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## Labor market dynamics under long-term wage contracting<sup>☆</sup>

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### ABSTRACT

Recent research seeking to explain the strong cyclical volatility of US unemployment emphasizes the role of wage rigidity. This paper proposes a micro-founded model of wage rigidity—an equilibrium business cycle model of job search, where risk neutral firms post optimal long-term contracts to attract risk averse workers. Equilibrium contracts feature wage smoothing, limited by the inability of parties to commit to contracts. The model is consistent with aggregate wage data if neither worker nor firm can commit, producing too rigid wages otherwise. Wage rigidity does not lead to a substantial increase in the cyclical volatility of unemployment.

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## 1. Introduction

In recent years significant research effort has been devoted to trying to understand the sources of the strong cyclical volatility of unemployment in the US. The standard tool for modeling unemployment, the Mortensen–Pissarides search and matching model (Pissarides, 1985), produces significantly smaller variation in unemployment than observed (Shimer, 2005a). This gap between model and data has led to the view that the observed cyclical volatility of unemployment is a manifestation of important rigidities affecting wage determination, suggested by the weak cyclical volatility of aggregate wage data, and not captured by the model (Hall, 2005). However, while imposing exogenous rigidity in wages easily allows the model to produce much larger variation in unemployment, mechanically explaining the puzzle, it does not provide a satisfactory economic answer to the problem. It is well known that outcomes in macroeconomic models with exogenously imposed rigidities can differ substantially from those in models where rigidities are derived from micro-foundations.<sup>1</sup> This paper shows that wage rigidity, as derived from a plausible microeconomic foundation and embedded into an equilibrium

<sup>☆</sup> This paper is based on the first essay of my dissertation at the University of Chicago, first version dated 2004. I am grateful to Fernando Alvarez, François Gourio, Lars P. Hansen, Hanno Lustig, Robert Shimer, Jonathan Thomas, seminar and conference audiences as well as the editor and referee for comments. Financial support from the Yrjö Jahnsso Foundation, the Finnish Cultural Foundation and the Emil Aaltonen Foundation is gratefully acknowledged.

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<sup>1</sup> For a striking example in the context of price-setting in the face of menu costs, Caplin and Spulber (1987) illustrate that the real effects of monetary shocks vanish when firms are allowed to optimize in price-setting, rather than being exogenously constrained.

model, need not lead to a substantial increase in the cyclical volatility of unemployment. By considering the impact of limited commitment as a contracting friction affecting wage determination in the model, I show that aggregate wage data are not informative about the measure of wage rigidity relevant for unemployment cyclicalities.

This paper develops an extension of the Mortensen–Pissarides model, where risk neutral firms use optimal long-term contracts to attract risk averse workers. Labor markets are subject to search frictions, but operate competitively (Moen, 1997). To attract workers, firms post vacancies. A vacancy specifies a long-term wage contract and the firm's choice of contract balances the costs of paying high wages with the benefits of attracting many job applicants. Unemployed workers observe all contracts offered and choose one to apply for, balancing the benefits of high wages with the costs of having to search longer for such jobs. Labor productivity varies over the business cycle and, when risk averse workers cannot smooth consumption privately, efficient wage contracts feature income smoothing. Jobs end due to idiosyncratic separation shocks, leaving the worker to face unemployment on his own, without protection from former employers. The ability to commit to contracts affects equilibrium outcomes. Under commitment, insurance motives lead to a constant contract wage, but when parties cannot commit, their outside options restrict the degree of wage smoothing possible. Three cases are studied: two-sided commitment, one-sided commitment, and two-sided limited commitment. In addition to affecting the cyclicalities of the aggregate wage through its effect on wage contracts, the ability to commit also has allocative effects on vacancy creation.

The quantitative results show that with the exception of the two-sided limited-commitment contracting environment, the model produces an aggregate wage which is very rigid compared to data. Wage rigidity does not come with the substantial increase in the cyclical volatility of unemployment seen in the context of exogenously imposed rigidity, however. Limited commitment works to increase the cyclicalities of both the aggregate wage and unemployment, bringing the model closer to data on both dimensions. These seemingly surprising results have a simple explanation: Wage smoothing within contracts translates into significant rigidity in the aggregate wage, but it does not imply that wages are rigid when it comes to hiring new workers. The relevant statistic for hiring decisions is the present value of wages used to attract new workers. Introducing limited commitment makes the present value more rigid, leading to greater variation in vacancy creation. However, it also leads to pro-cyclical adjustments in contract wages, as well as increased cyclicalities in starting wages, both of which increase the cyclicalities of the aggregate wage. Finally, the results show that while the impact of limited commitment on the aggregate wage is substantial, the impact on unemployment is relatively modest in magnitude. The findings warn against using aggregate wage data to draw inferences about wage rigidity as the cause of unemployment cyclicalities.

The unemployment dynamics of the model differ from the standard Mortensen–Pissarides model for two main reasons. The first has to do with the incomplete markets environment faced by workers. When risk averse workers cannot smooth their consumption across unemployment and employment spells, they gain less from finding a job with a high wage level than they would if they could smooth their consumption. This change in how workers value wages affects the wage contracts firms find optimal to offer, and distorts the equilibrium toward lower wages. In periods when high productivity bids up the wages firms use to attract new workers, the distortion increases, curbing the wage increase. In periods when low productivity causes the wages used to attract new workers to fall, the distortion relaxes, curbing the wage decrease. The resulting rigidity in the present value of wages used to attract new workers translates into increased cyclicalities in vacancy creation.<sup>2</sup> The second reason has to do with limited commitment exacerbating the above effects. Under full commitment, firms offer a permanently higher wage to workers hired in booms than those hired in recessions. When limited commitment binds in equilibrium, such contracts are no longer feasible. All the firm can do to raise the wages used to attract new workers in booms is to raise the starting wage, prevailing until the first recession arrives and the firm's participation constraint forces the wage down. Similarly, all the firm can do to lower the wages used to attract new workers in recessions is to lower the starting wage, prevailing until the first boom arrives and the worker's participation constraint forces the wage up. Creating differences in present values across booms and recessions in such an environment has to involve increasing the dispersion in starting wages across the two states. This exacerbates the distortion due to the incomplete markets environment in booms and relaxes it in recessions, adding to the rigidity in the present value of wages used to attract new workers and hence also the cyclicalities of vacancy creation.

The principal theoretical contribution of this paper is to embed the two-sided limited-commitment wage contracting problem of Thomas and Worrall (1988) into an equilibrium model of directed search with aggregate shocks.<sup>3</sup> The embedding involves incorporating flows in and out of employment relationships and endogenizing the outside options restricting contracting to reflect the equilibrium value of search. As is well known, solving the

<sup>2</sup> The impact of incomplete markets is discussed in detail in Rudanko (2008).

<sup>3</sup> My model has already been applied by others to study related questions: Reiter (2008) examines business cycles driven by embodied technology shocks and Kudlyak (2007) the cyclicalities of wages in individual level data. The empirical studies of Macis (2007) and Haefke et al. (2007) are also closely related. Interestingly, the contracts in the model are also observationally similar to those in MacLeod and Malcomson (1993), with renegotiation by mutual consent. In earlier work, Sigouin (2004) embedded two-sided limited-commitment contracts into an equilibrium model of job search, but in his model unemployment is constant over the business cycle.

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