
4.3. How important are organizational decisions in determining a firm's productivity?

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1. Motivation

Measuring and understanding differences and variations in firm, and therefore country, productivity is a difficult—and important—task. Economists throughout the world have documented large and persistent differences in measured productivity across firms: Syverson (2004), looking at the variation in revenue-based productivity across US plants within four-digit SIC industries, finds that the plant at the 90th percentile of the productivity distribution makes almost twice as much output, with the same measured inputs, as the 10th percentile plant.

The evolution of productivity is also at the center of the academic and policy debate, both in Portugal and abroad. How steeply productivity rises with firm age—the age-productivity profile—is quite heterogeneous across countries: older plants in the US are much larger and productive than younger plants, and this gap is (much) smaller in developing countries (Hsieh and Klenow, 2014). At the aggregate level, productivity growth seems to have slowed down in various advanced economies: labor productivity growth in the US has averaged 1.3 percent per year from 2005 to 2015, down from 2.8 percent in the previous decade (Syverson, 2017).

This Section, based on Caliendo *et al.* (2015a), tackles all these issues, and shows that a better understanding of the internal organization of a firm can go a long way towards understanding differences in productivity across Portuguese firms, as well as the evolution of firm-level and aggregate productivity.

The starting point is that a firm's productivity may depend on the way the firm organizes its production: the way different inputs and factors of production are combined with particular technologies, given demand for the firm product, determines the production efficiency of a firm. Some of these organizational decisions are taken

as a reaction to shocks to demand (e.g. a change in fashion), to changes in the institutional environment in which the firm operates (e.g. sudden changes in regulations), or to productivity shocks (e.g. the shutdown of an important supplier). This creates a measurement challenge: in order to understand how changes to the organization of the firm affect its productivity, we need to acknowledge that these changes may have been triggered by external shocks that also affect productivity. How to disentangle the two channels? Let's start by looking, in the next section, at a real world example.

2. How a reorganization, triggered by increased competition, affected productivity?

The first step we need to take is to distinguish between quantity-based and revenue-based productivity. The distinction is crucial since the first measures how effective is a firm in transforming inputs and factors—like capital, intermediate goods and labor—*into output*, while the other measures how effective is a firm in transforming inputs and factors *into sales*, and therefore also measures any price variation, perhaps related to markups, that results from market power. Once we are able to distinguish between a firm's quantity-based and revenue-based productivity, we can begin to study how a change in the organization of the firm affects either of them. In both cases, we will focus on within-firm changes in productivity as a result of firm re-organization: this is extremely useful since it allows us to sidestep the difficulties in comparing quantity-based productivity—which is expressed in units of the particular goods produced by a firm—across firms.

Let's then consider the case of a Portuguese firm producing "Knitted and crocheted pullovers"—as well as other similar articles—that heavily downsized between 2002 and 2005, as a consequence of the increased competition following China's entry into the World Trade Organization. The quantity sold by the firm declined by 50 percent, with prices increasing by 30 percent. Since changes in the organization of a firm are inherently lumpy, the firm adapted to the new competitive situation by adopting an organizational structure that was a bit too small for the size of its new market: it streamlined its organizational structure by firing a number of managers and employees performing secondary tasks, and by focusing on its main expertise by maintaining its "sewers and embroiderers". As a consequence of this significant change in the organization of the firm, quantity-based productivity declined by 53 percent, but revenue-based productivity—affected by prices—increased by 9.2 percent.

The increased competition from China stimulated a specific change in the organization of this apparel firm—the span of control, i.e. the number of production workers per manager, increased—and had a large negative impact on its quantity-based productivity, and a more modest positive impact on its revenue-based productivity. In the rest of the chapter, we will show that this kind of adjustment is typical, and that reorganizations are important not only to understand how productivity changes for a given firm, but also to understand the evolution of aggregate productivity.

3. Data and econometric challenges

Three firm characteristics were crucial in the previous example: the organization of the firm, the firm revenue-based productivity, and the firm quantity-based productivity. Luckily, the rich set of data available for Portuguese firms allows us to measure all three of them.

Our measure of firm organization relies on the theory of knowledge-based hierarchies developed in Rosen (1982), Garicano (2000) and, in an equilibrium context with heterogeneous firms, in Garicano and Rossi-Hansberg (2006) and Caliendo and Rossi-Hansberg (2012). This theory emphasizes that knowledge, interpreted as the ability to solve problems, is a key input for production. Given that individuals have a limited time to work then, in order to relax this time constraint, individuals can work in teams and specialize in solving different kinds of problems: less knowledgeable workers deal with routine production tasks, thereby economizing on the time of experts who specialize in managing tasks.

In Portugal—just like in France (Caliendo *et al.*, 2015b)—we find that when firms re-organize, they manage the knowledge characteristics of their labor force to save on labor costs: when a firm expands substantially, it adds well-trained experts, and routinizes lower-level jobs for which the firm now hires less skilled/trained employees. The increase in the wage bill associated with the hiring of upper-level management is compensated by the decrease in the average wages associated to lower level jobs. The opposite happens when a firm shrinks substantially: the apparel firm that we considered above decided to downsize and focus on less managers and relatively more "sewers and embroiderers" because its market became much smaller. We were able to detect this change in the organization thanks to the Quadros de Pessoal, a matched employer-employee dataset covering the universe of firms located in Portugal, with information on all their workers. Specifically, for any given firm and year, we can assign each

of the workers in the firm to one of 4 layers, from production workers to top management.

The theory of knowledge-based hierarchies has clear-cut implications for the evolution of firm productivity that match what we observe in the data. Let's consider the evolution of revenue-based productivity for a growing firm. When a firm grows, but not enough to reorganize, revenue-based productivity increases, driven by the rise in the price charged. However, when the firm does change its organization by adding a layer of managers, revenue-based productivity drops, as prices reflect the lower marginal costs. Changes in the organization of the firm can be seen as lumpy investments (or disinvestments) that become worthwhile once the market of a firm is large enough to sustain the higher fixed cost associated to a more complex organization. In Caliendo *et al.* (2015a) we show, among other things, that the implications of the theory are consistent with the evolution of a simple measure of revenue-based productivity, value added per worker, within a broad spectrum of industries.

Once we acknowledge that a firm's organization is one of the inputs affecting production, we need to face two challenges. First, when estimating the productivity of a firm, we need to control for a measure of firm organization, as opposed to simply controlling for the number of workers or the wage bill. Second, we need to take into account that firm organization is endogenous, and can depend on productivity shocks that are unobserved to the econometrician. In Caliendo *et al.* (2015a), we show how to solve both of these problems when computing several measures of firm revenue-based and quantity-based productivity.

Before jumping to the results, we need to address what is often the elephant in the room in many discussion in economics: causality. So far, we have discussed how to construct measures of productivity that incorporate the role of firm organization, based on a theory that associates increases in the number of layers of a firm to increases in quantity-based productivity and reductions in revenue-based productivity. To the extent that the organization of a firm, similar to what is usually assumed with capital, does not change much in the short run then we can interpret the relationship between a firm's number of layers and its productivity as causal.

However, we can also be more demanding. In Caliendo *et al.* (2015a) we employ two different strategies to instrument for a firm reorganization, and to make our results more robust. First, we resort to an instrumental variable strategy, and use a large set of instruments represented by demand and cost shocks, as well as real exchange rates and a firm's export and import patterns, that predict organiza-

tional changes but are uncorrelated with current productivity shocks. Second, we use the removal of quotas in sub-industries of the Textile and Apparel sector, that resulted from China's entry into the WTO, as an instrument for a firm's reorganization. In both cases, we get a consistent set of results that will be summarized in the next, final, subsection.

4. Organization is key

Our main results are based on the Wooldridge (2009) revenue-based productivity, and Forlani *et al.* (2016) quantity-based productivity approaches, extended to account for firm organization, and the instrumental variable strategy outlined above. We find that, as a result of an exogenous demand or productivity shock that makes the firm reorganize and add a management layer, quantity-based productivity increases by about 8 percent, while revenue-based productivity drops by around 7 percent. These effects are large in magnitude, and extremely significant and robust to alternative definitions of productivity, and empirical strategies.

The results are even more important once two additional facts are taken into account. First, reorganizations are fairly frequent in the data, and therefore are potentially an important driver of firm productivity: about 12 percent of firms in a layer reorganize by adding a layer, and about the same number downscale and drop one. This is not unique to the Portuguese market: Caliendo *et al.* (2015b), using data for France, find similar patterns.

Second, the effects of reorganization are important for understanding aggregate productivity dynamics: reorganization accounts for an increase in quantity-based productivity, when firms reorganize by adding layers, of about 8.3 percent, while the average increase in productivity for these firms was 6.5 percent. Similarly, when firms reduce the number of layers, reorganization accounts for more than 100 percent of the overall change in productivity of downsizing firms!

5. Final remarks

The results shown in this chapter underscore the importance of acknowledging that the organization of firms is a key input into the production process. This allows to better understand why some firms are much more productive than others, and to rationalize the change in productivity of expanding and downsizing firms.

An implication of the analysis is that failure to reorganize in order to grow—possibly due to institutional impediments or management inadequacy—can result in an inability to exploit available productivity improvements. This can be crucial, especially since we find that reorganization is a first-order source of aggregate productivity gains in the economy.

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