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Financial Constraints and Wage Differentials: Evidence from the NLSY

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《Abstract》

Using measures of financial constraints on firms, we investigate whether financial constraints explain the firm size–wage effect. The results suggest that financial constraints reduce the effect of firm size on wages, but that the effect remains statistically significant.

1. Introduction

Sources of wage differentials include sex, education, and occupation. In particular, it is well known that wages in large firms are generally higher than in small- and medium-sized enterprises (SMEs). Companies that are popular among new graduates are often large, not only because of their notoriety or financial soundness, but also because of their high wages.

One of the reasons why wage differentials attract people's attention is that they are an ethical concern. If they come from differences in workers' abilities, there is no problem, but if they come from some kind of market inefficiency, they lower economic welfare. Suppose that, other things being equal, there are wage differentials among ethnicities. In this case, firms that discriminate against their employees use resources inefficiently. In other words, they sacrifice the profits that they would earn if they did not discriminate. Such firms would not survive in highly competitive industries. However, the fact that wage differentials exist implies inefficiencies in markets and production.

The issue of wage differentials among firms of different sizes has a long history.[1] In his seminal study, Moore (1911) investigated the wages of female employees aged ≥15 years in Italian textile factories. He found that there is a strong relationship between the number of employees and wage rates. His explanation is that this is because large firms have large amounts of capital and excellent infrastructure, so they can provide opportunities for their workers to use their talents.

Following Moore (1911), Mellow (1982) used the current population surveys to estimate a log-linear wage equation. The results show that even if the characteristics of workers and industries are controlled for, both the size of plants or establishments and the size of firms positively affect wages. Using both employee and firm data to test seven hypotheses relating to wage differentials, Troske (1999) found evidence of wage premiums in large firms.

Wage differentials based on firm size broadly prevail. Miller (1981, 1985) find that almost all manufacturing firms exhibit a relationship between firm size and wages. Brown et al. (1990) present evidence of a firm size–wage relationship among firms outside manufacturing. This research indicates that wage differentials based on firm size are common in all industries.

It is difficult to determine what causes firm size and wages to be related. Some existing theoretical models provide plausible explanations. However,

1) For a survey of empirical analyses, see Oi and Idson (1999).

numerous recent empirical studies reveal that none of these theoretical explanations is consistent with the data.[2] Thus, wage differentials between different-sized firms remain an unexplained aspect of wage determination.

In response to this, Michelacci and Quadrini (2005a, b, 2009) developed a new hypothesis. They argue that the difficulties firms encounter in borrowing funds for investment influence wages. For example, small businesses without adequate collateral assets cannot obtain sufficient funds through loans. In response, they try to generate funds for investment by keeping their workers' wages low. Rapidly growing firms, on the other hand, can be expected to set current wages low and raise them in the future because they are likely to own adequate assets in the future. In other words, they "borrow" funds from their workers.

Michelacci and Quadrini (2005a) conducted an empirical analysis of this theory using data from the 1979 National Longitudinal Survey of Youth (NLSY79). First, they ran a simulation of the theoretical model, generated data, and obtained parameter estimates from a regression model. They then generated estimates from the NLSY79 data and compared them with the model estimates. It transpired that the two sets of estimates were similar. Based on these findings, they claim that financial constraints can explain the wage differentials between different-sized firms.

However, their empirical analysis does not explicitly include an indicator of financial constraints. Therefore, it is not clear whether their findings validate the theoretical model or whether they constitute evidence of wage differentials that are caused by other factors. Conversely, they might have simply presented a model that duplicates the data, in which case, there is no guarantee that the phenomenon that they claim exists is actually there

2) See Oi and Idson (1999).

to observe.

In this paper, to estimate the impact of financial constraints on wage differentials based on firm size, we use an indicator of the tightness of external financing. Our proposed indicator is the ratio of borrowings or debts to collateral assets. This is justified because financial constraints mean that borrowings cannot exceed the value of collateral. We use two indicators: the ratio of borrowings to total assets and the ratio of borrowings to tangible fixed assets. Our results suggest that these indicators weaken the relationship between firm size and wages. Furthermore, although the estimated effect of the ratio of borrowings to total assets is not statistically significant, the estimated coefficient of the ratio of borrowings to tangible fixed assets is negatively significant. This means that firms with sufficient tangible fixed assets, such as large firms, pay high wages. Hence, the hypothesis of Michelacci and Quadrini (2005a, b, 2009) is consistent with the data. Nevertheless, having accounted for these effects, there remains a statistically significant effect of firm size on wages; thus, financial constraints do not completely explain wage differentials.

The rest of this paper is organized as follows. In Section 2, we review theoretical models of wage differentials including that of Michelacci and Quadrini (2005a, b). In Section 3, we compare estimates from Michelacci and Quadrini's (2005a) model with those from models that include our proposed indicators of financial constraints. Section 5 concludes the paper.

2. Hypotheses of the Firm Size-Wage Premium

Can existing models explain wage differentials? Zabojnik and Bernhardt (2001) present a model in which employees in large firms are motivated to invest in human capital because of greater competition for promotion. As a result, more employees have high levels of human capital; i.e., greater competition for promotion within firms raises wages.

Shapiro and Stiglitz (1984) argue that when informational asymmetry between employers and employees prevents employers from effectively monitoring their employees' shirking, they pay an efficiency wage that gives employees an incentive not to shirk. However, this raises wages above the level that would prevail under symmetric information. In general, because it is more difficult for larger firms to monitor their employees, they pay higher wages.

According to MacDonald and Solow (1981), the higher is the bargaining power of the union relative to the firm, the higher are wages. Hence, given greater unionization in large firms, one would expect wage differentials based on firm size.

These explanations are plausible. However, Brown and Medoff (1989) suggest that even if all these effects are accounted for, firm size–wage effects remain. Therefore, existing theoretical models are not necessarily sufficient for explaining size-based wage differentials.

To deal with this problem, Michelacci and Quadrini (2005a, b, 2009) develop a new model in which firms require collateral to raise finance. Technically, they add a financial constraint à la Kiyotaki and Moore (1997) to the long-term contract models of Harris and Holmström (1982) and Holmström (1983). It is possible that borrowers cease production to renegotiate their financing contracts. Therefore, what borrowers can borrow is limited to the market value of their collateral. Because borrowers need collateral when raising finance, smaller firms, which do not have adequate collateral, implicitly borrow from their employees by paying lower wages because they are subject to financial constraints. Hence, smaller firms pay lower wages.

To investigate their hypothesis, Michelacci and Quadrini (2005a, b, 2009) use the NLSY79. They find that the estimates from the simulated data are similar to the estimates from the NLSY79. Hence, they conclude that their model is consistent with the data. To confirm this result directly, in the next section, we extend their empirical analysis.

3. The Empirical Models

3.1 Michelacci and Quadrini's Method

Michelacci and Quadrini (2005a) estimate the following model by using ordinary least squares:

$$\begin{aligned}\ln(wage_{it}) = \mu_1 + \alpha_1 \ln(size_{it}) + \alpha_2 growth_{it} + \alpha_3 growth_{it} \cdot tenure_{it} \\ + \alpha_4 growth_{it} \cdot exper_{it} + \beta X_{it} + \varepsilon_{it},\end{aligned} \tag{1}$$

in which the variables are defined as follows:

$wage_{it}$: hourly wage;

$size_{it}$: number of employees;

$growth_{it}$: average annual growth of the employer during the period of the worker's service;

$tenure_{it}$: period of service of the worker at time t;

$exper_{it}$: number of years of job experience (= age – years of education – 6);

X_{it} : vector of the control variables;

μ_i : unobserved individual (fixed) effects;

ε_{it} : error term.

The control variables are squared tenure, squared experience, a full set of year dummies, and a dummy variable that is unity if the firm had more than one establishment when the worker was hired. Also included are 12 industry dummies, four regional dummies, and a dummy variable for living in a metropolitan area, which is used to control for the possibly spurious correlation between firms' growth rates and their sectoral and geographical characteristics. We focus on the coefficient of firm size, α_1. If the estimate of α_1 is significantly positive, there is a firm size–wage effect.

3.2 Michelacci and Quadrini's Model

A financial constraint arises because the amount of borrowings cannot exceed the value of collateral assets. Because large firms tend to own adequate collateral assets, their borrowings rarely amount to the value of their collateral assets. On the other hand, because small businesses lack adequate collateral assets, their borrowings depend on the amount of their collateral assets. To represent this, we define the (average) ratio of borrowings to total assets of a firm to which individual i belongs at time t as follows:

$$finconst1_{J(i,t)} = \frac{\text{capital expenditure} - \text{cash flow}}{\text{total assets}}, \tag{2}$$

where $j = J(i,\ t)$ is the size of the firm to which individual i belongs at time t. The numerator of the ratio of borrowings to total assets is the portion of capital expenditure that cannot be covered by cash flows; i.e., external borrowings. In other words, the ratio indicates the extent to which the firm (on average) borrows up to the limit imposed by the size of its assets. Given that total assets is the denominator of the ratio of borrowings to total assets, and because the level of assets that can be used as collateral increases with firm size, Eq. (2) implies that the larger the firm, the lower the ratio.

However, total assets may include assets that are not of sufficient quality to be used as collateral. For example, intangible assets and assets deferred for tax purposes are not recognized as collateral, but are included in total assets in the balance sheet. Hence, based on an examination of mortgage loans in the U.S.,[3] we also use tangible fixed assets (specifically, land, buildings, plant and machinery, and equipment) in the denominator to measure the debt-to-assets ratio:[4]

$$finconst2_{J(i,t)} = \frac{\text{capital expenditure} - \text{cash flow}}{\text{tangible fixed assets}}. \tag{3}$$

Based on Eq. (2) or Eq. (3), we estimate the following model:

$$\begin{aligned} \ln(wage_{it}) = \mu_i + \alpha_1 \ln(size_{it}) + \alpha_2 growth_{it} + \alpha_3 growth_{it} \cdot tenure_{it} \\ + \alpha_4 growth_{it} \cdot exper_{it} + \alpha_5 finconst_{j(i,t)} + \beta X_{it} + \varepsilon_{it}, \end{aligned} \tag{4}$$

where $finconst_{j(i,t)}$ is $finconst1_{j(i,t)}$ or $finconst2_{j(i,t)}$. The control variables comprise the period of service and its square, the number of years of job experience and its square, year dummies, and a dummy variable that is unity for employers with two or more buildings. Additional control variables are dummy variables for 12 industry sectors, dummy variables for four geographical areas, and a dummy variable that is unity for workers residing in urban areas. Our main focus is on the firm-size coefficient α_1. If its estimated value is significantly positive, we can conclude that larger firms pay higher wages.

Because $J(i,\ t)$ is not a continuous function, we divide it into 13 levels. That is, $j=1$ for the average debt-to-total-assets ratio of a firm with a workforce of 1–9 employees, $j=2$ for the ratio of a firm with 10–19

3) See Small Business Administration Office of Advocacy (1987, Chapter 2).

4) For small businesses, the personal assets of business owners should perhaps be included in the collateral, but we could not include them because of data limitations.

employees, and so on for the following 11 employment levels: 20–49 employees; 50–99 employees; 100–199 employees; 200–499 employees; 500–999 employees; 1,000–1,999 employees; 2,000–4,999 employees; 5,000–9,999 employees; 10,000–19,999 employees; 20,000–49,999 employees; and 50,000 or more employees.

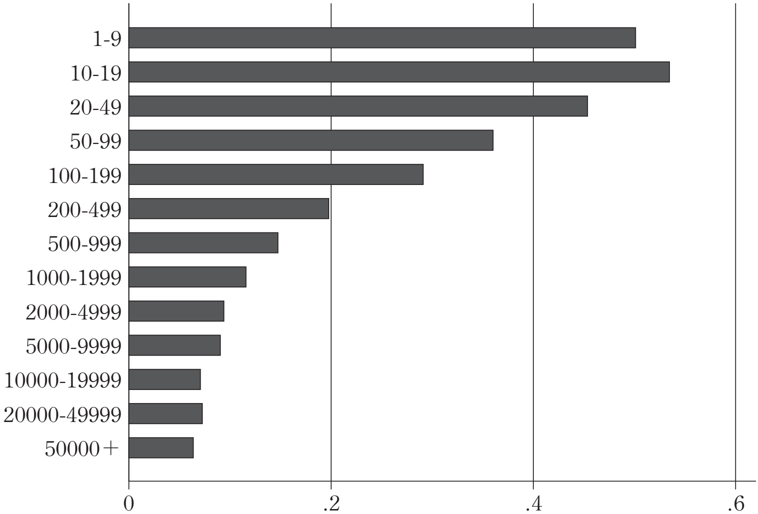
To construct the two debt-to-assets ratios, we use financial data covering 9,110 American firms during the 1986–2002 period, taken from the Compustat North America database. In order to make the sample sufficiently reliable, we exclude negative observations and those that are more than two standard deviations above or below the average for each indicator.

Figure 1 shows the average debt-to-total-assets ratios for the 13 levels of firm size (in terms of numbers of employees). Although the smallest firm size (1–9 employees) has a lower ratio than does the next stage (10–19 employees), the figure indicates that for the other levels, the debt-to-total-assets ratio falls as size increases. Figure 2 shows the ratio of borrowings to tangible fixed assets. This ratio clearly declines as firm size rises.

For the other variables, we use NLSY79. While Michelacci and Quadrini (2005a) obtained their estimates by using NLSY79, they imposed various constraints to obtain a suitable sample. First, they sampled only the noninstitutionalized civilian segment of the youth population in the U.S., and limited their sample to the 1986–2002 period, for which data on the number of employees were available. They also adopted constraints to limit the sample to representative workers, namely, full-time workers, those working for employers with annual growth rates of between −10% and + 100%, and workers whose hourly wages ranged from $2 to $500. For details, see the Data Appendix of Michelacci and Quadrini (2005a).

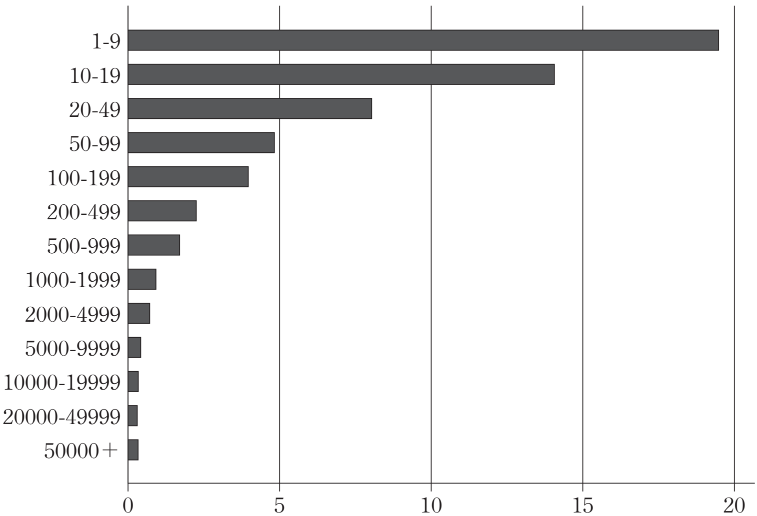
Because the data constraints imposed by Michelacci and Quadrini (2005a)

Figure 1: Average debt-to-total-assets ratio



Note: The average debt-to-total-assets ratio for the 13 levels of firm size in terms of number of employees.

Figure 2: Ratio of borrowings to tangible fixed assets



Note: Ratio of borrowings to tangible fixed assets for the 13 levels of firm size in terms of number of employees.

are strict, we attempt to confirm whether their estimation results are valid under more relaxed constraints. In particular, for the average growth rates of employers, we use a much wider range, from −100% to +100% (although, not surprisingly, the range of our data does not include −100%).

4. Estimation Results

The benchmark estimation results are shown in Table 1. In column (I), we use the same estimated equation reported by Michelacci and Quadrini (2005a). The null hypothesis that the coefficient of firm size is statistically insignificant is rejected at the 1% significance level. Hence, it is evident that firm size is correlated with wages. In column (II), we add the ratio of borrowings to total assets as an explanatory variable. Although its coefficient is not statistically significant, it is negative as expected. This indicates that wages tend to decline as financial constraints tighten. Comparing column (II) with column (I), the effect of firm size on wages is lower by 0.13 percentage points. This suggests that financial constraints have a slight effect. In column (III), we add the ratio of borrowings to tangible fixed assets as an explanatory variable. Its coefficient is significantly negative, indicating that the severity of financial constraints clearly lowers wages. This time, including financial constraints greatly reduces the effect of firm size: comparing column (III) with column (I), the coefficient of firm size is 0.58 percentage points lower.

In Table 2, we report the estimation results obtained by including additional variables. Column (V) includes the ratio of borrowings to total assets. Its coefficient is larger in absolute magnitude than that in column (II), in which there are fewer control variables. Comparing column (V) with column (IV), the effect of firm size on wages is 0.18 percentage points

Table 1: Benchmark estimates

Variable	(I)	(II)	(III)
$ln(size)$	0.0160 ***	0.0147 ***	0.0102 ***
	(0.0018)	(0.0040)	(0.0030)
$growth$	–0.0556 *	–0.0556 *	–0.0551 *
	(0.0287)	(0.0287)	(0.0287)
$growth \cdot tenure$	0.0013	0.0013	0.0013
	(0.0037)	(0.0037)	(0.0037)
$growth \cdot exper$	0.0026	0.0026	0.0026
	(0.0025)	(0.0025)	(0.0025)
$finconst1$		–0.0209	
		(0.0488)	
$finconst2$			–0.0020 **
			(0.0009)
Number of obs.	32,629	32,629	32,629
R-squared	0.1843	0.1844	0.1838

Note: The dependent variable is the natural logarithm of wages per hour. The models are estimated by using the fixed-effects estimator. Heteroskedasticity-robust standard errors are in parentheses. *** denotes statistical significance at the 1% level, ** denotes statistical significance at 5 %, and * denotes statistical significance at 10 %. The estimated coefficients of the control variables are omitted.

lower. However, caution must be exercised because the coefficient of the ratio of borrowings to total assets in (V) is not statistically significant. In column (VI), the coefficient of the ratio of borrowings to tangible fixed assets is significantly negative, as in column (III), but the coefficient of firm size is lower by 0.66 percentage points. Therefore, we estimate that up to 43% of the effect of firm size on wages is accounted for by financial constraints. We also estimate the model by including as explanatory variables interaction terms between the financial constraint variables and the industry dummy variables. However, this hardly affects the estimation results.

Table 2: Estimates with additional control variables

Variable	(I)	(II)	(III)
$ln(size)$	0.0154 ***	0.0136 ***	0.0088 ***
	(0.0018)	(0.0039)	(0.0030)
$growth$	–0.0417 *	–0.0416 *	–0.0413 *
	(0.0288)	(0.0288)	(0.0288)
$growth \cdot tenure$	0.0022	0.0022	0.0021
	(0.0036)	(0.0036)	(0.0036)
$growth \cdot exper$	0.0022	0.0022	0.0021
	(0.0025)	(0.0025)	(0.0025)
$finconst1$		–0.0279	
		(0.0483)	
$finconst2$			–0.0023 **
			(0.0009)
Number of obs.	32,215	32,215	32,215
R-squared	0.2049	0.2049	0.2042

Note: All estimated equations include the additional control variables.

5. Conclusions

In this paper, we used the NLSY79 to investigate the hypothesis that the tightness of financial constraints explains the hypothesized firm size–wage effect. In earlier work, Michelacci and Quadrini (2005a) compare simulation results with estimates from the NLSY79 and argue that their model well captures the behavior of actual data: that is, financial constraints matter. In this paper, we included two indicators of the tightness of financial constraints to confirm their hypothesis.

Our estimation results support the theoretical predictions of Michelacci and Quadrini (2005a, b, 2009): that is, the theory that a firm with few collateral assets faces financial constraints and must keep wages low to achieve a sufficient level of investment is consistent with real-world data. However, even when we include financial constraints, firm size continues to exert a statistically significant effect on wages. Consequently, financial constraints cannot completely explain firm size-based wage differentials.

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Data Appendix

Data on the ratio of debt to total assets and the ratio of debt to tangible fixed assets were taken from the Compustat North America database. We used data on 9,110 firms in the U.S. from 1986 to 2002. We used "capital expenditure" for capital expenditure. For cash flow, we used "Operating Activities - Net Cash Flow" plus "Inventory - Decrease (Increase)" plus "Receivables - Decrease (Increase)" plus "Accounts Payable & Accrued Liabs - Inc (Dec)". For total assets, we used "Assets - Total". For tangible fixed assets, we used "Property Plant and Equipment - Total (Net)". For the number of employees, we used "Employees". To exclude outliers, we chose firms with between one and 100,000 employees, and excluded firms with negative observations and with observations beyond two standard deviations of the mean.

Data on other variables were taken from the NLSY79. See Michelacci and Quadrini (2005a) and the NLSY79 User's Guide. However, we restricted our sample to firms with hourly wages of between \$2 and \$500 and with average growth rates of between −100% and +100%.

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