The Productivity-Wage Premium: Does size still matter in a service economy?

By Giuseppe Berlingieri, Sara Calligaris and Chiara Criscuolo*

The fact that larger businesses pay higher wages has long been considered a stylized fact in the literature. Since Moore (1911) numerous papers have confirmed the presence of a positive size wage premium (e.g. for the US see Brown and Medoff, 1989; Bayard and Troske, 1999; Troske, 1999; Barth, Davis and Freeman, 2018).

Both the theoretical and empirical literature have suggested that this positive size premium may, at least partly, reflect productivity differentials amongst firms of different sizes. Significant heterogeneity in productivity exists among firms (Syverson, 2011), and theories of the firms predict that this heterogeneity in productivity will translate in size differentials, with more productive firms being also larger (Lucas, 1978; Melitz, 2003). Models of on-the-job-search predict that high productivity firms will be larger and pay higher wages (Burdett and Mortensen, 1998). Moreover, models of imperfect competition in the labour market (e.g. see Manning, 2011; Card et al., 2018) predict that firm heterogeneity in productivity will affect the distribution of firm size and of firm-specific wage premia, as well as the degree of sorting of different skill groups across firms. Similarly, the empirical literature on rent sharing also provides evidence of a significant relationship between wages and firms productivity. Existing empirical evidence indeed points to a close link between dispersion in productivity and dispersion in wages, as well as their evolution over time.

The majority of these studies focus exclusively on manufacturing sectors and a single country. Often because of lack of data, services are rarely analyzed in this literature, especially in a cross-country dimension. With manufacturing representing only around 15% of total value added and employment in OECD economies (with a decreasing trend over time), it is therefore important to understand whether the stylized fact that size is strongly correlated with both wages and productivity can be extended at face value to the services sector, or whether there are significant differences between the two sectors.

This paper provides a systematic investigation of these links using a novel data source, the OECD MultiProd dataset, which is based on the full population of firms, or a re-weighted representative sample. Figures 1–4 illustrate the main message of this paper. By simply plotting (weighted) cross-country averages, the figures show that both productivity and wages increase significantly with firms' size in the manufacturing sector. Conversely, the distribution is much flatter in the non-financial market services sector, where firms above 20 employees pay on average rather similar wages to their workers, and exhibit very similar productivity levels. On the contrary, wages increase with productivity in both manufacturing and (especially) non-financial market services. The combination of these results suggests that, when looking at data going beyond manufacturing, the "size-wage premium" becomes rather a "productivity-wage premium".

* Berlingieri: ESSEC Business School, Centre for Economic Performance and OECD, 2, rue André Pascal - 75775 Paris Cedex 16, giuseppe.berlingieri@oecd.org. Calligaris: OECD, 2, rue André Pascal - 75775 Paris Cedex 16, sara.calligaris@oecd.org. Criscuolo: Centre for Economic Performance and OECD, 2, rue André Pascal - 75775 Paris Cedex 16, chiara.criscuolo@oecd.org. The opinions expressed and arguments employed herein are those of the authors and do not necessarily reflect the official views of the OECD or of the governments of its member countries. A longer version of this paper can be found at the following link:...

I. Data

The analysis conducted in this paper relies on the work undertaken in the last few years within the OECD "MultiProd" project. The implementation of the MultiProd project is based on a standardized routine that aggregates firm-level data from administrative sources, or from the combination of official production surveys and national business registers, to the level of cells more disaggregated than 2-digit sectors (such as at the level of size classes, or of quantiles of the sales/productivity distribution within 2-digit sectors). This *distributed micro-data analysis* involves running a common code in a decentralized manner by representatives from National Statistical Offices (NSOs), ministries or experts in research institutions, who have access to the national firm-level data.[1]

The advantages of this data collection methodology are manifold: it puts a lower burden on NSOs and limits running costs for such endeavours. Importantly, it also overcomes the confidentiality constraints of directly using official firm-level databases, while at the same time achieving a high degree of harmonization and comparability across countries, sectors, and over time. Finally, it provides a unique source of cross-country comparable longitudinal information on moments of the distributions of firm size, wages and productivity.

At the time of writing, 22 countries have been successfully included in the MultiProd database, from as early as 1994 to 2012. While the project collects data for all sectors of the economy (if available), for this analysis, we have restricted our sample to manufacturing and non-financial market services only.[2] In addition, and in order to guarantee comparability across countries, we restrict our sample to those countries providing wages and productivity statistics by size classes and productivity quantiles for both manufacturing and non-financial market services. The final sample includes 17 countries.[3]

The analysis relies on two measures of productivity, labour productivity (LP) and multi-factor productivity (MFP). LP has the advantage of being widely available and easily aggregatable to the sector- or country-level using employment weights, but does not account for other inputs, such as capital. In order to do this, the MultiProd code produces various measures of MFP. The measure used in this paper is based on firm level econometric estimates using the Wooldridge (2009) control function approach with value added as a measure of output and a Cobb-Douglas production function.[4]

The measure of wages contained in the dataset is computed as a firm's total labour costs divided by the number of employees, corresponding therefore to the average wage at the firm level. In fact, wages at the worker-level, as well as other worker characteristics are not observed in the source data. This implies that within-firm wage dispersion or its contribution to overall wage dispersion cannot be estimated.

In the MultiProd database, at the 2-digit sector level, firms have been categorized in five size classes and five bins of the productivity distribution. The size classes are: micro (1-9 employees), small (10-19), medium-small (20-49), medium (50-249) and large (more than 250). The bins of the productivity distribution are: 1^{st} to 10^{th} percentile, 10^{th} to 40^{th}, 40^{th} to 60^{th}, 60^{th} to 90^{th}, and 90^{th} to 100^{th}.

[1] Further details on data sources, methodology and the information available in the MultiProd project can be found in Berlingieri et al. (2017).

[2] Non-financial market services include the following 2-digit sectors: Wholesale and retail trade, repair of motor vehicles and motorcycles; Transportation and storage; Accommodation and food service activities; Publishing, audiovisual and broadcasting activities; Telecommunications; IT and other information services; Legal and accounting activities; Scientific research and development; Advertising and market research, other professional, scientific and technical activities, veterinary activities; Administrative and support service activities.

[3] Australia, Austria, Belgium, Canada, Chile, Denmark, Finland, France, Germany, Hungary, Italy, Japan, Netherlands, Norway, Portugal, Sweden and Switzerland.

[4] For a detailed discussion on control function approaches, see Ackerberg et al. (2007).

II. Results

To analyse the link of wages and productivity with size, we investigate the relationship within countries, 2-digit sectors and years. More precisely, to establish whether there is a systematic and significant difference in size (productivity) premia between manufacturing and services, we focus on the relative differentials between the two sectors estimating the following equation:

$$\mathbf{Y} = \mathbf{D}\boldsymbol{\beta} + \mathbf{MD}\boldsymbol{\gamma} + \boldsymbol{\theta} + \boldsymbol{\varepsilon} \quad (1)$$

where $\mathbf{Y}$ is the vector of dependent variables, where each element is the average y in size class s (or productivity bin), 2-digit sector j, country c and year t, and y stands for log-wages, log-LP or log-MFP.[5] Moreover, $\mathbf{D}$ is a matrix of categorical variables for size classes first, and productivity quantiles after, and $\mathbf{M}$ is a diagonal matrix whose elements are macro-sector indicator variables that take value 0 for manufacturing and 1 for non-financial market services. Therefore, the estimates of elements of β capture the average size-wage and size-productivity (productivity-wage) differentials for a given size class (productivity bin) with respect to micro firms (firms in the bottom decile of the productivity distribution) in manufacturing, whereas estimates of elements of γ capture the differential size-premium (productivity-premium) deriving from being a service firm with respect to manufacturing in each size class (productivity bin). In all regressions, we control for a full battery of country-sector-year fixed effects θ_{jct}, hence we rely on the variation across size classes within each of those triples.

Results of the regressions analysing the link between wages and productivity with size are shown in Table 1. First of all, the results confirm that the correlation of wages and productivity with size is strongly significant in manufacturing, in line with the existing literature.

Looking at the size-wage differential in services, the last four coefficients in Column (1) show that firms with less than 50 employees in the service sector pay on average higher wages compared to manufacturing firms in the same size classes. But this "service premium" decreases with size, and becomes negative for large firms. Overall these results suggest that the positive correlation between wages and size is lower in services than in manufacturing, and that the distribution of wages across size classes is flatter in services.

Looking at the correlation between productivity and size, we find similar results. For LP, we find a positive "service premium" only for small firms (with less than 20 employees), while for all other size classes service firms display a significantly lower productivity compared to equally sized firms in manufacturing. Furthermore, the negative interaction coefficient increases in absolute value with the size class, indicating that the difference between manufacturing and services increases with size and the productivity-size premium becomes much weaker, if not absent, in service firms above 20 employees. A very similar pattern is found for MFP. Again, there is a small service premium for small firms that becomes negative as size increases, with a weakening of the correlation between productivity and size. As in the case of LP, the negative differential with manufacturing increases in absolute value with the size class, reducing the size premium.

Having found a significantly weaker size premium for both wages and productivity in the services sector compared to manufacturing, we then turn to investigating the direct link between wages and productivity. The question is now how wages respond to firms' productivity across the two macro-sectors.

Results are shown in Table 2. The higher the productivity (both in terms of LP and MFP), the stronger the correlation between wages and productivity, as the coefficients in the first four rows of the table show.

[5] Since the data in MultiProd are micro-aggregated moments (and means in particular) from firm-level data, in all regressions we weight each observation $jsct$ by the number of firms reporting non-missing information for the relevant variable in a given country-sector-size class-year. The weighting strategy implies that our estimates are equivalent to those hypothetically generated using the underlying micro-data samples.

This result confirms that there is a strong productivity-wage premium in manufacturing. Moreover, the wage premium of firms at the productivity frontier (top decile) with respect to the laggards firms at the bottom of the distribution (bottom decile) is larger than the premium of large firms with respect to micro firms.

In addition, and in contrast with the size-wage premium, we find that, within the same productivity bin, being in the service sector provides an extra wage premium with respect to manufacturing. This result holds for all quantiles of both the LP and MFP distributions, with all four interaction coefficients being positive and strongly significant, as the last four rows of Table 2 show. Results for LP are particularly strong. Moreover, for both LP and MFP, the service premium significantly increases over the productivity percentiles. Overall these findings show that there is a tight and positive link between wages and productivity, and, contrary to the size-wage premium, this holds in both manufacturing and especially services, where the correlation between wages and productivity is stronger than in manufacturing.

III. Robustness and extensions

In the extended version of this article, we investigate whether existing explanations for the size premium can fully account for our findings. In particular, we control for firm age, capital intensity, skill and knowledge intensity, and industry concentration, allowing for a differential effect of these variables across size classes and sectors. As found in the literature (e.g. Troske, 1999), we confirm that these variables can explain some of the size premium found in manufacturing but they do not fully account for it. In addition, of particular importance for our focus, we find that they cannot fully explain the significant differential size premium between manufacturing and services.

The MultiProd dataset allows us to test the existence of these stylized facts over a large set of countries. However, given its micro-aggregated nature, we cannot investigate the underlying micro-mechanisms in greater detail. In a companion paper (Berlingieri, Calligaris and Criscuolo, 2018), we study what affects the link between size, productivity, and wages at the micro level using French matched employer-employee data. These data allow for a more flexible specification of the size and productivity dimensions, as well as distinguishing, among other things, between firm and establishment size. Moreover, thanks to the link with worker level information, these data offer much more precise measures of wages, skills, and the possibility to control for other observable and unobservable workers' characteristics, which enable us to unveil the sources of the differential size (productivity) premia across sectors. At the firm level, we find for France very similar results to those shown in the present paper: while both wages and productivity exhibit a much more concave distribution over size in services than in manufacturing, the same in not true when looking at wages over the productivity distribution.

IV. Conclusions

The main results of this paper can be summarized as follows. First, in the manufacturing sector, we find that both productivity and wages are increasing with firms' size, confirming the large evidence already provided by the literature. Second, in contrast to manufacturing, the size premium is much weaker in the service sector: productivity and wages display a significantly flatter pattern across size classes. Third, if we link wages to productivity, we find that they increase monotonically with productivity in both manufacturing and especially non-financial market services, where the correlation between wages and productivity is stronger than in manufacturing. Overall, these results suggest that when looking beyond manufacturing we might be the in presence of a "productivity-wage premium" rather than a "size-wage premium".

These results have first-order policy implications for both workers and firms. The traditional paradigm of a manufacturing economy, where the most productive firms were also the largest and therefore shared

the benefits of their high productivity with a very large number of workers, seems to have shifted in today's service economy. Previous research has shown that there are large and growing productivity gaps between the most and the least productive firms, even within sectors. This paper adds to this debate by showing that the most productive firms at the top might not be the largest ones in terms of employment, which increases the likelihood of productivity gains being shared only with the few workers that are employed there. Policy makers might need to reflect on the potential implications that these trends have for perceived and measured inequality.

REFERENCES

Ackerberg, Daniel, C. Lanier Benkard, Steven Berry, and Ariel Pakes. 2007. "Econometric Tools for Analyzing Market Outcomes." In *Handbook of Econometrics*. Vol. 6 of *Handbook of Econometrics*, , ed. J.J. Heckman and E.E. Leamer, Chapter 63. Elsevier.

Barth, Erling, James Davis, and Richard B. Freeman. 2018. "Augmenting the Human Capital Earnings Equation with Measures of Where People Work." *Journal of Labor Economics*, 36(S1): S71–S97.

Bayard, Kimberly, and Kenneth R. Troske. 1999. "Examining the Employer-Size Wage Premium in the Manufacturing, Retail Trade, and Service Industries Using Employer-Employee Matched Data." *American Economic Review*, 89(2): 99–103.

Berlingieri, Giuseppe, Patrick Blanchenay, Sara Calligaris, and Chiara Criscuolo. 2017. "The MultiProd Project: a Comprehensive Overview." OECD Publishing OECD Science, Technology and Industry Working Papers 2017/04.

Berlingieri, Giuseppe, Sara Calligaris, and Chiara Criscuolo. 2018. "Does the Sector Matter? Unbundling the Size-Productivity-Wage Premium." Mimeo.

Brown, Charles, and James Medoff. 1989. "The Employer Size-Wage Effect." *Journal of Political Economy*, 97(5): 1027–59.

Burdett, Kenneth, and Dale Mortensen. 1998. "Wage Differentials, Employer Size, and Unemployment." *International Economic Review*, 39(2): 257–73.

Card, David, Ana Rute Cardoso, Jörg Heining, and Patrick Kline. 2018. "Firms and Labor Market Inequality: Evidence and Some Theory." *Journal of Labor Economics*, 36(S1): S13–S70.

Lucas, Robert E. 1978. "On the size distribution of business firms." *The Bell Journal of Economics*, 508–523.

Manning, Alan. 2011. "Imperfect Competition in the Labor Market." , ed. O. Ashenfelter and D. Card Vol. 4 of *Handbook of Labor Economics*, Chapter 11, 973–1041. Elsevier.

Melitz, Marc J. 2003. "The impact of trade on intra-industry reallocations and aggregate industry productivity." *Econometrica*, 71(6): 1695–1725.

Moore, Henry Ludwell. 1911. *Laws of wages: An essay in statistical economics.* Macmillan.

Syverson, C. 2011. "What Determines Productivity?" *Journal of Economic Literature*, 49(2): 326–365.

Troske, Kenneth. 1999. "Evidence On The Employer Size-Wage Premium From Worker-Establishment Matched Data." *The Review of Economics and Statistics*, 81(1): 15–26.

Wooldridge, Jeffrey M. 2009. "On Estimating Firm-Level Production Functions Using Proxy Variables to Control for Unobservables." *Economics Letters*, 104(3): 112–114.

Figure 1. Wages by size classes.

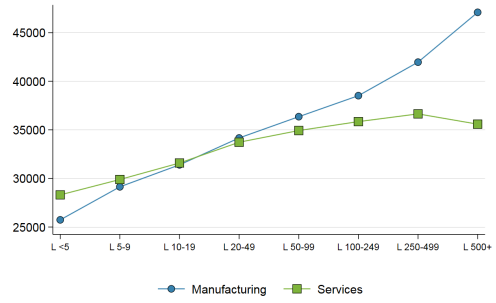


Figure 2. Labor productivity by size classes.

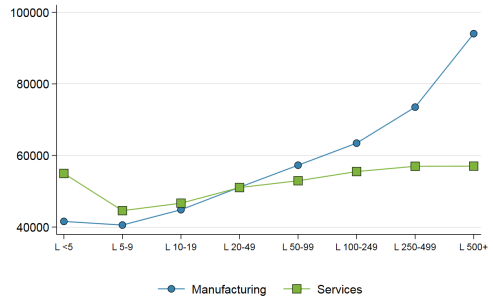


Figure 3. Wages by labor productivity quantiles.

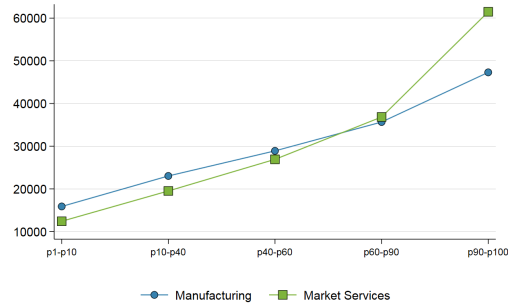
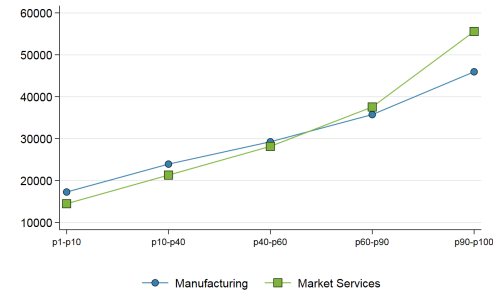


Figure 4. Wages by multi-factor productivity quantiles.



Note: Countries included: AUS, AUT, BEL, CAN, CHE, CHL, DEU, DNK, FIN, FRA, HUN, ITA, JPN, NLD, NOR, PRT, SWE. Figures 1 and 2 are weighted averages over 8 size classes: very micro (less than 5 employees), micro (5-9), small (10-19), medium-small (20-49), medium-large (100-249), large (250-499), very large (more than 500). Figures 3 and 4 are weighted averages over 5 bins of the productivity distribution: 1^{st} to 10^{th} percentile, 10^{th} to 40^{th}, 40^{th} to 60^{th}, 60^{th} to 90^{th}, and 90^{th} to 100^{th}. Wages are expressed in 2005 US dollars.

Table 1—Wages and productivity by size classes.

	(1) ln(W)	(2) ln(LP)	(3) ln(MFP_W)
Small (10-19)	0.247***	0.142***	0.329***
	(0.010)	(0.007)	(0.008)
MediumSmall (20-49)	0.326***	0.246***	0.511***
	(0.011)	(0.009)	(0.013)
Medium (50-249)	0.445***	0.368***	0.723***
	(0.013)	(0.010)	(0.017)
Large (250+)	0.618***	0.584***	1.040***
	(0.014)	(0.010)	(0.024)
Small (10-19) × Market Services	0.059***	0.022	0.030*
	(0.022)	(0.014)	(0.016)
MediumSmall (20-49) × Market Services	0.061**	-0.035**	-0.010
	(0.026)	(0.016)	(0.025)
Medium (50-249) × Market Services	0.014	-0.152***	-0.111***
	(0.031)	(0.020)	(0.040)
Large (250+) × Market Services	-0.151***	-0.395***	-0.290***
	(0.034)	(0.025)	(0.065)
Observations	20278	20085	18749
Adj. R-Square	0.963	0.964	0.988
Country-sector-year FE	YES	YES	YES
Num. Countries	17	17	17

Table 2—Wages by productivity quantiles.

	(1) ln(LP)	(2) ln(MFP_W)
p10-p40	0.529***	0.487***
	(0.007)	(0.008)
p40-p60	0.803***	0.734***
	(0.011)	(0.011)
p60-p90	1.009***	0.927***
	(0.012)	(0.012)
p90-p100	1.311***	1.174***
	(0.013)	(0.012)
p10-p40 × Market Services	0.115***	0.053***
	(0.012)	(0.011)
p40-p60 × Market Services	0.226***	0.109***
	(0.019)	(0.016)
p60-p90 × Market Services	0.326***	0.174***
	(0.025)	(0.017)
p90-p100 × Market Services	0.495***	0.296***
	(0.033)	(0.019)
Observations	20022	19286
Adj. R-Square	0.965	0.977
Country-sector-year FE	YES	YES
Num. Countries	17	17

Note: Clustered standard errors at the country-sector-year level in parentheses: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. The set of countries include: AUS, AUT, BEL, CAN, CHE, CHL, DEU, DNK, FIN, FRA, HUN, ITA, JPN, NLD, NOR, PRT, SWE.