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Improving the Realism of Tax CGE Models

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1. Introduction

The aim of including taxes in computable equilibrium (CGE) models is to capture the influences of tax policies on the economy as a whole. This provides insights into the overall effect of tax policy changes on the economy, taking account of the main inter-relationships between different parts of the economy. Such models can range from highly simplified static models that may or may not be based on actual economic data, to large-scale detailed models that are based on data from a particular country (or group of countries) and that may include many time periods (and so can provide insights into the effects of taxation on growth).

These models have provided a range of valuable insights into the effects of tax changes on the economy. However, there are a number of difficult modelling issues that can arise in these models, especially in connection with taxes on capital and their effects on investment and growth. These issues were identified in an analysis of HMRC's CGE model (HMRC, 2013) as part of the work of the Tax Administration Research Centre (TARC).[2] This work stopped when the responsibility for CGE modelling was moved from HMRC to HM Treasury (HMT). However, the insights that TARC gained before the work stopped may help others in developing their own CGE models that include taxes.

The issues identified by TARC include:

- The choices that firms make between different forms of financing investment (such as debt versus equity) depend on the degree of risk the firms face. However, CGE models are normally constructed without any representation of risk. This raises the issue of how the debt-equity choice should be modelled, an important issue because of the different tax treatment of interest payments and dividends.

- In considering transaction taxes, it is important to note that the available data are based on transactions between sectors of the economy, as measured in Consumption and Use tables (closely related to what economists call input-output tables) from national statistical offices. These are very useful in tracing the way in which price and quantity changes are diffused through the economy. However, the level of aggregation in these tables can mean that important differences between activities in the same sector are not captured in the data.

- Moving away from taxes on capital, the modelling of consumer preferences that is allowed in the HMRC and HMT models (and many other CGE models) rules out any

[1] I would like to acknowledge the substantial contribution of Yongmin Park to the ideas presented in this paper.
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possibility of changes in relative consumer prices affecting labour supply. This means that policies such as the subsidisation of child care cannot be represented fully in the model.

These three issues are discussed more fully in the three following sections, while a conclusion summarises the main points.

2. The debt-equity choice

The HMRC model represented the choice between debt and equity by a constant elasticity of substitution (CES) function (HMRC, 2013, p. 18). This provides a convenient form for the purposes of solving the model using MPSGE software. However, there is no theoretical basis for this specification.[3] In contrast, the current HMT model does not explicitly include a debt-equity choice but implicitly takes account of the debt-equity ratios in each sector of the economy by the variation between different firms (by sector and size) in their effective tax rates on profits.

Of course, the differences in the effective tax rates can also reflect other differences, such as different tax rules, capital allowances and more exotic methods of reducing taxable profits. This means that it is not possible to deduce what the actual debt-equity ratios are from the differences in effective tax rates.

While this modelling approach allows for the debt-equity ratios to be different between different types of firms, it does not allow for changes in company tax rates to result in changes in companies' debt-equity ratios. This is a shortcoming because one would expect reductions in corporation tax (such as those seen recently in the UK) to have reduced the attractiveness of debt.

An alternative approach to the issue of debt-equity choice is provided in the *IfoMod* computable general equilibrium model described in Radelescu and Stimmelmayr (2007 and 2010). This provides a clear rationale for limiting the use of debt finance, in terms of the increased risk of bankruptcy that arises as the share of debt in total capital rises. That, in turn, increases the cost of financing the debt. The remainder of this section illustrates the way that the debt-equity choice can be influenced by changes in corporation tax, making use of a simplified version of the relevant elements of Radelescu and Stimmelmayr (2010).

Consider a company that wishes to have a capital stock worth K and wishes to minimise the cost of financing the capital stock. Let r be the (constant) required rate of return on equity capital but assume that the cost of debt increases with the share of the capital stock that is financed by debt, reflecting the fact that higher levels of debt (all else the same) increase the chances of the business becoming insolvent. Letting b represent the proportion of the capital stock financed from debt, the cost of servicing the debt can be written as a quadratic function: $i.K.b + m'.K.b + m''.K.b$, where m' and m'' are strictly positive.

[3] HMRC's CES function also has the disadvantage that the total value of capital is not generally equal to the sum of the two components (debt and equity).

The financing problem for the firm can then be written as maximising after tax profits minus the required rate of return on equity:

$$\text{Maximise } (1-t).[F(K) - i.K.b - m'.K.b - m''.K.b^2] - r.K.(1-b) \qquad (1)$$

where F(K) is the firm's value added and t is the corporate tax rate.

The first order condition for maximisation with respect to b is:

$$(1-t).[-i.K - m' - 2m''.b] + r.K = 0 \qquad (2)$$

This can be rewritten as:

$$r/(1-t) = i + m' + 2m''.b \qquad (3)$$

Or:

$$b = [r/(1-t) - i - m']/2m'' \qquad (4)$$

Equation (4) shows that (all else constant) an increase in the corporate tax rate will increase the share of capital financing that comes from debt. It also shows that an increase in the interest rate (all else constant) would reduce the share of capital financing from debt.

It is important to note that different sectors of the economy will face different degrees of risk and so will choose different debt-asset ratios. This implies that baseline data for the debt-asset ratio of each sector is required to implement this approach to modelling the choice of debt-equity ratios. It is also necessary to know the sensitivity of the optimal debt-asset ratio to changes in taxes and interest rates. Radelescu and Stimmelmayr (2010) quote Gordon and Lee (2001) as reporting the elasticity of the debt-asset ratio as 0.36.

3. The effects of transaction taxes on investment

The aspect of the HMRC CGE model that TARC was initially asked to analyse was how to include taxes on financial services,[4] such as financial transaction taxes and the proposed Financial Activities Tax (Keen et al., 2010).

One important example difficulty in analysing this issue was the level of aggregation in the data on the financial services industry. This industry provides a range of services to both individuals and businesses. In the case of services to businesses, there are at least two very different services. One provides the services required for day-to-day operation of the business: making payments to creditors and receiving payments from debtors. The other provides services related to financing investment, such as advice and activities related to securing investment funds that are most appropriate to the business. This is an important distinction because the charges for the day-to-day operations (including any taxes) will be a cost to the normal production activities of the business, and so can be reasonably assumed to be roughly proportional to the level of the business's output and to increase the price of that output. On the other hand, the costs of services related to financing investment (including any

[4] This section does not address the insurance part of financial services, the taxation of which is subject to particular rules.

taxes) will not be proportional to the business's day-to-day operations, but to its level of investment financing, which will act as a disincentive to investment.

As financial transaction taxes in the UK are related to asset transactions, they only involve the financing and purchase of assets and do not apply to the payment services element of financial services. This means that the base on which such taxes are levied will not be linked to the financial services industry as a whole, but to the part that is involved with investment activities. A realistic model of how these taxes affect the economy therefore requires the identification and measurement of that part of the financial services industry that is involved in investment. TARC was unable to find any data sources that allowed that identification and measurement to be made.

In addition to the data issue, there is a related modelling issue. A general financial activities tax would apply to both payment services and investment services, and so would increase the price of both areas. However, transaction taxes on assets would only increase the cost of investment activity. Any modelling of transaction taxes on assets should therefore recognise that they represent an additional cost of investment, rather than a cost on financial services as a whole.

The HMRC and HMT models do not recognise this distinction. It models the effect of all taxes (and other cost increases) as applying to the general output of the sector and does not recognise that these cost increases discourage investment: increasing the spread between the costs to the investor and the payment to the provider of funds.

If the data issue is solved, then it should be possible to model the investment disincentive effect.

4. The interactions between income and consumption taxes

One of the advantages of a complete CGE model with taxation is that it can take account of the interactions between different taxes. This is represented to some extent in the HMRC and HMT models. For example, an increase in income tax reduces the disposable income of households and so reduces the revenue from VAT and excise duties. It also allows increases in consumer prices to affect labour supply, by reducing the real wage.

However, there are potentially important interactions that are not reflected in the model because of the way that consumer demand is modelled by the linear expenditure system that is used in both models. This specification allows the proportion of consumer expenditure spent on the various goods and services to vary with income. However, it is not able to capture the effect that price changes of some items may have a greater effect on labour supply than others. The obvious example of this is child care, where reductions in the price of this service are generally recognised as having a particularly strong effect on the labour supply of parents.

In the light of this limitation, it could be interesting to use a more flexible representation of consumer choices, calibrated with empirical evidence, to analyse the interactions between the taxation of consumption and the tax revenue from income tax.

5. Conclusions

This brief note has outlined three ways in which greater realism can be incorporated into CGE models that are used to study tax policy options. Given the current interest in taxing businesses and financial transactions, the first two proposals may be more immediately relevant to government concerns but the role of consumer prices in influencing labour supply should not be ignored.

One important fact that the TARC analysis reveals is the extent to which the assumptions in the HMRC and HMT models are driven by the wish to use the MPSGE software. This software has a number of very attractive features that make it particularly easy to use. However, it does constrain the possible functional forms that can be used to describe the economic relationships in the model. Basically, most of the functions used in the modelling must be constant elasticity of substitution functions, and these are very restrictive.

Progress in making a more realistic model may require a shift to more flexible software. This may well make the model somewhat more difficult to use. However, the experience of *IfoMod* and other CGE models shows that it is practical to use more flexible models to analyse practical policy issues.

Finally, the quality of the data in the model is also very important. The point made in section 3 on the need to separate out different parts of the financial services industry is particularly important, but there may be other areas in which data can be adapted to provide more realistic modelling.

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