INTERNATIONAL REVIEW OF ECONOMICS AND MANAGEMENT

ISSN: 2148-3493 IREM

DOI: 10.18825/irem.81315 Volume 3, Number 1, 2015, 1-13.

LABOR INTENSITY AND OPERATING LEVERAGE IN MANUFACTURING FIRMS

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Abstract

I show that industry adjusted labor intensity is positively related to expected returns for firms in the manufacturing industry. Labor is one the most important factor of productions for a firm. When a negative shock hits the economy, revenues fall. However, labor costs do not fall as much as revenues. On average at the firm level, revenues are more procyclical than labor costs and labor costs are less procyclical than capital expenditures. Therefore, firms with relatively high labor intensity are more vulnerable to the business cycle than those with less labor intensity. I also show that firms with higher labor intensity have higher cash flow sensitivity to the aggregate shocks. This result supports the operating leverage mechanism behind the labor intensity and return relationship.

Keywords: Labor intensity, Operating leverage, Cross section of expected returns

JEL classification: E22, G12

I. INTRODUCTION

Labor is one of the most important factors of production. Labor affects firm value whenever there are frictions in the labor market (Merz & Yashiv, 2007). In this paper, I show that a firm's labor intensity relative to its industry is associated with higher equity returns.

Firms do not own their labor input. Labor can only be rented. Wages are the rental fees paid to the employees in return for their human capital. The concept of wage rigidity and smoothness relative to marginal product of labor is well established in the literature (Shimer (2005), and Hall (2005)). Labor expense is a quasi-fixed cost to the firm. During the business cycle, revenues drop, however the wage

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I would like to thank Kürşat Aydoğan, Şelale Tüzel and seminar participants at the 16th EBES Conference in Istanbul for many comments and discussions.

expense stays the same. Firms cannot easily cancel or adjust the terms of contracts between their employees because of firing, hiring and other contractual costs.

This paper is an extension to the growing literature on labor-induced operating leverage by Danthine & Donaldson (2002), Chen, Kacperczyk & Ortiz-Molina (2011), Favilukis & Lin (2013), and Donangelo (2014). Chen et al. (2011) show that the cost of equity is significantly higher for firms in more unionized industries since unionization reduces operating flexibility. Favilukis & Lin (2013) develop a production-based asset pricing model with sticky wages and employment adjustment costs. Favilukis & Lin show that wage growth negatively forecasts stock returns at the industry level and this dependence is stronger if labor share is higher, or if wages are more rigid. Donangelo (2014) shows that firms face greater operating leverage by providing flexibility to mobile workers. Therefore Donangelo(2014) argues that firms in mobile industries are riskier and have higher expected returns.

In this paper, I construct a measure of the firm's relative labor intensity by dividing the firm's labor intensity into the industry average. Then, I run Fama-Macbeth panel regressions employing relative labor intensity ratio to document the relation between labor intensity and expected returns. Higher labor intensity is associated with higher expected stock returns for manufacturing firms. To investigate the risk mechanism behind expected returns, I show that, on average at the firm level, revenues are more procyclical than labor costs and labor costs are less procyclical than capital expenditures. I also show that firms with higher labor intensity have higher cash flow sensitivity to the aggregate shocks and thus are more exposed to the business cycle.

I include only manufacturing firms in the CRSP/Compustat database. Industry level data are at 4 digit Standard Industry Classification (SIC) code level from National Bureau of Economic Research (NBER) manufacturing industry database, provided by Becker & Gray (2009). Although I include only manufacturing firms, sub-industries within the manufacturing industry differ in their capital composition within the manufacturing industry. For example, apparel industry is more labor intensive compared to petroleum refining industry. Therefore, to compare firms from different industries, I adjust the firm's labor intensity by the corresponding 4 digit SIC level industry average. The measure of labor intensity is the firm's number of employees divided by the firm's net property, plant and equipment.

I further decompose property, plant and equipment into structures and equipment and show that when only structures are used in the denominator of labor intensity ratio, the association between labor intensity and expected returns becomes insignificant. For manufacturing firms in the Compustat database, structures, on average, constitute around 30% of firm capital. Structures are also a risky type of capital to the firm due to their slow depreciation rates. Firms with high levels of structures are more exposed to the business cycle risk assuming costly irreversibility and asymmetric adjustment costs (Tuzel, 2010). On the other hand, labor-induced operating leverage mechanism works even when there are moderate adjustment costs.

This paper is also related to the literature on the relationship between stock returns and operational and distress risk.[†] Higher labor intensity, holding everything else constant, leads to higher cash flow sensitivity and default risk during bad times. Labor is only a part of the firm's inflexible commitments and therefore partially contributes to the operating leverage. Also, risks related to labor constitute only a part of operational risks. Managers may offset the risk of labor intensity on equity through lower financial leverage, higher cash positions or in other ways. However, examining the direct impact of labor alone is also informative about the firm risk and return relation.

In summary, this paper provides new empirical evidence on the relation between labor intensity and expected stock returns at the firm level using NBER manufacturing industry database. Section 2 discusses the basic intuition behind the risk of labor intensity and shows the relationship between expected returns and labor intensity ratio. Section 3 concludes.

II. EMPIRICAL ANALYSIS AND RESULTS

In this section, I show the empirical link between the firm's relative labor intensity and expected stock returns in the cross section. I construct a measure of the firm's level of labor intensity using data from firm financial statements and then divide this firm level labor intensity with industry level labor intensity. I call this ratio, "relative labor intensity ratio". This ratio tells us whether the labor intensity ratio of the firm is high or low compared to the industry average. My key variable, relative labor intensity ratio, is as follows:

$$\text{Relative Labor Intensity Ratio} = \frac{\text{Firm's number of employees/Property, plant and equipment}}{\text{Industry's number of employees/Industry capital stock}}$$

The number of employees and property, plant and equipment data items are from Compustat. Industry level data are from NBER manufacturing industry database. In the U.S., only regulated firms are obliged to report their labor costs. This represents about 5% of all firms. There are some firms who voluntarily report their labor costs but that represent only another 5% of all firms in the Compustat database. Furthermore, this voluntary reporting is irregular. Therefore, I use firms' number of employees as a proxy for the level of labor intensity. I normalize firms' number of employees by firms' net property, plant and equipment since NBER manufacturing database has "capital stock" data item at the industry level.

I include firms whose SIC code is between 2000 and 3999. The sample is an unbalanced panel with 1823 distinct firms and 128 distinct industries. Accounting data span the period from 1963 to 2009. Accounting data end in 2009 because NBER manufacturing industry database is available until 2009. Following Fama & French (1993), I match CRSP stock return data from July of year *t+1* to June of year *t+2* with labor intensity information for fiscal year ending in year *t*. Monthly stock returns are from CRSP and

[†] See Vassalou and Xing (2004), Garlappi and Yan (2011)

span the period July 1964 to November 2011. I include only companies with ordinary shares and listed on NYSE, AMEX or NASDAQ. I exclude firms with missing SIC codes, negative book value, and missing June market values. I require a firm to have a December fiscal-year end in order to align the accounting data across firms. Following Fama & French (1993), I include only firms with at least two years of data to be included in the sample.

II.I. Descriptive Statistics

Labor intensity could be related to firm characteristics that are found to be related to firm risk and expected returns. Table I shows the dispersion in descriptive characteristics of firms with high and low labor intensity and the time-series averages of the cross-section Spearman rank correlations between other firm characteristics. Firms with high labor intensity are smaller. Their financial leverage is lower. Financial leverage is calculated as the ratio of long term debt plus debt in current liabilities divided by total assets. Chen, Harford & Kamara (2014) argue that firms with more inflexible operating costs endogenously choose lower financial leverage ex ante to reduce the likelihood of default in future bad states.

Table I

Descriptive statistics

Labor intensity	Relative labor intensity ratio	Size (millions)	Book-to-market	Financial leverage	Operating leverage	Cashflow-to-assets
Low	2.05	2,833	0.78	0.23	0.92	0.08
Medium	5.04	2,157	0.78	0.20	1.08	0.06
High	21.83	1,076	0.72	0.17	1.17	0.02

Spearman rank correlations

	Relative labor intensity	Size	Book-to-market	Financial Leverage	Operating leverage	Cashflow-to-assets
Relative labor intensity	1.00					
Size	(0.23)	1.00				
Book-to-market	(0.09)	(0.29)	1.00			
Financial leverage	(0.15)	0.02	0.18	1.00		
Operating leverage	0.23	(0.32)	0.14	(0.00)	1.00	
Cashflow-to-assets	(0.11)	0.37	(0.31)	(0.26)	0.04	1.00

The top panel reports the mean value of firm characteristics averaged over the years. The bottom panel reports the time-series averages of the cross-section Spearman rank correlations between the firm characteristics.

Labor intensive firms have lower internal available funds, cash flow to assets. Cash flow-to-assets ratio, which is income before extraordinary items plus depreciation and amortization divided by total assets, indicate firms that are financially constrained, as in Eisfeldt & Rampini (2009). Labor intensive firms have higher operating leverage, which is measured as the sum of cost of goods sold plus selling, general and administrative expenses, divided by total assets, as in Novy-Marx (2011).

II.II. Firm-Level Fama-Macbeth Regressions

To investigate the relationship between the labor intensity ratio and the expected excess returns (excess of the risk-free rate), I run firm level Fama-Macbeth cross-sectional regressions (Fama & MacBeth, 1973) using the lagged firm level labor intensity ratio as a return predictor. I estimate the following cross-sectional regression for firm $i = 1, \ldots, N$ in each month:

$$R_i = \propto + \beta\lambda_i + \gamma D_i + \varepsilon_i \qquad \text{(I)}$$

In the specification above, i is a firm index, and monthly returns are denoted by R_i. The measure of the labor intensity rate is denoted by λ_i, and D_i is a vector of controls. I measure λ_i and all control variables based on accounting ratios at the end of the previous year. In Table II, I show that labor intensity ratio is positively related to expected returns. The cross sectional regressions that include size, and book-to-market produce positive and statistically significant average slope for the labor intensity ratio. As in Fama & French (2008), I do not include the market beta since the market beta for individual stocks is not precisely measured in the data.

In the literature, although the theoretical relationship between financial leverage and firm systematic risk is well established, empirical evidence on the relationship between financial leverage and stock returns is mixed. When other firm characteristics are included in regressions, financial leverage often becomes insignificant in predicting returns (Fama & French, 1992). In Table I, I document that labor intensive firms have lower financial leverage and Fama-Macbeth regressions show that, financial leverage is not significantly related to expected returns.

Firms' capital and labor utilization decisions may depend on financial constraints. Livdan, Sapriza, & Zhang (2009) argue that tighter financial constraints leads to higher stock returns. I control for financial constraints, cash flow-to-assets ratio (measure of the firm's available internal funds) in Fama-Macbeth regressions since the source of risk may be financial constraints rather than labor intensity. Labor intensity has still a significant coefficient after controlling for financial constraints.

Table II

Fama-MacBeth regressions employing relative labor intensity ratio

Independent variables	(1)	(2)	(3)	(4)	(5)
Labor intensity ratio	0.013	0.010	0.006	0.007	
	(2.46)	(2.17)	(1.53)	(1.72)	
Log(Size)		-0.215	-0.192	-0.203	-0.190
		(-4.12)	(-4.27)	(-4.58)	(-4.24)
Log(B/M)		0.252	0.291	0.290	0.279
		(2.45)	(2.99)	(2.93)	(2.84)
Financial leverage			0.035	0.060	0.030
			(0.10)	(0.17)	(0.09)
Operating leverage			0.093		0.111
			(0.82)		(0.99)
Cashflow-to-assets			0.233	0.166	0.073
			(0.30)	(0.21)	(0.09)

This table reports results from Fama-MacBeth regressions of firms' returns on firms' relative labor intensity ratios. Specifications 2–5 include controls for firm characteristics. t-statistics are reported in parentheses below coefficient estimates (computed as in Newey-West with four lags).

In Table I, labor intensity is positively correlated with operating leverage. This is expected since labor costs constitute a significant portion of cost of goods sold and selling, general, and administrative expenses. Marginal effect of labor intensity becomes insignificant when I include Novy-Marx operating leverage measure. However, Novy-Marx operating leverage measure's coefficient is insignificant when firm characteristics other than labor intensity are included in the regressions.[‡]

II.III. Capital Composition

Physical capital is heterogeneous. Equipment and structures are the two components of the firm's capital stock in the NBER manufacturing database. Structures depreciate slowly whereas equipment depreciates much faster. Due to costly reversibility, firms cannot easily reduce their structures in a recession. Tuzel (2010) show that firms with high real estate holdings are more vulnerable to bad productivity shocks and therefore are riskier and have higher expected returns.

The denominator of my measure of labor intensity includes the sum of structures and equipment as the firm's total capital. In my sample, on average, equipment and structures account for 61% and 30% of property, plant and equipment, respectively. The remaining 8% and 1% belong

[‡] Novy-Marx (2011) sample includes all industries except financials whereas my sample includes only manufacturing firms.

to capital leases and other property, plant and equipment. Capital leases can both be structures and equipment. To further investigate the impact of labor intensity on firm risk, I decompose the capital stock into two parts in my relative labor intensity ratio: firm number of employees divided by equipment relative to the industry ratio of number of employees divided by equipment and firm number of employees divided by structures relative to the industry ratio of number of employees divided by structures. The two ratios are as follows:

$$\text{RLI Ratio 1} = \frac{\text{Firm's number of employees/Equipment}}{\text{Industry's number of employees/Industry equipment capital stock}}$$

$$\text{RLI Ratio 2} = \frac{\text{Firm's number of employees/Structures}}{\text{Industry's number of employees/Industry structures capital stock}}$$

Property, plant and equipment data in Compustat is decomposed into buildings, capitalized leases, machinery and equipment, natural resources, land and improvements, and construction in progress starting from 1969. I assume buildings, natural resources, land and improvements, and construction in progress constitute structures. The Compustat data on the composition of the property, plant and equipment are “net of depreciation” over 1969-1993 and “historical cost” over 1984-2009. I use net values until 1984 and switch to historical cost values starting in 1984, as in Tuzel (2010). I run Fama-Macbeth cross-sectional regressions using these ratios as return predictors. Results in Table III show that only relative labor intensity ratio 1 is significantly related to the firm’s expected returns. Including capital leases as equipment or structures do not change these results.

Relative labor intensity ratio 1 (RLI Ratio 1), which is basically number of employees per dollar invested in machinery and equipment is a measure of the degree of automation in firm’s production technology. Labor intensity has been decreasing steadily over the years. Employees can be replaced by machines but cannot be replaced by buildings. When deciding on labor-capital mix, firms take into account both the technical aspects of production and the costs of different inputs. Since my measure of labor intensity is adjusted for industry at the 4 digit SIC code level, the managerial choice is between labor and equipment rather than labor and building, given the firm specific characteristics and constraints.

Table III

Fama-MacBeth regressions employing relative labor intensity ratio

Independent variables	(1)	(2)	(3)	(4)
Labor intensity ratio 1	0.048		0.035	
	(2.59)		(2.19)	
Labor intensity ratio 2		0.001		0.000
		(0.94)		(0.03)
Log(Size)			-1.180	-0.145
			(-3.65)	(-3.14)
Log(B/M)			0.335	0.324
			(3.48)	(3.07)
Financial leverage			0.040	0.343
			(0.11)	(0.91)
Operating leverage			0.094	0.080
			(0.70)	(0.61)
Cashflow-to-assets			-0.207	0.728
			(-0.28)	(0.84)

This table reports results from Fama-MacBeth regressions of firms' returns on firms' relative labor intensity ratios. Specifications 3 and 4 include controls for firm characteristics. t-statistics are reported in parentheses below coefficient estimates (computed as in Newey-West with four lags).

II.IV. Gdp Betas

This paper builds on the idea that the firm's labor costs are inflexible during the business cycle. On average, revenues are more procyclical than costs. Furthermore, labor costs are less procyclical than capital expenditures. In order to show this proposition, I regress firms' real growth in revenues, wage expenses, and capital expenditures on real GDP growth with firm-fixed effects, as follows:

$$\Delta Revenues_{i,t}=\propto_i+\beta_1\Delta GDP_t+\varepsilon_{i,t}$$

$$\Delta Wages_{i,t}=\propto_i+\beta_2\Delta GDP_t+\varepsilon_{i,t}$$

$$\Delta Capitalexpenditures_{i,t}=\propto_i+\beta_3\Delta GDP_t+\varepsilon_{i,t}$$

Only 11% of the firms in my sample report their labor expense. In order to include all manufacturing firms in the cross section, I use a proxy for labor expense. I measure the industry-specific wage rate using data from the NBER manufacturing industry database. The data for industry level compensation per employee is available at the four digit SIC code. Firm level wage rate is computed by matching the firm-specific Compustat SIC code to the corresponding SIC code average annual wage data from NBER, and then by multiplying wages by the number of employees of the specific firm. Data on GDP are from BEA's NIPA Table 1.1.1. The corresponding GDP deflator is used to transform firm variables to real values. The term $\propto_i$ captures the individual firm effect. Table IV below reports the regression coefficients, GDP betas, which measure the cyclicality in costs and revenues.

The GDP beta of wage growth is lower than GDP betas of revenue growth and capital expenditure growth. As expected, labor costs have lower exposure to fluctuations in GDP than revenues and capital expenditure at the firm level.

Table IV

Sensitivity to GDP growth

	Dependent variable		
	Δrevenues	Δwages	Δcapitalexpenditure
ΔGDP	4.25	2.95	11.59
	(2.41)	(6.95)	(4.56)
R^2	0%	0%	0%
Number of observations	19,679	19,679	19,679

This table reports coefficients of panel data regressions of revenue, wage and capital expenditure growth on aggregate GDP growth. t-statistics are in parentheses. The sample period is from 1964 to 2009.

II.V. Cash Flow Sensitivity

I investigate further whether labor intensity is related to systematic differences in the sensitivity of firms' cash flows to aggregate shocks in the economy. The existence of such a difference could support the operating leverage mechanism behind the labor intensity and return relationship. I expect that the cash flows of firms with high labor intensity would be more sensitive to aggregate shocks than the cash flows of low labor intensity firms. Labor expenses have a priority claim in firm cash flows. After the labor expense is paid, residual cash flows are used for dividends and investment. The measure for cash flow is net cash flow from operating activities. I estimate the following pooled time series/cross sectional regressions:

$$\Delta CashFlow_{i,t}=\propto_i +\beta\Delta CashFlow_{agg,t}+u_{i,t} \qquad (II)$$

where $\Delta CashFlow_{i,t}$ is the change in cash flows of firm i between year *t -1* and *t*, scaled by firm assets in year *t-1*. $\propto_i$ captures the individual firm effect, and I proxy aggregate shocks with the cross-sectional average of $\Delta CashFlow_{i,t}$ over all firms in my sample. Since I use ΔCashFlow on each side of the regression, at the firm level on the left hand side and aggregate on the right hand side, I can interpret the regression coefficient as the firm's cash flow beta to aggregate shocks. I divide firms into 3 labor intensity groups based on their labor intensity ratio in year *t-1*, and I run panel regressions in each labor intensity ratio group and present the regression coefficients in Table V. High labor intensity firms have higher sensitivity to aggregate shocks in the economy. The regression coefficient is 1.33 for firms in the high labor intensity group, and 0.63 for the low labor intensity group.

A firm's cash flow sensitivity to existing sources of risk implies that volatility should increase with labor intensity. I further show that, firms with high labor intensity have higher volatility of cash flow growth. High labor intensity group's standard deviation of annual average cash flow growth is 2.18%, whereas low labor intensity group has a standard deviation of 1.16%.

Table V

Cash flow regressions

Dependent Variable: $\Delta CashFlow_{i,t}$

	Low	Medium	High
$\Delta CashFlow_{agg,t}$	0.63	0.80	1.33
	(0.11)	(3.73)	(2.01)
Number of observations	3,388	4,503	3,236

Volatility of cash flow growth

	Low	Medium	High
δ^{CF}	1.16%	1.46%	2.18%

The top panel in this table presents results of panel regressions of change in firm level cash flow on change in aggregate cash flow. Change in cash flow is measured as the level difference between operating net cash flows at time *t* and *t-1*, scaled by total assets at time *t-1*. Change in aggregate cash flow is measured as the cross sectional average of firm level changes. Firms are sorted into 3 groups based on the past year's relative labor intensity. The sample period is 1988-2009 since operating net cash flow data item is available from 1988. Firm fixed effects are included. t-statistics are in parentheses. The bottom panel presents the standard deviation of average cash flow growth of labor intensity groups.

III. CONCLUSION

This paper provides new empirical evidence about the link between firms' industry adjusted labor intensity and expected stock returns. I show that at the firm level that labor costs are less procyclical than capital expenditures and revenues. Therefore, residual cash flows become more procyclical in firms with high labor intensity. I also show that labor intensive firms have higher cash flow volatility and their cash flows are more sensitive to aggregate shocks.

There are several dimensions of labor that the labor intensity ratio ignores here. For example, differences in the composition of firms' labor (skilled and unskilled) can lead to cross-sectional differences in firms' risk because the skilled labor is more costly to adjust (Belo & Lin, 2012). Also, the length and terms of contracts and unionization have an impact on the degree of the flexibility of the labor force.

REFERENCES

Becker R.A. & W.B. Gray, 2009. NBER-CES Manufacturing Industry Database, available at http://www.nber.org/nberces.

Belo, F. & Lin, X., 2012. Labor heterogeneity & asset prices: The importance of skilled labor, unpublished working paper, University of Minnesota, Ohio State University.

Chen, H. J., Kacperczyk, M., & Ortiz-Molina, H., 2011. Labor unions, operating flexibility, & the cost of equity. *Journal of Financial & Quantitative Analysis*, 46 (1), 25-58.

Chen, Z., Harford J. and Kamara A., 2014. Operating inflexibility, profitability and capital structure, Working paper University of Reading and University of Washington.

Danthine, J. & Donaldson, J. B., 2002. Labor relations & asset returns. *Review of Economic Studies*, 69 (1), 41-64.

Donangelo, A., 2014. Labor mobility: Implications for asset pricing. *The Journal of Finance*, 69 (3), 1321-1346.

Eisfeldt, A. L. & Rampini A. A., 2009. Leasing, ability to repossess, & debt capacity. *Review of Financial Studies*, 22 (4), 1621-1657.

Fama, E. F. & MacBeth, J. D., 1973. Risk, return, & equilibrium: empirical tests. *Journal of Political Economy*, 81, 607-636.

Fama, E. F. & French, K. R., 1993. Common risk factors in the returns on stocks & bonds. *Journal of Financial Economics*, 33(1), 3-56.

Fama, E. F. & French, K. R., 2008. Dissecting anomalies. *Journal of Finance*, 63 (4), 1653-1678.

Favilukis J. & Lin, X., 2013. Does wage rigidity make firms riskier? Evidence from long-horizon return predictability, unpublished working paper. London School of Economics. Ohio State University.

Garlappi, L., & Yan, H., 2011. Financial distress & the cross-section of equity returns. *The Journal of Finance*, 66 (3), 789-822.

Hall, R., 2005, Employment fluctuations with equilibrium wage stickiness. *American Economic Review* 95, 50-65.

Imrohoroglu, A. & Tuzel, S., 2014. Firm level productivity, risk, & return. *Management Science*, 60(8), 2073-2090.

Livdan, D., Sapriza, H., & Zhang, L. 2009. Financially constrained stock returns. *The Journal of Finance*, 64(9), 1827-1862.

Merz, M., & Yashiv, E., 2007. Labor & the market value of the firm. *The American Economic Review*, 97 (4), 1419-1431.

Newey, W. & West, K., 1987. A simple, positive semi-definite, heteroskedasticity & autocorrelation consistent covariance matrix. *Econometrica* 55(3), 703-708.

Novy-Marx, R., 2011. Operating leverage. *Review of Finance* 15(1), 103-134.

Shimer, R., 2005. The cyclical behavior of equilibrium unemployment & vacancies. *American Economic Review*, 95(1), 25-49.

Tuzel, S., 2010. Corporate real estate holdings & the cross section of stock returns. *Review of Financial Studies*, 23(6), 2268-2302.

Tuzel, S. & Zhang, M. B., 2015. Local risk, local factors, & asset prices. *The Journal of Finance*, Forthcoming.

Vassalou, M., & Xing, Y., 2004. Default risk in equity returns. *The Journal of Finance*, 59(2), 831-868.