9. Welfare Effects and Robustness Checks

9.1. Welfare Analysis

In this section, we calculate the welfare effect associated to GAP. The measure is obtained for the different implementation lags of public investment, as well as for the distinct fiscal adjustment degrees. We consider the welfare effect for each financing scheme of government spending. The applied methodology calculates the constant percentage variation of consumption, u_j^i, $i \in \{c, h, k, Z\}$ and $j \in \{N=1, N=8, N=12, N=16\}$, so that the agent is indifferent between the implementation of the GAP and the alternative scenario (in which the variables remain in the steady state levels). The variable Z refers to the model without public debt, in which the tax rates are constant over time, and the government finances its expenditures through lump-sum taxes. The applied methodology allows glimpsing all the transition dynamics on consumption, and is usual in the literature, as in Lucas (1987):

$$\sum_{t=0}^{\infty} \beta^t U\left(c_t(1-u_j^i), g_t^c, l_t\right) = \sum_{t=0}^{\infty} \beta^t U(c_{ss}, g_{ss}^c, l_{ss}), \qquad (13)$$

where the subscript ss corresponds to the variables in steady state. In this methodology, positive values for u_j^i indicate positive welfare effects. In the tables below, we summarize the results.

The analysis that follows refers to the case for $\theta = 0.5$. The results suggest that the welfare gains associated to the GAP are small, for any fiscal adjustment scheme and implementation delay of public spending. In fact, in the more favorable scenario (under lump-sum taxation), the compensating variation is of only 0.27% for a three-year public investment lag. The tables also show that models without the time-to-build assumption tend to overestimate the welfare effects of public investment. In the absence of the time-to-build process for public capital, the compensating variation may be 25% higher than the obtained with a spending lag of four years. Moreover, the size of the drop in welfare does not depend significantly on the financing scheme of public expenditures.

We can also note in Table 10 that, as the fiscal adjustment becomes more flexible, the variation in welfare decreases, since the distortions generated by the tax rates on the economy are prolonged over the transition dynamics. In fact, given a time-to-build process, the ratio u^Z/u^c increases across different fiscal adjustment scenarios. Finally, although in the adopted calibration the harder taxation on capital generates a higher welfare than the rise in labor taxes, the size of this difference decreases as the implementation delays of public spending increase and the fiscal adjustments become less aggressive.[32]

With respect to the alternative calibration, in which $\theta = 0$, the welfare gains are even more reduced, since public consumption, in this case, is pure waste. In fact, except for the lump-sum taxation case, the higher welfare gain (0.18%) is obtained when the lags in public expenditures are of one quarter and the government spending is financed through taxes on consumption. Moreover, the fall in welfare due to the time-to-build process remains, to the extent that the decrease in compensating variation (in comparison to the one-quarter lag scenario) continues to stay around 10% and 25%. It is worth noting that the gains in welfare, in the case of higher taxation on capital, become very close to those obtained in the case of higher taxation on consumption.

Finally, even in the case of $\theta = 1$, the welfare effects associated to the program remains low, less than 0.5%. In this case, as in the previews ones, the financing of public investment through consumption taxes generate the highest percentages of compensating variation. The size of the gap between the welfare gains associated to taxation over consumption and hours worked, respectively, is also reduced. However, the most important aspect is that the relative decrease in compensating variation (due to the amplification of spending delays) remains roughly constant around: 12% for $N = 8$; 20% for $N = 12$; and 25% for $N = 16$. It is noticeable that this decline is constant between different financing schemes, fiscal adjustment scenarios and alternative calibrations (which assume positive externalities for public consumption).

[32] The higher welfare gain is due to the increase in consumption over the transition dynamics, generated by the taxation on capital. Instead, the harder taxes on hours worked induce a crowding out effect over consumption. Since the β parameter is low, the agent does not take into account the greater future distortion provoked by the first financing scheme. For a household patient enough, this result is no longer valid.

Table 7: Welfare gain – Different lags and fiscal adjustment scenarios

Compensating Variation (%) – θ = 0										
		5 years			10 years			15 years		
	Z	τ^c	τ^k	τ^h	τ^c	τ^k	τ^h	τ^c	τ^k	τ^h
$u_{N=1}$	0.21	0.19	0.19	0.17	0.18	0.18	0.17	0.18	0.18	0.16
$u_{N=8}$	0.19	0.16	0.16	0.15	0.16	0.16	0.15	0.16	0.16	0.15
$u_{N=12}$	0.17	0.15	0.15	0.14	0.15	0.15	0.14	0.15	0.15	0.13
$u_{N=16}$	0.16	0.14	0.14	0.13	0.14	0.14	0.13	0.14	0.14	0.12
$u_{N=1}/u_{N=1}$	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
$u_{N=8}/u_{N=1}$	0.90	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.88	0.89
$u_{N=12}/u_{N=1}$	0.84	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
$u_{N=16}/u_{N=1}$	0.78	0.76	0.75	0.76	0.77	0.76	0.76	0.76	0.76	0.76

The column Z reports the welfare gains corresponding to the lump-sum financing of government spending.

Table 8: u^i/u^c, $i \in \{c, h, k\}$ – Different lags and fiscal adjustment scenarios (θ = 0)

5 years				
	***N*=1**	***N*=8**	***N*=12**	***N*=16**
u^Z/u^c	1.12	1.13	1.14	1.16
u^c/u^c	1.00	1.00	1.00	1.00
u^k/u^c	1.00	1.00	0.99	0.99
u^h/u^c	0.90	0.90	0.90	0.91
10 years				
	***N*=1**	***N*=8**	***N*=12**	***N*=16**
u^Z/u^c	1.15	1.16	1.16	1.17
u^c/u^c	1.00	1.00	1.00	1.00
u^k/u^c	0.99	0.99	0.99	0.99
u^h/u^c	0.91	0.91	0.91	0.91
15 years				
	***N*=1**	***N*=8**	***N*=12**	***N*=16**
u^Z/u^c	1.16	1.17	1.18	1.19
u^c/u^c	1.00	1.00	1.00	1.00
u^k/u^c	0.99	0.99	0.99	0.99
u^h/u^c	0.91	0.91	0.91	0.91

Table 9: Welfare gains – Different lags and fiscal adjustment scenarios

Compensating Variation (%) – θ = 0.5										
		5 years			10 years			15 years		
	Z	τ^c	τ^k	τ^h	τ^c	τ^k	τ^h	τ^c	τ^k	τ^h
$u_{N=1}$	0.31	0.26	0.24	0.21	0.25	0.22	0.20	0.24	0.22	0.20
$u_{N=8}$	0.28	0.23	0.21	0.18	0.22	0.19	0.18	0.21	0.19	0.18
$u_{N=12}$	0.27	0.21	0.19	0.17	0.20	0.18	0.17	0.20	0.17	0.17
$u_{N=16}$	0.25	0.19	0.17	0.16	0.19	0.16	0.16	0.18	0.16	0.15
$u_{N=1}/u_{N=1}$	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
$u_{N=8}/u_{N=1}$	0.90	0.88	0.87	0.89	0.89	0.87	0.89	0.88	0.87	0.88
$u_{N=12}/u_{N=1}$	0.85	0.82	0.79	0.82	0.82	0.80	0.82	0.81	0.79	0.82
$u_{N=16}/u_{N=1}$	0.80	0.75	0.71	0.76	0.76	0.73	0.76	0.75	0.73	0.76

The column Z reports the welfare gains corresponding to the lump-sum financing of government spending.

Table 10: u^i/u^c, $i \in \{c, h, k\}$ – Different lags and fiscal adjustment scenarios (θ = 0.5)

5 years				
	***N*=1**	***N*=8**	***N*=12**	***N*=16**
u^Z/u^c	1.22	1.24	1.26	1.30
u^c/u^c	1.00	1.00	1.00	1.00
u^k/u^c	0.92	0.90	0.88	0.87
u^h/u^c	0.80	0.81	0.81	0.82
10 years				
	***N*=1**	***N*=8**	***N*=12**	***N*=16**
u^Z/u^c	1.27	1.29	1.31	1.34
u^c/u^c	1.00	1.00	1.00	1.00
u^k/u^c	0.90	0.88	0.87	0.86
u^h/u^c	0.83	0.83	0.83	0.83
15 years				
	***N*=1**	***N*=8**	***N*=12**	***N*=16**
u^Z/u^c	1.29	1.32	1.35	1.37
u^c/u^c	1.00	1.00	1.00	1.00
u^k/u^c	0.89	0.88	0.87	0.86
u^h/u^c	0.83	0.84	0.84	0.84

Table 11: Welfare gains – Different lags and fiscal adjustment scenarios

Compensating Variation (%) – θ = 1										
		5 years			10 years			15 years		
	Z	τ^c	τ^k	τ^h	τ^c	τ^k	τ^h	τ^c	τ^k	τ^h
$u_{N=1}$	0.42	0.32	0.29	0.24	0.31	0.26	0.24	0.30	0.25	0.24
$u_{N=8}$	0.37	0.28	0.24	0.21	0.27	0.22	0.21	0.26	0.22	0.21
$u_{N=12}$	0.35	0.26	0.22	0.20	0.25	0.20	0.20	0.24	0.20	0.19
$u_{N=16}$	0.33	0.24	0.19	0.18	0.23	0.18	0.18	0.22	0.18	0.18
$u_{N=1}/u_{N=1}$	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
$u_{N=8}/u_{N=1}$	0.90	0.88	0.86	0.88	0.88	0.86	0.88	0.87	0.85	0.88
$u_{N=12}/u_{N=1}$	0.85	0.81	0.77	0.82	0.81	0.78	0.81	0.80	0.77	0.81
$u_{N=16}/u_{N=1}$	0.80	0.73	0.68	0.76	0.75	0.70	0.75	0.74	0.70	0.74

The column Z reports the welfare gains corresponding to the lump-sum financing of government spending.

Table 12: u^i/u^c, $i \in \{c,h,k\}$ – Different lags and fiscal adjustment scenarios (θ = 1)

5 years				
	***N*=1**	***N*=8**	***N*=12**	***N*=16**
u^Z/u^c	1.28	1.32	1.35	1.40
u^c/u^c	1.00	1.00	1.00	1.00
u^k/u^c	0.88	0.86	0.84	0.82
u^h/u^c	0.75	0.76	0.76	0.77
10 years				
	***N*=1**	***N*=8**	***N*=12**	***N*=16**
u^Z/u^c	1.35	1.39	1.42	1.45
u^c/u^c	1.00	1.00	1.00	1.00
u^k/u^c	0.85	0.83	0.82	0.81
u^h/u^c	0.78	0.79	0.79	0.79
15 years				
	***N*=1**	***N*=8**	***N*=12**	***N*=16**
u^Z/u^c	1.38	1.43	1.46	1.49
u^c/u^c	1.00	1.00	1.00	1.00
u^k/u^c	0.85	0.82	0.81	0.80
u^h/u^c	0.79	0.80	0.80	0.80

9.2. Robustness Checks

We could plausibly argue that the recessive impact of the GAP is due to the small elasticity of output to the public capital stock. Although γ is a technological parameter – and, hence, does not vary substantially across countries –, a robustness check for the results is to adopt a very large value for γ, reflecting some huge Brazilian infrastructure constraints. This argument is equivalent to consider that the public capital stock is heterogeneous – an assumption that is absent from the baseline model, since all the infrastructure is condensed in only one input, K^g –, and, therefore, may be associated to distinct levels of productivity.

One of the few efforts to estimate the productivity of public capital in Brazil was performed by Ferreira and Maliagros (1999), who found values above 0.4 for the long run elasticity of output to public capital. Thus, we assume in the alternative calibration that $\gamma = 0.35$. The charts below report the impulse response functions for the same public investment shock analyzed previously. We consider spending delays of three years for a fifteen-year fiscal adjustment scenario. We report impulse response functions for the three alternative financing schemes (taxation on consumption, labor and capital).

The results make it clear that the recessive impact of public investment is not due to the value of γ, but, rather, are induced by the previously explained positive wealth-effect. In the Figure 14, we highlight that the increase in the productivity of public capital *attenuates* the recessive effect due to the time-to-build process in the short run. Moreover, the crowding-out effect on consumption, provoked by the increase in public spending, is replaced by a positive growth path over the transition dynamics. As we see in the figure below, the decrease in output is close to 1% in four years. After this period, the medium to long run expansionary effects are significant, reaching a growth rate around 2%. We also note that the fiscal adjustment based on higher capital taxes prompts a lower accumulation of capital by agents over the transition dynamics. Analogously, the financing of expenditures through taxation on labor attenuates the growth in hours worked.

Figure 13 – Reponses to the public investment shock: $\gamma = 0.35$.