1. Introduction

Since the approval of the American Recovery and Reinvestment Act (ARRA) stimulus package in 2009, much academic research has been developed in an attempt to assess the dynamic impacts of government purchases, and, in particular, the impacts of public investment.[1] Until recent years, government investment was often seen as the perfect type of public spending to counteract economic downturns. In the short run, public investment could stimulate GDP and employment through government purchases, as well as, in a longer term, it could increase economic growth due to the rise in the stock of infrastructure. The logic behind this argument was supported by traditional neoclassical growth models with productive public capital, as in the seminal work of Baxter and King (1993). However, as pointed out first by Leeper, Walker and Yang (2010), a time-to-build process for public capital in the spirits of Kydland and Prescott (1982) and a distortionary fiscal financing scheme can remarkably change this conventional view of the short and long run effects of public infrastructure spending.

This paper proposes a simple model in line with the real business cycles (RBC) literature which explains quantitatively both the employment and output responses to public investment shocks. The model is an otherwise deterministic standard neoclassical growth model extended to include a time-to-build process for productive public capital, variable capital utilization, adjustment costs in investment and indivisible labor supply. We test the theoretical implications of the model based on the very recent work of Leduc and Wilson (2012), who estimate the dynamic responses of GDP, employment and wages – among several other macroeconomic variables – to shocks in highway spending. We restrict attention to the empirical patterns of those variables, comparing them to the quantitative predictions derived in the model. According to their findings, public expenditures generate an immediate rise in output in spite of a muted response in employment. Following the short run boom, a recession in both variables occurs and, finally, a second round of economic stimulus takes place in the six to eight years after the

[1] Works by Auerbach and Gorodnichenko (2012), Woodford (2011), Christiano, et al. (2011) and Ramey (2011) are examples of the renewed interest in the estimation of the government spending multiplier.

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shock. Yet, the empirical responses suggest no permanent effect of public investment, also in line with the evidence of Perotti (2004).

In order to reduce the number of free parameters, the calibration follows, as much as possible, the values adopted by Leduc and Wilson in their new Keynesian framework. Their model was used to calculate spending multipliers, which were found to be qualitatively, but not quantitatively, consistent with the evidence. However, our theoretical predictions are able to account for the output and employment empirical dynamics. In the model, the short run boom is rationalized through the increase in public expenditures, which can match the initial response of employment. Subsequently, the recession in both variables is explained by the impact of the time-to-build process on private investment decisions. Finally, the second boom in the economy is generated by the increase in the public capital stock, once its building is complete.

An important feature in the model refers to the variable capacity utilization. Within a scenario of full use of the capital stock, the model predicts business cycles which barely account for the recessive and expansionary impacts of infrastructure spending shocks. However, introducing capital hoarding in the model increases starkly the quantitative predictions concerning both the downturn and subsequent stimulus in economic activity. This effect is consistent with an intuitive intertemporal substitution effect on investment decisions. In fact, since shocks to government investment imply a future increase in public capital stock, agents optimally choose to subutilize the available private capital as well as to postpone investment decisions, until public capital becomes available for production.

Consequently, the model predicts nontrivial quantitative recessions and expansions in output and employment. In this context, a small degree of adjustment costs in investment is required to attenuate the strong quantitative impacts of varying capital utilization within a time-to-build for public capital framework. King and Rebelo (2000) had already shown that an RBC with capital hoarding is useful in providing realistic business cycles from small, nonnegative technological changes. Finally, the indivisible labor supply does not play a significant role in the model, except to introduce variations in the extensive

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margin of hours worked, which is conceptually consistent with the empirical employment dynamics.

The model also introduces weak flypaper effects in government expenditures in response to shocks in federal grants. The flypaper effect occurs when grants-in-aid for a specific type of expenditure induces subsequent increases in local public purchases on that type of expenditure.[2] As suggested by Leduc and Wilson, due to the large highway spending multipliers estimated, federal transfers earmarked for highway construction and maintenance may be accompanied by non-reimbursable expenditures by state governments. In the model, the flypaper effects increase the tax burden borne by households, which in turn stimulates the economy in the short run due to the labor-leisure substitution.

1.1. Leduc and Wilson (2012) Methodology and Results

Leduc and Wilson try to isolate the dynamic macroeconomic effects of public investment based on a data set compiled on various measures of highway spending in United States. They use the specific institutional design of federal grant distributions in order to construct exogenous shocks to government highway spending. Since U. S. federal highway grants are apportioned to states obeying to somewhat strict formulas based on three-year lagged state-specific factors, the distribution of grants provides an exogenous source of highway funding, uncorrelated to current economic conditions. Moreover, there are substantial delays between the announcements of grant distributions and the subsequent outlays reported by states. Such delays reflect lags in the obligation of federal funds by states (about two years) and, more importantly, a time-to-build process required to complete highway projects (about four to six years for maintenance projects and nine to 19 years for new highway projects).

Therefore, the authors use these institutional features concerning highway spending in United States to construct exogenous shocks to public investment. They define the shocks as the revisions in forecasts about future highway grants apportioned to a state and, thus, revisions in expectations about the local government investment. Since the shocks are arguably exogenous by construction,

[2] Inman (2008) provides a brief theoretical explanation of the flypaper effect, as well as a survey on the recent literature concerning its empirical relevance.

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they estimate the impulse response functions (IRFs, henceforth) by OLS, controlling for aggregate time and state fixed effects. Importantly, controlling for the former actually removes any potential negative wealth effect on macroeconomic variables due to the federal tax policy. Yet, wealth effects implied by state nonreimbursable expenditures remain unaffected. These local purchases may be quite important, to the extent that outlays on federal-aid highways need to be complemented with state spending on police services, traffic control, future maintenance, etc.

As mentioned previously, the results reported by Leduc and Wilson suggest that shocks to highway expenditures affect the economy in three steps. First, there is a short run stimulus in GDP but not in employment. Second, the boom is followed by a slowdown in both variables. Lastly, a second rise both in GDP and employment occurs, but no permanent effect is found.

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