Heterogeneity in the Fiscal Reaction Function: An Empirical Analysis for EU Member States

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ABSTRACT

This paper studies heterogeneity in the fiscal reaction function for European Union members by resorting to the unconditional quantile regression estimation. Based on annual observations for the years from 2005 to 2018 it shows that the level of the covariates is relevant for the heterogenous response measured in terms of the cyclically adjusted primary balance. First, a positive reaction to different levels of debt is visible, which becomes weaker as the debt ratio rises. This indicates sustainable behaviour that peters out for higher indebtedness. Moreover, the fiscal position is poorer in countries with higher life-expectancy and governments seem to run more pronounced pro-cyclical fiscal policy during bad times. These problems question current as well as future policy design particularly against the background of the recent pandemic situation putting additional social and financial burden on the countries. In addition, the level of development matters for the response pattern and the reaction is stronger indicating more fiscal discipline in less developed countries. Finally, our estimations show that the fiscal position improves with the level of educational attainment and the external position.

JEL codes: C21, E62, H63

Keywords: Fiscal response function, Heterogeneity, Fiscal sustainability, Unconditional quantile regression

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1. Introduction

The global financial crisis of 2007-2008, followed in Europe by the Sovereign Debt Crisis have shown the fragile balance between fiscal activism, fiscal space and debt sustainability. Currently, the COVID-19 pandemic has plunged the world and EU economy into a severe recession. Against this background, EU policymakers have responded with unprecedented stimulus measures, both monetary and fiscal policies supporting this stance. As a result, budgetary deficits and public debt are expected to rise sharply in the EU at least over the short term. According to the Spring 2020 Forecast of the European Commission, in the EU the budgetary deficit is expected to rise from 0.6 percent of GDP in 2019 to 8.3 percent in 2020, while the level of public debt is projected to increase from 79.4 to 95.1 percent of GDP over the same period.

Thus, debt sustainability and fiscal policy analysis are more relevant than ever to understand and surveil the EU public finances situation. More to the point, it is crucial that the fiscal stimulus implemented in the context of the COVID-19 pandemic amid already high levels of debt in the EU is reconciled with a sustainable debt trajectory. The central issue is to discover the essential elements driving the fiscal response and key influence factors of fiscal performance. In this respect, is it possible that the fiscal behaviour might be different depending on the level of explanatory variables such as debt, interest rate or the economic situation? In short, does size matter for the amplitude of the fiscal response and, if so, how does it affect public debt sustainability?

Regarding the relevant empirical literature contributions there is usually two strands of research on fiscal response analysis. The first strand is based on the linear fiscal reaction function (FRF) with seminal papers by Bohn (1995, 1998), studying the response of the primary balance to changes in the debt ratio. Usually, a positive significant response coefficient is considered as sufficient condition (weak sustainability) for stabilizing debt and sustainability of public finances. The linear model of the FRF introduced by Bohn has several implications. On one hand, the government's response to changes in public debt is constant over time and does not vary with the level of the public debt. On the other hand, the public debt can increase indefinitely and the fiscal response is a positive and strong one regardless of its size. Finally, the financial markets are willing to lend money to governments, no matter how much they owe.

These implications have been the subject of numerous debates which have shown that this approach is quite unrealistic and have suggested the possibility of a varying fiscal reaction. Among the arguments brought are difficulties in reaching a consensus on fiscal consolidation (Bertola and Drazen, 1993) which has to lead to the increase in the primary surplus. These points lead us to the other literature strand which proved the existence of non-linearities of the fiscal response (e.g., Abiad and Ostry, 2005; Legrenzi and Milas, 2013) with a seminal contribution by Gosh et al (2013) who introduced the fiscal fatigue characteristic. Approximated by a cubic function it indicates that the fiscal response varies with the size of the public debt, switching from a positive to a negative one as the debt ratio raises and it peters out.

Our paper investigates the heterogeneity in the fiscal response by applying the unconditional quantile regression (UQR) for the EU economies. This procedure allows us to reveal the varying effects of the explanatory variables across the distribution of the fiscal response and,

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subsequently, assess the impact on sustainability. The conditional quantile regression (CQR) and fixed effects (FE) panel model results are reported for comparison reasons.

2. Methodology and data

One way to assess a heterogeneous distributional effect is the usage of CQR. Mathematically, at any level τ, across the distribution of y, given a set x, the conditional quantile $Q_y(\tau|x)$ shows $inf\{k: T(k|x) \geq \tau\}$ where $T(*|x)$ represents the conditional distribution function. In a panel data framework the most common approach is the CQR with fixed effects (Koenker, 2004):

$$Q_{y_{i,t}}(\tau|x_{i,t}) = \alpha_i + x_{i,t}^T \beta^{CQR}(\tau). \tag{1}$$

In Eq. (1), $i = \overline{1, N}$ and $t = \overline{1, T}$, represent countries and years, respectively, $y_{i,t}$ is the primary balance, $x_{i,t}$ denotes the set of covariates, $\beta^{CQR}(\tau)$ is the common slope coefficient while α_i is a location shift parameter. Using this method, Schalk (2012) showed that the fiscal response in the euro area countries differs depending on the chosen quantile.

However, when it comes to assess the effectiveness of government policies, including explanatory variables in CQR renders coefficients which fail to reflect the impact of these covariates across quantiles in an absolute sense. To overcome this problem, Firpo et al. (2009) proposed the UQR by computing a recentered influence function (RIF) designed without reference to covariates which is regressed subsequently on the explanatory variables:

$$RIF\left(y_{i,t}; v\left(F_{y_{i,t}}\right)\right) = v\left(F_{y_{i,t}}\right) + IF\left(y_{i,t}; v\left(F_{y_{i,t}}\right)\right). \tag{2}$$

In Eq. (2), $F_{y_{i,t}}$ represents the cumulative distribution function of $y_{i,t}$ while $v\left(F_{y_{i,t}}\right)$ cuantifies the marginal impact on the parameter of distribution $F_{y_{i,t}}$ when removing or adding a variable. The inflluence function (IF) measures the impact of a particular variable on a distributional statistics:

$$IF\left(y_{i,t}; v\left(F_{y_{i,t}}\right)\right) = \lim_{\varepsilon \to 0} \left(\frac{v[(1-\varepsilon)F_{y_{i,t}} + \varepsilon G_{y_{i,t}}] - v\left(F_{y_{i,t}}\right)}{\varepsilon}\right). \tag{3}$$

In Eq. (3), $0 \leq \varepsilon \leq 1$, and $G_{y_{i,t}}$ denotes the distribution that puts mass at the value $y_{i,t}$. The expected value of the RIF is $v\left(F_{y_{i,t}}\right)$, as the expected value of the $IF\left(y_{i,t}; v\left(F_{y_{i,t}}\right)\right)$ is zero. This indicates that regressing a particular statistic, such as the mean, generates the same coefficients as the OLS estimates and this principles are applicable to any statistics of interest along the dependent variable distribution. In addition, if we select the τth quantile as the statistic of interest denoted and choose to estimate the density functions for each quantile, the RIF is specified as follows:

$$RIF(y_{i,t}; q_\tau; F_{y_{i,t}}) = q_\tau + IF(y_{i,t}; q_\tau; F_{y_{i,t}}) = q_\tau + \frac{\tau - \mathbb{I}\{y_{i,t} \leq q_\tau\}}{f_{y_{i,t}}(q_\tau)}. \tag{4}$$

In Eq. (4), q_τ is the τth quantile of the unconditional distribution of $y_{i,t}$, $f_{y_{i,t}}(q_\tau)$ represents the pfd of $y_{i,t}$ evaluated at the τth quantile based on a Kernel density estimation, while $\mathbb{I}\{y_{i,t} \leq q_\tau\}$ is an indicator function showing whether $y_{i,t}$ falls bellow the τth quantile or otherwise. Thus, the UQR estimator is given by:

$$RIF(y_{i,t}; q_\tau; F_{y_{i,t}}) = x_{i,t}^T \beta^{UQR}(\tau). \tag{5}$$

To the best of our knowledge, we are the first examining the heterogeneity in the fiscal response using this the UQR method. The present paper fills this gap in the literature by applying the UQR technique on a panel comprising annual data ranged from 2005 to 2018

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extracted from Ameco and Eurostat for 26[1] EU members. Given our data structure, it is necessary to include fixed effects in the UQR to control for all unobserved country-specific characteristics. Consequently, we followed Borgen (2016), who extended on the work of Firpo et al. (2009) and use a Gausian Kernel for density estimation.

3. Empirical Results

Following the FRF model specifications in the literature, we use the cyclically adjusted primary balance (*CAPB*) as the dependent variable to measure the discretionary fiscal response. The debt stabilizing reaction is given by the distribution of the lagged gross debt. It is widely recognized that the highly politicized nature of the government budgeting makes it difficult to use an immediate reaction to change in the public debt (Everaert and Jansen, 2018) and, therefore, a delay is conventionally accepted. The business cycle stabilization effects are measured by the output gap. Inflation is included as an explanatory to capture the cooperative behaviours of fiscal and monetary authorities and to show how fiscal authorities contribute to the achievement of the monetary policy objectives. The long-term interest rate is used to examine the distribution of the fiscal response to financial markets movements. We also use the net exports to account for the interactions between the domestic and external sectors. Besides these explanatories, we add several other variables to capture the Musgravian allocative and redistributive functions of the fiscal policy which have to respond to the current challenges caused by the health crisis but that must also pursue the sustainable development goals. For this purpose, we include life expectancy at birth to measure the fiscal response to ageing population through spending allocation to healthcare and social protection. We use the tertiary education attainment to capture fiscal policy reaction to ensure the quality of education. The young people neither in employment nor in education or training are more likely to suffer from poverty and social exclusion and represent an unused productive capacity. Fiscal policy should react through active measures on labour market or through redistribution. The purchasing power adjusted GDP per capita is included to measure the disparities between the level of development of EU countries and how fiscal policy responds to challenges posed by the catching-up process. The greenhouse gas emissions is the explanatory that captures fiscal response to environmental issues.

Table 1 reports the estimates for the fixed-effects panel model, and the UQR and CQR coefficients for τ=10%, 25%, 50%, 75% and 90%. The FE estimations show a positive and significant discretionary fiscal response to the increasing public debt which proves the weak sustainability. Compared to the FE analysis that focuses on the mean, the CQR coefficients indicate a positive and monotonically decreasing impact throughout the distribution of the *CAPB*. On the other hand, the UQR analysis indicates a more pronounced positive and obviously decreasing fiscal response along the distribution to the upper quantiles with a small twist across the superior extreme quantile that suggests an increase in the fiscal reaction when the debt is too high.

The macro stabilizing discretionary fiscal response is a negative one and significant indicated by the FE and suggests a pro-cyclical fiscal policy in the EU countries. The CQR coefficients show evidence of pro-cyclicality across the entire distribution even if they exhibit a decreasing tendency that reveal a more pronounced procyclicality across the inferior extreme quantile. The UQR coefficients show a larger negative discretionary fiscal response and significant along the lower quartiles which turns to a positive one but not significant for upper quantiles. These

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[1] We excluded Estonia from the panel because of the data availability.

results point to a shift from a pro-cyclical to a counter-cyclical fiscal policy as the destabilization increases.

We failed to identify significant and robust patterns relating the inflation to the discretionary fiscal response.

The discretionary fiscal response to the long-term interest rate although is negative is not significant as the FE model shows. The CQR analysis indicates a negative and significant fiscal response only across the lower quantile distribution of the *CAPB* while the UQR coefficients change from negative to positive and sharply across the superior extreme quantile. This implies that for lower interest rates governments run a more relaxed fiscal policy while for higher values, fiscal policy can be more restrictive.

The net exports have a significant and positive impact. An improvement of the next exports translates into an improvement of the *CAPB*. However, the CQR coefficients show that the impact is significant and has a monotonically decrease across the entire distribution. In contrast, the UQR analysis shows the positive impact of net exports for the higher quantiles. The effect size is larger and increases for τ=75% and 90%. This suggests that the cyclically adjusted budget balance improves significantly only for high net exports.

The life expectancy at birth has a negative impact on the *CAPB*. The CQR model shows a deterioration in the fiscal response which suddenly improves across the 90th quantile distribution. The UQR coefficients indicate fluctuating effects on the fiscal response across the distribution with a sharp deterioration along the superior extreme quantile. High life expectancy is related to discretionary fiscal measures that lead to the deterioration of the *CAPB* and diminish the debt stabilizing reaction.

We found a positive fiscal response to the increase in the tertiary attainment for the FE model. The CQR estimates indicate an increasing effect across the fiscal reaction distribution with a significant and positive impact for τ=75%. The UQR coefficients show that fiscal response becomes significant at the middle of the distribution when the attainment is higher. This result could suggest that once a satisfactory level of tertiary education has been reached, the government can decide to reduce the costs allocated to these programs.

The fiscal response is negative to the increase in the young population neither in employment nor in education or training. The CQR model shows a significant negative fiscal reaction along the lower quantiles of the distribution while the UQR estimates indicate a significant and stronger response only along the lower extreme quantile and then it becomes statistically insignificant.

The FE model shows that a higher level of development generates a significant positive fiscal response in the sense of increasing the *CAPB*. We failed to identify significant and robust patterns relating the GDP per capita to the distribution of the dependent variable. The UQR estimates show a significant positive response only along the lower quantile while across the rest of the distribution the fiscal response becomes statistically insignificant and decreasing. These results would suggest that governments pursue a more restrictive policy if the level of development is lower and a more relaxed policy when the countries are more developed.

We failed to identify significant and robust patterns relating the greenhouse gas emissions to the fiscal response. Only the CQR model indicates a significant and positive reaction at across

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the superior quantiles distribution, which suggests that the effects of gas emissions on fiscal policy becomes significant only if the *CAPB* has a surplus.

4. Conclusions and Policy Implications

This paper examined the fiscal response to stabilization, allocative and redistributive purposes posed by ageing population and the pursuit of the SDGs. In this sense, we used the novel UQR technique that helped us reveal the heterogeneity of the fiscal reaction. This has several implications on fiscal sustainability especially in the current context caused by the health crisis. Thus, the weakening debt stabilizing fiscal response could constrain policymakers in highly indebted EU countries in providing a prolonged fiscal stimulus. The more pronounced pro-cyclical fiscal policy during bad times suggests that governments will have to face a trade-off between fiscal consolidation and economic recovery. Higher life expectancy deteriorates the fiscal position and weakens the debt stabilizing fiscal response. Thus, many expensive future problems accumulate and question possibilities to enhance fiscal space, particularly against the background of the current pandemic situation. Additionally, less developed countries need more discipline and cannot run excessive budget deficits. However, the fiscal space can increase once the educational attainment and external position improve. These findings could support fiscal policymakers in reaching a proper balance between fiscal activism, debt sustainability and structural reforms.

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Table 1. Estimation results

Dep: Cycl. Adj. Primary balance	FE	UQR	CQR	UQR	CQR	UQR	CQR	UQR	CQR	UQR	CQR
		τ=10		τ=25		τ=50		τ=75		τ=90	
Lagged Gross Debt	**0.1099** **(0.0000)**	**0.1769** **(0.0010)**	**0.0748** **(0.0000)**	**0.1138** **(0.0000)**	**0.0740** **(0.0000)**	**0.0417** **(0.0060)**	**0.0704** **(0.0000)**	0.0293 (0.1060)	**0.0651** **(0.0004)**	0.0537 (0.0140)	**0.0420** **(0.0067)**
Output Gap	**-0.2423** **(0.0002)**	**-0.3504** **(0.0810)**	**-0.3061** **(0.0157)**	**-0.2274** **(0.0440)**	-0.1085 (0.1975)	-0.0327 (0.6630)	-0.0108 (0.8929)	0.0201 (0.7760)	-0.1149 (0.1313)	0.0621 (0.5560)	-0.0734 (0.1963)
Inflation	0.1213 (0.2022)	-0.0562 (0.8150)	0.2636 (0.1322)	-0.0386 (0.7880)	0.0369 (0.7492)	-0.0382 (0.7140)	-0.0774 (0.4914)	0.0322 (0.7220)	0.0989 (0.3723)	-0.0470 (0.7160)	0.1024 (0.3331)
Long-term interest rate	-0.1479 (0.1202)	-0.4211 (0.1890)	**-0.6275** **(0.0087)**	**-0.4004** **(0.0700)**	-0.2871 (0.1069)	0.0571 (0.5280)	-0.0941 (0.5757)	0.1455 (0.1280)	-0.0938 (0.4375)	**0.45991** **(0.0020)**	-0.1210 (0.2834)
Net Exports	**0.1437** **(0.0039)**	0.1329 (0.2030)	**0.2361** **(0.0024)**	0.0864 (0.2730)	**0.2119** **(0.0004)**	0.0379 (0.512)	**0.1880** **(0.0148)**	**0.1810** **(0.0030)**	**0.1719** **(0.0126)**	**0.2500** **(0.0210)**	**0.1697** **(0.0030)**
Life expectancy at birth	**-1.7580** **(0.0000)**	**-1.5282** **(0.0090)**	**-0.6077** **(0.0045)**	-0.9585 (0.1140)	**-0.6552** **(0.0001)**	**-1.0425** **(0.0020)**	**-0.8045** **(0.0007)**	**-1.2718** **(0.0000)**	**-0.8652** **(0.0000)**	**-1.8869** **(0.0060)**	**-0.3957** **(0.0520)**
Tertiary education	**0.1305** **(0.0050)**	-0.0740 (0.4120)	-0.0169 (0.5917)	0.0976 (0.1530)	0.0123 (0.7042)	**0.2158** **(0.0000)**	0.0554 (0.1461)	**0.1640** **(0.0010)**	**0.0782** **(0.0261)**	**0.2443** **(0.0020)**	0.0454 (0.1363)
Young unemployment	**-0.4261** **(0.0000)**	**-0.5802** **(0.0490)**	**-0.2285** **(0.0693)**	-0.2362 (0.2280)	**-0.1487** **(0.0954)**	-0.0711 (0.4450)	-0.1377 (0.1332)	-0.1725 (0.1030)	-0.1483 (0.2158)	-0.1317 (0.3030)	-0.0568 (0.5592)
GDP per capita	**0.0552** **(0.0324)**	**0.0916** **(0.0650)**	-0.0136 (0.2008)	0.0442 (0.2720)	-0.0053 (0.6259)	0.0430 (0.1780)	0.0001 (0.9979)	-0.0307 (0.3500)	-0.0025 (0.8634)	-0.0380 (0.3130)	-0.0149 (0.2734)
Greenhouse gas emissions	-0.0055 (0.8356)	0.0311 (0.5180)	0.0105 (0.5555)	0.0381 (0.3750)	0.0175 (0.1249)	0.0070 (0.7950)	0.0243 (0.1246)	-0.0024 (0.9470)	**0.0482** **(0.0023)**	0.0107 (0.8050)	**0.0409** **(0.0004)**
Pseudo R-squared	0.5092	0.2160	0.2548	0.3240	0.2288	0.1613	0.1676	0.1464	0.1145	0.1762	0.1595

For UQR coefficients we use a Gaussian kernel while the standard errors were bootstrapped with 200 replications. CQR coefficients are estimated by setting λ=1, which is recommended given our data structure. However, imposing λ=0 or 5 or any value from this interval does not change significantly our results. P-values are reported in parentheses. Intercepts were included but not reported.