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Dynamic scoring of tax reforms in a small open economy model☆

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ABSTRACT

We examine dynamic revenue effects of a permanent tax cut on labor and capital income using a small open two-sector dynamic general equilibrium model. We use a dynamic scoring technique to calculate long-run as well as transitional effects on fiscal revenue when a tax cut is financed by either a lump-sum tax or consumption tax. We show that the revenue loss from an income tax cut becomes substantially smaller when agents can use international financial markets compared to the case of the closed economy. Responses of tradable and nontradable sectors to the capital income tax cut display a stark contrast in both long-run equilibrium and transitional dynamics due to different factor intensities. Capital income tax cut in the tradable sector is the most efficient policy instrument in terms of minimizing fiscal revenue loss. These simulation results suggest that fiscal sustainability issue when implementing a tax cut could be overstated.

1. Introduction

Expansionary fiscal policy has regained a significant attention since the global financial crisis as monetary policy has reached its limit in reviving the economy. A large body of research has examined the macroeconomic effects of expansionary fiscal policy such as a reduction in tax rates or an increase in government spending.[1] One of the key issues when implementing expansionary fiscal policy is fiscal sustainability because expansionary policy typically generates a negative impact on fiscal balance. However, quantifying the dynamic impact on fiscal balance, especially when a tax cut is implemented, is a hard task because a tax cut would affect tax base over time.

This paper studies fiscal consequences of a tax cut using a small open two-sector dynamic general equilibrium model. We use dynamic scoring to evaluate the effects on fiscal balance. Dynamic scoring calculates revenue effects of a tax policy using dynamic macroeconomic models, in which a change in tax rates generates feedback to tax revenues through changes in tax base over time.[2] That is, dynamic scoring considers both long-run effects through changes in steady states as well as transitional path. For example, a tax cut in capital income tends to reduce tax revenue on impact but it increases tax base (and tax revenue) over time because a tax cut enhances economic activities such as investment.[3]

On the other hand, a conventional method of revenue estimation, static scoring, ignores this dynamic effect through changes in tax bases over time. Most static scoring studies have employed a static model and simply analyzed equilibria in pre- and post-tax reform periods. Therefore, the static scoring method cannot provide accurate forecasts of tax revenue and budget balances over time, as economic activities such as investment and savings have intertemporal components.[4] Compared to dynamic scoring, static scoring tends to

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[1] For example, Lehmus (2011) finds that a tax cut in labor income financed by a consumption tax leads to an increase in capital accumulation, resulting in a rise in output. Forni et al. (2009) and Coenen et al. (2008) also present a similar result using estimated DSGE models for Euro area. Mountford and Uhlig (2009) use a vector autoregressive (VAR) model for the US economy and find that a deficit-financed tax cut yields a larger output multiplier than the deficit-financed government spending. Jha et al. (2014) also find a similar result to Mountford and Uhlig (2009) for 10 Asian countries.

[2] For dynamic scoring literature, see, for example, Auerbach (2005); Mankiw and Weinzierl (2006); Leeper and Yang (2008), Strulik and Trimborn (2012), and Houndonougbo and Mohsin (2016). Dynamic scoring literature is directly related to the literature on dynamic Laffer curve including Novales and Ruiz (2002) and Trabandt and Uhlig (2011).

[3] The first effect of a tax cut is called static scoring, while the second effect (related to an increase in tax base) is called the feedback (dynamic) effect.

[4] For instance, Broer and Westerhout (1993) explore the effects of a reduction in labor and capital income taxes financed by a consumption tax in a general equilibrium model. They find that a tax cut in capital income leads to the best result in terms of welfare.

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overestimate the fiscal revenue loss from a tax cut as it disregards changes in tax base.

This paper uses dynamic scoring to examine the effects of a permanent cut in capital and labor income tax (financed by an increase in either a lump-sum tax or consumption tax) on tax revenues, budget balances and external balances. Compared to previous literature in dynamic scoring, the model employed in this paper has several advantages. First, while the existing literature typically uses a closed-economy model, this paper uses an open-economy model with trade in goods and financial assets, which enables us to analyze the effects of tax policy on variables such as current account and net foreign asset positions.[5] Second, unlike the previous literature, we adopt a two-sector model (tradable and nontradable sectors) which allows us to further look into the effects of a tax cut on sectoral shift of resources. In particular, we can analyze differences in a way that each sector (tax base) responds to changes in tax rates. This framework is ideal for analyzing a small open economy with large trade sectors.

Several findings emerge in this paper. First, the revenue effects in an open economy are much larger than those in a closed economy. For example, dynamic scoring suggests that a 1% cut in labor income tax financed by lump-sum tax recovers around 77% of the revenue loss in the closed economy, whereas it recovers around 95% in the open economy. In the case of a 1% cut in capital income tax, it leads to 81% revenue recovery in the closed economy, while it leads to 121% recovery (in fact, budget surplus) in the open economy. These numbers are much larger than those documented in earlier studies. For example, Mankiw and Weinzierl (2006) use a neoclassical growth model calibrated to US data and report that a 1% permanent reduction in capital (labor) income tax expands the tax base enough to offset 53% (17%) of the revenue loss. Leeper and Yang (2008) examine dynamic scoring of a 1% reduction in capital and labor income taxes and report that the capital (labor) tax cut recovers 95% (47%) of revenue loss when financed by lump-sum transfers. The large feedback effects in our findings come from sectoral shift of resources, which is possible because we adopt an open economy multi-sector model.

Second, feedback effects are different in tradable and nontradable sectors. In both open and closed economies, a tax cut generates much larger feedback effects in the tradable sector than nontradable sector and the magnitude of revenue recovery in the long run is quite large in the tradable sector.[6] In contrast, a 1% capital income tax cut in the nontradable sector generates negative revenue effects in the long run. These results imply that a tax cut in the tradable sector is more effective than that in the nontradable sector due to the assumption that the tradable sector is more capital intensive than the nontradable sector. Changes in relative price play a major role in determining transitional dynamics of tax revenues and budget balances. However, this result can change if we assume that the nontradable sector is more capital intensive.

The paper is organized as follows. Section 2 lays out a small open two-sector dynamic general equilibrium model. Section 3 calibrates the model with explanations on deep parameters. Section 4 provides the main simulation results and the results from sensitivity check. Section 5 concludes the paper.

2. The model

The model consists of two sectors with an interaction of households, firms and government. Households consume two goods, tradable and nontradable goods, and supply labor and capital to firms. Their labor income and capital income are subject to taxes and the households pay a tax on their consumption as well. Firms use two factors, labor and capital, to produce two final goods, tradable and nontradable goods. The model allows for both current account and financial account transactions, which permits households to borrow and lend in international financial markets using one-period risk-free bonds. The government finances an exogenous stream of expenditures through domestic taxes.

A representative household solves

$$\text{Max}\sum_{t=0}^{\infty}\beta^t U(c_t,h_{xt},h_{nt}),\quad \text{where}\quad U_t=\frac{\left[c_t^{\theta}(1-h_{xt}-h_{nt})^{1-\theta}\right]^{1-\sigma}}{1-\sigma}, \tag{1}$$

subject to the budget constraint

$$\begin{aligned}(1+\tau_{ct})p_t c_t+i_{xt}+p_{nt}i_{nt}+B_{t+1}&\\ =(1-\tau_{ht})(w_{xt}h_{xt}+p_{nt}w_{nt}h_{nt})+\left[(1-\tau_{kt}^{x})r_{xt}+\tau_{kt}^{x}\delta_x\right]k_{xt}&\\ +\left[(1-\tau_{kt}^{n})r_{nt}+\tau_{kt}^{n}\delta_n\right]p_{nt}k_{nt}+p_{nt}T_t+R_tB_t,&\end{aligned} \tag{2}$$

where $w_{xt}, r_{xt}, h_{xt}, i_{xt}, k_{xt}(w_{nt}, r_{nt}, h_{nt}, i_{nt}, k_{nt})$ are wage rate, rental rate, hours worked, investment and capital for the tradable (nontradable) sectors. σ is the curvature parameter of the utility function and β is the discount factor. $\delta_x(\delta_n)$ is depreciation rate for the tradable (nontradable) sector. The price of composite consumption good c_t is p_t. B_t is the international bonds and therefore denotes the net quantity purchased in period t maturing in $t+1$. R_t is the exogenously given gross interest rate on bonds. T_t is the net transfer from the government in a lump-sum fashion, and τ is tax rates (τ_{ht} = labor income tax, τ_{kt}^{n} = tax on capital income from the nontradable sector, τ_{kt}^{x} = tax on capital income from the tradable sector, and τ_{ct} = consumption tax). Investment tax credit is incorporated in the budget constraint. All the prices are normalized in terms of tradable good (p_{xt}), which means that p_{nt} is the price of the nontradable good in terms of the price of the tradable good (reciprocal of the real exchange rate).

The law of motion for capital in each sector is subject to adjustment costs as in Baxter and Crucini (1993)

$$k_{x,t+1}=(1-\delta_x)k_{xt}+\phi\left(\frac{i_{xt}}{k_{xt}}\right)k_{xt}, \tag{3}$$

$$k_{n,t+1}=(1-\delta_n)k_{nt}+\phi\left(\frac{i_{nt}}{k_{nt}}\right)k_{nt}, \tag{4}$$

where $\phi(\cdot)$ is the adjustment cost function with the following properties: $\phi(\cdot)>0, \phi'(\cdot)>0$ and $\phi''(\cdot)<0$..

A composite consumption good consists of two goods, tradable (c_{xt}) and nontradable (c_{nt}) goods. The optimal consumption level of the tradable and nontradable goods can be derived from the expenditure minimization problem

$$\text{Min}\ p_t c_t-c_{xt}-p_{nt}c_{nt},\quad \text{s.t}\quad c_t=\left[b_x c_{xt}^{1-\gamma}+b_n c_{nt}^{1-\gamma}\right]^{\frac{1}{1-\gamma}}\quad\text{and}\quad b_x+b_n=1, \tag{5}$$

Where b_x and b_n are share parameters representing a relative weight to consumption of each good and γ is a parameter related to the price elasticity for two goods (i.e., inverse of γ is the price elasticity of demand for tradable and nontradable goods).

Two firms, tradable and nontradable sectors, produce output using labor and capital based on the typical Cobb–Douglas technology and they face the following profit maximization problems

$$\text{Max}\ \Pi_t^{x}=y_{xt}-w_{xt}h_{xt}-r_{xt}k_{xt},\quad \text{where}\quad y_{xt}=A_{xt}k_{xt}^{\mu}h_{xt}^{1-\mu}, \tag{6}$$

$$\text{Max}\ \Pi_t^{n}=y_{nt}-w_{nt}h_{nt}-r_{nt}k_{nt},\quad \text{where}\quad y_{nt}=A_{nt}k_{nt}^{\alpha}h_{nt}^{1-\alpha}, \tag{7}$$

where $\Pi_t^{x}(\Pi_t^{n})$ and $y_{xt}(y_{nt})$ denote the profit and output of the tradable (nontradable) sector and $\mu(\alpha)$ indicates the capital share of the tradable (nontradable) sector. A_{xt} and A_{nt} are defined as productivity in

[5] Some earlier papers have used an open economy setup including Mendoza and Tesar (1998, 2005).

[6] In the closed economy, the tradable sector can be regarded as another nontradable sector, so the economy has two nontradable sectors. There are still sectoral shifts in the closed economy, while there is no trade with foreign countries.