Network to Study Productivity in Canada from a Firm-Level Perspective

Skills, Human Capital and Firm's Productivity: What Can Be Learned from Microdata?

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Introduction

The recent availability of firm-level Canadian micro-data has the potential to contribute to a better understanding of the mechanisms by which firms' investments in human capital can increase their productivity.

In this report, we discuss four research questions related to this theme. These questions could eventually be investigated using Statistics Canada data available from the new Canadian Centre for Data Development and Economic Research (CDER).

In fact, one of the CDER's main objectives is to facilitate access to data sets with firm-level information that was previously hard to access. This is the case for example with the Annual Survey of Manufactures (ASM), the Longitudinal Employment Analysis Program (LEAP), and the Longitudinal Worker File (LWF).

The four research questions addressed are (1) the impact of firm-sponsored training on productivity, (2) possible substitutions between the internal and external labour market in meeting firm-level demand for skills, (3) the measurement of the firm's stock of human capital and the impact of labour force characteristics on productivity, and (4) the type of the matching of employers and employees.

All these research questions are related to identifying and understanding the varied mechanisms which influence firms' productivity levels. Further research on these subjects would certainly allow us to explain some persistent unobserved differences in productivity across firms (Syverson (2011)).

For each of these questions, we review several relevant articles from the recent literature, with a particular focus on the methodologies and data employed, and we speculate on the possible use of Canadian data to study these questions.

This brief overview reveals that there is little Canadian research on these key issues. One might even confidently suggest that Canada is significantly behind a number of other countries in our understanding of these research questions. If the CDER data allowed us to partially catch up in our economic analysis of these questions, this would already be a major achievement.

The impact of firm-sponsored training

The literature on the impact of firm-sponsored training has come a long way in recent years. While most earlier studies use wages as a measure of productivity, many recent studies use objective measures of productivity at the firm level. Some studies even estimate how the surplus generated by training activities is shared between employers and employees.

Still, there are a number of research questions on which any additional evidence would make a great contribution to our knowledge. For example, there is little information on the precise costs of training; this is needed to compute the internal rate of return on this investment, more useful for public policy purposes. There are also few studies allowing us to estimate differentiated returns for different categories of workers (e.g. Dostie and Léger (2011) on differentiated returns by age).

A number of studies also note that benefits from training might only be apparent in the longer term but they have not had the data to assess the dynamic of these returns. There are also few studies on possible complementarities between investments in human capital, in physical capital and in organizational capital, which explains the paucity of conclusive results (Bloom and Van Reenen (2010)). Finally, there is a lack of micro-data on the subjects of training and methods of delivery.

One explanation for the scarcity of studies on the rate of internal return on training is the difficulty of taking into account the opportunity cost of employees who receive training during working hours. To date, the best proposed solution to this problem is that of

Almeida and Carneiro (2009). They use Portugese data from 1995 to 1999 on firms of more than 100 employees. They estimate both production and cost functions at the firm level and determine that the average internal rate of return is 8.6%, one similar to that of investments in physical capital.

With respect to differentiated rates of returns to different types of training, there are a few studies which compare the impact of classroom and on-the-job training (such as, for example, Black and Lynch (2001) and Barrett and O'Connell (2001)). These studies find that the returns to classroom training are greater than from those to on-the-job training, the latter being close to zero.

Dostie (2013) examines this difference in returns using Canadian longitudinal data from the Workplace and Employee Survey (WES). He shows that employees taking part in classroom training are 3.4% more productive and that returns to on-the-job training are only 1.6% and not statistically different from zero. He finds that two factors explain this difference. First, on-the-job training is much more related to employee turnover. Secondly, certain subjects of training that increase productivity the most can only be offered in a classroom setting (for example professional training).

Zwick (2005) distinguishes between a number of ways of delivering training and examines their impact on firm-level productivity. The possible delivery methods are: formal courses offered outside the workplace and hours of work; formal courses given at the workplace; quality circles; self-induced learning; participation in seminars, job rotation, and on-the-job training. He finds that formal courses given outside the workplace and outside regular hours of work have the greatest impact on productivity. Internal courses and quality circles also have a positive but weaker impact. The other forms of training

have no effect, or a even a negative impact in the case of on-the-job training.

The study of long term effects of training has been relatively neglected. With data from the WES, Percival et al. (2012) find that both current and previous period training have positive effects on firms' productivity levels. However, this study presents a number of methodological issues. On the one hand, the authors select only establishments which are present over the 1999-2006 period. On the other hand, they do not take into account endogenous training decisions. Finally, we note that the measure of training expenditures they use does not distinguish classroom training from on-the-job training although the two types of training have very distinct impacts on productivity.

Unfortunately, in the CDER, there is a dearth of information on firms' investments in training. The Survey of Innovation and Business Strategy (SIBS) contains only some basic information on training practices. Nonetheless, this data set has a great deal of information on other outcomes at the firm level (such as innovation performance) which may be linked to training and which could certainly permit us to ascertain whether there are complementarities with other firm-level practices.

Information on training contained in the WES is much more detailed and available at both the worker and firm level and is still underutilized. This is the case for example with subjects of training. Given the longitudinal nature of the WES, it would also be useful to explore in more details the dynamic impacts of training.

Internal and external labour market

Although firms can always improve employees' skills through investments in training, they can also fill their skills needs by looking for outside labour. Indeed, examining the firm's training efforts (its internal market) without considering employee turnover and hiring/firing decisions (its external market) risks drawing an incomplete picture of the firm's strategy for managing human capital.

For example, the success of the federal government's recent plan to establish a firm subsidy for training purposes will depend in part on the substitution possibilities between investments in internal training and the external hiring of those with the necessary skills, as well as the costs and benefits of these two options.

Behaghel et al. (2012)'s study examines in details the substitutability between internal and external labour markets for France. Using a sample of almost 3,000 firms, they analyse firms' responses to increased demand for skill levels following the introduction of new information technologies (IT). They find major complementarities between investments in IT and investments in human capital. In fact, they show that IT investments clearly increase the firm's human capital needs.

However, the firm has a choice in how to fill its needs, either through increasing its training efforts or through finding the required skills externally. They show that, on average, French firms use training to fill their new skill needs, and they show that it is vital to consider the latter possibility to accurately assess the complementarities between the two types of investment.

This result can be contrasted with that obtained by Bauer and Bender (2003) with German data. They find that, in Germany, firms mostly adjust skills levels through external markets. Thus, hiring and lay-offs allow them to meet their new skill requirements after investing in new technologies.

To our knowledge, there are no Canadian studies on the possibilities of substitution between internal and external labour markets. To accurately assess the substitutability between internal and external labour markets, a researcher would need access to detailed data on the stock of human capital of the firm (to which we will return in the next section), on investments in human capital and on employee turnover (hires and separations).

The stock of human capital of the firm

The simplest theoretical framework used to analyse the firm-level determinants of productivity is based on the specification of a production function at the firm level. Let Q be the firm's valued added (or sales), K is its capital stock, and LE a measure of effective units of labour.

We define as a Cobb-Douglas production function the specification such that

$$\ln Q = \ln A + d \ln LE + f \ln K.$$

The parameter A represents the total productivity of factors, and parameters d and f the elasticity of the value added with respect to labour and capital respectively.

Many studies use the number of employees of the firm as a measure of the effective labour force (LE). This is problematic for two main reasons. First, if the level of skills of the labour force is correlated to other investment decisions, it will be impossible to correctly assess the causal impact of these investments on the firm's productivity. It is not clear then that the estimated impacts of IT or organizational capital investments would be robust to a better modelling of the firm's stock of human capital.

Secondly, it is equally impossible to determine the impact on productivity of the skills and human capital of the labour force used by the firm without detailed data on this labour force's characteristics. Only this type of data would allow us to, for example, estimate whether salary differentials between workers (by age, gender

or level of education, for example) correspond to differences in productivity. The comparison of these productivity differentials to wage differentials would allow us to draw conclusions about the types of contracts used between firms and workers or detect possible discrimination (Hellerstein and Neumark (2006)). Finally, only this type of data also allows for an analysis of the impact of the composition of the workforce on the firm's productivity (Hamilton et al. (2003)). For example, is a more heterogeneous firm more productive or innovative?

Therefore, answers to these questions require a linkage of employee data with that of their employer. Ideally, one would like to have information on all the employees in the firm. However, the creation of such data is fraught with challenges. Survey data are usually very rich; nonetheless, they generally provide less information about worker mobility between companies or contain merely a sample of the firm's employees and, thus, allow for only an approximation of the real proportion of workers with certain characteristics. (For example, this is the case with the WES (e.g. Dostie (2011) for an example where he estimates productivity-age differentials.))

Administrative data provide more complete coverage but are less rich in explanatory variables. The matching of employee data with that of the employer may also be very complex. For example, Hellerstein et al. (1999) use the Worker Establishment Characteristics Database (WECD) in which individuals drawn from the 1990 Decennial Census of Population are linked statistically with an establishment present in the Longitudinal Research Database (LRD). Unfortunately, the quality of pairing can be questionable because there are some differences between the average characteristics of the sample used and those of the population.

There are few applications in which researchers observe the characteristics of all a firm's workers rather than only a sample. One example is Ilmakunnas et al (2004) who manage to match two data sources for the the Finnish manufacturing sector. Unsurprisingly, they find that companies with the most educated work forces are, indeed, the most productive.

Another approach consists of using information on workers directly to build an improved measure of the firm's human capital stock. It is certainly possible that differences in the quality of the input used by the firm would be crucial in explaining observed differences in productivity between firms, and taking the education level of the work force into account partially allows us to do this (Fox and Smeets (2011)). However, it is also possible to consider unobserved factors which lead to differences in quality.

The approach of Abowd and Kramarz (2006), amongst other things, allows us to estimate a production function which depends on the distribution of the stock of human capital within the firm. This method was implemented using French administrative data in which all employees are observed. Abowd and Kramarz (2006) show that both observed and unobserved differences between workers have an impact on productivity, as measured by sales per employee. Abowd et al. (2007) also find a positive correlation between employees' skills and value added per worker.

Assortative matching

We know little about the matching process between employers and employees in Canada. Becker (1973) shows that if the productivity of an employee has a positive impact on the employer's productivity and vice versa, an optimal allocation in the economy would be characterized by matching of the most productive workers with the most productive firms. We characterize such a pairing as being positive or we speak about assortative matching. If such complementarities exist, this means that a random allocation of workers to firms would result in a great loss of production, an effect similar to those of frictions in the labour market.

Moen and Yashiv (2013) present an even more satisfactory matching model where a firm's decisions on hiring and lay-offs directly affect its productivity through resulting changes in the quality of its average match. In related work, Bartolucci and Devicienti (2012) propose an applied methodology which directly identifies the type of matching, based on the flows of workers between firms.

In general, there is an important link between the turnover of the labour force within and between firms, the quality of the matches, and productivity. On the one hand, job reallocation is significant. It is estimated that 15% of jobs disappear each year and are replaced by new ones (Cahuc and Zylberberg (2006)). On the other hand, it is also estimated that the reallocation of labour is two to three times greater than job reallocation, depending on the country studied (Cahuc and Zylberberg (2006)).

Certain recent studies have found that the contribution of labour reallocation to productivity growth is is even larger (Baldwin and Gu (2006), and Lentz and Mortensen (2008)). For example, the research of Lentz and Mortensen (2008) on Denmark shows a contribution of more than 70%.

In the international literature using micro-data on workers and firms, Abowd et al. (1999) estimate the correlation between unobserved productivity of employers and employees in France and find a weak negative correlation. For their part, Sorensen and Vejlin (2012) find evidence that the correlation is positive in Denmark.

It is also noteworthy that all this research is based on the use of data linking employers and employees. In addition, certain hypotheses must be satisfied for the type of matching to be identifiable based only on wage data. The basic model is essentially a wage equation that includes both firm- and work-specific unobserved effects.

These effects may be identified in a nonparametric fashion by repeated observations at both levels and by the mobility of workers between companies.The latter constraint explains why this type of research is difficult, indeed impossible, to do with survey data such as that of the WES where workers are not followed when they change employers. The type of match is then inferred on the basis of the correlation between the employer effects and those of employees.

However, Abowd et al. (2004) and Andrews et al. (2008) discover major biases using these methods due to sample limitations. Taking into account these biases, they still find no evidence for assortative matching in Germany, France and the United States.

The difficulties with these attempts to estimate the type of matching using only wage data have given rise to other approaches. For example, Mendes et al. (2010) use Portugese data on firm's productivity. Their approach is based on the estimation of a production function from which they identify the productivity of each enterprise which, in turn, they correlate with measurements of the skills of their labour force. They find evidence of assortative matching in Portugal, especially for the oldest companies.

To our knowledge, lacking data, there is no research on the type of matching characterizing the Canadian labour market, the links between the type of matching and the good functioning of the labour market, and the impacts on the levels and growth of productivity. The French data of Abowd et al. (1999) are administrative in nature and are based on the legally required firm declarations of wages which are then matched to firm-level surveys. In the United States, Abowd et al. (2004) use data for a number of American states based on declarations required for unemployment insurance. Sorensen and Vejlin (2012) have information available on wages for the entire Danish population for the period 1980–2006. Andrews et al. (2008) use German survey data. Mendes et al. (2010) use the same data as Almeida and Carneiro (2010), described earlier.

Similar Canadian data are not currently available but could potentially be developed through matching data at the employee level (e.g. the longitudinal data from the Longitudinal Worker File (LWF)) with another data source at the firm-level (e.g. the Longitudinal Employment Analysis Program (LEAP2)).

Conclusion

In this brief report, we have identified a number of research questions which could potentially be studied in more details or in novel ways with the data available at the CDER. In all cases, more evidence on these research questions could help shape public policy in significant ways. Most of the existing results in these areas have been obtained for other countries. The answers to these questions in Canada remain purely speculative.

Please note that these are merely a selection from amongst a much wider set of additional interesting questions. CDER data could potentially shed some light on an even vaster array of questions such as:

- What is the exact nature of persistent salary differentials between industries (e.g. Abowd et al. (2012))?

- What is the impact of a suboptimal pairing (the level of education required versus the level offered) on firms' productivity (Kampelmann and Rycx (2012))?

- What is the impact of firm decisions to outsource some of their core activities on training levels (Hummels et al. (2012))?

- What is the correlation between worker mobility, knowledge transfer and productivity (Stoyanov and Nabunov (2012))?

- Etc.

There is thus potentially much more work to be done!

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