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Search-and-matching analysis of high unemployment caused by the zero lower bound ☆

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ABSTRACT

A basic principle of macroeconomics holds that an excessive real interest rate is the cause of high unemployment at the zero lower bound on the nominal interest rate. Absent the bound, the rate could be negative and the real rate could be low enough to restore full employment. Models backing up this principle make controversial assumptions about price-stickiness and the failure of market-clearing in the product market and sometimes in the labor market. This paper generates realistic effects of the zero lower bound without those assumptions, by substituting a search-and-matching setup in both the product and labor markets.

> A landing on the non-Walrasian continent has been made. Whatever further exploration may reveal, it has been a mind-expanding trip: We need never go back to $\dot{p} = \alpha(D - S)$ and $q = \min(D, S)$.
>
> [Phelps and Winter, 1970, p. 337]

Dale Mortensen participated in the famous conference in January 1969 that gave rise to the Phelps volume, and his paper for the conference delivered on Phelps and Winter's promise to banish demand gaps and *ad hoc* adjustment processes from macroeconomics. But demand gaps abound in macro today. Major economies remained stuck at the zero lower bound on the short-term interest rate for many years following the crisis of 2008. The macro profession's analysis has relied uniformly on demand-gap models. This paper undertakes the task of building a model reasonably faithful to the basic facts about the zero lower bound without invoking a demand gap, but rather relying heavily on the Diamond–Mortensen–Pissarides search and matching model.

To frame the issue in this paper, consider a simple frictionless general-equilibrium macro model with a unique equilibrium. The model will describe an equilibrium value of the short-term safe real interest rate. Now implant a central bank in the model with a policy of setting that rate at a value above the equilibrium value. In particular, suppose that the bank's interest rate is elevated by the zero lower bound. What happens in the model? It cannot have an equilibrium—its only equilibrium is ruled out by assumption. One solution in macro theory is to disable one equation. Then the model has one less endogenous variable, the interest rate (made exogenous by the zero lower bound), and one less equation. One exam-

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ple is to drop a clearing condition for the labor market and to interpret the gap between labor supply and labor demand as unemployment. When the central bank sets a rate above equilibrium, labor demand will fall short of labor supply and unemployment will be above its normal level. This approach has some practical appeal and often gives reasonable answers.

A closely related approach is to place the demand gap in the product market. Krugman (1998) and Korinek and Simsek (2014) are examples of that approach. Farhi and Werning (2013) present a general analysis of demand gaps, where any set of prices and wages can be jointly restricted and gaps can occur in any market.

The New Keynesian tradition takes a different and more subtle approach to this issue by adding the price level as another endogenous variable without any corresponding equation. The model has demand gaps in the product market associated with temporarily sticky prices that adjust over time to close the gaps. Thus it contains both of the equations that Phelps and Winter hoped to supplant in macro theory. Eggertsson and Krugman (2012) and Christiano et al. (2011) apply the NK model to the zero lower bound issue. One branch of the NK literature—notably Walsh (2003), Gertler et al. (2008), and, most recently, Christiano et al. (2013)—uses the Diamond–Mortensen–Pissarides framework to describe the labor market, so the only role of demand gaps in the product market. Skeptics question their success in matching actual movements of the price level in recent years. Cochrane (2014) finds that the NK model has multiple equilibria, and that the equilibrium chosen in papers studying the zero lower bound has quite different properties from other equilibria.

This paper uses a simple version of the standard DMP model in the labor market and a somewhat less standard search-and-matching model in the product market. The model tracks the intuition of most discussions of the zero lower bound. An elevated real interest rate encourages the deferral of spending by raising the incentive to save. The incentive to create jobs that is the driving force of labor-market tightness in the DMP model is depressed on account of the deferral incentive. Higher unemployment implies lower employment and lower production, which squares with the lower product demand. The economy is in a depressed equilibrium. Unlike other accounts of the adverse effect of the zero lower bound (or the elevation of the real interest rate by central-bank action apart from that bound), the model implies that the depressing effect of a given elevation of the real rate is greatest at the beginning of the episode and gradually declines, even though the rate remains at the same level. The model encounters none of the subtle issues of multiple equilibria that plague the NK model, most recently discussed in Cochrane (2014).

I puzzled over the question of the link between the DMP labor market and the product market for some time before finding the setup described in this paper. I enlisted Mortensen in the quest for a coherent link when he was the discussant of an early ancestor of this paper in 2011. Mortensen (2011) was his answer—this written discussion appears in the appendix to this paper. He showed how to link a fixed-price product market to the DMP model. My objective here is different—it is to construct a DMP-style model of the product market and link it to the DMP labor market.

The basic idea of the model of the product market is that the opportunity to save at an elevated real interest rate alters the outside option of a consumer in the product market. In a standard Nash bargain, the product price is lower in the presence of cheaper consumption from a source other than a current producer. The product price is the payoff to the producer from hiring an added worker, so by standard DMP logic, the labor market softens and unemployment rises when the interest rate is elevated. The idea that a lower price in the product market diminishes employers' incentives to create jobs is not new. It appears directly in Kaplan and Menzio (2013) and Berentsen et al. (2011). Hall (2015) surveys earlier models where forces acting in the product market influence labor-market tightness according to the principles of the DMP model. The novelty in this paper is the connection of a depressed product price to the zero lower bound on the interest rate.

The paper deals only with the issue of an elevated real interest rate and does not tackle the interesting question of translating the bound on the nominal rate into one on the real rate. That is, the paper has nothing to say about expected inflation. Because almost nothing actually happened to expected or actual inflation after the financial crisis of 2008, working with the real rate makes practical sense, but it remains an important question why there was such a pronounced failure of $\dot{p} = \alpha(D - S)$.

1. Model

The economy lasts for T periods and has four kinds of agents:

(1) *Endowed households* of measure one, with utility

$$\sum_t c_t, \tag{1}$$

where c_t is consumption in period t. These households have unit endowments of a primary input in each period.

(2) *Workers* of measure $\lambda \geq 1$, with the capacity in each period to turn one unit of the primary input into consumption, for which they receive a wage of w units of consumption goods. Their reservation wage is z.

(3) *Firms*, intermediaries who receive the input from endowed households, hire workers at the wage w, and return $1 - p$ units of consumption to endowed households for each unit of the input. Firms enter freely and earn zero profit, so the preferences of their owners are irrelevant.

(4) A *central bank* that accepts deposits (reserves) from endowed households that pay interest, in the form of the primary input, at a per-period real rate of r, the *reserve rate*.

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