-related and technological competition at country and sectoral level. The overall picture indeed suggests that the countries' sectoral market shares are mainly shaped by technological factors while cost advantages/disadvantages do not seem to play any significant role. But within any sector, within any country, firms widely differ. Hence the question: does this property apply also at a micro level? Here, we first propose a heuristic model based on a generalized Polya urn process yielding such a property and, then, empirically attempt to identify the underlying dynamics at the firm level using a large panel of Italian firms, over nearly two decades. Results show that also at micro level in most sectors investments and patents correlate positively both with the probability of being an exporter and with the capacity to acquire and to increase exports, whereas labour costs show a negative effect only in some sectors. The result is reinforced when separating the short- and long-run effects, highlighting the predominant impact of technological proxies and basically the irrelevance of wage costs.

1. Introduction

In order to appreciate that countries are vastly different in terms of technological and organizational capabilities, to paraphrase Lucas (1988), one does not need an economist but just a vaguely informed tourist. And of course this is reflected by equally vast differences in productivities and per capita incomes. However – much less appreciated in the economic theory – this is also reflected by the patterns of trade and their dynamics over time. This relative neglect is probably due to a considerable extent to the early very neat representation by David Ricardo of the determination of trade flows in terms of comparative advantages, indeed one of the pieces of his work nearest to a contemporary, albeit rudimentary, general equilibrium theory whereby allocations are basically determined by opportunity costs under a long list of conditions including the fully employment of all resources in every country, absence of dynamic increasing returns, perfect capital and labour mobility across sectors, no idiosyncratic firm-specific or sector-specific technological capabilities, and a few others.

What happens if these latter conditions are not met? Or, somewhat dramatizing, as we argue in Cimoli et al. (2009), in turn paraphrasing Reinert (2009), what happens if, say, one opens up trade between a "Stone Age economy" and an ICT-based one? Most likely, if there will be bilateral trade at all, the "Stone intensive" economy will be more likely to export "stone intensive" products. However, will it? Maybe, the more advanced ICT economy will produce almost anything worth trading irrespective of the stone- or ICT-intensities of the products. What matters might be ultimately technological capabilities and not relative prices (and even less so shadow prices).

Indeed, at least since the seminal work of Posner (1961), a stream of analyses has been arguing that one of the main sources of (absolute) advantage of a country comes from its relative technological position against its competitors in any one activity, rather than from intersectoral opportunity costs within the same country. The roots of such a perspective date back to 18th and 19th centuries pre-Ricardian or anti-Ricardian theories of trade – including largely

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forgotten authors like Ferrier and List – and refined in modern technology-gap theories of international trade and related product-cycle views (in addition to Posner, 1961; see Freeman, 1963; Hirsch, 1965; Vernon, 1966; Hufbauer, 1970; Cimoli, 1988 and the preliminary attempt to get together the whole view in Dosi et al., 1990). In such a perspective, trade flows are primarily driven from sector-specific absolute advantages, in turn stemming primarily from widespread technological asymmetries between countries which relate in first instance to the capability of some countries to produce innovative commodities (i.e. commodities which other countries are not yet capable of producing, irrespective of relative costs) and to use process innovations more efficiently or more quickly thus reducing input coefficients.

In the following, we first try to offer a concise but hopefully exhaustive overview of the empirics of such literature, whose theoretical underpinnings rest, of course, upon, at least, *partial disequilibrium* assumptions, and more generally upon evolutionary notions of international dynamics of industries and trade. In turn, the "partial disequilibrium" (and most likely "general") perspective allows to easily disentangle *technological factors* from cost factors as determinants of trade flows. Again in the foregoing caricature, there will not be any cost adjustment that will induce the substitution of a stone-based product to a microprocessor in any economy, let alone the most advanced ones! Being less crude, one ought to ask, in tune with the seminal but neglected Kaldor (1978)'s question, what is the relative role of technological *vs.* cost conditions as determinants of trade flows. And this is what the sectoral "technology gap" literature does with quite robust results on the dominant role of the former (Fagerberg, 1988; Dosi et al., 1990; Amendola et al., 1993; Laursen and Meliciani, 2010). Granted that, what happens *within* sectors?

After all, intra-industry differences are large. Firms within each sector, irrespectively of the level of industry disaggregation, are highly heterogeneous on whatever measure chosen, both on the input and output sides, their efficiencies, degrees of innovativeness, market performances, even in presence of the same input prices (see, within an expanding literature, from Hildenbrand, 1981 and Nelson, 1981 to Bartelsman and Doms, 2000; Dosi and Grazzi, 2006; Dosi, 2007; Dosi and Nelson, 2010; Syverson, 2011). And the available evidence supports also at least equally deep degrees of heterogeneity in the participation on the export markets (see the review in Bernard et al., 2012; Melitz and Trefler, 2012). Hence one needs to discard any 'representative firm' like hypothesis and study what is the underlying micro evidence to the aggregate macro or 'meso' patterns.

Overlapping but distinct from new–new (micro) theories of international trade (see Melitz, 2003; Bernard et al., 2007; Melitz and Ottaviano, 2008), we address the microeconomics of competitiveness and export performance, on the grounds of a novel heuristic evolutionary model of selection and trade, and, in line with the technology gap tradition, we empirically try to distinguish the effects of technological and cost variables in shaping firm's exports.

Employing several sources of Italian firm level data we investigate the effects of technological and cost variables in affecting export market participation and trade volumes. While technology, as proxied by the firm's pool of patents, appears to matter, there is no widespread evidence that a lower cost of labor is a significant factor for international competitiveness. These results hold under a number of controls and robustness checks. In particular, the effectiveness of patents in shaping firm-level exports – as well as the limited impact of cost variables – is also confirmed when adapting a traditional technology gap framework which enables to spell out the short and long run effects of the determinants of international competitiveness. And our results still hold also when employing other variables proxying for the output of innovation activities, such as product and process innovation, as available through Community Innovation Survey (CIS). Finally, the paper also contributes to the emerging literature on quality sorting and trade (Crozet et al., 2012; Manova and Zhang, 2012) by investigating the channels which are responsible for the different patterns that we observe in the exports of innovating and non-innovating firms. Employing the volume of exports of firms to any given product-country destination we find that exports of firms engaged in innovative activities decrease less in response to an exogenous shocks as a real exchange rate appreciation, and this is mostly due a smaller reduction in the quantity sold.

Our contribution provides a framework in which to explicitly link technology-gap and evolutionary theories to the observed dynamics at the firm-level. Indeed, the separate analysis of technological and cost factors at the most disaggregate level statistically available is one of the distinguishing features of this work with respect to most of the recent firm level contributions studying the determinants of export status and export volumes. Sectors differ in terms of dominant technologies of production, patterns of innovation, competition mechanisms. And unlike any "Ricardian hypothesis", financial capitals are very mobile but capabilities are very sticky: one can switch from an investment into biscuits to microprocessors, but firms may hardly do the same in terms of what they are able to do. This also highlights a fundamental time dimension. Firms' capabilities are quite sticky (within a huge literature, see the overview in Dosi and Nelson, 2010) while cost are less so – think for example of a devaluation of a currency. Hence, the investigation of the long-run as distinguished from the shorter-term one is crucial.

The paper is organized as follows. Section 2 addresses the state-of-the-art on technology-gap interpretations of trade flows at country and sector levels. Section 3 reviews the literature on export and innovation at the micro level and presents an evolutionary model of selection and trade. Section 4 describes the data upon which our analyses are based. Section 5 presents the methodology and results. Section 6 adds further evidence on the role of product and process innovation using data from two waves of CIS surveys. Section 7 concludes.

2. Technology and costs in international competitiveness

Competitiveness is determined by several factors. One is certainly labour costs, the labour being the – relatively more – immobile factor among countries. However, the aggregate, sectoral, and micro literature within but also outside the "technology gap" tradition on international trade have debated the extent to which technological innovation is affecting trade performance, in addition to, or even against changes in labour costs.

Following Dosi et al. (1990), one can specify sectoral trade performance as a function of both technological absolute advantage (T_{ij}) and variable costs (C_{ij}):

$$X_{ij} = f(T_{ij}, C_{ij}) \quad (1)$$

where X_{ij} is some indicator of international competitiveness (say the market share of exports in sector i by country j); T_{ij} represents an indicator of technological levels (both product and process technologies in the same sector i for country j) and C_{ij} represents a proxy for variable costs, typically labour costs.

In the technology-gap and evolutionary account of international trade, Eq. (1) is consistent with macroeconomic disequilibrium: for example, it does not imply any clearing on factors' and commodities' markets and, indeed, it requires an implicit assumption on some "stickiness" in the reallocation of resources from one sector to another. More generally, it implies changes in trade and technology unpegged to some underlying equilibrium and imperfect