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Sophisticated jobs matter for economic complexity: An empirical analysis based on input-output matrices and employment data☆

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ABSTRACT

A wide range of economic development theoreticians has discussed the manufacturing sector's properties as an engine for economic growth. More recently, the sophisticated services sector began to share similar characteristics with the industrial sector as a driver for economic growth, particularly as a locus of technological innovation. This paper considers the symbiotic relationship between these two sectors, and assesses their importance in the technological development of countries. More precisely, this study uses economic complexity analysis and input-output matrices to assess the importance of employment creation in advanced sectors of countries. Results show that in the long-run economic complexity depends on the effort and the ability of countries to generate employment in manufacturing and sophisticated services sectors.

1. Introduction

Increased output sophistication in a given country leads to a higher labor division potential within and among companies, following Adam Smith's pin factory example. Sophisticated economies are able to efficiently create productive networks in manufacturing and advanced service sectors, with increasing returns to scale. This set of systemic characteristics implies higher individual worker productivity; a positive relationship between per-capita income and production sophistication or economic complexity (Hausmann et al., 2011). Labor productivity measures, calculated as value added divided by the number of workers, show empirically those characteristics of manufacturing and sophisticated services industries. These two sectors employ many workers with higher productivity levels than average. Rich countries stand out as having large shares of their population employed in manufacturing and sophisticated services industries.

For classical economic development, industrialization has always been regarded as the royal path to growth and increased productivity. The essence of structuralist thinking lies in the manufacturing sector being the key to economies' productivity gains. From the argument of the declining trend of terms of trade, through Prebisch's (1950) idea that productivity gains are incorporated into wages in industrialized countries and converted into price decreases in peripheral countries, one cannot conceive economic development within this framework without the idea of industrialization. The entire structuralist literature on deindustrialization, and even on the so-called Dutch Disease, stems from this perspective (Bresser-Pereira, 2016). As Kaldor (1966) argued, after Gunnar Myrdal, a country's technological and productivity dynamics are strongly dependent on the capital accumulation process, on its own aggregate output level, and on its level of industrialization.

Broadly speaking, these authors emphasized that productive sectors are different in terms of their potential to generate growth and development. Manufacturing sectors, with high increasing returns, high incidence of technological change and innovations

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and high synergies and linkages arising from labor division strongly induce Economic Development (Reinert, 2008). These are activities where imperfect competition rules, with all its typical features (learning curves, fast technical progress, high R&D spending, economies of scale and scope, high industrial concentration, entry barriers, product differentiation, etc.). This group of high value-added sectors are usually opposed to low value-added sectors typical of poor and middle income countries and its perfect competition market structure (Low R&D content, low technological innovation, perfect information, absence of learning curves, etc.) (Reinert, 2008).

We follow this literature to address the symbiotic relationship between the manufacturing and sophisticated services sectors, and evaluate their importance for the technological development of countries. More precisely, based on economic complexity databases and employment data from the WIOD world input-output database (Timmer et al., 2015a) and GGDC database (Timmer et al., 2015b), we use panel analysis to evaluate the importance of employment generation in advanced sectors for the technological development or, as we shall see, economic complexity of countries. The paper is divided into five sections. The first section reviews the importance of manufacturing as an economy's productivity powerhouse. The second section emphasises the importance of the so-called modern or sophisticated services sector and its relation to the manufacturing sector. Section three introduces the concept of economic complexity, and analyses the main characteristics of the manufacturing industry based on this new conceptual view. The fourth section empirically relates the employment structure worldwide with economic complexity indicators. The fifth and final section briefly concludes the study.

2. Manufacturing: the heart of productivity

The structuralist view defines economic development as a radical transformation of economies' productive structure in the sense of sophisticating production and jobs. Based on the assumption that a country's industrial productive structure affects both the pace and direction of economic development, the structuralist literature underscores the importance of industrialization in the growth process (Palma, 2005; Szirmai, 2012; Felipe et al., 2014; McMillan et al., 2014; Rodrik 2016). For structuralist economists, in the absence of a robust industrialization process a country's employment, productivity, and per-capita income cannot grow in a sustainable manner. For these authors, the development process involves a reallocation of output from low- to high-productivity sectors, where increasing returns to scale prevail. For these economic development authors, increased productivity stems precisely from climbing the technological ladder, migrating from low- to high-quality activities, toward sophistication of the economy and jobs (Bresser-Pereira, 2016). To this end, it is crucial to build a complex and diversified manufacturing system subject to increasing returns to scale, high synergies, and linkages between activities (Reinert, 2008). Specializing in agriculture and extractive industries does not enable such technological evolution.

The division of labor – the cause "of this improvement in the productive powers" – is featured in the works of A. Smith as a pillar of productive progress and, therefore, of productivity gains. The famed pin factory example shows in detail how production specialization and the division of tasks lead to productivity gains. For Adam Smith, the division of labor as seen in manufactures was of the utmost importance in explaining increased worker productivity as a result of three reasons: i) improvement and increased skill from concentrating on a single activity, or increase of dexterity, as Smith puts it, ii) time savings in connection of the site and task changes needed in the absence of division of labor; iii) mechanization of the production process, or use of machinery invented by workers, machine makers, and "philosophers". Manufacturing enables greater division of labor because of its intrinsic production characteristics, that is, manufacturing always features a lengthy linkage of production phases. To arrive at an automobile, for example, the engine, tires, chassis, windows, seats, etc. all have to be made. This form of linkages does not occur as strongly in agriculture or in commodities extraction; and happens only partially in commodities processing: economic activities differ in terms of the "unfolding" of their production process.

For Smith, economic activities are not neutral from the angle of their potential for generating division of labor; some are more conducive to it, others less. Agriculture and natural resources tend to foster less division of labor. More complex manufactures and products show a greater potential to foster production specialization and division of labor within and among firms, particularly those made on expansive networks, generating increased opportunities for productivity gains. Therefore, "Smithian" productivity gains are not sector-neutral, but depend on the production activity carried out in the economic space at hand. According to Smith, "The nature of agriculture, indeed, does not admit of so many subdivisions of labor, nor of so complete a separation of one business from another, as manufactures" (Smith, 1994, pg. 7, Book 1). Or: "The most opulent nations, indeed, generally excel all their neighbours in agriculture as well as in manufactures; but they are commonly more distinguished by their superiority in the latter than in the former" (Smith, 1994, pg. 8, Book 1).

Agriculture, on the other hand, develops fewer production linkages, whether within itself or with other sectors. In this sense, manufacturing must be regarded as a system, and not simply as a sector. Agriculture and simple commodities extraction do not amount to systems because they establish fewer linkages in the production phases of their outputs, precisely those links that might be mechanized and have higher potential for productive specialization. Even the agribusiness sector cannot be characterized as agriculture because it is about the processing of commodities (poultry, orange juice, sugar, etc.); it enables partial productive sophistication or "complexization", so to speak. The same applies to natural resources processing: it is not enough for an activity to be subject to mechanization and division of labor. It must have links to increase the potential for mechanization and the division of labor. The agribusiness sector may increase product complexity if its tractors, chemicals, seed mills and harvesters are made domestically and competently, as was the case in the United States and Canada, for example. But this is not guaranteed to be the case. Agriculture may simply import the machinery and chemicals it needs and, in this case, the country will continue to be a large automated farm, employing few to manage lean production processes (driving the tractors, seed mills and harvesters). The path to economic complexity shows that a country must produce tractors, harvesters, seed mills or fertilizers, or something complex besides soy beans, maize or wheat only.

Possibilities for mechanization and specialization are greater in manufacturing than in other sectors precisely because of the greater potential for division of labor, both inside the manufacturing sector and between it and other sectors, something that the structuralist economics literature has clearly explored and discussed based on the works of Kaldor (1966) and Myrdal (1957) from the 1960s and '70s. Smith's insights were expanded in the works of Allyn Young (1928). Kaldor (1966) starts out from the work of Allyn Young (1928) and the division of labor within and among business firms to emphasize the importance of increasing returns to scale in manufacturing. This feature of manufacturing and of the potential for division of labor became known as "roundaboutness", as follows: if Robinson Crusoe were alone on an island, it would be more worth his while to spend time making a boat

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