

High Discounts and High Unemployment *

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Abstract

In recessions, the stock market falls more than in proportion to corporate profit. The discount rate implicit in the stock market rises. All types of investment fall, including employers' investment in job creation. According to the leading view of unemployment—the Diamond-Mortensen-Pissarides model—when the incentive for job creation rises, the labor market tightens and unemployment falls. Employers recover their investments in job creation by collecting a share of the surplus from the employment relationship. The value of that flow falls when the discount rate rises. Thus high discount rates imply high unemployment. This paper does not explain why the discount rate rises so much in recessions. Rather, it shows that the rise in unemployment makes perfect economic sense in an economy where the stock market falls substantially in recessions because the discount rises.

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The search-and-matching paradigm has come to dominate theories of movements of unemployment, because it has more to say about the phenomenon than just associating unemployment with the difference between labor supply and labor demand. The ideas of Diamond, Mortensen, and Pissarides promise a deep understanding of the disequilibrium that occurs in the labor market, most recently following the worldwide financial crisis that began in late 2008. But connecting the crisis to high unemployment according to the principles of the DMP model has proven a challenge.

In a nutshell, the DMP model relates unemployment to job-creation incentives. When the payoff to an employer from taking on new workers declines, employers put fewer resources into recruiting new workers. Unemployment then rises and new workers become easier to find. Hiring returns to its normal level, so unemployment stabilizes at a higher level and remains there until job-creation incentives return to normal. This mechanism rests on completely solid ground.

The aspect of the model that is unresolved today, almost 20 years after the publication of the canon of the model, Mortensen and Pissarides (1994), is what force depresses the payoff to job creation in recessions. In that paper, and in hundreds of successor papers, the force is a drop in productivity. But that characterization runs into two problems: First, productivity either did not fall, or did not fall and remain low, in the last three recessions in the United States. Second, as Shimer (2005) showed, the model, with realistic parameter values, implies tiny movements in unemployment in response to large changes in productivity.

Researchers, including this writer, responded vigorously to Shimer's point, so that a reasonable case can be made that the response of unemployment to hypothetical productivity declines would be substantial. But no researcher has tried to make the case that any actual decline in productivity occurred following the financial crisis anywhere near large enough or timed in the right way to explain the high and lingering unemployment rate in the U.S., much less countries like Spain where unemployment rose into the 20-percent range.

This paper studies a new driving force in the DMP framework, the discount that employers apply to the future flow of benefits from a new hire. In the DMP model, the incentive to hire is the present discounted value of the new worker's contribution to revenue less the wage the worker will receive. I call this present value the *job value*. An increase in discount rates lowers the job value, lowers recruiting effort, makes jobs harder to find, and thus raises unemployment.

The attraction of the discount rate as a driving force in the context of a recession following a financial crisis is that a crisis may raise the discount rate that firms apply to future flows, such as the flow of benefits from a newly hired worker. Of course, a crisis results in *lower* discounts for safe flows—the yield on 5-year U.S. Treasury notes fell essentially to zero soon after the crisis of late 2008. The logic pursued here is that the flow of benefits from a newly hired worker has financial risk comparable to corporate earnings, so the dramatic widening of the equity premium that occurred in the crisis implied higher discounting of benefit flows from workers at the same time that safe flows from Treasuries received lower discounting. In the crisis, investors tried to shift toward safe returns, resulting in lower equity prices from higher discounts and higher Treasury prices from lower discounts.

This paper does not explain why risky flows receive higher discounts in recessions (but see Bianchi, Ilut and Schneider (2012) for a new stab at an explanation). Rather, it documents that fact by extracting the discounts implicit in the actual stock market. I use the framework of modern finance theory, where the discounter is stochastic and present values are the expected products of the discounter and the stochastic future cash flow. Then I demonstrate the plausibility of the hypothesis that the same stochastic discounter also applies to the net benefit of hiring a new worker.

Actual measurement of the flow of net benefits from a new hire is, I believe, impossible. Most of workers' earnings are Ricardian rents to a primary factor. Thus the gross benefit of a new hire is just a bit higher than the wage. The difference between a necessarily noisy measure of the gross benefit (the marginal revenue product) and the wage, also measured with noise, would be almost entirely noise. But the DMP framework provides a robust way to measure the resulting discounted value, the job value J , because it is the cost of recruiting a new worker. A direct comparison of J with the value of the U.S. stock market shows a remarkable similarity over the past two decades. The comparison based on finance theory confirms what the naked eye sees—that the job value fell after the financial crisis in line with the discounts implicit in the stock market. To put it differently, a huge increase in the equity premium appears to have applied to the net benefit of hiring a new worker as well as to the stock market.

I show that the similarity of the job value and the stock-market value is almost entirely the result of changes in the discount rate and not in current and future flows. This fact about the stock market is well known. Its extension to the valuation of job relationships is

new, I believe. The primary novelty of this paper is the measurement of the job value from vacancy and hiring data and its comparison to the stock market in a framework of modern finance theory.

The appendix discusses some of the large number of earlier contributions to the DMP and finance literatures relevant to the ideas in this paper.

1 Defining and Measuring the Employer’s Job Value

The incentive for a firm to recruit a new worker is the present value of the difference between the marginal benefit that the worker will bring to the firm and the compensation the worker will receive. In equilibrium, with free entry to job creation, that present value will equal the expected cost of recruitment. That cost depends on conditions in the labor market, measured by the number of job openings or vacancies, V , and the flow of hiring, H . A good approximation, supported by extensive research on random search and matching, is that the cost of recruiting a worker is

$$\kappa + c \frac{V}{H}. \quad (1)$$

The vacancy/hiring ratio $T = V/H$ is the expected time to fill a vacancy, so the parameter c is the per-period cost of holding a vacancy open. The equilibrium condition is

$$\kappa + cT = \bar{J}. \quad (2)$$

Here \bar{J} is the present value of the new worker to the employer. I let $J = \bar{J} - \kappa$, the net present value of the worker to the employer, so the equilibrium condition becomes

$$cT = J. \quad (3)$$

The Job Openings and Labor Turnover survey of the Bureau of Labor Statistics measures the stock of vacancies and the flow of new hires, from which the ratio T can be computed directly. Data from Silva and Toledo (2009) show that the daily cost of maintaining a vacancy is 0.43 days of pay, so $c = \$66$ per day for the average U.S. employee in January 2011. I use this value to calculate J , but the main results of the paper do not depend on knowing the value of c —it is absorbed in a parameter expressing the proportionality of J and the value of the stock market.

Figure 1 shows the result of the calculation for the total private economy starting in 2001, at the outset of JOLTS, through the beginning of 2013. The average job value over

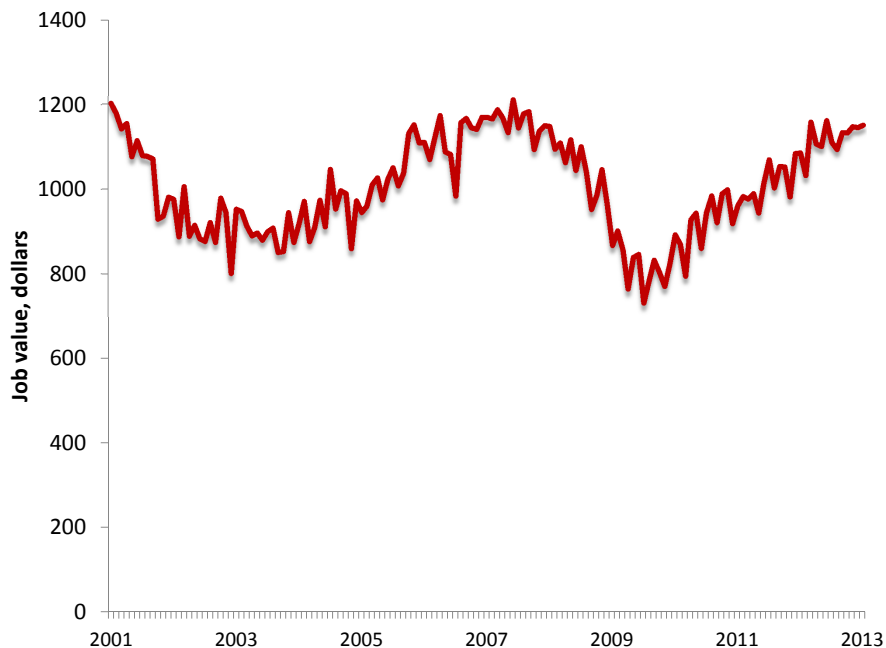


Figure 1: Aggregate Job Value, 2001 through 2013

the period was about \$1000 per newly hired worker. The value dropped sharply in the 2001 recession and even more sharply and deeply in the recession that began in late 2007 and intensified after the financial crisis in September 2008. The job value reached a maximum of \$1211 in June 2007 and a minimum of \$732 in July 2009. Plainly the incentive to create jobs fell substantially over that interval.

Figure 2 shows similar calculations for the industries reported in JOLTS. Average job values are lowest in construction, which fits with the short duration of jobs in that sector. The highest values are in government and health. Large declines in job values occurred in every industry after the crisis, including health, the only industry that did not suffer declines in employment during the recession. The version of the DMP model developed here explains the common movements of job values across industries, including those that have employment growth, as the common response to the increase in the discount rate.

2 Determinants of the Job Value

The equilibrium condition discussed in the previous section has endogenous variables on both sides. On the left, the tightness of the labor market, measured by the vacancy duration T , varies to maintain the equality, and on the left, the job value J also varies. This section

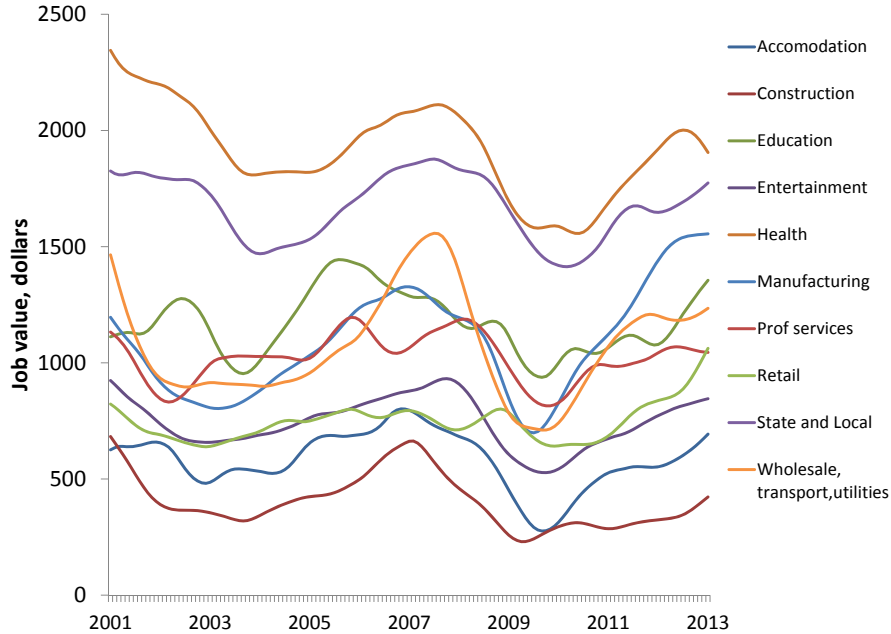


Figure 2: Job Values by Industry, 2001 through 2013

takes up the question of what forces might change their common value. In general, this is a somewhat complicated issue, because the job value may depend on market tightness. Two reasons for dependence come to mind immediately: (1) in a slacker market, unemployment is higher, so employment is lower and the marginal product of labor is higher, so the contribution of an incremental worker is higher, and (2) the wage bargain may depend on the jobseeker’s outside option, and the value of that option—to remain unemployed—falls if tightness falls and jobs become harder to find.

In the special case of no feedback—as would occur, for example, with a predetermined wage path for newly hired workers and a fixed value of the marginal benefit x —the job value J determines tightness directly. Then

$$T = \frac{J}{c}, \tag{4}$$

where a causal arrow runs from the right side to the left side.

Modern finance teaches that the economy has a present-value operator $\mathbb{V}(y)$ that gives the present value of a stochastic future stream y by taking the expected value of the stream multiplied at each future date by the economy’s stochastic discounter for that date. Thus

$$J = \mathbb{V}(x - w), \tag{5}$$

where x is the path of the future benefit that a new worker will deliver to the firm and w is the wage the worker will receive. Both x and w are in real terms. I assume fixed hours of work. It is straightforward to include variable hours in the analysis, but that extension seems to add little to understanding of the key issues.

Suppose for simplicity that a newly hired worker faces a constant monthly hazard $s = 0.033$, of separation (the average separation rate in JOLTS from 2007 through 2013), and the discount rate applicable to the financial risk of $x - w$ is 14 percent per year or 0.012 per month. The capitalization factor for a monthly flow is then

$$\frac{1}{0.033 + 0.012} = 22 \tag{6}$$

From Figure 1, the decline in the job value that occurred in the Great Recession was about \$200. Thus the decline in the monthly net flow to the employer, $x - w$, was $200/22 = \$9$ per month. The median hourly wage in 2011 was \$17, so the decline in the monthly flow was equal to about 30 minutes of wage earnings or a fraction 0.003 of monthly full-time earnings.

A small decline in the flow value of a newly hired worker corresponds to a large drop in labor-market tightness and a large increase in unemployment. In principle, powerful equilibrating forces might operate to prevent swings in unemployment by adjusting $x - w$ to keep it in a narrow range corresponding to a low, stable unemployment rate. Shimer (2005) describes a labor market with that property. In his model, x is taken as an exogenous driving force. The wage, w , adjusts directly through Nash bargaining by half of a change in x . In addition, a change in x changes the worker's outside option by almost the same amount, which then results in another adjustment in w of just under half the change in x . In consequence, the flow accruing to the employer, $x - w$, hardly changes at all and tightness and unemployment are left almost unchanged.

Even if w is not as responsive as in Shimer's model, another feedback mechanism operates in some cases. In the simplest version of the model, the benefit to the employer is the marginal product of labor. If a decline in total factor productivity resulted in an incipient decline in the marginal product and a squeeze on $x - w$, employment would fall. Lower employment implies a higher marginal product of labor and an offset to the squeeze. The labor market equilibrates at a somewhat higher unemployment level rather than the vastly higher unemployment that would result absent the feedback.

Because the change in the net flow value of a newly hired worker needed to rationalize the observed increase in unemployment following the crisis is absolutely tiny compared to

earnings and other flows, it appears hopeless to measure the job value by determining the flow and calculating its capital value to the employer. But see Yashiv (2000) and Merz and Yashiv (2007) for a contrary view. Pissarides (2009) suggested that research on the response of wages of newly hired workers showed too large a response to support a sticky-wage explanation of unemployment fluctuations. But Haefke, Sonntag and van Rens (2008), an ambitious attempt to estimate the response, concluded that it was not possible to pin it down with a sufficiently small standard error to resolve the subtle question of the variability of the flow. A further consideration is that it appears to be variations in the discount factor applied to the flow and not the flow itself that varies most over the cycle, as this paper argues.

I conclude that measuring the job value from the cost of recruiting a new worker is far more promising in empirical analysis of the DMP model than is any attempt to measure and then capitalize the net benefit of a new hire to the employer. The rest of the paper pursues this approach.

3 The Relation between the Job Value and the Stock Market

Kuehn, Petrosky-Nadeau and Zhang (2013) show that, in a model without capital, the return to holding a firm's stock is the same as the return to hiring a worker. In levels, the same proposition is that the value of the firm in the stock market is the value of what it owns. Under a policy of paying out earnings as dividends, rather than holding securities or borrowing, the firm without capital owns only one asset, its relationships with its workers. The stock market reveals the total job value of workers. Of course, in reality firms also own plant and equipment. One could imagine trying to recover the job value by subtracting the value of plant and equipment and other assets from the total stock-market value, but Hall (2001) suggests that the results would not make sense. In some eras, the stock-market value falls far short of the value of plant and equipment alone, while in others, the value is far above that benchmark, much further than any reasonable job value could account for. The appendix discusses Merz and Yashiv's (2007) work relating plant, equipment, and employment values to the stock market.

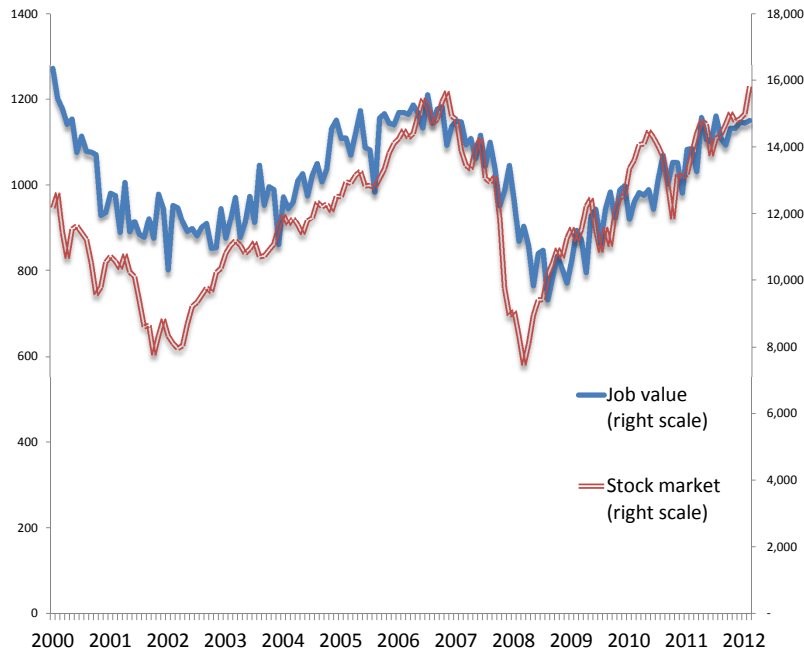


Figure 3: Job Value from JOLTS and Wilshire Stock-Market Index

3.1 Comparison of the job value to the value of the stock market

Figure 3 shows the job value calculated earlier, together with the Wilshire index of the broad stock market, deflated by the price index for GDP and detrended. The Wilshire includes almost all of the value of U.S. corporations. The similarity of the two series is remarkable. The figure strongly confirms the hypothesis that, however asset market value uncertain future payoffs, the valuation of the total payoff to corporations and the valuation of the payoff to employers from their workers results in quite similar movements of the resulting values.

A natural question is how close is the relationship between the two values in earlier years, prior to the onset of the JOLTS data. The Wilshire index begins at the end of 1970. Robert Shimer has calculated the job-finding rate from the CPS.¹ In a later section, I show that the job-finding rate is the the square of matching efficiency multiplied by tightness T , provided that the elasticities of the matching function with respect to unemployment and vacancies are both 0.5. This assumption appears to be reasonable—see Petrongolo and Pissarides (2001). Without reliable data on hires and vacancies from JOLTS, it is not possible to measure matching efficiency before 2001. JOLTS does suggest that the sharp decline in matching efficiency in recent years is unprecedented. On the assumption that efficiency was

¹ For additional details, please see Shimer (2012) and his webpage <http://sites.google.com/site/robertshimer/research/flows>.



Figure 4: Job Value from the CPS Job-Finding Rate Compared to the Wilshire Stock-Market Index

approximately constant prior to 2001, I use Shimer’s job-finding rate as a proxy for the job value.

Figure 4 shows the proxy for job value and the Wilshire index from 1971 through 2012, with pre-JOLTS job values imputed by multiplying the job-finding rate by a multiple calculated as the average ratio of the JOLTS figure to the job-finding rate during the overlap period, 2001 through 2006. For the period through the recession of 1973-75 and from 1992 onward, the correspondence is remarkable. During the period when the stock market had an unusually low value by almost any measure, from the mid-70s through 1991, the two series do not move together nearly as much.

3.2 Quantifying the relationship within finance theory

To illustrate the central topic of the paper, let y be the flow of profit that the stock market discounts, so the value of the market is:

$$P = \mathbb{V}(y). \quad (7)$$

Suppose, just for this simple illustration, that the value flow associated with a worker is a linear function of y :

$$x - w = \alpha + \gamma y. \quad (8)$$

Then the job value is

$$J = \mathbb{V}(x - w) = \mathbb{V}(\alpha + \gamma y) = \alpha \mathbb{V}(1) + \gamma \mathbb{V}(y) = \alpha C + \gamma P. \quad (9)$$

Here C is the market value of a safe real consol, a quantity that can be teased, in principle, from Treasury bond prices. This result suggests that it would be interesting to regress the job value on these securities prices, C and P . The plots in the previous section suggest that β would be robustly positive and that the relationship would fit quite well, except during the mystery period of the late 70s and the 80s.

The assumption in this simple approach that the duration of total corporate profit, y , is the same as the duration of the value of a worker to the firm, $w - w$, plainly does not hold. Profit rises as the economy grows, whereas the value of a worker declines because the monthly hazard of a separation is at least 3 percent. To deal with this issue, I need a financial pricing model.

3.3 Pricing model

I pursue a simple approach based on a Markovian economy. The economy has N states labeled i . I denote the state in the following period i' . The transition matrix is $\pi_{i,i'}$. Marginal utility is μ_i ; I normalize marginal utility in one of the states at one. The stock price satisfies the standard pricing condition,

$$P_i = \sum_{i'} \pi_{i,i'} \beta \frac{\mu_{i'}}{\mu_i} (P_{i'} + y_{i'}). \quad (10)$$

There are N equations in this condition, with $N - 1$ unknown values of marginal utility μ_i and one other unknown, β . It is mildly nonlinear and easy to solve. I have verified that the solution is unique among solutions with positive values of marginal utility. I discard any solution with any negative values. I have encountered no problems finding the single meaningful solution.

As the profit flow capitalized in the stock market, I use corporate profits in the National Income and Product Accounts, Table 1.12, line 13, deflated by the price index for GDP, Table 1.1.4, line 1. The implicit assumption is that the share of profits of firms included in the Wilshire index in total corporate profits is approximately constant. The coverage of publicly traded corporations in the Wilshire index is high enough to merit this treatment, but the fraction of corporations that are publicly traded does drift. This issue calls for

	<i>Deflated detrended Wilshire stock-market index</i>	<i>Deflated detrended corporate profits, billions of 2005 dollars</i>
L	1450	92
M	2411	130
H	3619	153

Table 1: Definitions of Categories of the Stock Price and Corporate Profits

		<i>Destination</i>									
			1	2	3	4	5	6	7	8	9
		<i>P</i>	L	L	L	M	M	M	H	H	H
<i>Origin</i>	<i>P</i>	<i>y</i>	L	M	H	L	M	H	L	M	H
1	L	L	0.73	0.09		0.18					
2	L	M	0.16	0.68	0.11		0.05				
3	L	H		0.13	0.87						
4	M	L	0.13			0.67	0.17		0.04		
5	M	M		0.10		0.10	0.60	0.15			0.05
6	M	H					0.08	0.58		0.17	0.17
7	H	L				0.20			0.70	0.10	
8	H	M					0.12		0.12	0.71	0.06
9	H	H						0.07		0.07	0.86
Marginal			0.13	0.11	0.09	0.14	0.12	0.07	0.06	0.10	0.17

Table 2: Transition Matrix among the 9 States

further work. The NIPA concept of profit is far closer to the appropriate concept than any measure derived from the accounting records of corporations.

I define the 9 states of the Markov process by dividing the ranges of P and y into 3 equally frequent categories. Table 1 shows the means of the two variables in each of the 3 categories and Table 2 shows the quarterly transition matrix among the 9 compound states. The marginal distribution across the states shown at the bottom of the table shows a key point about the joint distribution of stock-market value P and profit y —the correlation of remarkably low. With perfect correlation, only the L-L, M-M, and H-H cells would have positive frequency. Instead, conditioning on y has little discriminatory power for P except for the H category of P . Further analysis of the data will thus support the theme of modern finance that changes in discount rates have a larger role in equity values than do changes in the cash flows accruing to equity holders.

<i>State</i>	<i>P</i> <i>category</i>	<i>y</i> <i>category</i>	<i>Marginal</i> <i>utility</i>
1	L	L	1.82
2	L	M	2.08
3	L	H	2.73
4	M	L	1.12
5	M	M	1.00
6	M	H	0.74
7	H	L	0.58
8	H	M	0.50
9	H	H	0.55

Table 3: State-Dependent Marginal Utility Inferred from the Stock Market

Table 3 shows the solved value of marginal utility. The parameter controlling the overall discount factor, β , is 0.949 on a quarterly basis, or 0.810 on an annual basis. I normalize marginal utility at unity in the middle M,M state. The stock-market price or P component of the state is much more influential than the profit or y component. Marginal utility is around double its normal value when the stock price is low and about half when the price is high. Again, this confirms the conclusion of a large amount of earlier work in financial economics that variations in discounts are the dominant factor in stock-price volatility—see Cochrane (2011) for a recent discussion. Marginal utility falls with profit, as expected, in the middle P category but actually rises in the lower category and remains essentially unchanged in the high category.

Table 4 shows the stochastic discount factor for the transitions with positive probabilities. These are $\beta\mu_{i'}/\mu_i$. When the destination state is the same as the origin state, down the diagonal, the discount factor is just $\beta = 0.95$. Above the diagonal, the factors tend to be less than one, because marginal utility falls in most of these transitions, all of which involve at least as high a stock price and some an increase in profit. The lowest discount factor, 0.46, is from the low stock price and middle profit level to the middle stock price and middle profit level. Other transitions would have much lower discount factors but are not shown because they did not occur during the sample period. Below the diagonal, the discount factors tend to exceed one. The largest, 1.98, is from the middle, M,M state to the state with a low stock price and middle profit level. Investors put a high weight on this possibility, which, from Table 2, occurs with probability 0.10.

			<i>Destination</i>								
			1	2	3	4	5	6	7	8	9
			L	L	L	M	M	M	H	H	H
<i>Origin</i>	<i>P</i>	<i>y</i>	L	M	H	L	M	H	L	M	H
1	L	L	0.95	1.09		0.58					
2	L	M	0.83	0.95	1.24		0.46				
3	L	H		0.72	0.95						
4	M	L	1.54			0.95	0.85		0.49		
5	M	M		1.98		1.06	0.95	0.70			0.52
6	M	H					1.29	0.95		0.65	0.70
7	H	L				1.84			0.95	0.83	
8	H	M					1.88		1.09	0.95	1.03
9	H	H						1.28		0.87	0.95

Table 4: Stochastic Discount Factor Inferred from the Stock Market

With

$$m_{i,i'} = \beta \frac{\mu_{i'}}{\mu_i} \quad (11)$$

denoting the stochastic discounter, the value in state i of a payoff next quarter of $y_{i'}$ is

$$V_i = \mathbb{E}_{i'|i} m_{i,i'} y_{i'}. \quad (12)$$

Rewrite as

$$V_i = D_i \bar{y}_i, \quad (13)$$

where

$$D_i = \mathbb{E}_{i'|i} \left(m_{i,i'} \frac{y_{i'}}{\bar{y}_i} \right), \quad (14)$$

is the discount factor adjusting for risk, to be applied to the expected value of the payoff.

The discount rate in state i is

$$d_i = \frac{1}{D_i} - 1. \quad (15)$$

Table 5 shows the quarterly discount factors and corresponding discount rates, stated as annual percents. The mean shown at the bottom of the table is 14 percent per year, a bit above rates from the standard CAPM model (where they would be the real safe short-term rate of about 2 percent plus the equity premium of about 6 percent). The state-dependent rates are highly volatile, a direct implication of the high volatility of the stochastic discounter.

<i>State</i>	<i>P</i> <i>category</i>	<i>y</i> <i>category</i>	<i>Quarterly</i> <i>discount</i> <i>factor</i>	<i>Annual</i> <i>discount rate,</i> <i>percent</i>
1	L	L	0.90	46
2	L	M	0.94	24
3	L	H	0.92	33
4	M	L	0.98	8
5	M	M	0.99	3
6	M	H	0.89	51
7	H	L	1.11	-39
8	H	M	1.08	-29
9	H	H	0.97	13
Mean			0.97	14

Table 5: Discount Factors and Rates Implied by the Stochastic Discount Factor for Profit

In principle, the stochastic discount factor values all future payoffs. One interesting payoff is the same in all states. The real safe one-quarter interest rate is the discount rate for that payoff. Table 6 shows the implied rates by state and the unconditional mean at the bottom. As expected, the real rate is highly volatile, much more so than the actual U.S. real rate. And its mean is much higher. Based on the way that the stock market values future returns, even certain returns are heavily discounted.

Table 7 verifies the conclusion of much earlier work that discount volatility, not volatility of future payoffs, generates most stock-price volatility. The next-to-right column shows the stock price calculated under the assumption that marginal utility is the same in all states, so the only source of price volatility is the difference in the payoff by state. The standard deviation of the resulting price is only 298, against 942 in reality. The right-hand column shows the reverse calculation, with the payoff the same in all states and the discount rate as calculated above. The standard deviation of the calculated price is actually somewhat higher in that case, at 1130.

4 Interpreting the Valuation of Employment Relationships

The next step is to relate the job value calculated earlier in the paper to the valuation model in the previous section, on the assumption that employers value flows of profit contributions

<i>State</i>	<i>P</i> <i>category</i>	<i>y</i> <i>category</i>	<i>Safe real</i> <i>interest rate,</i> <i>percent per</i> <i>year</i>
1	L	L	47
2	L	M	28
3	L	H	35
4	M	L	5
5	M	M	-2
6	M	H	51
7	H	L	-41
8	H	M	-29
9	H	H	14
mean			14

Table 6: Real Safe Interest Rate Implied by the Stochastic Discount Factor

<i>State</i>	<i>P</i> <i>category</i>	<i>y</i> <i>category</i>	<i>Actual</i> <i>stock price</i>	<i>Stock price</i> <i>with no</i> <i>variation in</i> <i>discount</i> <i>factor</i>	<i>Stock price</i> <i>with no</i> <i>variation in</i> <i>profit</i>
1	L	L	1711	2499	2048
2	L	M	1931	2589	2031
3	L	H	2159	2708	1836
4	M	L	2491	2535	2889
5	M	M	2770	2640	3031
6	M	H	3128	2700	3325
7	H	L	3554	2521	4897
8	H	M	3901	2614	5140
9	H	H	4421	2752	4078
Standard deviation			942	298	1130

Table 7: Stock Price without Discount Variation and without Profit Variation

from workers according to the same principles that investors value the overall profit flows of corporations. Recall that the flow is $x - w$. I assume that $x - w$ is proportional to corporate profits y , with proportion parameter γ , but depreciates at the separation rate s rather than growing as profits do. Thus the pricing recursion is

$$J_i = (1 - s) \sum_{i'} \pi_{i,i'} \beta \frac{\mu_{i'}}{\mu_i} (J_{i'} + \gamma y_{i'}). \quad (16)$$

I denote the solved value from this equation with $\gamma = 1$ as \hat{J}_i . I further assume that the job value may be levered more or less than corporate profits, so that I include a constant in the equation for the observed J_i as well as \hat{J}_i . The constant will be negative and the factor γ larger if the job relationship involves more financial leverage than does traded equity. I also include a random component ϵ_t in recognition of measurement error in J_t , which I take as uncorrelated with the state of the economy i . Notice that I do not pursue the earlier idea that leverage might be modeled as a safe debt-type claim, because the valuation model does not work well for such claims. The model becomes

$$J_i = \alpha + \gamma \hat{J}_i + \epsilon_i. \quad (17)$$

To estimate the parameters α and γ , I treat this equation as a regression across the 9 states.

The estimated value of α is \$796 with a standard error of \$38, indicating that labor relationships have less leverage than does the typical shareholder interest. The estimated slope coefficient γ is 0.050 with a standard error of 0.011 (the units of γ inherit the arbitrary normalization of the Wilshire index). Table 8 shows that the model fits the job-value data quite closely.

4.1 Conclusions about the job value and the stock market

I conclude that financial economics confirms the visual impression in Figure 3 that the same principles influence the valuation of the employer's net flow value from an employment relationship as influence the stock market's valuation of corporate profits. Thus events such as a financial crisis increase the discount rates applied to both flows. In the labor market, employers respond by cutting back on job creation because the capital value of a new employment relationship is the driving force for job creation. The data support this view without any stretch in terms of parameter values.

<i>State</i>	<i>P</i> <i>category</i>	<i>y</i> <i>category</i>	<i>Actual</i> <i>job value</i>	<i>Fitted</i> <i>job value</i>
1	L	L	876	894
2	L	M	906	898
3	L	H	907	894
4	M	L	885	936
5	M	M	946	948
6	M	H	1004	966
7	H	L	1011	1033
8	H	M	1023	1052
9	H	H	1069	1007

Table 8: Actual and Fitted Job Values

5 Unemployment

So far, I have considered the labor market purely from the employer’s perspective, because the DMP model makes the sharp, asymmetric assumption that it is variations in employers’ job creation incentives that cause changes in market conditions and not changes in, for example, jobseekers’ search effort. Until recently, studies of the U.S. labor market in the DMP framework have used the same concept of tightness for employers, where it controls the success rate in generating matches by posting vacancies, and for workers, where it controls the job-finding rate. But the Great Recession results in a substantial departure. This section considers how the changes in tightness resulting from changes in job-creation incentives affect the job-finding rate and thus the unemployment rate.

5.1 Matching

A key element of the DMP model is the matching function. This function describes the technology that produces matches (hires) H_t from unemployment U_t and vacancies V_t . Following a large literature that favors constant returns to scale and approximately equal elasticities, I take the matching function to be

$$H_t = \omega_t \sqrt{U_t V_t}. \quad (18)$$

Recall that labor-market tightness is

$$T_t = \frac{V_t}{H_t}. \quad (19)$$

The job-finding rate $f_t = H_t/U_t$ is proportional to tightness; the proportion is sensitive to matching efficiency:

$$f_t = \omega_t^2 T_t. \quad (20)$$

Within a population that is always in the labor force, either employed or seeking jobs, the unemployment rate obeys the law of motion,

$$u_t = (1 - f_t)u_{t-1} + s_t(1 - u_{t-1}). \quad (21)$$

Here s_t is the separation rate, the fraction of workers whose jobs end each period. In the U.S. labor market, the separation rate is remarkably stable. In the Great Recession and the following weak recovery, the rate fell, with a large decline in quits and a somewhat smaller increase in layoffs. Figure 5 shows the rate, inferred from equation (21) by setting the job-finding f_t to the ratio of hires from JOLTS to unemployment from the household survey and then solving for s_t . Despite a large decrease in the number of employed workers, the flow of workers out of jobs declined from 2007 through 2009 and then stabilized. A large reduction in voluntary departures from jobs accounts for this otherwise counter-intuitive finding.

In the case of separation rates and matching efficiency that are constant over time, a decline in tightness T_t results in a fairly brief period of rising unemployment, as outflow $f_t u_{t-1}$ is low, but the outflow rises back to its normal level as the rise in u_t makes up for the fall in f_t . After f_t has remained stationary for a year or so, the stationary level of the unemployment rate is

$$u^* = \frac{s}{s + f}. \quad (22)$$

In a labor market with constant separation rate and matching efficiency, except for the transition effect, three variables—tightness T_t , the job-finding rate f_t , and the unemployment rate u_t —are equally good indicators of the state of the labor market.

Matching efficiency is not a constant. Instead, it declines following recessions. The decline was particularly large in the aftermath of the Great Recession. Figure 6 shows matching efficiency from the JOLTS data on hires and vacancies and the household survey for the

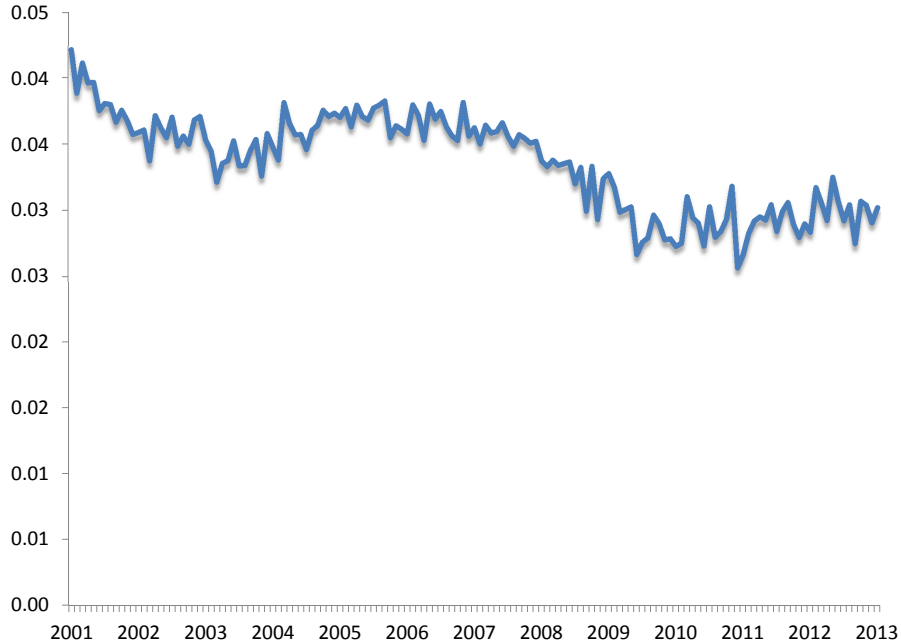


Figure 5: Job-Separation Rate

total number of unemployed, calculated as

$$\omega_t = \frac{H_t}{\sqrt{U_t V_t}}. \quad (23)$$

An extensive literature studies the pronounced decline in matching efficiency. The decline is often characterized as an adverse outward shift of the Beveridge curve. One important reason for the shift is that, in a deep recession and ensuing slow recovery, the composition of the unemployed shifts toward those with lower job-finding rates. In normal times, inflows to unemployment contain many workers who have quit earlier jobs, had temporary jobs come to an end, or are on layoff expecting fairly speedy recall. Job-finding rates in these categories are high, though like all job-finding rates, they decline in times of a slack labor market. Flows of workers who have lost jobs permanently are relatively small in normal times, but this category rises dramatically in recessions. Job-finding rates are high in this category in relation to other categories. In slack times, a large mix effect reduces aggregate matching efficiency. It is an open question whether the mix effect is enough to explain all of the decline in efficiency starting in 2009.

Figure 7 compares the series for tightness, $T = V/H$, and the job-finding rate, $f = H/U = \omega^2 T$. The decline shown in Figure 6 for ω corresponds to a large decline in f relative to T , thanks to ω^2 . Whereas tightness returned to its normal level in 2012, the

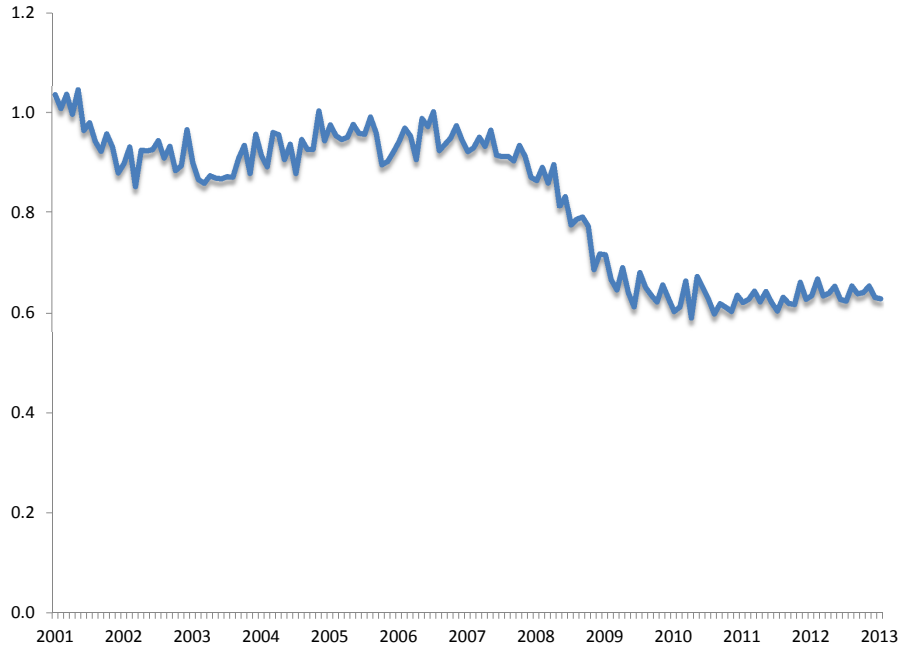


Figure 6: Matching Efficiency

job-finding rate was hardly above its trough level of late 2009. Figure 8 restates the evidence in terms of the actual unemployment rate, which lingered at high levels through 2012 and the unemployment rate that would have occurred if matching efficiency and the separation rate had remained at their levels of the end of 2006. In this case, the only force raising unemployment would have been the decline in tightness. With tightness returning to normal by 2013, unemployment would have been at a low level then as well.

Does Figure 8 mean that the DMP model—with its emphasis on employers’ job-creation incentives and labor-market tightness—is a sideshow in unemployment determination. Should macroeconomics attribute most of the recession to a decline in matching efficiency and not to a decrease in job-creation incentives? I think not. When the profession unravels the sources of the decline in matching efficiency, I believe that at least a good part of the decline is the result of the softening of the labor market, which removed easy-to-place quitters from the unemployment rolls and replaced them with hard-to-place individuals who lost jobs.

6 Concluding Remarks

Although a great deal of interesting research has studied the determination of the net flow benefit of a new employer—both on the gross benefit side and on the wage side—direct

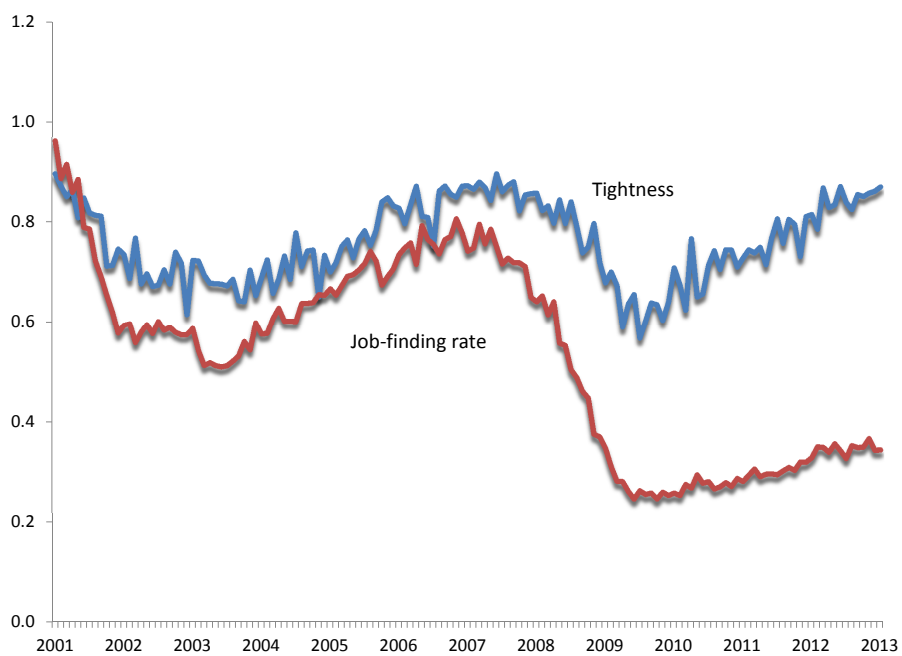


Figure 7: Labor-Market Tightness and the Job-Finding Rate

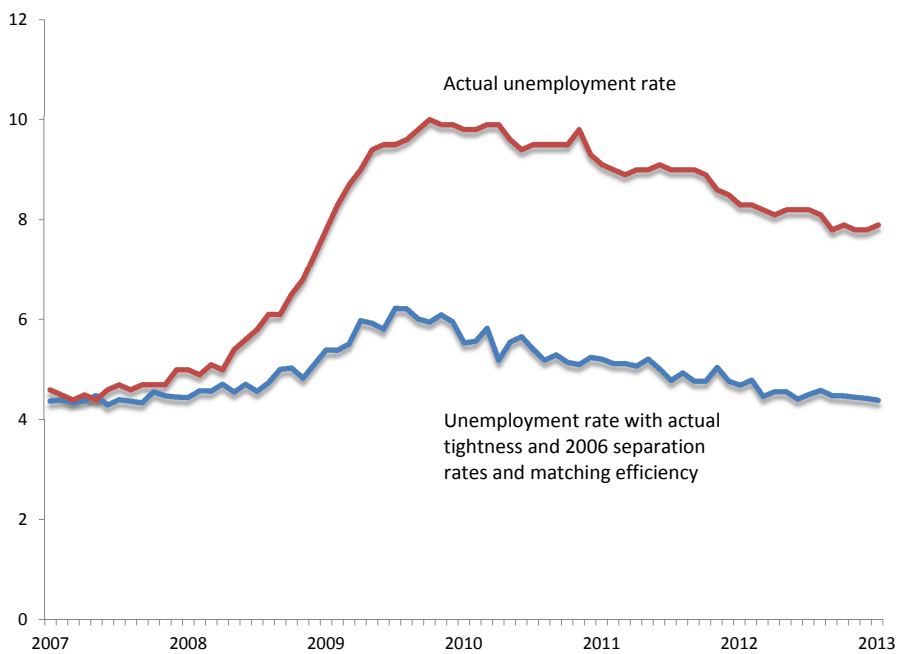


Figure 8: Actual and Counterfactual Unemployment Rates

measurement of the net flow appears to be close to impossible. But the zero-profit condition of the DMP model makes it easy to find the capital value of the flow, because it equals the cost of attracting a worker. The variation in that cost arises, in the DMP model, from the duration of a vacancy, an object measured directly in a large survey the BLS conducts every month. The implied value moves in close parallel, especially in the past two decades, with the stock market.

Financial economics has reached the inescapable conclusion that the large movements in the value of the stock market arise mainly from changes in discount rates and only incidentally from changes in the profit flow capitalized in the stock market. The field is far from agreement on the reasons for the volatility of discount rates.

In view of these facts, it is close to irresistible to conclude that whatever forces account for wide variations in the discount rates in the stock market also apply to the similar valuation problem that employers face when considering recruiting. If so, even the highly stable net flow value of a worker under Mortensen and Pissarides's (1994) assumption of Nash bargaining generates fluctuations easily consistent with the observed large swings in unemployment. Shimer's finding that the wage tracked productivity closely in the DMP-Nash model is not the end of the model because of large variations in the capitalized value of the employers share of the surplus.

References

- Bianchi, Francesco, Cosmin Ilut, and Martin Schneider, “Uncertainty Shocks, Asset Supply and Pricing over the Business Cycle,” December 2012. Duke University, Department of Economics.
- Campbell, John Y. and Robert J. Shiller, “The Dividend-Price Ratio and Expectations of Future Dividends and Discount Factors.,” *Review of Financial*, 1988, 1 (3), 195–228.
- Christiano, Lawrence J., Martin Eichenbaum, and Charles L. Evans, “Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy,” *Journal of Political Economy*, 2005, 113 (1), 1–45.
- Cochrane, John H., “Presidential Address: Discount Rates.,” *Journal of Finance*, 2011, 66 (4), 1047 – 1108.
- Danthine, Jean-Pierre and John B. Donaldson, “Labour Relations and Asset Returns,” *The Review of Economic Studies*, 2002, 69 (1), 41–64.
- Donaldson, John B. and Hyung Seok Eric Keam, “Shimer Meets the Production Based Asset Pricing Crowd: Labor Search and Asset Returns,” January 2012. Columbia University.
- Favilukis, Jack and Xiaoji Lin, “Wage Rigidity: A Solution to Several Asset Pricing Puzzles,” September 2012. Dice Center WP 2012-16, Ohio State University.
- Gertler, Mark and Antonella Trigari, “Unemployment Fluctuations with Staggered Nash Wage Bargaining,” *The Journal of Political Economy*, 2009, 117 (1), 38–86.
- , Luca Sala, and Antonella Trigari, “An Estimated Monetary DSGE Model with Unemployment and Staggered Nominal Wage Bargaining,” *Journal of Money, Credit and Banking*, 2008, 40 (8), 1713–1764.
- Gourio, Francois, “Labor Leverage, Firms’ Heterogeneous Sensitivities to the Business Cycle, and the Cross-Section of Expected Returns,” July 2007. Department of Economics, Boston University.
- Haefke, Christian, Marcus Sonntag, and Thijs van Rens, “Wage Rigidity and Job Creation,” September 2008. IZA Discussion Paper No. 3714.

- Hall, Robert E., “The Stock Market and Capital Accumulation,” *American Economic Review*, December 2001, *91* (5), 1185–1202.
- , “Measuring Factor Adjustment Costs,” *Quarterly Journal of Economics*, August 2004, *119* (3), 899–927.
- , “Employment Fluctuations with Equilibrium Wage Stickiness,” *American Economic Review*, March 2005, *95* (1), 50–65.
- , “By How Much Does GDP Rise If the Government Buys More Output?,” *Brookings Papers on Economic Activity*, 2009, (2), 183–231.
- , “What the Cyclical Response of Advertising Reveals about Markups and other Macroeconomic Wedges,” March 2013. Hoover Institution, Stanford University.
- Kuehn, Lars-Alexander, Nicolas Petrosky-Nadeau, and Lu Zhang, “An Equilibrium Asset Pricing Model with Labor Market Search,” January 2013. Carnegie Mellon University, Tepper School of Business.
- Merz, Monika and Eran Yashiv, “Labor and the Market Value of the Firm,” *American Economic Review*, 2007, *97* (4), 1419–1431.
- Mortensen, Dale T., “Comments on Hall’s Clashing Theories of Unemployment,” July 2011. Department of Economics, Northwestern University.
- and Christopher Pissarides, “Job Creation and Job Destruction in the Theory of Unemployment,” *Review of Economic Studies*, 1994, *61* (0), 397–415.
- Nekarda, Christopher J. and Valerie A. Ramey, “The Cyclical Behavior of the Price-Cost Markup,” June 2010. University of California, San Diego.
- Petrongolo, Barbara and Christopher A. Pissarides, “Looking into the Black Box: A Survey of the Matching Function,” *Journal of Economic Literature*, 2001, *39* (2), 390–431.
- Pissarides, Christopher A, “The Unemployment Volatility Puzzle: Is Wage Stickiness the Answer?,” *Econometrica*, 2009, *77* (5), 1339–1369.

Rotemberg, Julio J. and Michael Woodford, “The Cyclical Behavior of Prices and Costs,” in John Taylor and Michael Woodford, eds., *Handbook of Macroeconomics, Volume 1B*, Amsterdam: North-Holland, 1999, chapter 16, pp. 1051–1135.

Shimer, Robert, “The Cyclical Behavior of Equilibrium Unemployment and Vacancies,” *American Economic Review*, 2005, *95* (1), 24–49.

—, “Reassessing the Ins and Outs of Unemployment,” *Review of Economic Dynamics*, 2012, *15* (2), 127 – 148.

Silva, José Ignacio and Manuel Toledo, “Labor Turnover Costs and the Cyclical Behavior of Vacancies and Unemployment,” *Macroeconomic Dynamics*, April 2009, *13*, 76–96.

Uhlig, Harald, “Explaining Asset Prices with External Habits and Wage Rigidities in a DSGE Model,” *American Economic Review*, 2007, *97* (2), 239–243.

Walsh, Carl E., “Labor Market Search and Monetary Shocks,” in S. Altug, J. Chadha, and C. Nolan, eds., *Elements of Dynamic Macroeconomic Analysis*, Cambridge University Press, 2003, pp. 451–486.

Yashiv, Eran, “Hiring as Investment Behavior,” *Review of Economic Dynamics*, 2000, *3* (3), 486 – 522.

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Appendix

A Related Research

Investigation of driving forces in the DMP framework, apart from productivity, has been less active. Three channels have figured in this branch of the literature. The first is that declines in product demand caused firms to move down their marginal cost curves but they retained sticky prices, so the marginal revenue product of labor fell. The consequences in the DMP model are then the same as for a decline in productivity. The second channel involves declining price inflation. If the bargain between a newly hired worker and an employer involves an expected rise in the nominal wage that is sticky, but the growth of prices falls to a lower level, the benefit of a new hire to an employer falls and unemployment rises, according to standard DMP principles. The third channel considers the way a firm values a potential new worker if the firm retains its historical price

A.1 Sticky prices

Walsh (2003) first brought a nominal influence into the DMP model. Employers in his New Keynesian model have market power, so the variable that measures the total payoff to employment is the marginal revenue product of labor in place of the marginal product of labor in the original DMP model. Price stickiness results in variations in market power because sellers cannot raise their prices when an expansive force raises their costs, so the price-cost margin shrinks. Rotemberg and Woodford (1999) give a definitive discussion of the mechanism, but see Nekarda and Ramey (2010) for negative empirical evidence on the cyclical behavior of margins. Hall (2009) discusses this issue further. The version of the New Keynesian model emphasizing price stickiness suffers from its weak theoretical foundations and has also come into question because empirical research on individual prices reveal more complicated patterns with more frequent price changes than the model implies. Hall (2013) finds evidence against higher margins in slumps because advertising should rise substantially with margins but in fact advertising falls dramatically in recessions.

Walsh adopts the Nash wage bargain of the canonical DMP model, which implies that his model may generate low unemployment responses for the reason that Shimer (2005) pointed out. Conceptually, it remains the case that Walsh was the first to resolve the clash between Keynesian models with excess product supply and the DMP model of unemployment.

Mortensen (2011) establishes a direct connection between drops in product demand and the payoff to new hires. He makes the simple assumption that firms stick to their earlier prices when demand drops, so that firms are quantity-takers. He uses a Dixit-Stiglitz setup to map the consequences back into the labor market and shows that the fixity of output results in potentially large declines in the net benefit of a new hire.

A.2 Sticky wages

Another approach introduces a nominal element into wage determination. The canon of the modern New Keynesian model, Christiano, Eichenbaum and Evans (2005), has workers setting wages that are fixed in nominal terms until a Poisson event occurs, mirroring price setting in older versions of the New Keynesian model. That paper does not have a DMP labor market. Gertler, Sala and Trigari (2008) (GST) embed a DMP labor-market model in a general-equilibrium model, overcoming Shimer’s finding by replacing Nash bargaining at the time of hire with a form of wage stickiness. Gertler and Trigari (2009) developed the labor-market specification. A Poisson event controls firm-level wage bargaining, which takes the Nash form. Between bargaining times, the wage of newly hired workers adheres to the most recent bargain. If labor demand turns out to be higher than expected at bargaining time, the part of the surplus captured by the employer rises and the incentive to recruit workers rises. By standard DMP principles, the labor market tightens and unemployment falls. Though the model is Keynesian in the sense of sticky wages, it describes an equilibrium in the labor market in the sense of Hall (2005)—the relation between workers and an employer is privately efficient. GST build a model of the general-equilibrium response to monetary and other shocks in a version of the Gertler-Trigari setup where the wage bargain is made in nominal terms. The GST paper resolves the clash by making the DMP determination of unemployment sensitive to the rate of inflation.

A key idea in Gertler and Trigari (2009), put to work in the GST paper, is that workers hired between bargaining times inherit their wage terms from the most recent bargain. In principle, this setup could violate the private efficiency criterion by setting the wage too high to deliver a positive job value to the employer or too low to deliver a job value below the job candidate’s reservation level, but, again, in practice this is not likely to occur. If it were an issue, the introduction of state-dependent bargaining would solve the problem, at the cost of a more complicated model.

The GST model assumes that the wage bargain is made in money terms, as the traditional Keynesian literature likes to say. The substance of the assumption is that a state variable—the most recently bargained nominal wage—influences the job value for new hires until the next bargain occurs. This assumption has had a behavioral tinge in that literature—the role of the stale nominal wage arises from stubbornness of workers or employers or from money illusion. From the perspective of bargaining theory, however, as long as the stale wage keeps the job value in the bargaining set, that wage is an eligible bargain. See Hall (2005) for further discussion, not specifically in the context of a nominal state variable. There’s no departure from strict rationality in the GST model.

The implications of a model linking the current job value to a stale nominal variable are immediate: The more the price level rises from bargaining time to the present, the higher is the job value in real terms.

A.3 Forming the present value of a newly hired worker’s net benefit to the employer

Yashiv (2000) undertook the task I declare to be impossible in the body of this paper: forming the present value of the difference between a worker’s marginal product and wage. Equation (4) in his paper is equivalent to equation (2) here. On page 492, Yashiv notes the analogy between the valuation of a worker’s net contribution and valuation in the stock market of a stream of dividends. The primary difference between his approach and mine is that he takes the hiring cost to be strongly convex in the flow of hires at the level of the firm whereas I adopt the linearity that is that standard property of the DMP class of models. Under linearity, the asset value of the employment relationship is observed directly. By contrast, Yashiv uses GMM to infer the marginal hiring cost.

A.4 Variations in discounts

The basic proposition that the stock market varies largely because of changes in discount rates is the conclusion of a famous paper, Campbell and Shiller (1988). Cochrane (2011) discusses the finding extensively.

Kuehn et al. (2013) is an ambitious general-equilibrium model that combines a DMP labor market with a full treatment of financial markets. Its goal is roughly the reverse of the goal of this paper. It makes the case that volatility in real allocations resulting from amplification of

productivity shocks in the labor market causes financial volatility. In particular, the model can generate episodes that look like financial crises, with dramatic widening of the equity premium. The paper provides an endogenous source of economic disasters, an advance over the existing literature that takes large declines in output and consumption to be the result of exogenous collapses of productivity.

Kuehn and coauthors build in a number of the ideas from the post-Shimer literature to gain high amplification in the labor market from productivity shocks. These include (1) adding a fixed cost to the pre-bargain recruiting cost, on top of the cost that varies with the time required to fill a job, (2) assigning the worker a tiny bargaining weight, and (3) assigning a high value to the worker's activities while unemployed, apart from the value of search. They also build in ideas from modern finance that generate a high and variable equity premium along with a low and stable real interest rate. These are (1) an extremely high coefficient of relative risk aversion and (2) a quite high elasticity of intertemporal substitution. The paper briefly surveys related earlier contributions linking asset-price volatility to unemployment volatility: Danthine and Donaldson (2002), Uhlig (2007), Gourio (2007), and Favilukis and Lin (2012). Another recent paper linking the labor market to asset markets is Donaldson and Keam (2012).

A.5 Joint movements of labor-market variables and the stock market

Merz and Yashiv (2007) study investment, hiring, and the stock market jointly. Adjustment costs for both inputs result in values of Tobin's q for both inputs. They estimate a three-equation system comprising dynamic first-order conditions for investment and hiring and the equality of the market value of the firm to its capital stock and employment level valued by their respective qs . They find high adjustment costs and a high correlation of their fitted value of the U.S. corporate sector with the actual value.

Merz and Yashiv's results are consistent with earlier empirical work for investment in Tobin's framework. The one-equation statement dating from Tobin's original proposal measures q from debt and equity markets and infers a quadratic adjustment parameter from the relation between the investment flow and q . The invariable finding of that line of research is a weak relation, implying high adjustment cost. By contrast, estimates based only on the

dynamic first-order condition for investment tend to find moderate adjustment costs—see Hall (2004).

Hall (2001) considered the same evidence about the market value of the corporate sector as Merz and Yashiv (they adopted my data for the value), but reached rather a different conclusion. My paper rejected the assumption that the value arises only from rents associated with investment adjustment costs. It entertained the hypothesis that the corporate sector acquired highly valuable intangible capital during the run-up of the stock market in the 1990s. The value of that inferred intangible capital collapsed between the writing of the first version of the paper and its appearance in print.

The relation between Merz and Yashiv’s work and the approach in this paper is that they rely on the strong assumption that the market value of a firm arises solely from its investments in plant, equipment, and employees. This paper makes the weaker assumption that corporate profits arise from many sources, including its capital stocks, and uses evidence about how the stock market discounts the profit stream to rationalize the observed value of one element of the one part of the profit flow, that arising from the pre-bargain investment that employers make in recruiting workers.