Rent-sharing, Holdup, and Wages:
Evidence from Matched Panel Data

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ABSTRACT

When wage contracts are relatively short-lived, rent sharing may reduce the incentives for investment since some of the returns to sunk capital are captured by workers. This holdup phenomenon has been blamed for the decline of unionized firms in countries with decentralized bargaining. In this paper we use a matched data set from the Veneto region of Italy that combines Social Security earnings records for employees with detailed financial information for employers to measure the degree of rent sharing and test for holdup. We estimate wage models with job match effects, allowing us to abstract from permanent differences in productivity across workers, firms, and job matches. We also compare OLS and instrumental variables specifications that use sales of firms in other regions of the country to instrument value-added per worker. We find strong evidence of rent-sharing, with a "Lester range" of variation in wages between profitable and unprofitable firms of 15-20%. On the other hand we find little evidence that bargaining lowers the return to investment. Instead, firm-level bargaining in Veneto appears to split the rents after deducting the full cost of capital. Our findings are consistent with a dynamic bargaining model (Crawford, 1988) in which workers pay up front for the returns to sunk capital they will capture in later periods.

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In the standard neoclassical labor market model wages do not depend on employer profitability. A long-running strand of research, however, has argued that employees share some of the rents earned by their employers.[1] Early studies of rent-sharing used data on wages and profitability at the *industry* level (e.g., Slichter, 1950; de Menil, 1971; Dickens and Katz, 1986) while later studies use *firm-level* data (e.g., Nickell and Wadhwani, 1990; Chistofides and Oswald, 1992; Abowd and Lemieux, 1993; Blanchflower, Oswald and Sanfey, 1996; Hildreth and Oswald, 1997; Arai, 2003). Both literatures show a robust positive correlation between profitability and wages. How much of this is due to the non-random sorting of high-ability workers to high-profit firms is still unclear. Recent studies that use matched worker/firm data to control for unobserved worker abilities find smaller but generally significant effects of profitability on wages (e.g., Margolis and Salvanes, 2001; Martins, 2004; Gurtzen, 2008).[2]

Closely related to the notion of rent-sharing is the possibility that bargaining in a series of incomplete short-term contracts can lead to a holdup problem (Baldwin, 1983; Grout, 1984; Che and Sakovics, 2008). In particular, when capital is sunk, future bargaining over quasi-rents diverts some of the return on investment to workers, potentially causing firms to under invest.[3]

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[1]The idea of rent-sharing by a cartel of workers appears in Adam Smith (1976, Book I, Chapter 8). The post-war neo-institutionalists (e.g., Lester, 1952, Slichter, 1950) emphasized firm profitability (or ability to pay) as an important determinant of wages. De Menil (1971) laid out the basic model of bargaining that we use in this paper and has been adopted by many subsequent authors (e.g., Svejnar, 1986; Abowd and Lemieux, 1993; Blanchflower, Oswald and Sanfey, 1996).

[2]Guiso, Pistaferri, and Schivardi (2005) study the effect of firm-specific productivity shocks on employee wages using a matched longitudinal data set similar to ours. Although their empirical analysis focuses on risk sharing, rather than rent-sharing, their results suggest that firm-level productivity shocks have a positive effect on wages.

[3]A similar point was raised by Simons (1944) who wrote: “Frankly, I can see no reason why strongly organized workers, in an industry where huge investment is already sunk in highly durable assets, should ever permit a return on investment sufficient to attract new capital...”

Building on this insight, a number of authors have argued that holdup causes unionized firms to invest less than their non-union counterparts (e.g., Connolly et al., 1986; Denny and Nickell, 1992; Bronars and Deere, 1993), contributing to the decline in unionism in countries with decentralized bargaining (e.g., Addison and Hirsch, 1989; Hirsch, 2004).[4]

In this paper we use a matched data set that combines longitudinal earnings records for individual employees with detailed balance sheet data for their employers to measure the degree of rent sharing by firms in the Veneto region of Italy. We also test for the importance of holdup by testing whether capital costs are deducted from the quasi-rent expression that determines wages in the rent-sharing model. When capital costs are fully deducted, rent-sharing does not impose a tax on new investment and capital accumulation is potentially efficient. When some of the returns to investment are included as quasi-rent, however, firms that invest more will pay higher wages in the future, generating a holdup problem.

Our sample includes nearly one-half million workers employed at 9,000 firms, with annual wages and detailed financial information for the period from 1995 to 2001. These data enable us to estimate wage models that include worker-firm match effects (i.e., dummies for each worker-firm pair observed in the sample), as well as time-varying worker and firm variables. Match effects completely eliminate the influence of <u>any</u> (observed or unobserved) permanent components of worker, firm, or match-specific heterogeneity. For a majority of workers (about 75%) we can also identify the minimum wage specified by the sector-wide contract that covers

[4]As shown by Crawford (1988), and illustrated by the model presented in this paper, holdup does not necessarily arise in long term relationships, even with incomplete contracts. It should also be noted that not all previous studies have found that unionized firms have lower investment rates – see e.g., Machin and Wadhwani (1991).

the employment relationship.[5] Thus, we can measure the wage premium that arises through a combination of firm-level contracting and informal bargaining.[6] In an institutional setting like Italy with binding sectoral contracts, this premium is arguably the appropriate earnings concept for measuring firm-specific rent-sharing.[7]

We relate individual earnings to a firm-specific quasi-rent measure, defined as value added per worker net of the opportunity cost of labor and some share of the cost of capital per worker. A longstanding concern with empirical rent-sharing models is the endogeneity of observed profitability, arising through efficiency wage effects or other channels.[8] A related problem is measurement error in profitability, which is likely to be exacerbated by a within-spell estimation strategy. To address both issues, we use the revenues of firms in the same sector in other regions of Italy to construct an instrumental variable for value-added per worker for employers in Veneto. Our key identifying assumption is that (narrowly defined) industry demand shocks affect profitability but have no direct effect on local labor supply.

Our empirical findings point to three main conclusions. First, consistent with existing

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[5]In Italy contracts negotiated at the sector-level between national unions and employer groups are extended to cover essentially all employees. The sectoral contracts specify minimum wages by industry and occupation category (typically 5 or more categories).

[6]During our sample period about 40% of workers were covered by firm-level contracts that set pay scales above the sectoral minimum.

[7]Cristini and Leoni (2007) specify a two-level bargaining model that describes the determination of the sector wide minimum wages and the firm-specific wage premium. We abstract from the first and concentrate on the second.

[8]See e.g., Abowd and Lemieux (1993) and Van Reenen (1996). These authors are most concerned about the possibility that more profitable firms hire high-ability workers. As noted, by including job match dummies we control for any permanent differences in ability between employees.

studies, we find that more profitable employers pay higher wages. The elasticity of wages with respect to quasi-rents per worker is in the range of 0.04 to 0.10 – smaller than in some first generation studies of rent-sharing, but similar to recent estimates derived from specifications that control for worker-firm fixed effects. Second, instrumental variables estimates of the degree of rent-sharing with controls for match effects are comparable to OLS estimates from models with no control for unobserved worker or firm attributes. Within-job estimates estimated by OLS are substantially smaller, but appear to be attenuated by measurement errors and transitory fluctuations in value added. Third, firm-level wage bargaining in Italy is driven by a quasi-rent measure that deducts the full cost of capital. We find little indication that workers appropriate a share of the returns to capital investments. Our results are consistent with a dynamic bargaining model in which workers pay up-front for the portion of returns to sunk investments they will capture in future bargaining (Crawford, 1988). In such a model we show that the appropriate expression for the quasi-rent contains a deduction for the cost of the non-irreversible share of the *current* capital stock, plus a deduction for future holdup of the irreversible share of *future* capital. The sum of these deductions is (approximately) equal to the full cost of capital.

II. A Model of Rent Sharing and Wage Determination

In this section we outline a simple dynamic model of wage bargaining between a firm and a collection of identical workers. We assume that wages are renegotiated every period, and that some fraction of the current capital stock is sunk, and cannot be resold by the firm during the current period.[9] Although this is a textbook setting for holdup (e.g., Cahuc and Zylberberg, 2004, pp. 543-545) we show that holdup will not necessarily affect investment when bargaining today anticipates the possibility of rent-sharing tomorrow. Instead, as in Becker's (1962) on-the-job training model, workers make an up-front contribution by accepting lower wages today in return for a share of future quasi-rents. When workers and firms have the same discount rate this restores the incentive for firms to invest efficiently.

a. Basic Model with Fixed Employment

We start with the case where employment is fixed at L. We adopt a two-period model, and assume that the firm's revenue in period t (net of raw materials costs) is $R(K_t, \theta_t)$ where θ_t is a fully anticipated demand shock, and K_t is the firm's capital stock, assumed to be determined one period in advance. The firm's profit in period t is:

$$R(K_t, \theta_t) - w_t L - r_t K_t ,$$

where w_t represents the negotiated wage and r_t represents the user cost of capital. We assume that workers' preferences over wage outcomes in period t are represented by the excess wage bill:

$$u(w_t, L) = (w_t - m_t)L ,$$

where m_t represents in the opportunity cost of labor.[10] Finally, we assume that the parties discount the future at a common discount rate β.

[9]Thus, we are modeling a long term relationship governed by incomplete short term contracts. Our model is an adaptation of the one presented in Crawford (1988).

[10]In our empirical work we assume that m_t is either the minimum sectoral wage, or the average wage in the sector. The assumption of an excess wage bill objective means that in a setting with variable employment, the surplus-maximizing choice of employment equates the marginal product of labor to the outside wage m_t.

In the second period the only decision variable is the wage, w_2. Following de Menil (1971) and many subsequent authors we assume that w_2 is determined by generalized Nash bargaining:

$$(1) \qquad w_2 = \underset{w}{\operatorname{argmax}} \; [\, u(w, L) - u^0_2 \,]^{\gamma} \;\; [\, \pi(w, r_2; K_2, L, \theta_2) - \pi^0_2 \,]^{1-\gamma} ,$$

where u^0_2 and π^0_2 represent the fallback positions of the parties if no agreement is reached, and γ represents the relative bargaining power of workers. On the workers' side we assume that u^0_2 = 0. On the firm's side we assume that a fraction δ of the capital stock can be put to other uses in the event of no agreement.[11] In this case, the fallback position of the firm is a net cash flow of $-(1-\delta)r_2K_2$. Combining these assumptions with equation (1), the second period wage solves:

$$(2) \qquad \max_{w_2} \; [\, (w_2 - m_2)L \,]^{\gamma} \;\; [\, R(K_2, \theta_2) - w_2L - \delta r_2K_2 \,]^{1-\gamma} .$$

The first order condition for w_2 can be re-arranged to yield:

$$(3) \qquad w_2 = m_2 + \gamma\, Q_2/L , \quad \text{where}$$

$$Q_2 \equiv R(K_2, \theta_2) - m_2 L - \delta\, r_2K_2$$

presents the "quasi-rent" associated with reaching agreement in period 2. Notice that when δ=1, investment is reversible and the appropriate quasi-rent is value-added minus the opportunity cost of labor minus the full cost of capital. On the other hand, when δ=0, all investment is sunk and the appropriate quasi-rent is value-added minus the opportunity cost of labor.

The second period profits of the firm are:

$$(4) \qquad \pi_2 = (1-\gamma)Q_2 - (1-\delta)r_2K_2 ,$$

[11] A similar assumption is made by Grout (1984) who distinguishes between the price paid for capital and its resale value.

$$= \quad (1-\gamma) [R(K_2, \theta_2) - m_2 L] - r_2(1-\gamma\delta)K_2 .$$

Differentiating the second line with respect to K_2 yields:

$$(5) \qquad \partial\pi_2/\partial K_2 = (1-\gamma) [\partial R/\partial K_2 - r_2(1-\gamma\delta)/(1-\gamma)] .$$

If the firm chooses K_2 to maximize second period profits, this first order condition implies that it will under invest whenever $\delta<1$. In particular, when a fraction $1-\delta$ of investment is sunk, the firm acts as if the price of capital is $r_2(1-\gamma\delta)/(1-\gamma) > r_2$. Building on a similar analysis a number of previous authors have concluded that short term bargaining with sunk investment imposes a "tax" on capital.[12]

The simple intuition underlying equation (5) is arguably misleading, however, because it fails to recognize that the outcome of bargaining in period 1 will in general depend on the expected outcomes of bargaining in period 2.[13] Assume that the parties bargain in period 1 anticipating the returns in period 2 implied by the wage bargain of equation (3) (i.e., net utility of $(w_2-m_2)L = \gamma Q_2$ and profits specified in equation (4)). As in period 2, assume that the fallback position of workers in the event of no agreement in period 1 is a payoff of 0 (for one period), while the fallback for the firm is a cash flow of $-r_1(1-\delta)K_1$. In this case, bargaining in period 1 will maximize the expression

$$(6) \qquad [(w_1-m_1)L + \beta\gamma Q_2]^{\gamma} \quad [R(K_1,\theta_1)-w_1L-\delta r_1K_1 + \beta((1-\gamma)Q_2 - r_2(1-\delta)K_2))]^{1-\gamma}.$$

As was emphasized in the "efficient contracting" literature (e.g., MacDonald and Solow, 1981; Brown and Ashenfelter, 1986) it is potentially important to consider whether w_1 and K_2 are

[12]For example, Cahuc and Zylberberg (2004, pp. 543-545) present a simple analysis of the sunk investment case that yields essentially the same formula as equation (5), with $\delta=0$.

[13]The same point was made by Becker (1962) in an analysis of the return to general human capital investments.

jointly determined in period 1, or whether the firm selects K_2 unilaterally. For the moment, consider the case where K_2 is jointly determined. Then it is easily shown that the first order condition for maximization of (6) implies $\partial R(K_2, \theta_2)/\partial K_2 = r_2$, i.e., an "efficient" level of investment.[14]

Turning to the wage, the first order condition for w_1 can be written as:

$$(7) \qquad w_1 - m_1 = \gamma Q_1/L, \qquad \text{where}$$

$$Q_1 \equiv R(K_1,\theta_1) - m_1 L - \delta r_1 K_1 - \beta(1-\delta) r_2 K_2 \ .$$

Note that when the bargaining relationship is expected to continue the effective quasi-rent in period 1 deducts a fraction δ of current capital costs, and a complementary fraction $1-\delta$ of future costs (discounted by β). In essence, the firm is compensated *ex ante* for the share of returns to capital it will lose due to rent sharing in the second period. Note that if the return to capital is constant (r_1=r_2=r) and the capital stock is growing at the "steady state" rate $1/\beta$ then K_2=K_1/β and the quasi-rent expression becomes:

$$(8) \qquad Q_1 = R(K_1 , \theta_1) - m_1 L - rK_1 \ .$$

In this setting the appropriate expression for the quasi-rent deducts the full cost of capital even though capital is sunk.

Importantly, the expression for w_1 in equation (7) is the same whether K_2 is predetermined or jointly determined with wages. Instead of assuming that K_2 is jointly determined, assume that the firm determines K_2 unilaterally before wage bargaining in period 1.

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[14]For a maximand of the form $[\ a + bw + g(K)\ ]^{\gamma}\ [\ c - bw + h(K)\ ]^{1-\gamma}$, if w and K are the choice variables and there are no constraints on w the first order conditions require that $g'(K)+h'(K)=0$. In this setup w is an efficient transfer and any bargaining solution requires a surplus-maximizing choice of K. In applying this observation to (6) note that the sum of the second period payoffs to workers and the firm is equal to $R(K_2, L, \theta_2)-m_2L-r_2K_2$.

Using equations (4) and (7) it is easily shown that:

$$(9) \qquad \pi_1 + \beta\pi_2 = (1-\gamma)\,[\,R(K_1,\theta_1) - m_1L - \delta r_1K_1\,] - \gamma(1-\delta)r_1K_1$$
$$+ \beta(1-\gamma)\,[\,R(K_2,\theta_2) - m_2L - r_2K_2\,]\,.$$

An immediate implication is that

$$\partial[\pi_1 + \beta\pi_2]/\partial K_2 = \beta(1-\gamma)\,[\,\partial R(K_2,\theta_2)/\partial K_2 - r_2\,]\,.$$

When first period wages are determined by (7), the firm acting unilaterally will set the marginal product of capital in period 2 equal to r_2, implementing the jointly optimal decision. In this case ex post holdup has no distortionary effect on investment.

This rather surprising conclusion depends on two critical assumptions: (1) workers' preferences are linear in wages; (2) the parties share a common discount rate. Under these assumptions the bargaining parties have *identical linear preferences* over wage streams, and, as shown by Crawford (1988), short-term contracting can fully internalize the effect of future bargaining over relationship-specific quasi rents.

b. Allowing for Variable Employment

The preceding analysis can be extended to allow for variable employment. We proceed in two steps. First, we assume that employment is jointly determined by the bargaining parties, as in the efficient contracting models of Svejnar (1986) and Brown and Ashenfelter (1986). In this case the predictions of the fixed employment model remain intact: wage-setting fully anticipates opportunistic bargaining in the future, eliminating the effect of holdup on investment. We then consider a "right to manage" model in which the parties bargain over wages and the firm sets employment unilaterally. This creates a distortion in employment. Under reasonable assumptions, however, we show that the investment choices of firm remain approximately efficient.

Denote the revenue function for the firm in period t by $R(L_t, K_t, \theta_t)$. Following our earlier development it is straightforward to show that when wages and employment are determined jointly, the first order conditions for the optimal choices of w_2 and L_2 require:

$$w_2 = m_2 + \gamma Q_2/L_2 \quad \text{and}$$

$$\partial R(L_2, K_2, \theta_2)/\partial L_2 = m_2 \text{ , where}$$

$$Q_2 = R(L_2, K_2, \theta_2) - m_2 L_2 - \delta r_2 K_2 .$$

Likewise, the first order conditions for the optimal choices of w_1 and L_1 require

$$w_1 = m_1 + \gamma Q_1/L_1 \quad \text{and}$$

$$\partial R(L_1, K_1, \theta_1)/\partial L_1 = m_1 \text{ , where}$$

$$Q_1 = R(L_1, K_1, \theta_1) - m_1 L_1 - \delta r_1 K_1 - \beta(1-\delta) r_2 K_2.$$

Finally, the optimal choice for K_2 (which we assume is also made in period 1) requires

$$r_2 = \partial R(L_2, K_2, \theta_2)/\partial K_2 .$$

The expressions for w_1 and w_2 are the same as in the fixed employment case, except that L is replaced by the efficient level of employment that equates the marginal product of labor with the outside wage m_t. The expression for the firm's discounted profits also remains the same as in equation (9) (with the appropriate substitution for L_t), implying that the firm will unilaterally select the jointly optimal investment choice when wages and employment are jointly determined in a sequence of short-term bargains. Consequently, with jointly determined employment, holdup does not distort investment.

When the firm sets employment unilaterally the analysis is more complicated because now wages have three competing functions: to split the surplus between the parties; to regulate incentives for investment; and to allocate labor within the period. The conflict between these objectives leads to some inefficiency. In particular, with unilateral employment setting any bargained wage above the alternative wage will cause the firm to set employment below the efficient choice that maximizes the joint surplus of the parties. To first order, however, this is the only distortion: as in the fixed employment case the negotiated wage contains a discount for future holdup, and the level of capital selected by the firm sets the marginal product of capital approximately equal to the interest rate.

Specifically, in Appendix A we show that when: (i) the firm sets employment taking the wage as given; (ii) wage bargaining maximizes a generalized Nash objective with a fixed weight γ for workers; and (iii) the negotiated mark-up over the alternative wage is approximately constant over time; the first-period wage is approximately

(10) $w_1 = m_1 + \gamma Q_1^*/L_1^*$, where

$$Q_1^* = R(L_1^*, K_1, \theta_1) - m_1 L_1^* - \delta r_1 K_1 - \beta(1-\delta) r_2 K_2^*$$

and

$$L_1^* = L_1(m_t, K_1, \theta_1)$$

are the "efficient" levels of quasi-rent and employment, respectively, K_1 is the initial capital stock, and K_2^* is the "efficient" capital stock in period 2 (defined precisely in the Appendix).[15] Moreover, as in the simple case with fixed employment, the firm acting unilaterally will select

[15]The derivation of these expressions uses a linearization of the firm's profit functions in each period around the profit associated with the outside wage (m_1 or m_2). Assuming that γ is on the order of 10-20% and the ratio of profits to the wage bill is in the range of 0 to 1, the percentage wage markup implied by (10) is under 20% and the assumption of local linearity is reasonable. The average markup of wages over the sectoral minimum in our sample ranges from from 23% to 26%, so we believe condition (iii) is reasonable.

the capital stock K_2^*.

These results imply that when the firm sets investment *and* employment unilaterally, w_1 and K_2 will be set at (approximately) the same levels as would occur under joint employment setting. However, the firm's employment choice L_1 will be below the efficient level, L_1^*, and the observed measure of rents in period 1 will differ from the measure Q_1^* that determines wages. In particular, we show in Appendix A that the observed measure of rents in period 1 is:

$$(11) \qquad Q_1 = R(L_1, K_1, \theta_1) - m_1 L_1 - \delta r_1 K_1 - \beta(1-\delta) r_2 K_2$$

$$\approx Q_1^* (1 + \epsilon\gamma g_1^*)$$

where ϵ is the elasticity of the firm's labor demand schedule, and $g_1^* \equiv (w_1 - m_1)/m_1$ is the negotiated markup of the contract wage over the outside wage. Approximating $L_1 = L_1^*(1+\epsilon g_1^*)$, the "efficient" quasi-rent per worker is

$$(12) \qquad Q_1^*/L_1^* = \lambda\, Q_1/L_1 , \quad \text{where}$$

$$\lambda \approx (1 + \epsilon g_1^*(1-\gamma)) \leq 1 .$$

Thus, observed quasi-rent per worker overstates the appropriate expression Q_1^*/L_1^* in the wage determination model. For example, when $\epsilon=-1$, $\gamma=0.20$, and $g_1^*=0.15$, the adjustment factor λ is approximately 0.9.

c. Empirical Implementation

In the derivation of equation (10) we assumed that capital is homogeneous and that a fraction δ of the capital stock in each period can be put to other uses during a dispute, leading to a quasi-rent measure of the form:

$$Q_t^* = R(L_t^*, K_t, \theta_t) - m_t L_t^* - \delta r_t K_t - \beta(1-\delta) r_{t+1} K_{t+1} .$$

Since capital adjusts irregularly and is measured with some error, it is difficult to separately identify the effects of K_t and K_{t+1} on wages in any period. Moreover, we do not have period-specific estimates of the cost of capital. In view of these limitations we make the assumptions that $r_t = r_{t+1} = r$, and that capital accumulation is close to a steady state trajectory with $K_{t+1} = (1/\beta)K_t$. In this case, our bargaining model predicts that the appropriate quasi-rent measure for wage determination in period t is:

$$Q_t^* = R(L_t^*, K_t, \theta_t) - m_t L_t^* - r K_t .$$

Substituting this expression into equation (10) yields:

$$w_t = m_t + \gamma [R(L_t^*, K_t, \theta_t) - m_t L_t^* - r K_t] / L_t^* ,$$

and using (12) we obtain a relationship between wages and observed quasi-rents:

$$(13) \quad w_t = m_t + \lambda\gamma [R(L_t, K_t, \theta_t) - m_t L_t - r K_t] / L_t$$

$$= m_t (1 - \lambda\gamma) + \lambda\gamma R(L_t, K_t, \theta_t)/L_t - \lambda\gamma r (K_t/L_t) .$$

Inspection of equation (13) points to two immediate predictions: (1) value-added per worker affects wages with a coefficient $\lambda\gamma$ that understates the true rent-splitting parameter γ; (2) controlling for value-added per worker, capital per worker affects wages with a coefficient of $-\lambda\gamma r$. In contrast, in the presence of distortionary holdup, we would expect the coefficient of capital per worker to be <u>smaller</u> than $-\lambda\gamma r$ (in absolute value). In the limiting case of complete holdup the predicted coefficient of capital per worker is 0. Thus, our main empirical focus is on comparing the estimated effects of value-added per worker and capital per worker on negotiated wages, and testing whether the ratio is consistent with existing estimates of the cost of capital. We also compare the effects of different types of capital (e.g., physical versus working capital) and distinguish between firms with higher and lower levels of debt to check whether there is a larger offset for investments that are financed by debt (as suggested by Dasgupta and Sengupta, 1993).

The literature on physical capital investment in Italy suggests that during the mid-to-late 1990s a reasonable estimate of the user cost of capital is in the range of 8-12%. Elston and Rondi (2006) report a distribution of estimates of the user cost of capital for publicly traded Italian firms in the 1995-2002 period, with a median of 0.11 (Elston and Rondi, 2006, Table A4). Arachi and Biagi (2005) calculate the user cost of capital, with special attention to the tax treatment of investment, for a panel of larger firms over the 1982-1998 period. Their estimates for 1995-1998 are in the range of 10-15% with a value of 11% in 1998 (Arachi and Biagi, 2005, Figure 2).[16]

In our estimation we adopt a log-linearization of equation (13). Specifically, building on the observation that wages are approximately log-normally distributed, and that standard covariates like gender, age, and job tenure exert a proportional effect on wages, we fit models of the form:

$$(13') \quad \log(w_{it}) = \log(a_{it})\, b_1 + X_{it} b_2 + VA_{j(i,t),t}\, b_3 + KL_{j(i,t),t}\, b_4 + \xi_{it} \ ,$$

where w_{it} is the average daily wage earned by worker i in year t, a_{it} is a (potentially noisy) measure of the opportunity wage for the worker in that year, X_{it} represents a vector of measured characteristics of the worker, $VA_{j(i,t),t}$ represents measured value-added per worker at the firm j(i,t) that employed worker i in period t, $KL_{j(i,t),t}$ is measured capital per worker at the firm, and ξ_{it}

[16]Franzosi (2008) calculates the marginal user cost of capital taking into account the differential costs of debt and equity financing, and the effects of tax reforms in 1996 and 1997. Her calculations suggest that the marginal user cost of capital was about 7.5% pre-1996 for a firm with 60% debt financing, and fell to 6% after 1997.

is an error term. The prediction of no distortionary holdup implies that $b_4 = - r b_3$, while full holdup implies $b_4 = 0$. We fit this model using a variety of estimation strategies, including OLS, OLS with firm-worker-match fixed effects, and instrumental variables (IV) with match fixed effects, treating value added per worker (and in some cases capital per worker) as endogenous.

III. Institutional Background, Data Sources, and Descriptive Overview

a. Institutional Background

Wage setting in Italy is characterized by a "two-level" bargaining system.[17] Sectoral agreements (negotiated every two years) estabilish contractual minimum wages for different occupation classes that are automatically extended to all employees in the sector. Individual employers (or groups of employers) can negotiate supplemental local agreements with their workforce that provide wage premiums over and above the sectoral minimums. In the mid-1990s firm-level bargaining was in place at approximately 10% of firms with at least 10 employees, and covered about 40% of all private sector employees nationwide (ISTAT, 2000). Individual workers can also receive supplements and bonuses – including seniority adjustments – that add to the minimum contractual wage covering their job. As described below, our data allow us to identify the sectoral contract and occupation category for most workers, so in principle we know the sectoral minimum wage that applies to their jobs. We do not know whether a worker is covered by a local agreement. Conceptually, then, we think of wage bargaining as determining the sum of an individual-specific premium and any firm-wide premium paid as a result of a local

[17] This system was introduced in 1993, replacing an earlier system that included local and sectoral agreements and a national indexation formula. See Casadio (2003) and Dell'Aringa and Lucifora (1994). The Netherlands, Spain, and Portugal have similar two-level systems.

contract (or for other reasons).

b. Data Sources

Our data set combines three types of information: individual earnings records, firm balance sheet data, and contractual minimum wage rates. Our earnings data are taken from the Veneto Workers History (VWH) dataset, which was constructed by Giuseppe Tattara and colleagues at the University of Venezia using administrative records of the Italian Social Security System.[18] The VWH contains information on private sector employees in the Veneto region over the period from 1975 to 2001 (see Tattara and Valentini, 2007).[19] Specifically, it includes register-based information on both the employee and employer for any job that lasts at least one day.

On the worker's side the VWH includes total earnings during the calendar year for each job, the number of days worked during the year, the worker's occupation, the appropriate national contract and level within that contract (i.e., a "job ladder" code); the worker's gender, age, region (or country) of birth, and seniority with the firm. On the employer side the VWH includes industry (classified by 5-digit ATECO 91), the dates of "birth" and closure of the firm (if applicable), the firm's location, and the firm's national tax number (*codice fiscale*).

Column 1 of Table 1 provides an overview of the sample of individual workers age 16-64 in the VWH over the 1995-2001 period (the period of overlap with the firm financial data). The

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[18]We are extremely grateful to Giuseppe Tattara for making available the dataset and to Marco Valentini and Carlo Gianelle for assistance in using it.

[19]The Veneto region has a population of about 4.6 millio – approximately 8% of the total population of Italy.

sample includes just under 2 million individual workers who were observed in 3.11 million job spells at 191,000 firms. On average 42% of the sample are female, 45% are between the ages of 17 and 30, 37% are between the ages of 31 and 44, and 17% are age 45 or older. Just under 30% are white collar workers, and the mean daily wage (for jobs observed in 2000) was 65 Euros.

Firm-level balance sheet information was obtained from AIDA (*analisi informatizzata delle aziende)*, a database distributed by Bureau Van Dijk that contains annual balance sheet information for incorporated non-financial firms in Italy with annual sales of at least 500,000 Euros.[20] AIDA contains the official balance sheet data for these firms, and is available starting in 1995. These balance sheets include information on sales, value added, the wage bill, capital, the total number of employees, industry (categorized by 5-digit code), and the firm's tax number.

Contractual minimum wage levels were obtained from records of the national contracts. We were able to reconstruct contractual wages over our sample period for a total of 23 major nationwide contracts in construction, metal and mechanical engineering, textiles and clothing, food, furniture and wood products, trade, tourism, and services. We were unable to obtain information for one major sector – chemicals – and for a number of smaller sectoral contracts. For each occupation grade listed in the contract, we have information on the minimum wage, the cost-of-living allowance (a fixed amount equal to the payment set in the 1992 contract) and any special allowances. Typically, the cost of living amounts are adjusted once or twice per year.

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[20]See http://www.bvdep.com/en/aida.html. Only a tiny fraction of firms in AIDA are publicly traded. We exclude these firms, and those with consolidated balance sheets (i.e., holding companies)

c. Matching the Worker and Firm Data

We match job-year observations for people age 16 to 64 in the VWH (for the period from 1995 to 2001) to employer information in AIDA for the same year using the employer tax code identifier available in both datasets. The matching rate is high: in all years we were able to find at least one observation in the VHW for over 95% of the firms in AIDA sample. We investigated the quality of the matches by comparing the total number of workers in the VWH who are recorded as having a job at a given firm (in October of a given year) with the total number of employees reported in AIDA (for the same year). In general the two counts agree very closely. To reduce the influence of false matches (particularly for larger firms) we decided to eliminate the small number of matches for which the absolute difference between the number of employees reported in the balance sheet and the number found in the VWH exceeded 100. Removing these "gross outliers" (less than 1% of all firms) the correlation between the number of employees in the balance sheet and the number found in the VWH is 0.99. (A plot of the two measures against each other, available on request, shows that most of the points lie very close to the 45 degree line). We also compared total wages and salaries for the calendar year as reported in AIDA with total wage payments reported for employees in the VWH. The two measures are also highly correlated (correlation > 0.98), and the median ratio between them is close to 1.0.

Column 2 of Table 1 shows the characteristics of the job-year observations we successfully matched to AIDA. Just under 50% of all workers observed between 1995 and 2001 in the VWH can be matched to an AIDA firm. Non-matches include people working at unincorporated firms and at smaller incorporated firms that are not included in AIDA. The matched observations come from roughly 18,000 firms, or only about 10% of the total universe of firms contained in the VWH. Average firm size for the matched jobs sample (36.0 employees) is substantially above the average for all firms in the VWH (7.0 employees). Mean daily wages for the matched observations are also higher, whereas the fractions of female and younger workers are lower.

From the set of potential matches described in column 2 we made a series of exclusions to arrive at our estimation sample. First, we eliminated job-year observations for jobs that lasted only part of a year. Second, we eliminated apprentices, managers, and part-time employees.[21] Finally, we eliminated jobs at firms that had fewer than 10 employees or closed during the calendar year, and job-year observations with unusually high or low values for estimated value added per worker. The characteristics of the resulting sample are shown in column 3 of Table 1. This sample has one-half as many people (and 43% as many job spells) as the sample of all potential matches in column 2.[22]

We were able to match information on the sectoral minimum wage for about 75% of the observations in the overall estimation sample.[23] The resulting subsample is summarized in column 4 of Table 1. The age, gender, and earnings distributions of workers who can be matched to a sectoral minimum wage are not too different from those in the overall estimation sample. For this group we can also construct an estimate of the "wage drift" component of salary: the gap

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[21]Although we do not know hours worked, the VWH includes an indicator for part-time.

[22]The largest reduction in sample size comes from the year-round job requirement, which eliminates about 33% of individuals.

[23]As noted above, we do not have sectoral contract information for firms in the chemical industry, which is a relatively large employer in the Veneto region, and for firms in industries covered by relatively narrow sectoral agreements.

between the average daily wage and the sectoral minimum. As shown in row 7, the mean premium is 20.9 Euros per day. The average percentage premium (not reported) is 26%.

Rows 10-14 of Table 1 show the mean values of various indicators of firm profitability. Row 10 shows mean value added per worker (in thousands of Euros per year). This is slightly higher in the overall sample of matches (column 2) but very similar between columns 3 and 4. Row 11 shows the mean of value added per worker *minus* a crude estimate of the opportunity cost of labor, based on an the average wage in the firm's industry. In the notation of our model this is $R(L_t, K_t, \theta_t)/L_t - a_t$, where a_t is the industry mean wage. For comparison, row 12 shows an estimate of value added per worker minus the sectoral minimum wage (which is only available for the subsample that can be matched to contracts in column 4). Since the the industry average wage is above the sectoral minimum wage, the latter is substantially larger than the former. Finally, rows 13 and 14 show an estimate of value added per worker, minus the alternative wage, minus 10% of capital per worker, i.e., $R(L_t, K_t, \theta_t)/L_t - a_t - 0.1K_t/L_t$. Assuming there are no holdup issues, and that the user cost of capital is 10%, this is an estimate of quasi-rent per worker (i.e., Q_t/L_t, in the notation of equation 11). Again, we present two estimates, using either the industry average wage (row 13) or the minimum sectoral wage (row 14). Using the latter, the ratio of the mean quasi-rent to the wage bill (evaluated at the alternative wage) is approximately 2.11. Using equation (10), a comparison of this ratio to the average markup over the sectoral minimum wage implies that workers capture about 12% of firm-specific quasi rents.[24]

[24]The means in rows 10-14 are in thousands of Euros per year per worker. Assuming 312 paid days per year the mean contractual minimum wage is 15,600 per year ($=312\times67.5(1-0.26)$). Ignoring the fact that the mean of a ratio is not equal to the ratio of means, the mean ratio of

IV. Estimation Results

a. Basic Results

As a point of departure for our analysis Table 2 presents a set of simple OLS models which relate the average yearly wage earned by an individual worker to the components of observed quasi-rent at his or her employer and other control variables. Columns 1 and 2 show models estimated over our full estimation sample. In this sample we use the industry-wide average wage (calculated at the 4 digit level) for employees in Veneto region as our estimate of the alterative wage. Columns 3 and 4 use the subsample of observations that can be matched to a minimum sectoral wage. The baseline models in columns 1 and 3 include only the three covariates shown in the table and a set of year effects. The richer specifications in columns 2 and 4 add controls for age, tenure, gender, and foreign-born status, dummies for province and 2-digit industry, and controls for the age and total number of employees at the firm.

The estimation results in Table 2 confirm that in our sample, as in other samples analyzed in the literature, wages are higher at more profitable firms. The effect of value added per worker on wages is somewhat smaller in magnitude when the sectoral minimum wage is used as a measure of outside wage opportunities, and when controls for worker and firm characteristics are added (as in columns 2 and 4), but in all cases the estimated effects are precisely estimated. The implied elasticities of wages with respect to quasi-rent per worker are reported at the bottom of

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quasi-rents to the wage bill is 30.45/15.6 = 1.95. From equation (11), $(w-m)/m = \gamma\ Q^*/(Lm)$, implying that $\gamma = 0.26/1.95 = 0.13$. Note we are also ignoring any slippage between the observed quasi-rent and the "efficient" quasi-rent Q^*.

the table, and range from 0.04 to 0.07.[25] We also report the "Lester range" (Lester, 1952): the change in log wages associated with a 4-standard deviation shift in the value of quasi-rents per worker (i.e., from the bottom 5% to the top 5% of the profitability distribution, if quasi-rent per worker were normally distributed). This ranges from 11 to 21 percent.

A comparison of the estimated coefficients in rows 1 and 2 of Table 2, however, does not offer much support for the "no-holdup" prediction in equation (13). In fact, the estimates of the capital coefficient in columns 1 and 2 are positive - the opposite of the prediction from (13). Despite these findings, we fit a parallel set of models (available on request) – that impose the restriction that wages depends on a quasi-rent measure that deducts the 10% of the current capital stock from value added. Imposing this restriction, the estimated coefficients of quasi-rent per worker are very close to the coefficients on value-added per worker reported in Table 2, and the implied Lester range and elasticity of wages with respect to quasi-rents are also very similar.

Although the models in Table 2 fit relatively well (the R-squared from the model in column 4 of these tables is a respectable 60%), and yield estimated profit-sharing effects that are comparable to those in many earlier studies, an important concern is the potential impact of unobserved heterogeneity in firm profitability and workers' skills. In particular, if more profitable firms tend to hire better-qualified workers (as suggested by Abowd, Kramarz and Margolis, 1999, for example) OLS models like those in Table 2 will overstate the causal effect of rent-sharing on wages. A number of recent studies have used matched worker-firm data to relate

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[25]We estimate the elasticity by multiplying the coefficient of value-added per worker (in row 1 of the table) by the sample average value of quasi-rent per worker, assuming no holdup issues and a 10% return to capital. This is constructed as value added per worker, minus the alternative wage, minus 0.1 times capital stock per worker.

within-job changes in the profitability of the firm to within-job wage growth (see e.g., Margolis and Salvanes, 2001; Martins, 2004; Gurtzen, 2008). This approach eliminates all biases caused by permanent heterogeneity due to worker, firm, or match-specific effects.

Table 3 presents estimation results from models that include unrestricted match effects. All the models in the table also include the richer set of controls included in the even-numbered columns of Table 2. OLS models with match effects are presented in columns 1 and 3. These specifications yield relatively small (but precisely estimated) estimates of the effect of profitability on wages. Compared to models without match effects (e.g., in Table 2), the implied elasticities of wages with respect to quasi-rents, and the implied estimates of the Lester range, are reduced by a factor of 10. Taken at face value these models suggest that rent sharing is quantitatively unimportant in explaining wage variability in Italy.

We believe, however, that the measured response of wages to value added per worker is biased by measurement errors and transitory fluctuations in value-added. Measured value added can vary substantially from year to year depending on the timing of sales and payments for raw materials. We are also concerned that there may be some endogeneity in the relationship between wages and value added per worker, even within a job spell. To address both issues we constructed an instrument for value added per worker, based on average revenues per worker for firms in the AIDA data set in the same 4 digit industry but in other regions of Italy. This variable is a good proxy for industry-wide demand shocks that affect the profitability of employers in our sample, but should be uncorrelated with measurement errors or transitory fluctuations in value added. It is a strong predictor of value added per worker for the employers in our sample (see the first stage F-statistics in row 7).

Columns 2 and 4 of Table 3 report within-spell IV estimates of our wage determination model. The IV strategy leads to a substantial increase in the magnitude of the estimated response of wages to value added. In fact, within-job IV estimates of this response are quite similar to simple OLS estimates. The implied elasticities of wages with respect to quasi rents are also similar, as are the estimates of the Lester range.

The IV estimation strategy also yields estimates of the response of wages to capital per worker that are negative, and roughly one-tenth as large in magnitude as the responses to value added per worker. (The precise ratios of the coefficients are 0.109 and 0.112 for the models in columns 2 and 4, respectively). This pattern is consistent with the predictions of a no-holdup model with a user cost of capital of approximately 10%. As a check we fit a parallel set of models to those in Table 3 that impose the restriction from the no-holdup specification, and assume a 10% user cost. These restricted models fit about as those in Table 3, and yield essentially the same estimates of the elasticity of wages with respect to quasi rents, and of the Lester range in wages between high and low-profit firms.

The large increases in the estimated coefficient of value-added per worker between the OLS and IV specifications suggest that the causal effect of this variable is substantially downward-biased in the OLS models with job match dummies. A similar finding is reported by Abowd and Lemieux (1993) who estimate models of rent sharing using firm-specific wage contract data, and obtain IV estimates that are much larger than the corresponding OLS estimates. Likewise, Arai and Heyman (2004) compare OLS and IV estimates of rent-sharing in Sweden, using worker-firm data with job-match effects, and find much larger IV estimates. Finally, Guiso, Pistaferri, and Schivardi (2005) use Italian Social Security and balance sheet data from an earlier period (1984-1994) to analyze the response of workers' earnings to firm-specific shocks in value added, allowing different effects for transitory and permanent shocks. They find that the wage response to permanent shocks is about ten times larger than the response to temporary shocks. While their empirical setup and identification strategy are quite different than ours, we suspect that the permanent-transitory distinction in their results is consistent with our IV-OLS distinction, since our IV strategy identifies the response to industry-wide demand shocks, which are likely to be far more persistent than firm-specific deviations from the industry mean.

b. Long Differences

The estimates in Table 3 are based on annual observations on wages for workers in continuing jobs. One concern with these estimates is that negotiations over the share of rents awarded to workers may occur relatively infrequently. Most firm level contracts are renegotiated every 3 years. Individual-specific negotiations may occur more frequently, but perhaps not annually. A second concern is that changes in average hours of work (which we cannot measure) will lead to fluctuations in measured wages that are positively correlated with short-term industry demand shocks, leading to an over-statement of the degree of rent sharing. As a simple robustness check, we therefore constructed a set of "long differences" estimates, based on changes over 4 years. Changes over this horizon will capture both formal and informal renegotiations, and are also less likely to be affected by temporary demand shocks that lead to overtime or short time. For all workers who were observed in a job match that persisted at least 4 years we extracted one (randomly selected) change over 4 years, yielding a sample of 152,275 worker-firm observations. Of these, 104,714 can be assigned a contractual minimum wage for the start and end of the 4-year spell.

The results are presented in Table 4, following the same format as in Table 3. The estimated rent-sharing elasticities from the IV specifications are 12-26% larger using 4 year changes than using year-to-year changes, but the pattern of the coefficient estimates is otherwise similar. In particular, as in Table 3, the IV models in Table 4 suggest that capital per worker exerts a negative effect on wages, with a coefficient that is roughly 10% as large in magnitude as the effect of value-added per worker. We interpret the estimates as offering further support for the conclusion that rent sharing in Italy anticipates the returns to future holdup, leading to a quasi-rent expression that deducts the full cost of capital, on average.

c. Endogeneity of Capital per Worker

One concern with the IV estimates in Table 3 (and 4) is that although we have instrumented value added per worker, we have treated capital per worker as exogenous. As a check on this assumption, we re-estimated the models, using lagged capital per worker as an instrument for the current value. This procedure will reduce or eliminate the effect of any correlation between current measured wages and current employment, which would otherwise bias downward the coefficient on K/L.[26] The results are presented in Table 5. Lagged K/L is a powerful instrument and the IV estimates are relatively close to the OLS estimates (compare columns 1 and 2 of Table 5 to columns 2 and 4 of Table 3). The ratio of the coefficients of K/L

[26]If overtime hours and the level of employment are positively correlated, measured wages (which include overtime payments) will also be positively correlated with employment.

and VA/L are 0.117 and 0.131, respectively, consistent with the range of estimates for the user cost of capital in Italy. Based on these results we conclude that endogeneity and measurement error in K/L are a relatively minor concern in our empirical results.

d. Allowing for Different Forms of Capital

Holdup is potentially a bigger problem for some forms of capital than others. The AIDA balance sheets include information on three broad categories of capital: tangible fixed assets (buildings and machinery); intangible fixed assets (intellectual property, accumulated research and development investments, goodwill); and current assets or "working capital" (inventories, receivables, and liquid financial assets). To investigate the effects of different types of capital, we re-estimated the IV models in Table 3, allowing separate coefficients for measures of the amount of each type of capital per worker. The results are presented in Table 6. We find negative coefficients for all three types of capital, with the largest magnitude of effects for tangible fixed assets (implicit return $\approx$10%), an intermediate magnitude for tangible assets (implicit return $\approx$7-8%), and the smallest magnitude for working capital (implicit return $\approx$5%). The comparative returns for tangible assets and working capital are the <u>opposite</u> of what might be expected if holdup is a significant problem for sunk assets, since plant and equipment investments are presumably more difficult to liquidate than working capital. Rather, the pattern of coefficients is consistent with the alternative hypothesis that the user cost of fixed asset investments are relatively high (because of depreciation and uncertainty over future value), whereas the user cost of working capital is closer to the risk-free interest rate.

e. Differences by Sector

There are several reasons to expect that the parameters of our wage setting model may vary across industries. The extent of firm-level bargaining varies by sector, and if formal contracting leads to more rent-sharing than informal bargaining, the response of individual wages to firm-specific rents will vary accordingly. The types of capital and the riskiness of investment also vary by sector, leading to potential variation in the relevant user cost. To explore the heterogeneity by sector we fit a series of models similar to the specification in Table 5, using a number of alternative classifications of industries. We found that the parameter estimates vary somewhat between sectors, although it is difficult to discern a systematic pattern.

As an illustration, Table 7 presents a simple 3-way classification that divides workers into three (roughly equal) groups: employees at manufacturing firms with high capital-intensity; employees at low capital-intensity manufacturing firms; and employees in non-manufacturing.[27] The results for employees in non-manufacturing jobs (column 4) are quite similar to the pooled results (compare the estimates to those in column 2 of Table 5). The estimates for high capital intensity manufacturing suggest a somewhat higher degree of rent sharing, while the results for low capital intensity manufacturing suggest that rent sharing in this sector is minimal. Note that for both capital intensive manufacturing and non-manufacturing we find a significant negative effect of capital per worker, with implied user costs of 9.3% and 22%, respectively. We conclude that there is some heterogeneity across sectors, and that there may be a relatively large subset of firms for which rent-sharing is unimportant. The estimates from our pooled specifications,

[27]We construct an estimate of average capital per worker for each firm, and classify firms depending on whether the average is above or below the median for all firms in manufacturing.

however, appear to represent a reasonable "average" of the estimates across different sectors.

e. Debt versus Equity Financing

In our theoretical and empirical discussions so far we have made no distinction between different sources of capital financing. A number of authors have argued that the use of debt financing is one way to mitigate the holdup problems that arise between workers and firms, or between firms that supply intermediate inputs and those that use these inputs (e.g., Dasgupta and Sengupta 1993; Subramaniam 1996). In the simplest version of this argument, it is assumed that debt holders have to be repaid before workers and owners receive any payments, implying that debt-financed capital costs are fully deducted from the quasi-rent before any rent-splitting.[28] This line of research suggests that an alternative explanation for our "no holdup" finding is the use of debt financing, particularly by firms that are most vulnerable to holdup.[29]

To test this explanation we stratified the firms in our sample into two groups: those with an above-median ratio of debt to debt-plus-equity, and those with a below-median ratio. We then fit our basic IV specification (with match-specific fixed effects) to the two sets of firms separately. We found that the estimated coefficients of our model vary between subsamples, but that the no-holdup finding is present for both types of firms. For example, using the sectoral

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[28]This builds on an insight about the value of pre-committting to debt in Brander and Lewis (1986). As noted by Usman (2004), an implicit assumption is that renegotiation with creditors is costly in the event of no agreement. We are grateful to Bentley MacLeod for helpful discussions on the importance of debt in modeling holdup.

[29]Debt financing requires costly monitoring by lenders and may introduce its own moral hazard problems between managers and debt holders (Myers, 1977; Dasgupta and Sengupta, 1993). Thus, one would not expect debt financing to fully mitigate holdup.

minimum wage as a reference wage, for high-debt firms the estimated coefficient of value added per worker is 0.072 (standard error=0.042), and the estimated coefficient of capital per worker is -0.006 (standard error 0.006). For low-debt firms, by comparison, the estimated coefficient of value added per worker is 0.286 (standard error=0.064, and the estimated coefficient of capital per worker is -0.031 (standard error 0.007). In both cases the ratio of the capital coefficient to the value-added coefficient is very close to 10 percent. Based on these results, and other specifications that include interactions between the two main coefficients and the relative share of debt in the firm's financial structure, we conclude that the absence of holdup does not does depend on the use of debt. If anything, in fact, the finding is stronger for firms with relatively low levels of debt.

V. Conclusions

Relationship-specific investments are vulnerable to holdup: once a sunk investment is made by one party, some of the returns can be captured by the other, lowering the return to investment and potentially leading to inefficiency. As noted by Crawford (1988) the holdup problem can be solved in a long term relationship by having the party that is not making the investment pay "up front" for the returns they will capture in future negotiations. We show in a simple theoretical setting that the same intuition applies to worker-firm bargaining. We derive an expression for the quasi-rent that is split by the bargaining parties in each period and show that it deducts the cost of the fraction of the current capital stock that is fully reversible, plus the cost of the irreversible share of the future capital stock. The sum of these deductions is approximately equal to the full cost of capital. By comparison, in the presence of distortionary holdup only a fraction of the cost of the current capital stock is deducted, and firms have an incentive to under-invest.

We then use a matched employer-employee data set from the Veneto region of Italy that contains individual earnings records and firm-specific balance sheet data to estimate within-job models of rent-sharing and test for holdup. We find strong evidence of rent sharing, with an elasticity of wages with respect to profits on the order of 5-8%. We also find that firms with higher capital per worker pay lower wages, holding constant value-added per worker. The relative size of the deduction for capital is consistent with efficient intertemporal bargaining (i.e., no holdup) assuming a user cost of capital of around 10%. The deduction is larger for tangible investments than for working capital – a pattern that is inconsistent with a higher risk of holdup for tangible investments, but consistent with a lower user cost for liquid assets. The relative magnitude of the deduction is also similar for firms with relatively low and relatively high levels of debt, suggesting that the absence of holdup is not attributable to the strategic use of debt financing.

There are a number of limitations of our empirical analysis that need to be kept in mind. We have no information on the presence of formal firm-level contracts, so our analysis of rent sharing represents a combination of formal and informal contracting. Our matched data set also covers a relatively short period (6 years), so we have to rely on the reported book value of capital, rather than on a capital series derived from past investments. In view of these and other limitations our findings must be interpreted with some care. Nevertheless, we believe the weight of the evidence suggests that holdup may be less important for understanding the dynamics of investment and wages than has been argued in some previous studies.

Appendix A

This appendix derives expressions for wages and other outcomes when employment is set unilaterally by the firm. As in the simpler cases described in the text, we proceed backward from the second period. Given K_2 and θ_2, the second period wage negotiation solves

$$\text{(A1)} \quad \max_{w} \quad [\,(w - m_2)L_2\,]^{\gamma}\ [\,R(L_2,K_2,\theta_2) - wL_2 - \delta r_2 K_2\,]^{1-\gamma}\,,$$

where L_2 is endogenously determined from the labor demand schedule $L_2(w_2, K_2, \theta_2)$. Using the fact that $\partial R(L_2,K_2,\theta_2)/\partial L_2 - w_2 = 0$, the first-order condition for w_2 can be written as:

$$\text{(A2)} \quad (w_2 - m_2)\,L_2 \;=\; \gamma/(1-\gamma) \times [\,1 + \epsilon\,(w_2 - m_2)/w_2\,] \times [\,R(L_2, K_2, \theta_2) - w_2L_2 - \delta r_2 K_2\,]\,,$$

where ϵ is the elasticity of labor demand, which we assume is constant. Since L_2 is endogenous, we approximate (A2) around $L_2^* = L_2(m_2, K_2, \theta_2)$, the efficient employment level in period 2. We assume that

$$\text{(A3)} \quad L_2 \;\approx\; L_2^* \times (\,1 + \epsilon\,(w_2 - m_2)/w_2\,)$$

and use a first order approximation of the firm's profit function around the profit associated with the wage m_2:

$$\text{(A4)} \quad R(L_2, K_2, \theta_2) - w_2L_2 \;\approx\; R(L_2^*, K_2, \theta_2) - m_2\,L_2^* \;-\; L_2^*\,(w_2 - m_2)\,.$$

Substituting (A3) and (A4) into (A2) we obtain:

$$\text{(A5)} \quad w_2 \;=\; m_2 \;+\; \gamma\, Q_2^*/L_2^*$$

where

$$\text{(A6)} \quad Q_2^* \;=\; R(L_2^*, K_2, \theta_2) \;-\; m_2\,L_2^* \;-\; \delta r_2\,K_2$$

is the "efficient" quasi-rent in period 2. The optimized value of the second period bargain to workers is:

(A7) $(w_2 - m_2)\, L_2 \;=\; \gamma\, Q_2^* \times L_2 / L_2^* \;=\; \gamma\,(1 + \epsilon\, g_2^*)\, Q_2^*$

where $g_2^* = (w_2 - m_2)/w_2 = \gamma\, Q_2^*/(m_2\, L_2^*)$ is the optimized proportional wage markup. Using (A4) the firm's second period profits can be written as:

(A8) $$\pi_2 = R(L_2, K_2, \theta_2) - w_2 L_2 - \delta\, r_2 K_2 = Q_2^* - L_2^*(w_2 - m_2) - (1-\delta) r_2 K_2$$

$$= (1 - \gamma)\, Q_2^* - (1-\delta) r_2 K_2 \,.$$

Turning now to the first period, the wage w_1 is selected to maximize

(A9) $$[\,(w_1 - m_1)L_1 + \beta\gamma(1 + \epsilon g_2^*)Q_2^*\,]^{\gamma}$$

$$\times\ [\,R(L_1,K_1,\theta_1) - w_1 L_1 - \delta r_1 K_1 + \beta(1-\gamma)Q_2^* - \beta(1-\delta) r_2 K_2\,]^{1-\gamma}$$

subject to the condition that the firm selects L_1 once the wage is determined. We assume that the firm selects K_2 unilaterally in period 1, anticipating the choice for w_1 and w_2. The first order condition for the negotiated first period wage can be written as

(A10) $$(w_1 - m_1)\, L_1 + \beta\gamma(1 + \epsilon g_2^*)Q_2^* = \gamma/(1-\gamma) \times (1 + \epsilon(w_1 - m_1)/w_1)$$

$$\times [\,R(L_1,K_1,\theta_1) - wL_1 - \delta r_1 K_1 - \beta(1-\delta)\, r_2 K_2 + \beta(1-\gamma)Q_2^*\,]$$

Notice that if

$$(1 + \epsilon g_2^*) = (1 + \epsilon\,(w_1 - m_1)/w_1)$$

the terms involving Q_2^* cancel from the both sides of (A10). Since $g_2^* = (w_2 - m_2)/w_2$, this will be true if the markup of the wage over the outside wage is constant over time (or if ϵ=0) . Assuming a constant markup, (A10) can be written as

(A11) $$(w_1 - m_1)\, L_1 = \gamma/(1-\gamma) \times (1 + \epsilon\,(w_1 - m_1)/w_1)$$

$$\times [\,R(L_1,K_1,\theta_1) - wL_1 - \delta r_1 K_1 - \beta(1-\delta)\, r_2 K_2\,].$$

This has exactly the same form as (A2) – the first order condition for w_2 – and using a similar first order expansion of the profit function we get

(A12) $w_1 = m_1 + \gamma\, Q_1^*/L_1^*$

where

(A13) $Q_1^* = R(L_1^*, K_1, \theta_1) - m_1 L_1^* - \delta\, r_1 K_1 - \beta(1-\delta)\, r_2 K_2$

and $L_1^* = L_1(m_1, K_1, \theta_1)$, the efficient employment level in period 1. Note that, as in the baseline model with fixed employment, the quasi-rent expression deducts a share δ of first period capital costs, and a (discounted) share $(1-\delta)$ of second period costs. Comparing (A12) to (A5), the markup of the negotiated wage over the outside alternative will be constant if the ratio of efficient quasi-rent to efficient employment is constant – a situation that we regard as plausible.[30]

Finally, we turn to the determination of K_2, which we assume is made unilaterally by the firm, anticipating wages over the next two periods. Paralleling (A8), the firm's first period profits can be written as

(A14) $\pi_1 = (1-\gamma)\, Q_1^* - (1-\delta)\, r_1 K_1 + \beta(1-\delta)\, r_2 K_2$.

Thus,

(A15)
$$\begin{aligned}\pi_1 + \beta\pi_2 &= (1-\gamma)\, Q_1^* - (1-\delta)\, r_1 K_1 + \beta(1-\delta)\, r_2 K_2 \\ &\quad + \beta(1-\gamma)\, Q_2^* - \beta(1-\delta)\, r_2 K_2 \\ &= (1-\gamma)\,[\, Q_1^* + \beta\, Q_2^*\,] - (1-\delta)\, r_1 K_1\end{aligned}$$

which implies that the firm selects a K_2 that maximizes the discounted quasi-rent. Using the definitions of Q_1^* and Q_2^* we obtain:

[30] In a 2-period model, the quasi-rent in the second period does not include a discount for future capital costs. In a multi-period model, however, the quasi-rent in successive periods (except the last) will have the form of (A13).

$$(A16)\quad Q_1^* + \beta Q_2^* = R(L_1^*, K_1, \theta_1) - m_1 L_1^* - \delta r_1 K_1 + \beta[R(L_2^*, K_2, \theta_2) - m_2 L_2^* - r_2 K_2] .$$

Thus, the firm's first order condition for K_2 sets $\partial R(L_2^*, K_2, \theta_2)/\partial K_2 = r_2$, implying an efficient capital choice.

With unilateral employment-setting, L_1 will differ from L_1^*, and the observed level of quasi-rent for a particular bargaining pair (Q_1) will differ from the efficient quasi-rent (Q_1^*) that appears in the wage determination model. In particular, the observed quasi-rent implied by the model is

$$(A17)\quad Q_1 = R(L_1, K_1, \theta_1) - m_1 L_1 - r_1 \delta K_1 - \beta(1-\delta) r_2 K_2 ,$$

and, using an first-order expansion like (A4),

$$(A18)\quad Q_1 = R(L_1^*, K_1, \theta_1) - m_1 L_1^* - r_1 \delta K_1 - \beta(1-\delta) r_2 K_2 + (L_1 - L_1^*)(w_1 - m_1)$$
$$= Q_1^* + (L_1 - L_1^*)(w_1 - m_1) .$$

Using the approximation that $L_1 = L_1^* (1 + \epsilon (w_1 - m_1)/m_1)$ and equation (A12) this can be further simplified to:

$$(A19)\quad Q_1 = Q_1^* (1 + \epsilon\gamma g_1^*)$$

where $g_1^* = (w_1 - m_1)/m_1$ is the optimal first period markup. Finally, measured quasi-rent per employee is:

$$(A20)\quad Q_1 / L_1 = Q_1^* (1 + \epsilon\gamma g_1^*) / [L_1^* (1 + \epsilon g_1^*)]$$
$$\approx Q_1^* / L_1^* \times (1 - \epsilon g_1^*(1-\gamma)) > Q_1^* / L_1^* .$$

Measured quasi-rent per worker <u>overstates</u> Q_1^* / L_1^*, the measure of quasi-rent per worker that drives wage determination, by approximately $|\epsilon|\, g_1^*(1-\gamma)$ percent.

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Table 1: Descriptive Statistics for Workers, Firms and Job Matches

	Universe of Job-Year Observations (1)	Matched Job-Year Observations (2)	Estimation Sample: Full Sample (3)	Estimation Sample: Subset Matched to Sectoral Contract (4)
Characteristics of Workers:				
1. Number of Individual Workers	1,990,751	985,160	483,188	364,804
2. Percent Female	42.3	34.4	28.9	29.2
3. Percent Age 30 or Less	45.6	39.8	41.5	42.5
4. Percent Age 45 or More	17.1	19.8	18.3	17.7
5. Percent White Collar	29.6	29.8	30.7	31.9
6. Mean Daily Wage (real Euros)	64.8	74.2	68.2	67.5
7. Mean Drift Component of Daily Wage (real Euros)	–	–	–	20.6
Characteristics of Firms:				
8. Number of Individual Firms	191,202	18,312	9,005	7,237
9. Firm Size [a]	7.0	36.0	49.5	49.9
10. Value Added/Worker (1000's real Euros)	–	59.7	45.9	45.8
11. Valued Added/Worker less Industry Mean Wage (1000's of real Euros)	–	31.5	25.1	25.1
12. Valued Added/Worker less Sectoral Min. Wage (1000's of real Euros)	–	–	–	31.0
13. Quasi-rent/Worker, using Industry Mean Wage (1000's of real Euros)	–	23.3	20.7	21.0
14. Quasi-rent/Worker, using Sectoral Min. Wage (1000's of real Euros)	–	–	–	26.8
Characteristics of Job Match:				
15. Number of Job Matches	3,111,990	1,223,889	528,936	395,923
16. Mean Duration of Job (years)	2.1	2.5	3.4	3.4

Notes: Sample in column 1 includes observed jobs for individuals between the ages of 16 and 64 in Veneto Worker History File during a calendar year between 1995 and 2001. Sample in column 2 includes subset of job-year observations that can be matched to AIDA balance sheet data for the firm (in the same calendar year). Estimation sample excludes part-year jobs, jobs at firms with under 10 employees, part-time jobs, and jobs held by apprentices and managers. Sample in column 4 includes job-year observations that can be matched to information on the minimum wage in the relevant sectoral contract. See text for further details.

[a]In column 1 firm size is based on number of employees as of October in VWH data. In other columns firm size is from AIDA data.

Table 2: OLS Estimates of Rent Sharing Model

	Using Industry Mean As Alternative Wage		Using Sectoral Minimum As Alternative Wage	
	(1)	(2)	(3)	(4)
1. Value Added per Worker	0.258 (0.014)	0.183 (0.010)	0.196 (0.011)	0.135 (0.008)
2. Capital Stock per Worker	0.012 (0.005)	0.012 (0.004)	-0.026 (0.005)	-0.002 (0.004)
3. Alternative Wage	0.629 (0.022)	0.110 (0.012)	1.809 (0.015)	1.669 (0.018)
4. Additional Controls	no	yes	no	yes
5. R-squared	0.212	0.439	0.456	0.599
6. Number of Person-Year Observations	1,653,190	1,653,190	1,200,889	1,200,889
Addendum:				
Elasticity of Wages w.r.t. Rents	0.065	0.046	0.061	0.042
Lester's Range	0.205	0.145	0.159	0.109

Notes: Dependent variable in all models is log of average daily wage. Standard errors clustered by firm and year in parentheses. All models include year dummies. Controls added in columns 2 and 4 are: quadratic in age, quadratic in job tenure, dummies for gender and foreign-born, and dummies for province (6) and 2-digit industry, firm age (in years) and number of firm's employees.

Table 3: OLS and IV Within-Spell Estimates of Rent Sharing Model

	Using Industry Mean As Alternative Wage		Using Sectoral Minimum As Alternative Wage	
	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)
1. Value Added per Worker	0.035	0.229	0.029	0.214
	(0.001)	(0.027)	(0.001)	(0.035)
2. Capital Stock per Worker	-0.0001	-0.025	-0.0001	-0.024
	(0.0006)	(0.003)	(0.0001)	(0.004)
3. Alternative Wage	0.009	0.081	0.799	0.790
	(0.001)	(0.002)	(0.004)	(0.007)
4. Additional Controls	yes	yes	yes	yes
5. Number of Person-Year Observations	1,653,190	1,495,773	1,200,889	1,078,212
6. Number of Job Spells	527,749	370,332	395,557	272,880
7. First-stage F-statistic	–	855.5	–	391.0
Addendum:				
Elasticity of Wages w.r.t. Rents	0.009	0.057	0.009	0.066
Lester's Range	0.028	0.181	0.024	0.173

Notes: Dependent variable in all models is log of average daily wage. All models include a complete set of job-spell dummies as well as year effects and the covariates described in Table 2 that vary within job spells. In IV models (columns 2 and 4) value-added per worker is treated as endogenous. Instrument is revenue per worker for firms in the same 4 digit industry in the same year in other regions of Italy.

Table 4: Long Differences (4-year) Estimates of Rent Sharing Model

	Using Industry Mean As Alternative Wage		Using Sectoral Minimum As Alternative Wage	
	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)
1. Change in Value Added per Worker minus Alternative Wage	0.049	0.257	0.040	0.269
	(0.004)	(0.043)	(0.003)	(0.047)
2. Change in Capital Stock per Worker	-0.002	-0.022	-0.006	-0.034
	(0.002)	(0.004)	(0.002)	(0.006)
3. Change in Alternative Wage	0.049	0.038	0.800	0.783
	(0.006)	(0.007)	(0.010)	(0.014)
4. Additional Controls	yes	yes	yes	yes
5. Number of Observations	152,275	152,275	104,714	104,714
6. First-stage F-statistic	–	1080.2	–	392.6
Addendum:				
Elasticity of Wages w.r.t. Rents	0.012	0.063	0.011	0.078
Lester's Range	0.034	0.177	0.026	0.171

Notes: Dependent variable in all models is change in log average daily wage over 4 years. Standard errors in parentheses. All models include year effects and the covariates described in Table 2. In IV models (columns 2 and 4) value-added per worker is treated as endogenous. Instrument is revenue per worker for firms in the same 4 digit industry in the same year in other regions of Italy.

Table 5: IV Within-Spell Estimates of Rent Sharing Model with Capital Endogenous

	Using Industry Mean As Alternative Wage (1)	Using Sectoral Minimum As Alternative Wage (2)
1. Value Added per Worker	0.221 (0.023)	0.176 (0.022)
2. Capital Stock per Worker	-0.026 (0.004)	-0.023 (0.004)
3. Alternative Wage	0.006 (0.003)	0.707 (0.009)
4. Additional Controls	yes	yes
5. Number of Person-Year Observations	861,919	618,430
6. Number of Job Spells	231,303	169,452
7. First-stage F-statistic Value added per Worker	2100.0	1582.2
8. First-stage F-statistic Capital Stock per Worker	12894.1	8635.3
Addendum:		
Elasticity of Wages w.r.t. Rents	0.055	0.053
Lester's Range	0.167	0.135

Notes: Dependent variable in both models is log of average daily wage. Models include a complete set of job-spell dummies as well as year effects and the covariates described in Table 2 that vary within job spells. Value-added per worker and capital per worker are treated as endogenous. Instruments are revenue per worker for firms in the same 4 digit industry in the same year in other regions of Italy, and lagged capital per worker at the firm.

Table 6: IV Within-Spell Estimates of Rent Sharing Model, Distinguishing Three Types of Capital

	Using Industry Mean As Alternative Wage	Using Sectoral Minimum As Alternative Wage
	(1)	(2)
1. Value Added per Worker	0.262 (0.034)	0.236 (0.044)
2. Tangible Fixed Assets per Worker (plant and equipment)	-0.027 (0.004)	-0.024 (0.005)
3. Intangible Fixed Assets per Worker (intellectual property, R&D, goodwill)	-0.021 (0.004)	-0.016 (0.004)
4. Current Assets per Worker (inventories, receiveables, non-fixed financial assets, liquid funds)	-0.012 (0.002)	-0.011 (0.003)
5. Alternative Wage	0.082 (0.002)	0.790 (0.007)
6. Additional Controls	yes	yes
7. Number of Person-Year Observations	1,495,773	1,078,212
8. Number of Job Spells	370,332	272,880
9. First-stage F-statistic Value added per worker	548.13	258.6
Addendum:		
Elasticity of Wages w.r.t. Rents	0.066	0.073
Lester's Range	0.207	0.191

Notes: Dependent variable in both models is log of average daily wage. Models include a complete set of job-spell dummies as well as year effects and the covariates described in Table 2 that vary within job spells. Value-added per worker is treated as endogenous. Instrument is revenue per worker for firms in the same 4 digit industry in the same year in other regions of Italy.

Table 7: IV Within-Spell Estimates of Rent Sharing Model by Broad Sector

	Manufacturing			Non Manufacturing
	All	High K/L	Low K/L	
	(1)	(2)	(3)	(4)
1. Value Added per Worker	0.125 (0.030)	0.354 (0.009)	-0.020 (0.028)	0.164 (0.030)
2. Capital Stock per Worker	-0.010 (0.005)	-0.033 (0.005)	0.000 (0.005)	-0.037 (0.006)
3. Alternative Wage (Sectoral Minimum)	0.667 (0.011)	0.665 (0.018)	0.657 (0.013)	0.797 (0.017)
4. Additional Controls	yes	yes	yes	yes
5. Number of Person-Year Observations	489,586	228,403	261,183	128,844
6. Number of Job Spells	132,257	61,045	71,212	37,195
7. First-stage F-statistic Value added per worker	891.81	941.4	286.89	620.7
8. First-stage F-statistic Capital stock per worker	6037.98	5153.9	2166.2	2959.3
Addendum:				
Elasticity of Wages w.r.t. Rents	0.037	0.101	-0.006	0.053
Lester's Range	0.085	0.227	–	0.169

Notes: Dependent variable in all models is log of average daily wage. Models include a complete set of job-spell dummies as well as year effects and the covariates described in Table 2 that vary within job spells. Value-added per worker and capital per worker are treated as endogenous. Instruments are revenue per worker for firms in the same 4 digit industry in the same year in other regions of Italy, and lagged capital per worker at the firm. Manufacturing firms are classified as having high or low capital per worker (K/L) if their ratio of capital per worker is above or below the median for all manufacturing firms.