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Sub-National Government's Risk Premia: Does Fiscal Performance Matter?

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Sub-National Governments' Risk Premia: Does Fiscal Performance Matter?

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Abstract

This paper examines the determinants of sub-national governments risk premia using secondary market data for U.S., Canada, Australia and Germany. It finds that, as for central governments, fiscal fundamentals matter in the pricing of risk premia, and sub-national governments with higher public debt and larger deficits pay higher premia. However, this relationship is not uniform across countries. Market pricing mechanisms are less effective in presence of explicit or implicit guarantees from the central government. Specifically, we show that in pricing risk premia of sub-national governments, markets are less responsive to fiscal fundamental when sub-national governments depend on high transfers from the central government, i.e., when there is some form of implicit guarantee from the center. Using primary market data, the paper also looks at whether transfer dependency from the central government influences sub-national governments' incentive to access markets. We show that high transfer dependency lowers the probability of sub-national governments to borrow on capital markets.

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I. INTRODUCTION[1]

The European debt crisis has revived the interest in the determinants of sovereign risk in fiscal or quasi-fiscal federations. The difference between the pre-crisis compression in government bonds risk premia in Euro area countries and the subsequent divergence over the last few years has been stark. A similar phenomenon has occurred for sub-national governments in fiscal federations (e.g., Spain). These divergent trends can have different explanations. These fluctuations could be due to the erroneous pricing of default risk in the years prior to the crisis, to the post-crisis worsening of fiscal fundamentals, or to investors' panic, which led markets to be overly sensitive to countries' fiscal and macroeconomic fundamentals. As the policy discourse around the possible creation of a fiscal union in Europe evolves, looking at the role of market discipline in fiscal federations and how markets price sub-national governments (SNGs)' securities in federations acquire particular importance. How much are markets willing to forego their assessment of fiscal performance of a region or province when there is a presumption of an implicit (or even explicit) bailout guarantee by the centre? What is the importance of institutional arrangements such as transfer schemes or revenue independence at the sub national level?

Little empirical literature has, however, focused on the determinants of risk premia in fiscal federations and on the role of the institutional design of federations. Most of the existing studies focus on single countries and do not examine the role of institutional features of fiscal federations in determining risk premia for SNGs (for example, Goldstein and Woglom 1992; Bayuomi, Goldstein and Woglom 1995; Poterba and Rueben 1999; Booth et al 2007; Lemmen 1999 and Shuknecht, von Hagen and Wolswijk 2009). Yet, several institutional parameters of federations may influence market perceptions of the default risk of sub-national debt and the probability of bailout by the center. These parameters include, for example, the presence of explicit or implicit guarantees by the central government, which help SNGs in times of fiscal distress, intergovernmental transfers and/or tax revenue sharing arrangements (e.g., the fiscal equalization scheme in Germany).[2] Schuknecht et al (2009) analyzed these issues and examined the behavior of risk premia on primary market yields paid by central governments in Europe and by sub-national governments in Germany, Spain and Canada over the period 1995-2005. They concluded that SNGs that receive more transfers from the central government tend to pay a lower interest rate on their market borrowing. Their results do not, however, hold over time as the relationship disappeared in post-EMU Germany. A more recent attempt to isolate the effect of institutional design is Feld et al. (2013). They studied the effect of no-bailout rules on Swiss cantons towards their

[1] Thanks to Santiago Acosta Ormaechea, Marcio V. Da Cruz, Mark De Broek, Xavier Debrun, Salvatore Dell'Erba, Eva Jenkner, Serhan Cevik, Sebastian Weber, and Veronika Zavacka for very useful comments and suggestions. All errors remain our own. Special thanks go to Jeta Menkulasi and Asad Zaman for discussions and the precious help in collecting data.

[2] In theory the presence of bail-out guarantees of central governments to sub-national governments could also have the effect of increasing the yield paid by central governments. See Jenkner and Lu (2014) for an analysis of this channel.

municipalities and showed that credible no-bailout rules tend to reduce the risk premia of cantons by about 25 basis points. In addition, the introduction of a no-bailout rule appears to break the link between risk premia of cantons and the financial situation of the municipalities. Overall, however, the evidence about the role of institutional arrangements in shaping the pricing of sub-national risk premia remains at best not conclusive.

This paper examines the determinants of risk premia for sub-national bonds focusing on macroeconomic and fiscal performance, and on institutional design of federations. In general, SNGs borrow at a premium over central governments, although large heterogeneity exists in the level of such risk premia both across federations and within the same federation. This paper analyzes how much of these premia can be explained by fiscal fundamentals and how much are instead due to institutional arrangements. The analysis focuses on a panel of sub-national governments in the four fiscal federations (U.S., Canada, Australia and Germany) with the most liquid markets for sub-national bonds. Differently from most of the existing literature, risk premia are measured using secondary market data. The role of institutional arrangements is gauged both by estimating separate models for each federation and by analyzing the role of transfer dependency from the central government in pricing risk at local level. The idea is that transfers dependency captures the involvement of the center in sub-national finances and this can affect the way markets price fundamentals, or even determine fiscal fundamentals themselves.

The paper finds that differences in the institutional design of fiscal federations matter for how macroeconomic and fiscal fundamental determine SNGs' risk premia. We find that transfer dependency does not have a direct impact on risk premia, but it plays an important role on how fiscal fundamentals are priced in that they matter less for SNGs with high transfer dependency. For example, the effect of the debt to GDP ratio on risk premia is about five times stronger for sub-nationals with low transfer dependency. This result is consistent with the view that large involvement of the central government in the financing of sub-national governments is perceived by market participants as an implicit guarantee. These results are consistent with some earlier analysis using primary market data (e.g., Schuknecht et al. 2009) and suggest that the institutional design matters for the effectiveness of markets' disciplining role in fiscal federations. In addition, we explore whether fiscal decentralization leads to "common pool" problems, i.e., higher deficit in sub-national governments (see for instance Eyraud et al. 2013). We find no evidence that high transfer dependency leads SNGs to run higher budget deficits but it does make sub-national governments' fiscal policy pro-cyclical.

Finally, using primary market data, we find that transfer dependency also affects the incentive of sub-national governments to tap the market. Because of data availability the analysis focuses on sub-national governments in Canada, Australia, Germany and Spain. While we find that high transfer dependency reduces the probability of sub-national governments to issue bonds, fiscal fundamentals still matter in determining bonds risk premia once bonds are issued on the market. To our knowledge, no other study has examined the role of transfer dependence for SNGs in accessing markets.

The rest of the paper is organized as follows. Section II presents some stylized facts about sub-national spreads and their correlation with the dependency of SNGs from central governments. Section III describes the econometric models to be tested. Section IV presents the data used in the analysis. Section V and VI discuss the results and the robustness checks that have been performed. Section VII concludes.

II. MAIN CHARACTERISTICS OF SUB-NATIONAL GOVERNMENTS SPREADS

Spreads of sub-national governments are generally positive except for the U.S. states where, at times, they take negative values.[3] Positive spreads can be due to different reasons, for instance SNGs have smaller tax capacity, more mobile tax base, and are unable to inflate away debt. Negative spreads for U.S. states can be explained by the specific favorable tax treatment of sub-national government bonds in the US. Differently from federal government bonds, whose interests are taxed at the income tax rate, interest income from sub-national government debt in the US is tax free.[4] As a consequence, sub-national debt instruments pay a lower return than equivalent federal government bonds, generating a negative spread.

The distribution of spreads of sub-national governments varies considerably both across countries and across sub-nationals within countries (Figure 1). As argued in IMF (2014), the dispersion in SNGs' spreads can be related to the different institutional features of federations and to whether institutional arrangements include a bail-out guarantee from the central government. Whenever the center guarantees sub-national government debt, in fact, default premia should disappear and positive spreads would result from liquidity considerations only. This could cause a compression in the distribution of spreads within each federation. In line with IMF (2014), in our sample, the U.S., where no-bailout arrangements prevail, show very dispersed SNG spreads, followed by Australia and Canada. On the other hand, Germany, where is there is a history of bailouts, shows the smallest variability in spreads among Laenders (Figure 1).

Likewise, the level of transfer dependency of SNGs varies across countries and could capture institutional features of federations likely to influence SNGs' spreads (Figure 2). We measure this dependency as the ratio of transfers from the central government to sub-nationals' total revenue (as in Escolano et al. 2012). In theory, high transfer dependency could be considered akin to a form of bail-out guarantee from the central government and hence affect the pricing mechanism of SNG's securities. In our sample, the average level of transfer dependency is inversely related to the average spreads of sub-national governments. The size of transfer as a share of revenue of SNGs is higher in Germany (with a median around 60 percent of revenue), where the distribution of spread is smaller, and it is the lowest in the U.S. (with the median of around 25 percent), where the distribution of spreads is larger (Figure 2). Canada and Australia are intermediate cases. There is however variation in

[3] Spreads of SNGs' also take negative values in sporadic cases for some German Laenders.

[4] As long as the investor resides in the same state as the issuer.

transfer dependency within the same federation too. The distribution of transfer over revenue is tighter in Australia and U.S., while it is more dispersed in Germany and Canada. In Canada however, the upper tail of the distribution is dominated by states like Northwest Territories and Nunavut and Yukon which are the smallest in terms of population and with the smallest tax capacity.

III. ECONOMETRIC MODEL

The empirical strategy relies on a multi-stage approach where the first step is to estimate a standard equation of risk premia for SNGs. Using secondary market data we estimate a standard risk premia equation and assess the role of macroeconomic and fiscal fundamentals in determining SNGs' spreads vis-a-vis central governments' yields. The equation is estimated by pooling all countries together and controlling for sub-national (and country-level) heterogeneity. The specification also checks for the presence of non-linear effects of fiscal fundamentals. The same baseline model is then re-estimated country-by-country to gauge the extent to which country-specific institutional arrangements can affect the pricing mechanism of sub-nationals' risk premia.

As a second step, we investigate how institutional arrangements affect the pricing mechanism of sub-national risk premia. We focus on transfer dependency from the central government and test whether fiscal fundamentals matter less when dependency is high. We then test whether dependency from the center affects the incentives of SNGs to run large deficits (common pool problem).

Finally, we analyze how transfer dependency and fiscal fundamentals affect the decision of sub-national governments to issue bonds. To perform this analysis, we rely on primary market data and use a Heckman selection model. This model allows us to estimate the decision to issue bonds modeled explicitly as a function both of fiscal and macroeconomic fundamentals and of transfer dependency. Besides analyzing separately the problem of issuance from that of pricing, this methodology also allows us to correct for potential sample selection biases in the estimation of the determinants of risk premia.

A. Baseline Model: Explaining Sub-National Governments Spreads

The baseline model is a simple linear regression in which the regressors are specified in deviation from the benchmark. This model specification is relatively standard in the literature on risk premia (e.g., Goldstein and Woglom, 1992, and Shuknecht, von Hagen and Wolswijk, 2009) with the difference that, in our case, for each sub-national entity the benchmark is represented by the central government. This particular specification allows us to isolate the variation in fundamentals which is specific to the sub-national entities and not instead due to country-specific shocks. It is in fact likely that part of the fluctuations in sub-national variables are due to country-wide business cycle fluctuations. Hence, estimating a model with variables expressed in levels generates both a problem of cross-correlation at the sub-national level and a problem of identification, as it makes it impossible to tell apart the

portion of variation which is due to country-level shocks. Instead, specifying the regressors in deviation from the benchmark allows controlling for that.[5]

The estimated model controls for unobserved heterogeneity at the sub-national level as well as for global factors. While country-specific shocks are captured by expressing regressors in deviation from the benchmark, global shocks are captured by the introduction of the VXO index.[6] To capture time invariant unobservable elements, the specification includes sub-national fixed effects. The introduction of sub-nationals fixed effects makes country-fixed effects redundant as it already controls for time-invariant unobservable elements at the lowest level of aggregation.

The estimating equation can be written as follows:

$$(1) \qquad Spread_{it} = \alpha_i + \beta Growth^{D}_{it-1} + \gamma Pbal^{D}_{it-1} + \delta Debt^{D}_{it-1} + \vartheta Liq^{D}_{it-1} + \varphi VXO_t + \varepsilon_{it}$$

where $Spread_{it}$ is the spread of the SNG *i* at time *t* measured with respect to the yields of the central government and expressed in basis points; ${Growth_{i-1t}}^{D}$ denotes GDP growth rate; ${PBal_{it-1}}^{D}$ indicates the primary balance to GDP ratio; ${Debt_{it-1}}^{D}$ indicates debt to GDP ratio; ${Liq_{it-1}}^{D}$ is a proxy for the liquidity of the bond (see Section IV for more details), and VXO_t is the proxy for global risk aversion. Superscripts *D* indicate that variables are expressed as deviations from the benchmark, where the latter is the value of the same variable for the central government. For instance ${Growth_{it}}^{D} = (Growth_{it} - {Growth_{jt}}^{B})$ where ${Growth_{jt}}^{B}$ is GDP growth of country j in which sub-national *i* is located. α_i are sub-national level fixed effects. This same specification is used when we estimate the model country-by-country.

The baseline model is estimated using various methodologies. We rely on standard OLS, but also report results obtained using a random effects estimator (RE) because a Hausman test indicates that the random effects specification cannot be rejected.[7] To control for endogeneity, regressors are lagged one period (as in Ardagna et al. 2004). Section VI shows that the results from the baseline model are robust to other estimation techniques (e.g., IV, GMM) which address more directly any endogeneity problem.

The effect of transfer dependency from the central government on SNG's risk premia is analyzed by splitting the sample and by using interaction terms. To test whether the

[5] It is worth noticing that alternative specifications could be used to isolate country-specific variability from global shocks. For instance, Beber et al. (2009) specify the right-hand-side variables in deviation from cross country averages to capture the effects of global factors. Dell'Erba and Sola (2013), instead, estimate a spreads equation using variables in levels and introducing principal components as additional regressors to control for global shocks.

[6] The VXO is the S&P 100 implied volatility computed by the Chicago Board Options Exchange (CBOE).

[7] The p-value of the Hausman test is about 0.25.

degree of transfer dependency from the central government affects how markets price fundamentals for sub-national governments, we proceed in two different ways:

- First, we split the sample according to the magnitude of transfer dependency and analyze separately low and high transfer dependent SNGs. We distinguish high (low) transfer dependent SNGs depending on whether the value of transfer dependency is respectively higher (lower) than the median of the entire sample.

- Second, we augment the baseline model with interaction terms between fiscal variables and transfer dependency. In this case, we define transfer dependency in difference with respect to the average transfer in each federation. As such, the interaction term allows us to analyze the different effect of fiscal fundamentals on SNG's spreads as the degree of transfer dependency within the same fiscal federation varies.

B. System of Equations: Investigating the Common Pool Problem

As a second step, we examine whether transfer dependency affects the incentives of SNGs to run large deficits, thus affecting SNGs' risk premia (common pool problem). Large reliance on transfers from the central government can generate a "common pool problem" whereby SNGs do not fully internalize the consequences that their budget can have on the central government finances. Moreover, high transfers can also generate moral hazard and further increase the incentive to run large deficits. The literature has so far been inconclusive on whether these mechanisms are at work (E.g., Ahrend et al., 2013).[8]

To test for the "common pool problem", we estimate a system of equations where the standard spreads equation is combined with a fiscal reaction function. The spreads equation is the same as equation (1), while the standard fiscal reaction function is modified to contain the transfer dependency variable. Specifically:

$$Spread_{it} = \alpha_i + \beta Growth_{it-1}{}^{D} + \gamma Bal_{it}{}^{D} + \delta Debt_{it-1}{}^{D} + \vartheta Liq_{it-1}{}^{D} + \rho \left(\frac{Transf}{Rev}\right)_{it-1}{}^{D} + \varphi VXO_t + \varepsilon_{it}$$

$$Bal_{it}{}^{D} = \varphi_i + \pi Growth_{it-1}{}^{D} + \tau Debt_{it-1}{}^{D} + \theta \left(\frac{Transf}{Rev}\right)_{it-1}{}^{D} + \mu_{it} \qquad (2)$$

As for regression (1), all regressors are expressed in deviation from the benchmark and are lagged one period. Transfer dependency is instead expressed as the difference with respect to the median of the sample.

[8] A parallel line of investigation has instead analyzed whether common pool problems emerge in countries characterized by higher decentralization. Eichler and Hofmann (2013) and Jin and Zou (2002) have found that indeed decentralization tends to worsen the central government fiscal position.

Differences in fiscal behavior are also evaluated by estimating fiscal reaction functions separately for low and high transfer dependent SNGs. While the joint analysis of fiscal reaction function and pricing equation as in equation (2) is desirable, issues with small sample size prevents from running the same analysis separately for high and low transfer dependent sub-nationals. We therefore opt for a more parsimonious model and analyze only the fiscal reaction function separately for high and low transfer dependent SNGs. The split between high and low transfer dependent SNGs is performed – as for the baseline model – on the basis of the median of transfer dependency variable in the sample. To avoid endogeneity, the estimation of the fiscal reaction function is performed using different techniques: (i) standard OLS with regressors lagged one period, (ii) Arellano Bond estimator (see Arellano and Bond 1991) and (iii) system GMM estimators (Arellano and Bover 1995).

C. Heckman Selection Model: Investigating Incentives to Issue Bonds

Finally, we turn to primary market data and examine the effect of transfer dependency on SNGs' decision to issue bonds and on bonds pricing. Analyzing separately the decision of issuing debt from that of pricing can cast light on the importance of transfer dependency in shaping the incentives of SNGs to tap the market. Following Jahjah, Wei and Yue (2012), we estimate a Heckman Selection Model where the first equation (selection equation) expresses the probability of sub-national governments to issue bonds and the second equation (outcome equation) is a simple linear spreads equation, similar to equation (1).[9] This methodology has the desirable property of correcting for possible sample selection bias. The bias could arise because not all SNGs borrow continuously on the market so it may well be the case that only SNGs with relatively good fundamentals find it convenient to issue bonds. If this were the case, our analyses based on secondary market data would suffer from sample selection bias. Also, using primary data ensures that the prices of SNG bonds are determined in an active market. As such, the results obtained can be interpreted as a robustness check for the results obtained using secondary market data where market liquidity could be an issue.

In the selection equation, the excluded instrument is the size of the sub-national entity (proxied by its GDP share in the country it belongs to). The assumption is that larger SNGs have higher probability of issuing debt while their size does not affect the risk premia they pay to the market. This assumption is justified by the fact that the larger is a sub-national government, the larger will be its financing needs. For this reason, everything else equal, they will pay a lower liquidity premium on the market and therefore will have a larger incentive to issue bonds compared to smaller entities. However, after controlling for market liquidity and for fiscal and macroeconomic fundamentals, their size should not matter in determining the risk premia of the bonds at issuance.

[9] Heckman selection models aim at addressing selection bias (see Heckman 1979). In our model, the selection bias is determined by the fact that we can only look at SNGs that have actually issued bonds.

The estimated model can be written as:

$$P(Issuance_{it}=1)=\pi Growth_{it}+\psi Pbal_{it}+\lambda Debt_{it}+\tau\left(\frac{Transfer}{\text{Re}venue}\right)_{it}+\rho VXO_{t}+\omega GDPShare_{it}+\eta_{it}$$

$$Spread_{it}=\beta Growth_{it}+\gamma Pbal_{it}+\delta Debt_{it}+\vartheta Liq_{it}+\phi Maturity_{it}+\theta\left(\frac{Transfer}{\text{Re}venue}\right)_{it}+\varphi VXO_{t}+\varepsilon_{it}$$

As for the baseline model, the spread equation contains fiscal and macroeconomic fundamentals and the VXO index for measuring global risk aversion. It is also augmented with a measure of the time to maturity of the bond issued ($Maturity_{it}$). Differently from the analysis conducted using secondary market data, where the dependent variable is a constant maturity yield, in this case the maturity of the bonds at issuance differs. It is therefore necessary to control for the maturity at issuance as – everything else equal – bonds with longer maturity will have higher yields. The regression also includes and a variable that captures the liquidity of the bond (Liq_{it}) (see Section IV for more details), as well as the VXO to proxy for global risk aversion. Compared to regression (1), here regressors are expressed in level rather than in deviation from the benchmark. However, we verify that results are robust to a specification in differences too.[10]

IV. DEFINITIONS, DATA, AND SOURCES

Spreads of sub-national government bonds measure risk premia of SNGs' debt over the central government. The spread is computed as the simple difference between the yield to maturity of bonds issued by each SNG and the yield to maturity of a comparable bond issued by the central government. The analysis has been conducted using secondary market data, except when testing the model explained in Section III.C, which is estimated using primary market data.

Secondary market data for US, Canada and Australia rely on constant maturity yield curves from Bloomberg. In particular, the yield spread is measured as the difference between the 5 years constant maturity yield of a representative bond issued by SNGs and the 5 years constant maturity yield of the benchmark bond issued by the central government. These data are available from 2000 and they are available at monthly frequency. We construct yearly spreads by taking simple averages of monthly data. The advantage of using constant yield curve data is that by construction they should represent the yield to maturity of the most traded benchmark bonds. This selection criterion also ensures comparability across yields of different SNGs in different countries.

For German Laenders, we use data from Schultz and Wolff (2009) as constant maturity yield curves are not available. Schultz and Wolff analyzed the issuing behavior and pricing of bonds issued by German federal states since 1992. Differently from Bloomberg, they use all bonds with maturities between four to seven years and they compute the yield as a

[10] Results available upon request.

weighted average of all the yields of the bonds within this maturity range. Because the five year maturity bond is relatively important in their data, pooling them together with the five year constant maturity yield data available for the other countries does not constitute a major problem.

The resulting dataset covers US, Canada, Australia and Germany and generates an unbalanced panel of risk premia for bonds issued by 48 SNGs between 2000 and 2010. The dataset includes 19 U.S. states, 15 German Laenders, 10 Canadian provinces and 4 Australian territories.

Data on yield spreads on the primary market come from Capital Data Bondware. In this database, spreads are measured as the difference between the yield to maturity of a newly issued bond and the yield to maturity of a comparable bond issued by the sovereign. The database collects all bonds issued by sub-national governments and municipalities for both local and foreign currency bonds. It reports not only the spread at issuance but also the face value of the debt issued and its maturity. In the analysis, we consider only bonds issued by SNGs in domestic currency as these are by far the most popular bonds, facilitating cross countries and within country analysis. Moreover, because the database provides poor coverage of bonds issued by U.S. states, in this part of the analysis the U.S. is excluded from the sample. Instead, the database provides good coverage of bonds issued by Spanish regions, which are included in the sample.

The resulting database for primary markets contains all bonds issued by Australian states, Canadian Provinces, German Laenders and Spanish Regions over the period 1990 and 2010.[11] In particular, the database covers 36 sub-national governments of which 13 in Germany, 12 in Spain, 10 in Canada and one in Australia (Table 2). The total number of bonds issued is 1,641 with the highest number of bonds being in Germany and Canada (749 and 770 issuances, respectively). Except for Australia, where only one of the sub-national governments is recorded to have issued debt in the period under consideration, the composition of the sample is pretty balanced. In Spain, for instance, 12 out of the 17 autonomous communities have been issuing debt; 10 out of 13 provinces in Canada and 13 out of 16 Laenders for Germany. Overall, the number of SNGs that have never issued debt in the period under consideration is rather limited which is important for the validity of the empirical analysis.

Data on the macroeconomic variables are collected from national sources. The main variables used in the regressions are: GDP growth, primary balance to GDP ratio, debt to GDP ratio and transfer to revenue ratio.[12] For GDP growth, in absence of data on real GDP at

[11] Data from Capital Data Bondware are available from 1980, but to ensure consistency with the secondary market data I limit the sample to the period 2000-2010.

[12] Data sources are: Bureau of Economic Analysis and the Census for the U.S.; Statistics Canada for Canada; Australian Bureau of Statistics and the Commonwealth Budget Documents for Australia; the Federal Ministry of Finance, the Federal Statistical Office and the Statistical Office of the Laender for Germany and the Bank of Spain for Spain.

the sub-national level for all countries, we use nominal GDP growth. The primary balance is measured as revenue minus non-interest expenditure where revenue includes transfers from the central government. This could potentially lead to identification issues in case the measure of transfer dependency was somewhat correlated with the budget balance. For the sub-nationals in the sample however the correlation is around zero, thus ruling out identification problems.[13]

The estimated models also include a control for bond liquidity. When performing the analysis using secondary market data, an appropriate measure of liquidity hard to find. Because the frequency of the data is annual, one cannot rely on bid-ask spreads, which are the usual measure of liquidity used in high frequency analyses. For this reason, following Gomèz Puig (2009), we use outstanding debt stocks as a measure of liquidity. In particular, we measure liquidity at time *t* for sub-national *i* as the ratio between its outstanding debt stock for that year and the sum of all the outstanding debt stocks of the sub-national governments in that country in that year. As all the other variables in the analysis, also liquidity enters the estimations in deviation from the benchmark. The measure of liquidity for the benchmark bonds is constructed following the same logic, except that the ratio is between the outstanding debt stock of central government at time *t* and the total debt stock of all the central governments in the sample in the same year. In the analysis which uses primary market data, instead, liquidity is measured using the face value of the bond issued. Again, liquidity of a bond in a given year is measured as the ratio between the face value of the bond issued by the sub-national and the sum of the face value of bonds issued by all of the other sub-national governments in that country during that year.[14]

V. RESULTS

A. Baseline regression

The role of macro-fiscal variables and market conditions

On average, spreads of sub-national governments' bonds respond to their fiscal fundamentals. Results from the baseline model show that the SNG' balance to GDP ratio has a negative and significant coefficient (Table 3, column 1). If the SNG's balance worsens with respect to the central government by one percentage point of GDP, the spread over the central government security increases by about 3 basis points. The effect of the debt to GDP ratio on SNGs' bond yields is also statistically significant. If the difference between the debt to GDP ratio of the SNG and the central government increases by 10 percent, the spreads of SNGs increase by about 10 basis points. The effects of the balance on SNGs' spreads are consistent with existing literature (see for instance Wolswijk et al. 2009), while the effects of the debt stock are larger than commonly found. For instance, Wolswijk et al. (2009) found an

[13] It is about -0.02 and not statistically significant at any reasonable level.

[14] As for the liquidity measure computed with secondary market data, this is supposed to capture the size of a bond issued by a given sub-national in year "*t*" relative to the total size of the sub-national bonds market in the country in year "*t*".

effect of about 4 basis points for the government balance and only 0.4 basis points for the debt to GDP ratio.[15] The higher effects of the debt stock found in this analysis can be explained with the existence of non-linearities with the crisis period. Recent studies have in fact shown the effect of the debt stock to be stronger in times of financial stress (see for instance Dell'Erba and Sola 2013 and Jaramillo and Weber 2013 among others) and our results point to the fact that this is likely to be the case also for SNGs.

Market conditions and macroeconomic variables also contribute to explain risk premia. As expected, global risk aversion has a positive and statistically significant coefficient: a 1 point increase in the VXO index increases risk premia by about 1.6 basis points. Liquidity has the expected negative sign, although it is not statistically significant. As for GDP growth, because it is measured in nominal terms its sign is a priori uncertain. While real growth should reduce the risk premia, a higher inflation could have the opposite effect. In this case GDP growth turns out to be positive, but it is however not statistically significant.[16] Results are similar when using random effects regressions (Table 3, column 2).

Both the impact of the primary balance and the debt to GDP ratio on sub-national governments' spread show evidence of non-linearity. Following the literature on the determinants of risk premia, we test for the presence of non-linear effects of fiscal fundamentals for SNGs' spreads (see for instance Ardagna et al. 2007 for a discussion non-linear effect for central government bond spreads). To this purpose, the baseline model is augmented with a quadratic term and a splice term both for the balance to GDP ratio (Table 4, columns 1-2) and for the debt to GDP ratio (Table 4, columns 3-4).

- *Primary balance.* There is a discontinuity in the effect of the primary balance on spreads in that deficits affect borrowing costs only when they are large (i.e., the balance is smaller than its median value), while they do not have significant effect otherwise (Table 4 column 2). There is instead no evidence of a quadratic relationship (column 1). This result could indicate the importance that financing needs can have in thin debt markets. Despite the fact that we look at federations with the largest amount of traded sub-national debt, these markets are still relatively thin and this can reflect in high premia charged to sub-national governments when these tend to tap the market with considerable financing needs.

- *Debt*. Interestingly, for SNGs' debt– which is the variable most likely related to fiscal solvency – the results show the opposite effect: higher debt-to-GDP levels are associated with higher but decreasing risk premia (Table 4, column 3 and 4). The specification with the quadratic term suggests that eventually this relationship changes sign when the difference between the debt to GDP ratio of the sub-national

[15] Similar results are found also in studies which analyze risk premia of central government bonds (i.e. Ardagna et al. 2007).

[16] Because of data limitations at local level, nominal rather than real GDP is used in the analysis. However, results are similar when using GDP deflated by CPI where data are available.

government and the central government is larger than about 28 percent of GDP. This suggests that when SNGs' debt stocks become too large, markets start reducing the premia charged for debt possibly because they take into account the intervention of the central government. In our sample, these highly indebted SNGs are some German Laenders and a couple of Canadian Provinces. This result hints at the presence of heterogeneity across countries in the responses of risk premia to fiscal variables. Moreover, it also suggests the possibility of moral hazard with sub-nationals benefiting of government guarantee having the incentive of accumulating larger stocks of debt.

The heterogeneity in risk premia responses to fiscal variables is evident when estimations are performed country by country (Table 5). While a country by country analysis is not ideal from an econometric standpoint because it leads to a loss of degrees of freedom, it allows quantifying and comparing the market pricing mechanisms in the different countries in the sample. To be consistent with the baseline model (1) (see Table 3), we report the results obtained using: (i) standard OLS estimation (columns 1 to 5) and (ii) random effects estimator (columns 6 to 10) Results indicate that the market pricing mechanism is clearly operational in the U.S. and Australia and, to a lesser extent, in Canada. In general, however, none of the fiscal or macroeconomic variables are statistically significant for German Laenders. These results seem to suggest that market discipline ceases to work when there is a perceived bail-out guarantee of the central government onto sub-national entities as it is the case for Germany (see Shuknecht et al. 2009). Interestingly, the fixed effect model shows that the effect of the debt to GDP ratio is much larger for the U.S. states than for SNGs in other federations. The budget balance instead is not statistically significant, which might point to the importance that U.S. states' budget rules have in anchoring market participants' expectations.[17] These results might hint to the importance of institutional design of federations in the pricing of risk.

The effects of vertical dependency: the role of transfers

For SNGs with low transfer dependency (i.e. with less links to the central government), local debt and risk aversion have strong effects on risk premia. The effect of dependency from the central government can be gauged by re-estimating the baseline model (1) on two sub samples, differing for the level of transfer dependency. In particular, we consider *high transfer dependent* SNGs all those governments for which the median transfer dependency is higher than the sample median, and *low transfer dependent* sub-nationals all the others. Results (Table 6 column 1 and 2) show that the effect of the debt to GDP ratio is about 5 times larger and the effect of an increase in global risk aversion is about double for SNGs with low transfer dependency compared to high transfer dependency SNGs. This suggests that SNGs with larger support from the central government tend to be less penalized by markets for having large stocks of debt; in other words, they are considered safer regardless of their debt to GDP ratio.

[17] The effect of fiscal rules per se cannot be estimated because of the presence of fixed effects.

The effect of short-term financing needs on risk premia of sub-national governments do does not depend on transfer dependency. Specifically, results show that impact of the government balance on spreads is negative and significant for high-transfer dependent SNGs (Table 6, column 1). This result may appear to contradict our hypothesis. However, while the effect of the debt to GDP ratio is more directly linked to expected solvency, the counterintuitive result about effect of the primary balance on premia could be due to the presence of large financing needs in relatively thin local debt markets. This seems to be the case in our sample. Regardless of whether a SNG has high or low transfer dependency, larger financing needs are associated with higher risk premia (Table 6, columns 3 and 4). In our sample of SNGs, these large financing needs occur on average when the deficit of the sub-national government is at least 1.7 percentage points of GDP higher than the deficit of the central government.

Vertical dependency within fiscal federations

Differences in vertical dependency within each federation could be taken into account by market participants when pricing SNGs' risk. So far, we have treated transfer dependency as a variable which allows us to identify differences in institutional design. As Figure 2 shows, however, transfer dependency displays some variability across SNGs within the same federation. It is natural to ask therefore whether such differences within each federation affect how SNGs' market spreads respond to fiscal fundamentals. To answer this question, we re-estimate regression (1), including as additional variable an interaction term between transfer dependency and fiscal fundamentals. In particular, to gauge the effect of differences in transfer dependency across SNGs within the same country we express the transfer dependency variable as the difference between transfer dependency of a given SNG in year *t* and the average transfer dependency for that particular year in the country where the SNG is located.

Within the same federation, larger transfer dependency reduces the effect of fiscal variables on risk premia but the effect is relatively small. Compared to the results of the baseline model, the introduction of the interaction term does not modify either the significance or the magnitude of regression coefficients (Table 7, column 1-2). As for the interaction terms, their signs are as expected although the coefficients are not statistically significant:

- The positive sign of the parameter for the interaction term between the government balance to GDP ratio and the transfer dependency indicates that higher transfer dependency reduces the negative impact of running high deficits;
- The negative sign for the interaction between the debt to GDP ratio and transfer dependency indicates that higher transfer dependency reduces the impact of having high stocks of debt;

The effect of the interaction variable is represented graphically in Figure 3. The figure shows the marginal effect on SNGs' spreads of government balance and debt to GDP ratio at different levels of transfer dependency. The blue lines depict the coefficients of the interaction terms estimated in Table 7 (with units reported on the left axis); the black dashed

lines represent the 95 percent confidence interval around the marginal effect. The horizontal axis reports the value of the transfer over revenue variable, expressed in deviation from the country average. Finally, the dashed orange curve represents the kernel density estimation of the transfer over revenue variable (with units reported on the right axis). As already suggested in Figure 2, the kernel density line shows that within each country there is large dispersion in the transfer dependency ratio across SNGs, with quite a large fraction of sub-nationals characterized by transfer dependency much higher or much lower than the sample median. The two panels of Figure 3 suggest that the effect of fiscal fundamentals for SNGs characterized by low transfer dependency are about half of the effects for those with high transfer dependency. The magnitudes of such differences, however, are small. As we move from SNGs with low to high transfer dependency the effect of worsening the budget balance by 1 percentage points below that of the central government goes from 4 to 2 and a half basis points. The effect of a similar worsening in the debt to GDP ratio instead goes from 2 to 1 basis point. The large confidence bands also suggest that such differences are not statistically different from each other.

Relative transfer dependency within a federation, however, effectively functions as a risk sharing mechanism protecting SNGs from country risks. One of the benefits of transfer dependency could be to shield sub-national governments from aggregate shocks. To test this prediction, we re-estimate the baseline model with the transfer dependency variable interacted with GDP growth of the central government (Table 7 column 3). The results show that country specific shocks have strong and significant effects on sub-national governments risk premia: a one percentage point decrease in nominal GDP growth at the state level increases sub-national governments risk premia by about 13 basis points. However, such effect is significantly reduced as transfer dependency increases. It goes from 13 basis points for SNGs with lower transfer dependency to about 3 basis points for SNGs with the highest level of transfer dependency (Figure 4).

B. Transfer Dependency and Budget Balances

High transfer dependency may create moral hazard for the sub-national governments, hence indirectly affecting their spreads. Sub-national governments that receive relatively large transfers from the central government might find it convenient to run undisciplined fiscal policies and then arm-twist the central government into covering these larger deficits with higher transfers. If this is the case, transfer dependency could have an indirect effect on SNGs' spreads by increasing sub-national governments' deficits. Alternatively, it is also possible that transfers from the central governments work as "substitutes" for market borrowing, therefore larger transfers would translate into lower budget deficits.

We test this possibility by estimating a system of equations (Section III.B) and find that high transfers improve SNG's balances, with no sign of moral hazard behavior. We estimate two specifications which differ slightly for the inclusion of the transfer dependency variable in the spreads equation. The results show that – contrary to the common pool hypothesis – larger transfer dependency increases SNG's primary balance which suggests that sub-nationals use transfers from the center as an alternative way of financing (Table 8 columns 2 and 4). In the spreads equation, instead, fiscal fundamentals remain significant and of the expected sign (Table 8, column 1 and 3).

While transfer dependency does not seem to lead to moral hazard on the part of SNGs, it does affect how SNGs conduct their fiscal policy and react to fundamentals. Results from the estimation of fiscal reaction functions show that the conduct of fiscal policy is different in low and in high transfer dependent SNGs (Table 9 columns 1 to 6). Fiscal policy appears to be anti-cyclical in low transfer dependent SNGs, while it turns to be pro-cyclical in the high transfer dependent ones. Using the most preferred specifications (Table 9 columns 3 to 6), fiscal policy also seems to be more responsive to high debt levels in low transfer dependent SNGs while debt does not matter in other SNGs. Finally, the effect of risk aversion is larger for low transfer SNGs (about double). These findings can have two complementary explanations: (i) because for low transfer dependent SNGs larger risk aversion means much larger risk premia, SNGs need to run tighter fiscal policy in order to counterbalance this effect; alternatively, (ii) because SNGs might be bailed out by the central governments in case of distress, high transfer dependent SNGs do not respond with tighter fiscal policy to increases in risk aversion and risk premia.

C. Probability of Issuance and Determinants of Risk Premia on the Primary Market

Using primary market data, we show that SNGs' primary balance affects their risk premia at issuance. In particular, a one percent improvement in fiscal balance to GDP ratio reduces spreads by about 4 to 7 basis points. This is consistent with previous results using secondary market data that financing needs affect risk premia. Differently from previous results, however, the debt to GDP ratio does not appear to have significant effects (Table 10, column 1). As expected, the maturity premium increases spread by about 1 basis points and a similar effect is found for increases in global risk aversion.

However, the fiscal balance does not influence the decision of sub-national governments to issue debt, while their rollover needs do matter. The balance to GDP ratio does not have significant effects on the probability of issuing debt (Table 10) while higher debt to GDP ratios do. A 10 percent increase in the debt to GDP ratio increases the probability of new issuances by about 40 percent. The positive effect of the debt to GDP ratio can be explained by the need to roll over existing debt. A large debt stock means higher roll over needs and therefore higher probability of issuing new debt.[18] Also, it could possibly be explained by the presence of fixed costs of issuing debt. Primary dealers might not find it profitable to place on the market only small tranches and as a result, only countries which place reasonably large tranches will find dealers to help them with the issuance. Also, one percentage point higher GDP growth decreases the probability of issuing debt by about 4.5 percent. This is because higher growth can reduce the interests paid on debt and therefore – for a given primary balance – reduce the necessity of issuing new debt.

High transfer dependency increases the probability that SNGs issue debt. Regression results show that a 1 percent increase in transfer dependency decreases the probability of

[18] It would be interesting to control also for a measure of roll over needs, like the residual maturity of outstanding debt. However such data are not available for sub-national governments.

issuing debt by 1 percent (Table 10, Column 2). This result suggests that high transfers function, to a certain extent, as substitutes of borrowing on the market. In terms of the identification of the selection equation, higher GDP share seems to be a strong predictor of the probability of issuing debt on the market. Finally, the inverse mills ratio is never significant which suggests that there is no evident problem of sample selection bias.

VI. Robustness Checks

In this section we discuss the results of robustness checks. We conducted several experiments to test the stability of the results of regression (1). To correct for endogeneity, we estimate the baseline model using alternative estimation techniques (IV, GMM); possible non-stationarity is addressed by estimating the model in first differences. Finally, we cast another look at the heterogeneity across countries by estimating equation (1) allowing for heterogeneity of the coefficients both across countries and at the sub-national level.

Other robustness checks – not reported here for sake of brevity – include tests on the stability of the results obtained with the model with the interaction terms. We re-estimated it adding the size of the sub-national entity as additional control variable. It is possible in fact that transfer dependency is correlated with the size of the sub-national entity, and therefore excluding it could potentially bias the results. Size is measured both by the sub-national's population as a share of the country's total population and by the sub-national's GDP as a share of the country's total GDP. Including these additional controls however does not modify the results.[19]

A. Endogeneity

Results are robust to endogeneity tests. Endogeneity in regression (1) could emerge for two reasons: (i) spreads and macroeconomic and fiscal fundamentals are simultaneously determined, and (ii) high risk premia can have a feedback effect onto GDP growth and fiscal fundamentals. To address the simultaneity issue, we used lagged independent variables, in addition, we could use IV or GMM estimators:

- ***Instrumental variables*** (Table 11). The first and the second columns of Table 11 report the results for the FE-IV estimation and the RE-IV estimation, respectively. In both cases, the right hand side variables have been instrumented with two own lags, except for the VXO which is considered exogenous. The results are consistent with those of the baseline model. The effect of the primary balance however is slightly higher when using this estimation technique, while the opposite happens for the debt to GDP ratio which is also not statistically significant when using the FE-IV estimator.

[19] The statistical significance of the coefficients of regression (1) is also tested using bootstrapped standard error and different assumptions on the error term (i.e. GLS). These modifications do not affect the levels of significance of the coefficients. Results are available upon request.

- ***GMM techniques.*** Similar results are obtained when estimating the models using the Arellano Bond estimator (Table 11, column 3) and the system GMM estimator (Table 11, column 4). In these specifications, the primary balance continues to be strongly statistically significant with an effect ranging between 3.5 and 5 basis points. Table 11 also reports the results from the AR tests performed when using the Arellano Bond and system GMM estimator. In both cases the test strongly rejects the null hypothesis of no AR (1) for the first-differenced model while it accepts the null of no second order autocorrelation.

B. Non-Stationarity

To account for possible non-stationarity issues, we estimate the baseline model in first differences and results remain broadly unchanged (Table 12).[20] In this specification, the effect of the debt to GDP ratio is, however, about six times larger than in basic specification. This hints at the possibility that both the stock of debt and whether the debt to GDP ratio is increasing or not matter in determining SNGs' risk premia. When using the specification in first differences the VXO index continues to be only marginally significant (but, strangely, the sign of the parameter becomes negative). The country-by country estimations confirm that fiscal fundamentals are important determinants of risk premia in all fiscal federations except Germany (columns 2 to 5, Table 12).

C. Heterogeneity at the Sub-National Government Level

Alternative estimation techniques can be employed to account for the heterogeneity in the effects of fundamentals across fiscal federations and across SNGs. The results so far have revealed heterogeneity in the effect of fiscal and macroeconomic fundamentals across fiscal federations. This was particularly evident in the country-by-country estimations. The presence of heterogeneity, however, can also be addressed by estimating pooled models, which allow the estimated coefficients to be different across SNG or across country.

Heterogeneity is tackled by using the mean group estimator (MG) and random coefficients models. Table 13 reports the results of these estimations. Column 1 shows the results obtained from the mean group estimator (Pesaran and Smith 1995). Columns 2 and 3 report results from applying random coefficient models where the right hand side variables are allowed to differ across SNGs (Column 2) or across countries (Column 3). The results are broadly consistent with the baseline model. However, the MG estimator indicates that there is much heterogeneity especially in the effects of the debt to GDP ratio and the liquidity coefficient. This confirms the results obtained in the country-by-country analysis where the coefficients on the debt to GDP ratio and the liquidity coefficients appeared much larger for the U.S. states. The random coefficient models, instead, deliver results which are both quantitatively and qualitatively more similar to the results from the baseline model.

[20] Expressing the right-hand side variables in deviations from the benchmark is already one possible way to avoid non-stationarity issues. Unfortunately however, because of the short time dimension in the sample, a formal test of non-stationarity is not possible.

Heterogeneity across fiscal federations is also evident in the response of risk premia to global shocks. Spreads of SNGs which benefit from actual or implicit bail-out guarantee from the center are lower and have lower standard deviation during a global shock. Figure 5 illustrates this point. It shows the estimated time fixed effects for the year 2008 from country by country regressions (like in columns 2 to 5 of Table 5) augmented with time fixed effects. These estimates can be interpreted as the average effect that the 2008 global shock which had on the average sub-national spread in each country. In presence of such large shocks, it is plausible to assume that risk premia would increase, as investors would fly to safety and liquidity. The only reason why spreads would not move is the case in which the security issued by the sub-national government was perceived as a perfect substitute with the one issued by a sovereign, which would of course be the case whenever the sovereign is perceived as ultimate guarantor of the security. As expected the change in spreads was basically inexistent in Germany, while it was much larger in Australia and Canada and highest in the U.S where the sub-national spreads during the crisis increased by about 80 basis points on average.

VII. CONCLUSIONS

This paper investigates the determinants of market risk premia of sub-national governments in fiscal federations and the role played by the institutional design of federations. Differently from most of the existing literature, the paper looks at secondary market data using yields on long-term bonds, focusing on the U.S. states, Australian territories, Canadian provinces, and German Laenders.

Results shed new lights on the pricing mechanism of SNGs' securities:

- ***The disciplining role exerted by markets on SNGs varies across federations.*** Like for central governments, fiscal fundamentals matter in the pricing of risk premia of SNGs, and SNGs with larger stock of debt and deficits pay higher market premia. However, this relationship is not uniform across countries.

- ***Institutional arrangements between sub-national and central governments in fiscal federations can explain how SNGs' borrowing costs respond to fiscal fundamentals.*** Specifically, high transfer dependency from the central government halves the effect that budget deficits and debt have on SNGs' risk premia.

- ***Transfer dependency from the central government does not appear to induce SNGs to run higher deficits nor to increase their risk premia*** (common pool hypothesis). Transfers from the central government, however, function as a risk sharing mechanism therefore isolating sub-national governments from country-wide shocks.

- ***Finally, transfer dependency affects the incentives of sub-national governments to issue bonds.*** Using primary market data, we show that transfer dependency lowers the probability of sub-national governments to borrow on capital markets. Fiscal

fundamentals instead do not deter SNGs from doing so, although they still matter in determining the risk premia of the bonds once they are issued on the market.

The important role of institutional features in determining the extent to which markets discipline SNGs poses an important question about the design of fiscal federations. Forbidding explicit bail-out guarantees is the first step in allowing markets to operate. However, choices about the extent of transfers and revenue-sharing mechanisms within federations also matter. Such instruments help the cohesion and the credibility of federations and help to protect weaker sub-nationals from aggregate shocks. However, they also appear to transfer the risk away from SNGs at the risk of watering down the effectiveness of markets' disciplining role within federations. Balancing the trade-off between market discipline and intra-national cohesion depends, among others, on the federation design.

Looking forward, broadening the sample of fiscal federations and developing new proxies for institutional design of federation would be a valuable addition to this area of research. Expanding data coverage would allow contemplate a broader variety of institutional arrangements. Developing new institutional proxies could shed light on alternative features of federal federations that may affect SNG's fiscal behavior.

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Tables

Table 1. Summary Statistics

Country	Spreads	Growth	Pbal/GDP	Debt/GDP	VXO	Transf/Rev
Australia	45.7	7.8	0.1	3.8	22.8	45.1
Canada	35.8	4.9	0.2	28.2	22.8	36.2
Germany	20.5	2.3	0.2	25.2	22.8	49.6
USA	-43.6	3.7	0.8	6.9	22.8	24.9

Table 2. Summary Statistics – Primary Market Bonds and Spreads

Country	N. of SNG issuing debt	N. of Issuances	Average Spread (Bps)
Australia	1	8	75.2
Canada	10	770	61.4
Germany	13	749	18.9
Spain	12	114	98.9
Total	36	1641	

Table 3. Baseline Model

Dep Var:	(1)	(2)	(3)
Spreads	FE	RE	Diff
GDP Growth	0.366	0.349	1.114*
	[0.391]	[0.356]	[0.622]
Gov Balance/GDP	-3.000***	-3.034***	-2.752***
	[0.534]	[0.509]	[0.773]
Debt/GDP	1.018**	0.991***	6.917***
	[0.478]	[0.180]	[2.026]
Liquidity	-0.783	0.189	-3.080
	[1.268]	[0.487]	[2.250]
VXO	1.617***	1.570***	-0.413**
	[0.191]	[0.158]	[0.202]
Observations	357	357	306
R-squared	0.521		0.189
Number of id	48	48	47

Robust standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Note: All regressors are expressed in deviation from the benchmark (central government). The regressions include a linear trend. To avoid endogeneity the regressors are lagged one period.

Table 4. Non-Linearities with Fiscal Fundamentals

Dep Var:	(1)	(2)	(3)	(4)
Spreads	Pbal SQ.	Pbal spl.	Debt SQ.	Debt spl.
GDP Growth	0.381	0.367	0.206	0.294
	[0.394]	[0.388]	[0.395]	[0.412]
Gov Balance/GDP	-2.871***		-2.666***	-2.949***
	[0.613]		[0.615]	[0.549]
Debt/GDP	1.034**	1.021**	1.718**	
	[0.500]	[0.488]	[0.682]	
Debt/GDP^2			-0.028**	
			[0.012]	
Gov Balance/GDP^2	0.109			
	[0.123]			
Debt/GDP < Median				1.244**
				[0.524]
Debt/GDP > Median				0.901*
				[0.453]
Gov Balance/GDP < Median		-3.683***		
		[0.569]		
Gov Balance/GDP > Median		-1.940		
		[1.327]		
Liquidity	-0.770	-0.752	-0.852	-0.819
	[1.308]	[1.309]	[1.543]	[1.306]
VXO	1.621***	1.636***	1.729***	1.609***
	[0.195]	[0.205]	[0.238]	[0.191]
Observations	357	357	357	357
R-squared	0.522	0.523	0.531	0.523
Number of id	48	48	48	48

Robust standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Note: All regressors are expressed in deviation from the benchmark (central government). The regressions include a linear trend. To avoid endogeneity the regressors are lagged one period. The non-linearities are constructed using a spline specification where the debt to GDP ratio and the balance to GDP ratio are interacted with dummies which take value 1 respectively if the debt to GDP ratio or the balance to GDP ratio are below or above the sample median.

Table 5. Heterogeneity at the Country Level

	FE ESTIMATOR					RE ESTIMATOR				
Dep Var:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Spreads	ALL	USA	AUS	CAN	DEU	ALL	USA	AUS	CAN	DEU
GDP Growth	0.366	0.038	-0.431	-0.040	0.957	0.349	0.640	-0.724	-0.213*	1.584
	[0.391]	[1.570]	[0.563]	[0.213]	[1.254]	[0.356]	[1.136]	[0.479]	[0.122]	[1.232]
Gov Balance/GDP	-3.000***	3.769	-6.493***	-2.145	-2.179	-3.034***	-3.763**	-6.054***	-3.144**	-2.583*
	[0.534]	[1.858]	[0.702]	[1.792]	[1.394]	[0.509]	[1.583]	[1.156]	[1.355]	[1.559]
Debt/GDP	1.018**	25.876***	-0.157	0.259	-0.755	0.991***	1.036	0.285	-0.004	0.057
	[0.478]	[2.876]	[0.131]	[0.310]	[0.650]	[0.180]	[0.773]	[0.353]	[0.058]	[0.057]
Liquidity	-0.783	-25.058***	-0.315	-0.377	15.788	0.189	1.503	-0.395**	-0.214**	-0.261*
	[1.268]	[5.782]	[0.331]	[0.804]	[9.060]	[0.487]	[0.987]	[0.167]	[0.085]	[0.139]
VXO	1.617***	5.250***	0.522**	1.367***	1.234***	1.570***	1.819***	0.575***	1.255***	1.320***
	[0.191]	[0.621]	[0.140]	[0.157]	[0.185]	[0.158]	[0.412]	[0.095]	[0.120]	[0.171]
Observations	357	152	37	80	88	357	152	37	80	88
R-squared	0.521	0.805	0.875	0.799	0.417					
Number of id	48	19	4	10	15	48	19	4	10	15

Robust standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Note: All regressors are expressed in deviation from the benchmark (central government). The regressions include a linear trend. To avoid endogeneity the regressors are lagged one period.

Table 6. High and Low Transfer Dependency

Dep Var:	(1)	(2)	(3)	(4)
Spreads	High Tr/Rev	Low Tr/Rev	High Tr/Rev	Low Tr/Rev
GDP Growth	0.187	-0.616	0.419	-0.602
	[0.676]	[0.499]	[0.665]	[0.431]
Gov Balance/GDP	-4.007***	-0.406		
	[0.695]	[1.756]		
Gov Balance/GDP < Median			-3.777***	-3.599***
			[0.557]	[1.150]
Gov Balance/GDP > Median			-3.313	2.722
			[2.809]	[2.268]
Debt/GDP	1.090**	5.555**	0.888*	4.981**
	[0.459]	[2.374]	[0.451]	[2.138]
Liquidity	-0.713	0.745	-0.54	1.072
	[1.074]	[4.533]	[1.094]	[3.549]
VXO	1.303***	2.905***	1.353***	2.821***
	[0.239]	[0.566]	[0.237]	[0.522]
Observations	194	163	194	163
R-squared	0.543	0.558	0.536	0.582
Number of id	26	22	26	22

Robust standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Note: All regressors are expressed in deviation from the benchmark (central government). The regressions include a linear trend. To avoid endogeneity the regressors are lagged one period.

Table 7. Interaction Terms

Dep Var:	(1)	(2)	(3)
Spreads	PrBal	Debt	CG Growth
GDP Growth	0.289	0.365	-0.089
	[0.400]	[0.426]	[0.400]
Gov Balance/GDP	-3.400***	-3.235***	-3.290***
	[0.621]	[0.665]	[0.650]
Debt/GDP	1.247**	1.326**	2.554**
	[0.478]	[0.549]	[0.719]
Transfers/Rev	-0.303	-0.255	-2.095***
	[0.378]	[0.369]	[0.478]
Liquidity	-0.992	-0.946	-1.609
	[1.221]	[1.262]	[1.106]
VXO	1.574***	1.634***	1.044***
	[0.189]	[0.212]	[0.218]
CG Growth			-13.156***
			[3.700]
(Gov Balance/GDP)*(Transfers/Rev)	0.026		
	[0.025]		
(Debt/GDP)*(Transfers/Rev)		-0.016	
		[0.013]	
(CG Growth)*(Transfers/Rev)			0.202***
			[0.057]
Observations	286	286	286
R-squared	0.515	0.516	0.569
Number of id	43	43	43

Robust standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Note: All regressors are expressed in deviation from the benchmark (central government). The regressions include a linear trend. To avoid endogeneity the regressors are lagged one period.

Table 8. System of Equations

VARIABLES	(1) Spreads	(2) Gov Bal/GDP	(3) Spreads	(4) Gov Bal/GDP
Transfers/Revenue		0.018**	-0.264	0.025**
		[0.009]	[0.196]	[0.011]
Gov Balance/GDP	-3.498***	0.402***	-3.689***	0.402***
	[0.882]	[0.047]	[0.890]	[0.047]
Debt/GDP	0.610	-0.018	0.814	-0.024
	[0.511]	[0.031]	[0.531]	[0.031]
GDP Growth	-0.177	0.068**	-0.050	0.062*
	[0.610]	[0.035]	[0.615]	[0.035]
Liquidity	-0.621		-0.704	
	[0.825]		[0.824]	
VXO	1.938***	0.007	1.806***	0.011
	[0.265]	[0.016]	[0.282]	[0.017]
Observations	263	263	263	263
R-squared	0.785	0.720	0.786	0.721

Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Note: All regressors are expressed in deviation from the benchmark (central government). The regressions include a linear trend. To avoid endogeneity the regressors are lagged one period.

Table 9. Fiscal Reaction Functions

	(1)	(2)	(3)	(4)	(5)	(6)
Dep Var:	OLS		A. Bond		Sys GMM	
Gov Balance/GDP	Low Tr/Rev	High Tr/Rev	Low Tr/Rev	High Tr/Rev	Low Tr/Rev	High Tr/Rev
Transfers/Rev	-0.045	-0.041**	-0.010	0.023	-0.026	-0.009
	[0.032]	[0.015]	[0.016]	[0.014]	[0.017]	[0.021]
L.Gov Balance/GDP	0.362***	0.448***	-0.107	0.405***	0.442**	0.567***
	[0.099]	[0.051]	[0.130]	[0.089]	[0.213]	[0.086]
Debt/GDP	-0.033	0.003	0.289***	0.024	0.243*	0.014
	[0.077]	[0.064]	[0.089]	[0.052]	[0.139]	[0.063]
GDP Growth	0.128**	-0.146**	0.200***	-0.151***	0.169***	-0.152***
	[0.057]	[0.053]	[0.046]	[0.051]	[0.057]	[0.052]
VXO	-0.169***	-0.073***	-0.116***	-0.046**	-0.102***	-0.053**
	[0.036]	[0.020]	[0.018]	[0.018]	[0.015]	[0.025]
AR(1) test					0.016	0.048
AR(2) test					0.613	0.487
Observations	144	168	113	150	70	106
R-squared	0.691	0.537				
Number of id	22	22	22	22	21	22

Robust standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Note: All regressors are expressed in deviation from the benchmark (central government). The regressions include a linear trend. To avoid endogeneity the regressors are lagged one period.

Table 10. Heckman Selection Model – Issuance and Pricing

VARIABLES	(1) Spreads	(2) P(issuance)
Gov Bal./GDP	-4.860***	-0.014
	[1.265]	[0.039]
Debt/GDP	-0.042	0.037***
	[0.186]	[0.011]
GDP Growth	-0.552	-0.045**
	[0.770]	[0.018]
Transfers/Revenue	-0.019	-0.011**
	[0.129]	[0.005]
VXO	1.096***	
	[0.198]	
Years to Maturity	1.250***	
	[0.340]	
Liquidity	0.086	
	[0.180]	
GDP Share		11.402***
		[1.256]
Lambda		5.923
		[8.828]
Observations	813	813

Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Table 11. Controlling for Endogeneity

Dep Var:	(1)	(2)	(3)	(4)
Spreads	ALL (IV-FE)	ALL (IV-RE)	Ar. Bond	Sys Gmm
L.spreads			0.762***	0.746***
			[0.031]	[0.057]
GDP Growth	0.703	0.526	-0.963	0.248
	[2.456]	[2.294]	[0.678]	[0.618]
Gov Balance/GDP	-5.023**	-4.655**	-3.576***	-4.038***
	[1.992]	[2.142]	[0.774]	[1.130]
Debt/GDP	0.301	0.814***	0.068	-0.362
	[0.558]	[0.242]	[0.092]	[0.246]
Liquidity	-0.269	0.249	-0.508***	0.078
	[0.633]	[0.461]	[0.187]	[0.224]
VXO	1.833***	1.924***	0.172*	2.321***
	[0.352]	[0.357]	[0.098]	[0.339]
AR(1) Test - P Value			0.07	0.004
AR(2) Test - P Value			0.109	0.148
Observations	323	324	361	361
Number of id	47	48	48	48

Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Note: All regressors are expressed in deviation from the benchmark (central government). The regressions include a linear trend.

Table 12. Specification in First Differences

	FIRST DIFFERENCE				
Dep Var:	(1)	(2)	(3)	(4)	(5)
Spreads	ALL	USA	AUS	CAN	DEU
GDP Growth	1.114*	1.132	0.430	-0.713	1.657*
	[0.622]	[1.671]	[0.562]	[0.304]	[0.796]
Gov Balance/GDP	-2.752***	-4.234***	-6.683***	-6.363**	-0.756
	[0.773]	[0.801]	[1.609]	[1.628]	[2.005]
Debt/GDP	6.917***	31.658***	0.684	0.053	-0.464
	[2.026]	[1.066]	[1.107]	[1.760]	[1.129]
Liquidity	-3.080	-35.745***	-3.312	-0.513	-2.992
	[2.250]	[8.193]	[4.062]	[2.055]	[10.269]
VXO	-0.413**	2.477***	-0.695***	-0.320	-0.652*
	[0.202]	[0.254]	[0.143]	[0.243]	[0.345]
Observations	306	133	70	32	71
R-squared	0.189	0.568	0.314	0.584	0.183
Number of id	47	19	10	4	14

Robust standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Note: All regressors are expressed in deviation from the benchmark (central government). The regressions include a linear trend. To avoid endogeneity the regressors are lagged one period.

Table 13. Controlling for Heterogeneity

Dep Var:	(1)	(2)	(3)
Spreads	MG- Pesaran	Mixed Model	Mixed Model
GDP Growth	1.784	0.159	0.095
	[2.009]	[0.473]	[0.445]
Gov Balance/GDP	5.918***	-2.578***	-4.243***
	[1.806]	[0.733]	[0.711]
Debt/GDP	26.684***	1.155***	0.050
	[3.946]	[0.232]	[0.106]
Liquidity	-51.798**	-0.080	0.201
	[23.241]	[0.201]	[0.411]
VXO	5.275***	1.704***	1.348***
	[0.869]	[0.210]	[0.207]
Observations	262	357	357
Number of id	32	48	4

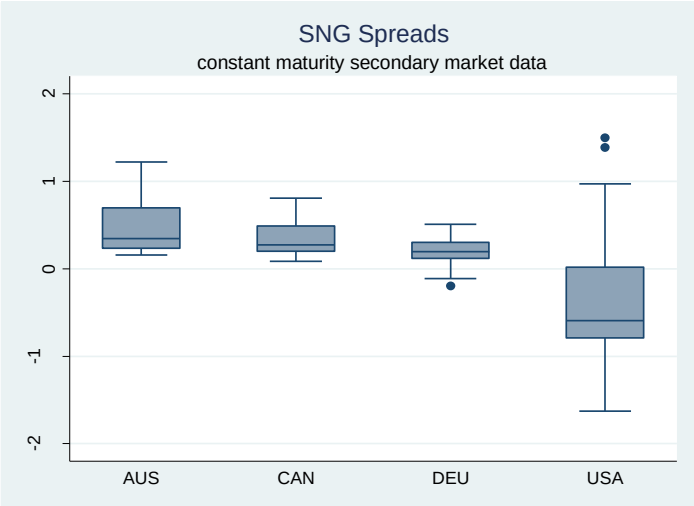
Standard errors in brackets

*** p<0.01, ** p<0.05, * p<0.1

Note: All regressors are expressed in deviation from the benchmark (central government). The regressions include a linear trend. To avoid endogeneity the regressors are lagged one period.

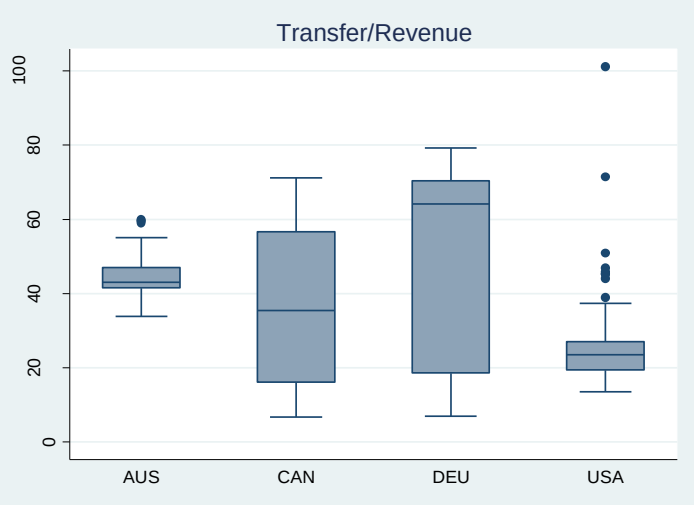
Figures

Figure 1. Sub-National Government Spreads



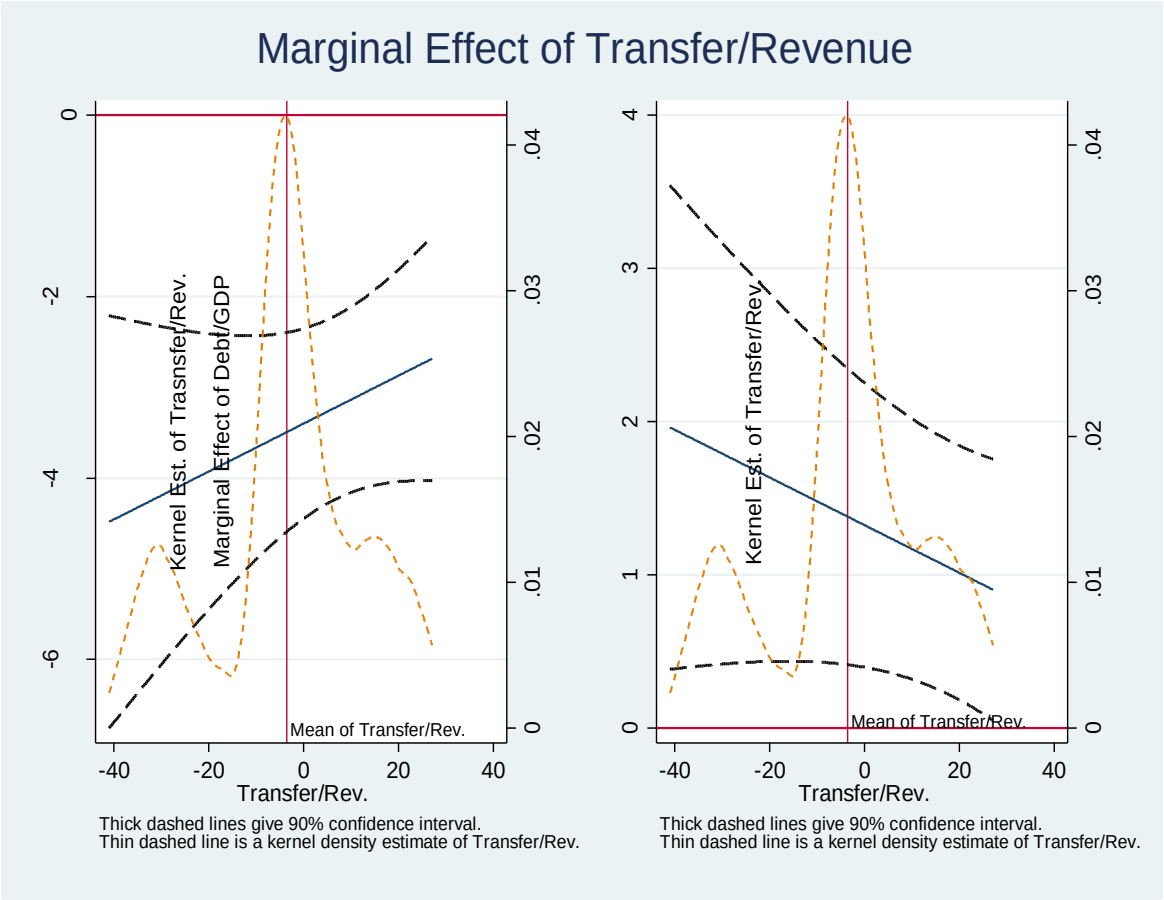
The figure shows box plots for SNG spreads in each of the fiscal federations in the sample

Figure 2. Transfer Dependency Across Countries



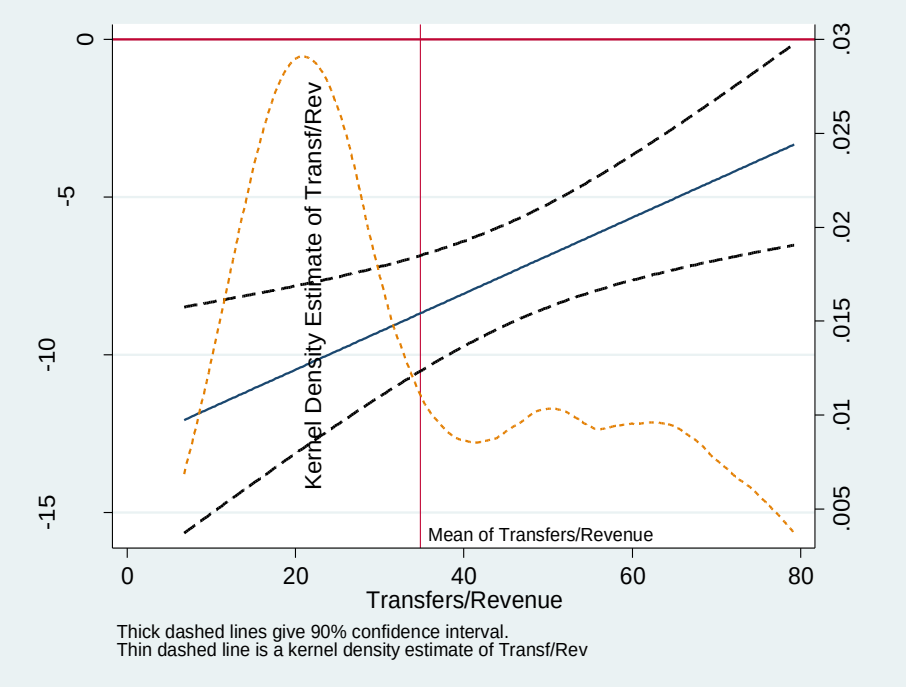
The figure shows box plots for SNG transfer dependency in each of the fiscal federations in the sample

Figure 3. Interaction Terms



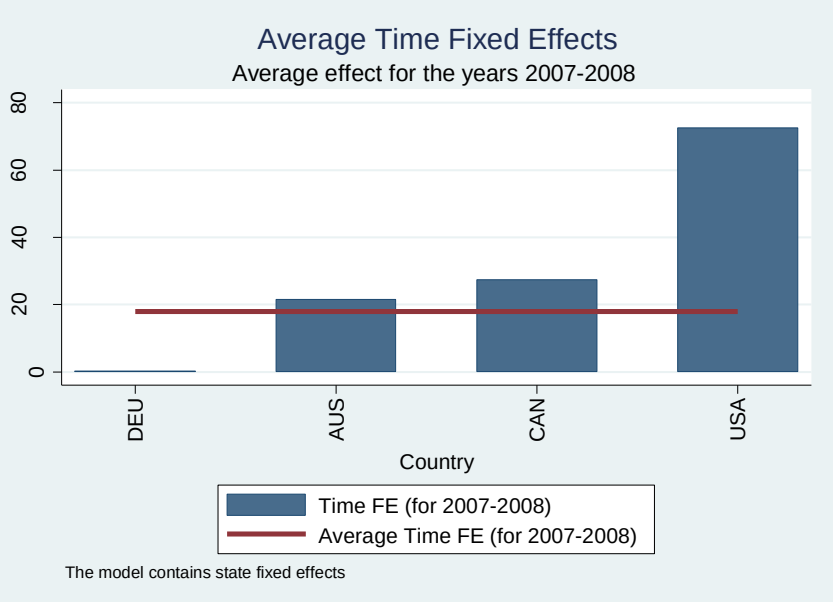
The figure shows the graphical representation of the marginal effects estimated in Table 7 (columns 1, 2). The blue line and the black dashed lines represent the marginal effect across different levels of transfer dependency (left hand side scale). The red dashed line is the kernel density of transfer dependency in the sample (right hand side scale).

Figure 4. Interaction term with Central Government Growth



The figure shows the graphical representation of the marginal effects estimated in Table 7 (columns 3). The blue line and the black dashed lines represent the marginal effect across different levels of transfer dependency (left hand side scale). The red dashed line is the kernel density of transfer dependency in the sample (right hand side scale).

Figure 5. Average Sub-National Spreads by Country During the 2008 Crisis



The blue bars show the time fixed effect for year 2008 estimated using country-by-country two-way-fixed effects regressions for SNG spreads.