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LSM: A DSGE model for Luxembourg ☆

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ABSTRACT

Luxembourg is a small open economy with a set of particular features, including rather limited competition in the domestic goods market, strong union power, and a segmented labor market for resident and non-resident workers. In this paper we develop a medium scale DSGE model that captures these features, calibrate it to mimic the actual behavior of the key macroeconomic aggregates, and use it to conduct policy experiments aimed at relaxing some of the existing rigidities in the goods and labor market.

1. Introduction

The key features of models based on the New Open Economy Macroeconomics and Dynamic Stochastic General Equilibrium (NOEM-DSGE) approaches are an optimization-based dynamic general-equilibrium approach; the presence of sticky prices and/or wages in at least some sectors of the economy; the incorporation of stochastic shocks; and the evaluation of economic (typically monetary) policy based on household welfare, with results robust to the Lucas (1976) critique. As in closed-economy DSGE models, early NOEM-DSGE models were highly theoretical and provided only a very stylized representation of the economy, see e.g. Obstfeld and Rogoff (1995). Later developments, such as Ghironi (2000), Bergin (2003), Lubik and Schorfheide (2005), and Justiniano and Preston (2004), estimated small-scale NOEM-DSGE models, usually by Bayesian techniques. Current research, often conducted in policy institutions, aims at further extending NOEM-DSGE models to provide a tool for policy analysis.

We follow this approach and build a medium-scale NOEM-DSGE model for Luxembourg, named LSM (Luxembourg Structural Model). LSM aims at assessing the effects of policy reforms such as greater product and labor market competition (as advocated, e.g., by the OECD (2010) and the IMF (2006)). We pay particular attention to modeling the real side of the economy, combining some original theoretical features with modeling choices aimed at capturing specific characteristics of the Luxembourg economy. In particular, we adopt an overlapping generations approach for households, and combine it with Heijdra and Ligthart (2007) style investment decisions and a right-to-manage specification of a segmented labor market, with both resident and non-resident workers.

The equilibrium conditions resulting from the optimization problems at the cohort and firm level are aggregated analytically. The resulting model is calibrated to match specific features of the Luxembourg economy and solved using a nonlinear local solution method.

There already exist three macroeconometric models for Luxembourg: the STATEC model Modux Adam (2004, 2007), the model of the Banque Central du Luxembourg Guarda (2005), and the STATEC multi-sector model LuxMod STATEC (2006), each developed for specific purposes but none belonging to the NOEM-DSGE class. This is the distinctive feature of our model, LSM, as will clearly emerge from its description in the following sections. With respect to the Modux and BcL models, LSM is substantially more theory-based, but less detailed in terms of the dynamics. Hence, it is more suitable than these models for policy simulations, but perhaps less adapted to short and medium-term forecasting. With respect to LuxMod, the underlying economic

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theory is also more developed and coherent, but there is no sectoral disaggregation. Hence, LSM should be more appropriate than any of the existing models to evaluate the aggregate effects of changes in economic policy.

To conclude, while some features of LSM are tailored to the specificities of the Luxembourg economy, its overall structure could be easily adapted to assess economic policy in other small open economies.

The paper is structured as follows. In Section 2 we describe the different sectors of LSM. In Section 3 we briefly discuss the equilibrium conditions, with full details provided in Appendix A. In Section 4 we discuss the calibration of LSM, with full details in Appendix B. In Section 5 we use LSM to analyze the effects of increasing competition in the Luxembourg product and labor markets. Finally, in Section 6 we summarize the main results and propose directions for further development.

2. The structure of LSM

In the specification of LSM we follow the Bank of England model BEQM Harrison et al. (2005), the Bank of Belgium model NONAME Jeanfils and Burggraeve (2008), and the Bank of Finland model AINO Kilponen and Ripatti (2006). However, we also introduce a set of technical refinements, mostly needed to tackle the additional complications introduced by the OLG structure when deriving the aggregation equations in closed form, to introduce sufficient flexibility in the dynamics of the model, and to model the specificities of the Luxembourg economy. In the following subsections we will describe in detail the behavior of the different types of agents in LSM, namely: Households, Government, Firms and Unions.

2.1. Households

We provide a detailed description of the household problem at the cohort level in the first subsection. In the second subsection we focus on aggregation. In the third subsection we consider investment and capital accumulation. In the final subsection we discuss the determination of the net foreign asset position.

2.1.1. The consumer's problem at the cohort level

Following the discrete time version of Blanchard (1985), in period t, the representative consumer of generation z maximizes her expected lifetime utility:

$$u_{z,t} = E_t\left[\sum_{s=t}^{\infty}\beta^{s-t}u\left(x_{z,s}\right)\right] = \sum_{s=t}^{\infty}(\varphi\beta)^{s-t}u\left(x_{z,s}\right),$$

where $\varphi\in(0,1)$ represents the constant *survival rate*, i.e. the share of individuals that survive in each period, β the subjective discount factor, $x_{z,t}\equiv\{c_{z,t},d_{z,t}\}$ with c_t denoting non-durable consumption (from now on, consumption *tout court*) and d_t the end-of-period desired stock of durable consumption goods (from now on, durables).

The utility function, $u(x_{z,t})$, is of the constant relative risk aversion (CRRA) type, with CES preferences over consumption and durables:

$$u\left(x_{z,t}\right)\equiv\frac{\left\{\left[\phi c_{z,t}^{\upsilon}+(1-\phi)\,d_{z,t}^{\upsilon}\right]^{\frac{1}{\upsilon}}\right\}^{1-\sigma}-1}{1-\sigma}. \tag{1}$$

In Eq. (1), ϕ is related to the expenditure shares of consumption and durables. If we define by σ^c the (constant) intertemporal elasticity of substitution and by σ^m the elasticity of substitution between consumption and durables, then:

$$\sigma=\frac{1}{\sigma^c},\quad \upsilon=\frac{\sigma^m-1}{\sigma^m}.$$

The period-by-period budget constraint for the representative agent in generation z can be written as

$$a_{z,t}=\frac{R_t}{\varphi}a_{z,t-1}+\omega_t-(1+\tau_C)p_t\left[c_{z,t}+\varkappa_t^d\left(d_{z,t}-\frac{1-\delta_D}{\varphi}d_{z,t-1}\right)\right], \tag{2}$$

where

$$R_t\equiv 1+(1-\tau_K)i_t.$$

The variables are defined as follows: a_t is the end-of-period asset stock, R_t is gross rate of return common across assets, τ_K is the tax rate on financial asset returns, i_t the *exogenous* (small open economy assumption) gross-of-tax interest rate, ω_t is current non-financial income, p_t is the price of the final good, τ_C is the tax rate on consumption, δ^D is the depreciation rate of durables, and $\varkappa_t^d$ is an exogenous shock to the relative price for durables. Note that we are assuming that the final consumption good can be transformed into durables at a rate $\varkappa_t^d$. Furthermore, note that $a_{t,t-1}=0$, for $t\geq z$, meaning that new generations have no endowments.

Following Schmitt-Grohe and Uribe (2004), we assume the existence of a debt-elastic interest-rate premium, i.e. an interest rate that is increasing in the country's net foreign debt:

$$i_t=\bar{\imath}+\xi_i\left[\exp\left(\bar{f}-\frac{F_t}{GDP_t}\right)-1\right]+\varepsilon_{it},$$

where F_t represents the country's net foreign asset position, $\bar{\imath}$ the constant and exogenous long-run interest rate if the country runs its steady-state net foreign asset position ($\bar{f}$), and ε_{it} an interest-rate shock.

Current non-financial income is defined as

$$\omega_t\equiv(1-\tau_L)\left[w_{1,t}n_{1,t}+\overline{w}_{1,t}\left(1-n_{1,t}\right)\right]+(1-\tau_K)\pi_t+tr_t, \tag{3}$$

where $n_{1,t}$ is the employment rate of resident workers (at the individual level, the unemployment rate $1-n_{1,t}$ can be interpreted as the probability of being unemployed), $w_{1,t}$ their wage rate, τ_L the tax rate on labor related income, $\overline{w}_{1,t}$ the unemployment benefits for resident former workers (to be defined more precisely below), π_t the exogenous, individual share of total firm profits, and tr_t the net government transfer. Note that the expression for labor income reflects the assumption of perfect unemployment insurance, and distinguishes two types of labor, resident and non-resident.

In each period the consumer can use available resources (current income, assets and durables), or borrow in the financial market to finance consumption or to increase her asset stock (which includes claims on the physical capital stock).[1] The intertemporal budget constraint is the following:

$$(1+\tau_C)\sum_{s=t}^{\infty}\mathrm{R}_{t,s}p_s\left[c_{z,s}+\varkappa_t^d\left(d_{z,s}-\frac{1-\delta_D}{\varphi}d_{z,s-1}\right)\right]=\frac{R_t}{\varphi}a_{z,t-1}+\sum_{s=t}^{\infty}\mathrm{R}_{t,s}\omega_s, \tag{4}$$

where $\mathrm{R}_{t,t}\equiv 1$ and, for $s\geq t+1$, $\mathrm{R}_{t,s}\equiv\prod_{j=t+1}^{s}\frac{\varphi}{R_j}$.

As usual, the representative consumer maximizes intertemporal utility subject to the budget constraint, taking the sequence of prices

[1] Notice that, even if the life expectancy of the consumer decreases exponentially, she could still live for an infinite number of periods. Therefore, it is important to impose as an additional constraint the no-Ponzi game condition (NPG): $lim_{T\to\infty}\prod_{s=0}^{T}\varphi\frac{a_{z,t+s}}{R_{t+s}}=0$, which prevents overborrowing. This constraint simply ensures that the market will never allow an individual to finance consumption indefinitely via new debt: sooner or later, financial liabilities of any kind have to be honored.