



Investment, matching and persistence in a modified cash-in-advance economy



Stéphane Auray^{a,b,c,d,*}, Beatriz de Blas^e

^a CREST–Ensaï, Campus de Ker-Lann, Rue Blaise Pascal, BP 37203, 35172 BRUZ Cedex, France

^b ULCO (EQUIPPE), France

^c GREDI, Canada

^d CIRPÉE, Canada

^e Departamento de Análisis Económico: Teoría e Historia económica, Universidad Autónoma de Madrid, Spain

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ABSTRACT

We simulate and estimate a new Keynesian search and matching model with sticky wages in which capital has to be financed with cash, at least partially. Our objective is to assess the ability of this framework to account for the persistence of output and inflation observed in the data. We find that our setup generates enough output and inflation persistence with standard stickiness parameters. The key factor driving these results is the inclusion of investment in the CIA constraint, rather than any other nominal or real rigidity. The model reproduces labor market dynamics after a positive increase in productivity: hours fall, nominal wages hardly react, and real wages go up with some delay. Regarding money supply shocks, we investigate the conditions under which our model specification generates the liquidity effect, a fact which is absent in most sticky price models.

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1. Introduction

It is well known that standard new Keynesian models, or more generally dynamic stochastic general equilibrium models (henceforth DSGE models), fail to generate enough output and inflation persistence. One way to solve it has been suggested by Wang and Wen (2006) who analyze output persistence in a sticky price model with investment in the cash-in-advance (CIA hereafter) constraint. In this paper, we empirically evaluate the contribution of a CIA hypothesis for investment goods for generating persistence. We show that this assumption is supported by the data. We then go one step further by investigating how labor market frictions (real or nominal) help in a model with investment in the CIA to make this channel stronger to solve the persistency problem (in a context of technology and monetary shocks). Additionally, there is no unique and simple model which can reproduce both the liquidity effect (see for instance Galí, 2003) and labor

* Corresponding author at: CREST–Ensaï, Campus de Ker-Lann, Rue Blaise Pascal, BP 37203, 35172 BRUZ Cedex, France.
Tel.: +33 2 99 05 32 71; fax: +33 2 99 05 32 06.

E-mail addresses: stephane.auray@ensai.fr (S. Auray), beatriz.deblas@uam.es (B. de Blas).

market dynamics (see for instance Liu and Phaneuf, 2007). We show that our model allows one to reproduce labor market dynamics after a positive increase in productivity as well as the liquidity effect.

Our model builds on Wang and Wen (2006) in that we consider investment in the CIA constraint in a sticky price model, but we go further in modeling the labor market and estimating the model. We consider an economy with search and matching in the labor market with sticky nominal wages in the line of Trigari (2006), Thomas (2008) and Christoffel et al. (2009) among many others. Our model extends Wang and Wen (2006) to an economy with labor market frictions, and generalizes Christoffel et al. (2009) to an economy with investment. We use Bayesian methods to estimate the parameters of the model, in particular to assess the relevance of the cash constraint on investment in U.S. data. We show that the data do not reject the model. We then run counterfactual exercises to disentangle the role of cash-financing, sticky wages and labor frictions on inflation and output persistence. Analyzing the response of the economy to technology and money supply shocks under different degrees of nominal rigidities and looking at the moments observed in the data, we clearly show the importance of considering that investment might be financed by cash; labor market rigidities help to generate persistence but models with or without those rigidities are empirically equivalent. Adding habits in consumption as well as adjustment costs in investment do not improve the fit of our model.

Wang and Wen (2006) find that investment being a cash good is crucial for generating output persistence in a standard sticky price model. Our setup is similar to theirs in that we also consider sticky prices *à-la*-Calvo and investment as a cash good. However, we go further and investigate alternative channels that may generate persistence. In Auray and de Blas (2011), we use sticky wages *à-la*-Calvo as in Erceg et al. (2000), and show that this is a more important mechanism in generating persistence than sticky prices.¹ However, in that case, the model fails to reproduce the impact response of inflation to a money injection and fully sticky wages were required to obtain the liquidity effect pointing to a better modeling of the labor market to reproduce the data.

Recently, a growing branch of the literature is considering imperfect labor markets in otherwise standard new Keynesian economic models to enhance persistence of macroeconomic variables. However, some degree of wage rigidity is also needed in these models, and the search and matching structure is the ideal scenario for this analysis. There is no clear consensus on the persistence generated by real wage rigidities. Krause and Lubik (2007) find that real wage rigidity, although it helps improve labor market dynamics, is irrelevant for persistence after a monetary shock, whereas it is an important channel in Christoffel and Linzert (2010), Thomas (2008), Christoffel et al. (2009), and Faccini and Ortigueira (2010) among others. In an alternative setting, Lechthaler et al. (2010) show that a model with labor turnover costs (in the form of linear hiring and firing costs) generates enough output persistence to temporary monetary shocks. Their model has no capital and monetary policy follows a Taylor rule, but is able to reproduce the Beveridge curve. Most of these papers abstract from physical capital, and focus mainly on monetary policy shocks. Merkl and Snower (2009) find that wage and price staggering are complementary in generating monetary persistence, and analyze their relative importance in a model with homogeneous and firm-specific capital. They find that under homogeneous capital, wage staggering generates more persistence than price staggering. The opposite is true when firm-specific capital is considered. The authors also consider the complementarity of both degrees of staggering in output persistence to monetary shocks.

In contrast to previous new Keynesian models, where the role of monetary holdings is usually modeled as real balances in the utility function, we introduce money through a CIA constraint. In spite of the different setups, the timing is equivalent to that of a model with money in the utility function, but at the same time it allows for extensions of interest such as making investment a cash good. Previous research stressed the role of inflation on investment demand, and introduced investment decisions constrained that way (Stockman, 1981; Abel, 1985). Empirically, although it is still topic of debate, there seems to be some evidence regarding the effects of firms' internal cash flows on investment demand in the context of capital market imperfections (Fazzari et al., 1988). In this sense, cash flows are often used as a proxy for net worth in determining investment. Recently, some studies for the US and countries in the Euro area reveal a significant effect of cash flows on investment demand, although the strength of the effect varies across countries (Chirinko et al., 1999; Angeloni et al., 2003; Boileau and Moyen, 2010; Acharya et al., 2011). The relevance of cash flows for investment demand, and therefore, the ability of firms to react to shocks can be addressed in our model by including investment in the CIA constraint. Notice that introducing investment as a cash good operates in a way similar to adjustment costs in investment, reducing the speed of adjustment in aggregate demand, while being or providing a more clear economic interpretation.

We estimate and show the relevance of this assumption for this model. We also show its importance with regards to considering labor market frictions. Our model permits the reproduction of monetary and labor market facts thanks to the interaction of the labor and goods markets frictions *i.e.* the search friction, the sticky wages assumption and investment in the cash-in-advance friction. It generates enough inflation and output persistence compared to that observed in the data. The key factor driving these results is the inclusion of investment in the CIA constraint, which delays the response of demand to shocks. Finally, we investigate the conditions under which our setup is able to generate the liquidity effect. We find that this result stresses the relative relevance of sticky wages and labor market frictions versus sticky prices in modeling the monetary transmission mechanism. Also, we need investment partially or completely financed with cash to

¹ Adding wage stickiness to a sticky price model has been shown to be quite successful in the recent literature, in particular, in generating output persistence. See for instance Christiano et al. (2005).

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