# Online Appendix
## to
## Discretionary Tax Changes and the Macroeconomy: New Narrative Evidence from the United Kingdom

*By* James Cloyne\*

## I. Data construction: specific details

This section contains the most important specific details of the data construction. For a complete discussion see the full narrative paper Cloyne (2012).

### A. The sample period

The first Budget I consider is October 1945. UK GDP is not available quarterly prior to 1955 so the results in the paper are for the sample post-1955.

The final Budget I consider is April 2009. The December 2009 Pre-Budget Report (PBR) contained measures to be implemented in the 2010 Finance Bill but, with a General Election scheduled for the first half of 2010, it was unclear at the time of analysis which measures would actually become law. I do, however, use macroeconomic data up to and including 2009Q4; being in December, PBR measures would have been dated 2010Q1 at the earliest (because most measures were to be implemented in 2010 and because of the timing conventions discussed in the main paper).

The lack of quarterly National Accounts data pre-1955 also affects the construction of the tax shock. In the text I noted that I divide the revenue projections by nominal GDP. Annual GDP is available from 1948 to 1955 and for these years I use the annual figure for the four quarters within that year. This allows me to construct a tax series back to 1948. Below I will use the full sample with an industrial production measure available from 1948.

### B. The revenue estimates

As noted in the main paper, I make use of the estimated 'full year' revenue cost or yield of the change. In earlier Budgets this 'full year' figure is clearly labeled.

In more recent years estimates are given for several years ahead rather than as a single 'full year' estimate. However, the figures for the later years are usually, if not the same, then very similar (i.e. from the first year onwards). It is therefore clear that these estimates correspond to the 'full year' concept and where this was not the case it is signposted in the Budget documents. I generally use the last year given in the Budget table to exclude the possibility that changes are to do with the timing of revenue collection. However, I check each measure individually to ensure the estimate I use reflects the 'full year' concept.

### C. Social Security Contributions

Changes in Social Security contributions (National Insurance contributions or NICs) are considered when they are part of the Budget process. In the earlier part of the sample, changes to NICs were announced separately and closely followed changes in welfare transfers; this reflected the original 'Contributory Principle' behind National Insurance. I am therefore confident that these extra-Budgetary changes were spending-driven and not 'exogenous' (in the sense discussed in the main paper). In later years NICs became more like a tax (both in structure and use) and were brought into the Budget process. When included in the Budget process I make use of these changes.

The 'spending-driven' endogenous series will not, therefore, capture spending-driven National Insurance changes in the first half of the sample. As the main paper only uses the exogenous series, this assumption is unproblematic.

### D. Retroactive tax changes

There are a minority of changes which have retroactive elements (about 120 of the 2500). I follow Romer and Romer (2010) (RR) in dealing with this issue. A tax change with a retroactive implementation date has two components, the future effect on revenues going forward (the non-retroactive element) and the outstanding liabilities for the period before the announcement.

As in RR, the baseline dataset simply excludes the retroactive elements and I assign the 'full year' revenue estimate to the announcement date. There are several reasons for using the announcement date. Firstly, many changes are passed by Budget Resolution and are implemented on Budget day (see figure (9) below). Secondly, few taxes are altered in debate and so this Budget announcement is often presented as the implementation (unless of course a later date is given). When an implementation date is in the past, the day the change becomes known seems the most appropriate 'implementation' for the non-retroactive element. See Cloyne (2012) for how this compares with RR.

As a robustness check I derive a series which assigns the accumulated retroactive liabilities as a levy to the same date, removing this the following quarter. The effects are very similar to the baseline results. The impact multiplier is 0.5 ($p = 0.07$) and the maximum effect is 2.3 ($p = 0.002$). Given the complications of

adding retroactive components in this way, the purpose is really to check that the broad result is not distorted, which it is not.

### E.   The alternative classification method

Budgets tended to have an overall motivation as well as providing specific justification for each measure. In the companion paper, Cloyne (2012), I individually classify all the discretionary policy changes and provide evidence for the categorization.

However, there is an important grey area that requires discussion. In a few cases the overall motivation appears in direct conflict with the specific objective for individual measures. Consider a simple example. In 1968 all but two changes were stated to limit demand (tax increases) but the other changes were designed to help the elderly (a tax cut) and deliver on a long-run social objective. In one sense the latter is exogenous but, if the Chancellor had a target for lowering demand in mind, then this cut had to be offset elsewhere. Furthermore, the measures often have different implementation dates and do not offset each other in the aggregate. Two actions may therefore be correlated if a seemingly exogenous action precipitates a larger endogenous one. It is usually very unclear the extent to which the Chancellor intended for some measures to offset others. In these more complicated cases I provide an alternative classification taking the whole Budget package together. In the 1968 example I classify all measures, including an ideological tax cut, as demand management.

I use this 'alternative' series as a robustness check. Again GDP increases 0.4 percent on impact, rising to 2.2 percent after 10 quarters.

### F.   Packages of measures

Another complication is how to treat packages of measures or actions designed to offset other actions. For example, between 1979 and 1997 there were considerable changes in the balance between income tax and Value Added Tax (VAT). It was argued that the VAT rise was funding an income tax cut and the income tax cut was designed to stimulate long-term growth. Rather than categorize the income tax cut as 'long-run' and the VAT rise as, for example, 'deficit reduction', it seems wise to categorize the package as 'long-run', even if a VAT rise on its own might harm the economy.

### G.   Temporary tax changes

Some tax changes were specifically legislated to be temporary. This is in contrast with the majority of changes which were legislated without assuming they would be repealed (what I call permanent changes). For a temporary change the appropriate revenue estimate is not the 'full year' cost but rather the value which most closely reflects the total yield or cost of the action. This is usually clear and I assign this figure to the implementation date, reversing it on the end date.

An alternative approach would be to treat temporary and permanent changes separately (i.e. not in the same dataset). There are only around 100 temporary changes, many of which are quite small. To check my main results are not driven by the inclusion of both types of tax change, I re-estimate the results using only permanent tax changes. Figure (1) shows that the main results of the paper are unaffected. The impact effect is 0.58 ($p = 0.023$) and the peak is 2.45 ($p = 0.001$).
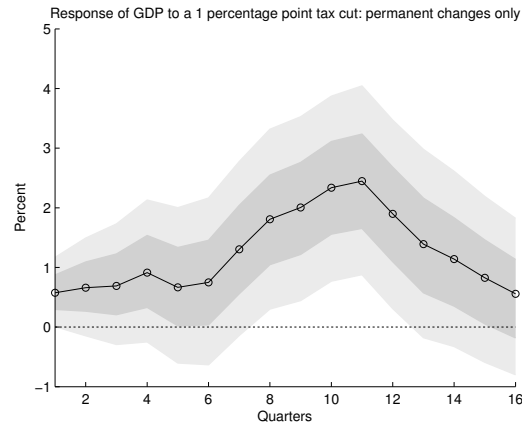


FIGURE 1. RESPONSE OF GDP TO A 1 PERCENT TAX CUT: PERMANENT TAX CHANGES

## H.   Excluded actions

A few policy actions are not included in the dataset. These include personal income tax credits (the Treasury and the Institute for Fiscal Studies regard these as spending; they have to be claimed and are closer to a definition of welfare transfers) and statutory or pre-expected indexation of duties, allowances and thresholds (for example uprating of the personal allowance each year with inflation or simple inflation increases in excise duties). Inflation increases in certain taxes are recorded by the Treasury as zero-revenue changes against the indexed base and also contain no new discretionary policy information so are excluded. RR do the same, arguing that these types of changes are basically an automatic uprating, containing no new policy information. For further detail and justification again see Cloyne (2012).

## 1. Budget 19th March 1968

*Chancellor:* Roy Jenkins; *Prime Minister:* Harold Wilson (Labour)

**Context**
The economy grew strongly through the first half of 1967. However, as the year progressed GDP growth was slowing down.[2] Export growth, by contrast, had either been low or negative through 1967. In May the Government announced Britain's intention to join the EEC. Suspicion arose that joining may be accompanied by devaluation. The Six Day War in the Middle East, an oil embargo and the closure of the Suez Canal occurred in June. Interest rate relaxations were also reducing the incentive to hold sterling. By the end of the year the balance of payments was showing a significant deficit. Cairncross (1992) notes that at some stage in 1960, almost regardless of government policy, devaluation was perhaps inevitable, the UK's competitive power had simply failed to keep up in the post-war period.[3] Devaluation occurred on 18th November 1967 and Callaghan [the previous Chancellor] resigned on the 29th. A deflationary package of measures accompanied the devaluation (dealt with below). In January the new Chancellor Roy Jenkins announced large expenditure cuts of £500 million (1.1 per cent of GDP) in 1968-9 – reversing the trend of growth in public expenditure.[4] Still, in the first quarter of 1968 real household consumption was 7 per cent higher than it had been in the first quarter of 1967.[5] Speculative pressure on sterling was to continue all the way to March 1968.

**Overall Budget Objectives and Motivation**
The Chancellor set straight to work in the Budget speech: "this Budget is concerned with the structural changes in the pattern of economic demand and activity that are required to enable us to take full advantage of devaluation and establish a substantial and continuing balance of payments surplus… These measures are in themselves severe".[6] On the external position the Chancellor was frank "we are still in a position of great difficulty", although mediated by "but also of great opportunity".[7] In his budget judgement, Jenkins explained "we must check the growth of public expenditure and private consumption, which were the main expansionary forces last year, and release the resources necessary to sustain as large an increase in exports and industrial investment as possible".[8] Succinctly, "the vital thing this year and next is to put the balance of payments into substantial surplus. This can only be done by sacrificing the normal claims of home demand on our resources."[9] Jenkins decided he needed to raise a "very large sum of additional taxation".[10] In total this amounted to £923 million (2.1 per cent of GDP) in a full year and was in addition to significant cuts in expenditure and a tough incomes policy. Blackaby (1978) described this as "perhaps the most formidable deflationary budget since the war". All but two of the tax measures in the 1968 Budget were a tax rise and there can be no doubt that all of these were *endogenous, demand management*.

**Pre-Budget Measures**
First I deal with the deflationary measures which accompanied the devaluation on 18th November 1967. These were an increase in the Bank Rate, a limit on bank advances, increase in hire purchase deposits on cars, an increase in Corporation Tax to 42.5 per cent (although this was justified in the 1968 Budget speech and FSBR), abolition of the export rebate and withdrawal of some of the Selective Employment Tax (S.E.T.) rebates. As these measures accompany the devaluation I classify them as *endogenous, demand management*. The removal of the export rebate and the changes to the S.E.T. appear in the data series.

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[1] Part of the longer companion paper, Cloyne (2012), available at http://ideas.repec.org/e/pcl85.html
[2] ONS (2010)
[3] Cairncross (1992), p.164
[4] Ibid.
[5] ONS (2010)
[6] HC Deb 19 March 1968 vol 761 c253
[7] HC Deb 19 March 1968 vol 761 c258
[8] HC Deb 19 March 1968 vol 761 c259
[9] HC Deb 19 March 1968 vol 761 c261
[10] HC Deb 19 March 1968 vol 761 c273

**1968 Budget Tax Measures**

All the tax rises follow the Chancellor's statement about the need to raise a considerable sum of money. Income tax allowances were reduced from 6th April 1968. From 6th April 1969, a child's investment income was to be considered together with the parent(s). There were very heavy increases in consumption taxes having concluded "that I ought to look for obtaining the bulk of my additional revenue from indirect taxation, but that it should be levied in as selective and non-regressive a way as possible".[11] Purchase Tax went up from 20th March 1968; duties on spirits and wine also went up on the same day. Hydrocarbon duties rose from 19th March 1968. Betting and gaming duties rose from 25th March 1968 and motor vehicle duties from 20th March 1968. In all, these duty increases raised £440 million in a full year (1 per cent of GDP).

On the business tax front, as announced in November 1967, Corporation Tax rose to 42.5 per cent – raising nearly £100 million. This was applied retrospectively, as was typical, from 1st April 1967. There was also a significant rise in the Selective Employment Tax on 2nd September 1968, although accompanying rebates also rose leaving the net revenue increase at just over £150 million in a full year.

A significant amount of revenue was raised from the one year 'special charge': "it is right, in the context of this uniquely rigorous Budget, to propose a special charge to be calculated and expressed as a charge upon investment income".[12] This was implemented on 6th April 1967 retrospectively and for one year only, raising £100 million (0.2 per cent of GDP). But there were also a number of other capital and capital income tax measures, together raising £13 million in a full year and implemented on a variety of dates.

Based on the overall objectives of the Budget I classify all these tax increases as *endogenous, demand management.*

There were two concessions. On income tax the age exemption limit was increased "I believe that when what I hope will be a relatively short-term stringency has to be applied the elderly are entitled to some special consideration".[13] Second, having ruled out an increase in Capital Gains Tax, the Chancellor announced "certain limited changes in the incidence of the tax which I propose. In making these proposals I have particularly in mind the need to simplify the tax wherever possible".[14] On face value these final two measures I classify as *exogenous* – the first as *ideological*, the second as *long run*. These remissions were very small compared with the increases. However, to ensure these were not sums needing to be offset by the increases, I assign an alternative justification of *endogenous, demand management.*


## 2. Budget 19th March 1985

*Chancellor:* Nigel Lawson; *Prime Minister:* Margaret Thatcher (Conservative)

**Context**

The Chancellor faced a familiar environment in 1985: 1984 had been another year of decent growth at 2.7 per cent. This was 1 percentage point slower than the previous year but may well have been affected by the miners' strikes. Inflation was edging up, but still comparatively low at 5 per cent in 1984. Unemployment was again around 100,000 higher than the previous March. Britton (1991) noted that the PSBR presented a problem but was disguised by increased revenue from various privatisations - a key ideological objective of the Government.[15]

**Overall Objectives and Motivation**

From the outset unemployment was acknowledged as a problem: "my Budget today has two themes: to continue the drive against inflation and to help create the conditions for more jobs".[16] However, a demand stimulus was not the answer. The Government published an employment White Paper in March as well – unemployment was viewed as a microeconomic problem: "boosting demand without the necessary

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[11] HC Deb 19 March 1968 vol 761 c277
[12] HC Deb 19 March 1968 vol 761 c299
[13] HC Deb 19 March 1968 vol 761 c295
[14] HC Deb 19 March 1968 vol 761 c298
[15] Britton (1991), page 71
[16] HC Deb 19 March 1985 vol 75 c783

improvements to the performance of the economy would only generate higher inflation".[17] In short, "The Government's economic strategy has two key components: a monetary policy designed to bring down inflation and a supply-side policy designed to improve the competitive performance of the economy".[18] The higher PSBR was justified by the cost of the coal strike but this year Lawson planned to keep to his previous plans; there were to be no giveaways "for the coming year, a substantial reduction in the PSBR must take precedence over our objectives for reducing the burden of tax".[19] However, the Chancellor argued "this Budget carries forward the theme of tax reform I set out last year… reform designed to improve our economic performance over the longer term, on which the jobs of the future will depend"[20] and almost all the tax changes were, in the end, *exogenous long run* changes.

**Major Budget Tax Measures**

The Chancellor continued the switch from personal income tax to indirect consumption taxes: "My Budget last year shifted some of the burden of personal taxation from earnings to spending. Today I propose to make a further move in this direction".[21] As a consequence, the Chancellor sought the revenue required from excise duties. Alcohol, fuel, tobacco and vehicle excise duties all rose on the 19th March 1985. In choosing which taxes to cut, the Chancellor argued "this year, a Budget for jobs and for enterprise has to give high priority to raising the tax thresholds".[22] The main, additional and age allowances all increased by more than indexation. There were indexation increases in the basic rate limit and the further higher rate thresholds. All these changes took place from 6th March 1985. Based on the comments here, those above and those from the previous year I classify this package of measures as *exogenous, long run*.

There were also a number of changes to VAT which, the Chancellor explained, (combined with the excise duty increases) "will help me to lighten the burden of income tax".[23] VAT was extended to magazines and newspapers from 1st May 1985; changes to VAT on credit cards and similar payment cards also raised revenue from 1st May 1985; and "I propose to include in this year's Finance Bill legislation to implement most of the recommendations of the first two volumes of the Keith report on the enforcement powers of the revenue departments, including measures to deal with the problem of the late payment of VAT".[24] I classify these changes together with the excise duties as *exogenous, long run*.

There were also reforms to Capital Gains Tax. The Chancellor explained "I have a number of other important proposals for tax reform to announce today, which will both simplify the system and encourage enterprise".[25] These took the form of changes to indexation relief from 6th March 1985. In terms of revenue there were more minor remissions; however, they followed a change, announced on 28th February 1985, that prevented the converting of income into less heavily taxed capital gains. As reforms to Capital Gains Tax, I classify these changes as *exogenous, long run*.

Finally the Chancellor announced significant cuts and reform of National Insurance: "I want to do more to improve job prospects for young people and the unskilled, among whom the problem of unemployment is most severe…I have concluded that an effective response to this problem must include direct action in two related areas — to cut the costs of employing the young and unskilled, and to sharpen their own incentive to work at wages which employers can afford to pay… They tackle the problem of unemployment where it is most acute".[26] I classify this measure as *endogenous* (related to current unemployment levels), *supply stimulus*.

These changes account for 95 per cent of the increases and nearly 90 per cent of the remissions.

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[17] Britton (1991), page 73. A point reiterated in the 1985 Budget speech (c785)
[18] HC Deb 19 March 1985 vol 75 c784
[19] HC Deb 19 March 1985 vol 75 c786
[20] HC Deb 19 March 1985 vol 75 c790
[21] HC Deb 19 March 1985 vol 75 c795
[22] HC Deb 19 March 1985 vol 75 c797
[23] Ibid.
[24] HC Deb 19 March 1985 vol 75 c798
[25] HC Deb 19 March 1985 vol 75 c791
[26] HC Deb 19 March 1985 vol 75 cc798-800

## II.   The aggregate dataset: further discussion

### A.   Relationship to movements in aggregate revenues

Whilst my series is not based on *actual* realized revenues[1] we would hope for a close relationship between the narrative-implied change in tax revenue to GDP and what actually occurred.

Summing all my tax changes implies that tax revenue as a share of GDP would have been 4 percentage points lower in 2009 than in 1948. By contrast, figures based on the UK Office for National Statistics *Public Sector Finances* imply that total receipts from taxes and National Insurance contributions (NICs) rose from around 32 percent of GDP in 1948 to 33 percent by 2009.[2]

This difference can largely be explained by my treatment of NICs. As noted above, these are implicitly treated as spending-driven for the period before NIC decisions became part of the Budget process. One of the first National Insurance interventions using the main Budget process was the National Insurance Surcharge. This took effect from 1977. From 1977 to 2009 tax receipts (including NICs) as a share of GDP rose by 2.2 percentage points. Summing my narrative series over the same period implies a change of 2.3 percentage points, a comparable figure.

Considering the pre-1977 period, the narrative measure implies a drop of 6.3 percentage points in revenues to GDP. The fall in the share of total tax and NICs to GDP in the aggregate statistics is much smaller . However, examining the tax receipts data *excluding* National Insurance contributions shows a fall of 5.8 percent between 1948 and 1977. Given that my earlier sample does not include NICs, the narrative data do mirror the changes in actual tax receipts to GDP.

### B.   The Guajardo, Leigh and Pescatori (2011) dataset

As briefly discussed in the main paper, Guajardo, Leigh and Pescatori (2011) construct a series of tax and spending changes from historical sources for a range of OECD countries, including the UK. Their and my datasets, while based on some of the same sources, are quite different. Below I cover the six main differences.

First, Guajardo, Leigh and Pescatori (2011) follow Romer and Romer (2010), who argue that the deficit changes identified in the US are exogenous because they are the product of past shocks. While the exogeneity of this category can be debated for the US (see, for example, results in Mertens and Ravn (2012)), there are clear examples in the UK where deficit driven changes are endogenous. For example, the early 1980s fiscal consolidation was a response to the rising deficit caused by the current recession. There are similar measures in the early 1990s Budgets.  The Guajardo, Leigh and Pescatori (2011) dataset therefore covers

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[1]There may also be other reasons why the measures diverge, such as my treatment of tax credits and statutory indexation.

[2]This series is a combination of ONS codes: NMBY, NMCU, LIQR and AIIH (NICs).

deficit actions in both my exogenous and endogenous deficit categories. I only make use of the exogenous series.

Second, the overlap between my full dataset and theirs is quite small. The deficit-driven changes only account for around 300 of the 2500 tax changes I identify. This makes my tax series more extensive, covering a wide variety of tax changes.

Third, I directly apply the RR method by individually classifying all the measures to specifically construct an exogenous series.

Fourth, I use the 'full year' estimates of the tax changes to reflect the on-going full year cost or yield of the change. This follows RR who use projected revenues in the first full year of implementation. Guajardo, Leigh and Pescatori (2011) use the current year estimates — which may not reflect the on-going annual cost. I also have a list of the individual implementation dates and I make use of these directly, constructing the dataset from the bottom up. Guajardo, Leigh and Pescatori (2011) take the aggregate current year estimates and assign the changes proportionally to the present and following calendar year (as fiscal years span both).

Fifth, I exclude measures that automatically uprate tax thresholds and allowances with inflation, whereas the revenue effects of these changes are included in the Guajardo, Leigh and Pescatori (2011) dataset.

Sixth, my tax series is quarterly and goes back to 1945. The Guajardo, Leigh and Pescatori (2011) data are annual and begin with the 1979 Budget.

These differences aside, both datasets broadly pick up the same periods of *fiscal consolidation* — the early 1980s Budgets, the early to mid-1990s Budgets and the 1997 Labour Government's adherence to the previous Government's strict fiscal plans for two years — although the exact numbers in the datasets differ.

## III. Taxes in the UK

Consistent revenues data for different types of taxes are unavailable over a longer period in the UK. This issue aside, figure (2) plots the shares in overall receipts of different tax types between 1978 and 2008. This is to illustrate the form of the UK tax system and how it has changed over the last few decades. This dataset is freely available from the Institute for Fiscal Studies (http://www.ifs.org.uk/fiscalFacts/taxTables, under 'Composition of Revenue').

Income tax, social security contributions (NICs) and Value Added Tax (VAT) raise a sizable sum of central government revenue. Income tax has several bands although the number and the rates have been brought down over the period. In 2012 there are currently three bands: a 20 percent rate, a 40 percent higher rate and a 50 percent top rate. By contrast, in 1978 there were 11 bands, with the top rate at 83 percent. VAT has been increased over the decades from a relatively low level of 8 percent in 1979 to 20 percent in 2012.

Corporation taxes (the chart category also includes Petroleum Revenue taxes) have been cut over recent decades with the main rate falling from 52 percent in
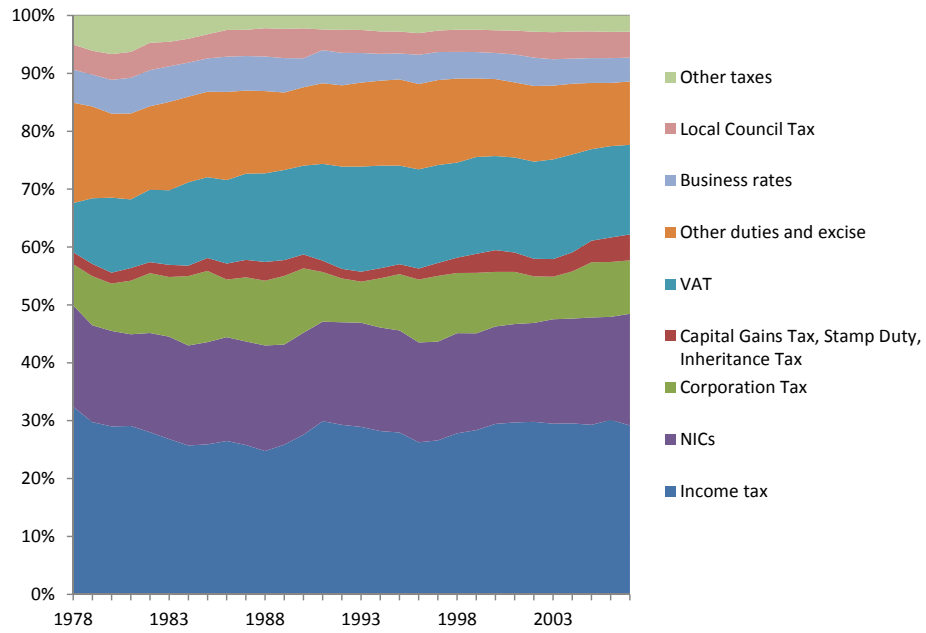
FIGURE 2. SHARE OF DIFFERENT TAXES IN TOTAL RECEIPTS

1979 to 26 percent in 2011. There have also been various reforms to the capital taxes over the years.

The 'other duties and excise' category contains taxes on alcohol, fuel, tobacco, gambling and so forth. Figure (2) also shows that the contribution from local Council Tax is small — highlighting the point made in the main paper that the UK tax system is very centralized.

## IV. Macroeconomic data

Specific definitions of the other macroeconomic data used in the main paper can be found in table (1). Per capita variables are the real chained volume measures, seasonally adjusted, divided by population. Log variables are multiplied by 100 so that the log change in a variable is a growth rate expressed in per cent (the tax variable is a percentage).

Revenues are the only variable not cyclically adjusted at source. It is therefore cyclically adjusted using the X-12 ARIMA software from the United States Census Bureau.

In September 2011 the UK Office for National Statistics (ONS) released revised National Accounts data for the period 1997–2011. Series used in this paper are the old data and will not exactly match currently available data on the ONS website. Given the revisions, I have re-estimated the results in this paper and they are largely unaffected. However, it is unclear whether one should use the new data. The new series contain a different method for constructing National Accounts data pre- and post-1997. Making use of the new data may potentially improve the National Accounts data post-1997 but it introduces a break in measurement methodology across the sample. It therefore does not seem appropriate to use the new revised data until the ONS have finished revising the full sample. At present this is not available.

## V. Additional results and figures

### A. The effect on total factor productivity

Figure (3) shows the effect of the tax cut on Total Factor Productivity (constructed as the Solow Residual). As noted in the main paper, TFP rises to around 1 percent for most of the horizon.

### B. The response of the exchange rate

Figure (4) shows that both the nominal and real effective exchange rates appreciate following the tax cut. The similarity between the responses implies that the short-run appreciation in the real exchange rate is driven by movements in the nominal exchange rate. This short-run appreciation is broadly consistent with the prediction of the Mundell-Fleming model.

TABLE 1—DATA SOURCES

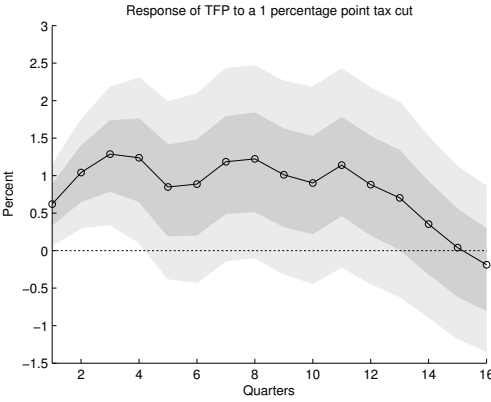| Series | Source | Description | Series |
|---|---|---|---|
| Output | ONS | GDP | ABMI |
| Consumption | ONS | Final household consumption expenditure | ABJR |
| Investment | ONS | Gross Fixed Capital Formation | NPQT |
| Imports | ONS | Trade in Goods and Services: Total Imports | IKBL |
| Exports | ONS | Trade in Goods and Services: Total Exports | IKBK |
| Real Wage | ONS | Average Earnings Index divided by GDP deflator | LNMQ/YBGB |
| Hours | ONS | Weekly hours worked per worker | YBUS/MGRZ |
| Inflation | ONS | Change in Retail Prices Index | CZBH |
| Index of Production | ONS | Covers manufacturing, mining and quarrying and energy supply | CKYW |
| Interest rate | Bank of England | Bank Rate/ Minimum Lending Rate/ Repo Rate / Official Bank Rate | "Official Bank Rate history" |
| Population | Eurostat | UK Total Population (Datastream) | |
| Employment | ONS | Total in employment | MGRZ |
| Capital stock | ONS | Volume Index of Capital Services | VICS |
| Labor share | Bank of England | Sample average labor share | |
| http://www.bankofengland.co.uk/publications/quarterlybulletin/threecenturiesofdata.xls | | | |
| Total factor productivity | ONS | Solow Residual | ABMM, YBUS, VICS, Labour Share |
| Real exchange rate | Eurostat | Effective real exchange rate | ert_eff_ex_q |
| Nominal exchange rate | Eurostat | Effective nominal exchange rate | ert_eff_ex_q |
| Government consumption | ONS | Government consumption of goods and services | NMRY |
| Total gov't expenditure | ONS | Nominal total managed expenditure minus debt interest divided by GDP deflator | (EBFT-NMFX)/YBGB |
| GDP deflator | ONS | Implicit price deflator for GDP | YBGB |
| Nominal GDP | ONS | GDP in current prices | YBHA |
| Tax receipts | ONS | Total tax and NI receipts | NMBY+NMCU+LIQR+AIIH |

Response of TFP to a 1 percentage point tax cut

FIGURE 3. RESPONSE OF TFP TO A 1 PER CENT OF GDP CUT IN TAXES

Response of the nominal effective exchange rate to a 1 percentage point tax cut

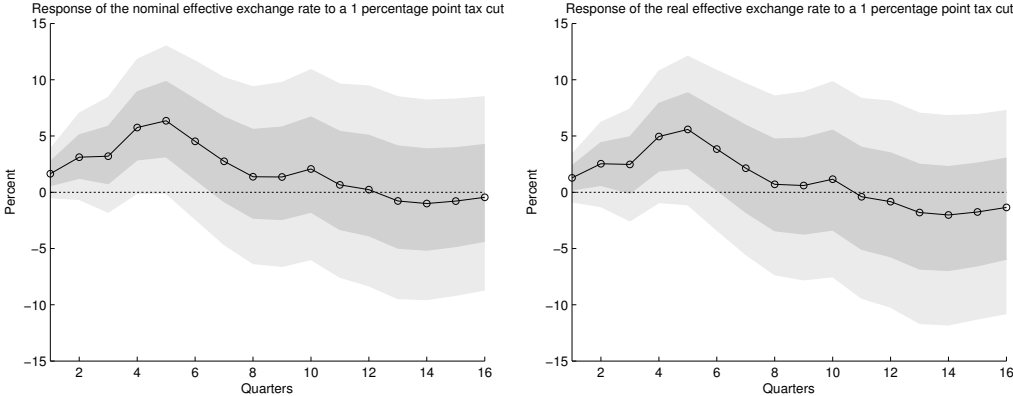Response of the real effective exchange rate to a 1 percentage point tax cut

FIGURE 4. RESPONSE OF THE NOMINAL EXCHANGE RATE (LEFT) AND THE REAL EXCHANGE RATE (RIGHT)

## C.  The response of employment

The main paper considered hours per worker as the measure of labor input. I showed that hours per worker did not respond significantly to the tax cut. In this section I examine the extensive margin. I look at the effect of the tax cut on employment and the employment rate, these results are shown in figure (5) . The effect on employment and the employment rate is sizable and significant rising to around 1.7 and 1.8 percent (respectively) over the 3 years. This is greater than the response of hours per worker but smaller than the effect on GDP.
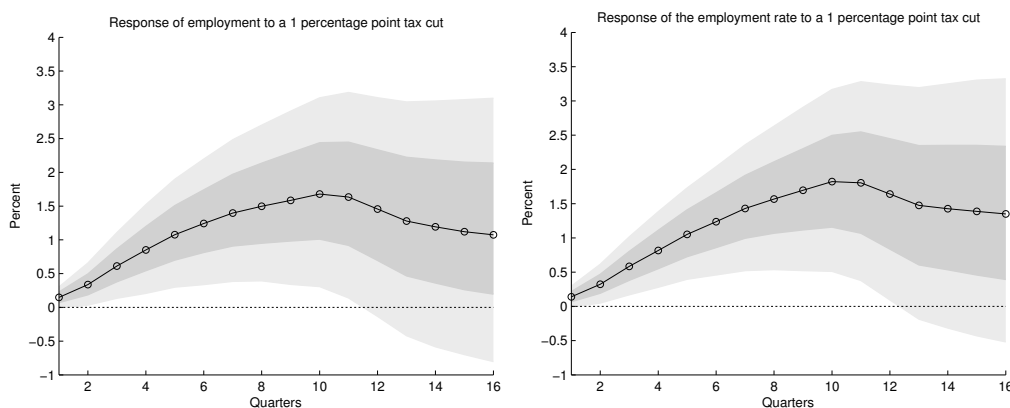


Figure 5. Response of employment to a 1 percentage point cut in taxes

## D.  Controlling for monetary policy

Figure (6) presents the full set of figures from the monetary policy robustness section of the main paper. The effect on the nominal interest rate and inflation are repeated here for completeness. We can see that the effect on output, consumption and investment is broadly similar to the baseline results in the paper.

## E.  Controlling for other fiscal policy

Figure (7) presents the full set of figures from the fiscal policy robustness section of the main paper. The baseline results for output, consumption and investment are broadly unaffected by the inclusion of changes in government spending.[3] The result that government spending does not fall following the tax cut can be seen from the figure. As noted in the main paper, this government spending response is similar to the results in Romer and Romer (2009).

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[3]Denoted as government consumption on goods and services. I also used government total managed expenditure net of debt interest payments (as in RR). The results were very similar.
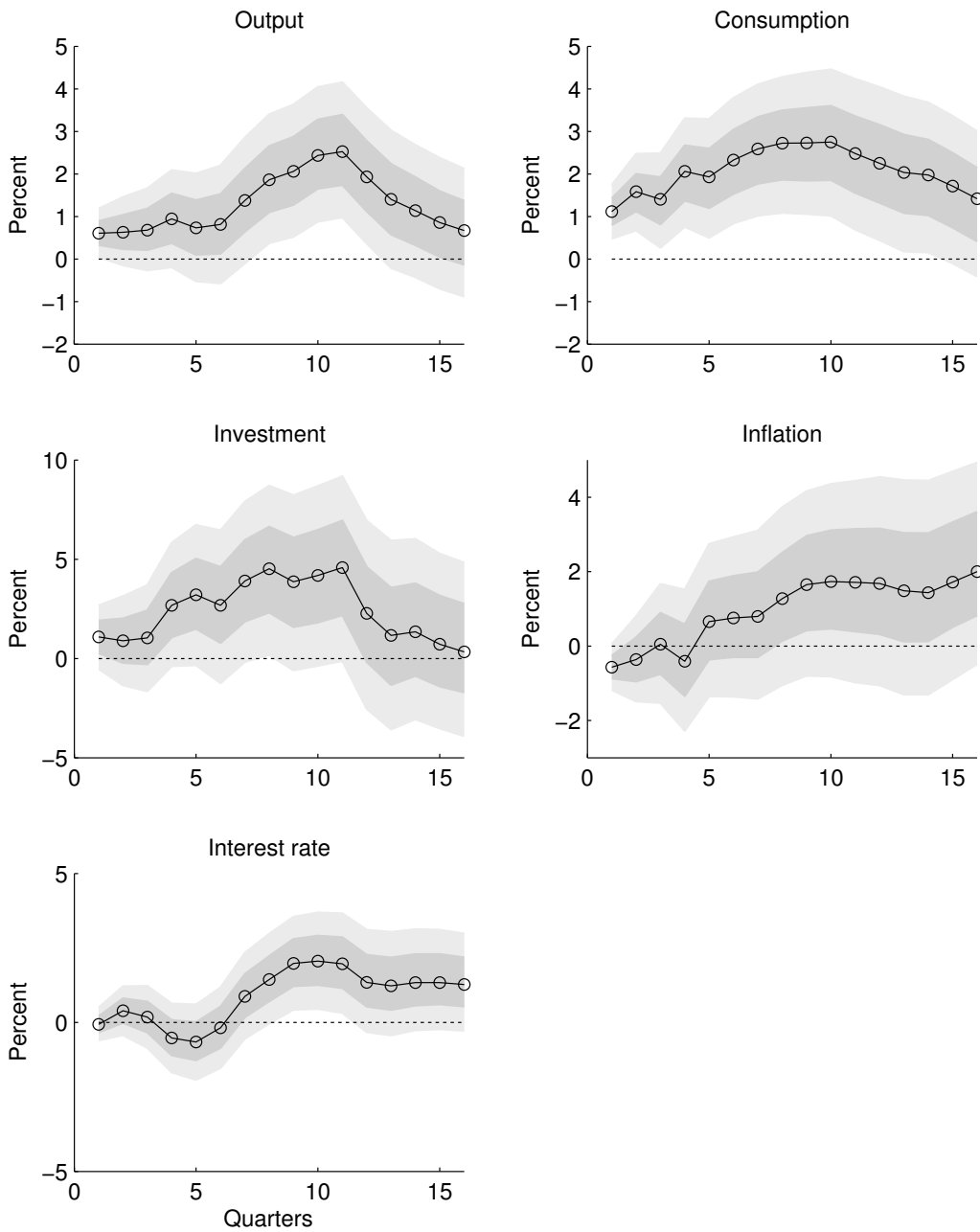
FIGURE 6. THE EFFECTS OF A TAX CUT AFTER CONTROLLING FOR MONETARY POLICY CHANGES
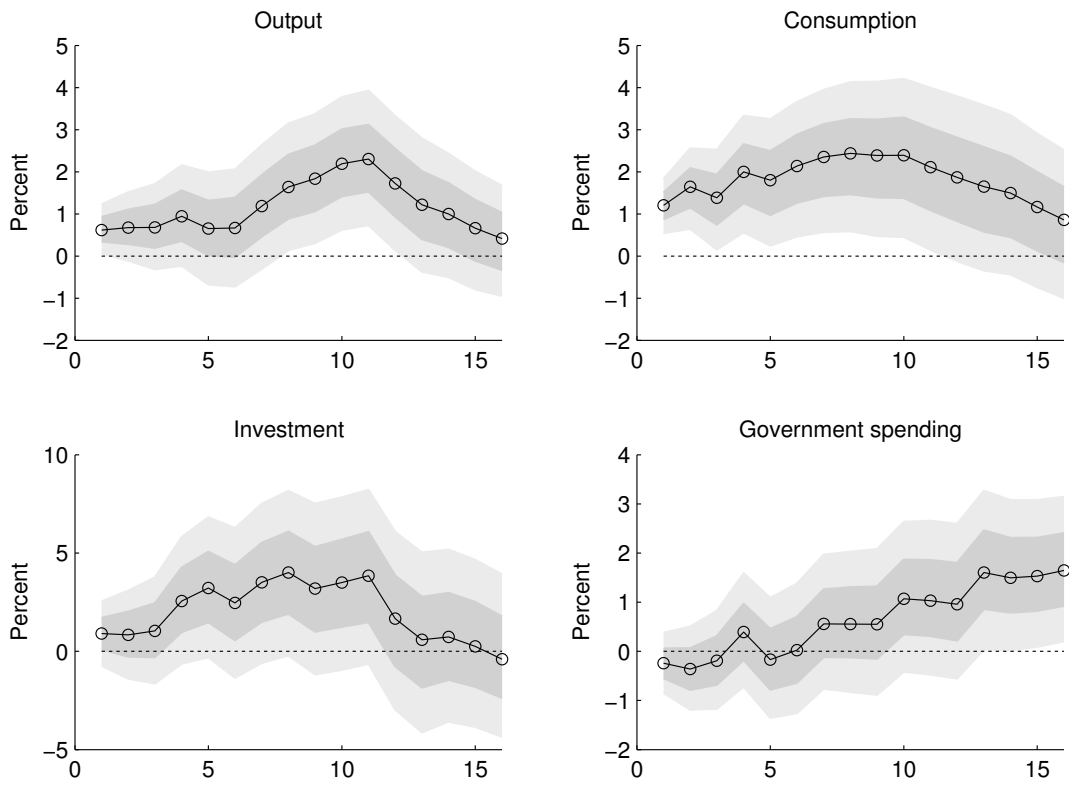
FIGURE 7. THE EFFECTS OF A TAX CUT AFTER CONTROLLING FOR FISCAL POLICY SHOCKS

## VI. Further robustness exercises

### A. An alternative empirical specification

To guard against the possibility of spurious results deriving from unit roots in the output, consumption and investment series,[4] I also estimate an alternative empirical specification.

The vector of endogenous variables includes the growth rate of output $\Delta y_t$ and the ratios of consumption and investment to output $\frac{c}{y}$ and $\frac{i}{y}$.[5]

The estimated effect of the tax cut on output is shown in figure (8). On impact the contraction is very similar at 0.62 per cent ($p = 0.02$) and the greatest impact is again at 11 quarters at 2.66 per cent ($p = 0.03$). The shape is very similar although the VAR with output in growth rates produces a more persistent response. Certainly the short to medium term magnitudes and dynamics are very similar to the model estimated using levels. However, this model produces wider standard errors, particularly at longer horizons. Given the focus on short to medium term effects in this paper, I focused on the baseline specification presented in the paper.



Response of GDP to a 1 percentage point tax cut: alternative empirical specification
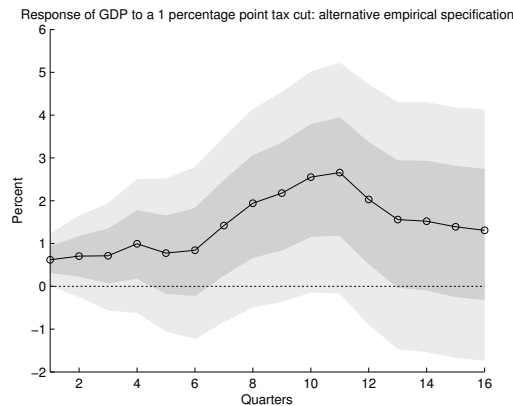
FIGURE 8. EFFECT ON GDP OF A 1 PERCENTAGE POINT TAX CUT: ALTERNATIVE EMPIRICAL SPECIFICATION

### B. Excluding anticipated shocks

By assigning the liabilities change to the implementation date we are implicitly assuming that agents react to the shock when implemented and not before. However, the implementation date is sometimes later than the announcement date

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[4]Augmented Dicky Fuller tests fail to reject the null hypothesis of a unit root in these log real per capita series.

[5]I thank one of the referees for this suggestion.

and we may be concerned that agents anticipate the implementation. I therefore examine the possibility that the results are being influenced by anticipation effects.

Following Mertens and Ravn (2012), I define a surprise shock as one which is implemented within one quarter (90 days) of the announcement date. The sample is therefore split into discretionary actions whose announcement and implementation dates are the same quarter and those which may be anticipated. Figure (9) provides a histogram of the implementation lags, the time between announcement and implementation. We can see that the overwhelming majority of
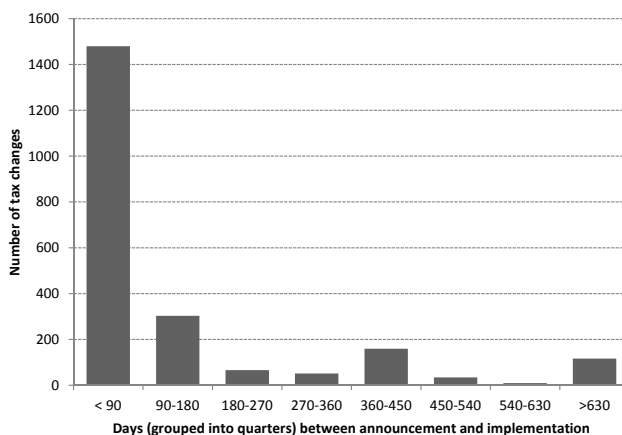


FIGURE 9. DISTRIBUTION OF IMPLEMENTATION LAGS, GROUPED BY QUARTERS (90 DAYS)

actions are surprise actions, being implemented within one quarter of announcement (and many of these are actually implemented on or around announcement). This suggests a straightforward check: I simply exclude the potentially anticipated changes, that is I only use the surprise shocks.

The first panel in figure (10) illustrates the effect of a surprise tax shock on output. The shape of the response and magnitude are again broadly similar although the largest effect on output is slightly greater at over 3 per cent, still occurring between 10 and 12 quarters.

### C. *Comparison with the Romer and Romer method*

Romer and Romer's baseline results come from the estimation of

$$(1) \qquad \Delta y_t = \mu + \sum_{j=0}^{Q} \gamma_j d_{t-j} + \nu_t$$

taking $Q = 12$.

The purpose of this subsection is to compare the results gained from this simpler approach to the baseline VAR results above. The second panel in figure (10) reports the results from the single equation (darker line, crosses and long dashes) and the single equation modified by lagged GDP (lighter line, circles and short dashes). Firstly, these two are very close, with both point estimates falling within the other's confidence intervals. Secondly, the magnitudes and shapes are very similar to the baseline VAR results: an impact multiplier between 0.5 and 1 per cent, rising to around 2.5 per cent after 10-12 quarters.

### D. *Using all discretionary policy changes*

Having constructed the exogenous tax series, it is instructive to ask whether the results are actually different when using the full discretionary policy decision series (endogenous and exogenous). The third panel of figure (10) shows that the response using all discretionary policy changes is much closer to zero. Interestingly, this magnitude is closer to the Blanchard and Perotti (2002) type estimates — suggesting that the identified shocks from this approach are biased downwards. The split between exogenous and endogenous does again appear to be an important and meaningful distinction in identifying the effects of tax shocks.

### E. *Outliers*

VAT was increased in 1979Q3, income tax allowances were cut for the whole year 1979-80 and so the implementation date is taken as the announcement, but the accompanying income tax rate changes were not implemented until 1979Q4.

The timing of the income tax cuts in 1979Q4 (and income tax allowance changes for the whole fiscal year), which were to be counteracted by the VAT rise in 1979Q3, lead to two large outliers in the exogenous series. Obviously these changes may be important but we want to ensure that the timing properties do not unduly drive the main results. The income tax allowance increases were for the whole year, which means there was a retroactive element dating back to 1979Q2. Given the way I deal with retroactive elements, the implementation date was therefore taken to be 1979Q3 — the same date as the VAT rise. For consistency, I bring the implementation date for income tax cuts (due in October) forward one quarter from Q4 to Q3. Once these three changes are considered together (the original intention in the Budget), the spikes in 1979 are removed. This

seems a more sensible way of dealing with the timing issue than simply excluding all three changes as outliers. Again, I am checking that the overall magnitude and dynamics are not being distorted. The magnitudes and dynamics are once again very similar to the baseline case, again rising to 2.3 per cent ($p = 0.003$) after 11 quarters.

### F.   *Making use of observations back to 1948*

Although the narrative in Cloyne (2012) dates from the first postwar Budget in 1945, the relevant quarterly National Accounts data are only available from 1955. However, as our tax shock series goes back to 1948 (and 1945 in revenue changes), it is desirable to use all the data. Before 1955 the UK did publish the Index of Production which, in the contemporary editions of *Economic Trends*, was presented as an aggregate production measure. To make use of the dataset from 1948Q1, I run the single equation model (1) using the quarterly Index of Production growth rather than quarterly real GDP growth as the dependent variable.

As can be seen in the fourth panel of figure (10), although the magnitudes are slightly greater, the thrust of the main result remains — a sizable impact multiplier increasing to several per cent after 10-12 quarters.

### G.   *Controlling for other shocks to revenues*

In the main paper I implemented a robustness check to address the concerns raised in Perotti (2012). In this section I discuss the argument in more detail. Perotti (2012) argues that one needs to control for the possibility that changes in revenues have an additional effect on output other than via changes in $d_t$ (for example, the effects of the automatic stabilizers). In general — and illustrated below — Perotti's argument implies one needs to control for other shocks to revenue to consistently estimate the effects of the exogenous taxes. Suppose that (log of real) revenues ($s_t$) is described by the following relationship:

$$(2) \qquad \qquad \Delta s_t = \eta \Delta y_t + \chi d_t + \epsilon_t^s$$

where $\epsilon^s$ can be thought of as a shock to revenues and picking up influences other than the cyclical changes due to output growth or policy. Perotti argues that estimating a model such as the baseline regression ignores the effect of other changes in revenues. For consistent estimation we must implicitly maintain the assumption that revenues (or in his setup, specifically $\Delta s_t - \chi d_t$) do not affect the endogenous variables other than via $d_t$.

However, the problem is more general and applies even if we include revenues in the regression. Consider the following regression model:
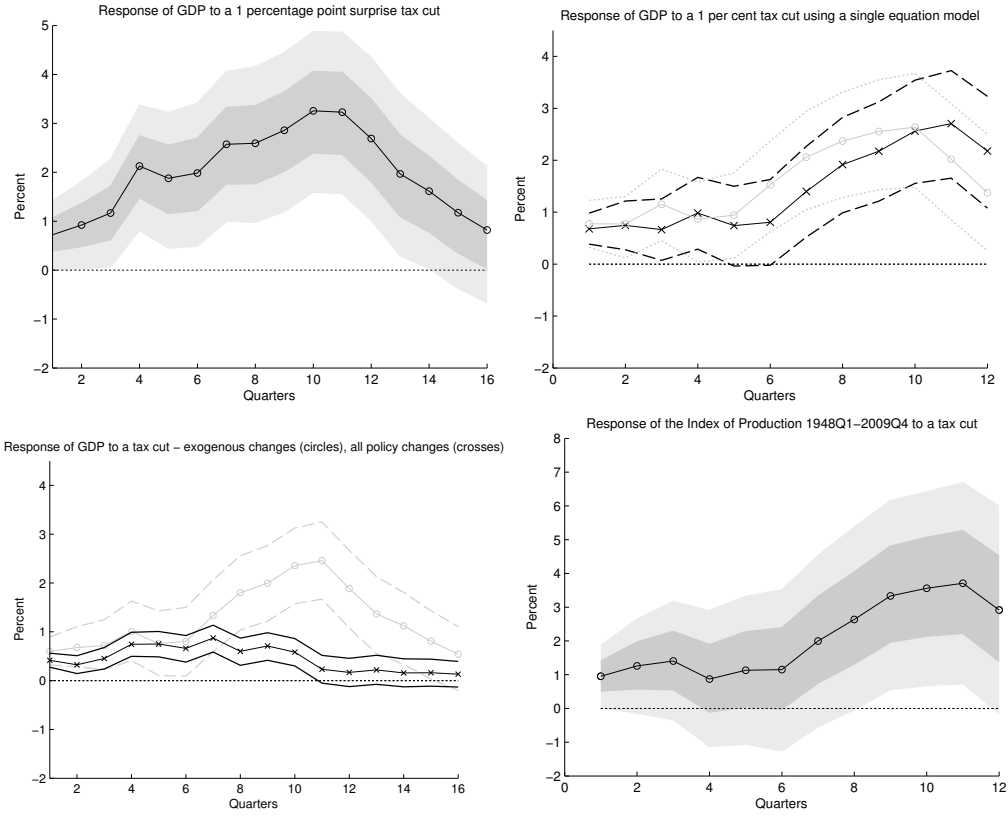
FIGURE 10. ROBUSTNESS CHECKS: (1) ONLY CONSIDERING SURPRISE SHOCKS, (2) COMPARISON WITH RR SINGLE EQUATION BASELINE, (3) USING ALL DISCRETIONARY POLICY CHANGES, AND (4) USING DATA BACK TO 1948

$$(3) \qquad \Delta y_t = \alpha_1^y \Delta y_{t-1} + \beta_0^y \Delta s_t + \beta_1^y \Delta s_{t-1} + \gamma_1^y d_t + \gamma_2^y d_{t-1} + \epsilon_t^y$$

$$(4) \qquad \Delta s_t = \alpha_0^s \Delta y_t + \alpha_1^s \Delta y_{t-1} + \beta_1^s \Delta s_{t-1} + \gamma_1^s d_t + \gamma_2^s d_{t-1} + \epsilon_t^s$$

where equation (4) nests equation (2). We can always rewrite this model in the Perotti form with the new regressor being $\Delta s_t - \chi d_t$. Write this system as:

$$(5) \qquad \begin{bmatrix} 1 & -\beta_0^y \\ -\alpha_0^s & 1 \end{bmatrix} \begin{bmatrix} y_t \\ s_t \end{bmatrix} = \begin{bmatrix} \alpha_1^y & \beta_1^y \\ \alpha_1^s & \beta_1^s \end{bmatrix} \begin{bmatrix} y_{t-1} \\ s_{t-1} \end{bmatrix} + \mathbf{\Theta(L)} d_t + \mathbf{e}_t$$

were $\mathbf{\Theta(L)}$ is a $(Q+1)$ lag polynomial.

Defining the left hand side coefficient matrix as $\mathbf{A}$, the coefficient matrix on the lagged terms $\mathbf{\Xi}$ and $\mathbf{Z}_t$ as the vector of endogenous variables, the reduced form of this model can be written as:

(6) $$\mathbf{Z}_t = \mathbf{A}^{-1}\mathbf{\Xi}\mathbf{Z}_{t-1} + \mathbf{A}^{-1}\mathbf{\Theta}(\mathbf{L})d_t + \mathbf{A}^{-1}\mathbf{e}_t$$

which implies a relationship between the reduced form residuals $\mathbf{u}_t$ of:

(7) $$u_t^y = \beta_0^y u_t^s + \epsilon_t^y$$

(8) $$u_t^s = \alpha_0^y u_t^y + \epsilon_t^s,$$

requiring $n(n-1)/2 = 1$ restriction on the $\mathbf{A}$ matrix to identify the structural shocks $\epsilon_t$. Given that we are including contemporaneous $d_t$ it does not make sense to then restrict $\beta_0^y = 0$ and equation (2) implies that we should not restrict $\alpha_0^s = 0$ either. In short, there is a standard identification problem unless we are willing to assume that the only way revenues affect output contemporaneously is through shocks to $d_t$ ($\beta_0^y = 0$).

The consequences of this are twofold. First, and more obviously, excluding revenues from the model may lead to inconsistent estimates. But second, even when we include revenues in our VAR specification as an additional endogenous variable, we cannot consistently estimate the coefficients. To see this more clearly, substitute the revenues equation into the output equation. To simplify the exposition and enhance the comparability with equation (2), I restrict the coefficients as follows: $\gamma_2^s = \alpha_1^s = \beta_1^s = 0$, $\gamma_1^s = \chi$ and $\alpha_0^s = \eta$. We can now write the reduced form, single equation model as:

(9)
$$\Delta y_t = \frac{\alpha_1^y + \eta\beta_1^y}{1 - \beta_0^y\eta}\Delta y_{t-1} + \frac{\gamma_1^y + \chi\beta_0^y}{1 - \beta_0^y\eta}d_t + \frac{\gamma_2^y + \chi\beta_1^y}{1 - \beta_0^y\eta}d_{t-1}$$
$$+ \frac{\beta_0^y}{1 - \beta_0^y\eta}\epsilon_t^s + \frac{\beta_1^y}{1 - \beta_0^y\eta}\epsilon_{t-1}^s + \frac{1}{1 - \beta_0^y\eta}\epsilon_t^y$$

and note that if $\beta_0^y \neq 0$ then shocks to $\Delta s$ affect $\Delta y$ contemporaneously. This implies that the lagged $\epsilon^s$ terms are correlated with the lagged $y$ terms.

As can be seen from equation (9), the problem is that we need to control for potential other shocks to revenue. However, we cannot simply include a fitted residual $\epsilon^s$ in equation (9): as shown above, $\epsilon^s$ is not identified without restrictions on the $\mathbf{A}$ matrix. Obviously one restriction that would work is $\beta_0^y = 0$ but this was ruled out above. Additionally we could impose the restriction $\eta = 0$, allowing

us to construct $\epsilon^s$ from equations (7) and (8).[6] But again this was ruled out.

Equation (9) illustrates the two problems mentioned above. If we exclude revenues and they do exert an independent effect on output our estimates will be inconsistent. Furthermore, including $s_t$ does not solve the identification problem.[7]

Perotti pursues an instrumental variable approach which solves the identification problem without requiring restrictions on the **A** matrix. We cannot directly estimate equation (2) as $\epsilon^s$ is correlated with $\Delta y_t$. A solution is to use lagged values of $\Delta y_t$ as instruments and then estimate the parameters $\eta$ and $\chi$. This allows us to construct a fitted value of $\epsilon^s$ which can be used in the regression (9).

As a robustness check I implement this method in the main paper itself, showing that the results are largely unaffected. Given the specification of equation (2), it is more straightforward to directly use the model with the **X** vector in first differences (as in Perotti (2012)):

$$(10) \qquad \Delta \mathbf{X}_t = \tilde{\mathbf{A}}_0 + \tilde{\mathbf{A}}_1 \mathbf{t} + \tilde{\mathbf{B}}(\mathbf{L})\Delta \mathbf{X}_{t-1} + \tilde{\mathbf{C}}(\mathbf{L})d_t + \tilde{\mathbf{D}}(\mathbf{L})\hat{\epsilon}^s_t + \mathbf{u}_t$$

## VII. Additional business cycle simulations

In the main paper I presented a counterfactual simulation for GDP using the narrative tax shocks. In figure (11) I also present the same results for consumption and investment. The four key episodes identified in the main paper — the late 1950s, early 1970s, the 1980s and the mid-1990s — can all also be seen in these series.

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[6]Note that this discussion works the other way round if we had substituted the output equation into the revenues equation.

[7]Of course, in the special case where all the $\beta$ coefficients are zero or where $\epsilon^s_t = 0$, $\forall t$ neither problem arises.
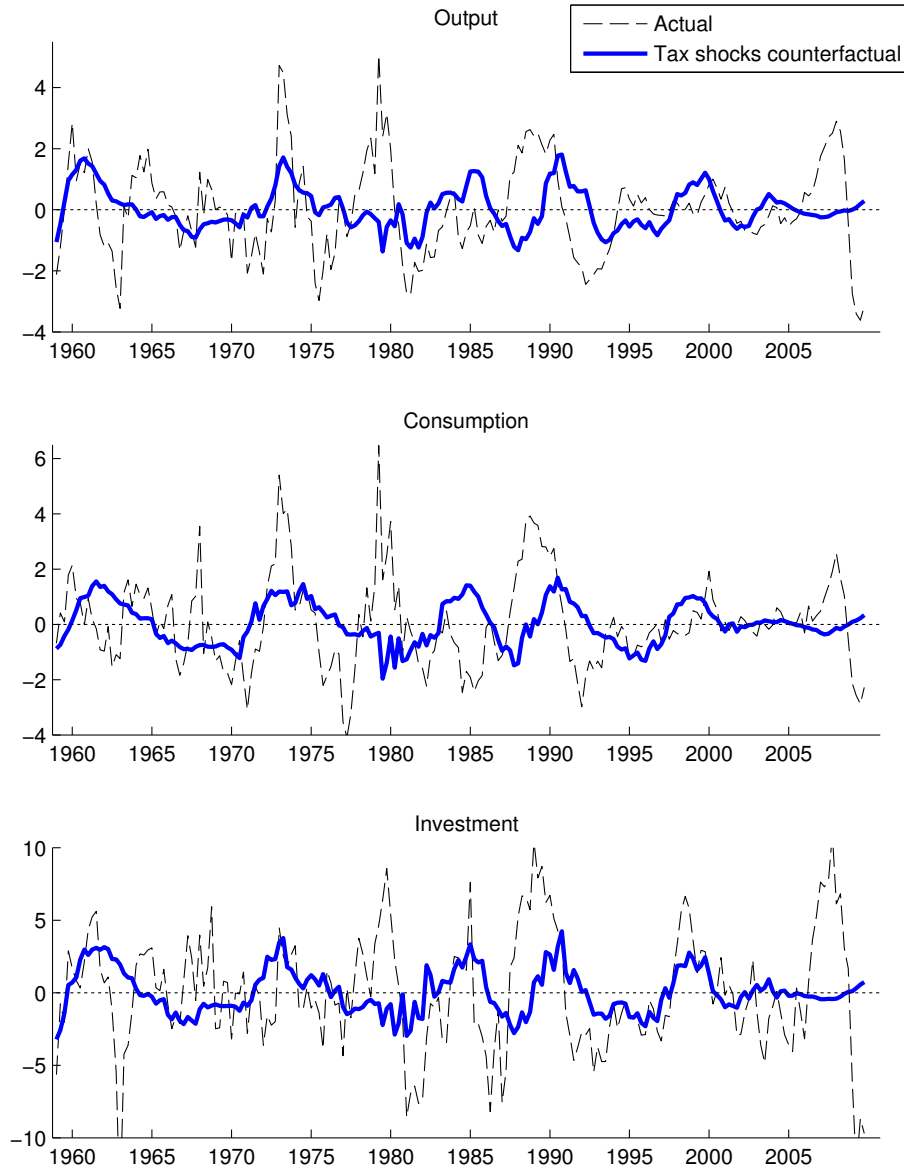
FIGURE 11. SIMULATED OUTPUT, CONSUMPTION AND INVESTMENT BASED ON TAX SHOCKS VS ACTUAL

## VIII. The narrative approach and the Blanchard–Perotti method

In this section I discuss the popular SVAR approach to identifying the effects of tax changes proposed by Blanchard and Perotti (2002). Consider the following simple model. Suppose taxes are measured by (log of real) tax revenues, $s_t$. Also assume that the change in tax revenues is affected by movements in aggregate output and another shock, $\xi_t$:

$$(11) \qquad \Delta y_t = \alpha_0 + \psi \Delta s_t + u_t$$

$$(12) \qquad \Delta s_t = \eta \Delta y_t + \xi_t$$

where $\eta$ is taken to be the elasticity of output with respect to revenues.

The Blanchard and Perotti (2002) approach seeks to identify $\xi_t$ as the 'structural' shocks to revenues: those uncorrelated with other contemporaneous economic shocks. The method assumes policymakers are not informed about, or are unable to respond to, shocks within the same quarter. The method then uses external information to calibrate the elasticity $\eta$. A series for $\xi$ can then be constructed. Under these assumptions the $\xi$ series is interpreted as the discretionary policy decisions uncorrelated with other fluctuations.

There are at least three potential issues with this method. First, if the timing assumptions do not hold, then $\eta$ does not simply reflect the *automatic* response of revenues to output. $\eta$ would also be capturing any legislated changes in policy which are contemporaneously correlated with output. Second, we need to be confident that the specification (12) adequately captures the cyclical influences on revenues. Of course, we could add extra variables such as inflation or the interest rate to the right hand side but, as many factors are likely to affect revenues, it is unclear what a comprehensive list would be. Errors in the specification would lead to $\xi$ incorrectly capturing the structural, policy-induced, shocks to revenues. Third, legislated tax shocks are not simply shocks to revenues; they alter rates and liabilities, which themselves are likely to affect the elasticity $\eta$.

The narrative approach can therefore be seen as a way of trying to directly measure $\xi_t$ — making the shocks observable — without employing these identifying assumptions.

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