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ABSTRACT

Government Deficit Shocks and Okun's Coefficient Volatility: New Insights on the Austerity versus Growth Debate*

This paper connects two salient economic features: (i) Fiscal shocks have asymmetric effects across business cycle phases (Gechert et al., 2019); (ii) Okun's coefficient is time varying and may be unstable. The intertwined dynamic behavior of fiscal shocks and unemployment-output trade-offs are studied in this paper using state-of-the-art TVP-VAR modelling techniques applied to the analysis of six selected economies: France, Japan, Spain, Sweden, the United Kingdom (UK), and the Unites States of America (USA). We confirm the heterogeneity of Okun's coefficient across country, and its time-varying nature across time, showing in addition its fluctuation around a reference long-run value. We document a significant short-run impact of fiscal shocks on Okun's trade-off which, based on the experience of the Global Financial Crisis, becomes larger in periods of economic turmoil. Okun's coefficient is most volatile in Spain and most stable in Sweden and Japan, with France, UK and USA in between. Policy wise, we claim that austerity policies may have unexpected adverse effects on job creation if implemented during slumps, precisely when the labor market sensitivity with respect to the performance of the product market is likely to be more acute.

JEL Classification: E24, E32, E62

Keywords: fiscal shocks, Okun's coefficient, business cycle, austerity, TVP-VAR

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I. INTRODUCTION

A vivid debate, first on the appropriateness of austerity versus growth policies and then on the best approach to cure public finances, followed the Global Financial Crisis (GFC). Given the level of governments' indebtedness worldwide, the question remains: What is the best strategy to reduce the ratio of public debt as percent of GDP left by the crisis? To put it in the most simple and rough way, austerity focuses on the numerator of this ratio and sets the reduction in public deficit (and thereby in public debt) as the main priority, even at the expense of flat or negative growth. In contrast, the growth strategy is less demanding in re-balancing public accounts and prioritizes the denominator: it sees economic growth as the less harmful way to attain the reduction of public debt as percent of GDP.

To respond to the question of which strategy is the best one, the literature has mainly evolved around the doctrine of the supposedly "expansionary austerity" initially brought by Giavazzi and Pagano (1990) and then reinforced by Alesina and Ardagna (2010). By studying the sign and extent of fiscal multipliers, this literature focuses on the relationship between fiscal stimuli (through either taxes or expenditures) and growth. Little attention is paid, however, to other macroeconomic consequences of the fiscal policy such as unemployment. For example, the recent contributions by Fatás and Summers (2018) and Gechert *et al.* (2019) take a critical stance on the fiscal consolidation policies, but their analysis is still constrained to the consequences on the GDP path.

This paper fills this void by bringing unemployment into the analysis and scrutinizing the extent to which fiscal shocks may have a direct short-sun social impact via the changing trade-off between economic growth and unemployment, the so-called Okun's tradeoff (Okun, 1962). If Okun's coefficient is zero, austerity policies and the resulting flat growth rates have mild social consequences to the extent that the labor market is not sensitive to growth. On the contrary, economies in which Okun's coefficient is large should rather opt for a growth strategy since the unemployment cost of austerity will certainly be high. If follows that, beyond the consequences for the GDP path and the potential hysteresis effects

of fiscal consolidation measures, policy makers should pay deep attention to this tradeoff before deciding on how to re-balance the public sector accounts.[1]

The standard way of characterizing Okun's tradeoff is by approaching the value of its coefficient as if it was relatively constant (see Perman *et al.* 2015; and Ball *et al.*, 2017). However, to what extent is this a time-varying coefficient? Does it also vary across the business cycle phase? Was this trade-off especially large in 2008, when the GFC hit the world? The aim of this paper is to respond to these questions and learn from the answers to reassess a policy strategy that has caused significant short-run pain, and has not yet offered significant long-run gains. At least in the Eurozone, this strategy has followed the route of austerity in the sense that all public budgets are subject to the condition of re-balancing public deficits and debts to meet the 3% and 60% limits, respectively. Consequently, all states have enforced expenditure control and larger tax revenues with significant welfare costs as noted in Holland and Portes (2012) and Gechert *et al.* (2019).

In this context, the contribution of this paper is threefold. First, we reassess Okun's coefficient in a recent period (1995-2017) in which the consequences of the GFC have left a world of highly indebted economies. Second, we reassess Okun's coefficient in response to government deficit shocks for a variety of representative economies.[2] Spain and France, which are both in the Eurozone and belong to the so-called Club-med countries but have had different experiences with respect to the sovereign debt crisis. Sweden, which is a European country not in the Eurozone, and representative of the Nordic model in terms of welfare state and the fiscal policy. Japan, which has a very specific labor market structure. Finally, the UK and US, which are representative of the Anglo-Saxon model characterized by labor market flexibility and low unemployment records. Third, we apply new estimation methods that allow Okun's coefficient to be estimated as a time varying parameter across

[1] Some recent literature has argued that Okun's coefficient was no longer relevant because of jobless recoveries (Valadkhani and Smyth, 2015). In the event that (un)employment does not respond to economic growth in the aftermath of a crisis, Okun's coefficient becomes zero (or not-significant), in which case is no longer useful. Ball *et al.* (2017) and Dixon *et al.* (2017), however, claimed that this relationship still holds and is fit according to their analysis on 20 developed economies.

[2] Other European countries such as Germany and Italy were left out from the analysis due to data limitations in availability and timespan coverage at quarterly frequencies. Further Anglo-Saxon countries could be explored (Australia, Canada), but in this paper we have favored a specific country-analysis on a narrow selection, rather than a more superficial appraisal of a wider amount of economies.

countries, time and horizon.[3] Indeed, to the best of our knowledge, this is the first paper to evaluate Okun's coefficient in selected countries of interest by taking into account the different lagged response of both output and unemployment using a time varying parameter (TVP) structural vector autoregression (VAR) model (Primiceri, 2005; Del Negro and Primiceri, 2015)[4].

There are different methodological decisions on which we would like to be explicit. The first one refers to the concept of fiscal shock. As noted, we detach from the literature on fiscal multipliers and look at a summary measure of changes in the fiscal policy stance. In this way, we resort to the literature concerned with the twin deficit hypothesis and focus on shocks in governments' deficit. More precisely, we follow Kim and Roubini (2007) and subsequent studies, which use the primary government budget deficit (as percent of GDP) to take into account fiscal shocks arising from changes in either taxes or expenditures, but excluding interest payments on debt.

This modelling of the fiscal shock requires consideration of interest rates so that the estimates of the TVP-VAR allow for interacting effects between the monetary and fiscal policies, and are able to account for the impact of borrowing costs on fiscal sustainability. Tkačevs and Vilers (2019) have recently proved the relevant effect of borrowing costs on the fiscal policy stance.

The second issue concerns the specification of the system of equations to be estimated in the TVP-VAR. Exploration of how fiscal shocks affect Okun's trade-off requires modelling GDP together with unemployment. In turn, focusing on the primary government budget deficit as representative of the fiscal policy shock comes together, as explained, with short-term interest rates as additional control variable. Given the focus of our analysis, international issues such as the ones considered in Kim and Roubini (2007) are left out

[3] Horizon refers to the lagged response of output and unemployment to fiscal policy shocks. The method we use allows for idiosyncratic output and unemployment persistence of these shocks so that Okun's coefficient becomes unconstrained not only across time (it varies depending on the year at which the shock takes place), but also across horizon (it also varies specifically at a quarterly frequency in the aftermath of the shock).
[4] We employ the TVP-VAR implementation in the BEAR Toolbox version 4.2 (see Dieppe *et al*., 2016).

from the estimated system (hence we consider unemployment and nominal interest rates instead of real exchange and interest rates).

The third issue relates to the way Okun's trade-off is embedded into the TVP-VAR estimated system. We use the difference version and not the gap version of Okun's (1962) model because it can be naturally inserted in the system without a preliminary computation of the natural rates of output (y*) and unemployment (u*). In addition, we compute Okun's trade-off by exploiting the information obtained from the TVP-VAR Impulse-Response Functions (IRFs) in a way that would be unfeasible if using the gap version model (details on this computation are provided in Section 4).

Our findings confirm the heterogeneity of Okun's coefficient across country, and its time-varying nature across time. We show, in addition, that country-specific time-varying trade-offs fluctuate around their reference long-run values. When such trade-offs are examined as the combined reaction of unemployment and economic growth to fiscal shocks, we uncover additional sensitivities during the GFC. On top of these findings, we also identify different volatilities across countries. In this way, Okun's coefficient appears to be most volatile in Spain, where the temporary share of workers is among the highest in the world, while it is most stable in Sweden and Japan, two economies with very specific labor relations and welfare systems. France, UK and USA rank in between. The changing volatility of Okun's coefficient and its enhanced sensitivity during economic slumps, lead us to warn on the potentially unexpected effects of fiscal consolidation policies in terms of persistent unemployment. If implemented during slumps, austerity policies may have unexpected adverse effects on job creation, precisely when the labor market sensitivity with respect to the product market performance is likely to be more acute.

These results, which are valid under a short-run perspective, complement those in Gechert *et al.* (2019) for the long-term in calling for a fine-tuning fiscal policy. Generic policy receipts to re-balance public accounts may have strong asymmetric effects across countries (when applied in the same year), but also within countries (depending on the year in which the policy is applied). In addition, coordination with supply-side policies such as labor market reforms is also necessary to avoid harmful effects of adjustment policies. In this

sense, Spain provides an example of a socially painful adjustment process. The combination of austerity measures (starting in May 2010) with a weak labor market (which was subject to reforms in 2011 and 2012) caused the fiscal shock to have utmost impact on unemployment, as the growing Okun's coefficient shows (note that the rate of unemployment surpassed 26% in 2013).

The rest of the paper is structured as follows. Section 2 briefly summarizes some selected literature; characterizes the six economies under scrutiny in terms of our key variables of interest (economic growth, unemployment, interest rates and public deficit); and offers some preliminary evidence based on the standard first difference model. Section 3 connects the fiscal policy with Okun's coefficient and presents a suitable VAR methodology to undertake a time-specific analysis. Section 4 presents this analysis and a policy discussion. Section 5 concludes.

II. SETTING THE SCENE

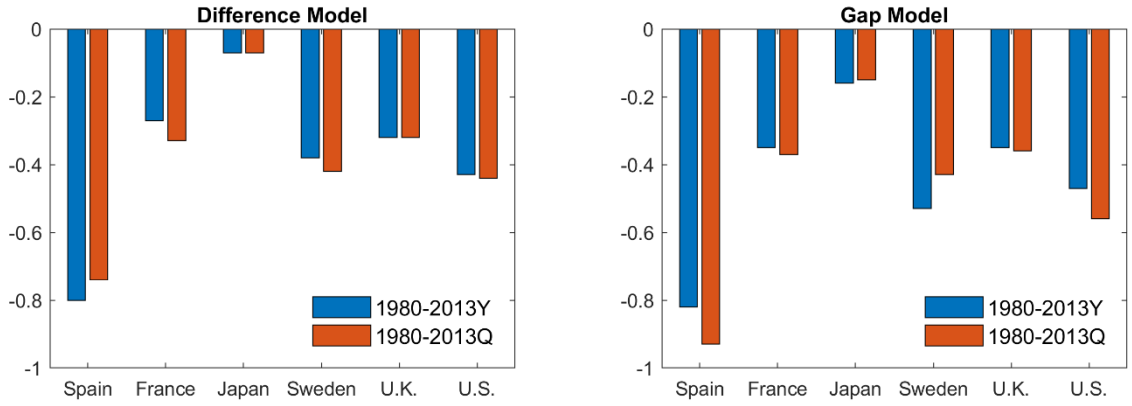
II.1. Related literature

Okun's Law is one of the most well-known and studied relationship in macroeconomics. Among the many relevant studies in this area, we would like to highlight just some recent contributions. Based on a meta-regression analysis covering 269 estimates of Okun's coefficient, Perman et al. (2015) conclude that the "true" estimated coefficient is in the range (-0.25;-0.40) depending on the methodology used to correct for publication bias. Okun's (1962) original estimate for the US falls right in the middle of this range.

Updated accounts of the validity of Okun's Law have been recently provided by different studies. In one of them, Dixon et al. (2017) revisit Okun's relationship by augmenting the standard first difference and output gap models with determinants of y* and u*. In this way, they show that labor market institutions shape the output-unemployment trade-off. In addition, by conducting their analysis by age cohorts, they unveil a distributional impact of this trade-off arising from a larger sensitivity of youth unemployment to product market performance. This implies that economies with high employment volatility due, for

example, to a large share of temporary work like in Spain, or economies with larger oscillations of youth unemployment than aggregate unemployment across business cycle phases (like in Spain, also) will tend to display a larger Okun's coefficient. Ball *et al.* (2017), who provide country-specific estimates of Okun's coefficient, confirm this intuition. Figure 1 summarizes their results for the economies considered in this paper: the left and right-hand-side panels display, respectively, the results corresponding to the difference and gap models.

Figure 1. Okun's coefficient estimated in Ball *et al.* (2017) over 1980-2013.



According to Ball *et al.* (2017), Spain shows the largest sensitivity of unemployment to output among the 20 OECD countries considered, with a coefficient around -0.80. The US coefficient is the second largest one (it is close to -0.50 and can be found even larger when quarterly data and the output gap model are used) and is followed by the Swedish one, which is robust across estimated models only when using quarterly data (larger than -0.40). The UK and France come next with a value larger than -0.30 (which can be found smaller in France when yearly data and the output gap model are used). In contrast, Japan is characterized by a very small unemployment-output trade-off below -0.10 under the first difference model, and above (-0.15) under the output gap model estimation. Below we show that these coefficients do not change substantially when the sample period is updated to start in the 1990s and finish in 2017.

In parallel to this literature, the process of fiscal consolidation in the aftermath of the GFC called the attention of the profession. Although many were the studies examining the

impact of austerity on economic growth, our analysis is particularly close to the one by Blanchard and Leigh (2013). Not only because of the methodology used, but also because they deal with growth forecast errors, which are also part of Okun's Law literature. Indeed, Blanchard and Leigh (2013) show that the relationship between fiscal consolidation forecasts and subsequent growth forecast errors is statistically more negative in the Eurozone during 2010 – 2011. The finding of stronger impacts of fiscal shocks during economic downturns has recently been endorsed by Gechert *et al.* (2019), who assert that the fiscal multipliers were underestimated in the EU in 2000 – 2011. More precisely, when assessing the long-term impact of fiscal policy shocks (which may arise from stimulus or austerity measures), Gechert *et al.* (2019) pay specific attention (as we do in this paper) to the precise timing of the policies implemented. They find that the initial Keynesian response to the GFC had durable beneficial effects. In contrast, "the subsequent turn to austerity was badly timed and thus not only deepened the crisis but caused evitable hysteresis effects" [Gechert *et al.* (2019), p. 1]. This negative appraisal of austerity policies is shared, among others, by De Long and Summers (2012), Holland and Portes (2012), and Fatás and Summers (2018).

Not only the impact of the fiscal shocks is asymmetric across the business cycle, however. Okun's coefficient itself behaves asymmetrically across phases of the business cycle as the literature has shown. This asymmetry may not deliver a structural break in Okun's coefficient as Moosa (1999) showed for the US, even though the short-run and long-run estimates of Okun's Law differed and proved the instability of Okun's coefficient. In the same vein, Meyer and Tasci (2012) argued that "if Okun's rule were stable across time, then the breakeven output growth rate would be fairly constant". In contrast, they uncovered a remarkable discrepancy in Okun's estimates between U.S. expansion and downturn phases of the business cycle. This evidence firmly supports Knotek (2007), who was the first one to point specifically to the asymmetric behavior of Okun's Law over the business cycle.

Asymmetric behaviors may be the result of different patterns in expansion and downturns, but may also take place along a structural fall in Okun's coefficient. This is what Zanin and Marra (2012) claim for a set of six economies within a set of nine Euro countries examined

over 1960-2009. The time-varying characteristics of Okun's Law is then related to widespread labor market reforms implemented in these economies over these decades, together with demographic changes and other policies that took place over time in these economies. The asymmetry of Okun's Law is also associated to labor market institutions by Cazes *et al.* (2013). They show that Okun's coefficient varies across country and time and outline the larger coefficient found in Spain and the U.S. during the GFC. They also show that the sensitivity of the inverse relationship between unemployment and output growth is lower in those countries with stricter job protection legislation.

More recently, Jalles (2018) provides estimates of the time-varying Okun's coefficient for twenty advanced economies which spread out from the low of -0.18 (Japan) to the high of -0.81 (Spain). His main claim is that "the unemployment–output responsiveness has been changing over time" in response to both cyclical and structural drivers. It is in this context, that our analysis is novel in connecting the asymmetric response of the unemployment-output trade-off to the asymmetric impact of fiscal shocks. An additional novelty is that we take into account the specific period in which those fiscal shocks take place. Therefore, our study can be regarded as complementary to the one by Gechert *et al.* (2019).

II.2. Stylized facts

The variables we work with are real output growth (y_t), the rate of unemployment (u_t), primary public deficit (PD_t) as percent of GDP, and the long-term nominal interest rate, which is the 10-year bond rate, i_t^{10}.[5] Table 1 presents some descriptive statistics.

Sweden and US are the two economies with the highest average growth rate (2.5%) followed by Spain and the UK, which have grown, respectively, 2.2% and 2.0%. The difference is that the UK and US data goes back to 1990, while for Spain and Sweden the sample period does not include the crisis of the early nineties. France displays an inferior

[5] Primary public deficit for the EU countries is obtained from Eurostat (Quarterly non-financial account for general government, gov_10q_ggnfa, %GDP); for the US and Japan from the OECD Economic Outlook (General Government Primary Balance, %GDP). Data on real GDP and unemployment rates of all countries are from the OECD Economic Outlook, while the long-term (10-year) bond rates are obtained from Eurostat, OECD, and St. Louis FRED.

performance (1.6% since 1990), while Japan (1.0%) seems to be caught in a permanent 'lost decade'.

Japan is also the country with the highest average primary public deficit (5.2%), and the lowest unemployment rate (4.1%). At the other extreme, the rate of unemployment in Spain is the highest one (16.2%), followed by France (10.0%). Sweden (7.4%) is in the middle, while it falls in the Anglo-Saxon economies (UK 6.6%, and the US 6.0%). France and the UK keep large public deficits close to 4%, which are approximately twice the Spanish (2.2%) and US (1.8%) ones. On the contrary, Sweden have their public accounts on balance. Note that the standard deviations of public deficit are relatively similar across countries around 2.3, with France below (1.6) and the US above (3.4).

Table 1. Descriptive statistics. 1990-2017.

	Δy_t	u_t	i_t^{10}	PD_t	Δy_t	u_t	i_t^{10}	PD_t
	SPAIN (ES)*				FRANCE (FR)			
Mean	2.179	16.298	4.577	2.228	1.578	9.964	4.572	3.815
Median	3.000	16.800	4.325	2.316	1.743	9.533	4.255	3.798
Max	6.378	26.200	11.680	6.708	5.038	12.500	10.166	7.372
Min	-6.397	7.967	1.075	-1.448	-6.586	7.267	0.169	-0.798
Std.Dev	2.610	5.570	2.027	2.275	1.839	1.408	2.426	1.600
Obs	92	92	92	92	112	112	112	112
	JAPAN (JP)**				SWEDEN (SE)*			
Mean	0.968	4.137	1.456	5.220	2.545	7.435	3.953	0.012
Median	1.054	4.180	1.359	4.870	2.791	7.433	3.947	-0.123
Max	9.668	5.430	4.654	10.120	9.479	10.300	10.963	9.432
Min	-20.003	2.760	-0.145	0.800	-14.934	5.100	0.163	-3.575
Std.Dev	3.938	0.769	0.997	2.301	3.580	1.173	2.345	2.303
Obs	95	95	95	95	92	92	92	92
	UNITED KINGDOM (U.K.)				UNITED STATES (U.S.)			
Mean	1.969	6.630	5.182	3.919	2.475	5.988	4.651	1.795
Median	2.275	6.167	4.787	3.373	2.550	5.583	4.615	1.730
Max	7.711	10.400	12.317	10.663	7.500	9.933	8.703	10.660
Min	-8.686	4.233	0.841	-2.772	-8.400	3.900	1.563	-4.000
Std.Dev	2.407	1.688	2.668	2.990	2.417	1.552	1.911	3.415
Obs	112	112	112	112	112	112	112	112

Effective sample: (*) 1995 – 2017; and (**) 1994 – 2017.

The heterogeneity in terms of output, labor market and public deficit performance contrasts with the homogeneity in terms of the 10-year bond interest rates, with four economies around an average of 4%-4.5%, the UK ranking higher (5.2%) and Japan installed quite close to the zero bound (1.5%) and small volatility (1.0%).

II.3. Preliminary evidence

Given the information provided above, we use Okun's (1962) first difference model to obtain two preliminary estimations of Okun's coefficient. The simplest specification of this model is:

$$du_t = \alpha + \beta * dy_t + \epsilon_t \quad (1)$$

where β denotes Okun's coefficient and ϵ_t is a white noise error term. The model is estimated using the full sample for each economy (see Figure 2).

Table 2. Okun's constant coefficient from the first difference model.

Country	ES	FR	JP	SE	UK	US
Okun's coefficient	-0.793	-0.271	-0.036	-0.138	-0.229	-0.256
Standard Error	(0.068)	(0.038)	(0.016)	(0.031)	(0.031)	(0.039)

Table 2 shows that Spain is the economy where labor market performance is the most sensitive one to product market performance. The coefficient of -0.79 implies that a 1% decrease in the unemployment rate only requires a rise of 1.27% in output. On the contrary, the coefficients of -0.27 for France, -0.23 for the UK, and -0.26 for the US, imply that output needs to increase between 3.7% and 4.4% to achieve the same reduction in unemployment. These values are even higher for Sweden and especially Japan, where the labour market seems disconnected from the product market.

Note that the estimate places the highest sensitivity at the country with the highest unemployment rate, and the lowest to the one with the lowest unemployment rate. Although this is plausible, this is still a descriptive picture which, as argued in Ball *et al.* (2017, p. 1417), can be refined by letting Okun's coefficient vary across time. We thus

modify the estimation of the first difference model using a state-space method where parameter β is allowed to change while assuming α fixed.

$$du_t = \alpha + \beta_t * dy_t + \epsilon_t \qquad , where\ Var(\epsilon_t) \sim N(0, \sigma_e^2) \tag{2}$$
$$\beta_t \quad = \beta_{t-1} + \nu_t \qquad\qquad Var(\nu_t) \sim N(0, \sigma_\nu^2)$$

The estimated values of β are presented in Figure 2 together with the corresponding root mean squared errors (RMSE) and, for reference, Okun's coefficient when estimated as a constant (as presented in Table 1), which in some way could be considered as the long-run OLS estimate.

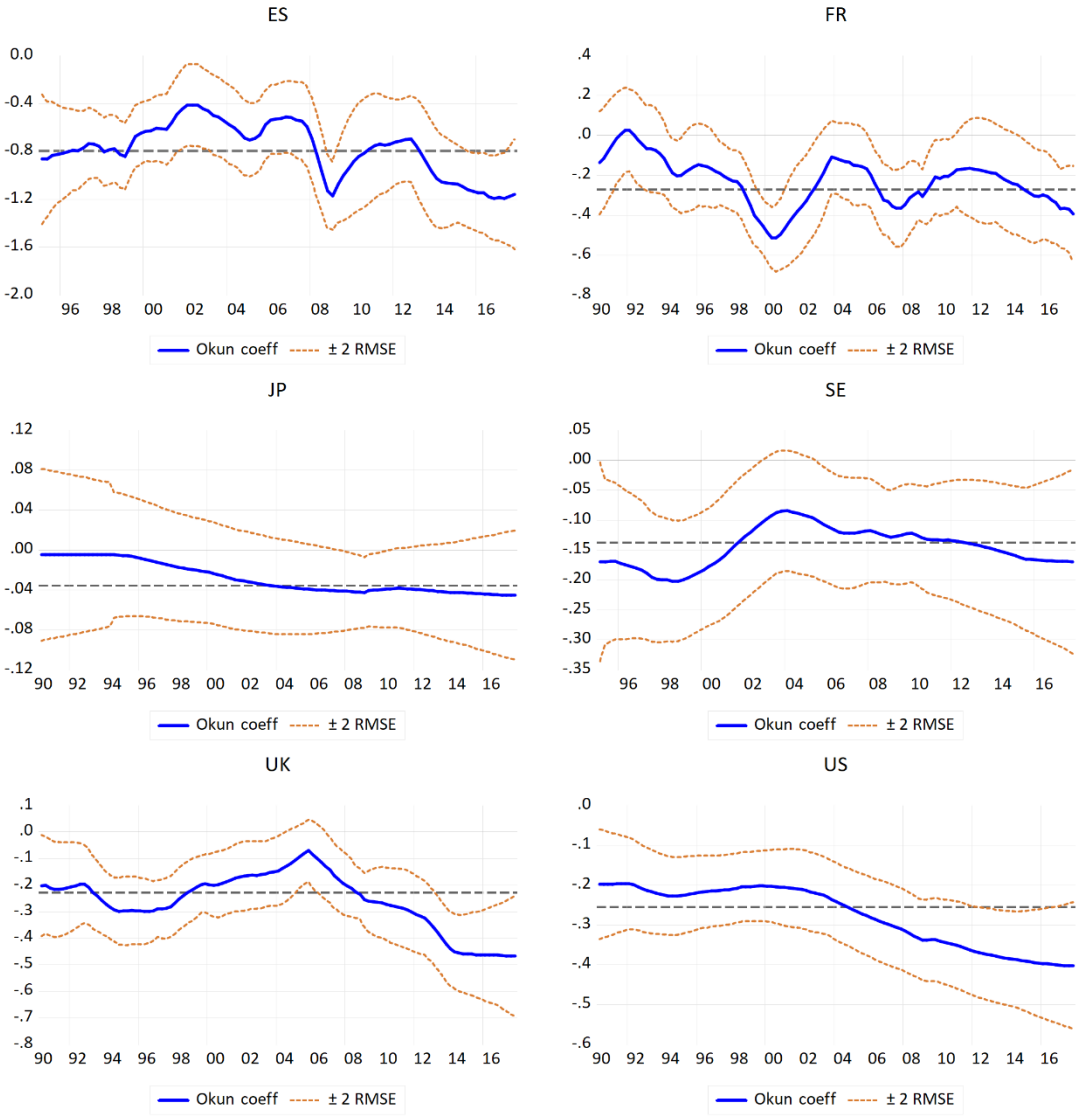
It can be observed that all time-varying coefficients broadly evolve around their corresponding long-run value (dashed-grey line). Sweden displays the most stable values, always within the range (-0.10, -0.20), together with France where they have stabilized within the range (-0.20, -0.40) after displaying lower values in the early 1990s. The rest of the economies share a common upward tendency in Okun's coefficient. This tendency seems to start in the mid-1990s in Japan, departing from a null output-unemployment trade-off, while in Spain and the US it starts in the early 2000s and just afterwards in the UK.

Our hypothesis is that the larger degree of unemployment responsiveness with respect to product market performance is related to the intensification in the globalization process brought by the entrance of China in the WTO. According to Rodrik's (1997) conjecture, enhanced labor market flexibility is one of the natural outcomes of globalization, which is confirmed in Hijzen and Swaim (2010). In addition, the structural reforms implemented by many countries in response to the GFC have tended to exacerbate the sensitivity of the labor market to changes in the product market (for example, the emergence of irregular work in Japan, or the increased use of part-time employment in Spain).

Note that by 2017 Okun's coefficient has fallen to -1.20 in Spain, -0.45 in the UK, -0.4 in the US (as in France), while in Japan it has steadily detached from zero to fall beyond -0.04. This new evidence points to the relevance of focusing on selected periods of interest rather than staying with invariant coefficients, which if taken at face value may misguide the design of economic policy. In fact, this first round of findings provides support to the

unstable nature of Okun's Law, which is affected by macroeconomic complexities as pointed out in Meyer and Tasci (2012) and Cazes *et al.* (2013), among others.

Figure 2. Time-varying Okun's coefficient from the first difference model.



Note: the horizontal dashed line signals Okun's coefficient as reported in Table 2.

III. VAR MODELLING STRATEGIES TO APPRAISE OKUN'S COEFFICIENT IN RESPONSE TO A FISCAL POLICY SHOCK

Among the endless variety of stimuli to which output and unemployment respond, the fiscal policy is a major one. The immediate reason is the fiscal multiplier, which is the most powerful enhancer of changes in public expenditures and/or taxes. Beyond the multiplier, however, the current situation in most advanced economies is one in which public deficits and debts have to be re-balanced. This has brought back the focus towards the fiscal policy, which is more conditioned than ever by the sustainability of public accounts in a period in which the echoes of the GFC are still heard. Hence, the question of the extent to which austerity may harm (or not) the labor market via its (presumably self-defeating) output effects is of prominent relevance.[6]

Accordingly, we next reappraise Okun's coefficient in response to fiscal policy shocks. We conduct our analysis in two steps. In Section 3.1, we estimate a simple reduced VAR model and estimate Okun's coefficients from Cholesky's impulse-response functions (IRFs). This provides us with key information that will be used in the second step to define the sign restrictions to be imposed on the response of the variables to the impulse. The second stage consists in estimating a Time-Varying-Parameter (TVP) VAR model in which the estimation of Okun's coefficient is unconstrained and the tradeoff can be reappraised by examining the precise response of output and unemployment to fiscal policy shocks in selected periods of interest.

III.1. The reduced VAR analysis

The basic or reduced vector autoregression (VAR) model (Sims, 1980) takes the form

$$y_t = \nu + A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + \epsilon_t \qquad (3)$$

where $y_t = (y_{1t}, y_{2t}, \dots, y_{Kt})'$ is a vector of K endogenous variables; and ν and $A_1 \dots A_p$ represent matrices of parameters – having size $K \times 1$ and $K \times K$, respectively – to be estimated. The vector of white noise process ϵ_t has also K dimensions assumed to have zero-mean and a positive definite covariance matrix, i.e., $E(\epsilon_t \epsilon_t') = \boldsymbol{\Sigma_e}$, so that

[6] On self-defeating austerity, see Delong and Summers (2012), and Holland and Portes (2012).

$\epsilon_t \sim N(0, \boldsymbol{\Sigma_e})$. The model is generally estimated equation-by-equation using the least-squares estimator.

We set up a VAR model comprising the four variables defined in Table 3, which are organized in the following order: Δy_t, Δu_t, PD_t^{hp}, and i_t^{10}. The recursive ordering follows Kim and Roubini (2007) and subsequent literature and differs from Blanchard and Perotti's (2002) scheme. The reason is twofold. First, we presume an ex-post determination of government budgeting given that the fiscal planner reacts to the behavior of output and unemployment knowing that fiscal policy has generally lagged effects; in addition, public deficit is defined as a ratio over GDP, and is thus endogenously determined by current output. Second, the central bank and financial markets are supposed to adjust their expectations after knowing the current state of the economy; hence, variable i_t^{10} comes last in the ordering. In any case, the ordering of the variables is overall relatively innocuous. The reason is that this recursive structure will become much less relevant in next subsection, when the structural shocks are identified using sign restrictions.

Table 3. Variable definitions

Variable	Definition
Output growth (dy_t), %pa	= 400*($log(y_t) - log(y_{t-1})$).
Change in unemployment rate (du_t)	= 4*($u_t - u_{t-1}$).
Deficit (PD_t), %.	= Primary budget deficit as percentage of GDP.
10-year bond rate, % per annum (i_t^{10}).	

Another issue is the choice of the lag-length p, which is usually based on several information criteria. In this analysis, we follow Akaike and Schwarz indicators and, accordingly, pick a common value of 2 for p. We thus treat all countries in the sample in a homogeneous way regarding the choice of the optimal lag-length underlying our estimation.

To focus on the short-run impact of the primary public deficit, we abstract from structural considerations, and use a cyclically adjusted measure of this variable.[7] It is also important to note that the 10-year bond interest rate controls for the changes that interest payments

[7] We apply the HP filter with λ=1600. Figure A1 in the Appendix plots these corresponding filtered series.

(on account of public debt) experience due, for example, to financial crisis (or the related sovereign debt crisis in the Eurozone since the end of 2009). Since the official interest rates and the 10-year bond rates are intimately related, this variable broadly controls for changes in the monetary policy such as the quantitative easing ECB program launched in 2015, which has managed to keep these rates at manageable low levels (see Tkačevs and Vilers, 2019).

As noted, the aim of this analysis is to confirm the expected responses according to theory and empirically enlighten the sign restrictions to be imposed in the estimation of the TVP-VAR. As shown in Figure A.2, this is the case in all countries as the IRFs show the expected positive output and negative unemployment responses to (structural) fiscal shocks to revert subsequently to the baseline. Spain exhibits the widest significant responses of Δy and Δu, with a slower reaction in unemployment than in output. This is a general feature across countries, which is taken into account in the sign-restriction scheme. The speed at which output reaches its peak and unemployment its trough is different across countries with France, for example, responding quicker than Spain, and the UK responding even quicker.

III.2. A Time-Varying Parameter (TVP) VAR model

A salient characteristic of the data on output growth and unemployment is their recursive inflection points reflecting, across countries, the different phases of the business cycle. A second feature we want to remark is the strong variation in Okun's coefficient when the model is estimated using a state-space method (as presented in Figure 1). These two features call for an even more careful assessment of the impact of fiscal policy shocks, which we do using a Bayesian SVAR model allowing for both time-varying coefficients with stochastic volatility and sign identifications (see e.g., Primiceri, 2005; Arias *et al.*, 2018; and Dieppe *et al.*, 2016; among others). Note that, by employing the TVP-VAR method we are not only accounting for time variation effects, but also for regime switching in the fiscal stance.

The model is written as

$$y_t = A_{1,t}y_{t-1} + A_{2,t}y_{t-2} + \cdots + A_{p,t}y_{t-p} + Cx_t + \epsilon_t \quad (4)$$

where the residuals are distributed according to $\epsilon_t \sim N(0, \mathbf{\Sigma_t})$, i.e., the residual covariance matrix changes over time; while $A_{1\ldots p,t}$ represent matrices of time-varying parameters.

The VAR model can be expressed in compact form as

$$y_t = \bar{X}_t\beta_t + \epsilon_t$$

with

$$\bar{X}_t = I_n \otimes X_t \quad , \quad X_t = (y'_{t-1}\ y'_{t-2}\ \ldots\ y'_{t-p}\ x'_t)$$

and

$$\beta_t = vec(B_t) \quad , \quad B_t = \left(A'_{1,t}\ A'_{2,t}\ \ldots\ A'_{p,t}\ C'_t\right)'$$

The VAR coefficients are assumed to follow a random-walk process such that:

$$\beta_t = \beta_{t-1} + \nu_t \quad , \quad \nu_t = N(0, \Omega)$$

For $\mathbf{\Sigma_t}$, we assume it can be decomposed as $\mathbf{\Sigma_t} = F\Lambda_t F'$, where F is a lower triangular matrix with ones on its diagonal. Meanwhile, Λ_t is a time-varying diagonal matrix with $diag(\Lambda_t) = \left(\bar{s}_1 \exp\left(\lambda_{1,t}\right), \ldots, \bar{s}_n \exp\left(\lambda_{n,t}\right)\right)$. Thus, F and Λ_t are as follows:

$$F = \begin{bmatrix} 1 & 0 & \cdots & \cdots & 0 \\ f_{21} & 1 & & & \vdots \\ f_{31} & f_{32} & 1 & \ddots & \vdots \\ \vdots & & \ddots & \ddots & 0 \\ f_{n1} & f_{n2} & \cdots & f_{n(n-1)} & 1 \end{bmatrix}$$

$$\Lambda_t = \begin{bmatrix} \bar{s}_1 \exp\left(\lambda_{1,t}\right) & 0 & \cdots & \cdots & 0 \\ 0 & \bar{s}_2 \exp\left(\lambda_{1,2}\right) & & & \vdots \\ \vdots & & & \ddots & \vdots \\ \vdots & & & & 0 \\ 0 & \cdots & \cdots & \cdots & \bar{s}_n \exp\left(\lambda_{n,t}\right) \end{bmatrix}$$

The term $\lambda_{i,t}$ is also assumed to follow an AR process such that $\lambda_{i,t} = \gamma\lambda_{i,t-1} + \nu_t$ with $\nu_{i,t} \sim N(0, \phi_i)$. In this context, the parameters to be estimated include: (i) the VAR coefficients β_t; (ii) the covariance matrix Ω; (iii) the elements f_{ii}^{-1} of matrix F; (iv) the set of dynamic coefficients $\lambda_{i,t}$; and (v) the heteroscedasticity parameters ϕ_i.

In addition, in order to be able to identify the shocks, we consider a number of sign restrictions that determine the initial response of the variables to the shocks. These restrictions are based on the theoretical relationships implied by Okun's Law and, empirically, on the results obtained from the reduced VAR estimation and the corresponding Choleski's IRFs (Figure A.2 plots those of output and unemployment). Finally, we keep the lag-length ($p = 2$) as in the previous VAR model and estimate specification (4) using the Bayesian algorithm described in Dieppe *et al.* (2016).[8]

Table 4 presents the sign-restriction settings. Economic growth is constrained to respond positively and contemporaneously to a demand-side shock and negatively to a supply-side shock, with no restriction on the number of periods (quarters) in which this negative response takes place. In turn, a monetary shock on the 10-year bond interest rate causes output growth to decrease in quarters 1 and 2 after the shock hits the economy. The opposite occurs when a fiscal shock takes place. Unemployment growth responds positively and contemporaneously to a supply-side shock (exactly as output growth with respect to a demand-side shock), while it falls up to the first quarter after a fiscal shock takes place. The only restriction on the interest rate reaction is an immediate positive response to a monetary policy shock. The same restriction holds for public deficit in response to a fiscal shock in which case there are two additional restrictions. First, a slow negative response to a demand-side shock, which will increase public revenues and/or reduce public expenditures between the first and second quarters after the shock takes place. Second, an even slower negative response to a monetary policy shock, which will increase public revenues and/or reduce public expenditures between the second and third quarters after the

[8] We employ BEAR Toolbox 4.2 for the computation.

shock takes place. Beyond these informed and specific sign restrictions, the variables are free to move when confronted to a shock.[9]

Table 4. Sign restrictions.

	DEMAND	SUPPLY	MONETARY	FISCAL
Δy_t	(0 0) +	-	(1 2) -	(1 2) +
Δu_t		(0 0) +		(0 1) -
i_t^{10}			(0 0) +	
PD_t	(1 2) -		(2 3) -	(0 0) +

Note: Quarters affected by the sign restriction in parenthesis; the sign -/+ indicates the constrained negative or positive response during the specified period, which is theoretically and/or empirically guided.

IV. FISCAL POLICY AND OKUN'S COEFFICIENT

IV.1. Time specific Okun's coefficient

The TVP-VAR model allows the characterization of Okun's coefficient not only as a time-varying parameter, but also as a period-specific coefficient. Figure 3 shows, for the case of Spain and the US, the change in output growth and the rate of unemployment in response to a fiscal policy shock (note that the color expresses how large the value of the IRF is: greener areas depict higher values than blue areas, while fading intensities account for diminishing values). Figures A3 and A4 complete in the Appendix this information for the rest of the economies considered.

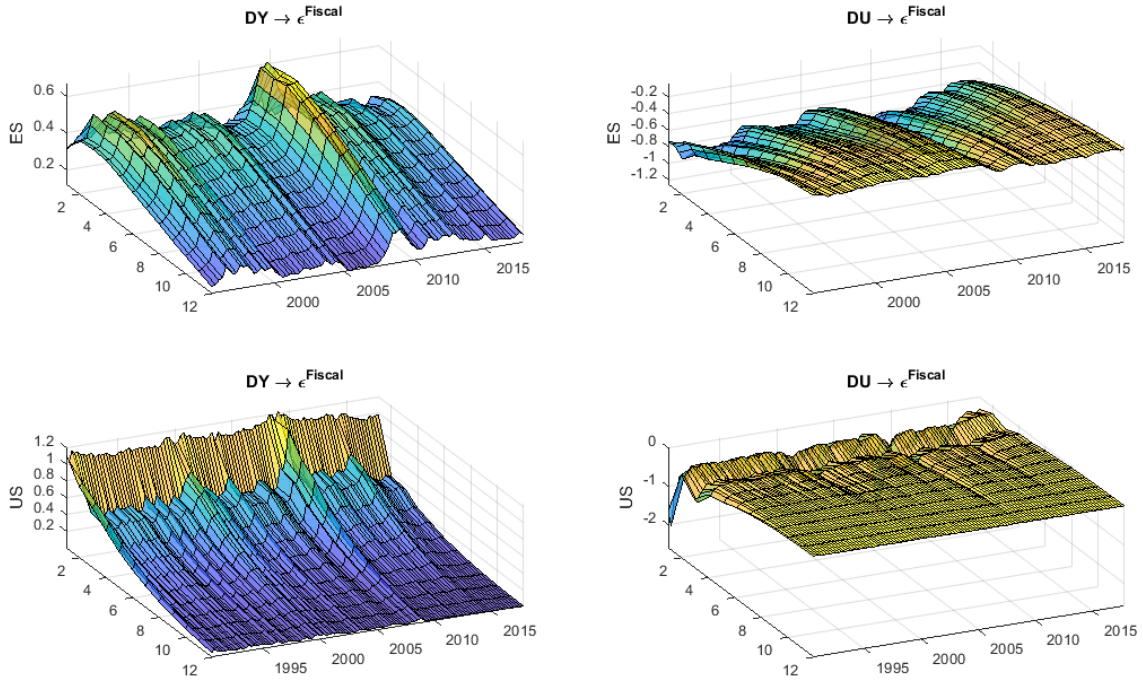
In the initial vertical axis, we have the magnitude of the immediate output or unemployment response to the fiscal policy shock. In the second axis, we have the evolution of this impact across the following 12 quarters. In the third axis, we have the sequence of quarterly IRFs. Consideration of this third dimension is an important

[9] Beyond the informed choice based on Okun's Law and the IRFs obtained from the reduced VAR estimation, we have tried to take the perspective of a policy maker and her expectations (according to the literature) in terms of the sequence of impacts of each type of shock. In addition, we have conducted robustness analyses with different combinations of periods in which the sign restriction holds. We found no significant departures from the results presented in the paper, nor from the conclusions reached through our investigation.

contribution of our analysis, since uncovers a time varying response per quarter per variable (output and unemployment) to the fiscal shock.

Figure 3a shows that the immediate output response to a standard deviation of a fiscal shock in Spain is around 0.4%, but critically jumps to 0.6% during the critical years of 2008/2009. All responses almost die out to zero as time goes by (after ten quarters); however, in 2008/2009 a larger sensitivity is still visible in quarter 12. Figure 3b shows a falling response of unemployment to a fiscal policy shock. From a sensitivity close to -0.8% there is a tendency to evolve towards -0.6% which seems to be interrupted with the onset of the GFC (2008/2009) and resumed subsequently. Unemployment responses consolidate as times goes and reach larger values between -1.2 and -1.0 up to quarter 5.

Figure 3. IRFs for Δy and Δu in response to structural fiscal shocks



Note: Estimation method = TVP-VAR (Section 4.2); Identification = Sign restrictions scheme (as shown in Table 4); IRFs over full-sample periods. Four plots are indexed (a), (b), (c) and (d) from left-to-right, from top-to-bottom.

Figure 3c shows that output's response to a fiscal policy shock in the US is more intensive than in Spain and initially close to a one-to-one relationship (then, as in Spain, this response dies out to zero in quarter 12). With the onset of the GFC there is a period with a more

sluggish response to this shock, but the extent of the response does not change significantly as in Spain. Figure 3d shows that also the immediate response of unemployment is larger in the US, with an immediate response close to -1 that diminishes across the years, but augments to -2 after 4 quarters. This increase is what causes Okun's coefficient to reach values close to -0.5 (resulting, rounding up, from the unit response with respect to output and an unemployment response that doubles that of output).

Figure 4 picks up selected IRFs implicit in Figures 3, A3 and A4. The central year is 2008, the year in which the GFC started. Years 2006 and 2012 reflect, respectively, the situation at the peak of the previous expansion and two years after the implementation of austerity policies started in 2010. Year 2016 is considered as the year in which the crisis has been surpassed (for example, by the end of that year Spain had recovered its lost GDP due to the GFC).

Tables 5 and 6 summarize the information provided by Figures 3 and 4. More precisely, given the richness of the information attained through the estimation of the TVP-VAR, we adapt Ilzetzki's et *al.* (2013) notion of fiscal multipliers to compute Okun's tradeoff as follows:

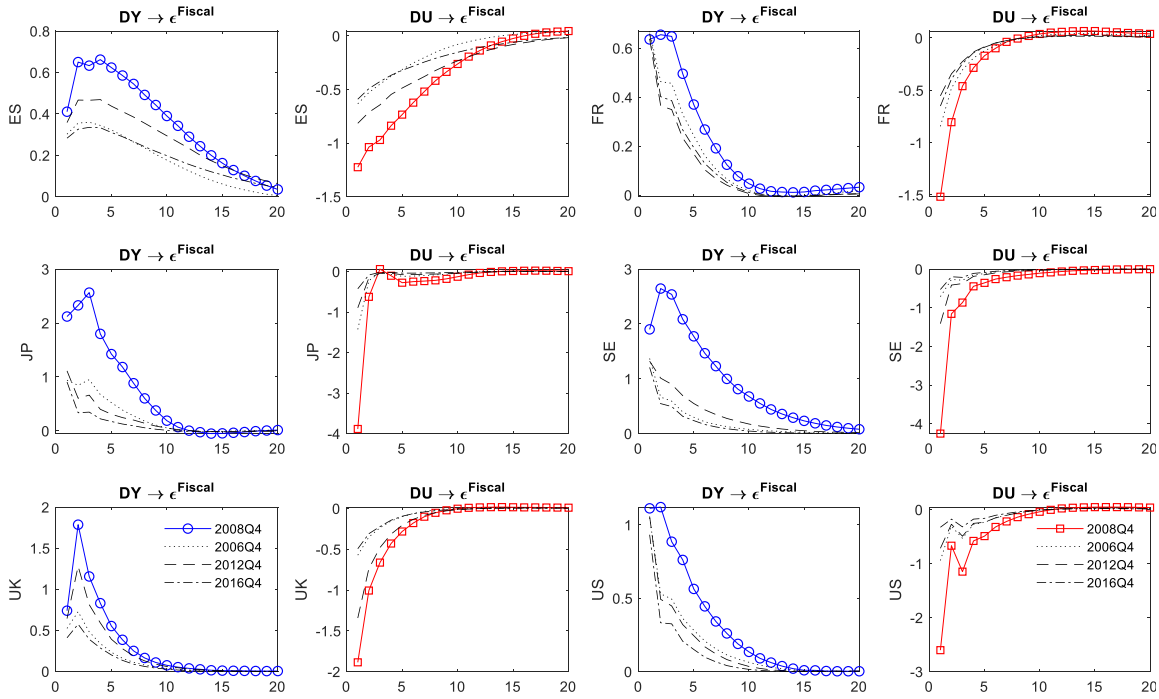
$$\beta_{okun(h)} = \frac{\sum_{i=1}^{h=\{1,4,8\}} \Delta u_i}{\sum_{i=1}^{h=\{1,4,8\}} \Delta y_i} \tag{5}$$

where *h* denotes different forecasting horizons (initial, four quarters, and eight quarters). The resulting values are presented in Table 5.

Figures 3 and 4 show that the initial impact is always the biggest as the IRFs progressively die out (quicker across time). A second finding is the higher sensitivity of Okun's coefficient during the crisis in all countries, as can be perceived from the figures, and is explicitly reported in Table 5 (2008Q4). A salient feature of our analysis is the stable value of Okun's coefficient in the European countries in 2006 and 2016. This implies that in Spain, France, Sweden and the UK the unemployment-output trade-off *in response to fiscal policy shocks* has returned to its original value notwithstanding the GFC and the subsequent policy measures and structural reforms that were undertaken before 2016. In contrast, the

economies of Japan and the U.S. are characterized by the downward trend of its Okun coefficient, thus indicating a falling trade-off and sensitivity of the labor market with respect to the product market performance. We believe this is consistent with the jobless recoveries that the US have progressively witnessed, and the growing stimuli required by the Japanese economy to keep its growth path without labor market performance and social progress lagging too much behind.

Figure 5. Impulse – Response of Δy and Δu to structural fiscal shocks.



Overall, our analysis is revealing of a structural change in Japan and the U.S. (regarding the unemployment-output trade-off in response to fiscal stimuli), that the European economies seem to have managed to circumvent once the GFC has been reversed. Table 6 complements this information with some descriptive statistics providing further intuition on the volatility of the multipliers underlying Okun's coefficients. The reported statistics are grouped by country so that 'overall' accounts for all Okun multiplier values computed at the specific IRF horizon. Between-group values refer to variations among countries, while the within-group counterparts show the fluctuations of Okun's multipliers across time over the timespan 1990Q4 – 2017Q4.

The overall coefficient decreases as time goes by and the IRFs die out to zero (from a mean of -1.186 to -0.706). Most of this fall takes place in the first 4 quarters (from -1.186 to -0.793). Between-group variation (differences across countries) dominates in all horizons, but within-group variation is important when the fiscal shock hits the system. As expected, differences across countries vanish as the IRFs die out after the 8th quarter after the shock.

Table 5. Okun's multipliers in selected periods and different time horizons

Country	Spain	France	Japan	Sweden	U.K.	U.S.
Initial impact (β_{okun1})						
2006Q4	-2.094	-1.260	-1.519	-0.520	-1.093	-0.898
2008Q4	-2.983	-2.386	-1.833	-2.239	-2.553	-2.339
2012Q4	-2.276	-0.867	-0.805	-1.069	-2.088	-0.677
2016Q4	-2.089	-0.986	-0.469	-0.437	-1.209	-0.350
1-year cumulative impact (β_{okun4})						
2006Q4	-1.459	-0.949	-0.512	-0.470	-0.635	-0.842
2008Q4	-1.728	-1.260	-0.517	-0.733	-0.884	-1.288
2012Q4	-1.544	-0.791	-0.409	-0.608	-0.864	-0.747
2016Q4	-1.468	-0.834	-0.303	-0.409	-0.705	-0.554
2-years cumulative impact (β_{okun8})						
2006Q4	-1.172	-0.828	-0.451	-0.440	-0.577	-0.814
2008Q4	-1.383	-0.998	-0.428	-0.527	-0.785	-1.123
2012Q4	-1.295	-0.721	-0.385	-0.497	-0.777	-0.778
2016Q4	-1.229	-0.736	-0.306	-0.396	-0.654	-0.638

Note: Okun's multiplier $\beta_{okun\{h\}} = \sum_{i=1}^{h=\{1,4,8\}} \Delta u_i \,/\, \sum_{i=1}^{h=\{1,4,8\}} \Delta y_i$.

Table 6. Descriptive statistics of Okun's multipliers

Variable		Mean	Std. Dev.	Min	Max	Obs	
β_{okun1}	Overall	-1.186	0.639	-3.424	-0.288	N =	602
	Between		0.589	-2.357	-0.845	n =	6
	Within		0.379	-3.659	-0.444	T =	100
β_{okun4}	Overall	-0.793	0.355	-1.757	-0.236	N =	602
	Between		0.392	-1.539	-0.407	n =	6
	Within		0.102	-1.291	-0.547	T =	100
β_{okun8}	Overall	-0.706	0.273	-1.397	-0.256	N =	602
	Between		0.303	-1.245	-0.370	n =	6
	Within		0.072	-1.060	-0.537	T =	100

IV.2. A reappraisal of the output-unemployment trade-off: lessons for the austerity versus growth debate

In the previous analysis, we were concerned by the specific behavior of output and unemployment in response to fiscal shocks taking place in different periods. Our interest now is the opposite one. We want to collect all available information produced by our TVP-VAR estimation, produce a single representative measure of Okun's coefficient, and perform different comparisons across countries with respect to this representative measure. Accordingly, we organize all the information as explained in Figure 6 so that all output and unemployment responses per country, per quarter (within each year), and horizon (in terms of quarterly lagged responses to the shock) are taken into account.

Note that this information implies working with up to close to 4300 observations: 89 observations per country (from 1995Q4 to 2017Q4)[10]; 8 observations per quarter (since for each period, as shown in Figures A3 and A4, we have an IRF of which we take the first 8 values); and 6 economies (that is, 89 x 8 x 6 = 4,272 observations).

The multi-level panel structure of this data allows the estimation of mixed-effects linear models. We therefore adapt model (1) so that Okun's coefficient will be estimated for each country in a hierarchical linear structure that combines both a random-intercept and random-coefficients.

Let us write the reduced equation – using Rabe-Hesketh and Skrondal (2012) notation – as follows:

$$du_{jhk} = \alpha + \beta_1 dy_{jhk} + \beta_2 dum_{jhk}^{crisis} dy_{jhk} + \xi_{jhk} \qquad (6)$$

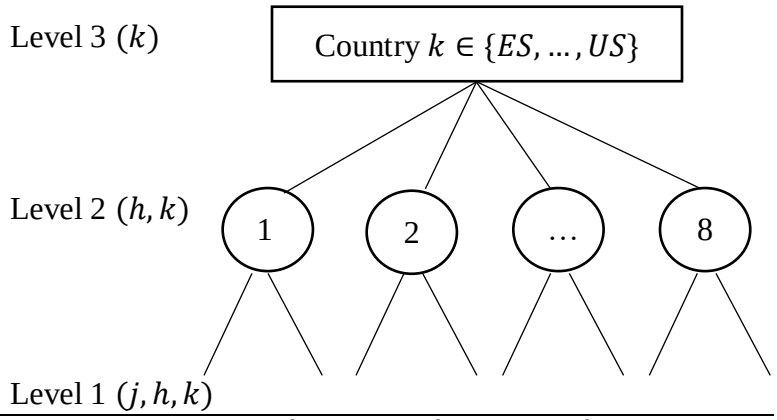
where the triplet indices (j, h, k) represent $(period\ j^{th}, horizon\ h^{th}, country\ k^{th})$ so that we categorise the computed IRFs of du and dy over the period in time $j \in [1995Q4, \dots, 2017Q4]$ into eight different horizons $h \in [1 \dots 8]$ for each country $k \in \{ES, FR, JP, SE, UK, US\}$. Dummy variable $dum_{(\cdot)}^{crisis}$ takes value of 1 if $j \in [2008Q1, \dots, 2013Q4]$, or 0 (zero) otherwise. It is worth emphasizing that the interaction

[10] We take the shortest timespan 1995Q4 – 2017Q4 to make estimates comparable among countries.

between dy and $dum_{(\cdot)}^{crisis}$ captures the average magnitude of the change in Okun's coefficient over the GFC, 2008 – 2013. The term α is the overall intercept with expected zero mean given that du and dy are mean reverting to their corresponding steady state.

In the context of model (6), the key target is to measure β_1 and β_2 by considering the variability of these parameters within-horizon (level 2) and between-country (level 3) across estimated periods (level 1) as illustrated in Figure 6.

Figure 6. Information from within-horizon and between-country variation in estimated IRFs.



Note: (j, h, k) represent $(period\ j^{th}, horizon\ h^{th}, country\ k^{th})$.

We model a random intercept at level 3, $\zeta_k^{(3)}$, by assuming that all six assessed countries are drawn from a population of countries. Likewise, the deviation of coefficients β_1 and β_2 from their mean levels are captured through random-slopes $\delta_{1hk}^{(2)}$ and $\delta_{2hk}^{(2)}$ at level 2 and $\delta_{1k}^{(3)}$ at level 3, respectively.[11] Therefore, equation (6) can be written as:

$$du_{jhk} = \left(\alpha + \zeta_k^{(3)}\right) + \left(\beta_1 + \delta_{1hk}^{(2)} + \delta_{1k}^{(3)}\right)dy_{jhk} + \left(\beta_2 + \delta_{2jk}^{(2)}\right)dum_{jhk}^{crisis}dy_{jhk} + \epsilon_{jhk} \quad (7)$$

Note that if $dum_{(\cdot)}^{crisis} = 1$, then $\beta_{okun} = \beta_1 + \beta_2 + \delta_{1hk}^{(2)} + \delta_{2hk}^{(2)} + \delta_{1k}^{(3)}$, while β_2 and its variation due to $\delta_{2hk}^{(2)}$ has no impact under normal economic conditions ($dum_{(\cdot)}^{crisis} = 0$).

[11] We use the superscript (2) or (3) referring to the level to which the random-coefficient belongs.

To further elaborate on the economic interpretation of random-intercept and random-coefficient variability, we denote $\boldsymbol{X_k}$ the vector of data computed for country k^{th}, and express the total residual ξ_{jhk} as:

$$\xi_{jhk} = \zeta_k^{(3)} + \left(\delta_{1hk}^{(2)} + \delta_{2hk}^{(2)} + \delta_{1k}^{(3)}\right) dy_{jhk} + \epsilon_{jhk}.$$

Under the assumptions $E\left(\epsilon_{jhk} \middle| \boldsymbol{X_k}, \zeta_k^{(3)}, \delta_{1hk}^{(2)}, \delta_{2hk}^{(2)}, \delta_{1k}^{(3)}\right) = 0$,
$E\left(\delta_{1hk}^{(2)}, \delta_{2hk}^{(2)} \middle| \boldsymbol{X_k}, \delta_{1k}^{(3)}, \zeta_3^{(3)}\right) = 0$, $E\left(\delta_{1k}^{(3)} \middle| \boldsymbol{X}_k, \zeta_k^{(3)}\right) = 0$ and $E\left(\zeta_k^{(3)} \middle| \boldsymbol{X}_k, \delta_{1k}^{(3)}\right) = 0$, the composition of the total variance is:

$$\sigma_\xi^2 = \sigma_\zeta^2 + \sigma_{\delta 1hk}^2 + \sigma_{\delta 2hk}^2 + 2\sigma_{\delta 12hk} + \sigma_{\delta 1k}^2 + \sigma_\epsilon^2 \qquad (8)$$

where the $\sigma(\cdot)$ denotes the standard deviation of the respective random variable. It should be noted that the term $\sigma_{\delta 12hk}$ expresses the correlation between the two random slopes δ_{1hk} and δ_{2hk} since they are in the same level 2. If, however, one imposes $\sigma_{\delta 12hk} = 0$, then the two random slopes would be independent of one another.

We estimate model (7) and the variance decomposition (8) using the data organized as explained in Figure 6. We then compute Okun's coefficient for each specific country.[12] The outcome of this exercise is reported in Table 7.

Results by country point to an estimate for Spain of -1.409. Not only this nearly doubles the mean value of -0.80 obtained through the OLS estimation of model (1), but it is also characterized by the highest variance across the six countries considered ($\sigma_{\delta 1hk}^{(2)} = 0.468$). As noted before, this reflects the strong fluctuations of Okun's coefficient across the IRF horizon (always 8 quarters after the shock hits the system) and is consistent with an economy in which the share of temporary contracts is the highest one within the OECD countries.

At the other extreme, we find Japan, which displays a relatively inactive coefficient across horizons (-0.204) with volatility in line with all other economies (ranging from 0.14 to

[12] See StataCorp, L.P. (2017, p.558) for technical details about the MLE estimator.

0.24), except Spain. Sweden is close to Japan (-0.412), while the UK, U.S. and France (with coefficients across horizon between -0.7 and -0.8) take an intermediate place, leaving Spain as a rather singular case. One important implication of these low variances is that it is possible to use Okun's coefficient for prediction if properly assessed.

Table 7. Okun's coefficient volatility

Country	$\boldsymbol{\beta_1}$	$\boldsymbol{\beta_2}$	$\boldsymbol{\sigma_{\zeta}^{(3)}}$	$\boldsymbol{\sigma_{\delta 1hk}^{(2)}}$(*)	$\boldsymbol{\sigma_{\delta 2hk}^{(2)}}$(**)	$\boldsymbol{\sigma_{1k}^{(3)}}$	$\boldsymbol{\sigma_{\epsilon}}$
Spain	-1.409	-0.072	-	0.468	0.085	-	0.034
	[0.000]	[0.021]		(0.117)	(0.023)		(0.001)
France	-0.697	-0.020	-	0.159	0.079	-	0.071
	[0.000]	[0.585]		(0.052)	(0.029)		(0.002)
Japan	-0.204	-0.123	-	0.224	0.197	-	0.234
	[0.017]	[0.096]		(0.057)	(0.052)		(0.006)
Sweden	-0.412	0.039	-	0.140	0.163	-	0.153
	[0.000]	[0.511]		(0.037)	(0.042)		(0.004)
UK	-0.819	0.034	-	0.234	0.150	-	0.089
	[0.000]	[0.953]		(0.059)	(0.041)		(0.002)
US	-0.724	-0.097	-	0.157	0.032	-	0.125
	[0.000]	[0.000]		(0.047)	(0.023)		(0.000)
All	-0.666	-0.088	0.026	0.268	0.148	0.337	0.135
countries	[0.000]	[0.006]	(0.011)	(0.030)	(0.019)	(0.106)	(0.001)

Note: p-values are in squared bracket. Standard errors are in parentheses. (*) and (**): for individual country estimation there is no level 3 (country) so that we drop index k. The superscript (2) and (3) represent the grouping levels.

Estimation of models (7) and (8) allow us to gather the specific impact of the GFC on the unemployment-output trade-off. This is the information brought by the estimates of the interaction term β_2 reported in Table 9. For Spain, U.S. and Japan our estimates deliver a negative slope which is significant at critical values of 5%, 1% and 10%, respectively. Within these estimates, a salient finding is that β_2^{JP} is the largest in absolute value, while β_2^{ES} is the smallest. This implies that it is in Japan where Okun's coefficient changed the most during the economic turmoil brought by the GFC. On the contrary, although Okun's trade-off also becomes larger in Spain (and in the US by a similar magnitude), this change is quantitatively less relevant when compared to a value of -1.409 (-0.724 in the U.S.). The rest of European economies did not experience a shift in Okun's coefficient during the GFC period, 2008 – 2013. This homogeneity may be a reflection of the stability of the European

employment, unemployment and welfare protection system (to which Spain is an outlier because of its outstanding share of temporary work).

The volatility of Okun's coefficient in economic downturns is an extra indication of the (in)stability of the connection between the labor and product markets when subject to fiscal shocks. This is captured by $\sigma_{\delta 2hk}^{(2)}$, which amounts to 0.148 on average and reaches its maximum level in Japan. This may be due to the specific nature of Japan's economic cycle, characterized by the protracted downturn in 1990s dubbed as the "lost decade". This singularity can also be perceived in terms of the residual variance (0.234) which is twofold the average (0.135). Whether representative of an Asian model or just Japan, the combination of export power and relatively rigid labor legislation is very specific and may be the source of such specific behavior when confronted to fiscal shocks (recall from Table 2 that Japan is the country with the highest public deficit, and the lowest unemployment rate). Sweden, which is also an open economy characterized by a developed labor relations and protective system, shows the second largest standard deviations of Okun's coefficient during the GFC (0.163). At the other extreme, the fluctuation of β_2^{US} is the lowest, with $\delta_{2hk}^{US} = 0.032$. We interpret this stability as the natural consequence of the structural flexibility of US markets, which does not display extra sensitivity in downturns probably because there is no need.

V. CONCLUSIONS

In this paper, we have first used standard methods to reproduce the standard values reported in the literature on Okun's coefficient. A persistent criticism of the old type of analysis is the time-varying nature of the coefficient and the resulting instability across different phases of the business cycle.

Okun's trade off may be examined as such, without assuming any underlying driving force, or in connection to the fiscal policy, as proposed in this paper. The reason is the asymmetric effects that fiscal shocks have depending, also, on the timing of the fiscal policy (Gechert *et al.*, 2019). To study the dynamic intertwined behavior of Okun's coefficient in response to fiscal shocks that take place in different periods, it is important to unconstrain the

estimation of Okun's coefficient to make it time-varying (in each country) across year and horizon. This is possible using state-of-the-art TVP VAR estimation techniques, which, in addition, have been extended to allow for a different behavior during downturns and to exploit all the information obtained from the variation of the unemployment and output IRFs.

Conducted in this way, our analysis of Okun's coefficient leads to a reappraisal of the austerity versus growth debate. When is it more convenient to favor fiscal stimuli or implement fiscal consolidation policies? We have learnt that the unemployment-output trade-off in most economies becomes either larger or more volatile in downturns with respect to their usual value, the U.S being the salient exception. This implies that enforcing fiscal consolidation during a recession, precisely when the automatic stabilizers tend to push public expenditures up, may not be the right strategy. The reason is that not only the re-balancing of public accounts is specifically costly in a recession (certainly from an economic and social point of view, and maybe even politically), but it may also worse the labor market consequences of the crisis on account of the larger and/or more volatile Okun's coefficient. This extra sensitivity between unemployment and output in bad times is precisely the reason why fiscal stimuli would appear as a first sensible strategy until the labor market is decoupled from the extra impact that would be suffered from an expedite fiscal consolidation process, which would add to the recession.

Overall, our findings give support to the idea that more targeted fiscal policies are needed in both expansion and recession. Rather than generic recommendations to re-balance the public sector accounts, there is a need to identify the momentum in which an expansionary or contractionary set of measures needs to be implemented, as well as the strength of the stimuli/adjustment to be enforced. This is crucial to avoid a short-run pain and guarantee a long-term gain of the fiscal policy.

With respect to future research on the unemployment-output trade-off, our analysis is eloquent in calling for a dynamic approach. For example, if more is to be learned on the fiscal policy transmission channels among developed economies, which may differ substantially from the ones just explored. Expanding datasets on emerging market

economies will be useful to learn more on Okun's trade-offs in macroeconomic settings different than those that characterize the advanced economies.

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APPENDIX

Figure A1. Cyclically adjusted primary public deficit, % GDP.

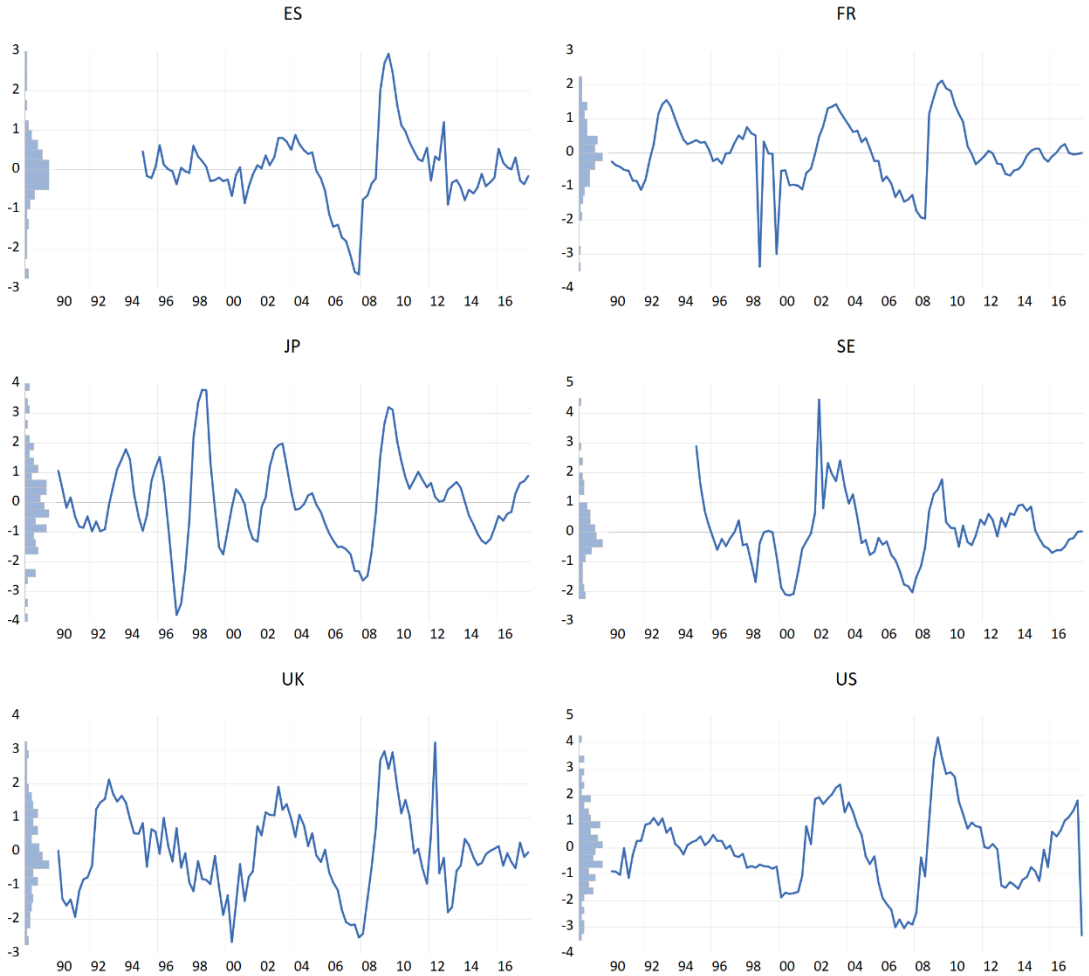


Figure A2. Impulse – response of Δu and Δy in VAR model.

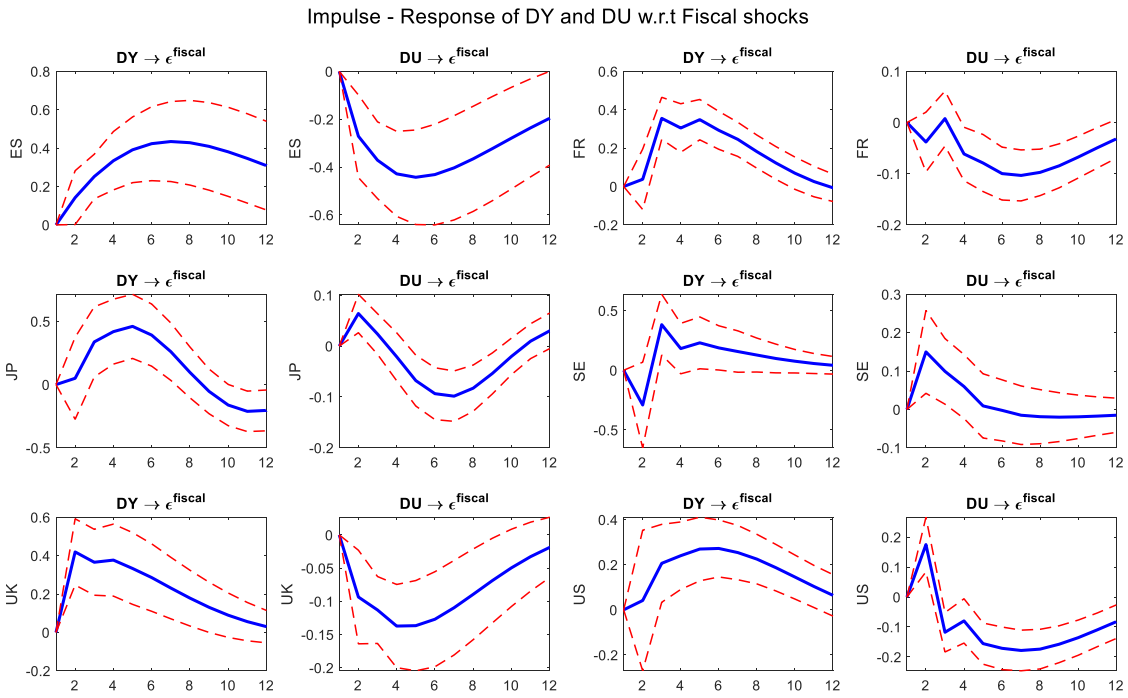


Figure A3.

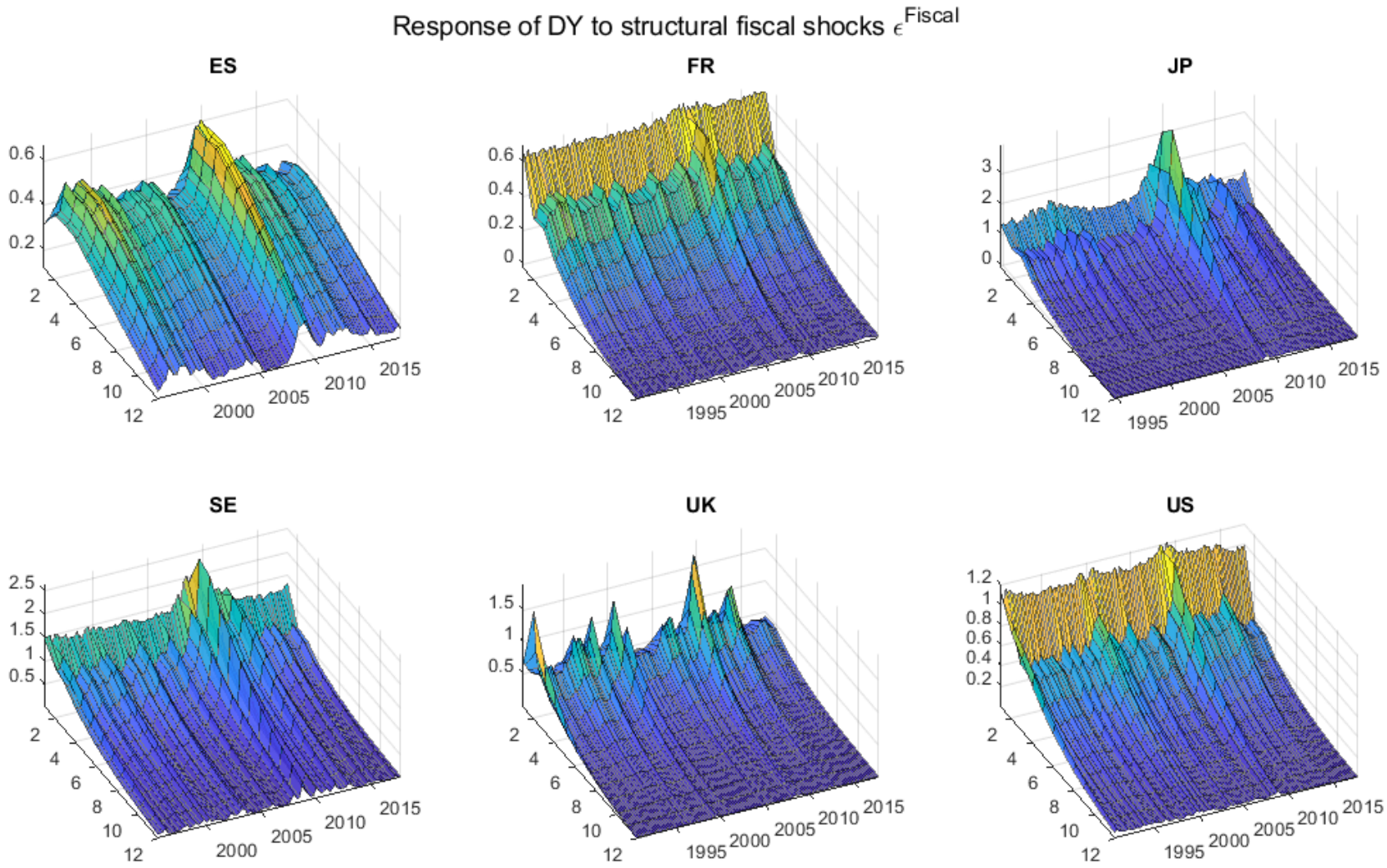
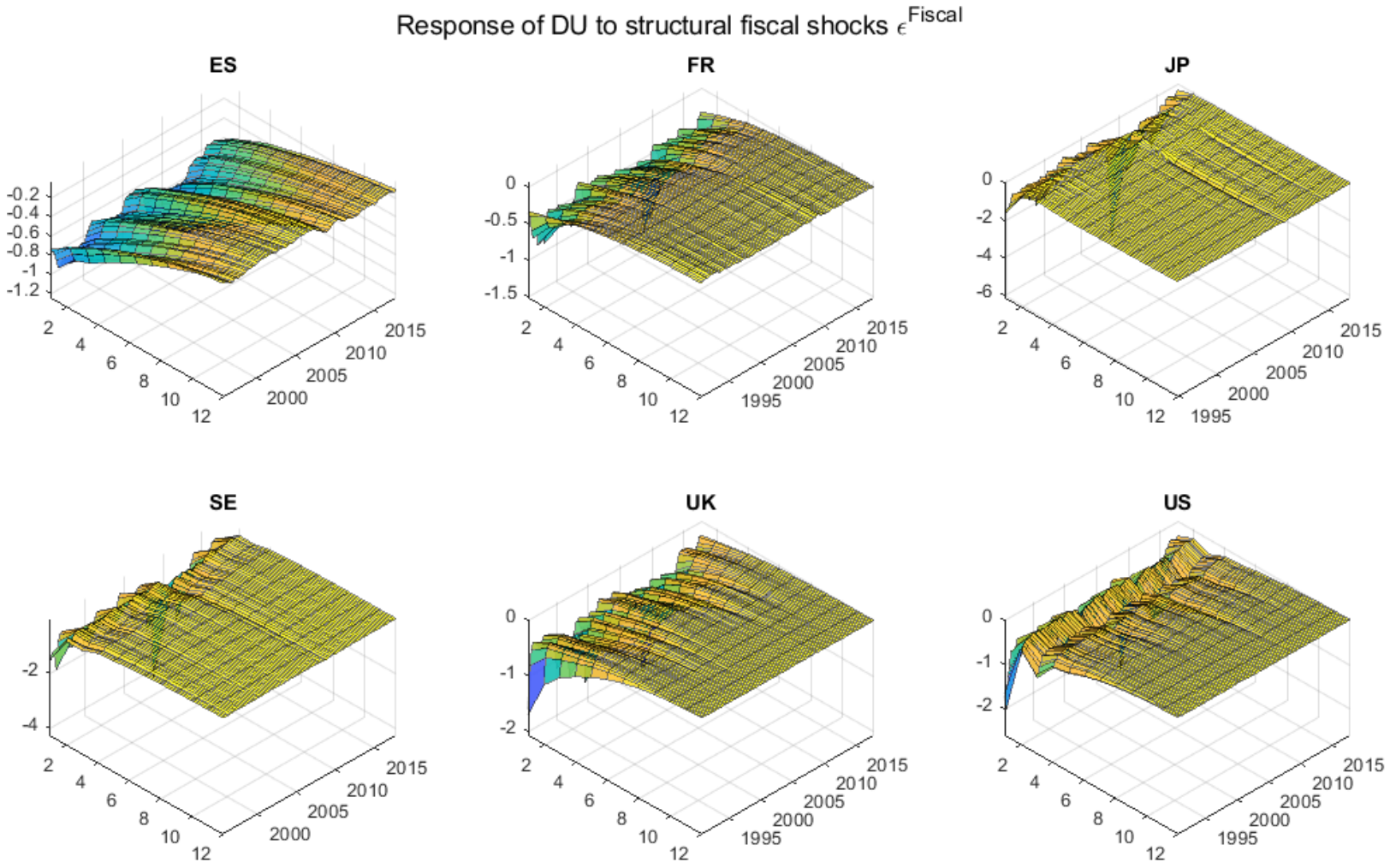

Response of DY to structural fiscal shocks ϵ^{Fiscal}
ES
FR
JP
SE
UK
US

Figure A4.


Response of DU to structural fiscal shocks ϵ^{Fiscal}
ES
FR
JP
SE
UK
US