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Abstract

This paper examines the relationship between firm size and productivity. In contrast to previous studies, this paper offers evidence of the relationship not only from manufacturing firms, but from non-manufacturing firms as well. Furthermore, the aggregate importance of the firm size-productivity relationship is gauged by calculating to what extent shifts in the distribution of employment over firm size categories has affected Canadian aggregate productivity, and whether differences in the employment distribution over firm size categories between Canada and the United States can account for the Canada-U.S. labour productivity gap. The importance of large and small firms to changes in productivity is also examined.

A positive relationship between firm size and both labour productivity and TFP is found in both the manufacturing and non-manufacturing sectors. Given this relationship, the difference in the employment distribution over firm sizes between Canada and the United States can account for half of the Canada-U.S. labour productivity gap in manufacturing.

JEL classification: L11, L25, O47
Bank classification: Productivity

Résumé

Les auteurs étudient la relation entre la taille de l’entreprise et la productivité. À la différence des études antérieures, leur analyse englobe non seulement les entreprises de fabrication mais aussi les firmes non manufacturières. L’importance globale de la relation entre taille et productivité est évaluée en calculant dans quelle mesure les variations de la répartition de l’emploi par taille d’entreprise ont influé la productivité globale des firmes canadiennes et en examinant si les différences dans cette répartition entre le Canada et les États-Unis permettent d’expliquer l’écart de productivité du travail entre eux. L’incidence du poids relatif des grandes et des petites entreprises sur la productivité est aussi analysée.

Les auteurs décèlent une relation positive à la fois dans les secteurs manufacturier et non manufacturier entre, d’une part, la taille de l’entreprise et, d’autre part, la productivité du travail et la productivité totale des facteurs. Compte tenu de cette relation, les différences dans la répartition de l’emploi par taille d’entreprise entre le Canada et les États-Unis parviennent à expliquer la moitié de l’écart de productivité du travail entre les secteurs manufacturiers des deux pays.

Classification JEL : L11, L25, O47
Classification de la Banque : Productivité

1. Introduction

The relationship between firm size and productivity has many facets. On the one hand, there is a positive correlation between a country's level of per capita income and the concentration of employment in large firms.[1] This casual observation is likely the source of the pre-1980s view that economic development went hand in hand with the gradual disappearance of small firms in the economy. In this paradigm, economic prosperity depends on the ability of a country to grow its corporations into global giants. On the other hand, the trend toward increasing concentration of employment in large firms reversed in a number of OECD countries in the 1970s[2] and small firms began to be more commonly viewed as sources of dynamism and productivity growth. This view was substantiated by studies using longitudinal microdata sets on firms and establishments that found that underlying the gradual increase in the number of firms was a large amount of firm turnover, and that the net entry of firms (entry of new and exit of old) contributed significantly to the aggregate productivity growth.[3] In this world, new, generally smaller firms continuously enter into the economy. While many fail in short order, those that survive have productivity growth rates that are usually higher than those of incumbent firms. New entrants are also thought to enter into the economy with the newest technologies, so aggregate productivity growth is also facilitated by the creative destruction associated with firm turnover.

This paper explores the importance of both aspects of the relationship between firm size and productivity discussed above. Using a Canadian administrative dataset covering the 1984-1997 period, firm-level measures of labour productivity and total factor productivity are constructed and used to gauge the magnitude of the firm size-productivity relationship. The importance of this relationship is then assessed through a couple of experiments: by how much was the level of Canadian productivity affected by changes in distribution of employment across firm size categories over the 1984-1997 period, and how much of the

[1] Snodgrass and Biggs (1995) show that more labour is concentrated in large firms in high-income countries than in low and middle income countries.

[2] See Van Ark and Monnikhof (1996).

[3] See Bartelsman and Doms (2000) and OECD (2001) for the stylized facts established in these studies.

Canada-U.S. difference in productivity levels in 1997 can be explained by differences in the distribution of employment across firm size categories.

This paper contributes to the literature in a number of ways. While there are many papers that have examined the heterogeneity of firm-level productivity and firm dynamics, few have focused on the relationship between size and productivity. In this paper, not only is the relationship between size and productivity documented, the importance of that relationship to aggregate productivity and productivity changes is examined. Furthermore, much of the previous Canadian and U.S. research focuses on the experience of manufacturing plants. In this paper, firm-level evidence for all corporations with employees in the Canadian economy is presented.

It is found that there is a significant firm size-productivity relationship in terms of labour productivity and TFP. As expected, the labour productivity relationship is stronger in the manufacturing sector than the non-manufacturing sector. For TFP, a slightly stronger positive relationship is found for non-manufacturing. Although over 1984-1997 employment became less concentrated in small firms in Canada, the magnitude of the size-labour productivity relationship is such that aggregate sales per employee was only slightly affected. Instead, the change in aggregate and manufacturing sales per employee is due to productivity improvements with each firm size category. Finally, the much larger Canada-U.S. differences in the employment distribution across firm size categories can account for approximately 20 per cent of the Canada-U.S. sales per employee gap at the aggregate level and 48 per cent in manufacturing. The rest of paper is organized as follows. Section 2 gives a brief summary of the relevant findings in previous research. The third section outlines the data and the measures of size and productivity used in this paper. The main findings of the paper are presented in Section 4. First, evidence on the cross-sectional relationship between size and productivity is presented. Next, the implications of such a relationship for changes in aggregate productivity levels and productivity differences between Canada and the United States are then examined. Concluding remarks are given in section 5.

2. Related Literature

The relationship between firm size and labour productivity is well documented. Van Ark and Monnikhof (1996) document this relationship for France, Germany, Japan, the United Kingdom and the United States, and evidence for less-developed countries, such as India, the Philippines, Thailand, Korea, Taiwan, Turkey and countries in Africa can be found in Snodgrass and Biggs (1995) and Van Biesebroeck (2005). These papers, which concentrate on manufacturing firms or plants, show that the gap between the largest and smallest firms is large. For example, Van Ark and Monnikhof (1996) show that in 1987, the gross output per employee in U.S. manufacturing plants with 0-9 employees was 62 per cent of that of all manufacturing plants, while the gross output per employee in plants with 500 or more employees was 126 per cent of that of all manufacturing plants. Evidence for Canadian manufacturing suggest a similar or even stronger relationship than in the United States. Baldwin, Jarmin and Tang (2002) show that shipments per employee in plants with 100 or fewer employees is 62 per cent of the industry average, while shipments per employee in plants with more that 500 employees is 165 per cent that of the industry average.

Baldwin, Jarmin and Tang (2002) also make comparisons using value-added per employee. While the differences between large and small establishments are smaller than when shipments per employee are used, the differences are not great, especially in the United States. In Canada, value-added per employee in plants with more than 500 employees is 147 per cent of that of the industry average, while value added per employee in plants with fewer than 100 employees is 67 per cent of that of industry average. In the United States, plants with more than 500 employees have labour productivity levels that are 136 per cent of the average when measured by shipments per worker, and 137 per cent when measured by value added per worker. For firms with fewer than 100 employees, the numbers are 67 per cent and 69 per cent for shipments per worker and value added per worker, respectively. This suggests that in manufacturing, large plants are using intermediate inputs only slightly more intensively than smaller plants.

Evidence for industries outside manufacturing and for TFP is more scarce. The evidence that does exist shows that there is a positive relationship between firm size and TFP. Van Biesebroeck (2005) concludes that the TFP distributions of large and small African manufacturing firms are significantly different, but he does not indicate by how much large firms are more productive. Using data on publicly-traded manufacturing firms, Lee and Tang (2001) find that firms with more than 500 employees, and firms with between 100 and 500 employees are 17 per cent and 15 per cent more productive than firms with less than 100 employees in Canada, respectively. For the United States, Lee and Tang find a similar advantage for firms in the 500+ (18 per cent) and 100-500 (15 per cent) over firms in the less than 100 category. Using the same data, Rao and Tang (2000) show that the TFP advantage for large firms persists even after controlling for other characteristics such as foreign control, export intensity, unionization, and age. There are some other papers, such as Baily et al. (1992), that calculate firm or plant-level TFP, but the focus is not on the relationship of productivity and firm size.

The importance of firm size for aggregate productivity levels and growth has also not been widely studied. Research using longitudinal micro data has tended to focus on decomposing changes in aggregate productivity into parts due to within-firm growth, reallocation across surviving firms and the contributions of entry and exit.[4] To emphasize the role of size, each component of the above decomposition could be further split by firm size.

A paper that does something similar to what was suggested above is Baldwin and Gu (2003). In that paper, a distinction is made between single and multi-plant Canadian manufacturing firms. It is found that the contribution of multi-plant firms greatly exceeds that of single-plant firms in both the within-firm and net entry components, and that the contribution of multi-plant firms to productivity growth is much greater than their share of employment. Based on that evidence, Baldwin and Gu conclude that small single-plant

[4] These studies, that once again mostly use data from manufacturing plants, conclude that while the effect of net entry is significant, the within-firm productivity growth of incumbents accounts for the largest fraction of aggregate labour productivity growth and that fluctuations in aggregate productivity growth are driven largely by incumbents. (See Bartelsman and Doms (2000) and OECD (2001).) In the case of TFP, the role of within-firm TFP growth of incumbents lessens and the role of net entry becomes more important. Since entrants are usually smaller than incumbents, the importance of net entry does suggest that small firms contribute to aggregate productivity growth. However, the decomposition between entrants and incumbents is more related to firm age than firm size.

firms have little impact on labour productivity growth in manufacturing.

3. Data and Measurement Issues

The T2-LEAP is the firm-level data used in this study. The T2-LEAP is the result of the linkage of two sets of administrative files, the Longitudinal Employment Analysis Program (LEAP) and Corporate Tax Statistical Universe (T2). It covers the 1983-1997 period and contains close to 9 million firm-year observations. The LEAP is a record of all firms, incorporated or unincorporated, in Canada that have registered a payroll deduction account with the Canadian Revenue Agency.[5] Thus firms without a payroll, are not included in the LEAP. In addition to firm counts, the LEAP can provide the payroll of each firm from the sum of their T4 slips issued to workers and a measure of the labour input, an average labour unit (ALU). The ALU is derived by dividing the payroll of the firm by the average annual earnings of workers in the firm's detailed industry (3-digit SIC), province and employment size class, where the calculation of average annual earnings is done using the Survey of Employment Payroll and Hours. Kanagarajah (2001) notes that the LEAP's ALU measure of the level of employment falls between those from the Survey of Employment Payroll and Hours and the Labour Force Survey, and that the employment trends from the three sources are similar for the major industry groups. However, the ALU measure underestimates employment of firms that are born and exit during the year because the payroll is for a partial year and the average earnings are for the full year. Also, since the LEAP file begins in 1983, the age of firms that existed in 1983 cannot be determined, but the age of entrants after 1983 can.

The T2 provides sales, profits, and book-value assets from the firm's corporate tax returns. While the LEAP is recorded on a calendar year basis, the year of attribution on the T2 files is the end year of the fiscal period. However, for the T2-LEAP file, Statistics Canada has converted the value of financial variables in the T2 file to calendar year terms. Since the T2 data only includes corporations, the T2-LEAP covers corporations in Canada with

[5] See Kanagarajah (2001) for more details on the LEAP.

a payroll.[6] Figure 1 compares sales from the T2-LEAP and gross output from the Statistics Canada's KLEMS database for the major industries.[7,8] The level and growth pattern of sales and gross output are nearly identical in manufacturing, transportation, warehousing and storage, and mining, oil and gas. For business services, accommodation and food, and arts, entertainment and recreation, the level and pattern of growth of sales is similar to that of gross output, but not as close as for the previous three industries. For agriculture, forestry and fishing, construction, communication and utilities, wholesale trade, retail trade, health care and social services (excluding hospitals), and other services there are substantial differences between the level of sales and gross output. However, in many of these cases this is likely due to the high share of unincorporated businesses or incorporated businesses without employees in these industries. Furthermore, despite the difference in levels, the patterns of growth are similar. The sole industry where the pattern of growth and levels are different is FIRE. FIRE is therefore excluded from the analysis.[9] Consequently, the results in this paper pertain to non-financial corporations in the business sector that have employees.

A firm-level measure of labour productivity is constructed by taking the ratio of real output to ALUs, where real output is sales of the firm deflated by an industry-specfic price index for gross output taken from the KLEMS database. Similar to Lee and Tang (2001) and Rao and Tang (2000), a firm-level measure of TFP is obtained by estimating a production function using ordinary least squares (OLS):

$$\ln Y_{ijt} = \alpha_{0jt} + \alpha_{Kjt} \ln K_{ijt} + \alpha_{Ljt} \ln L_{ijt} + \alpha_{Mjt} \ln M_{ijt} + e_{ijt}, \tag{1}$$

where i indexes firms, j indexes industries, t indexes time, Y is real output as defined above, K is book value of assets deflated by the industry-specific price index for capital in KLEMS, L is ALUs, and M is a nominal measure of intermediate inputs (sales - wage bill - gross

[6]See Baldwin, Dupuy and Penner (1992) for more details on the construction of T2-LEAP.

[7]See Baldwin and Harchaoui (2002) for more details on the KLEMS data. The T2-LEAP uses the SIC industrial classification system, so the older SIC-based KLEMS data is used.

[8]It must be noted that while sales does correspond to the concept of gross output for many industries, there are some industries where it does not. For example, in retail and wholesale trade, gross margins are used to form gross output in the industry accounts.

[9]Education services (excluding universities) cannot be compared because data from KLEMS is secured. As a result, education services is also excluded in this paper.

profits) deflated by the industry-specific price index for intermediate inputs in KLEMS. The residuals from a series of these regressions for each year and industry yields the percentage deviation of each firm's level of TFP from their industry and year averages.

Other measures of capital, such as replacement values or ones derived from the perpetual inventory method (investment data) would be preferable to the book value of assets because book values are at historical cost and do not reflect price and quality factors. Adjusting book values by a deflator, like the a price of capital from KLEMS, does adjust for changes in the asset mix in terms of price and efficiency over time at the industry level. Baldwin and Gu (2004a) use the T2LEAP to create an aggregate TFP measure for retail trade and find the long-run TFP growth rate calculated from the T2-LEAP is similar to that published by Statistics Canada. Furthermore, Becker et al. (2004) find a high correlation, 0.99, between TFP measures derived from adjusted book values and the perpetual inventory method for U.S. manufacturing plants. However, the use of industry deflators will still not adjust for within industry differences in asset mix and price between firms, but without firm-specific deflators this problem can not be avoided.[10]

There are also a variety of methodologies that can be used to retrieve estimates of TFP using (1). The most straightforward is to replace the factor elasticities by factor shares. While this approach allows one to avoid the endogeneity problem associated with regression-based techniques, perfect adjustment of all factors is implicitly assumed and the assumptions of constant returns to scale and perfect competition may be necessary as well.[11] These is also the question of what factor shares to use. Baldwin and Gu (2004a) and van Biesebroeck (2005) use industry shares, while Caves et al (1982) use the average of industry and individual firm's shares.

The most straightforward regression-based approach is OLS, but estimating (1) with OLS would ignore the fact that TFP and the inputs may be contemporaneously correlated.

[10] See Abbott (1992) for a discussion about the mismeasurment that is introduced by using industry deflators for firm-level variables.

[11] When data on the user cost of capital is not available, constant returns to scale can be assumed and capital's share of total cost backed out by one minus the shares of other inputs. If total cost is not available, perfect competition in the output markets can be imposed and total cost replaced with total revenue.

It might be argued that to some extent the inputs are pre-determined because of high adjustment costs or contractual obligations, but this argument is less convincing for low frequency data.

Instrumental variables (IV) estimation could be used to control for endogeneity, but it is not simple to overcome the weak instrument problem.[12] Moreover, lagged inputs, which are relatively more highly correlated to today's inputs than some other possible instruments, are endogenous if firm-level TFP is serially correlated. Olley and Pakes (1996) address the endogeneity problem by taking an inverted investment function (assuming monotonicity, investment as a function of TFP and capital can be solved for TFP) and using it as a predictor of TFP in (1). This however assumes that investment adjusts to the complete TFP shock, which may not be the case because of time to build or if investment responds only to the permanent component of TFP.[13] Levinsohn and Petrin (2000) get around the possible weak relationship between TFP and investment by using intermediate inputs in place of investment, but this leads to the need to instrument intermediate inputs and possibly capital later in the procedure.

This paper presents TFP estimates using OLS to estimate (1).[14] Estimates using lagged inputs as instruments were also computed, but the results were similar to the ones presented. More advanced methodologies were not used because of data limitations: the lack of investment data and the need to obtain a measure of nominal intermediate inputs indirectly. Since nominal intermediate inputs are derived from sales minus gross profits and wages, it is a volatile measure and it is likely not to be as highly correlated with TFP as the one used by Levinsohn and Petrin (2000).

Regardless of the econometric techniques used, obtaining TFP by estimating (1) does

[12] For example, Eslava et al. (2005) uses output of downstream producers, regional government expenditures and energy and material prices to instrument, but only achieves partial R^2s of 0.128 and 0.139 for capital and labour, respectively. For general discussion of the weak instrument problem, see Staiger and Stock (1997).

[13] Furthermore, observations of zero investment by some firms makes the assumption of monotonicity problematic.

[14] Haltiwanger (2004) shows that OLS estimates of TFP can be highly correlated to ones where factor shares are used.

not get around the problem associated with choosing which factor shares to use in the previous approach. Instead of choosing between the continuum of possibilities between firm-specific and industry factor shares, the decision is now whether to let each firm have the same weight in the regression, or put more weight on firms with a higher share of output. The first approach would give estimates of the "technology" parameters for the average firm. Since almost all firms are small, the estimates would undoubtedly reflect the technology used by smaller firms. By giving more weight to firms with higher output, the second approach gives parameter estimates that reflects the technology effectively used by the industry to produce its output. Since a large fraction of industry output is produced by larger firms, the weighted regression would give estimated parameters more applicable to larger firms.

Larger firms use relatively more capital, so the weighted parameter estimate on capital will be larger than the unweighted estimate, while the weighted parameter estimate on labour would be smaller than the unweighted estimate. If the weighted parameter estimates were applied to all firms then very high levels of TFP might be estimated for small firms that use little capital and mostly labour; weighted estimates give large weight to the input small firms use the least and little weight to the input they use the most. An implication of the above is that when the weighted parameter estimates are used, the TFP gap between large and small firms will likely be small. Conversely, if unweighted parameter estimates were applied to all firms, the input that large firms use relatively more (less) would be given less (more) weight than in the case of weighted parameter estimates. The result would be a larger TFP gap between large and small firms.

Overall, it is unclear which approach is the most appropriate given the data restrictions. That is why this paper presents both weighted and unweighted measures. If industry TFP performance is the focus, as it is in Lee and Tang (2001) and Rao and Tang (2000), then weighted parameter estimates that reflect an industry production function are more appropriate. On the other hand, if the focus is on firm-level differences, then one must take into account that all the differences between firms which are size-related, but are not incorporated into the process to estimate TFP, would ultimately affect the magnitude of the firm size-TFP relationship. Ideally, parameter estimates would be estimated at the firm level and would incorporate firm-specific prices using the dual side of the firm's profit maximization problem.

4. Results

4.1 The Magnitude of the Firm Size and Productivity Relationship

4.1.1 Labour Productivity

A strong relationship between firm size and productivity can be observed in the T2-LEAP data. Table 1 shows the relative sales per employee for each firm size class. Although the strength of the relationship does fluctuate over time, the overall pattern is clear; small firms are less productive than larger ones. Relative to the firms with 0-100 employees, firms with more than 500 employees are roughly 30 percent more productive and firms with between 100 and 500 employees are roughly 20 per cent more productive. Over time, large firms also appear to become relative more productive than small firms. This is due to the fact that productivity in large firms has risen faster than productivity in small firms, and not to shifts in industry structure.[15] Furthermore, the increase in steepness of the productivity-employment size relationship is not the result of larger firms simply becoming larger. As shown later, the average number of employees per firm has decreased in large firms.

Some of the difference between large and small firms could be due to a concentration of small firms in less productive industries, so Table 2 presents the relative labour productivity numbers by industry groups. There exists a clear relationship between size and productivity in most of the industries in the goods sector. Only in agriculture do small firms clearly have higher labour productivity than large firms.This may be due to the fact that there are relatively few firms with more than 100 employees in agriculture. The positive size-productivity relationship is particularly strong in manufacturing where firms with more than 100 employees are 80.3 per cent more productive than firms with less than 100 employees. The

[15] See the appendix for more details.

relationship is weaker in non-manufacturing and in the services industry. Although large firms are more productive than small firms in some service industries, such as wholesale trade, accommodation and food, and arts and recreation, this is offset by a negative relationship in retail trade and other services. The finding of a negative relationship between size and productivity in retail trade is surprising given the widely-held impression that big-box retailers are more productive than smaller retailers. One possible explanation for this discrepancy is that the firm size-productivity relationship is due mostly to an establishment-size productivity relationship and that there are many large retailing firms with mainly small establishments.

Industry labour productivity is usually highly correlated with industry capital intensity, but Table 2 shows that capital intensity also appears to be associated with the magnitude of the relationship between size and productivity. According to the KLEMS data, the industries with the lowest capital to labour ratios are: business services, other services, construction, accommodation and food and retail trade. These are also some of the industries where the relationship between size and productivity is the weakest. A weaker firm size-labour productivity relationship in industries that are less capital intensive is consistent with the notion that the correlation between firm size and labour productivity works through capital intensity. The systematically lower capital intensity of small firms in turn points to the likelihood that small firms face greater capital constraints than larger firms.

To see how much the industry variation in the size of firms and in the strength of the firm size-productivity relationship affects the aggregate numbers, each firm's deviation from the industry-year average sales per employee is calculated.[16] These percentage deviations are then regressed on a indicator variable for firms with more than 100 employees and a constant. The results are shown in Table 3. Large firms are 10.5 per cent more productive than small firms controlling for industry-year differences in productivity and size. This is compared to the raw gap of 27.1 per cent presented in Table 2. In other words, industry

[16] Specifically, a regression (using employment weights) for each year and industry of firm log sales per employee on a constant is performed. The predicted error term for each firm gives their level of productivity as a deviation from the industry-year average.

variation in average productivity and average firm size accounts for roughly 60 per cent of the raw size-labour productivity relationship.

Despite the fact that there is a strong size-productivity relationship at the aggregate level even after controlling for industry differences, this relationship is only true on average. There are many small firms that are more productive than large firms in the same industry. Figure 2 plots the distributions of log of sales per employee for large and small firms. The productivity distribution for large firms dominates the one for small firms, but there is much heterogeneity. This underlines the fact that size is only one of the factors that accounts for productivity differences across firms.

The T2-LEAP is not rich in variables that represent these other factors, but it does contain an imperfect measure of firm age, the year the firm exits and corporation type. Bartlesman and Doms (2000) indicate that firm age plays a role in accounting for some of the firm-level heterogeneity in productivity. Griliches and Regev (1995) find that in the years leading up to exit, firm employment and productivity drop significantly. Rao and Tang (2000) find evidence that suggests foreign-controlled manufacturing firms are more productive than ones under Canadian control. Perhaps foreign-controlled and publicly-traded firms have greater access to capital markets,[17] or perhaps Canadian controlled private corporations have not adopted the latest management practices or technologies.[18] The degree of foreign control is not available from the T2-LEAP, but the corporate tax data does indicate whether a firm is a Canadian controlled private corporation, (CCPC), an other private corporation or a public corporation. CCPC is a definition for tax purposes and to qualify as a CCPC a firm cannot be indirectly controlled by foreigners or public corporations. So while CCPCs are not foreign controlled, the other corporation types are a mix of foreign and Canadian-controlled firms.

The remaining row in Table 3 shows how the relationship between size and productivity

[17] Globerman, Ries and Vertinsky (1994) find that the labor productivity level advantage of foreign-controlled establishments in manufacturing is due to differences in capital intensity and firm size.

[18] Rao and Tang (2000) find that Canadian controlled manufacturing firms have lower MFP than foreign-controlled firms even after controlling for differences in labour quality, firm age, unionisation, export oreintation, firm size and industry structure.

is impacted when these other variables are introduced into the productivity regression.[19] Overall, the magnitude of the relationship between size and productivity drops by another half, but is still significant. Within manufacturing, allowing for the industry composition effect reduces the advantage for larger firms from 80 to 39 per cent, and including firm age and organizational type further reduces it to 24 per cent. For non-manufacturing, the relationship between size and productivity becomes statistically insignificant after controlling for other effects.

4.1.2 Total Factor Productivity

Table 4 presents the TFP gap between firms with more than 100 employees and less than 100 employees after taking into account differences in industrial structure. Firm-level TFP is calculated as the estimated residual in equation (1). Since the constant term in (1) is allowed to vary by year and detailed industry, the resulting measures of firm-level TFP are percentage deviations from industry-year averages. Table 4 shows the difference in average TFP between the two firm size categories. The first column shows the TFP-size relationship when each firm is given equal weight in estimating the parameters of the production function. For the entire 1984-1997 period, a gap of roughly 8.4 per cent between the TFP of firms with more than 100 employees and firms with less than 100 employees is found. There also appears to be a slight decline in the difference over time. During the first five years of the period, the average difference is 10.2 per cent, while over the last five years the difference is 5.1 per cent.

The second column in Table 4 presents the TFP gap when the production function parameters are estimated weighting each firm by the level of its output. As expected, the TFP gap is smaller than when weighted parameter estimates are used.[20] For the entire

[19] The regressions in Table 3 are not meant to capture a causal relationship, rather the intent is to see whether there is a relationship between size and productivity after controlling for other variables related to both size and productivity.

[20] Alternatively, a TFP gap that allows the technology parameters (ie. the elasticities of output with respect to the inputs) to differ between large and small firms can also be calculated. In that case, it is found that a TFP gap between large and small firms is zero in every year. Apparently, allowing firms of different sizes to operate using different production technology eliminates the TFP gap between them. This third

period, it is found that firms with more than 100 employees are 5 per cent more productive than firms with less than 100 employees. Again, a downward trend in relative TFP is observed. The average difference in the first five years is 5.8 per cent, while the average difference in the last five years is 3.4 percent.

Table 5 presents the TFP gaps between large and small firms by major sector. Unlike labour productivity differences, which can be driven by capital intensity differences, there is no prior expectation of how TFP differences between large and small firms should vary across sectors. Unlike with labour productivity, the manufacturing industry does not exhibit greater differences between large and small firms than non-manufacturing industries. In fact, the differences in the non-manufacturing industries are larger than in manufacturing. Similarly, the differences in the services sector are larger than the differences in the goods industries. As in the case of the aggregate numbers, the differences based on unweighted estimates are larger than the ones based on weighted estimates.

The estimates that are most comparable to estimates reported in earlier studies are the unweighted estimates for manufacturing. Lee and Tang (2001) report a 16.6 per cent difference between firms with more than 500 employees and firms with less than 100 employees, and a 15.6 per cent difference between firms with 100-500 employes and firms with less than 100 employees for publicly-traded manufacturing firms. Rao and Tang (2000) give estimates for the differences between firms with more than 500 employees and firms with less than 100 employees that range from 14.1 to 17.1 per cent, and give estimates for the difference between firms with between 100 and 500 employees and firms with less than 100 employees that range from 10.1 to 12.2 per cent. This paper reports a difference around 7 per cent between large (100+) and small (<100) firms in the manufacturing industry.

This paper covers all corporations, whereas the previous studies use only publicly traded

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approach is not necessarily the correct method because the fact that firms use different mixes of capital and labour need not reflect different production technologies. It is possible that firms use different input mixes because the relative prices they face for these inputs are different. There is evidence to suggest that small firms face higher costs of capital than larger firms. For example, Leung et al. (2008) show that even after controlling for firm and loan characteristics, small firms pay a higher rate of interest on loans than larger firms in both Canada and the United States. Furthermore, Witmer and Zorn (2007) find that the cost of equity is also negatively related to firm size.

firms, so it might be expected that a larger gap would be found in this paper. This is because the small firms in the T2-LEAP data should be on average smaller than the small firms in a collection of publicly-traded companies. Furthermore, Rao and Tang (2000) control for more explanatory variables such as labour quality, firm age, foreign control, export propensity and unionization. The time periods covered in the studies are shorter than in this paper. Both Rao and Tang's (2000) and Lee and Tang's (2001) data sets cover the 1985-1995 period. The extra years of data used in this study, 1984, 1996 and 1997, may partly account for our findings relative to theirs because in two of the three years differences in TFP between large and small firms are below average. Another possible explanation is that while publicly-traded firms in the less-than-100-employees category are larger than small firms in the T2-LEAP, publicly traded firms in the 100-plus category are larger than large firms in the T2-LEAP. While difference in the average size between publicly traded and all firms in the less-than-100-employees category is bounded, the difference in average size between publicly traded and all firms in the 100-plus category is unbounded and potentially larger than the former.

4.2 Aggregate Implications of the Size-Productivity Relationship

4.2.1 Canadian Productivity Levels Over Time

Given the size-productivity relationship, a change in the relative importance of large and small firms can have a long-term impact on aggregate labour productivity. Table 6 shows the evolution of the firm size distribution between 1984 and 1997. The percentage distribution of businesses across firm sizes has changed little over time.[21] However, firm counts themselves do not reveal changes in the average size of the firms within each category. Table 7 shows that the average size of firms in Canada has fallen from 17.5 employees in 1984 to 15.3 employees in 1997, a 12.6 per cent decline. It also shows that the decline is due mostly to decreases in the average size of firms with more than 500 employees. In this category, the average size fell from 2683 in 1984 to 2261 in 1997, a 15.7 per cent drop.[22] This decrease in

[21] This finding is consitent with Kanagarajah (2001), who used the 1983-2001 LEAP file that includes unincorporated firms as well as corporations.

[22] Again, these findings are not sensitive to the inclusion of unincorporated firms. See Kanagarajah (2001)

the average size of large firms has reduced the fraction of employees that work in this firm size category from 42.3 per cent in 1984 to 37.2 per cent in 1997 (Table 8). The reason for the decline in average size of Canadian firms and in particular Canada's largest firms is unclear. Shift-share analysis shows that industrial restructuring has little to do with the decline, and that most of the decline is due to decreases in average size within industries, most notably mining, oil and gas, manufacturing, transportation and storage, and communication and utilities.

The impact on labour productivity of the shift away from employment in large firms can be assessed by a similar shift-share analysis. The change in aggregate labour productivity can be decomposed as follows.

$$\begin{aligned} LP_{97} - LP_{85} &= \sum_{k=1} \left(LP_{k97} - LP_{k84}\right) w_{k84} + \sum_{k=1} \left(w_{k97} - w_{k84}\right) LP_{k84} \\ &\quad + \sum_{k=1} \left(w_{k97} - w_{k84}\right)\left(LP_{k97} - LP_{k84}\right), \end{aligned} \tag{2}$$

where LP_t is aggregate sales per employee in year t, LP_{kt} is labour productivity for firm employment size category k at time t, and w_{kt} is the fraction of total employees working in employment size category k at time t. Equation (2) decomposes the change in aggregate labour productivity between 1997 and 1984 into within-firm-size-category changes in labour productivity, shifts in the distribution of employees across firm sizes and the interaction between the two aforementioned impacts.

Aggregate sales per employee advanced \$30,700 between 1984 and 1997.[23] Table 9 shows that shifts in the distribution of employees across firm sizes caused aggregate sales per employee to fall \$1700, accounting for -5.6 per cent of the aggregate increase. If the employment distribution had not shifted toward smaller firms, aggregate sales per employee would have increased by \$33,000, accounting for over 100 per cent of the aggregate increase. Thus while the decline in firm size exerts a negative drag on aggregate sales per employee, the magni-

for more details.

[23] The correlation between the industry labour productivity calculated using the T2-LEAP and KLEMS is examined in the appendix. Despite the large differences in the definitions used in putting together the measures from the two data sets, the correlation between them is strong at 0.77. See the appendix for more details.

tude of the effect is small. The magnitude of the effect could have been more pronounced in industries where the decline in firm size was concentrated (mining, oil and gas, and manufacturing), but even here the effect is relatively small. The effect of the decline in firm size is -12.8 per cent in mining, oil and gas, and -5.3 per cent in manufacturing.

The contribution of within size category productivity changes can be examined by firm size. For all industries, large firms are found to have contributed disproportionately to the change in productivity. Firms with more than 500 employees accounted for 42.3 per cent employment, but 51.5 per cent of the within size category change in productivity. The contribution of large firms is even more striking in manufacturing, where firms with more than 500 employees accounted for 51.9 per cent of employment but 72.1 per cent of the change in productivity. This is consistent with Baldwin and Gu's (2003) finding that the contribution of multi-plant manufacturing firms to manufacturing productivity growth exceeds their share of employment. In contrast, small firms contribute disproportionately to the total within size category productivity change in the non-manufacturing sector. However, these results need to be interpreted with caution. The LEAP data handles the mergers and acquistion of companies by retroactively combining the records of the companies that merged. For example, two small companies that merged in the last year of the data set, 1997, would be combined into a single company for the entire 1984-1997 time period. Therefore, the contribution of small firms to productivity changes is likely underestimated.

4.2.2 Canada-U.S. Difference in Productivity Levels

The Canada-U.S. differences in the employment shares across firm sizes are larger than the changes over time that occurred within Canada. Table 10 shows that there was a 14 percentage points difference between the employment shares of U.S. and Canadian firms with more than 500 employees in 1997.[24] It is mainly differences in the smaller size categories

[24] The U.S. data are from a custom tabulation from the Statistics of U.S. Businesses (SUSB). These data usually contain both unincorporated and incorporated firms. To match the T2-LEAP, a custom tabulation was requested to remove unincorporated firms. The SUSB data also differs from the T2-LEAP in that certain industries, such as crop and animal farms, are excluded. In this case, the exclusion restrictions were also applied to the T2-LEAP data to allow a comparison. This is why the data in Table 11-13 differs slightly from the numbers already presented in this paper.

that balance this gap in the 500+ category, not a difference in the 100-500 employee class. Canada has 8.1, 4.6 and 1.7 percentage points more employment than the United States in the less than 20, 20-100 and 100-500 size categories, respectively.

With the exception of the mining, oil and gas industry, the finding that the United States has a higher fraction of employment in firms with more than 500 employees compared to Canada also holds at the industry level. The difference is greater than 10 percentage points in agriculture, manufacturing, transportation, wholesale trade, retail trade and other services, and 5 percentage points in construction.

Before decomposing the Canada-U.S. difference in sales per employee, Canadian real sales per employee must be converted to U.S. dollars. This is done by taking industry PPPs for gross output from Rao, Tang and Wang (2004). Rao, Tang and Wang do not report a PPP for gross output for the entire business sector, but the application of the industry PPPs leads to an effective PPP of 1.18 for all industries.

Overall, Canada's level of sales per employee is 82 per cent of that of the United States in 1997 (Table 11). This is nearly identical to the 83 per cent for value-added labour productivity obtained by Rao, Tang, and Wang (2004).[25] Unlike Rao, Tang and Wang (2004), it is possible to see whether there are differences within each firm size category. It is found that almost all of the difference is concentrated in the 0-20 and 500+ employment categories. Canada's level of sales per employee is 77.4 and 79.6 per cent of that of the United States in the 0-20 and 500+ categories, respectively. In the other categories, Canadian firms are more or as productive as firms in the United States. Relative to the United States, Canada's levels of sales per employee in the 20-100 and 100-500 categories are 96.3 per cent and 106.4 per cent, respectively. Interestingly, these gaps in productivity correspond to the difference

There are also other differences between the T2-LEAP data and the data from the SUSB. The most important one is the concept of employment used.

[25] The smaller gap could be due to the use of gross output based labour productivity in this paper, compared to value-added labour productivity in Rao, Tang and Wang (2004). This would imply Canada uses intermediate inputs more intensively. The difference could also be due to the omission of the unicorporated sector. Baldwin and Chowhan (2002) show that the unincorporated sector in Canada performed poorly relative to the United States unincorporated sector in terms of labour productivity in the 1988-2000 period. Also, Rao, Tang and Wang (2004) use data based on NAICS, while the industrial classification system used in this paper is SIC.

in average employment per firm by size category. Table 12 shows that in the size categories where Canada's productivity lags that of the United States, it also has on average smaller firms. In the less than 20 category, Canadian firms are roughly 12 per cent smaller than U.S. firms, and in the 500+ category, Canadian firms are one-half the size of U.S.firms. On the other hand, in categories where Canada leads the United States in productivity, Canadian firms are roughly the same size as U.S. firms. Together, Table 11 and 12 indicate that it is in the 500+ category where the Canada-U.S. gap in productivity lies, and it is also where the difference in average firm size is the greatest. Canada lacks the extremely large firms in the 500+ category that increases the U.S. average firm size in this category by over 2000 workers per firm.

Table 11 also shows that Canada lags the United States in sales per employee in a number of industries including: mining, oil and gas (81.2 percent of that in the United States), manufacturing (84.8 per cent), transportation, communication and utilities (70.5 per cent), wholesale trade (49.8 per cent), and other services (86.0 per cent). Canada leads the United States in agricultural services, forestry and fishing (142.9 per cent of that in the United States), construction (104.4 per cent) and retail trade (103.4 per cent). With the exception of retail trade, the country that is found to have higher level of sales/employee in this paper is also found to have a higher level of valued-added labour productivity in Rao, Tang and Wang (2004).[26]

The same decomposition to the one in the previous section can be used to ascertain the contribution of the difference in the employment distribution across firm size categories to the Canada-U.S. productivity level gaps in 1997. However, unlike the decomposition across time, there is no natural country to treat as the "base year." Therefore, the decomposition is done

[26]For a number of individual industries, the relative levels of sales/ermployee presented in this paper are similar to the relative labour productivity levels found by Rao, Wang, and Tang (2004). For example, sales/employee in Canadian manufacturing is found to be 84 per cent of that of U.S. manufacturing. This is identical to the 84 per cent calculated by Rao, Wang and Tang (2004). Other industries where our numbers are similar to those in Rao, Wang and Tang (2004) include: other services (.86 compared to .79 in RWT), and construction (1.04 compared to 1.15 RWT). Industries where the differences are large include: wholesale trade (.50 compared to .73 in RWT), retail trade (1.03 compared to .85 in RWT), and mining, oil and gas (.81 compared to .99 in RWT). Agricultural services excludes farms, so it cannot be compared to agriculture in Rao, Tang and Wang (2004).

both ways. First, Canada is used as the base country. The U.S.-Canada productivity gaps are decomposed into three elements: (1) the part accounted for by differences in productivity levels across size categories given the Canadian employment distribution across firm size categories, (2) the part accounted for by differences in the employment distributions across size categories given the Canadian productivity levels for each category, (3) and the cross-product term. The top portion of Table 13 presents the results of this decomposition. It is found that differences in the distribution account for 14 per cent of the U.S.-Canada productivity gap, and differences in productivity within each size category accounts for 76 per cent. The cross-product term, which is generally not substantial, is also large at 10 per cent. The size of this cross-product term is large in this case because of the substantial gap in the employment shares of the 500+ category and the large productivity gap in the 500+ category.

This large cross-product term also causes the second decomposition to differ substantially from the first decomposition. In the second decomposition, the United States is treated as base country and it is U.S. productivity levels and employment distribution that are "held constant" when the employment distribution and productivity levels are allowed to change. The results of this second decomposition are presented in the bottom half of Table 13. Roughly 24 per cent of the Canada-U.S. productivity gap is accounted for by differences in the employment distribution across firm sizes, and 85 per cent is accounted for by differences in productivity levels within the size categories. The cross-product term accounts for a negative 9 per cent.

Both decompositions suggest the difference in the employment distributions across firm size categories between the two countries is a significant factor in accounting for the difference in productivity levels. The average of the two decompositions suggests 19 per cent of the productivity gap between Canada and the United States can be accounted for differences in the employment distributions. This is likely an underestimate of the actual importance of firm size because the major difference in productivity levels within firm size categories is in the 500+ class. This productivity difference between the largest firms itself is likely caused partly by the fact that the United States has larger firms than Canada in this category, a factor that the decomposition cannot pick up.[27]

Differences in productivity within employment size categories account for the majority of most industry-level productivity gaps between Canada and the United States. An important industry where the factors are more balanced is manufacturing. In manufacturing, within-size category productivity differences account for 45 to 52 per cent of the productivity gap between Canada and the United States, while differences in the employment distribution account of 48 to 54 per cent. The larger proportion accounted for by differences in employment distribution is due to the fact that firms with more than 500 employees in manufacturing are more than twice as productive than firms in the 0-20 employee category. For all industries the productivity differential between the 500+ and the 0-20 category is roughly 30 per cent, smaller than the productivity differentials between the 500+ and the 100-500 category in manufacturing of 60 per cent in Canada and 80 per cent in the United States. This last point underlines the importance of having large firms in manufacturing.

Another industry of note is retail trade. As mentioned above, it is the one industry where there is a discrepancy between the relative productivity findings in this paper and that of Rao, Tang and Wang (2004). Looking within the employment size categories, it is found that this paper's finding of a more productive retail trade industry in Canada is driven by a productivity advantage Canada holds in the 20-100 employee category. In this category, Canadian firms are 36 per cent more productive than U.S. firms, but in all other size categories the productivity of Canadian firms trail that of U.S. firms. Whether this productivity advantage is genuine or is due to measurement issues pertaining to retail trade needs to be further investigated. For example, Baldwin and Gu (2004a) point out that the preferable measure for output in retail trade is gross margins - sales minus cost of goods purchased for resale - and not sales.

[27] More detailed size categories at the top end would not necessarily allocate more of the Canada-U.S. productivity difference to differences in employment distributions. This is because it is not only the case that Canada has fewer large firms in the highest categories, there could also be categories in which Canada has no firms. In this case, the decomposition would break down as there would be no Canadian reference point.

The decomposition of the U.S.-Canada difference in sales/employee for retail trade also stands out because of the large contribution from the difference in employment distributions and from the cross-product term. However, this is less of a puzzle because the absolute size of the gap in retail trade productivity levels between Canadian and U.S. is small; it is by far the smallest among all industries.

5. Conclusion

This paper examines the relationship between firm size and productivity. In contrast to previous studies, this paper offers evidence of the relationship not only from the manufacturing sector, but from non-manufacturing firms as well. Furthermore, the aggregate importance of the firm size-productivity relationship is gauged by calculating to what extent shifts in the distribution of employment over firm size categories has affected Canadian aggregate productivity, and whether differences in the employment distribution over firm size categories between Canada and the United States can account for the Canada-U.S. labour productivity gap.

Evidence of a relationship between firm size and labour productivity (as measured by sales per employee) is found at the aggregate level and in both manufacturing and non-manufacturing. The stronger relationship found in manufacturing is hypothesized to be the result of greater capital intensity in that sector. Next, evidence of a relationship between firm size and TFP is presented. The finding that the relationship is slightly stronger in non-manufacturing than in manufacturing confirms that TFP is not driving the stronger size-labour productivity relationship in manufacturing. Despite the strong relationship between firm size and labour productivity, the small changes in the distribution of employment across firm size categories in Canada over time have had only a minimal impact on aggregate labour productivity. Instead, within firm size category productivity growth accounts for much of the change in aggregate labour productivity. In contrast, the more substantial differences in the employment distributions between Canada and the United States accounts for 19 per cent of the aggregate labour productivity gap and 51 per cent of the labour productivity gap in manufacturing. The latter finding is driven by the large productivity differential between large and small firms in manufacturing in both countries.

There are a number of findings in the paper that need further investigation. For example, the negative size-productivity relationship in retail trade. In these cases, either alternative measures of output are needed, or plant and firm-level data need to be compared. Therefore, these issues are left to future research.

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Appendix

Productivity in KLEMS and T2-LEAP

T2-LEAP contains information for most firms operating within Canada. Theoretically, only unincorporated firms (restriction of the T2 file) and nonemployers (restriction of LEAP) are omitted. So despite the fact T2-LEAP is not used in putting together the KLEMS data (which forms the basis of Statistics Canada official labour and multifactor productivity numbers), the industry productivity numbers from T2-LEAP and from KLEMS should be correlated. The correlation should not be perfect because the T2-LEAP excludes the unincorporated self-employment sector, which Baldwin and Chowhan (2003) show has a significant impact on the business sector labour productivity (value-added output) over the 1987-1998 period. Also, the definition of output, labour and capital differs between the data sets. Gross output is sales in the T2-LEAP. For some industries, sales is used as a measure of output in KLEMS, but in others, such as FIRE, retail trade and wholesale trade, a margin concept is used. For example, in retail trade, output is sales less the cost of goods purchased for resale. While capital in T2-LEAP is book value of assets, KLEMS' measure of capital is based on a perpetual inventory method and is quality adjusted to reflect different rates of service per dollar of capital for different types of capital. In addition, while labour in T2-LEAP is similar to job counts (employment in the Survey of Employment Payroll and Hours), KLEMS' measure of labour is hours worked. Together, these differences between KLEMS and T2-LEAP should will drive a significant wedge between the productivity estimates. However, it would be surprising if the productivity estimates from the two sources are uncorrelated. The industry annual average labour productivity growth rates for 1984-1997 from the T2-LEAP and KLEMS are positive correlated at 0.77. Furthermore, the rates from the T2-LEAP do not appear to be systematically underpredicting over overpredicting the labour productivity numbers from the KLEMS.

Statistics of U.S. Business and the T2-LEAP

Data for the firm counts, employment and sales comes from the Statistics of U.S. Small Business (SUSB) and Statistics Canada's T2-LEAP. In both countries, firms are enterprises that can own or control more than one establishment, firm counts are obtained from business registers, employment counts are derived from payroll data, and there is no distinction made between part and full-time employees. In addition, only firm with paid employees are included. Self-employed individuals who do not have employees working for them are not included. The U.S. omits crop and animal production, rail transportation, postal service, pension, health and vacation funds, trusts, estates, agency accounts, private households, and public administration. Industry codes in the T2-LEAP allow the removal of most of the these data from the Canadian data. The T2-LEAP only contain corporations while the SUSB is for all employer businesses, but a custom tabulation from the SUSB was obtained to remove the unincorporated firms in the U.S. data.

There are some methodological differences in the way the employment counts are obtained. In the U.S., payroll data in pay period including March 12 is used to determine employment counts. In Canada, the annual earnings on all T4s (issued by the firm to each employee detailing annual earnings of each employee of the firm for tax purposes) of the firm are summed to obtain the firm's payroll. The payroll is then divided by the average annual earnings of a typical worker (from the Survey of Employment Payroll and Hours (SEPH) - an establishment survey generating numbers similar to that of the Current Employment Statistics in the United States) in the firm's industry, province and employment size class. The resulting average labour unit is conceptually identical to the employment measure in SEPH.

In the U.S. data, there are instances where a firm has zero employees. In the United States, firms might have an annual payroll and thus be included in the counts, but no employees around March 12. These firms include those that exited before that period or entered after that period. These firms are omitted in the calculation of sales per employee. This implicitly assumes that this subset of entrants and exiters have the same average labour productivity as incumbents in the size class they enter into or exit from. The sales of these firms is less than one per cent of the total, and should not significantly affect the conclusions presented in the paper.

Table 1. Relative Sales Per Employee by Employment Size of Firm

	0-20	20-100	100-500	500+
1984	1.000	1.066	1.190	1.335
1985	1.000	1.068	1.162	1.281
1986	1.000	1.062	1.192	1.316
1987	1.000	1.039	1.158	1.210
1988	1.000	1.012	1.144	1.186
1989	1.000	1.008	1.165	1.276
1990	1.000	1.003	1.151	1.309
1991	1.000	1.027	1.206	1.303
1992	1.000	1.075	1.233	1.379
1993	1.000	1.114	1.287	1.491
1994	1.000	0.963	1.179	1.370
1995	1.000	0.917	1.133	1.329
1996	1.000	1.054	1.276	1.435
1997	1.000	1.124	1.289	1.427
All years	1.000	1.036	1.201	1.330

Table 2. Relative Sales Per Employee by Employment Size Category for Major Industries

	0-100	100+
Agriculture, forestry and fishing	1.000	0.886
Mining, oil and gas	1.000	1.110
Manufacturing	1.000	1.803
Construction	1.000	1.133
Transportation and storage	1.000	1.246
Communication and utilities	1.000	0.979
Wholesale trade	1.000	1.152
Retail trade	1.000	0.894
Business services	1.000	1.007
Health and social services	1.000	0.676
Accommodation and food	1.000	1.060
Arts and recreation	1.000	1.202
Other services	1.000	0.687
Non-manufacturing	1.000	1.028
Manufacturing	1.000	1.803
All industries*	1.000	1.271

*Excluding public administratsion, FIRE and educational services.

Table 3. Size-Productivity Relationship Controlling for Industry Composition, Firm Age and Organizational Type

	All industries*	Manufacturing	Non-manufacturing
Raw gap	0.271	0.803	0.028
With controls for:			
Industry composition	0.1045 (0.0117)	0.3943 (0.0130)	0.0264 (0.0160)
Industry composition, firm age and type	0.0521 (0.0116)	0.2404 (0.0097)	-0.0081 (0.0157)

Standard errors in parentheses.
*Excluding public administratsion, FIRE and educational services.

Table 4. Deviation of TFP from Industry-Year Means, Gap Between Large (100+) and Small (<100) Firms

	Unweighted	Output weighted
1984	0.102	0.062
1985	0.104	0.076
1986	0.105	0.035
1987	0.101	0.063
1988	0.097	0.054
1989	0.103	0.064
1990	0.108	0.041
1991	0.117	0.079
1992	0.118	0.067
1993	0.056	0.044
1994	0.065	0.040
1995	0.034	0.033
1996	0.039	0.033
1997	0.063	0.018
All years	0.084	0.052

Table 5. Deviation of TFP from Industry-Year Means, Gap Between Large (100+) and Small (<100) Firms, by Major Sector

	Unweighted	Output weighted
Non-manufacturing	0.096	0.064
Manufacturing	0.066	0.036

Table 6. Firm Size Distribution (%)

	0-20	20-100	100-500	500+
1984	89.0	9.3	1.4	0.3
1985	88.8	9.5	1.4	0.3
1986	88.6	9.7	1.4	0.3
1987	88.2	10.1	1.4	0.3
1988	88.1	10.2	1.5	0.3
1989	88.0	10.3	1.5	0.3
1990	88.6	9.8	1.4	0.3
1991	89.2	9.3	1.3	0.3
1992	89.5	9.0	1.2	0.2
1993	90.0	8.6	1.2	0.2
1994	89.8	8.6	1.3	0.2
1995	89.7	8.7	1.4	0.3
1996	89.5	8.9	1.3	0.3
1997	89.5	8.9	1.3	0.3

Table 7. Average Number of Employees Per Firm

	0-20	20-100	100-500	500+	Total
1984	4.4	38.5	191.6	2683.2	17.5
1985	4.4	38.6	192.0	2680.5	17.5
1986	4.4	38.6	190.9	2637.2	17.4
1987	4.5	38.8	191.1	2561.7	17.6
1988	4.5	39.0	190.9	2492.2	17.8
1989	4.5	38.9	191.8	2525.7	17.6
1990	4.5	39.0	191.4	2534.6	16.9
1991	4.4	39.1	192.7	2558.0	16.3
1992	4.2	39.0	191.8	2536.3	15.5
1993	4.2	38.7	190.0	2461.1	15.0
1994	3.9	39.8	187.7	2335.3	15.1
1995	3.9	40.3	188.4	2327.8	15.4
1996	4.1	39.3	189.2	2296.6	15.3
1997	4.1	39.1	188.6	2261.2	15.3

Table 8. Distribution of Employment Across Firm Size Categories (%)

	0-20	20-100	100-500	500+
1984	22.3	20.6	14.8	42.3
1985	22.4	21.0	15.2	41.4
1986	22.6	21.6	15.3	40.5
1987	22.6	22.1	15.5	39.8
1988	22.5	22.3	15.8	39.4
1989	22.5	22.7	15.8	39.0
1990	23.5	22.7	15.5	38.3
1991	23.8	22.3	15.3	38.6
1992	24.4	22.6	14.7	38.2
1993	25.0	22.2	15.1	37.8
1994	23.5	22.7	16.4	37.4
1995	22.7	22.8	17.0	37.5
1996	23.9	22.9	15.9	37.3
1997	24.2	22.9	15.7	37.2

Table 9. Decomposition of Change in Sales per Employee Between 1997 and 1985

	Within size category	Shift in distribution	Cross Product
All industries*	1.077	-0.056	-0.021
Agriculture, forestry and fishing	1.042	0.001	-0.043
Mining, oil and gas	1.022	-0.128	0.106
Manufacturing	1.091	-0.053	-0.037
Construction	1.015	-0.068	0.053
Transportation and storage	1.221	-0.012	-0.210
Communication and utilities	1.002	-0.035	0.033
Wholesale trade	0.973	-0.009	0.036
Retail trade	0.790	0.102	0.108
Business services	0.988	0.037	-0.025
Accommodation and food	0.952	0.034	0.014
Arts and recreation	0.739	0.592	-0.331
Other services	1.016	-0.005	-0.010
Non-manufacturing	0.972	0.007	0.021
Manufacturing	1.091	-0.053	-0.037

*Excluding public administratsion, FIRE and educational services.

Table 10. Distribution of Employment Across Firm Size, Canada and the United States, 1997

	0-20	20-100	100-500	500+
Canada				
All industries*	23.9	23.2	16.0	36.9
Agricultural services, foresty and fishing**	55.8	29.8	14.4	-----
Mining, oil and gas	10.0	11.7	15.5	62.9
Manufacturing	9.8	20.1	21.4	48.7
Construction	52.5	29.3	11.4	6.8
Transportation, communication and utilities	15.7	15.4	12.8	56.1
Wholesale trade	28.8	31.1	19.5	20.7
Retail trade	27.5	22.6	9.7	40.3
Other serivces	28.4	25.2	16.1	30.3
United States				
All industries*	15.8	18.6	14.3	51.2
Agricultural services, foresty and fishing**	45.4	27.9	26.7	-----
Mining, oil and gas	11.6	15	11.9	61.4
Manufacturing	6.7	15.4	15.6	62.3
Construction	35.9	35.4	16.8	11.9
Transportation, communication and utilities	10	12.2	10.2	67.5
Wholesale trade	23.1	25.4	15.7	35.9
Retail trade	16	19.9	10	54.1
Other serivces	17	16.5	16.8	49.7

*Excluding public administration, FIRE, and crop and animal production.
**The 100-500 and 500+ categories are combined for this industry.

Table 11. Sales per Employee (Thousands of U.S. Dollars), Canada and the United States, 1997

	0-20	20-100	100-500	500+	Total
Canada					
All industries*	121.5	133.7	148.4	160.3	142.9
Agricultural services, foresty and fishing**	102.6	102.2	102.3	-----	101.9
Mining, oil and gas	211.2	251.5	232.9	246.1	241.2
Manufacturing	103.1	108.7	154.2	242.4	183.0
Construction	153.6	178.7	183.1	157.2	164.5
Transportation, communication and utilities	124.8	128.3	118.8	161.2	145.0
Wholesale trade	276.4	304.0	387.8	301.4	311.9
Retail trade	116.6	181.3	143.9	101.3	127.7
Other serivces	72.8	54.2	58.8	61.7	62.5
United States					
All industries*	157.0	138.9	139.5	201.5	173.9
Agricultural services, foresty and fishing**	82.1	64.9	59.8	-----	71.3
Mining, oil and gas	185.2	183.1	204.9	363.8	296.9
Manufacturing	125.2	121.9	148.8	265.3	215.7
Construction	151.9	144.7	162.3	206.8	157.6
Transportation, communication and utilities	114.5	104.8	131.8	248.7	205.6
Wholesale trade	492.4	393.4	450.0	955.7	626.8
Retail trade	119.4	133.1	153.9	115.6	123.5
Other serivces	93.9	67.7	57.6	72.3	72.7
Canada/United States					
All industries*	0.774	0.963	1.064	0.796	0.822
Agricultural services, foresty and fishing**	1.250	1.575	1.711	-----	1.429
Mining, oil and gas	1.140	1.374	1.137	0.676	0.812
Manufacturing	0.823	0.892	1.036	0.914	0.848
Construction	1.011	1.235	1.128	0.760	1.044
Transportation, communication and utilities	1.090	1.224	0.901	0.648	0.705
Wholesale trade	0.561	0.773	0.862	0.315	0.498
Retail trade	0.977	1.362	0.935	0.876	1.034
Other serivces	0.775	0.801	1.021	0.853	0.860

*Excluding public administration, FIRE, and crop and animal production.
**The 100-500 and 500+ categories are combined for this industry.

Table 12. Average Firm Size, Canada and the United States, 1997

	0-20	20-100	100-500	500+	Total
Canada					
All industries*	4.2	39.2	188.8	2160.3	15.6
Agricultural services, foresty and fishing**	3.6	33.9	194.8	-----	6.0
Mining, oil and gas	3.3	40.5	204.8	1639.6	29.2
Manufacturing	5.3	41.7	193.2	1948.4	40.4
Construction	3.4	35.3	181.1	998.0	6.1
Transportation, communication and utilities	3.4	38.5	196.1	3200.1	19.5
Wholesale trade	4.5	38.2	182.9	145.0	13.7
Retail trade	4.7	40.0	168.8	4225.0	15.5
Other serivces	4.1	38.9	193.5	1824.1	13.1
United States					
All industries*	4.8	39.4	194.8	4235.1	25.8
Agricultural services, foresty and fishing**	4.6	34.4	283.6	-----	9.2
Mining, oil and gas	4.4	37.1	131.9	894.8	31.3
Manufacturing	6.3	41.3	177.6	2456.5	64.7
Construction	4.7	37.4	164.7	850.4	11.4
Transportation, communication and utilities	4.4	38.3	160.2	2480.4	37.4
Wholesale trade	4.9	36.1	127.3	711.3	17.8
Retail trade	5.3	37.8	162.7	3682.2	27.9
Other serivces	4.3	38.8	180.9	2010	22.1
Canada/United States					
All industries*	0.875	0.995	0.969	0.510	0.605
Agricultural services, foresty and fishing**	0.783	0.985	0.687	-----	0.652
Mining, oil and gas	0.750	1.092	1.553	1.832	0.933
Manufacturing	0.841	1.010	1.088	0.793	0.624
Construction	0.723	0.944	1.100	1.174	0.535
Transportation, communication and utilities	0.773	1.005	1.224	1.290	0.521
Wholesale trade	0.918	1.058	1.437	0.204	0.770
Retail trade	0.887	1.058	1.037	1.147	0.556
Other serivces	0.953	1.003	1.070	0.908	0.593

*Excluding public administration, FIRE, and crop and animal production.
**The 100-500 and 500+ categories are combined for this industry.

Table 13. Decomposition of U.S.-Canada Difference in Sales per Employee (%), 1997

	Within Size Category	Difference in Distribution	Cross Product
Canada as base country			
All industries*	75.7	14.2	10.1
Agricultural services, foresty and fishing	93.7	0.1	6.2
Mining, oil and gas	106.0	-0.3	-5.7
Manufacturing	45.4	48.0	6.7
Construction	142.4	-47.9	5.6
Transportation, communication and utilities	75.2	6.7	18.1
Wholesale trade	75.3	-0.5	25.2
Retail trade	80.4	89.7	-70.1
Other serivces	121.6	-6.2	-15.4
United States as base country			
All industries*	85.2	23.7	-8.9
Agricultural services, foresty and fishing	101.5	7.9	-9.4
Mining, oil and gas	99.9	-6.4	6.4
Manufacturing	51.8	54.4	-6.2
Construction	148.4	-41.9	-6.4
Transportation, communication and utilities	93.2	24.8	-18.0
Wholesale trade	100.8	24.9	-25.6
Retail trade	9.7	19.0	71.3
Other serivces	106.7	-21.1	14.4

*Excluding public administration, FIRE, and crop and animal production.

Figure 1. Gross output from KLEMS and Sales from T2-LEAP

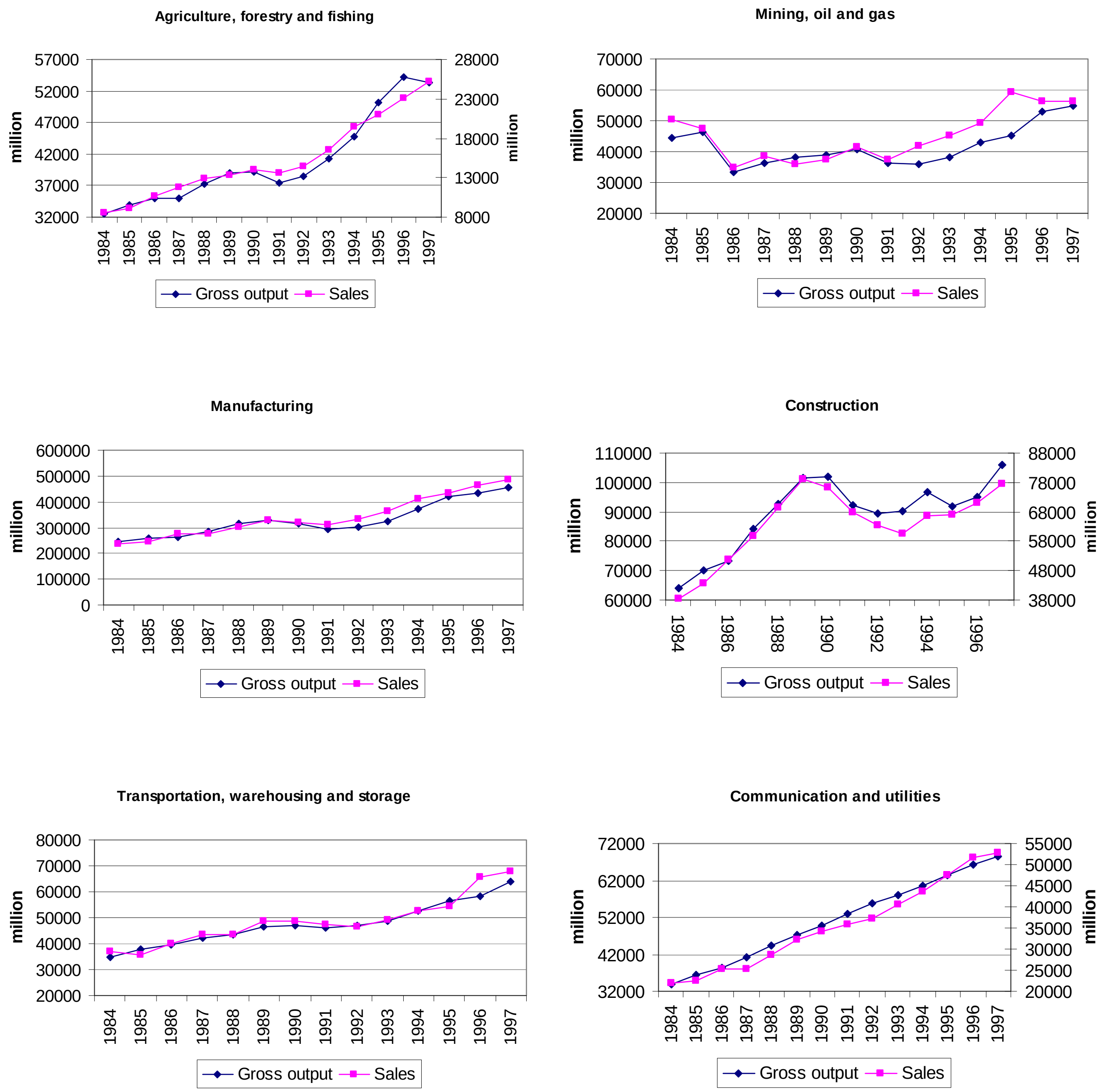
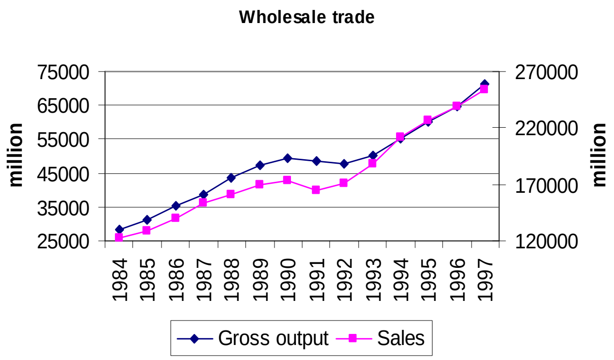
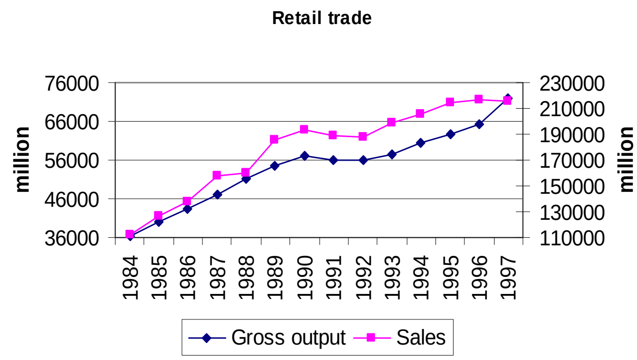
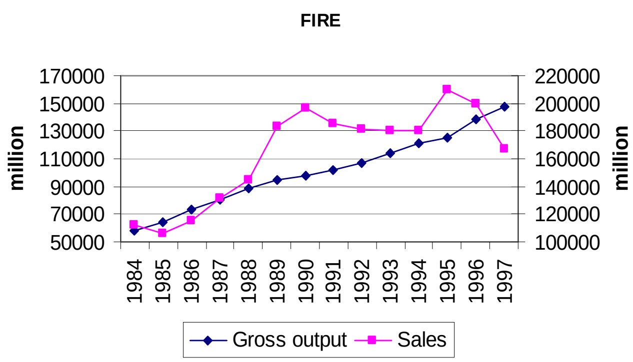
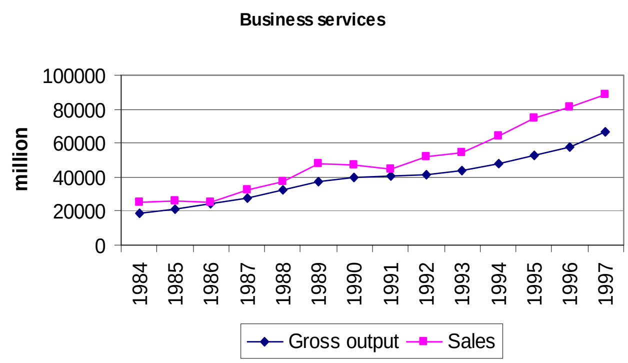


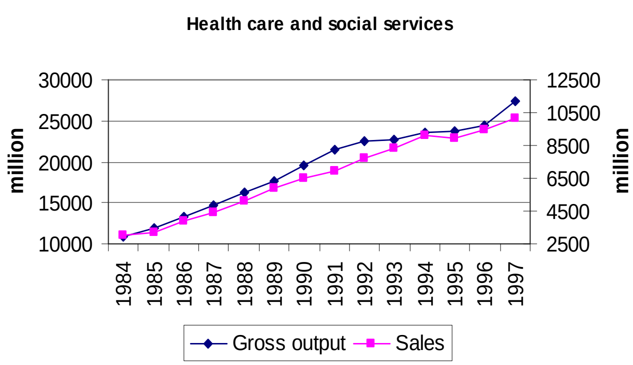
Figure 1. Gross output from KLEMS and Sales from T2-LEAP, continued











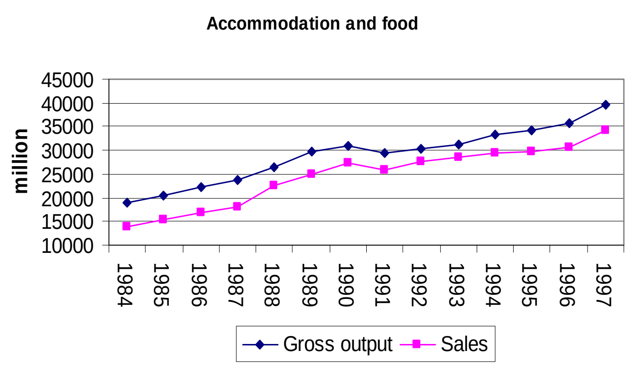
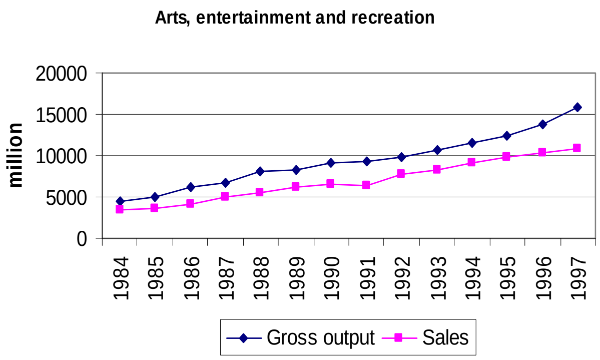


Figure 1. Gross output from KLEMS and Sales from T2-LEAP, continued



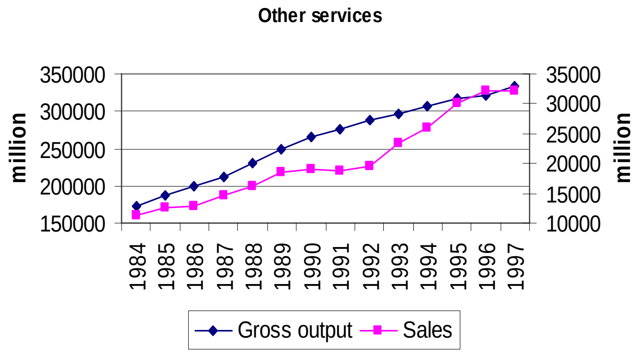


Figure 2. Distribution of Log Sales Per Employee