# 3. The Aggregate Dynamics of Output, Employment and Wages in Response to Shocks to Public Investment

## 3.1. Baseline Calibration

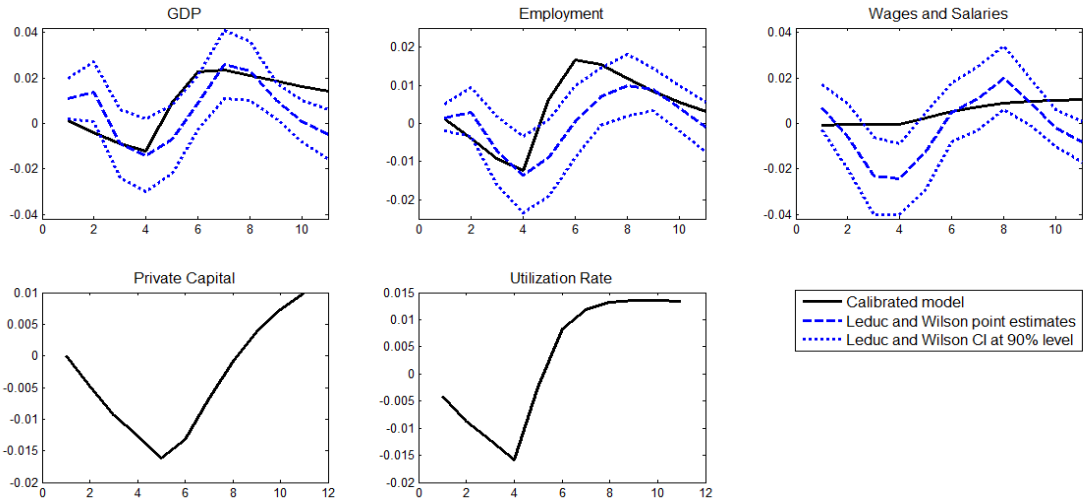
In this section, we report the aggregate dynamics of output, employment and wages in response to shocks to outside transfers (frequency is annual). We compare quantitatively the dynamics implied by our model with the evidence reported by Leduc and Wilson (2012). As pointed out by Leeper, et al. (2010), to the extent that public capital is productive, the expectation of higher public investment expenditures leads to a positive wealth effect, which reduces current hours worked. Depending on the degree of implementation delays, this positive wealth effect may dominate the usual negative wealth effects implied by the increase in current government purchases. Thus, higher government investment may actually result in slightly negative responses in labor and output in the short run.

In our model, the variable capital utilization rate, together with implementation delays, plays a prominent role in generating short-run recessions. Given the expectation of a higher stock of infrastructure in the future, the private sector subutilizes the available amount of private capital and postpones investment decisions until the new public capital becomes productive. Such an intertemporal substitution effect on capital accumulation amplifies considerably both recessive and expansionary impacts due to expected increases in the public capital stock. On the other hand, costs to investment mitigate such impacts, since movements on the stock of private capital become costly.

In Figure 1, we report the responses (as percentage deviations from steady state levels) of output, employment and wages to a shock of 1 percent in outside transfers. We also plot dynamics of the utilization rate and the stock of private capital. The impulse response functions estimated by Leduc and Wilson are displayed too, so that we can compare our theoretical predictions with the empirical IRFs. In the baseline calibration, the model can match precisely the recession in output and employment. The shock leads initially to a muted response in both variables, which decline until the new public capital becomes productive.

Once the infrastructure stock is increased, the model predicts a rise in output, reaching the estimated peak. In the same way, the theoretical increase in employment is quantitatively consistent with the empirical one, though the timing for this boom is predicted to occur earlier in comparison to estimates. Finally, turning to wages, the model implies a somewhat flat response in initial periods, leading to a later qualitatively consistent growth.

Figure 1 – Responses to a 1 percent shock to outside transfers: Baseline calibration




An important feature implied by the model is the quantitative response of the utilization rate of private capital. An unanticipated shock in outside transfers implies an immediate fall in the variable, which declines until the effect due to the time-to-build process is vanished. This pattern is consistent with the previously mentioned intertemporal substitution effect on the capital accumulation process. The agents optimally choose to subutilize the available capital stock since they will benefit from the future externality generated by the current infrastructure spending. A similar argument applies to investment decisions.

## 3.2. The Role of Variable Capital Utilization, Adjustment Costs in Investment and Lump-Sum Taxes

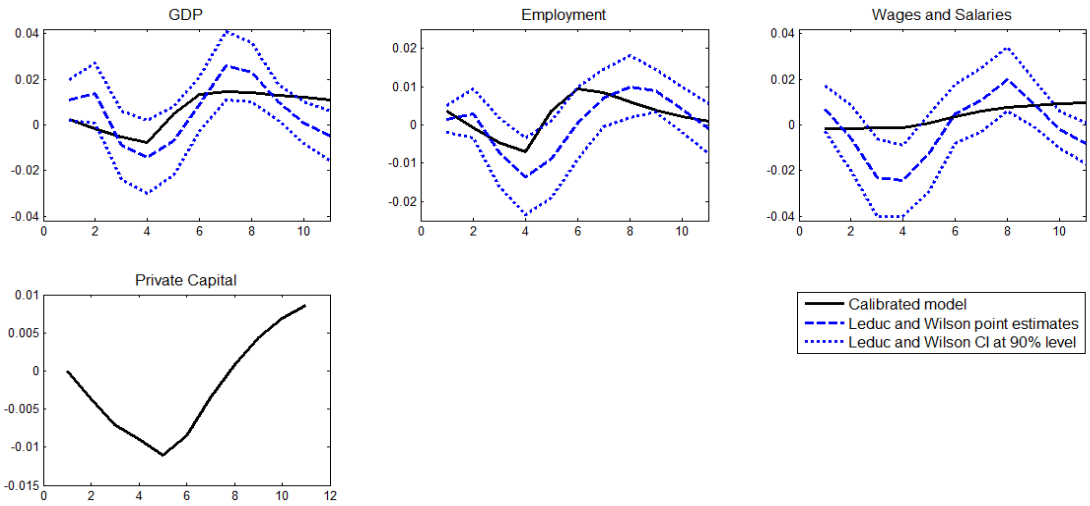
In this section, we analyze the role of key assumptions in our model, namely the variable capital utilization rate, costs to investment and lump-sum

taxation.

### 3.2.1. Variable Capital Utilization

As emphasized before, the utilization rate plays a key role in the model. In Figure 2, we report the dynamics of output, employment and wages in the absence of capital hoarding. In this case, we cannot replicate the initial response in employment, even without costs to investment ($\nu = 0$). Increments in $\nu$ simply move theoretical responses upwards, attenuating the S-shaped dynamics in output and employment due to the higher costs involved in changing the capital stock.

Figure 2 – Responses to a 1 percent shock to outside transfers: No Capital Hoarding



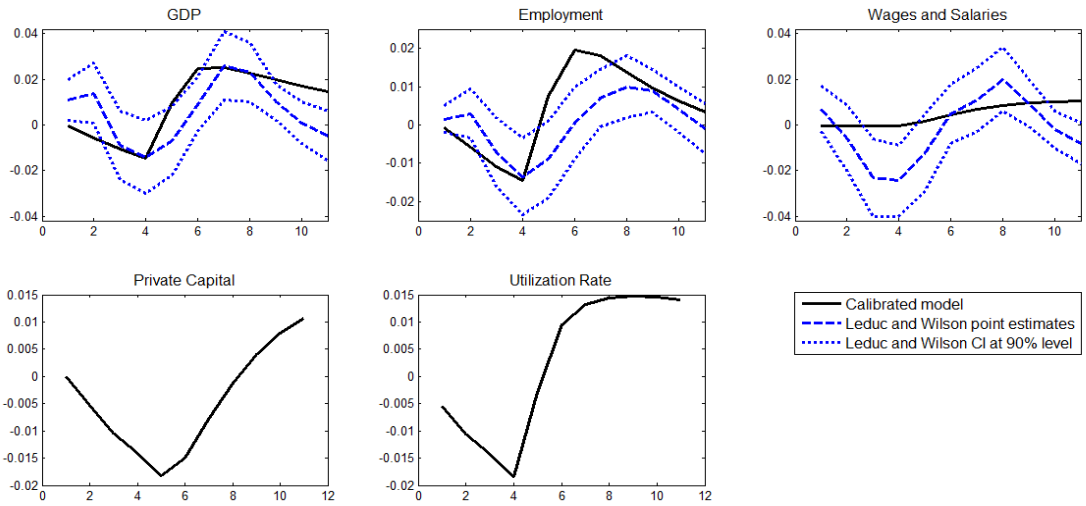

As we can see, without varying capital utilization, the model cannot replicate quantitatively point estimates concerning the overall business cycles generated by public investment shocks. However, qualitative dynamics in output and in employment remain due to a weak impact of intertemporal substitution effect on investment decisions.

### 3.2.2. Adjustment Costs in Investment

Costs to investment are needed to mitigate the quantitative effects generated by the varying capital utilization. In Figure 3, we keep the latter feature

in the model, but we impose no costs to investment ($\nu = 0$). The output and employment dynamics show that the model generates slightly deeper recessions in output and employment, as well as a greater response of both variables in the medium to long run, since the incentives to change the stock of private capital are amplified. In fact, the model predicts higher peaks in variables, especially in employment.

Figure 3 – Responses to a 1 percent shock to outside transfers: No costs to investment




### 3.2.3. Lump-Sum Taxes

### 3.2.3. a) Windfall-Financed Expenditures

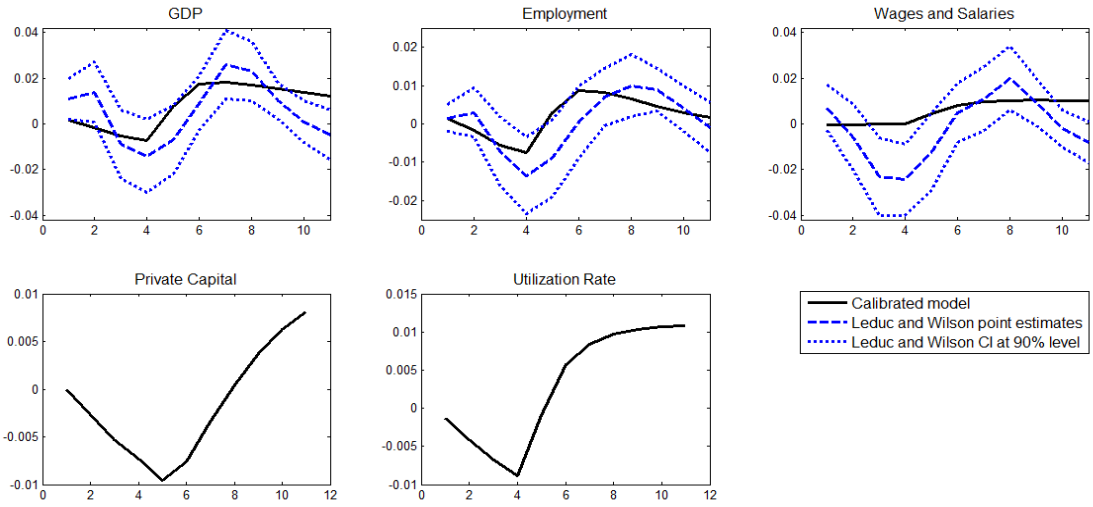
In Figure 4, we adopt exactly the same calibration as in Figure 1, except to the degree of lump-sum taxes required to finance public expenditures. In this case, we assume windfall-financed infrastructure spending, but a flypaper effect on public consumption is assumed.[15] In this new calibration, adjustment costs in investment, $\nu$, are set to 0.07.

In this new parameterization, the employment response lies quite inside the confidence interval (CI), although the model does not generate a deep decrease in the variable. The same occurs with the output, and its peak reaches a more

[15] In this case, it is equivalent to assume that the local government finances 30% of the infrastructure spending.

modest magnitude. At this point, it should be clear that we could always quantitatively account for the short run fall and long run rise in output and employment, at the cost of not capturing the initial response in the latter variable. As previously mentioned, since we have to increase costs to investment, $\nu$, to match the initial response of employment, intertemporal substitution effects on investment decisions are drastically diminished. Yet, all variables, including wages, keep the same qualitative responses.

Figure 4 – Responses to a 1 percent shock to outside transfers: Windfall-financed expenditures

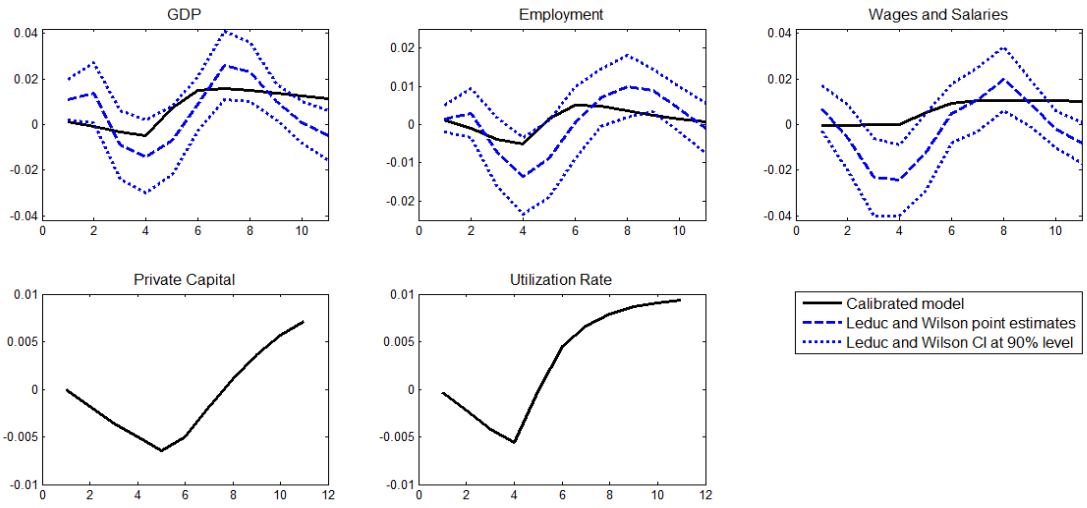



### 3.2.3. b) Flypaper Effects

In the model, the flypaper effects are required to stimulate the economy in the short run, to the extent that they increase the tax burden borne by households. Since higher taxes imply a stronger negative wealth effect, leisure substitution for labor is greater. In Figure 5, we report the theoretical dynamics in the absence of flypaper effects. In order to match the initial response in employment, we have in this case to increase the amount of costs to adjustment, $\nu$, to 0.13.

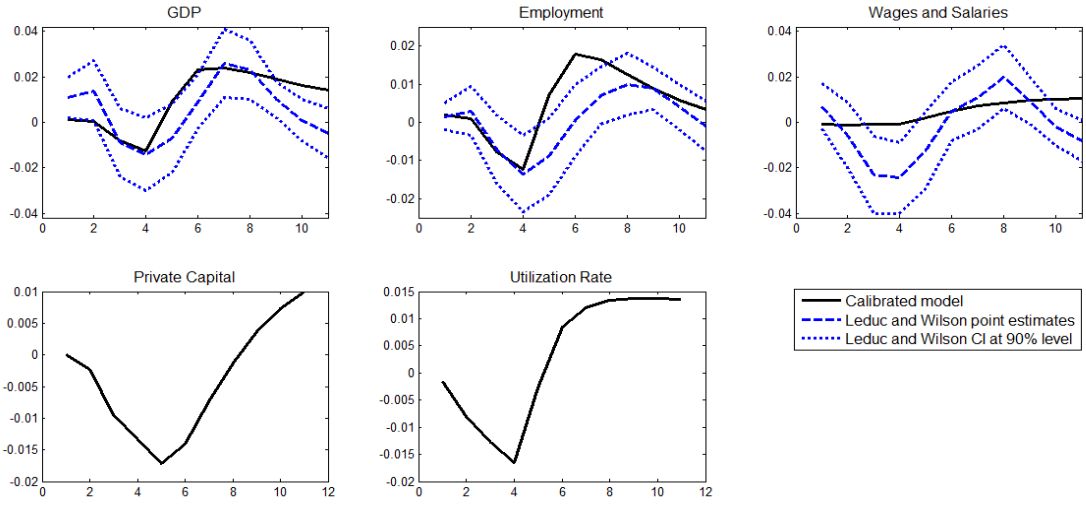
In the same way of windfall-financed expenditures, the model does not imply sharp economic downturns, to the extent that the large value of $\nu$ flattens the impact of varying capital utilization on output and employment. Accordingly,

Figure 5 – Responses to a 1 percent shock to outside transfers: No Flypaper Effects




the quantitative predictions concerning the decrease in private capital and utilization rate are quite diminished.

Figure 6 – Responses to a 1 percent shock to outside transfers: Strong Flypaper Effects




Finally, we report charts imposing strong flypaper effects on public consumption. In this case, we assume a magnitude of $0.45 for the flypaper effect

($0.05 for current and $0.40 for lagged outside transfers).[16] The costs to investment, $\nu$, are set to 0.01. As can be seen in Figure 6, within a looser modeling and calibration for flypaper effects, we can match precisely the short run dynamics for employment. Concerning the output, its initial response lies now inside the CI. In addition, both recession and peak are also remarkably replicated.



[16] In this parameterization, we assume that $C_t^G = \tilde{C}^G + \gamma_0 A_t + \gamma_1 A_{t-1}$, but $\gamma_0$ and $\gamma_1$ are treated as free parameters calibrated to 0.05 and 0.40, respectively. The degree of required local financing remains at 20%.