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MACRO-FISCAL VOLATILITY AND THE COMPOSITION OF PUBLIC SPENDING

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Abstract

Earlier empirical literature has examined some long- and medium-term aspects of macro-fiscal volatility while leaving its short-term fiscal impact unexplored. To help fill that gap, we examine the impact of macro-fiscal volatility on the composition of public spending. To that end, we analyse a panel of 10 EU countries during 1991—2007. Our results suggest that contemporaneous increases in the volatility of regularly collected revenues such as the VAT and income taxes tend to tilt the expenditure composition in favour of public investment. In contrast, increases in the volatility of ad hoc –type of taxes such as capital taxes tend to favour public consumption spending. A possible explanation to these differences concerns news about the underlying economic conditions embedded in short-term volatility changes: the policy maker may be more inclined to increase public investment in response to persistent changes in the economic conditions, while temporary changes may prompt a reaction on consumption spending.

1. Introduction

The volatility of macro-economic and fiscal variables has become an increasingly fashionable topic. A number of recent empirical papers, reviewed below, have sought to assess the link between macro-fiscal volatility and the volatility or cyclicality of public spending. Others have examined the link between macro-fiscal volatility and countries' growth performance.

Earlier literature has thus addressed some issues related to the longer-term (growth) and medium-term (cyclicality) aspects of macro-fiscal volatility but, to the best of our knowledge, its shorter-term effects have not been examined at all. Specifically, volatility and changes in volatility tell us something about "news" to the policy maker, and it seems that our knowledge of how policy makers respond to such news is almost non-existent.

To start filling this gap, we consider the impact of macro-fiscal volatility on the composition of government spending. That is, we study how (changes in) the volatility in macroeconomic and fiscal (revenue-side) variables affect the relative weights of government investment and government consumption spending. As a result, we seek to gain some first insights into fiscal policy responses to short-term macro-fiscal volatility.

Before proceeding, it is important to clarify two issues related to the terminology used in the remainder of the paper.

First, the terms "public investment (spending)" and "government investment (spending)" will be used interchangeably, as is customary in related literature. However, as pointed out by Gonzalez Alegre et al. (2008), government investment comprises gross fixed asset formation by the general government, while public investment also includes investment in government-owned corporations, such as many utilities. Thus, although we succumb to custom and frequently refer to public investment (spending) below, our sole focus is on government investment (spending).

Second, as will become clear in next section, earlier studies have examined public expenditure composition in number of different ways, relating the evolution of public investment to different other spending categories such as public consumption expenditure, primary spending, current expenditure, or even total outlays. Our focus will be on the relationship between investment and consumption spending, both because that is arguably the economically most relevant comparison, and because consumption is most similar to investment as a policy maker's decision variable; thus, by focusing on consumption rather than, e.g., current spending we reduce unwelcome noise due to inherent differences between the components constituting our dependent variable.

These caveats duly noted we proceed to a review of earlier related literature (section 2). Section 3 presents the empirical analysis, section 4 interprets the results and section 5 concludes.

2. Related literature

A few recent empirical papers have considered indicators of macro-fiscal volatility either as right-hand side or as left-hand side variables. First, the impact of macro-fiscal volatility on economic growth has been assessed (Afonso and Furceri, 2008; see also Ramey and Ramey, 1995). Second, determinants of government spending volatility have been assessed in general (Furceri and Ribeiro, 2008), and the cyclicality of different categories of government spending has been studied in particular (Lane, 2003), with a special focus on the impact of output volatility.

Starting with macro-fiscal volatility as a determinant of economic growth, Afonso and Furceri (2008) estimate the effects of the size and volatility of government spending and revenues on output growth. They observe 28 EU and OECD countries over seven five-year periods between 1970 and 2004 and specify separate panel growth models for government revenues, including their volatility, and government expenditure, again including their volatility. They find that both the size and the volatility of government spending and revenues have a negative impact on growth. Specifically, indirect taxes (size and volatility); social contributions (size and volatility); government consumption (size and volatility); subsidies (size); and government

investment (volatility) have a sizeable, negative and statistically significant effect on growth.

Ramey and Ramey (1995) investigate the relation between macro-fiscal volatility and growth in a panel of 92 countries in the period 1960-85, and in a subset of 24 OECD countries in the period 1950-88. They first regress the mean of GDP growth on its volatility, finding a significant and negative relationship. They then regress per capita GDP growth on a set of control variables—including government spending volatility—and on the volatility of the regression residuals, finding a strongly significant and negative relationship between government spending volatility and growth.

Turning then to the determinants of government spending volatility, Furceri and Ribeiro (2008) examine the link between country size and government spending volatility. The sample includes observations for 160 countries from 1960 to 2000. The authors regress the standard deviation of annual growth in government consumption spending on the (log of) population and controls for demographic, geographical and macroeconomic factors (GDP per capita, openness, CPI inflation, and government size). They conclude that smaller countries tend to have more volatile government (consumption) spending.

Finally, considering the impact of output volatility on the composition of government spending, Lane (2003) seeks to explain the cyclical behaviour of fiscal policy by analysing the effects of output volatility (and also power dispersion) on various categories of government spending. The sample comprises 22 OECD countries observed over the period 1960-98 (annual data). The categories of government spending considered are total government spending, government consumption and its breakdown between wage and non-wage components, government investment, and non-interest total government spending. Lane constructs measures of cyclicality for each of these spending categories and regresses them on output volatility, political power dispersion, output per capita, openness and the share of public sector employment. He concludes that investment is the most pro-cyclical component of government spending, while current spending is mildly counter-cyclical. Further, countries with volatile output and dispersed political power are most likely to run pro-

cyclical fiscal policies, with government wage expenditure as the most important channel through which this effect operates.

To sum up, recent work has cast some light on how fiscal volatility affects economic growth and on what determines the volatility (or cyclicality) of different types of government spending. In general, it has been found that macro-fiscal volatility is detrimental for growth and that country size, output volatility and political dispersion all affect government spending volatility or cyclicality.

3. Empirical analysis

3.1 Model and estimation methodology

Our goal is to model the determinants of the composition of public expenditure, with a special focus on the volatility of macroeconomic and fiscal (revenue-side) variables. To that end, we consider the ratio of public investment to public consumption spending as our dependent variable. We are interested in estimating short-term impacts on the composition of public spending, so we make use of the observation that the ratio of public investment to consumption expenditure has shown persistence over time[1] and specify a dynamic model in reduced form as follows:

$$\left(\frac{I}{C}\right)_{\text{it}} = \alpha\left(\frac{I}{C}\right)_{it-1} + \sum_j \beta_j \sigma_{jt} + \sum_k \delta_k X_{kt} + \gamma_i + u_{it} \qquad (1)$$

where $u_{it} \sim$ i.i.d $(0, \sigma_u^2)$, with subscript i referring to observations in the cross-section dimension (individual countries) and t to observations in the time dimension.

The dependent variable is the ratio of public investment to public consumption spending (I/C).

[1] The first-order autocorrelation of that ratio in our sample, described in detail in section 3.2, is as high as 0.862.

Our macro-fiscal volatility variables of interest are collected in the second term of (1). The macro-volatility variables include the volatility (standard deviation) of real GDP, CPI inflation and also total tax revenues. The more specific fiscal volatility variables include the standard deviation of four types of tax revenues (taxes on capital; current taxes on income and wealth; taxes on production and imports; the Value Added Tax (VAT)). These taxes are more closely described in the next section; suffice it to mention here that we consider the volatility of these taxes both in levels and in relation to GDP.

The third term on the right-hand side of (1) contains a number of control variables X. Their role is simply to render the model empirically well-specified, and we do not seek to give them any economic interpretation. The selection of controls is based on earlier empirical literature summarised in section 2, with a special focus on controlling for any cyclical influences.

This dynamic specification of our model (1) allows us to interpret the impact of the volatility measures as "news" about the underlying economic conditions to which the composition of public spending reacts.[2] The volatility variables measure only the impact of any contemporaneous (at time t) change in the standard deviation, as the volatility history is entirely captured by the lagged dependent variable. In what is to come, such contemporaneous volatility innovations are interpreted as news to the policy maker to which he reacts by changing the composition of public spending.

The estimation of (1) will have to account for the correlation between the regressors (lagged dependent) and the composite term ($\gamma_i + u_{it}$) where γ_i denotes country-specific random effects, which renders least squares estimators inconsistent even asymptotically. To circumvent this problem we employ General Method of Moments (GMM) estimation (Arellano and Bond, 1991)[3]. To that end, we need to specify a set of moment conditions using instruments that are orthogonal to the error term. Assuming that the error term is not serially correlated and that the explanatory variables are weakly exogenous, higher-order lags of the dependent variable constitute

[2] We adopt here the term "news", based on Greene (2003, p. 307).
[3] Note that the estimation is done in first differences, eliminating any long-term trend behaviour, the constant term, as well as any fixed effects from (1).

valid instruments. (Higher-order) lags of other, possibly endogenous explanatory variables can also be used as instruments under the same assumptions.

While identification requires the number of instruments to equal the number of explanatory variables, overidentification is in practice necessary, as it both allows the testing of the moment conditions and improves efficiency. There is, however, a possible trade-off between bias and efficiency when the number of instruments (moment conditions) is increased with small samples (see, e.g. Roodman, 2007). We employ the Sargan overidentification test, together with a consideration of the robustness of coefficient estimates to different instrument sets, as a criterion to manage this trade-off.

3.2 Data

The dataset consists of a panel of 10 EU member states[4], with annual data for the period 1991-2007. Due to the unbalancedness of the panel the total number of observations is 121—138.

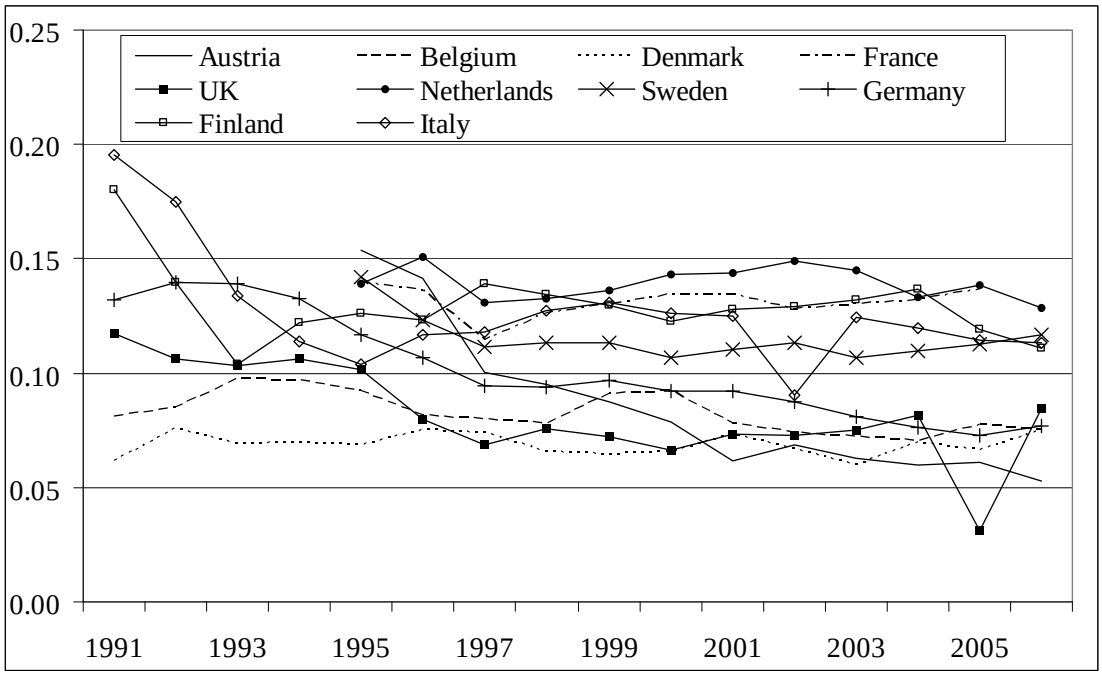
The ratio of public investment to public consumption expenditure is depicted in Figure 1. That ratio is, on average, about 0.1, which seems high at the outset, given that total government expenditure in our sample is roughly 50 percent of GDP while investment only amounts to some 2.5 percent of GDP. While we consider government investment as is customary (gross fixed capital formation of the general government), our focus on government consumption means that some categories of current spending, such as interest payments and some subsidies and transfers, are excluded from our denominator.

More specifically, and following Straub and Tchakarov (2007), we employ the variable "final consumption expenditure of the general government", as defined in the UN System of National Accounts, to account for governments' true consumption spending. It comprises non-market output and social transfers in kind related to expenditure on products supplied to households via market producers. Final

[4] Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Sweden, and the UK.

consumption expenditure thus defined amounts on average to 25 percent of GDP in our sample. All data on government investment are obtained from Eurostat, while the data on government consumption originate from the OECD.

Figure 1. Dependent variable



Source: Eurostat, authors' calculations.

Turning then to our variables of interest, we construct a time series of annual observations on the standard deviation of each volatility variable of interest. We assume that public expenditure composition in year *t* can be affected by the volatility of revenues in year *t* and *t-1* but that further lags do not add any explanatory power. The annual observations on the volatility of revenues are computed on the basis of a rolling window covering eight quarters, covering the year of the observation on the dependent and the preceding year. In other words, the volatility variables explaining public expenditure composition in year *t* are calculated on the basis of quarterly observations in year *t* and *t-1*. The standard deviations are calculated using seasonally adjusted quarterly data.

The macro-volatility variables comprise real GDP (labelled volrealgdp henceforth, source Eurostat) and CPI inflation ("volinflation", source OECD). We also consider the volatility of total tax revenues, both in levels and as a share of GDP ("voltaxtot" and "voltaxtot_gdp", respectively, source Eurostat), among the macro-volatility indicators.

Volatility indicators for individual sub-groups of taxes are based on the breakdown of taxes according to European System of Accounts (ESA), version 1995, and include current taxes on income and wealth (abbreviated “taxiw” in subsequent tables); taxes on capital (“taxc”); taxes on production and imports (“taxpm”); and the VAT (“taxvat” or “vat”).

- Current taxes on income and wealth comprise all taxes levied regularly on personal and corporate income, as well as taxes on capital gains.

- Taxes on capital include ad hoc taxes such as inheritance taxes, death duties, taxes on gifts and so-called betterment levies (e.g., taxes on the increase in land value due to planning permissions).

- Taxes on production and imports include taxes on products except the VAT (general sales or turnover taxes, excise duties, stamp taxes, taxes on financial and capital transactions, car registration taxes, export duties, etc.); taxes on imports (import duties and all other taxes on imports, excluding the VAT); and other taxes on production (e.g., payroll taxes, property taxes on enterprises, licence fees, pollution taxes).

All these taxes, including also the VAT, are reported at the level of the general government. The volatility measures are constructed as explained above, based on a backward-looking eight-quarter rolling window. The volatilities are calculated on each tax type in level terms and in relation to GDP.

Finally, the set of significant controls include log real GDP per capita (log_gdp_pc; source OECD); public debt relative to GDP (debt_gdp; source Ameco); and external trade balance relative to GDP (extbal_gdp; source OECD). We also report the (insignificant) coefficient estimates for a dummy variable indicating EMU participation (emu). We also consider the interaction term of each tax volatility variable (in level terms) and the real GDP variable, so as to discern the direct effect of the tax volatility on the composition of public spending and its indirect effect through GDP (business cycle).

Table 1 reports descriptive statistics of the variables employed in the estimation.

Table 1. Descriptive statistics of the data

	N	mean	max	min	sd
IC	160	0.104	0.177	0.025	0.031
volrealgdp	158	2549.882	10433.5	247.124	2504.076
volinfl	142	0.330	1.156	0.069	0.181
voltaxtot	158	1751.951	7529.375	86.280	1652.336
voltaxtot_gdp	158	0.223	1.419	0.009	0.210
voltaxiw	158	700.413	3589.953	7.009	755.090
voltaxiw_gdp	158	0.148	0.520	0.006	0.123
voltaxc	158	29.264	316.740	0.132	48.525
voltaxc_gdp	158	0.009	0.093	0.000	0.015
voltaxpm	158	703.948	2653.672	28.039	645.411
voltaxpm_gdp	158	0.103	1.044	0.003	0.146
voltaxvat	158	350.745	1287.957	18.817	320.985
voltaxvat_gdp	158	0.052	0.221	0.002	0.041
log_GDP_pc	160	8.790	12.587	4.259	3.050
debt_gdp	160	0.671	1.340	0.221	0.255
extbal_gdp	160	0.029	0.115	-0.032	0.033
emu	170	0.618	1.000	0.000	0.487

Panel unit root test results are reported in Annex 1, including both the Levin, Lin and Chu test assuming homogeneity in the individual unit root processes, and the Im, Pesaran and Shin test allowing for individual heterogeneity in the unit root processes. Both tests confirm that all variables are difference stationary.

Annex 2 reports correlation coefficients between the volatility variables. The macro-economic volatility variables are highly correlated with the tax volatility variables, especially in level terms, so we perform separate analyses of how the former affect the composition of public spending and how the latter affect it.

Similarly, the correlation coefficients among the tax volatility variables, when based on real levels data, are high, in some cases 0.8—0.9. The only exception is the capital tax volatility variable, whose correlation coefficient with the other tax volatilities never exceeds 0.5. We therefore group the tax volatilities into three groups within which correlations are low—combining the capital tax volatility with each of the others—and run separate regressions for each group. In contrast, when measured relative to GDP the tax volatilities are much less correlated with one another, with the

correlation coefficient always below 0.31, so we can include all of them in one regression.

3.3 Results

In this section we report the estimation results for the preferred specifications of model (1). The results with macro-economic volatility variables as regressors are reported first, including the volatility of aggregate tax revenues, followed by the results with the volatility of sub-groups of taxes as regressors. The tables below show the preferred model specifications in terms of the variables treated as endogenous; the number of lags included as instruments; and the set of control variables employed. The robustness of the estimation results to changes in the specification is discussed as appropriate. The interpretation of the results from an economic perspective is done in section 4.

Starting with the impact of macro-economic volatility on the composition of public spending, Table 2 shows the results with real GDP volatility, CPI inflation volatility, and total tax revenue volatility as regressors. Table 2 shows seven different model specifications (A—G) which differ mainly in terms of the controls and variables treated as endogenous. In all cases the number of lags of the dependent and the endogenous variables used as instruments is 3. This choice is based on the Sargan test for overidentifying restrictions (shown at the bottom of the table), as well as on the observation that coefficient estimates change materially as the number of lags is increased. This suggests a possible bias from employing too many instruments; hence, we opt for a small number of lags, possibly losing some efficiency in the estimation. Tests for the first and second order residual autocorrelation are also shown at the bottom of the table.

We note based on the diagnostic test results that all seven models are well specified; however, the test statistic for the Sargan test suggests a possible problem with the set of overidentifying restrictions for specification C, where GDP alone is included and is considered endogenous. That is also the only specification where the coefficient for the lagged dependent is insignificant and much smaller in magnitude than otherwise.

In specifications A, D and E both GDP and public debt are endogenous. GDP is insignificant throughout, but lagged public debt (to GDP) is significant. Note that we can interpret the GDP variable as controlling for the impact of business cycles, given that the estimation is done in first differences (which eliminates any trend effects) and given that the data frequency is annual (which eliminates any seasonal effects).

Both real GDP volatility and CPI inflation volatility are strongly insignificant throughout, as is the control variable trade openness. (In A the EMU dummy was also included but is not shown due to insignificance.) The macro-economic volatility variables are also insignificant in the most parsimonious specification B.

Consequently, innovations to neither GDP volatility nor inflation volatility affect the composition of public spending in our sample. Note that the dynamic specification of the model implies that the estimated impact of the volatility variables measures the impact of contemporaneous innovations to them, over and above the impact of the lagged dependent.

Columns F and G show the preferred specification with the volatility of total tax revenues (in levels) and the volatility of total tax revenues as a share of GDP, respectively, as a regressor. The volatility of total tax revenues is insignificant when measured in levels, but weakly significant when measured in relation to GDP. In the latter case it has a negative sign, implying that a contemporaneous increase in volatility tends to reduce the dependent variable, that is, increase the relative share of public consumption spending at the cost of public investment.

Table 2. Estimation results: Macro-volatility
(dependent variable: ratio of public investment to public consumption spending)

	A coef/p-value	B coef/p-value	C coef/p-value	D coef/p-value	E coef/p-value	F coef/p-value	G coef/p-value
LD.i_c	0.335**	0.467**	0.119**	0.346**	0.335**	0.673**	0.256**
	(0.000)	*(0.000)*	*(0.320)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.006)*
D.log_gdp_pc	0.077		-0.201+	0.097	0.077		0.040
	(0.599)		*(0.106)*	*(0.502)*	*(0.597)*		*(0.769)*
LD.log_gdp_pc	-0.136		0.160	-0.162	-0.136		-0.116
	(0.345)		*(0.186)*	*(0.246)*	*(0.343)*		*(0.375)*
D.debt_gdp	0.038			0.041	0.038		0.022
	(0.423)			*(0.393)*	*(0.421)*		*(0.618)*
LD.debt_gdp	-0.1090**			-0.114**	-0.109**		-0.079*
	(0.021)			*(0.015)*	*(0.021)*		*(0.056)*
D.volrealgdp	0.000	0.000	0.000+	0.000	0.000		0.000
	(0.221)	*(0.304)*	*(0.102)*	*(0.217)*	*(0.219)*		*(0.243)*
D.volinflation	0.002	0.003	-0.001	0.003	0.002		-0.004
	(0.831)	*(0.779)*	*(0.947)*	*(0.772)*	*(0.830)*		*(0.659)*
D.voltaxtot						0.000	
						(0.794)	
D.voltaxtot_gdp							-0.012*
							(0.072)
D.extbal_gdp	-0.069				-0.069		
	(0.424)				*(0.422)*		
Number of observations	121	121	121	121	121	121	121
lags	*3*	*3*	*3*	*3*	*3*	*3*	*3*
p_sargan	*0.289*	*0.279*	*0.075*	*0.260*	*0.269*	*0.238*	*0.130*
p_ar1	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
p_ar2	*0.623*	*0.695*	*0.614*	*0.605*	*0.622*	*0.832*	*0.617*

note: ** p<0.05, * p<0.1, + p<0.12

As the evidence concerning the impact of the volatility of total tax revenues is weak and inconclusive, we consider next the volatility of individual sub-groups of taxes on the composition of public spending. The estimation results are shown in Table 3—5. Each table shows a different combination of tax volatilities in levels, based on the sample correlation properties as explained above. Both (the log of per capita) GDP and public debt relative to GDP are considered endogenous to ensure robustly satisfactory diagnostic test results. To test the robustness of the estimation results with respect to changes in controls (including interaction terms), each table shows eight different model specifications (A—H), together with the corresponding diagnostic test results. The coefficient estimates of interest are indicated in bold. When discussing the results we bear in mind the interpretation of the coefficient estimates based on the dynamic model specification, although the discussion is given a more straight-forward spin for ease of comprehension.

Table 3 considers the volatility of taxes on income and wealth as well as on capital (in levels, specifications A—D), as well as all tax volatilities in relation to GDP (specifications E—H). The difference between Tables 3—5 in terms of specifications E—H concerns the interaction terms; Table 3 focuses on the interaction terms between GDP and the volatilities of taxes on income and wealth as well as capital.

Starting with the tax volatilities in levels, we note that the volatility of taxes on income and wealth is significant and positive throughout, while the volatility of capital taxes is significant and negative throughout. The interaction term between GDP and the volatility of taxes on income and wealth is significant and negative, while the interaction term between GDP and the volatility of capital taxes is insignificant. Of the controls, GDP and public debt (to GDP) are both significant, especially their lags, while neither trade openness nor the EMU dummy is significant.

In sum, innovations to the volatility of taxes on income and wealth tend to increase public investment relative to consumption spending, but their indirect impact through GDP dampens that increase. Innovations to the volatility of capital taxes tend to reduce public investment relative to consumption spending.

Consider then specifications E—H, focussing on the volatilities of these taxes relative to GDP. All controls behave as above, with the estimated coefficients remarkably stable. The volatility of taxes on income and wealth relative to GDP is predominantly significant and positive, and the volatility of capital taxes relative to GDP is predominantly significant and negative. The interaction terms behave as above.

All in all, the volatility of taxes on income and wealth has a robustly positive direct impact, increasing public investment relative to consumption. The indirect cyclical effect dampens that relative gain of public investment. The volatility of capital taxes has a robust negative direct impact, decreasing public investment relative to consumption.

Table 3. Estimation results: Focus on taxes on income and wealth as well as on capital

(dependent variable: ratio of public investment to public consumption spending)

	A	B	C	D	E	F	G	H
	coef/p-value	**coef/p-value**	**coef/p-value**	**coef/p-value**	**coef/p-value**	**coef/p-value**	**coef/p-value**	**coef/p-value**
LD.i_c	0.228793**	0.251217**	0.207281**	0.230412**	0.300198**	0.240334**	0.232415**	0.270123**
	(0.007545)	*(0.002693)*	*(0.020572)*	*(0.005855)*	*(0.000435)*	*(0.005975)*	*(0.006836)*	*(0.002012)*
D.log_gdp_pc	0.168883+	0.189519*	0.194885*	0.180651*	0.174148+	0.152396	0.165895	0.137008
	(0.110378)	*(0.075607)*	*(0.063241)*	*(0.088136)*	*(0.112543)*	*(0.162703)*	*(0.121339)*	*(0.216727)*
LD.log_gdp_pc	-0.224076**	-0.249594**	-0.238574**	-0.221615**	-0.238261**	-0.258703**	-0.271241**	-0.222620**
	(0.031779)	*(0.015652)*	*(0.019928)*	*(0.032446)*	*(0.030571)*	*(0.019607)*	*(0.012313)*	*(0.045885)*
D.debt_gdp	0.075490*	0.071932+	0.087893**	0.077915*	0.034199	0.026144	0.024537	0.020779
	(0.076538)	*(0.100871)*	*(0.034397)*	*(0.072627)*	*(0.414874)*	*(0.507364)*	*(0.532743)*	*(0.605960)*
LD.debt_gdp	-0.150808**	-0.148278**	-0.153946**	-0.137844**	-0.102235**	-0.106416**	-0.108052**	-0.093779**
	(0.000479)	*(0.000502)*	*(0.000367)*	*(0.001073)*	*(0.016209)*	*(0.008714)*	*(0.007631)*	*(0.023620)*
D.voltaxiw	**0.000004***	**0.000004***	**0.000018****	**0.000018****				
	(0.065290)	*(0.087637)*	*(0.025375)*	*(0.012871)*				
D.voltaxc	**-0.000139****	**-0.000134****	**-0.000126**	**-0.000145****				
	(0.000101)	*(0.000105)*	*(0.503659)*	*(0.000041)*				
D.extbal_gdp	-0.102777		-0.121021+	-0.102942	-0.058021	-0.036545	-0.033876	-0.016660
	(0.159396)		*(0.103982)*	*(0.147609)*	*(0.436528)*	*(0.620785)*	*(0.644298)*	*(0.823450)*
D.emu	0.004166		0.003843		0.001825	0.003969	0.003716	0.002531
	(0.344540)		*(0.385678)*		*(0.689219)*	*(0.381110)*	*(0.408369)*	*(0.575448)*
D.voltaxiw_loggdppc			**-0.000002+**	**-0.000002****				
			(0.105388)	*(0.030561)*				
D.voltaxc_loggdppc			**-0.000006**					
			(0.893333)					
D.voltaxiw_gdp					**-0.008966**	**0.078863****	**0.081129****	**0.083157****
					(0.415097)	*(0.028891)*	*(0.021125)*	*(0.021201)*
D.voltaxpm_gdp					-0.009969	-0.030447	-0.014925	-0.001996
					(0.249997)	*(0.505403)*	*(0.128826)*	*(0.826803)*
D.volvat_gdp					0.050400*	0.355505**	0.335552**	0.062590**
					(0.090650)	*(0.001426)*	*(0.000147)*	*(0.038484)*
D.voltaxc_gdp					**-0.305184****	**-0.450706+**	**-0.299578****	**-0.432723**
					(0.006127)	*(0.100714)*	*(0.005836)*	*(0.121187)*
D.voltaxiwgdp_ loggdppc						**-0.009731****	**-0.009819****	**-0.010373****
						(0.012176)	*(0.010272)*	*(0.008174)*
D.voltaxpmgdp_ loggdppc						0.001395		
						(0.706853)		
D.volvatgdp_ loggdppc						-0.031659**	-0.029762**	
						(0.003603)	*(0.001329)*	
D.voltaxcgdp_ loggdppc						**0.027787**		**0.016449**
						(0.571248)		*(0.743656)*
Number obs	138	138	138	138	138	138	138	138
lags	3	3	3	3	3	3	3	3
p_sargan	*0.280650*	*0.239957*	*0.307360*	*0.275901*	*0.163144*	*0.190828*	*0.161312*	*0.198632*
p_ar1	*0.000001*	*0.000001*	*0.000001*	*0.000001*	*0.000000*	*0.000000*	*0.000000*	*0.000000*
p_ar2	*0.433567*	*0.449710*	*0.377300*	*0.402811*	*0.405322*	*0.476528*	*0.501198*	*0.559585*

note: ** p<0.05, * p<0.1, + p<0.12

Next, consider Table 4 showing the estimation results with a focus on taxes on production and imports. The volatility of capital taxes is considered alongside as above as a robustness check, and we note that the results with respect to it are remarkably similar to those reported in Table 3.

Measured in level terms the volatility of taxes on production and imports has a significant and positive impact, with the GDP-interaction dampening it. However, measured relative to GDP, that volatility is no longer significant either directly or through its interaction with GDP. In sum, the volatility of taxes on production and imports does not have an unambiguously significant effect on the composition of public spending.

Table 4. Estimation results: Focus on taxes on production and imports (dependent variable: ratio of public investment to public consumption spending)

	A	B	C	D	E	F	G	H
	coef/p-value	**coef/p-value**	**coef/p-value**	**coef/p-value**	**coef/p-value**	**coef/p-value**	**coef/p-value**	**coef/p-value**
LD.i_c	0.212915**	0.226054**	0.202533**	0.223137**	0.300198**	0.240334**	0.232415**	0.306414**
	(0.012424)	*(0.007100)*	*(0.021245)*	*(0.008055)*	*(0.000435)*	*(0.005975)*	*(0.006836)*	*(0.000401)*
D.log_gdp_pc	0.206197**	0.205139*	0.242151**	0.215161**	0.174148+	0.152396	0.165895	0.177941+
	(0.047654)	*(0.051874)*	*(0.021800)*	*(0.041241)*	*(0.112543)*	*(0.162703)*	*(0.121339)*	*(0.113302)*
LD.log_gdp_pc	-0.259136**	-0.253042**	-0.282501**	-0.254565**	-0.238261**	-0.258703**	-0.271241**	-0.243381**
	(0.011664)	*(0.014145)*	*(0.006133)*	*(0.013450)*	*(0.030571)*	*(0.019607)*	*(0.012313)*	*(0.031816)*
D.debt_gdp	0.086420**	0.083033*	0.115886**	0.097937**	0.034199	0.026144	0.024537	0.033963
	(0.043797)	*(0.058285)*	*(0.006644)*	*(0.026840)*	*(0.414874)*	*(0.507364)*	*(0.532743)*	*(0.425348)*
LD.debt_gdp	-0.159971**	-0.150626**	-0.178958**	-0.158141**	-0.102235**	-0.106416**	-0.108052**	-0.104348**
	(0.000207)	*(0.000388)*	*(0.000028)*	*(0.000196)*	*(0.016209)*	*(0.008714)*	*(0.007631)*	*(0.015112)*
D.voltaxpm	**0.000004***	**0.000004+**	**0.000021****	**0.000022****				
	(0.096032)	*(0.116488)*	*(0.003715)*	*(0.002905)*				
D.voltaxc	**-0.000124****	**-0.000118****	**-0.000114**	**-0.000104****				
	(0.000164)	*(0.000248)*	*(0.374081)*	*(0.001664)*				
D.extbal_gdp	-0.125453*	-0.110758	-0.152973**	-0.139947*	-0.058021	-0.036545	-0.033876	-0.058357
	(0.085165)	*(0.121475)*	*(0.042262)*	*(0.054425)*	*(0.436528)*	*(0.620785)*	*(0.644298)*	*(0.436119)*
D.emu	0.004191		0.002858		0.001825	0.003969	0.003716	0.002408
	(0.332338)		*(0.514401)*		*(0.689219)*	*(0.381110)*	*(0.408369)*	*(0.602559)*
D.voltaxpm_loggdppc			**-0.000002****	**-0.000002****				
			(0.011062)	*(0.008455)*				
D.voltaxc_loggdppc			**0.000002**					
			(0.928035)					
D.voltaxiw_gdp					-0.008966	0.078863**	0.081129**	-0.006239
					(0.415097)	*(0.028891)*	*(0.021125)*	*(0.598262)*
D.voltaxpm_gdp					**-0.009969**	**-0.030447**	**-0.014925**	**0.021112**
					(0.249997)	*(0.505403)*	*(0.128826)*	*(0.577333)*
D.volvat_gdp					0.050400*	0.355505**	0.335552**	0.037549
					(0.090650)	*(0.001426)*	*(0.000147)*	*(0.265163)*
D.voltaxc_gdp					**-0.305184****	**-0.450706+**	**-0.299578****	**-0.372931**
					(0.006127)	*(0.100714)*	*(0.005836)*	*(0.185777)*
D.voltaxiwgdp_ loggdppc						-0.009731**	-0.009819**	
						(0.012176)	*(0.010272)*	
D.voltaxpmgdp_ loggdppc						**0.001395**		**-0.002708**
						(0.706853)		*(0.408084)*
D.volvatgdp_ loggdppc						-0.031659**	-0.029762**	
						(0.003603)	*(0.001329)*	
D.voltaxcgdp_ loggdppc						**0.027787**		**0.015165**
						(0.571248)		*(0.765019)*
Number obs	138	138	138	138	138	138	138	138
lags	3	3	3	3	3	3	3	3
p_sargan	*0.382172*	*0.341106*	*0.450411*	*0.489931*	*0.163144*	*0.190828*	*0.161312*	*0.211623*
p_ar1	*0.000002*	*0.000001*	*0.000002*	*0.000001*	*0.000000*	*0.000000*	*0.000000*	*0.000000*
p_ar2	*0.429669*	*0.470479*	*0.516694*	*0.507533*	*0.405322*	*0.476528*	*0.501198*	*0.405528*

note: ** p<0.05, * p<0.1, + p<0.12

Finally, Table 5 reports the estimation results with a special focus on the VAT. Again, we confirm the robustness of the results pertaining to the volatility of capital taxes.

Measured in level terms, the volatility of VAT revenues has a significant and positive direct effect, dampened by its interaction with GDP. These results are confirmed when the volatility of VAT receipts is measured relative to GDP.

Note that in terms of the estimated magnitude of the impact, volatility of VAT and capital taxes is similar. Their volatility is orders of magnitude bigger than the volatility of taxes on income and wealth.

Table 5. Estimation results: Focus on VAT

(dependent variable: ratio of public investment to public consumption spending)

	A	B	C	D	E	F	G	H
	coef/p-value	**coef/p-value**	**coef/p-value**	**coef/p-value**	**coef/p-value**	**coef/p-value**	**coef/p-value**	**coef/p-value**
LD.i_c	0.204621**	0.218443**	0.195559**	0.214629**	0.300198**	0.240334**	0.232415**	0.265101**
	(0.015793)	*(0.008936)*	*(0.025795)*	*(0.010452)*	*(0.000435)*	*(0.005975)*	*(0.006836)*	*(0.001951)*
D.log_gdp_pc	0.199339*	0.197849*	0.230149**	0.205006*	0.174148+	0.152396	0.165895	0.186252*
	(0.057263)	*(0.062831)*	*(0.030042)*	*(0.052990)*	*(0.112543)*	*(0.162703)*	*(0.121339)*	*(0.090976)*
LD.log_gdp_pc	-0.257401**	-0.250462**	-0.269611**	-0.242658**	-0.238261**	-0.258703**	-0.271241**	-0.272604**
	(0.012961)	*(0.016046)*	*(0.009848)*	*(0.019667)*	*(0.030571)*	*(0.019607)*	*(0.012313)*	*(0.014689)*
D.debt_gdp	0.084559**	0.081141*	0.111675**	0.094209**	0.034199	0.026144	0.024537	0.043647
	(0.045462)	*(0.060811)*	*(0.008065)*	*(0.031004)*	*(0.414874)*	*(0.507364)*	*(0.532743)*	*(0.292637)*
LD.debt_gdp	-0.157010**	-0.147456**	-0.174530**	-0.152954**	-0.102235**	-0.106416**	-0.108052**	-0.117874**
	(0.000211)	*(0.000407)*	*(0.000032)*	*(0.000239)*	*(0.016209)*	*(0.008714)*	*(0.007631)*	*(0.005163)*
D.volvat	**0.000011***	**0.000010***	**0.000036****	**0.000036****				
	(0.053394)	*(0.063173)*	*(0.020011)*	*(0.017205)*				
D.voltaxc	**-0.000122****	**-0.000116****	**-0.000120**	**-0.000110****				
	(0.000187)	*(0.000289)*	*(0.352526)*	*(0.000661)*				
D.extbal_gdp	-0.124410*	-0.109617	-0.146973*	-0.134776*	-0.058021	-0.036545	-0.033876	-0.077023
	(0.085970)	*(0.123296)*	*(0.050751)*	*(0.063734)*	*(0.436528)*	*(0.620785)*	*(0.644298)*	*(0.297038)*
D.emu	0.004320		0.003668		0.001825	0.003969	0.003716	0.003440
	(0.317459)		*(0.401107)*		*(0.689219)*	*(0.381110)*	*(0.408369)*	*(0.444372)*
D.volvat_loggdppc			**-0.000004***	**-0.000004***				
			(0.061881)	*(0.060314)*				
D.voltaxc_loggdppc			**0.000002**					
			(0.941658)					
D.voltaxiw_gdp					-0.008966	0.078863**	0.081129**	-0.006914
					(0.415097)	*(0.028891)*	*(0.021125)*	*(0.530535)*
D.voltaxpm_gdp					-0.009969	-0.030447	-0.014925	-0.022466**
					(0.249997)	*(0.505403)*	*(0.128826)*	*(0.021331)*
D.volvat_gdp					**0.050400***	**0.355505****	**0.335552****	**0.347602****
					(0.090650)	*(0.001426)*	*(0.000147)*	*(0.000124)*
D.voltaxc_gdp					**-0.305184****	**-0.450706**+	**-0.299578****	**-0.428606**+
					(0.006127)	*(0.100714)*	*(0.005836)*	*(0.119209)*
D.voltaxiwgdp_ loggdppc						-0.009731**	-0.009819**	
						(0.012176)	*(0.010272)*	
D.voltaxpmgdp_ loggdppc						0.001395		
						(0.706853)		
D.volvatgdp_ loggdppc						**-0.031659****	**-0.029762****	**-0.032515****
						(0.003603)	*(0.001329)*	*(0.000605)*
D.voltaxcgdp_ loggdppc						**0.027787**		**0.033070**
						(0.571248)		*(0.503771)*
Number obs	138	138	138	138	138	138	138	138
lags	3	3	3	3	3	3	3	3
p_sargan	*0.377504*	*0.335572*	*0.402109*	*0.426898*	*0.163144*	*0.190828*	*0.161312*	*0.185912*
p_ar1	*0.000002*	*0.000001*	*0.000003*	*0.000001*	*0.000000*	*0.000000*	*0.000000*	*0.000000*
p_ar2	*0.405149*	*0.448490*	*0.460832*	*0.467493*	*0.405322*	*0.476528*	*0.501198*	*0.315477*

note: ** p<0.05, * p<0.1, + p<0.12

4. Economic interpretation of the results

Our key results can be summarised as follows:

- (Innovations to) the volatility of GDP or CPI inflation do not directly affect the composition of public spending. There is some evidence that the volatility of total tax revenues increases public consumption spending at the cost of investment; however, that evidence is weak and inconclusive;

- The volatility of taxes on income and wealth as well as of VAT tend to increase public investment relative to consumption spending, but their indirect impact through GDP dampens that increase;

- The volatility of capital taxes tend to reduce public investment relative to consumption spending;

- The volatility of taxes on production and imports does not have an unambiguously significant effect on the composition of public spending;

- In terms of the estimated magnitudes, the volatility of taxes on income and wealth as well as VAT has a much bigger effect than that of capital taxes.

In other words, the composition of public spending is not affected directly by macro-economic "news". However, they affect public expenditure composition indirectly through their revenue impact, which is clearly visible at the level of individual tax groups, less so at the level of total tax revenues. Note that the volatility of GDP is very highly correlated with the volatility of tax revenues; given that tax revenues can be observed more directly and more frequently by the policy maker than GDP, it is reasonable to assume that he uses tax revenues as a primary source of information about the underlying economic conditions.

The relative share of public investment increases following increases in the volatility of income taxes and the VAT, despite the fact that the indirect impact of these volatilities through the business cycle (GDP) works in the opposite direction. The relative share of public consumption spending, in turn, increases with increases in the volatility of capital taxes.

So we have found that even controlling for the effect of business cycles, volatility innovations to tax receipts have a significant impact on the composition of public spending. Changes in the volatility of VAT and income tax receipts tilt the composition of public spending in favour of public investment, while changes in the volatility of capital taxes tilt the composition against it.

These findings raise two broad questions. First, why is the impact of tax volatility visible at the level of individual tax groups but not at the level of total tax revenues? And second, why do innovations to the volatility of individual tax groups affect the composition of public spending the way they do? We will address both these broad questions in turn.

As regards the first question, the near-insignificance of the volatility of total tax revenues is obviously a sum of effects at the level of individual tax groups that offset one another to a great extent. The individual tax groups respond to different underlying economic factors, so such individual effects can provide valuable and timely news to the policy maker about underlying economic conditions. After all, many taxes are collected on a monthly basis, so news embedded in their collection can convey information about different kinds of incipient changes in the economic environment.

But what exactly can such news tell the policy maker? This leads us to the second question concerning possible reasons for the observed effects at the level of individual tax groups. This question, in turn, breaks down into two sub-questions: Why do tax volatilities change and why do those changes have the observed effect on public expenditure composition.

There are, in principle, two possible reasons for changes in tax revenues and, hence, their volatility: changes in tax rates or tax bases.

First, changes in contemporaneous tax volatility can reflect changes in tax rates. Such rate changes are known to the policy maker in advance, and he can change the expenditure composition based on that advance knowledge. Thus, changes in the VAT and income tax rates could, ceteris paribus, raise the contemporaneous volatilities of VAT and income tax revenues temporarily, and that contemporaneous and temporary increase in volatility could be accompanied with a shift in the expenditure composition.

Assume now that public investment spending is more responsive to permanent than temporary factors while consumption spending is more responsive to temporary factors. Conceivably, then, (permanent) increases in VAT and income tax rates could be used to boost public investment, while decreases might be used to curtail current spending. However, tax rates do not change very often, so changes in tax rates are unlikely to be the dominant driver of tax volatilities.

Second, changes in contemporaneous tax volatility can reflect changes in tax bases. The dominant driver of changes in tax bases—especially those for the VAT and income taxes—is the business cycle. However, to the extent that the cyclical situation differs from what was expected at the time of budgeting revenues, the tax base; tax revenues; and their volatility are also different from what was expected. Such unexpected changes could conceivably translate into the kinds of effects observed in this study: a sudden change in the cyclical outlook, especially if expected to persist beyond the current period, could prompt the policy maker to increase the relative weight of public investment. One can only speculate why; in the case of positive news the relative increase in investment could conceivably be related to relaxed liquidity constraints for the government; in the case of negative news it could be related to the government's attempt to counter-cyclical fiscal policy.

Capital taxes, as explained in section 3.2, are ad hoc in character, so their base has a significant random element to it—as also suggested by the volatile capital tax revenues in our sample (see Table 1). Thus, innovations to the volatility of capital tax

base and revenues are by nature unexpected and temporary. It is intuitively appealing to conclude that unexpected revenue surpluses are more likely spent on consumption than investment, and that unexpected temporary shortfalls hit consumption more than investment.

To sum up, the observed effect of tax volatilities on the composition of public spending may be related to the way policy makers react to news embedded in tax revenues, among other similar sources of news. Revenue surprises linked to the cyclical situation and perceived to last beyond the current period could conceivably boost the relative share of public investment. Revenue surprises linked to temporary factors, in turn, could conceivably prompt changes in current spending rather than investment.

These explanations for the results obtained are, of course, speculative. Besides, they abstract from any political considerations involved in public expenditure policies. To the best of our knowledge, neither theoretical nor earlier empirical literature can guide us in assessing their validity. The explanations suggested above are, however, economically plausible and something for future research to validate or challenge.

5. Conclusion

While earlier literature has considered long-term (growth) and medium-term (cyclical) aspects of macro-fiscal volatility, our study has focussed on its short-term impact. Specifically, we consider contemporaneous changes in the volatility of macro-economic and fiscal (revenue-side) variables as news to the policy maker and seek to examine the impact of such news on the composition of public spending.

We find that news about growth or inflation are immaterial for the composition of public spending as such; however, they do have a significant impact through news about revenue collections, visible at the level of individual tax groups and less so at the level of total tax revenues. Contemporaneous increases in the volatility of taxes such as the VAT or income taxes are that are frequently collected tend to increase the share of public investment relative to consumption spending, possibly because they convey news about non-temporary changes in the underlying economic conditions. In

contrast, contemporaneous increases in the volatility of ad hoc –type of taxes such as capital taxes tend to increase the relative share of public consumption spending, possibly because such increases are likely to reflect temporary factors.

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Annex 1. Panel unit root test results

			Levin, Lin, Chu		Im, Pesaran & Shin	
	stationarity	N	statistics	p-value	statistics	p-value
IC	level	147	-2.219	0.013	-2.654	0.004
	difference	139	-9.151	0.000	-7.323	0.000
volrealgdp	level	145	-5.360	0.000	-4.548	0.000
	difference	135	-10.748	0.001	-9.395	0.000
volinfl	level	123	-5.384	0.000	-4.353	0.000
	difference	118	-7.457	0.000	-4.811	0.000
voltaxtot	level	130	-1.553	0.060	-2.652	0.004
	difference	123	-7.268	0.000	-5.525	0.000
voltaxtot_gdp	level	136	-3.459	0.000	-2.526	0.006
	difference	129	-4.580	0.000	-3.788	0.000
voltaxiw	level	131	2.483	0.994	-1.003	0.158
	difference	125	-4.530	0.000	-3.652	0.000
voltaxiw_gdp	level	134	-4.879	0.001	-3.133	0.001
	difference	131	-6.587	0.002	-5.034	0.000
voltaxc	level	134	-1.240	0.108	-1.150	0.125
	difference	127	-6.064	0.000	-4.381	0.000
voltaxc_gdp	level	135	-1.621	0.053	-2.105	0.018
	difference	127	-5.742	0.000	-4.628	0.000
voltaxpm	level	131	-7.278	0.001	-8.748	0.000
	difference	122	-7.570	0.002	-6.886	0.001
voltaxpm_gdp	level	136	-1.948	0.026	-1.891	0.029
	difference	131	-7.432	0.000	-4.829	0.000
voltaxvat	level	133	-5.905	0.000	-3.171	0.001
	difference	121	-9.755	0.001	-7.590	0.000
voltaxvat_gdp	level	137	-8.378	0.002	-5.530	0.000
	difference	128	-5.653	0.000	-4.439	0.000
log_gdp_pc	level	146	-1.256	0.105	3.624	1.000
	difference	140	-6.265	0.000	-4.779	0.000
debt_gdp	level	143	-1.348	0.089	-0.955	0.170
	difference	138	-4.696	0.000	-2.887	0.002
extbal_gdp	level	148	-0.068	0.473	1.953	0.975
	difference	140	-7.668	0.000	-6.105	0.000

Note: Automatic selection of lags by SIC

Annex 2. Correlation matrix

	voltaxtot	volrealgdp	volinflation	voltaxiw	voltaxpm	volvat	voltaxc	log_gdp_pc	debt_gdp	extbal_gdp
voltaxtot	1.000									
volrealgdp	0.801	1.000								
volinflation	-0.385	-0.407	1.000							
voltaxiw	0.947	0.757	-0.348	1.000						
voltaxpm	0.957	0.732	-0.384	0.826	1.000					
volvat	0.959	0.794	-0.423	0.847	0.954	1.000				
voltaxc	0.439	0.299	-0.362	0.440	0.452	0.396	1.000			
log_gdp_pc	-0.161	-0.146	0.201	-0.013	-0.181	-0.152	-0.411	1.000		
debt_gdp	-0.134	-0.145	-0.215	-0.132	0.005	-0.120	0.401	-0.227	1.000	
extbal_gdp	-0.530	-0.503	0.535	-0.516	-0.514	-0.530	-0.394	0.043	-0.177	1.000

	voltaxtot_gdp	volrealgdp	volinflation	voltaxiw_gdp	voltaxpm_gdp	volvat_gdp	votaxc_gdp	log_gdp_pc	debt_gdp	extbal_gdp
voltaxtot_gdp	1.000									
volrealgdp	-0.097	1.000								
volinflation	0.086	-0.407	1.000							
voltaxiw_gdp	0.623	-0.045	0.069	1.000						
voltaxpm_gdp	0.805	-0.069	0.267	0.307	1.000					
volvat_gdp	0.252	-0.133	0.262	0.086	0.266	1.000				
voltaxc_gdp	0.068	-0.009	-0.171	0.022	0.042	-0.061	1.000			
log_gdp_pc	0.187	-0.146	0.201	0.006	0.141	0.146	-0.417	1.000		
debt_gdp	0.162	-0.145	-0.215	0.012	0.129	-0.024	0.608	-0.227	1.000	
extbal_gdp	0.128	-0.503	0.535	0.171	0.117	0.041	-0.113	0.043	-0.177	1.000