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Factor complementarity and labour market dynamics ☆

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ABSTRACT

We propose and estimate a dynamic stochastic general equilibrium model featuring search and matching frictions, deep habits and a CES production function. The model successfully replicates the cyclical properties of labour market variables in the US economy for three main reasons. First, two of the endogenous mechanisms of the model – factor complementarity and unemployment benefits – play a key role for explaining the amplification in unemployment and vacancies. Second, deep habits have a smaller but significant role as an endogenous mechanism. Third, capital-augmenting productivity, investment-specific and matching efficiency innovations explain large part of the variation in labour market variables.

1. Introduction

It is well known that general equilibrium models used to study macroeconomic fluctuations display limited amplification and propagation of labour market variables. The search and matching model developed by Mortensen and Pissarides (1994) has played an important role in macroeconomic analysis and has become the mainstream theory of equilibrium unemployment. A study by Shimer (2005) has, however, pointed out that the standard search and matching model driven by neutral productivity innovations is unable to match the volatility of labour market variables observed in the US data, generating no amplification in unemployment and vacancies. A wide range of explanations, seeking to improve the performance of the standard search and matching model, have been proposed. These solutions to the *unemployment volatility puzzle* can be classified into endogenous and exogenous mechanisms of amplification. The purpose of our study is to empirically validate, through the lenses of an estimated general equilibrium model, the role of three endogenous

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amplification mechanisms – factor complementarity, deep habits and unemployment benefits – and to quantify the extent to which exogenous innovations matter for replicating the business cycle properties of labour market variables.

To this end, we develop and estimate, with US data using Bayesian techniques, a dynamic stochastic general equilibrium (DSGE) model featuring search and matching frictions, nominal price rigidities and a general production technology. We adopt a balanced modelling approach by introducing endogenous mechanisms of amplification affecting the supply and demand sides. The supply side of our model features a Constant Elasticity of Substitution (CES) production function with factor-biased technology innovations (e.g. León-Ledesma et al., 2010a). The use of general production technologies such as the CES has only recently been shown to be important for the study of the business cycle with many economic applications (see Choi and Ríos-Rull, 2009; León-Ledesma et al., 2010a,b; Cantore et al., 2014a,b; Klump et al., 2012; McAdam and Willman, 2013). To the best of our knowledge, our work is the first to examine the role of factor complementarity as an additional source of labour market amplification. The demand side of the model exhibits *deep habits* in (private and public) consumption as in Ravn et al. (2006). The deep habits mechanism changes the pricing behaviour of firms, generating endogenous fluctuations in mark-ups not due to price rigidities. Moreover, as is standard in the literature, *unemployment insurance* is considered as a potential source of endogenous amplification. The choice of the innovations also follows a balanced approach: we include supply side innovations such as factor-biased productivity, matching efficiency, labour supply and demand-side innovations such as preference, investment-specific, monetary and government expenditure innovations.

A strand of the literature has proposed a set of modifications to the standard search and matching model, while preserving total factor productivity (TFP) innovations as the only source of exogenous variation. Hagedorn and Manovskii (2008) (HM henceforth) argue for an alternative calibration of the standard search and matching model. Costain and Reiter (2008) point out that this calibration implies an implausibly large elasticity of unemployment to unemployment benefits. Di Pace and Faccini (2012) propose a mechanism that changes the pricing decision of firms through deep habits in private consumption.[1]

Another strand of the literature has sought to improve the performance of the search and matching model by introducing alternative sources of exogenous variation. Rotemberg (2008) and Krause et al. (2008) show that price-elasticity innovations can help generate amplification in labour market variables.[2] Gertler et al. (2008) and Faccini and Ortigueira (2010) argue that investment-specific innovations are important exogenous sources of labour market fluctuations. Furlanetto and Groshenny (2015) find that matching efficiency innovations are relevant during "abnormal times". Monacelli et al. (2011) and Zanetti (2015) investigate the role of credit market innovations to match labour market dynamics in economies featuring financial frictions.

The closest study to ours is Cantore et al. (2014d). By developing a model calibrated to the US and featuring a CES production function and deep habits, they analyse the effects of fiscal policy on employment and output during the recovery phase of the business cycle. Our model, instead, is estimated for the US, it exhibits a wider set of structural innovations, an active role for monetary policy, instantaneous matching between workers and firms, and non-stationary labour-augmenting technology innovations. The aim of our paper is to empirically address the following research question: *What is the role of the endogenous mechanisms of amplification for explaining labour market dynamics and how do these mechanisms interact with factor-biased productivity and demand-side innovations?*

We find that the model is able to replicate reasonably well the volatility of unemployment and vacancies present in the US data. This property of the data can be explained through the interaction between endogenous and exogenous sources of amplification. Concerning the latter, we find that capital-augmenting productivity innovations explain a large part of fluctuations in labour market variables over the medium and long term. This result follows from the fact that the estimated model gives strong support for *factor complementarity*. The intuition is as follows: if capital and labour are gross complements, then a capital-augmenting productivity innovation will increase the demand for labour, resulting in more vacancy creation. Another finding is that investment-specific innovations play an important role at explaining the unconditional variance of unemployment and vacancies. In line with much of the literature, we find that matching efficiency innovations act as an important source of exogenous variation.

Regarding the endogenous sources of amplification, the combination of unemployment benefits and factor complementarity helps explain large part of the amplification in labour market variables. The posterior mean estimate of the elasticity of substitution is significantly lower than one, which gives empirical support for strong factor complementary.[3] This finding means that expansionary productivity innovations affecting one factor of production increase, by relatively

[1] Another solution introduces wage rigidities into the standard model. See Hall (2005a), Shimer (2005), Gertler et al. (2008), Gertler and Trigari (2009) and Blanchard and Gali (2010) for a discussion. This mechanism is excluded from our analysis because: (a) given the structure and the data, the wage stickiness parameter is not well identified and (b) microeconometric evidence (see Pissarides, 2009; Haefke et al., 2013) is suggestive that wages for newly hired workers are more cyclical than average wages. Huckfeldt et al. (2015) provide evidence in favour of wage rigidities for the newly hired workers by introducing on-the-job search. Other solutions have been proposed by Reiter (2007), Christoffel and Kuester (2008), Guerrieri (2008), Quadrini and Trigari (2008), Gomes (2015), Menzio and Shi (2011), Robin (2011), Alves (2012), Petrosky-Nadeau (2013), amongst others.

[2] These innovations have the following drawbacks: (i) price-elasticity innovations are highly controversial because they entail large shifts in the competitive structure of the economy over the short-run (see Chari et al., 2007); and (ii) as observed by Rotemberg (2008), the size of the innovations needed to match volatilities is relatively large.

[3] For earlier attempts to estimate the elasticity of substitution see Cantore et al. (2014a) in a RBC model with only two observables, and see Cantore et al. (2015) in a medium scale DSGE model with seven observables.