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# Declining Labor Share and Innovation\*

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1st December 2017

## Abstract

In this paper, we document declining labor share using a sample of international companies from developed economies. While this trend makes internal funds available for financing innovation, we find that R&D expenditures fall alike. Firm-level fixed effects estimation, controlling for the intensity of competition and financial constraints, confirms a positive correlation between labor share and R&D expenditures. A counterfactual analysis shows that a percentage point fall in labor share reduces output growth by 0.01 percentage point in the short run, and up to 0.02 percentage point in the long run, due to declining innovation.

**Keywords:** Innovation, Labor share.

**JEL Classification:** D63, D33, E25, O31.

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# 1 Introduction

Declining labor share, that is the share of value added accruing to labor, is well documented in the economic literature. Karabarbounis & Neiman (2014) document 5% drop in the global corporate labor share since the 80s and show that this trend stems from within industry rather than between industries. More recently, Autor *et al.* (2017b) highlight the role of large firms in driving the downward trend in the labor share. As suggested by Alvaredo *et al.* (2017), declining labor share tends to raise income inequality, because wealth distribution is typically more concentrated than labor endowment. More importantly, declining labor share hinders growth because it reduces household consumption. One countervailing factor to these adverse effects is innovation, as declining labor share makes more profit available to finance investment. However, there is still a lack of evidence on the relationship between labor share and innovation.

In this paper, we use firm-level panel data on Research and Development (R&D), capital and labor expenditures, to investigate the relationship between the labor share and innovation. Our data come from FactSet, an online database similar to Thomson Reuters and Bloomberg, and cover 4760 international companies from developed economies over 20 years, from 1994 to 2013. The labor share is measured by the ratio of labor expenditures to value added, and innovation is measured by R&D intensity, the ratio of R&D expenditures to sales.

We first document a 15 percentage points fall in the labor share between 1994 and 2013, consistently with a divergence between labor productivity and average wage of our sampled firms. A similar downward trend is observed for R&D expenditures which fall by 0.2 percentage point during the same period. Secondly, we investigate the correlation between these two variables by estimating a fixed effects regression, controlling for the intensity of competition, cash flow and debt stock. We find a robust, positive and statistically significant correlation between R&D intensity and labor share. A counterfactual analysis of the effects on output suggests that a percentage point decline in the labor share reduces output growth by 0.01 percentage point in the short run, and up to 0.02 in the long run, due to declining R&D expenditures.

The findings of this paper are related to the literature on the causes and consequences of the evolution of the labor share. Karabarbounis & Neiman (2014) document a declining labor share but did not relate its to innovation within the firm. Autor *et al.* (2017a,b) emphasize the role of large firms in driving the declining labor share, but they also did not relate its to innovation. This paper complements the literature by showing that the declining labor share can reduce output through lower innovation.

The remainder of the paper is organized as follows. Section 2 briefly summarizes the related

literature. Section 3 presents the data, some descriptive statistics and the econometric model. Section 4 presents the results and section 5 concludes.

## 2 Related literature

Declining labor share is well documented in the macroeconomic literature. At the global scale, Karabarbounis & Neiman (2014) find a 5% decline in corporate labor share since the 1980s. In the OECD, the share of national income accruing to labor drops from 66% in 1990 to 62% in 2009, according to OECD (2012). This downward trend is steeper in high-productivity industries.

In general, the labor share falls when average wage increases less than labor productivity (OECD, 2015). Several factors have been put forward to explain this divergence between labor productivity and average wage. OECD (2012) and ILO (2010) examine the sectoral shift hypothesis, according to which falling labor share stems from a shift of employment from labor-intensive to capital-intensive sectors where the labor share is lower. They find that the overall downward trend in the labor share is largely due to variation within industries, rejecting the sectoral shift hypothesis. Bentolila & Saint-Paul (2003) highlight the role of several factors such as globalization, capital-augmenting technological change, product and labor market institutions, and the bargaining power of labor. Hutchinson & Persyn (2012) reassessed these factors and find that the effects of globalization is smaller than the effects of skill-biased technological change and the cyclical price change of intermediary goods. Epstein & Burke (2001) pinpoint the effect of unemployment induced by the threat to internationalize production. Weil (2013) stresses the role of finance through its influence on business to increase shareholder value and to focus on core activities while subcontracting labor-intensive activities.

More recently, Autor *et al.* (2017a,b) examine the microeconomic causes of the falling aggregate labor share and find that industry concentration, as reflected by the rise of "superstars" firms, is the main driver. Using data from the US, they observed that the labor share of the average firm is rather flat, suggesting that falling aggregate labor share might be driven by rising heterogeneity between firms as competition develops into a "winner take most" feature.

A straightforward impact of the falling labor share is rising inequality because capital is more concentrated than labor endowment (Alvaredo *et al.*, 2017). However, the relationship can be complex as the labor share typically increases for top wage earners (Atkinson, 2009). Another effect is on household consumption due to higher propensity to consume from labor income than from capital income. As a result, falling labor share can hinder economic growth. To

counter this effect, one might expect that falling labor share means more profit available for investment. However, recent statistics from the G20 countries show no positive effects of the falling labor share on investment (OECD, 2015). Rather, aggregate investment remains stable while the labor share is falling.<sup>1</sup>

According to OECD (2015), the disconnection between labor share and investment can be explained by two factors. First, much of increase in profit occurred in the financial sector, and second, in advanced countries, profits of non-financial firms have increasingly been used to pay dividends and to invest in financial assets rather than to make productive investments. However, the correlation between labor share and investment can be jointly driven by factors such as the intensity of competition and financial constraints. As shown by Aghion *et al.* (2005) and Hashmi (2013), investment, and more specifically innovation, tends to fall with competition, particularly at higher initial level of competition. Moreover, Carpenter & Petersen (2002) and Savignac (2008) show that financial constraints could affect investment. In the following sections, we revisit the relationship between labor share and innovation, focusing at the firm level and controlling for confounding factors such as the intensity of competition and financial constraints.

### 3 Empirical framework

#### 3.1 Data and descriptive statistics

Our data come from FactSet, an online financial database similar to Thomson Reuters and Bloomberg databases.<sup>2</sup> We use these data to build a panel of 4760 international companies over 20 years, from 1994 to 2013. The panel is strongly unbalanced due to missing values on key variables such as R&D expenditures, labor expenditures, capital expenditures and debt services. The average number of observations per company is 2.74, making a total of 13063 observations. Up to 10% of these companies have their headquarters in the United States of America (US) or Canada, 35% in Europe or Africa and 55% in the Asia-Pacific region, mainly Australia, China, Japan and Hong Kong. These companies operate in all sectors of the economy. However, 84% generate positive international sales. We exclude companies that did not innovate during the period of the study. More specifically we remove companies with zero total research and development (R&D) expenditures over the 20 years of observation.

For these companies, we obtain yearly data about firms' size, expenditures and financial status. Size variables include sales and the number of employees, both full-time and part-time workers.

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<sup>1</sup>Note that in the meantime investment has been rising in emerging countries.

<sup>2</sup>FactSet is used in academic studies such as Ferreira & Matos (2008).

Expenditures data include total operational expenditures, as well as expenditures in R&D, capital, and labor. Capital expenditures are typically investments in equipment and physical infrastructures. Labor expenditures encompasses wages. Financial status data include free cash flow and debt.

Table 1 below describes the main variables. The summary statistics suggest that our sample is made of large firms. The average firm employs 14,000 workers and generates 6 billions of US dollars yearly sales.<sup>3</sup> Our sample also comprises smaller firms as suggested by a median size which is smaller than the average. Firms with zero sale and workers are typically new entrants. On average, R&D expenditures represent 1% of sales, whereas capital expenditures represent 8% of sales. R&D and capital expenditures are lumpy as firms do not invest every year (zero expenditures). Labor expenditures account for 9-10% of sales. Free cash flow is calculated as the difference between cash flow (depreciation and amortization) and capital expenditures. It can be negative if internal funds are not sufficient to cover capital expenditures. Debt stock represents 32% of sales.

Table 1: Variables and descriptive statistics

<b>variable</b>	<b>definition</b>	<b>Obs.</b>	<b>min</b>	<b>med</b>	<b>mean</b>	<b>max</b>	<b>sd</b>
<i>Y</i>	Sales	13063	0.00	329.88	5940.39	2.87e+06	56738.08
<i>N</i>	Number of workers	10569	0.00	2642	13555.75	595002	37162.22
<i>RD</i>	R&D expenditures	13063	0.00	1.22	61.65	13460.69	443.08
<i>K</i>	Capital expenditures	13063	0.00	12.54	518.23	708943.50	9081.49
<i>wN</i>	Labor expenditures	13063	0.00	33.43	524.37	179638.03	4097.77
<i>II</i>	Ebitda	13063	-1572.30	48.65	1242.45	861836.81	14274.05
<i>cf</i>	Free cash flow	13063	-2.12e+05	0.56	3.90	127710.15	3185.96
<i>x</i>	debt stock	13057	0.00	63.47	1895.86	1.30e+06	22543.18

Sales and expenditures are expressed in millions of current US dollars. Ebitda stands for Earnings before interest, taxes, depreciation and amortization. Observations are at firm-year level.

We follow the literature by measuring innovation as R&D expenditures (Aghion *et al.* , 2005, 2017). Alternative measures such as citations-weighted patents and factor productivity are not available in our dataset. By using R&D expenditures, we focus on the input of innovation, instead of the output. We neutralize the firm size effects by taking the ratio of R&D expenditures to sales. Let  $rd_{it}$  denote innovation in firm  $i$  in year  $t$ . It can be expressed as:

$$rd_{it} = \frac{RD_{it}}{Y_{it}}$$

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<sup>3</sup>For instance, the average large firm, as defined by the French statistical office in 2011, employs 18,000 workers and generates 6 billions euros.

Where  $RD_{it}$  and  $Y_{it}$  stand respectively for R&D expenditures and sales. The distribution of  $rd_{it}$  is highly skewed toward zero. More than 90% of firms spend less than 5% of their revenues in R&D. The largest R&D expenditures represents 22% of sales.

Labor share is measured at the firm level as the ratio of wages to value added. This latter corresponds to the sum of wages and profit. Formally, the labor share can be expressed as:

$$lshare_{it} = \frac{w_{it}N_{it}}{w_{it}N_{it} + \pi_{it}}$$

$w$  denotes average wage and  $N$  the number of workers. Profit  $\pi_{it}$  is calculated as:

$$\pi_{it} = \Pi_{it} - (A_{it} + I_{it})$$

Where  $A_{it}$  denotes depreciation and amortization, and  $I_{it}$  denotes debt interest.

Labor share is also highly skewed, but towards 1. The average labor share stands at 70%, while the median is close to 77%.

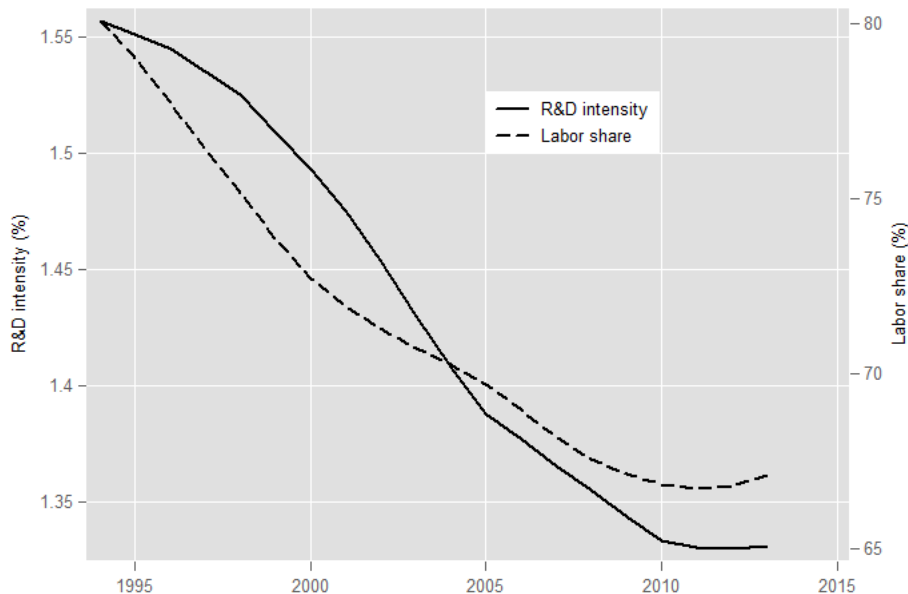
Figure 1 presents the trends in labor share and innovation between 1994 and 2013. These trends have been obtained from the local polynomial smoothing of the yearly average labor share and R&D expenditures. The local polynomial smoother is useful to get rid of noises.

Figure 1 highlights a dramatic fall in the labor share, by 15 percentage point in 20 years, from 80% in 1994 to 65% in 2013. This trend accords well with the findings from other studies on the evolution of the aggregate labor share such as OECD (2015). The magnitude of this fall is consistent with the findings by Autor *et al.* (2017b), whereby large firms are the main drivers of the declining labor share. This large decline in the labor share stems from a divergence between labor productivity and average wage. As shown in Figure A-1 in the appendix, labor productivity increases 8 folds between 1994 and 2013, whereas average wage merely doubles over the same period. A second force driving down the labor share is employment. Indeed, as shown in Figure A-1 in the appendix, the average number of workers per firm in our sample declines by 25%, from 16,000 in 1994 to 12,000 in 2013. Meanwhile, we also observe a slight fall in R&D intensity by 0.2 percentage point, from 1.55% in 1994 to 1.35% in 2013.

These joint downward sloping trends suggest a positive correlation between labor share and innovation. However, they might be driven by firm specific effects such as entry and exit. For instance, to the extent that new entrants have lower R&D intensity and lower labor share, a rise in entry could drive the joint downward trends. In addition, the intensity of competition as well as financial constraints could jointly drive labor share and innovation. We specify an

econometric model that controls for firms and year fixed effects, as well as the intensity of competition and financial constraints.

Figure 1: Labor share and R&D intensity



Note: Local polynomial smoothing of the trends in R&D intensity and labor share. We use the epanechnikov kernel with a polynomial of degree zero (constant) and the bandwidth of 2.36 for labor share and 3.56 for R&D intensity.

### 3.2 Econometric model

To test the relationship between labor share and innovation, we specify the following econometric model:

$$rd_{it} = \alpha + \beta lshare_{it} + \gamma X_{it} + \mu_t + \mu_i + \varepsilon_{it} \quad (1)$$

$X$  is a vector of controls and  $\mu_t$ ,  $\mu_i$  and  $\varepsilon_{it}$  are respectively time fixed effects, firm fixed effects and residuals.

Our goal is to estimate  $\beta$ , the correlation between labor share on innovation, controlling for the intensity of competition, financial constraints as well as time and firm-specific effects. Equation (1) is estimated on the basis of Ordinary Least estimator (OLS). Following Karabarbounis & Neiman (2014), we expect  $\beta$  to be negative, meaning that declining labor



share comes with rising innovation. This negative correlation would lend support to the hypothesis that capital-augmenting innovation tends to shift value added from labor to capital. However, a positive  $\beta$  would mean a declining labor share and innovation.

We control for the intensity of competition and financial constraint. The intensity of competition is measured on the basis of the Lerner index of monopoly power.<sup>4</sup> Given that marginal cost is not observed, we assume that firms produce homogeneous products with constant marginal cost. Under this assumption, the Lerner index is equivalent to the ratio of profit to sales. This ratio is typically used as a measure of the intensity of competition as in Aghion *et al.* (2005). We use two measures of financial constraint, namely the ratio of free cash flow to sales and the natural logarithm of debt stock.<sup>5</sup>

## 4 Results

Table 2 presents OLS estimates of equation (1). Consistently with Figure 1, the coefficient  $\beta$  is positive and statistically significant at 1% level. It implies that a percentage point decrease in labor share is associated with 0.005 percentage point fall in R&D intensity. In spite of its statistical significance, this correlation is economically small. It represents roughly 0.16% of the standard deviation of R&D intensity.

Controlling for the intensity of competition, cash flow and debt stock in specification (2) does not affect the sign, magnitude and precision of the estimate of the correlation between R&D intensity and labor share. This finding means that the positive correlation between labor share and innovation is not driven by the intensity of competition or by financial constraints. Though, in accordance with the findings from the literature, R&D intensity significantly falls with the intensity of competition, and rises with cash flow and debt.

Specification (3) tests the validity of the econometric specifications (1) and (2) by using the logarithm of R&D expenditures as a dependent variable and the logarithm of sales as a control. The coefficient of the logarithm of sales is not statistically different from 1, lending support to R&D intensity as a valid dependent variable in specifications (1) and (2). The Fisher's statistic of the test equals 0.

Specification (4) tests whether the declining R&D intensity is compensated by a rising capital expenditures. It turns out that capital expenditures also fall alike. A percentage point decline

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<sup>4</sup>The Lerner index can be expressed as  $\frac{p-c}{p}$ , where  $p$  and  $c$  denote respectively price and marginal cost.

<sup>5</sup>The sensitivity of free cash flow to investment has been criticized by Kaplan & Zingales (1997) as a measure of financial constraint. However, as emphasized by Fazzari *et al.* (2000), it still provides a useful proxy for financial constraint.

in the labor share is associated with 0.05 percentage point fall in capital expenditures. Hence, the rising profit share of firms in our sample has not been devoted to increasing investment within the firms.

Specification (5) presents the reduced-form estimate of the correlation between labor share and output. The estimation accounts for the adjustment cost in output by introducing the lagged of sales as an explanatory variable. We find a negative and significant correlation between labor share and output. This means that the declining labor is associated with rising sales, consistently with the large increase in productivity shown in Figure A-1. More specifically, a percentage point decline in the labor share corresponds to 0.10% rise in output. In addition, the coefficient of lagged sales is positive, significant and less than 1, lending support to an adjustment cost of output.

To test whether the declining R&D expenditures, induced by the falling labor share, reduces output growth we introduce R&D expenditures as a control in specification (6). The coefficient of labor share in this equation corresponds to the correlation with output holding R&D expenditures constant. OLS estimates presented in the last column of Table 2 show a stronger negative correlation between labor share and sales. If R&D expenditures were held constant, a percentage point decline in labor share would have been associated with 0.11% rise in sales. Therefore, the declining R&D expenditures, induced by a percentage point fall in labor share, costs 0.01 percentage to output growth. The adjustment cost is such that this cost is multiplied by a factor of 1.7 in the long run.

Table 2: Estimation results

	<i>rd</i>		<i>lnRD</i>	<i>capex</i>	<i>lnsales</i>	
	(1)	(2)	(3)	(4)	(5)	(6)
<i>lshare</i>	0.005*** (0.001)	0.005*** (0.001)	1.048*** (0.273)	0.050*** (0.004)	-0.101*** (0.032)	-0.109*** (0.032)
<i>comp</i>		-0.007*** (0.003)	-0.103 (0.557)	0.017** (0.008)	0.186 (0.194)	0.185 (0.194)
<i>cashflow</i>		0.011*** (0.003)	0.616 (0.710)	-0.070*** (0.013)	-0.085 (0.147)	-0.089 (0.148)
<i>lndebt</i>		0.0001** (0.00007)	0.046 (0.033)	0.0003 (0.0002)	0.022*** (0.004)	0.023*** (0.004)
<i>lnsales</i>			1.006*** (0.142)			
<i>lnsales<sub>t-1</sub></i>					0.415*** (0.084)	0.412*** (0.084)
<i>lnrd</i>						0.008*** (0.002)
$\mu_i, \mu_t$	✓	✓	✓	✓	✓	✓
<i>constant</i>	0.010*** (0.001)	0.015*** (0.003)	-8.759*** (2.792)	-0.001 (0.009)	10.888*** (1.606)	10.866*** (1.595)
<i>N</i>	13063	13052	13052	13052	12411	12411
<i>n</i>	4760	4754	4754	4754	4580	4580
$\bar{T}$	2.74	2.75	2.75	2.75	2.70	2.70
F	4.06	4.34	6.28	16.37	171.57	168.28

Significant at 1%(\*\*\*), 5%(\*\*) and 10%(\*). Standard errors robust to heteroskedasticity and autocorrelation in parentheses.  $N=n\bar{T}$ , where  $n$  is the number of firms.

## 5 Conclusion

In this paper, we investigate the relationship between labor share and innovation. We find a robust, positive and significant correlation between labor share and innovation. This finding suggests that the internal funding capacity yielded by the declining labor share is not channeled into financing innovation within the firm. On the contrary, R&D expenditures decline along with the labor share. This downward trend in innovation lowers output growth by 0.01 percentage point for every percentage point decline in the labor share.

One potential explanation of the positive correlation between labor share and innovation is the rise of finance. The incremental profit generated by declining labor share is either used to invest in financial or in productive assets with higher returns that typically outweigh the cost to internal output growth. However, as emphasized by OECD (2015), aggregate investment in the G20 countries has remained rather flat so far. Therefore, an alternative explanation would be that rising profit is channeled into developing countries where the OECD (2015) observe rising investment.

Of course, the relationship between labor share and innovation is not causal. As emphasized by Karabarbounis & Neiman (2014), innovation, particularly in capital-augmenting technologies, is a strong determinant of the declining labor share. In addition, a confounding factor driving the correlation between labor share and innovation is the taxation policy. More favorable taxation of capital income, in the form of lower tax on investment return for instance, provide an incentive to redirect internal funds towards higher return investment outside the firm. Future research should investigate these alternative mechanisms.

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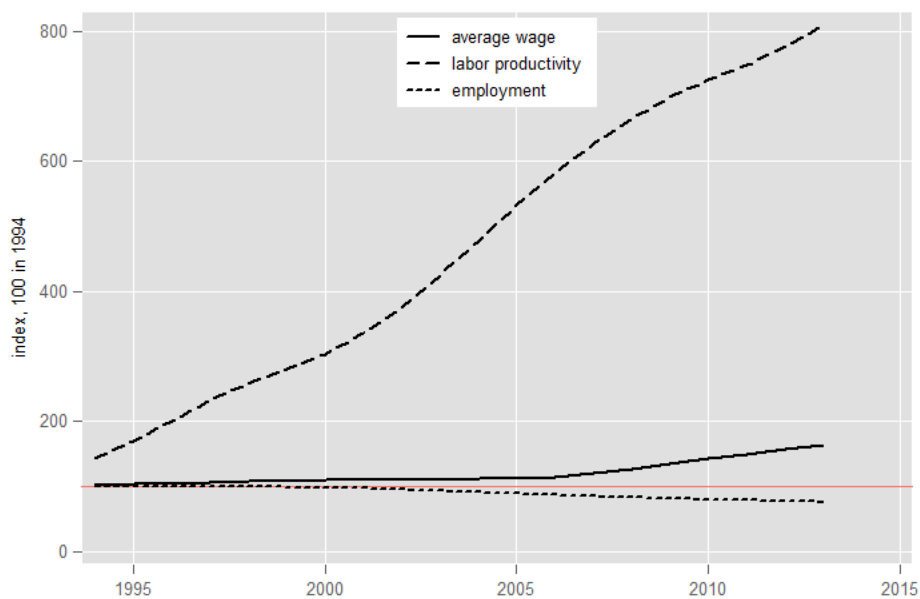
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# Appendix

Table A-1: Summary Statistics

variable	definition	obs.	mean	sd	min	med	max
<i>lnRD</i>	log of R&D exp.	13063	12.61	5.53	-0.58	14.02	23.32
<i>lnsales</i>	log of sales	13063	19.72	2.32	7.38	19.61	28.68
<i>rd</i>	R&D intensity	13063	0.01	0.03	0.00	0.00	0.95
<i>lshare</i>	labor share	13063	0.69	0.25	0.00	0.77	1.00
<i>comp</i>	1 - Lerner	13063	0.86	3.41	-254.47	0.94	1.00
<i>cashflow</i>	free cash flow-to-sales	13058	-0.01	0.29	-21.27	0.01	0.49
<i>lndebt</i>	log of debt stock	13057	17.74	3.53	0.00	17.97	27.89

Figure A-1: Average wage, labor productivity and employment



Note: Local polynomial smoothing of trends. Average wage is measured as the ratio of labor expenditures to the number of workers. Labor productivity is measured as the ratio of value added to the number of workers. Employment is measured as the number of workers. Each data point corresponds to the average across all firms within a given year.