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A computational general equilibrium model with vintage capital

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Abstract

This paper presents a vintage capital model assuming putty–clay investment and perfect foresight. The model is written in discrete time and is simulated by using a second order relaxation algorithm. By computing the eigenvalues of the dynamic system, we have checked the conditions of existence and uniqueness of a solution (Blanchard and Kahn's conditions) and identified the echo effect that characterizes vintage capital models and the related dynamics of creation and destruction. By calibrating the model on French data, it has been proved useful to explain the medium-term movements in the distribution of income in France during the last three decades.

JEL classification: C68; C63; E22

Keywords: Vintage capital models; Replacement echoes; Dynamic model solving; Medium-term dynamics

1. Introduction

Computational general equilibrium models usually assume a putty–putty technology: the capital intensity of the production process can be changed instantaneously and without cost. Thus, in a competitive framework, the factors of production fully and instantaneously adjust to current economic conditions. This means that "realistic" changes in real wages or in the cost of capital lead to very significant and quick moves in demand for labor and capital. Moreover, the quick adjustment of the capital stock should cause huge variations in the flows of investment.

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However, actual employment and capital stock exhibit much weaker movements than those predicted above. Hence, the integration of this theoretical framework in a realistic model requires some improvements. One way to decrease the cost-sensitivity of production factors consists in assuming non-linear adjustment costs (usually quadratic costs). This results in smoother dynamic adjustments of labor and capital. However, this specification rests upon an ad hoc assumption without wholly rigorous microeconomic foundations and empirical verification. Moreover, it is not a fully convincing way to model the irreversibility of investment and the firing costs of labor. Finally, the putty–putty framework is unable to give simple, acceptable explanations for the medium-term movements in the wage share in value-added, which are observed in many European countries (see for instance Blanchard, 1997; Prigent, 1999). Although adjustment costs smooth the dynamics of factor demands in the short run, they are far from sufficient to produce medium-term changes in the income distribution between capital and labor.

A key feature of the putty–putty specification, that is central to its empirical failure, is that all the vintages of capital have the same capital intensity. On the contrary, we would expect the current technology menu to be only available to the newly created units of production. This is precisely what the putty–clay specification does. In this framework, current economic conditions affect the capital intensity of the new production units (their technological choice) and the number of these units created (investment in the economy). The other production units keep the technology they were given at their creation. However, current economic conditions affect their profitability and lead to the scrapping of non-profitable units. Hence, the aggregate capital–labor ratio changes gradually with the flows of investment and the scrapping of old obsolete production units. Putty–clay investment may thus provide medium-term dynamics in the distribution of income.

This specification has some other advantages. The irreversibility of investment is embedded in the model and firing costs can easily be introduced. This gives a convincing foundation to the stickiness of employment.

Despite all its advantages, the putty–clay technology suffers from a serious drawback. Its implementation in a macroeconomic model is cumbersome for two reasons. First, the model has a long memory since it keeps track of all the vintages of capital created in the past, that are still in working order. Thus, the model has "variables with long lags". Second, the planning horizon of investors stretches far into the future. More precisely, the decision concerning new production units involves forward variables that cover the expected lifetime of these units. The model has then "variables with long leads".

However, these problems can be easily overcome nowadays. Models with variables presenting long leads and lags can be solved with powerful algorithms, and simulation time is decreasing with the improvement of personal computers.

The first section presents a model representing the production of goods and the demand of factors with a putty–clay technology. In the second section we close the model by completing its demand side, by introducing a "wage curve" and by assuming the equilibrium of the goods market. Then, we describe the determination of the equilibrium. The third section presents the results of the simulation of the model. The calibration is such that the steady state of the model is identical to the situation of