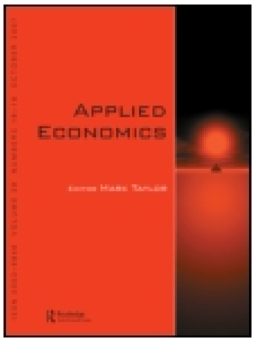

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Market power and fiscal policy in OECD countries

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We compute average markups as a measure of market power throughout time and study their interaction with fiscal policy and macroeconomic variables in a VAR framework. From impulse-response functions, the results, with annual data for a set of 14 OECD countries, show that the markup (i) depicts a pro-cyclical behaviour with productivity shocks and (ii) a counter-cyclical behaviour with fiscal spending shocks. We also use a PVAR, increasing the efficiency in the estimations, which confirms the country-specific results.

Keywords: fiscal policy; markup; VAR; PVAR

JEL Classification: D4; E3; E6; H6

I. Introduction

The interaction between imperfect competition and fiscal policy effectiveness has attracted some attention in economic theory.[1] This can be observed in the renewed interest over fiscal policy effectiveness as seen in Christiano *et al.* (2011), Hall (2009) or Woodford (2011). In particular, the cyclical behaviour of markups following government-spending shocks has been closely analysed. New Keynesian synthesis models produce undesired endogenous markups due to nominal rigidity, enhancing the effectiveness of demand-side policy, including fiscal policy (e.g. Christiano *et al.*, 2011). Additionally, macroeconomic models with time-varying desired markups are even more attractive as they work similarly to productivity shocks in the presence of active fiscal policy (e.g. Ravn *et al.*, 2006).

The theoretical literature on endogenous markups is dominated by the view that markups behave counter-cyclically following a demand shock. When a positive shock originates in the demand side (e.g. a government-spending shock), the marginal cost function is only indirectly affected and the main effect depends on how the individual demand function responds. Nominal rigidity as in Clarida *et al.* (1999), Goodfriend and King (1997) or Hairault and Portier (1993), varying composition of aggregate demand as in Galí (1994) or Heijdra (1998), deep habits in consumption as in Ravn *et al.* (2006), variety-specific subsistence levels as in Ravn *et al.* (2008), non-CES utility functions as in Bilbiie *et al.* (2012) or Feenstra (2003), implicit collusion in the supply side as in Rotemberg and Woodford (1991, 1992), Cournot competition as in Costa (2004), dos Santos Ferreira and Lloyd-Braga (2005) or Portier (1995), or feedback effects of entry as in Linnemann (2001) or Jaimovich (2007) are just examples of models that produce counter-cyclical markups in the presence of demand shocks.

However, with a positive supply shock, we expect marginal costs to decrease for a given output. Therefore,

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[1] See Costa and Dixon (2011) for a survey.

assuming that the indirect effect on prices via demand is small, markups tend to increase implying a pro-cyclical average markup.

Several papers that try to measure markups for different industries over a period, following the seminal paper of Hall (1988), e.g. Christopoulou and Vermeulen (2012), Martins *et al.* (1996) and Roeger (1995). Although these studies do not provide time series for markups, Martins and Scarpetta (2002) provide evidence of a mildly counter-cyclical behaviour in OECD countries.

Nevertheless, Rotemberg and Woodford (1991, 1999) (henceforth RW) produced markup time series for the US using macroeconomic data and simple assumptions on both the technology and long-run features exhibited by variables. Again, evidence points towards moderately counter-cyclical markups. Rotemberg and Woodford (1991) also pioneered the study of the interaction between fiscal policy and endogenous (counter-cyclical) markups.

The combination of the two above-mentioned types of shocks (demand and supply) is a possible explanation for the existing evidence on mildly counter-cyclical markups.

The renewed interest in the effects of fiscal policy produced a series of papers aiming to analyse the cyclical behaviour of markups following a government-spending shock, including Afonso and Costa (2010). Monacelli and Perotti (2008) use a quarterly VAR for the US with both structural and narrative strategies and conclude that increasing public spending leads to a fall in the average markup, as measured using changes in the labour share. Nekarda and Ramey (2010) use both aggregate and manufacturing industry-level US (quarterly and annual) data, correcting the markup measure in order to accommodate a marginal-average adjustment factor and conclude that markups are either pro-cyclical or acyclical. Juessen and Linnemann (2012) assume a common economic structure (based upon US data) for a sample of OECD countries with annual data and estimate a panel VAR, concluding that an increase in government spending increases output and lowers markups.

We contribute to this literature on the cyclical behaviour of average markups after an unexpected government-spending shock, following the RW approach to generate markup time series for OECD countries. We introduce a methodological innovation since we allow for smooth changes in the technological parameters. Furthermore, we also generate a measure of total factor productivity (TFP) compatible with the above-mentioned markup to assess the interaction between both variables. We produced illustrative results with annual data for a group of 14 OECD countries in the period 1970–2007: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Sweden, UK and US. The VAR impulse-response functions show that, in general, average markups (i) depict a pro-cyclical behaviour with productivity shocks and (ii) a counter-cyclical behaviour with government-spending shocks, although varying across countries.

Finally, using also a Panel Vector Auto-Regression (PVAR) analysis, which allows more efficient estimations, we are able to confirm the country-specific results regarding markups counter (pro)-cyclicality with government-spending (productivity) shocks.

The article is organized as follows. Section II describes the theoretical underpinnings of our markup measure. Section III computes the average markup and TFP throughout time. Section IV conducts the VAR and PVAR analysis. Section V concludes.

II. The Markup: Theoretical Framework

Our measure of market power, henceforth the 'markup', is the price wedge, i.e.

$$\mu_{it} = \frac{P_{it}}{MC_{it}} \tag{1}$$

where P_{it} represents the price of the good produced by firm i and MC_{it} stands for its marginal cost, both measured for period t.

The problem in determining markup measures is that marginal costs are not observable. However, for a profit-maximizing firm, we know that its marginal cost equals the ratio between the price of an input and its marginal product. Thus, we can estimate the marginal cost using the relationship $MC_{it} = W_t/MPL_{it}$, where W_t represents the nominal wage rate[2] and MPL_{it} stands for the marginal product of labour, i.e. $MPL_{it} = \partial Y_{it}/\partial L_{it}$, where L_{it} is the labour input used in the production of firm i, here represented by Y_{it}. A general production function can be represented by $Y_{it} = F(L_{it}, \cdot\,)$ and we assume it exhibits the usual properties, namely, a positive decreasing MPL_{it}.

Following Rotemberg and Woodford (1991), we assume the representative firm uses a technology represented by

$$Y_t = A_t.\left(K_t^{\alpha_t}.L_t^{1-\alpha_t} - \Phi_t\right) \tag{2}$$

where Y_t stands for output, K_t is the capital stock and L_t represents the labour input. A_t is a (nonobservable) measure of TFP, $0 < \alpha_t < 1$ and $\Phi_t > 0$.

Considering imperfect competition in product markets, real factor prices are not equal to their marginal products, so profits are

[2] For the sake of simplicity, we assume that all firms use a homogeneous labour input.

$$\pi_t = A_t.\left(\frac{\mu_t - 1}{\mu_t}.K_t^{\alpha_t}.L_t^{1-\alpha_t} - \Phi_t\right)^3 \tag{3}$$

Since the average labour share in aggregate income is given by $s_t = W_t.L_t/(P_t.Y_t)$, where P_t is the aggregate producer price index, we obtain the following short-run expression for the markup:

$$\mu_t = \frac{1-\alpha_t}{s_t}\cdot\frac{1}{1-\phi_t} \tag{4}$$

where ϕ_t is a measure of increasing returns given by $\phi_t = \Phi_t/\left(K_t^{\alpha_t}.L_t^{1-\alpha_t}\right)$.

In the long run, entry and exit eliminate pure profits. Thus, the following equality must hold in order to obtain $\pi_t^* = 0$ from Equation 3 and where asterisks identify the balanced-growth-path values for variables:

$$\Phi_t = \frac{\mu^* - 1}{\mu^*}.K_t^{*\alpha_t}.L_t^{*1-\alpha_t} \tag{5}$$

Therefore, using Equation 5 in 4, the long-run labour share is given by $s_t^* = 1 - \alpha_t$.

We can now compare the methodology described above with related work. Monacelli and Perotti (2008) use $(1–\alpha)/s_t$, i.e. they consider that $\phi_t = 0$ at any point in time, which produces a measure with high cyclical correlation with our benchmark markup. Nekarda and Ramey (2010) correct the markup measure (the marginal cost) to consider the effect of overtime labour. Hence, they estimate the 'average marginal' change in overtime hours with respect to a change in average hours using monthly microdata. Juessen and Linnemann (2012) consider a CES production function and variable capital utilization. However, they use US parameter values for the elasticity of substitution between capital and labour and the elasticity of the marginal cost of capital utilization to calibrate the marginal cost for the entire set of 19 OECD countries, and they postulate a common steady-state markup for 10 of those countries equal to 1.3.

Instead of constructing a complex method of estimating the time series for average markups, using a structural model based upon alternative technologies (e.g. CES and intermediate goods) or frictions (e.g. variable capital utilization and labour hoarding), we opted for using a simpler approach. Considering that it is difficult to find comparable data at the micro level and country-specific estimates for deep parameters for the 14 countries used in our analysis, we opted for making use of parameter heterogeneity instead.

III. Computing the Average Markup Throughout Time

The data

We consider the already mentioned 14 OECD countries for which there were data on average markups for a long period (1970–2007), and the macroeconomic variables were taken from the European Commission AMECO database:[4]

- Y_t represents real GDP per capita, i.e. per head between 15 and 64 years old, measured in 2000 Purchasing Power Standards (PPS).
- K_t stands for real capital stock per capita, measured in 2000 PPS.
- L_t is total hours worked, i.e. the product of average hours per employee and total employment, per capita.
- s_t represents the adjusted wage share in total income.[5]

For the data on μ^*, i.e. the constant long-run markup ratios for the economy, we used Table 3 in Martins *et al.* (1996) and calculated the gross-production-weighted average markups for each country.[6]

Markup time series

We allow the long-run parameters (α_t, Φ_t) to change smoothly over time. We obtain the balanced-growth-path series for the pair of parameters using the Hoddrick–Prescott (HP) filter with $\lambda = 100$. The series for α_t is simply given by HP($1 - s_t$). The series for Φ_t is obtained by applying the HP filter to the right-hand side of Equation 5.

Finally, we obtain our markup measure by substituting these values in Equation 4. Then, the markup is

$$\mu_t = \frac{1-\alpha_t}{s_t}\cdot\frac{\mu^*}{\mu^* - (\mu^* - 1).x_t} \tag{6}$$

where $x_t \equiv \dfrac{\mathrm{HP}\left(K_t^{\alpha_t}.L_t^{1-\alpha_t}\right)}{K_t^{\alpha_t}.L_t^{1-\alpha_t}}$ is a measure of the cyclical position of the input combination.

When inputs are being used above (below) its long-run value, then x is less (greater) than one. Thus, there are two

[3] For details, see Afonso and Costa (2010).
[4] See Appendix 1 in Afonso and Costa (2010) for the database codes.
[5] This share is adjusted using the ratio between the concepts of employment and number of employees (in full-time equivalents when available) that exist in the national accounts for domestic industries.
[6] These values compare with the markup of 1.23 reported for the US in Bayoumi *et al.* (2004).

Table 1. Cyclical properties of the markup (1970–2007)

Country	Corr (μ_t, Y_t)	Corr (μ_t, Y_{t-1})	Corr (μ_t, Y_{t+1})
Australia	0.396**	−0.072	0.406**
Belgium	0.011	−0.437***	0.266
Canada	0.347**	−0.099	0.425***
Denmark	0.379**	−0.282*	0.555***
Finland	0.110	−0.439***	0.417***
France	0.269	−0.291*	0.486***
Germany	0.224	−0.149	0.330**
Italy	0.199	−0.418***	0.207
Japan	0.390**	0.011	0.422***
Netherlands	−0.179	−0.546***	0.067
Norway	−0.130	−0.376**	0.115
Sweden	0.041	−0.380**	0.330**
UK	−0.069	−0.561***	0.194
US	−0.112	−0.598***	0.230

Notes: Correlations between the ratios of each variable and its trend component given by a HP filter.
Asterisks indicate if the correlation coefficient is statistically different from zero at 1 (***), 5 (**) and 10% (*) significance levels.

effects pushing μ_t away from its long-run value (μ^*): (i) the labour-share cyclical fluctuations and (ii) input-combination deviations from its long-run value. When the labour share overshoots its trend, the markup is lower than its average value, while x_t has the opposite effect.

Table 1 shows that the markup measure depicts no contemporaneous cyclical pattern, being acyclical for most countries, but it tends to be counter-cyclical with lagged and somewhat pro-cyclical with leaded output.[7]

We also observe a nonstationary behaviour of TFP (in logs), indicating that the series are I(1), and a stationary pattern for the markup, I(0), confirmed by ADF unit root tests.[8]

IV. VAR Analysis

Setting up the VAR

We estimate a five-variable VAR model for the period 1970–2007 and the above-mentioned set of countries. Variables in the VAR are real total final government consumption expenditure plus real government investment (G), real output (Y), real taxes (T), all in logarithms, the markup (μ) and the logarithm of TFP (A). Productivity, output, total final government expenditure and real taxes enter in first differences, and the markup enters in levels, so that all variables in the VAR are I(0). The unit root tests provide similar stationarity results for all countries.

The VAR in standard form can be written as

$$\mathbf{X}_t = \mathbf{c} + \sum_{i=1}^{p} \mathbf{V}_i \mathbf{X}_{t-i} + \varepsilon_t \qquad (7)$$

where $\mathbf{X}_t$ denotes the (5 × 1) vector with the endogenous variables given by $\mathbf{X}_t \equiv \left[\Delta \ln A_t \quad \Delta \ln G_t \quad \Delta \ln T_t \, \Delta \ln Y_t \quad \mu_t\right]'$, $\mathbf{c}$ is a (5 × 1) vector of intercepts, $\mathbf{V}_i$ is the (5 × 5) matrix of autoregressive coefficients of order i and $\varepsilon_t \equiv \left[\varepsilon_t^A \quad \varepsilon_t^G \quad \varepsilon_t^T \quad \varepsilon_t^Y \quad \varepsilon_t^\mu\right]'$ is the vector of random disturbances. The lag length of the endogeneous variables (p) is determined by the usual information criteria.

The VAR is ordered from what we assumed to be the most exogenous variable to the least exogenous one, with the log of TFP in the first position. Consequently, a productivity shock may have an instantaneous effect on the remaining variables, but it does not respond contemporaneously to any structural disturbances on them. Likewise, total final government expenditure does not react contemporaneously to taxes, GDP or markups due to lags in government decision making. In other words, markups, GDP, taxes and government spending may affect productivity with a one-period lag.

Since we are restricted to annual data, one could question the issue of contemporaneous responses of some variables, e.g. the fiscal ones.[9] However, this can also obviate some concerns related to the fact that, with high-frequency data, policy actions may be anticipated one period in advance, given that changes can be enacted within the year.[10] Furthermore, Beetsma *et al.* (2009) showed that, for a panel sample of seven European countries (a subset of our sample), imposing that government spending does not respond contemporaneously to output appears to be a reasonable approximation for an annual SVAR.

In addition to the data used in Section III, we also used the following series: total final government consumption expenditure (consumption and gross fixed capital formation) and government revenues given by the sum of direct and indirect taxes, and social security contributions, divided by the GDP deflator.

Estimation and results

For Sweden, there is a break around 1991 in the series for GDP and taxes, linked to the banking crisis and economic

[7] The data set we used is available at https://aquila.iseg.utl.pt/aquila/homepage/f619/research/datasets/afonso-and-costa:-market-power-and-fiscal-policy-in-oecd-countries.
[8] See Afonso and Costa (2010) for details.
[9] See Ilzetki *et al.* (2013) for a detailed discussion on the controversy over the correct identification strategy for fiscal policy shocks.
[10] See Blanchard and Perotti (2002) for further discussion on this point.

downturn in the beginning of the 1990s. Therefore, we include a dummy variable that assumes the value one for 1991 (zero otherwise) and that turns out to be statistically significant in the regressions for real GDP, real taxes and TFP for Sweden. For the same reason, we used a dummy variable for 1991 for Finland. For Germany, a dummy variable was also needed in 1991, and it was strongly significant when the series reflect the reunification effect.[11]

The VAR order used in the estimation of each model was selected with the Akaike and the Schwarz information criteria. Those tests led us to choose a parsimonious model with one lag for eleven countries and two lags for three countries (Australia, Denmark and Germany), which helped avoiding the use of too many degrees of freedom. With such specifications we also could not reject the null hypothesis of no serial residual correlation. In addition, we did not reject the null hypothesis of normality of the VAR residuals.[12]

In Fig. 1, we plot simultaneously the average responses of output and markups to a one-standard-deviation shock to final government spending and to a one-standard-deviation productivity shock for all countries.

First, let us analyse the reaction of output to unexpected productivity shocks. In general, there is strong evidence of a positive impact effect on output (see Table 2) despite the fact that Australia, Belgium and the Netherlands present a large variance. Italy, the Netherlands and UK present small positive effects. Considering the cumulated effect after two, five and ten periods, we observe a similar overall pattern with more significant results for Italy and UK, but with small longer-run effects for Australia.

Second, there is also strong evidence of an increase in average markups following a positive TFP shock. Australia is the exception for the impact period, the Netherlands presents a large variance and Belgium presents a small effect. Considering the cumulated effects, Norway occasionally joins the group with either small negative or positive effects. We only observe positive cumulated effects after ten periods.

Therefore, markups present a pro-cyclical behaviour after a productivity shock, at least for 12 countries in our sample in either the impact period and also considering the cumulated effects after two, five and ten periods. This outcome is consistent, but rarely referred, with most existing endogenous markups hypotheses, either of the undesired or of the desired kinds: a productivity shock strongly shifts the marginal cost schedule downwards and it has a smaller effect moving rightwards along both the marginal cost and demand curves when output increases.[13]

Despite the fact that TFP shocks could be explicitly considered in a VAR used for studying fiscal policy, the observed pro-cyclical behaviour is important from a policy design point of view: following a negative (positive) TFP shock its effect on output is partially offset by a decrease (increase) in market power. Therefore, the size of the fiscal policy shock needed to stabilize output is smaller than in a fixed markup model.

Third, for an unexpected shock in government final spending on output, a group of six countries show a considerable short-run (i.e. impact) positive[14] effect: Canada, Denmark, Germany, Italy, Japan and UK. Table 2 also shows a large variance of impact effects for nine countries. Australia, Belgium and Finland join the group with positive effects on output when we consider cumulated effects after two, five and ten periods, but UK leaves it. Canada shows a long-run (i.e. the first ten periods cumulated) negative effect. The US presents a strong short-run negative effect that quickly fades away, and France, the Netherlands and Norway present evidence of negative effects.[15]

Fourth, there is strong evidence of decreasing average markups following a positive government-spending shock. The US is the exception to this pattern in the impact period,[16] but it presents a large variance, jointly with Germany, Japan, the Netherlands and Sweden. Japan occasionally presents a positive effect on markups for larger time windows, but no more than four countries present simultaneously a nonnegative cumulated effect on markups.

Thus, for most countries, markups present a countercyclical behaviour following a government-spending shock. This is observed at least for seven countries in our sample in either the impact period or considering the cumulated effects after two, five and ten periods. Australia, Belgium, France, the Netherlands, Norway and Sweden are the short-run exceptions. We can only find evidence of consistent pro-cyclical behaviour of markups for France, the Netherlands and Norway.

[11] We used the Zivot and Andrews (1992) recursive approach to test the null of unit root against the alternative of stationarity with structural change at some unknown break date. The results allow the rejection of the unit root hypothesis in particular for the logarithmic growth rate of taxes and GDP in Sweden, and for GDP and markups in Finland. A similar result occurs for Germany.

[12] See Table 4 in Afonso and Costa (2010).

[13] Nominal rigidity provides a good example of a constant or sluggish marginal-revenue curve faced by each producer.

[14] Sometimes the literature refers to it as a 'Keynesian' effect. However, we should expect it to happen even in a Real Business Cycle environment due to the expansionary effect of higher taxes on labour supply.

[15] Notice that nothing can be said for higher frequencies, e.g. quarterly data.

[16] Nekarda and Ramey (2010) claim that markups in the US tend to be either acyclical or pro-cyclical. However, we will see below that the effect of spending shocks on output we obtained is not identical.

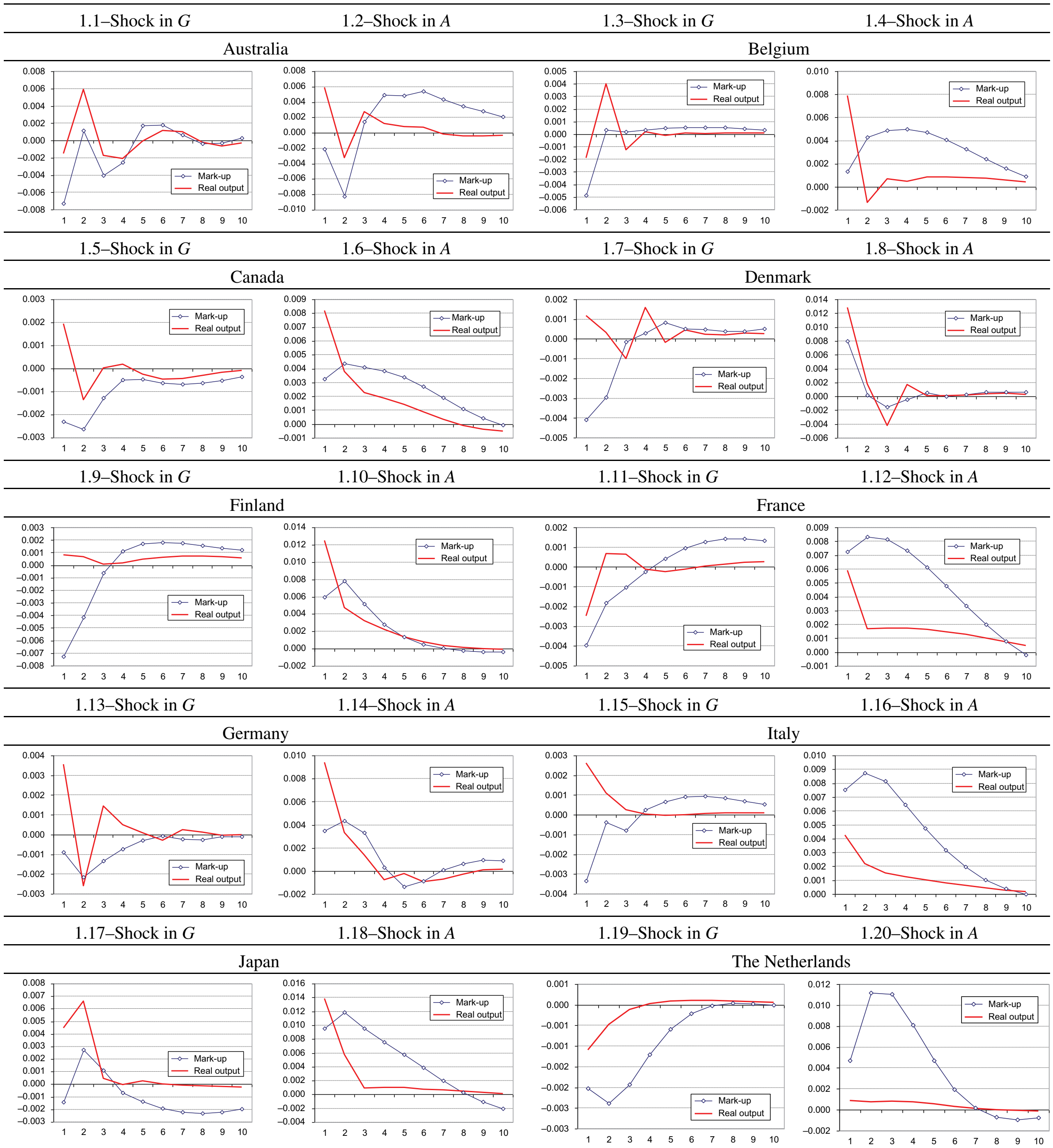

Fig. 1. Responses to a one-standard-deviation shock

Canada, Italy, Japan, UK and US also present occasionally less expected combinations. Again, the results obtained for most countries tend to favour existing theoretical models with endogenous counter-cyclical markups for demand shocks: a government-spending shock, or a similar aggregate-demand shock, implies a shift to the right in the demand curve and a rightward movement along the marginal cost curve when output increases, with a smaller increase in prices than the one observed in marginal costs.[17]

However, most (desired or undesired) endogenous markups theoretical models with predict counter-cyclical

[17] Once again, the nominal rigidity example illustrates how the (undesired) markup reduction (increase) arises simultaneously with an output increase (reduction).

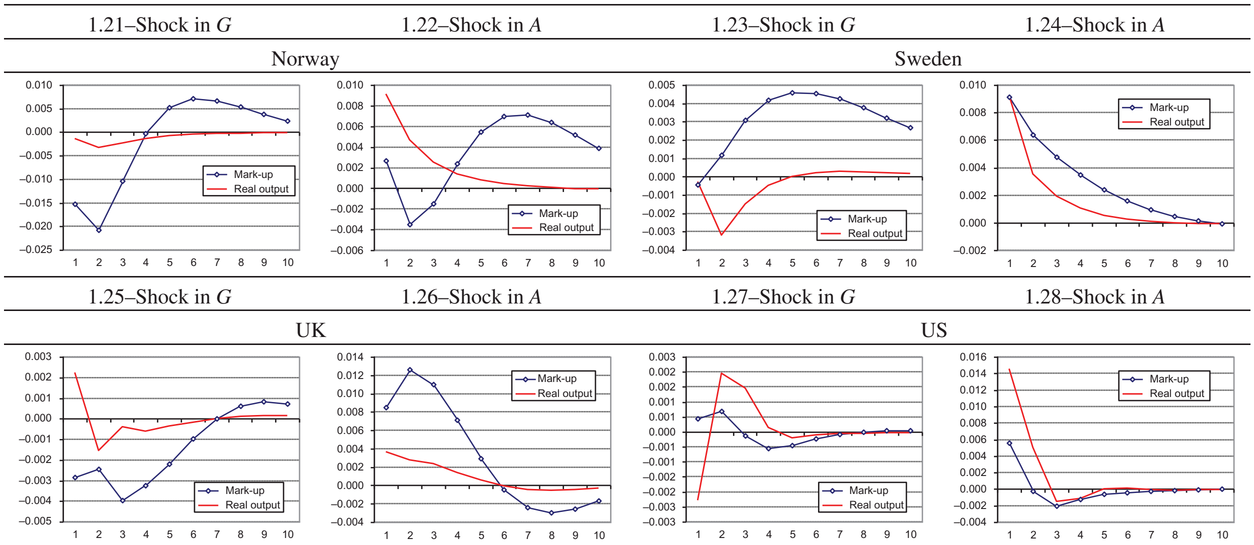

Fig. 1. Continued

Table 2. Cyclical behaviour of average markups: signs of impact responses of μ and Y after a shock in $q = A, G$

Country i	$q = A$: Sign $(\mu_{i1}(\varepsilon^q_{i1}))$	$q = A$: Sign $(\Delta \ln Y_{i1}(\varepsilon^q_{i1}))$	$q = G$: Sign $(\mu_{i1}(\varepsilon^q_{i1}))$	$q = G$: Sign $(\Delta \ln Y_{i1}(\varepsilon^q_{i1}))$
Australia	–	+	–	–
Belgium	+	+	–	–
Canada	+	+	–	+
Denmark	+	+	–	+
Finland	+	+	–	+ (a)
France	+	+	–	–
Germany	+	+	–	+
Italy	+	+	–	+
Japan	+	+	–	+
The Netherlands	+	+ (a)	–	− (a)
Norway	+ (a)	+	–	–
Sweden	+	+	− (a)	− (a)
UK	+	+	–	+
US	+	+	+ (a)	–

Notes: $X_{i1}(\varepsilon^q_{i1})$ stands for the response of $X = \mu, \Delta \ln Y$ to a shock in $q = A, G$ occurring at time $t = 1$ in country i. (a) the zero response of X to an impulse in q is within the confidence bands.

markups when shocks originate on the demand side of the economy and pro-cyclical markups with TFP shocks. The evidence produced here points precisely in this direction. On the other hand, the relative strength of positive and negative effects of fiscal policy is also rather controversial in the empirical literature.

Hall (2009) surveys the literature on fiscal policy effectiveness, especially on VAR estimates of short-run multipliers, and relates it to markup measures using a counter-cyclical markup model.

Robustness

We replicated the VAR estimations for all the countries using three alternative ordering permutations that keep TFP in the first position, while changing the relative position of government spending with respect to output and markups, following Christiano *et al.* (1999).

If we concentrate in the first-period response to a TFP shock, we conclude that the pattern is exactly the same as in our baseline: the markup is pro-cyclical for permutations in all countries, apart from Australia that remains counter-cyclical. This should not come as a surprise, given the fact that we always kept TFP in the first position.

When we observe the response to a spending shock in the first relevant period,[18] the conclusion is not clear-cut: Finland and US present counter-cyclical markups, i.e. markups and output move in opposite directions, for all permutations; Norway always presents pro-cyclical markups; Canada, Denmark, Germany, Italy, Japan, the Netherlands, Sweden and UK present counter-cyclical markups in at least half of the permutations; Australia, Belgium and France present pro-cyclical markups in most orderings. Notice that the Netherlands and Sweden have mostly counter-cyclical markups in the permutations considered, contrary to the baseline estimation.

When we place G after Y, but keep μ at the end, we still have a negative response of markups to spending shocks in all countries but Sweden, although the increased variance more than doubles the number of countries for which zero is within the bands. The response of output is similar even if the countries with positive (negative) responses are not the same.

The other permutations that place μ before Y increase the number of countries with a positive response of output, but decrease the number of those with a negative response of markups to a spending shock. Nonetheless, we always observe at least 8/14 negative responses.

Using alternative markups and the corresponding TFP measures in the VAR analysis for a selection of countries provided similar results.[19]

In addition, we estimated the VAR models using first differences of the variables' level, instead of logs, but results were broadly similar.

Panel VAR

In this section, we estimate the PVAR model to pool together the time and cross-sectional dimensions and gain efficiency in the estimation.[20] The PVAR specification draws on the country-specific case (Equation 7) and can be written as

$$\mathbf{X}_{it} = \mathbf{c}_0 + \sum_{j=1}^{p} \mathbf{V}_j \mathbf{X}_{it-j} + \mathbf{v}_i + \varepsilon_{it} \tag{8}$$

Index i ($i = 1,\ldots,N$) denotes the country, index t ($t = 1,\ldots,T$) the period, $\mathbf{X}_{it} \equiv \left[\Delta \ln A_{it} \quad \Delta \ln G_{it} \quad \Delta \ln T_{it} \quad \Delta \ln Y_{it} \quad \mu_{it}\right]'$ is the vector of the endogenous variables, $\boldsymbol{c}0$ is a vector of intercepts, $\mathbf{V}$ is the matrix of autoregressive coefficients, $\mathbf{v}_i$ is the matrix of country-specific fixed effects and $\varepsilon_{it} \equiv \left[\varepsilon_{it}^{A} \quad \varepsilon_{it}^{G} \quad \varepsilon_{it}^{T} \quad \varepsilon_{it}^{Y} \quad \varepsilon_{it}^{\mu}\right]'$ is the vector of random disturbances. The lag length for endogenous variables (p) is set to one, based on the previous country-specific VAR evidence.[21] Since our time dimension is not small, using time dummies would imply an efficiency loss.

PVAR allows treating all variables as jointly endogenous, each one depending on its past information and on the realizations of the other. In addition, this approach increases the degrees of freedom in the estimation. However, PVAR imposes a similar lag structure across all countries. Nevertheless, cross-sectional heterogeneity can be accounted for via fixed effects, and the bias due to the existence of lagged endogenous variables can be overcome by using GMM.[22]

Moreover, the cross-sectional dimension analysis is useful since it can take into account cross-country dependence, reflecting common changes in the behaviour of fiscal authorities in several countries, e.g. European countries in the run-up to European and Monetary Union. It can also capture significant financial markets integration and liberalization or increased business cycle synchronization for this set of homogeneous OECD economies.

We also checked for the existence of unit roots in the panel using the panel data integration tests of Im *et al.* (2003) and Levin *et al.* (2002), which assume cross-sectional independence among panel units (except for common time effects). Concerning the first difference of TFP, government spending, revenues and GDP, the panel data unit root tests[23] reveal that the null unit root hypothesis can be rejected. The same is true for the markup level, which overall confirms the same integration as in the country-specific analysis.

The results of the PVAR impulse-response functions are presented in Fig. 2. Accordingly, we observe a pro-cyclical behaviour of markups with TFP shocks and a counter-cyclical behaviour of markups with fiscal-spending shocks. Such results confirm the overall picture uncovered with the country-specific VAR evidence.

We also checked PVAR for robustness using the permutations described in Section 'Robustness'. For TFP

[18] We mean the first when G precedes both Y and μ in the VAR order. However, we have to consider the cumulated effect of the first two periods when either Y or μ are ordered before government spending.

[19] The results are not shown due to space constraints. However, all the alternative markup measures produced are available in the data set.

[20] Beetsma *et al.* (2008) also use a PVAR approach in a related context for fiscal and external imbalances.

[21] The use of fixed effects is adequate since this is essentially the set of countries available and we are not concerned with a larger population, in generalizing the results or in out-of-sample predictions (that would be the use of random effects).

[22] In our computations, we use the programs from Love and Zicchino (2006), which include a routine for the removal of the fixed effects via the Helmert transformation and uses GMM to estimate the system OLS.

[23] See Appendix 3 in Afonso and Costa (2010).

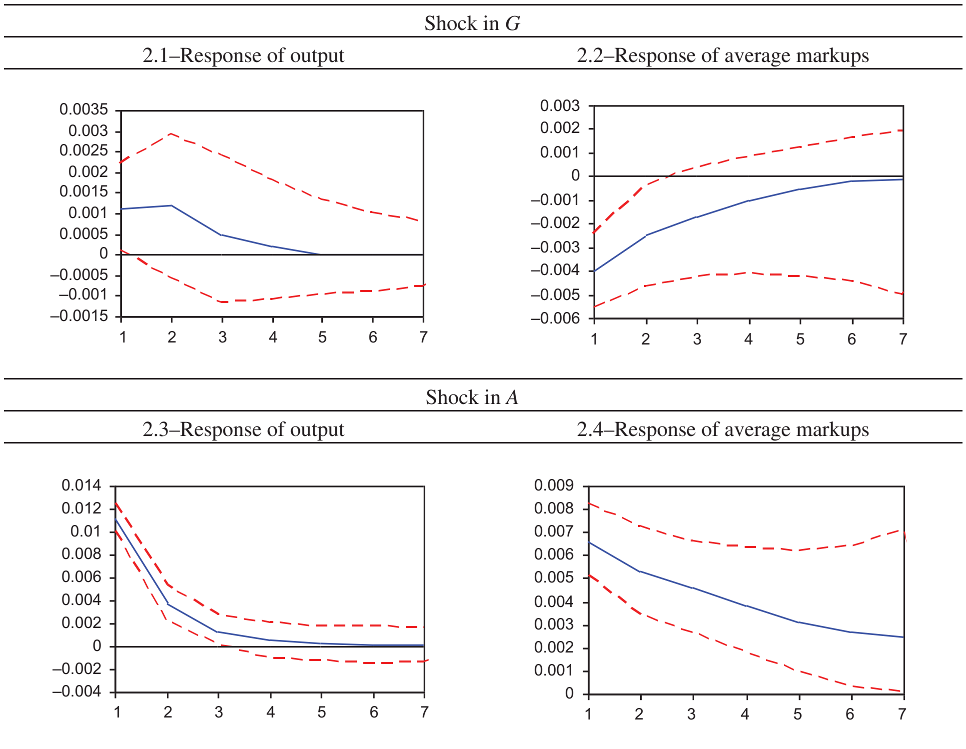

Fig. 2. Panel VAR impulse-response functions
Note: Errors are 5% on each side generated by Monte Carlo with 1000 replications.

shocks, we conclude that markups are also pro-cyclical in all permutations and for spending shocks markups are counter-cyclical in half of them (when government spending is in the last position or when the markup precedes it).

V. Conclusion

We computed average markups throughout time as a market-power measure and studied its interaction with fiscal policy and other macroeconomic variables, using a five-variable annual VAR for OECD countries. The markup measure is calculated in a standard fashion, but we allowed for smooth changes in the long-run technological parameters.

We produced illustrative results with annual data for the period 1970–2007, for a group of 14 OECD countries. The VAR impulse-response functions show that, in general, markups depict (i) a pro-cyclical behaviour with productivity shocks and (ii) a counter-cyclical behaviour in most countries with fiscal-spending shocks.

Finally, we used a PVAR analysis, increasing the efficiency in the estimations, which overall confirmed the country-specific results regarding the behaviour of markups. The robustness analysis carried out confirms the baseline results.

From a policy point of view, positive productivity shocks imply, by its nature, a rightward shift in labour demand, but an increased markup weakens the initial expansive effect on both employment (and output) and real wages. On the other hand, positive government-spending shocks show, besides their usual wealth effect via future taxes expanding the labour supply, an additional effect due to a decrease in markups that shifts the labour demand rightwards, stimulating further employment (and output) and also real wages. Our results, illustrating the counter-cyclical behaviour of markups with government-spending shocks, imply stronger fiscal policy effectiveness on output and this is especially relevant when the fiscal multiplier is positive.

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References

Afonso, A. and Costa, L. (2010) Market power and fiscal policy in OECD countries, European Central Bank Working Papers 1173, ECB, Frankfurt am Main.

Bayoumi, T., Laxton, D. and Pesenti, P. (2004) Benefits and spillovers of greater competition in Europe: a macroeconomic assessment, NBER Working Papers 10416, NBER, Massachusetts, MA.

Beetsma, R., Giuliodori, M. and Klaassen, F. (2008) The effects of public spending shocks on trade balances and budget deficits in the European Union, *Journal of the European Economic Association*, **6**, 414–23.

Beetsma, R., Giuliodori, M. and Klaassen, F. (2009) Temporal aggregation and SVAR identification, with an application to fiscal policy, *Economics Letters*, **105**, 253–5.

Bilbiie, J., Ghironi, F. and Melitz, M. (2012) Endogenous entry, product variety, and business cycles, *Journal of Political Economy*, **120**, 304–45.

Blanchard, O.-J. and Perotti, R. (2002) An empirical characterization of the dynamic effects of changes in government spending and taxes on output, *The Quarterly Journal of Economics*, **117**, 1329–68.

Christiano, L., Eichenbaum, M. and Evans, C. (1999) Monetary policy shocks: what have we learned and to what end?, in *Handbook of Macroeconomics*, (Eds.) J. Taylor, and M. Woodford, Elsevier, Amsterdam, pp. 65–148.

Christiano, L., Eichenbaum, M. and Rebelo, S. (2011) When is the government spending multiplier large?, *Journal of Political Economy*, **119**, 78–121.

Christopoulou, R. and Vermeulen, P. (2012) Markups in the euro area and the US over the period 1981–2004: a comparison of 50 sectors, *Empirical Economics*, **42**, 53–77.

Clarida, R., Galí, J. and Gertler, M. (1999) The science of monetary policy: a new Keynesian perspective, *Journal of Economic Literature*, **37**, 1661–707.

Costa, L. (2004) Endogenous markups and fiscal policy, *Manchester School*, **72**, 55–71.

Costa, L. and Dixon, H. (2011) Fiscal policy under imperfect competition with flexible prices: an overview and survey, *Economics: The Open-Access, Open-Assessment E-Journal*, **5**, 1–57.

dos Santos Ferreira, R. and Lloyd-Braga, T. (2005) Non-linear endogenous fluctuations with free entry and variable markups, *Journal of Economic Dynamics and Control*, **29**, 847–71.

Feenstra, R. (2003) A homothetic utility function for monopolistic competition models, without constant price elasticity, *Economics Letters*, **78**, 79–86.

Galí, J. (1994) Monopolistic competition, business cycles, and the composition of aggregate demand, *Journal of Economic Theory*, **63**, 73–96.

Goodfriend, M. and King, R. (1997) The new neo-classical synthesis and the role of monetary policy, *NBER Macroeconomics Annual*, **12**, 231–83.

Hairault, J.-O. and Portier, F. (1993) Money, new-keynesian macroeconomics and the business cycle, *European Economic Review*, **37**, 1533–68.

Hall, R. (1988) The relationship between price and marginal cost in U.S. Industry, *Journal of Political Economy*, **96**, 921–47.

Hall, R. (2009) By how much does GDP rise if the government buys more output?, *Brookings Papers on Economic Activity*, **40**, 183–249.

Heijdra, B. (1998) Fiscal policy multipliers: the role of monopolistic competition, scale economies, and intertemporal substitution in labour supply, *International Economic Review*, **39**, 659–96.

Ilzetki, E., Mendoza, E. and Végh, C. (2013) How big (small) are fiscal multipliers?, *Journal of Monetary Economics*, **60**, 239–54.

Im, K., Pesaran, M. and Shin, Y. (2003) Testing for unit roots in heterogeneous panels, *Journal of Econometrics*, **115**, 53–74.

Jaimovich, N. (2007) Firm dynamics and markup variations: implications for sunspot equilibria and endogenous economic fluctuations, *Journal of Economic Theory*, **137**, 300–25.

Juessen, F. and Linnemann, L. (2012) Markups and fiscal transmission in a panel of OECD countries, *Journal of Macroeconomics*, **34**, 674–86.

Levin, A., Lin, C.-F. and Chu, C.-S. (2002) Unit root tests in panel data: asymptotic and finite sample properties, *Journal of Econometrics*, **108**, 1–24.

Linnemann, L. (2001) The price index effect, entry, and endogenous markups in a macroeconomic model of monopolistic competition, *Journal of Macroeconomics*, **23**, 441–58.

Love, I. and Zicchino, L. (2006) Financial development and dynamic investment behavior: evidence from panel VAR, *Quarterly Review of Economics and Finance*, **46**, 190–210.

Martins, J. O. and Scarpetta, S. (2002) Estimation of the cyclical behaviour of mark-ups: a technical note, *OECD Economic Studies*, **34**, 173–88.

Martins, J., Scarpetta, S. and Pilat, D. (1996) Mark-up pricing, market structure and the business cycle, *OECD Economic Studies*, **27**, 71–105.

Monacelli, T. and Perotti, R. (2008) Fiscal policy, wealth effects, and markups, NBER Working Paper 14584, NBER, Massachusetts, MA.

Nekarda, C. and Ramey, V. (2010) *The Cyclical Behavior of the Price-Cost Markup*, *mimeo*, University of California, Berkeley.

Portier, F. (1995) Business formation and cyclical markups in the French business cycle, *Annales D'economie Et De Statistique*, **37/38**, 411–40.

Ravn, M., Schmitt-Grohé, S. and Uribe, M. (2006) Deep habits, *Review of Economic Studies*, **73**, 195–218.

Ravn, M., Schmitt-Grohé, S. and Uribe, M. (2008) Macroeconomics of subsistence points, *Macroeconomic Dynamics*, **12**, 136–47.

Roeger, W. (1995) Can imperfect competition explain the difference between primal and dual productivity measures? Estimates for U.S. manufacturing, *Journal of Political Economy*, **103**, 316–30.

Rotemberg, J. and Woodford, M. (1991) Markups and the business cycle, *NBER Macroeconomics Annual*, **6**, 63–128.

Rotemberg, J. and Woodford, M. (1992) Oligopolistic pricing and the effects of aggregate demand on economic activity, *Journal of Political Economy*, **100**, 1153–207.

Rotemberg, J. and Woodford, M. (1999) The cyclical behavior of prices and costs, in *Handbook of Macroeconomics*, (Eds.) J. Taylor and M. Woodford Elsevier, Amsterdam, pp. 1051–135.

Woodford, M. (2011) Simple analytics of the government expenditure multiplier, *American Economic Journal – Macroeconomics*, **3**, 1–35.

Zivot, E. and Andrews, D. (1992) Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis, *Journal of Business and Economic Statistics*, **10**, 251–70.