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The Transitory VAT Cut in the UK: A Dynamic General Equilibrium Analysis

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ABSTRACT

This paper studies the macroeconomic effects of the transitory Value Added Tax (VAT) cut in the UK using a dynamic general equilibrium approach. The temporary VAT cut policy was announced on 24 November 2008, and was due to come into effect on 1 December 2008, with VAT reverting to its previous level as from 1 January 2010. We quantify the effects of that temporary fiscal stimulus policy on the key aggregate variables of the UK economy and on tax revenues. Overall, we obtain that this policy is too temporary to have important quantitative effects on the economy but qualitative effects are of great interest. We show that the temporary VAT cut will generate an overshooting effect on key macroeconomic variables, and will provoke a significant reduction in investment. Consumption and output will increase during the VAT cut, but they will decrease below their steady state values after VAT reverts to the previous level. Our model economy also predicts that fiscal revenues will decrease about three per cent during the VAT cut. Finally, we find that the VAT cut policy would have provided better results if it had been announced earlier.

'There is no such thing as a good tax'
— Winston Churchill

1. INTRODUCTION

THIS PAPER USES A DYNAMIC GENERAL EQUILIBRIUM MODEL along the lines of Baxter and King (1993) to study the effects of the temporary VAT-cut stimulus policy in the UK. In particular, we seek to quantify the consequences of that policy for key macroeconomics variables and for tax revenues, taking into account all general equilibrium effects derived from the tax change. In this context, dynamic general equilibrium models can be a very useful tool for evaluating the macroeconomic consequences of economic policies such as the one we are interested in here.

The VAT cut policy in the UK was announced on 24 November 2008 and came into effect on 1 December, just six days after the announcement. Thus, we first consider it as an unanticipated tax shock. The VAT rate was reduced from 17.5 per cent to 15 per cent. Second, the reduction was announced for a period of 13 months implying that VAT was to revert to 17.5 per cent on 1 January 2010. Thus, we simulate this tax policy as an unanticipated transitory tax shock, with a known end. With these two ingredients in mind we conduct an exercise that simulates a transitory, and unanticipated VAT reduction using a general equilibrium model calibrated for the UK economy.

The recent temporary VAT-cut stimulus policy in the UK has been studied by a number of authors, such as Crossley *et al.* (2009), Barrell and Weale (2009) and Blundell (2009). However, they all use a partial equilibrium approach. Given a change in taxes, we can distinguish between two effects: the income effect and the (intertemporal) substitution effect. However Crossley *et al.* argue that in the case of a temporary change the former is likely to be small because the change in lifetime income would be minimal.[3] The second effect is likely to be of much more importance because the reduction in the price of goods (given a pass-through effect) provides an incentive to increase consumer spending. These authors point out that the relevant behavioural parameter is the elasticity of intertemporal substitution and that a value of one seems to be an appropriate elasticity value for the UK.

Crossley *et al.* (2009) estimate that, assuming that prices will fall by exactly the amount of the VAT cut (full pass-through), the proportional change in the relative prices of current consumption will be -1.2 per cent so that the level of consumption increases by 1.2 per cent. Blundell (2009) suggests that around 75 per cent (less than full pass-through) of the VAT reduction will be passed on to consumers, who will react to maintain roughly constant expenditure levels and therefore increase their demand for consumption goods.

As shown by Barrel and Weale (2009), evidence from the National Institute's Global Economic Model suggests that the temporary VAT cut will result in consumption increasing by less than one per cent by the fourth quarter of 2009 and that GDP is likely to rise by less than 0.5 per cent relative to what would have happened without the VAT cut. Moreover, after the temporary reduction is over, both consumption and GDP will be depressed as a result of the policy. On the other hand, Crossley *et al.* (2009) estimate that VAT revenues will fall by 13.4 per cent. Similarly, the Treasury estimates the cost of the temporary VAT cut at £12.4 billion, or equivalently 13.5 per cent of fiscal revenues.

However, since all previous studies use a static partial analysis approach, they fail to take into account intertemporal and general equilibrium effects. As pointed out by Barrell and Weale (2009), the key policy issue in this context is to quantify the impact of the temporary VAT cut on output, and to that end a model for the whole economy is needed. In this paper we develop such a model using the general equilibrium approach to simulate a temporary reduction in the VAT rate from 17.5 per cent to 15 per cent, which at this rate means a cut of 14.3 per cent for this particular VAT rate.

The approach used in this paper has several advantages as it allows us to take into account all general equilibrium effects and to estimate the effects of the fiscal change on the key macroeconomic variables studied here. Moreover, using a Dynamic General Equilibrium (DGE) model makes it possible to quantify the effects of the VAT cut not only on VAT revenues but also on total fiscal revenues. This is particularly important, as the slowdown in VAT revenues associated with the fiscal stimulus policy may be offset by a rise in revenues from other taxes. The results obtained from the model confirm this possibility.

We find that this policy is too temporary to have important quantitative effects on the economy, but its qualitative effects are of great importance. The temporary VAT cut will generate an overshooting effect on key macroeconomic variables with respect to their steady state values. Consumption and output will increase during the VAT cut, but will decrease below their steady state values once VAT reverts to its previous level. Investment will decrease during the VAT cut, but slightly increase above its steady state value when VAT reverts to its previous level. Finally, total fiscal revenues will decrease during the temporary VAT cut and return to their steady state values after the policy ends.

The rest of the paper is structured as follows. Section 2 describes the theoretical framework. Section 3 presents the data used and the calibration procedure. Section 4 shows the result of simulating a temporary VAT cut. Section 5 studies a counterfactual exercise to study the effects of an anticipated VAT cut. Finally, Section 6 presents some conclusions.

2. The model

We use a version of the models of Baxter and King (1993) and Conesa and Kehoe (2008) in which three taxes are considered: a consumption tax, a labour income tax and a capital income tax. It is assumed that there exists habit persistence in consumption. We consider a production function that relates output to two inputs: labour and private capital stocks.[3] The government taxes private consumption goods, capital income and labour income to finance an exogenous sequence of lump-sum transfers, $\{T_t\}_{t=0}^{\infty}$.

2.1. Households

Consider a model economy where the decisions made by consumers are represented by a representative consumer, whose preferences are represented by the following utility function:

$$U(C_t,\ N_t\overline{H}-L_t)=\gamma\log(C_t-\phi C_{t-1})+(1-\gamma)\log(N_t\overline{H}-L_t) \quad (1)$$

Private consumption in period t is denoted by C_t. C_{t-1} is consumption in the previous period and $\phi>0$ is a constant reflecting habit persistence. The utility function depends on a quasi-difference of consumption introducing non-separability of preferences over time. Given that we want to study the effects of change in the consumption tax, habit persistence may be a key element of the model.

Leisure is $N_t\overline{H}-L_t$, and is calculated as the number of effective hours in the week times the number of weeks in a year $\overline{H}$, times the population at the age of taking labour-leisure decisions, N_t, minus the aggregated number of hours worked in a year L_t. The parameter γ $(0<\gamma<1)$ is the proportion of total income represented by expenditure on consumption goods. The budget constraint faced by the representative consumer is:

$$(1+\tau_t^c)C_t+I_t=(1-\tau_t^l)W_tL_t+(1-\tau_t^k)R_tK_{t-1}+T_t \quad (2)$$

where T_t is lump-sum transfers received by consumers from the government, I_t is gross investment, K_t is capital stock, W_t are compensations to employees, R_t is rental rate, δ is the capital depreciation rate, modelled as tax-deductible, and τ_t^c, τ_t^l, τ_t^k, are a private consumption tax, a labour income tax, and a capital income tax, respectively.

Capital holdings evolve according to:

$$K_t=(1-\delta)\ K_{t-1}+I_t \quad (3)$$

where δ is the capital depreciation rate. Substituting the capital accumulation equation in expression (2) results:

$$(1+\tau_t^c)C_t+K_t-K_{t-1}=(1-\tau_t^l)W_tL_t+(1-\tau_t^k)\left[(R_t-\delta)K_{t-1}\right]+T_t \quad (4)$$

The budget constraint indicates that consumption and investment cannot exceed the sum of labour and capital rental incomes, net of taxes and lump sum transfers. The problem faced by the representative consumer is to maximise the value of his/her lifetime utility given by:

$$Max_{\{C_t,\ L_t\}_t^\infty}\sum_{t=0}^{\infty}\beta^t\left[\gamma\log(C_t-\phi C_{t-1})+(1-\gamma)\log(N_t\overline{H}-L_t)\right] \quad (5)$$

subject to the budget constraint (2), given τ_t^c, τ_t^l, τ_t^k, and given the endowment of private capital K_0. The consumer's discount factor is $\beta\in(0,\ 1)$.

2.2 Firms

The problem for the firm is to find optimal values for the utilisation of labour and capital, given prices. The representative firm is assumed to have a standard Cobb-Douglas production function. The production of final output, Y_t, requires labour services, L_t, and private capital, K_t. Goods and factor markets are assumed to be perfectly competitive. The firm rents capital and hires labour to maximise period profits, taking factor prices as given. The technology exhibits constant returns to scale on all factors and thus firms earn zero economic profit. The technology is given by:

$$Y_t = A_t K_{t-1}^{\alpha} L_t^{1-\alpha} \tag{6}$$

where A_t is a measure of total factor productivity, and α denotes the capital share of output.

The firm's decision problem can be defined as:

$$\max_{\{K_t, L_t\}} A_t K_{t-1}^{\alpha} L_t^{1-\alpha} - R_t K_{t-1} - W_t L_t \tag{7}$$

where R_t is the rental rate on private capital and W_t is the real wage.

2.3. Government

Finally, we consider the dual role of the government — as a tax-levying entity and as supplier of private goods through transfers, T_t. We assume that the government balances its budget period-by-period by returning revenues from distortionary taxes to agents via lump-sum transfers.

The government obtains resources from the economy by taxing consumption and income from labour and capital, the effective average taxes on which are τ_t^c, τ_t^l, τ_t^k, respectively. The government budget in each period is given by:

$$\tau_t^c C_t + \tau_t^l W_t L_t + \tau_t^k \left[(R_t - \delta) K_{t-1}\right] = T_t \tag{8}$$

Transfers to consumers are the counterpart of fiscal revenues. The assumption of a period balanced budget is made to highlight the distortionary effects of taxes, mainly on capital accumulation.[5]

2.4. Equilibrium

Our model has two production factors. Based on the firm's profit maximisation problem, the first-order conditions are:

$$R_t = \alpha A_t K_{t-1}^{\alpha-1} L_t^{1-\alpha} \tag{9}$$

$$W_t = (1-\alpha) A_t K_{t-1}^{\alpha} L_t^{-\alpha} \tag{10}$$

From the above equations we can obtain the following relationships that will be useful for our calibration:

$$R_t K_{t-1} = \alpha Y_t \tag{11}$$

$$W_t L_t = (1-\alpha) Y_t \tag{12}$$

Thus, the economy satisfies the following feasibility constraint:

$$C_t + I_t = R_t K_{t-1} + W_t L_t = Y_t \tag{13}$$

To compute the solution of the model, we assign the Lagrange multiplier λ_t to the budget constraint at date *t*. The first-order conditions for the consumer are:

$$\beta^t \left[\gamma \frac{1}{C_t - \phi C_{t-1}} - \lambda_t (1+\tau_t^c) \right] - \beta^{t+1} \left[\gamma\phi \frac{1}{C_{t+1} - \phi C_t} \right] = 0 \tag{14}$$

$$-(1-\gamma)\frac{1}{N_t \overline{H} - L_t} + \lambda_t (1-\tau_t^l) W_t = 0 \tag{15}$$

$$E_t \beta^t \lambda_{t+1} \left[(1-\tau_{t+1}^k) R_{t+1} + 1 - \delta \right] - \lambda_t \beta^{t-1} = 0 \tag{16}$$

where λ_τ, the Lagrange multiplier of the budget constraint at time *t,* is defined as:

$$\lambda_t = \frac{1}{(1+\tau_t^c)} \left[\gamma \frac{1}{C_t - \phi C_{t-1}} - \beta\gamma\phi \frac{1}{C_{t+1} - \phi C_t} \right] \tag{17}$$

Combining (14) and (15) we obtain the condition that equates the marginal disutility of additional hours of work with the marginal return on additional hours:

$$(1-\gamma)\frac{1}{N_t \overline{H} - L_t} = \frac{(1-\tau_t^l)}{(1+\tau_t^c)} \left[\gamma \frac{1}{C_t - \phi C_{t-1}} - \beta\gamma\phi \frac{1}{C_{t+1} - \phi C_t} \right] W_t \tag{18}$$

Equation (16) is an intertemporal Euler equation that equates the marginal cost of additional capital with the return on investment. Combining equation (14) with expression (16) yields:

$$\frac{(1+\tau_{t+1}^c)}{(1+\tau_t^c)} \frac{\left[\gamma \frac{1}{C_t - \phi C_{t-1}} - \beta\gamma\phi \frac{1}{C_{t+1} - \phi C_t} \right]}{\left[\gamma \frac{1}{C_{t+1} - \phi C_t} - \beta\gamma\phi \frac{1}{C_{t+2} - \phi C_{t+1}} \right]} = \beta \left[(1-\tau_{t+1}^k) R_{t+1} + 1 - \delta \right] \tag{19}$$

Note that the intertemporal equation for investment is not affected by the consumption tax if constant. Together with the first-order conditions of the firm, the budget constraint of the government (8), and the feasibility constraint of the economy (13), it characterises a competitive equilibrium for the economy.

Definition: A competitive equilibrium for this economy is a sequence of consumption, leisure, and private investment $\{C_t,\ N_t\overline{H}-L_t,\ I_t\}_{t=0}^{\infty}$ for the consumers, a sequence of capital and labour utilisation for the firm $\{K_t,\ L_t\}_{t=0}^{\infty}$, and a sequence of government transfers $\{T_t\}_{t=0}^{\infty}$, such that, given a sequence of prices, $\{W_t,\ R_t\}_{t=0}^{\infty}$, and taxes, $\{\tau_t^c,\ \tau_t^k,\ \tau_t^l\}_{t=0}^{\infty}$:

i. The optimisation problem of the consumer is satisfied.
ii. Given prices for capital and labour, the first-order conditions of the firm are satisfied with respect to capital and labour.
iii. Given a sequence of taxes, the sequence of transfers is such that the government constraint is satisfied.
iv. The feasibility constraint of the economy is satisfied.

Notice that according to the definition of equilibrium of our model economy, the government enters completely parameterised, and fiscal policy is drawn up consistently with the model and the data. In other words, in our model the private sector reacts optimally to policy changes, and those policy changes take place exogenously. This is of particular importance as we want to simulate an unanticipated temporary tax cut.

3. Data and calibration

Before simulating the temporary VAT cut in the model, values must be assigned to the parameters. The parameters of the model are:

$$(\alpha,\ \beta,\ \gamma,\ \delta,\ \phi,\ \tau_c,\ \tau_l,\ \tau_k)$$

In calibrating the model presented in the previous section we need three different sets of information: tax rates $(\tau_c,\ \tau_l,\ \tau_k)$ technological parameters, $(\alpha,\ \delta)$ and preference parameters, $(\beta,\ \gamma)$. Following Kydland and Prescott (1982), we set as many parameters as possible in advance based upon *a priori* information. First, to determine the value of the total disposable effective time endowment of individuals, $N_t\overline{H}$, that is, the non-sleeping hours of the working-age population, we assume that each adult has a time endowment of 96 hours per week $(\overline{H}=96)$. Data on the population aged from 15 to 64 and the average hours worked per year were obtained from the OECD Corporate Data Environment Database.

Tax rates $(\tau_c,\ \tau_l,\ \tau_k)$: Computational macroeconomic models of fiscal policy depend crucially on realistic measures of tax rates. Agents' decisions depend on marginal tax and therefore effective marginal taxes should be used in the calibration. However, marginal tax rates are hard to estimate and, as pointed out by Mendoza *et al.* (1994), it is often impractical to do so given the limitations of data availability and difficulties in dealing with the complexity of tax systems. Mendoza *et al.* proposed a method for estimating effective average tax rates and showed that they are within the range of marginal tax rates estimated in previous works and display very similar trends. On the other hand, these authors argue that their definition of effective average tax rates can be interpreted as an estimation of specific tax rates that a representative agent, in a general equilibrium context, takes into account.

Carey and Rabesona (2002) estimate OECD tax rates using a revision of the method proposed by Mendoza *et al.* (1994), though relaxing some assumptions. They find that for the period 1990-2000, for the UK, the consumption tax rate is 0.157, the labour income tax rate is 0.226 and the capital income tax rate is 0.340. For the same sample period, the estimates of Boscá *et al.* (2008) are fairly similar (0.136 for the consumption tax, 0.239 for the labour tax and 0.298 for the capital income tax).

We use effective average tax rates,[6] borrowed from Boscá *et al.* (2008), who used the methodology proposed by Mendoza *et al.* (1994) to estimate them. For the year 2004, the estimated values are a consumption tax rate of 0.124, a labour tax rate of 0.255 and a capital tax rate of 0.325.

As pointed out by Adam and Browne (2006) about 55 per cent of (gross) consumption is taxed at 17.5 per cent. This implies that about 51 per cent of (net) consumption is taxed and that the average tax rate is about 8.9 per cent. The VAT cut implies a reduction of -14.3 per cent in the 17.5 per cent VAT rate. However, other taxes on consumption remain unchanged. Therefore, for the simulation we consider a consumption tax rate of 0.124 and that the consumption tax rate cut is of -11.6 per cent.

Preference parameters $(\beta,\ \gamma,\ \phi)$: Preference parameters are calibrated as in Conesa and Kehoe (2008). First, the intertemporal discount factor is 0.99, as we simulate the model using quarterly data. This is the standard value used in the literature. Second, the parameter γ is obtained using first-order conditions from the model and data observations for 2008, taken from the OECD National Accounts Database. From the first-order conditions we can obtain the following value for γ as a function of data observations:

$$\gamma = \frac{C_t}{(\frac{1-\tau_t^l}{1+\tau_t^c})W_t(N_t\overline{H} - L_t) + C_t}$$

Finally, the habit persistence parameter is set at 0.7, the estimate reported in Boldrin *et al.* (2001) and similar to the value frequently used in the literature. Simulations have also been done for $\phi = 0$

Technological parameters (α, δ): Third, we use data from national income and product accounts to calibrate technological parameters. The capital income share, α, and the depreciation rate of private capital, δ, are taken from the EU-Klems database.[7] The selected values for the UK are and for a quarterly basis. The selected values for the UK are $\alpha = 0.295$ and $\delta = 0.025$ for a quarterly basis.

Table 1 summarises the calibrated parameter values for the UK economy to be used in the computations.

Table 1. Calibrated parameter values

Parameter	*Source*	*Value*
α	EU-Klems database	0.295
β	Arbitrary	0.990
γ	OECD database	0.443
δ	EU-Klems database	0.025
ϕ	Boldrin *et al.* (2001)	0-0.7
τ_c	Boscá *et al.* (2008)	0.124
τ_l	Boscá *et al.* (2008)	0.255
τ_k	Boscá *et al.* (2008)	0.325

4. The impact of the temporary VAT cut

Given the calibration of the model for the UK economy, we can quantify the effects of the temporary VAT cut on all the variables defined in the model: output, consumption, gross investment, labour, total tax revenues and tax revenues from each tax. We proceed as follows. First, the model is calibrated for the year 2008 to replicate the main macroeconomic aggregates of the UK economy. We consider this calibration as the steady state of the economy. Second, we calculate the implicit change in the consumption tax rate derived from the VAT cut policy. Finally, we use the calibrated model economy to simulate a transitory VAT cut for 2009, with the tax reverting to its previous level in the first quarter of 2010. Our simulation exercise considers that the VAT cut was not anticipated but that the time when the tax will return to its previous value is known by the agents and, accordingly used as information in their decision process.

A VAT reduction policy results in two effects: an income effect and a substitution effect. Income effects result from the fact that a VAT reduction is equivalent to a rise in disposable income. This effect is important in the case of a permanent VAT cut, and indeed is the only effect operating in the long-run. However, in the case of a temporary VAT cut, income effects are likely to be small given that changes in lifetime income will be minimal. However, as shown by Blundell (2009) and Barrell and Weale (2009), only in the case of myopic or credit-constrained consumers would, the income effects of a temporary VAT cut be important. Second, intertemporal substitution effects will operate only in the case of a transitory VAT change or an anticipated VAT change. In the case of a permanent, unanticipated VAT cut, intertemporal substitution effects do not apply as consumers re-optimise their consumption path at the new tax level.

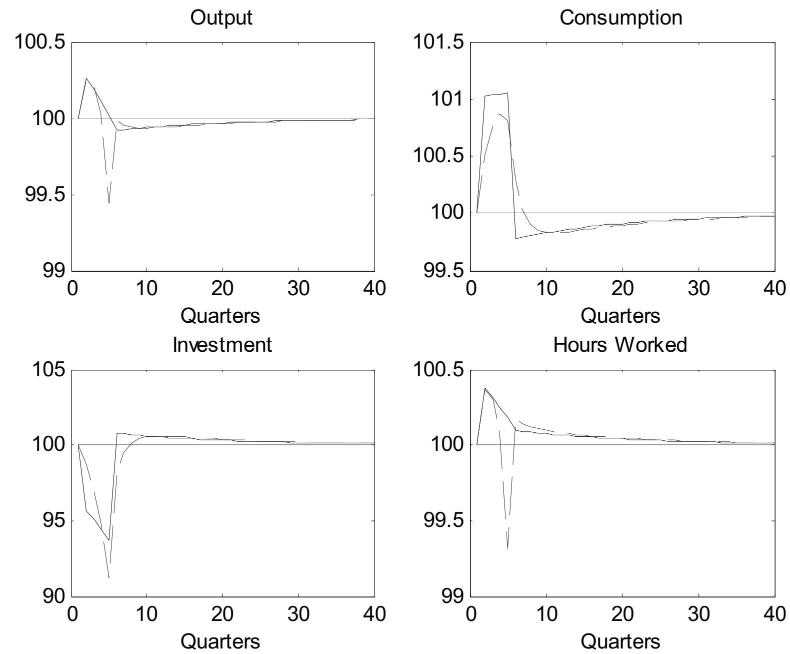
Barrell and Weale (2009) report that simulations from the National Institute's Global Economic Model suggest that the VAT cut will result in consumption increasing by less than one per cent by the fourth quarter of 2009 and GDP by less than 0.5 per cent, relative to what would have happened without the VAT cut.

Since the simulation is carried out using quarterly data, we simulate a VAT cut during four quarters as an approximation to the 13 months VAT-cut stimulus policy (December 1, 2008-December 31, 2009). We also consider a change in the consumption tax, which includes other indirect taxes as well as VAT. The VAT reduction to 15 per cent implies an effective reduction in the consumption tax of 11.6 per cent. Therefore, this implies that the consumption tax of 0.124 calibrated for the UK will be reduced for four quarters to 0.1096.

First, we conduct an exercise on the effect of a transitory VAT cut, replicating the policy applied in the UK. Table 2 summarises the main results. We use this exercise as a benchmark for the permanent VAT cut simulation. Figure 1 shows the effects of a transitory VAT cut where the substitution and arbitrage effects are the only relevant effects, as the transitory VAT cut does not affect lifetime income. Steady state values for each variable are normalised to 100. Impulse-response functions reflect percentage changes with respect to steady state values. We plot the impulse-response of the main variables with habit persistence and the standard model without habit persistence. The temporary VAT cut increases consumption, output and labour and decreases investment. In all cases except hours worked, we observe an overshooting effect after the end of the temporary VAT cut. Nevertheless, the effects on selected key macroeconomic variables are quantitatively small, except on consumption (a 1 per cent increase) and investment (a 4 per cent decrease) during the temporary VAT cut period.

The model predicts a rise in output of about 0.2 per cent in the first quarter, 0.13 per cent in the second quarter and 0.07 per cent in the third quarter. After VAT reverts to its previous level, the model predicts a persistent reduction in output. This implies that the temporary VAT cut gives rise to an undershoot in output.

Figure 1: Response to the temporary VAT cut: Main variables. Standard model (solid line), Habit persistence (dash line)



The tax cut policy was announced only six days before it came into effect (i.e., it was a surprise), so the possibility of agents changing their consumption path prior to the change was very limited. After the change, agents vary their consumption path, given that consumption during 2009 will be cheaper than in 2010. This explains the impulse-response of consumption, which increased by around one per cent in 2009, and the reduction in consumption after the tax reverts to its previous level. Gross investment shows a similar but inverted path. The reduction in investment is about 4 per cent. It is important to note that this large reduction in investment results in a reduction in the capital stock accumulation process. This is responsible for the predicted undershooting effect in output. When VAT reverts to its previous level the model predicts an instantaneous recovery of investment to its steady state value.

Table 2 compares the effect of the temporary VAT cut with a permanent VAT cut. We show the estimation under our model of a cut in the consumption tax on output (GDP), consumption (C), labour (L), Investment (I), and fiscal revenues (FR), as percentage changes from the level at the time of impact. We compute the percentage change of each variable in all four quarters of 2009, the first and fourth quarter of 2010, the fourth quarter of 2011 and the long-run. Obviously, the long-run effect of the transitory consumption tax cut is zero.

The differences between the simulations of the temporary VAT cut and a permanent VAT cut are due to the income effect. In the case of a temporary tax change the income effect is likely to be very small as changes in permanent income will be minimal, whereas in the case of a permanent tax change all consequences are due to the income effect. Only in the case of credit-constrained agents will income effects be significant under a transitory tax change.

Table 2. VAT cut policy

	Percentage change									
	Temporary VAT cut					*Permanent VAT cut*				
Period	*GDP*	*C*	*L*	*I*	*FR*	*GDP*	*C*	*L*	*I*	*FR*
2009Q1	0.19	1.04	0.27	-3.59	-3.09	0.70	0.49	1.00	1.67	-2.80
2009Q2	0.13	1.05	0.22	-3.92	-3.12	0.71	0.50	0.99	1.63	-2.79
2009Q3	0.07	1.05	0.18	-4.28	-3.16	0.73	0.52	0.98	1.59	-2.79
2009Q4	0.00	1.06	0.13	-4.67	-3.19	0.74	0.54	0.98	1.56	-2.79
2010Q1	-0.07	-0.17	0.07	0.39	-0.04	0.74	0.55	0.97	1.52	-2.78
2010Q4	-0.06	-0.14	0.06	0.33	-0.03	0.75	0.57	0.97	1.49	-2.78
2011Q4	-0.05	-0.14	0.05	0.27	-0.03	0.76	0.58	0.96	1.46	-2.77
Long-run	0.00	0.00	0.00	0.00	0.00	0.85	0.85	0.85	0.84	-2.73

As mentioned in the Introduction, Crossley et al. (2009) calculate an increase of 1.2 per cent in consumption. We obtain slightly lower measures of about 1.05 in 2009, and a much lower figure when the VAT tax cut is permanent, with an increase of 0.85 per cent in the long run, suggesting that, as in Blundell (2009), there is an incomplete pass-through of the tax. Our measure is therefore closer to that of Barrell and Weale (2009), who estimate an increase in consumption of less than one per cent by the fourth quarter of 2009. They also estimate an increase in output of less than a half of one per cent and we indeed find that output peaks on impact, reaching a mere 0.19 per cent. As predicted by these authors, output and consumption return to their previous level after overshooting to negative per cent changes. Barrell, Fic and Liadze (2009) report output multipliers for indirect tax cuts in a number of countries and demonstrate that they are generally below one.

Another relevant question is that related to the impact of the fiscal stimulus policy on tax revenues. An additional advantage of a general equilibrium model is that we can quantify the effects on all variables considered. This means that the model allows us to quantify not only the change in consumption tax revenues but also the change in the other two taxes revenues and in total taxes revenues. Obviously, a reduction in VAT will reduce VAT revenues. HM Treasury (2008) provides an estimation of a reduction of £12.4 billion (13.5 per cent of revenue) from the temporary VAT cut. Crossley *et al.* (2009) estimate that the revenue cost of the stimulus will be lower by 0.1 per cent, as they expect a slightly stronger expenditure response.

Figure 2: Response to the temporary VAT cut: Fiscal Revenues. Standard model (solid line), Habit persistence (dash line)

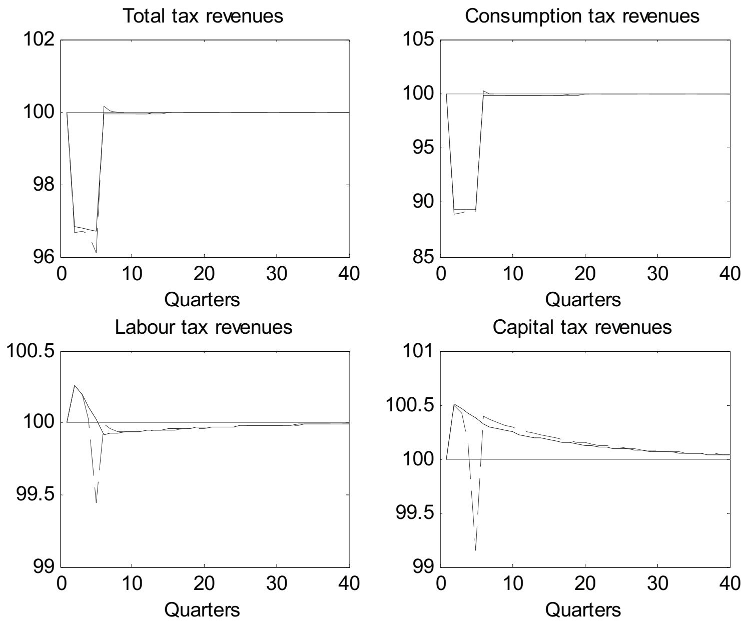


Figure 2 shows the total effect on fiscal income of a temporary VAT tax cut, and the breakdown of the total effect into the three types of taxes that we consider in our model economy. The measure provided for total fiscal revenues is a contraction of 3.19 per cent for the fourth quarter of 2009. The decomposition of this can be seen in Figure 2. The 10 per cent fall in VAT revenues predicted by our model, in line with 13.5 per cent estimates from HM Treasury and Crossley *et al.* (2009), is tempered by the stimulus in labour supply and the increase in the rental rate of capital. From this general equilibrium approach we can trace the sources of these changes: total labour fiscal income peaks on impact due to increased labour use, although it is lowered by the decrease in wages. The opposite occurs with investment: the real return on capital increases and this nominal increase dives the increase in fiscal capital income despite the reduction in total investment. Overall, the temporary consumption tax cut will decrease total fiscal revenues by around 3 per cent in the four quarters in which the cut is in place. However, given the overshooting effect of the economy, in the first quarter of 2010, fiscal revenues will be slightly below the steady state value.

As can be seen from Table 2, and unlike other estimates, we regard our results better in terms of fiscal revenue costs as a consequence of the behaviour of consumption in the short term dynamics, and the behaviour of total wages paid together with an increase in capital rents. The results indicate that under a permanent consumption tax cut of the same magnitude, total fiscal revenues would decrease by -2.80 per cent on impact and by -2.73 per cent in the long-run, while other variables such as GDP, consumption, investment and labour would respond proportionally.

5. The effects of an anticipated fiscal policy

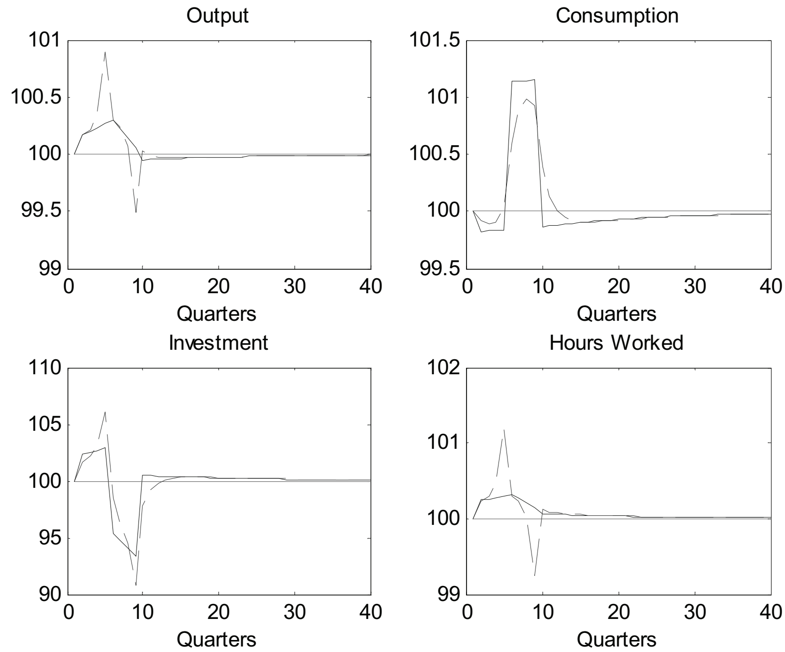
The short run dynamics of a policy consisting of a temporary change of the tax code vary depending on whether the policy comes as a surprise or anticipated, even if it is of the same magnitude. The model that we have presented can assess these differences. We next present the equivalent of Table 2, but assuming that the government had announced the policy one year in advance. In this case agents can change their consumption and investment paths in accordance with their information about future VAT rates.

Table 3. Anticipated temporary VAT cut

	Percentage change				
	Anticipated temporary VAT cut				
Period	*GDP*	*C*	*L*	*I*	*FR*
2009Q1	0.14	-0.15	0.20	1.40	0.07
2009Q2	0.15	-0.14	0.21	1.47	0.08
2009Q3	0.17	-0.14	0.22	1.56	0.09
2009Q4	0.19	-0.13	0.23	1.65	0.10
2010Q1	0.21	1.10	0.24	-3.73	-3.08
2010Q4	0.02	1.12	0.10	-4.80	-3.18
2011Q4	-0.04	-0.10	0.04	0.23	-0.02
Long-run	0.00	0.00	0.00	0.00	0.00

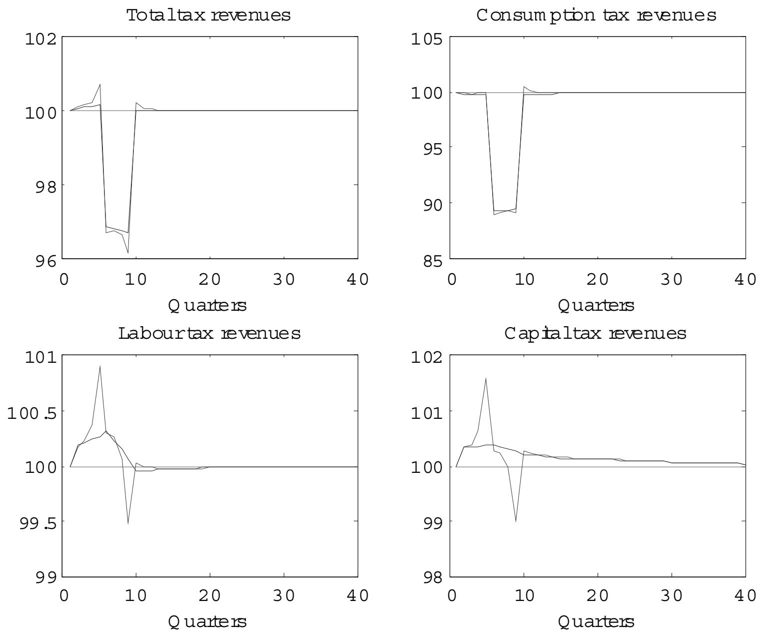
Table 3 shows that modelled rational agents make use of available information, improving the results of the policy when compared to the same unanticipated change in the fiscal tax code. Since in this exercise the decrease in the VAT rate is anticipated, consumers tend to reshape their consumption path, waiting for the fiscal advantages of postponing consumption over a year. After the shock, aggregate consumption increases more than it does if the shock is unanticipated. The negative effect on fiscal revenues is almost identical, but postponed over a year, allowing fiscal authorities to react to the change in the next fiscal year. The effects on output are similar, with the difference that the positive stimulus lasts longer and the overshoot is smoothed out. The impact of the announcement is positive on investment and also on consumption in the short run, while the contraction originated by the return to the previous fiscal tax code is slightly smoothed.

Figure 3: Anticipated response to the temporary VAT cut: Main variables. Standard model (solid line), Habit persistence (dash line)



These differences are shown clearly in Figure 3. The overshooting effects are smoothed over the first periods, leaving the positive aspects of the policy almost unchanged. The minimum level reached by GDP with the anticipated change is -0.04 per cent, whereas the minimum level with the unanticipated policy is -0.07 per cent, which implies that around three-quarters of the negative impact is smoothed by the announcement. The negative effect on consumption peaks at -0.17 per cent with the unanticipated change, compared with -0.15 per cent with the anticipated policy, meaning that 13.3 per cent of the negative effect is smoothed by the announcement. Investment peaks at 1.65 per cent with the announced policy, compared with 0.27 per cent under the non-anticipated policy. The negative effect is minimal when compared with the positive difference. It is not surprising that the main difference is found in investment, since in this type of forward-looking models investment is the smoothing variable. When the shock is anticipated, investors can react optimally to the decision made by the government, and as a consequence the announced policy provides better results.

Figure 4: Anticipated response to the temporary VAT cut: Tax revenues. Standard model (solid line), Habit persistence (dash line)



The same quantitative results can be derived from the impact on fiscal revenues of the announcement of the policy. Figure 4 shows this. Fiscal revenues peak at 0.1 per cent by the end of 2009, while they are negative in all periods with the unanticipated policy. The minimum change with respect to the base year is -3.18 per cent by the end of 2010 with the anticipated policy, while the minimum level attained with the unanticipated policy is -3.19 per cent, just 0.31 per cent more. Overall, it is clear that anticipating this kind of policy is a better option for the economy.

6. Summary

This paper provides a quantitative measure of the effects on the temporary VAT cut policy in the UK using a canonical Dynamic General Equilibrium model. We provide a comparison with other results and with a rationale for the differences found. We find that in the long run the general equilibrium approach provides similar results to those obtained from a linear model where all variables react proportionally to exogenous change in policy, but the results are different when the short run dynamics are analysed.

We find that the temporary VAT cut policy will generate an overshooting effect on consumption, output and investment. Consumption and output will increase during the VAT cut, but will decrease below their steady state values after the VAT rate reverts to its previous level. In contrast, investment will decrease during the VAT cut, but increase slightly above its steady state value after the end of the temporary fiscal stimulus policy.

The dynamic approach also allows us to perform a different kind of analysis once the model has been validated by estimates made by other authors following different approaches, to measure the policy implications of the fiscal change, namely to compare anticipated and unanticipated policies. The results show that providing economic agents with enough information to enable them to smooth their behaviour, yields better results for the economy.

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ENDNOTES

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2. Crossley *et al* (2009) argue that consumers expect the temporary VAT cut today to be offset by higher taxes in the future (i.e. Ricardian equivalence holds), and therefore the present value of wealth is unchanged.

3. An alternative specification, following Guo and Lansing (1997) and Cassou and Lansing (1998), would include public capital. We have disregarded such a production function because the consideration of public capital stocks does not substantially change our results, given the level of aggregation of the model.

4. Government consumption is not considered in our model in order to keep things as simple as possible. Nevertheless, the same analysis has been repeated using a model in which government consumption is included, and the results do not change significantly (these results are available from the authors upon request).

5. This assumption has been used by Barro (1990), Glomm and Ravikumar (1994), and Cassou and Lansing (1998), among others. They argue that this setup may represent a closer approximation to actual constraints than one which allows the government to borrow or lend large amounts.

6. The use of average effective tax rates involves the use of conservative values (smaller implied behavioural responses).

7. www.euklems.net.

References

Adam S and Browne J (2006) 'A survey of the UK tax system', *IFS Briefing Note no. 9*, Institute for Fiscal Studies.

Barro R (1990) 'Government spending in a simple model of endogenous growth', *Journal of Political Economy*, 98, 103-125.

Barrell R, Fic T and Liadze I (2009) 'Fiscal policy effectiveness in the banking crisis', *National Institute Economic Review*, 207, 43-50.

Barrell R and Weale M (2009) 'The economics of a reduction in VAT', *Fiscal Studies*, 30, 17-30.

Baxter M and King R (1993) 'Fiscal policy in general equilibrium', *American Economic Review*, 83, 315-334.

Boldrin M, Christiano L and Fisher J (2001) 'Habit persistence, asset returns and the business cycle', *American Economic Review*, 91, 149-166.

Boscá J, García J and Taguas D (2008) 'Taxation in the OECD: 1965-2004', Documento de Trabajo Ministerio de Economía y Hacienda, Gobierno de España.

Blundell R (2009) 'Assessing the temporary VAT cut policy in the UK', *Fiscal Studies*, 30, 31-38.

Carey D and Rabesona J (2002) 'Tax Ratios on Labour and Capital Income and on Consumption', *OECD Economic Studies*, no. 35.

Cassou S and Lansing K (1998) 'Optimal fiscal policy, public capital, and the productivity slowdown', *Journal of Economic Dynamics and Control*, 22, 911-935.

Conesa J C and Kehoe T (2008) 'Productivity, Taxes and Hours Worked in Spain: 1970-2005', Working Paper.

Crossley T F, Low H and Wakefield M (2009) 'The economics of a temporary VAT cut', *Fiscal Studies*, 30, 3-16.

Glomm G and Ravikumar B (1994) 'Public investment in infrastructure in a simple growth model', *Journal of Economic Dynamics and Control*, 18, 1173-1187.

Guo J and Lansing K (1997) 'Tax structure and welfare in a model of optimal fiscal policy', Federal Reserve Bank of Cleveland, Economic Review, Q1, 11-23.

HM Treasury (2008) *Pre-Budget Report November 2008: Facing Global Challenges: Supporting People Through Difficult Times.*

Kydland F and Prescott E (1982) 'Time to build and aggregate fluctuations', *Econometrica*, 50, 1345-1370.

Mendoza E, Razin A and Tesar L (1994) 'Effective tax rates in macroeconomics. Cross-country estimated of tax rates on factor incomes and consumption', *Journal of Monetary Economics*, 34, 297-323.