

Regional Growth, Debt Thresholds and Subnational Sustainability

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Abstract

Aim: To examine the nexus between subnational debt sustainability and regional economic growth. **Method:** The study employs dynamic panels by Arellano-Bond and the kink model to estimate debt thresholds by Seo and Shin. **Results:** The study finds a positive association between subnational debt and regional GDP growth, which differs by type of debt. The fiscal intergovernmental architecture of federal system in Mexico results in lower debt thresholds compared to national thresholds. **Recommendations:** Fiscal, regulatory and normative rules on bank debt should aim to provide the right incentives to encourage regional growth. **Limitations:** Results from a small sample are a first approximation to the regional debt-growth nexus in Mexico. The lack of updated and consistent data for longer horizons on subnational public finance limits the generalization of the findings. **Originality:** The study helps to understand the effect of increasing debt on regional GDP growth in centralized fiscal systems and the differential effect by type of financing. **Conclusions:** Highly centrally regulated fiscal models with limited revenue autonomy could engender soft budget problems and create financial management inefficiencies.

JEL Classification: H6, H63, H7.

Keywords: Municipal Debt, Subnational Capital Markets, Growth Threshold, Debt Limits.

Crecimiento Regional, Umbrales de Deuda y Sustentabilidad Subnacional

Resumen

Objetivo: Examinar el nexo entre la sustentabilidad de la deuda subnacional y el crecimiento regional. **Métodos:** El estudio emplea paneles dinámicos (Arellano-Bond) y modelos de curvatura (Seo-Shin) para estimar umbrales de deuda. **Resultados:** Encontramos una asociación positiva entre la deuda subnacional y el crecimiento del PIB regional que difiere por tipo de deuda. La arquitectura de las intergubernamentales fiscales del sistema fiscal federal en México genera umbrales menores respecto a los nacionales. **Recomendaciones:** Las reglas fiscales, regulatorias y normativas sobre la deuda bancaria deberían proveer incentivos para alentar el crecimiento regional. **Limitaciones:** Los resultados de la muestra pequeña en este estudio son una primera aproximación al nexo entre deuda y crecimiento. La falta de datos actualizados y consistentes para horizontes de tiempo largos limita la generalización de los resultados. **Originalidad:** El estudio ayuda a comprender el efecto de la deuda subnacional sobre el crecimiento del PIB regional en sistemas fiscales centralizados y el impacto diferencial por tipo de endeudamiento. **Conclusiones:** Modelos fiscales centralizados con autonomía limitada pueden generar problemas de presupuestos suaves e crear ineficiencias en la administración financiera.

Clasificación JEL: H6, H63, H7.

Palabras clave: Deuda de gobiernos locales; mercados de capital subnacional; deuda subnacional; umbrales de crecimiento; límites de endeudamiento.

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1. Introduction

Credit risk analysts have warned that the extraordinary fiscal responses to the recession in developing countries induced by the coronavirus pandemic will send local and regional governments' debt into historic highs (Ejge and Franch, 2020). Subnational governments' debt will significantly increase with the subsequent debt burden in the forthcoming years. Central governments will struggle to provide stable sources of revenue, posing a threat to the fiscal and debt sustainability of local governments.

Some authors question whether current and future debt increases at the local and national levels are sustainable and whether debt burdens can limit or boost regional economic growth (Quiroga and Smith 2019; Cabral et al., 2021; Allers and Natris, 2021). The nexus between debt, debt sustainability and economic growth deserve closer examination at the local government levels. Such a study will allow assessing the prospects of economic recovery and determine the possible limits that exist with debt thresholds and the conditions imposed by intergovernmental fiscal relations in federal governments. The literature on the debt growth nexus has been discussed extensively (see Blanchard 2019 for an exhaustive list), yet, there needs to be more consensus on whether higher debt levels are suitable for economic growth or even what type of debt is best for growth. There needs to be more evidence of the impact of subnational debt on economic growth and on whether a threshold exists for local governments in developing countries.

The debate on fiscal discipline, made famous by the controversial seminal contribution by Reinhart and Rogoff (2010), has found inconclusive evidence in favor of the debt-threshold hypothesis at the national level. Reinhart, Reinhart and Rogoff (2012) suggest that highly indebted countries slow down economic growth when debt rises above 90% of GDP (Irons and Bivens, 2010), but this has been contended in detail, for example by Herndon et al. (2014). Other influential authors have recently found opposing evidence suggesting that more debt is suitable for a country's growth in highly indebted developed economies (Blanchard, 2019).

The study on the sustainability of subnational debt and the effect of debt on regional economic growth is pertinent for developing countries. Even more so, the question affects these countries in the aftermath of the coronavirus economic crisis. The subnational debt of governments in Mexico has grown significantly to encourage economic recovery and economic growth since the crisis of 2009 and has intensified since the pandemic. Some authors have noted that the financial pressure of these crises of 2009 and from 2020 with the pandemic has dramatically affected the credit strength of local governments (Herrera, Brandaza and Ortiz, 2010). Other authors have looked for evidence on whether fiscal discipline has contributed to maintaining subnational finances healthy or impacted the build-up of debt in the long term (Smith, et al. 2019; Sönmez, 2013). While assessing the long-term financial sustainability of local governments in highly centrally regulated countries, Bethlendi et al. (2020) noted the consequences of soft budget problems regarding debt sustainability. The literature is long and unconvincing as to the effectiveness of the fiscal policy on growth (Horne, 1991; Blanchard, 1990; Paunovic, 2005; Talvi and Végh, 2000; Mendoza and Oviedo 2004). The soft budget constraint problem arises when local governments count on help from central governments to bail them out in financial distress (Kornai, et al., 2003). Bailing out mechanisms include soft taxation, ad hoc subsidies and soft bank credits. Bethlendi et al. (2020) suggest controlling the

phenomenon of soft budgeting by reducing the amount of debt and by reducing expectations of bailing out, and reinforcing market discipline through tight budget constraints.

The contribution of this study resides in transferring the debate on fiscal discipline and the debt-threshold hypothesis to the context of subnational governments—highly dependent and ridden by soft budget problems—in highly centralized fiscal regimes. The literature is specifically inconclusive on whether more debt outstanding leads to higher growth or to the existence of a debt threshold in developed countries for growth to occur. Almost no studies investigate the threshold at the subnational level, and no studies distinguish the impact of the various types of debt on growth. Easily accessible credit by commercial banks or governmental guarantees based on transfers may be more accessible for governments to allow debt issuances. However, financing through bond markets or long-term debt issuances based on source revenues for repayment structures can make subnational governments more fiscally sound and thus have a longer-term impact on growth.

This research employs state data from Mexico for the period 2001-2016 to examine, first, the nexus between debt sustainability and regional economic growth, and second, to establish a threshold level between debt and regional growth following the ideas of Reinhart and Rogoff (2010) and Reinhart, Reinhart and Rogoff (2012). The Mexican constitution provides the golden fiscal rule that borrowing from federal and subnational governments can only finance public investment (Cabral et al., 2021; Hernández-Trillo, 2018). This rule, together with the prohibition of incurring liabilities with foreign entities, might encourage the sustainability of subnational debt. These rules, however, need to distinguish the convenience of each type of debt to encourage economic growth. This study investigates the individual effect of each type of debt on growth.

This study employs the dynamic panel approach by Arellano and Bond (1991) to test the impact on growth from each type of debt. This model allows controlling for different types of endogeneity. Then, to estimate the threshold from which economic growth is affected by increasing levels of debt, we employ Seo et al. (2016) dynamic panel approach with threshold effects. Similar to other studies and because of the asymmetry of growth patterns in developing countries:

“we apply the regression kink model to the growth and debt problem made famous by Reinhart and Rogoff (2010). These authors argued that aggregate debt's nonlinear effect on economic growth, specifically that as debt to GDP increases above some threshold, aggregate economic growth would tend to slow. This idea can be formally tested employing a regression kink model, where GDP growth is the dependent variable, and the debt/GDP ratio is the key regressor and threshold...” Hansen (2017).

Understanding whether increasing debt may have benign effects on regional GDP growth is necessary. After this specific threshold level, local governments could have the ability to surmount the recession caused by the recent COVID crisis. The results of our study point to a weak but positive association between debt and GDP growth by type of debt. The threshold levels are also distinct depending on the nature of the debt.

This paper is organized as follows. Section two presents a brief literature review on debt sustainability and growth. Section three presents the salient features of fiscal federalism in developing countries like Mexico. In contrast, section four shows the methods employed in this paper to test the effect of debt on growth and estimate a threshold value after which regional growth can be affected. Section five presents the most relevant findings concerning the hypotheses raised by Reinhart and Rogoff (2010) and Blanchard (2019) and the effect of the fiscal environment on

growth. Finally, section six discusses the main findings of the model and provides policy implications and recommendations.

2. Economic Growth and Public Debt

The fiscal sustainability of local governments to assess the impacts of debt on the local public finances and financial management has undergone close examination (Blanchard, 1990; Mendoza and Oviedo, 2009). Some studies find that Latin American countries approach a natural debt line. In contrast, others test whether governments can sustain high indebtedness trends, accounting for interest rates, growth rates, deficit levels and debt-to-GDP ratios (Paunovic, 2005; Croce and Juan-Ramón, 2003). Quiroga and Smith (2019) look for evidence on whether centralizing the control of subnational debt in Mexico supports the promotion of sustainable finances in municipal governments. The authors' results point to a large continuing fiscal gap without the country seeking more autonomy in its fiscal decision-making at the local level.

This line of research acknowledges that the relationship between subnational debt and economic growth closely links debt sustainability to the federal fiscal environment. Several confounding factors, including political budget cycles, devolution of authority and intergovernmental transfers, conditional and unconditional, play a significant role. Mendoza and Rubio (2021) have found evidence in Mexico of federal transfers' positive but weak effect on regional growth. These authors suggest that indebtedness, corruption, and lack of transparency could be the root causes of the feeble pass-through from decentralization to regional growth.

Fiscal variables play a significant role in explaining economic growth. There is increasing literature investigating the nexus between government structure and debt issuances. Reinhart and Rogoff (2010) argue that the strength of the relationship between Gross Domestic Product (GDP) and the debt/GDP ratio depends on the levels of indebtedness. While Reinhart and Rogoff find a weak nexus between GDP and debt at low debt-to-GDP ratios, they report that such a relationship strengthens with debt increases. High debt levels negatively affect economic growth, and debt thresholds are lower for developing countries. Reinhart, Rogoff & Savastano (2003) later introduced the concept of "debt intolerance," i.e., the pressure experienced by emerging market economies at different levels of indebtedness. These authors find that, while advanced economies could tolerate high levels of debt before economic growth is compromised, emerging economies' debt thresholds are extremely low and largely depend on the country's economic history. This debt-growth nexus is deeply rooted in the fiscal equation of federal systems.

Decentralization processes in many emerging market economies during the past 20 years have strengthened the fiscal capacities of local governments. Sub-sovereign entities now have better access to sophisticated and diversified debt markets to finance infrastructure and public investment projects (Kehew et al., 2005; Bethlendi et al., 2020). Bonds issued by sub-sovereign entities compete with traditional bank loans to finance local governments' infrastructure. The growing trend towards diversified sub-sovereign debt, banking, and capital markets is now a reality for these countries (Platz, 2009; Moldogaziev et al., 2018).

The debt threshold literature focuses mainly on highly indebted economies and assesses how much debt country governments can tolerate to promote economic growth. However, two decades

ago, Giugale et al. (2000) argued that even with the significant increase in the levels of sub-sovereign indebtedness, the amount of subnational debt does not represent a threat to the macroeconomic environment of the country. Despite the steep hikes in subnational debt in Mexico, it continues to be extremely small compared to national and local GDP (Quiroga and Smith, 2019; Astudillo Moya et al., 2018). The tendency of federal governments to maintain explicit and implicit agreements to absorb sub-sovereign debt can lighten local governments' financial pressure and explain the subnational debt's small GDP share. Several authors have warned about the negative consequences of such conduct of federal governments and their propensity to bail out subnational finances. Such conduct strengthens moral hazard incentives, fiscal irresponsibility, and opacity and reveals soft budget problems (Hernández-Trillo, 2002; Quiroga and Smith, 2019; Mendoza-Velázquez, 2018; Hernández-Trillo, 2018).

Recent provocative advances in the study of the nexus between government debt and economic growth suggest, on the contrary, that more debt can encourage economic growth (Blanchard, 2019). These conclusions come from the study of highly indebted developed economies (i.e., Japan, Europe and the United States). Ilzetzki, Reinhart and Rogoff (2019) state that the periods in which government debt rises above 90% of GDP are associated with slowdowns and low economic growth. Quiroga and Smith (2019) highlight the role of institutions and argue that the final result depends on the type of debt employed in the fiscal policy equation. Ter-Minassian (1997) notes that for developing countries with less evolved institutions, the question is not just what type of debt instruments to employ but, more crucially, when to use them.

Blanchard's (2019) argues that governments can take out more debt because the social costs of more debt distribute over longer horizons. However, Blanchard does not indicate what type of debt, e.g., subnational, national, commercial banking, market-based or government issued or other types, can promote economic growth. The condition under which this is possible at the macroeconomic level is that economic growth exceeds debt interest rates. Debt management becomes more manageable with stable interest rates, as debt as a share of GDP shrinks, with no need for new taxes.

Translating this fiscal ecosystem to local governments in emerging markets becomes an additional requirement for capital market investors to take into consideration, as well as the federal or central government's institutional and legal system, political context, its decision-making, fiscal capacity, and transparency of the local governments, which may or may not be consistent with federal level institutions.

In this study, we test two hypotheses. First, following the research of Blanchard (2019) we investigate whether more debt is associated with higher growth in local governments immersed in a federal system with high fiscal dependence and soft budget problems. Second, we test for threshold levels for different types of debt to evaluate whether a benign form of debt exists.

3. The Salient Features of Intergovernmental Fiscal Federalism in Mexico

Several developing countries run a vertical type of fiscal federalism with a high degree of subnational dependency on federal share transfers, little streams of local revenue, and expenditure autonomy are salient features. Intergovernmental fiscal systems undergo several discipline-enhancing fiscal reforms to lighten the burden of these pervasive salient features. Mexico, for instance, has introduced accounting and harmonizing fiscal laws since the beginning of the 2000s (Pérez-Benitez and Villarreal-Páez, 2018; Hernández-Trillo, 2018): the fiscal reform of 2003, the redesign of federal share transfers formulas in 2007 and the General Law of Government Accountability and Transparency (LGCG) in 2016. Finally, in April 2016, the Mexican government enacted the Law of Financial Discipline to States and Municipalities (FD Law), which set limits on local public debt.

There are differences between these reforms. In comparison, the 2003 reform was comprehensive, with more than 300 fiscal arrangements favoring local governments. The Fiscal Coordination Law of 2007, in effect from 2008, focused on providing new rules to federal share conditional and unconditional arrangements (Mendoza and Rubio, 2021). To some analysts, the reform of 2007 has reinforced the dependency of local governments on conditional transfers while encouraging tax collection (Pérez-Benitez and Villarreal-Paez, 2018). For others, fiscal reforms have been designed to strengthen intergovernmental relations of local governments in Mexico (Cabreró-Mendoza, 2013). Some recent studies provide encouraging evidence of the positive effect of these reforms on GDP from 2003 (Mendoza and Rubio, 2021). However, these authors also warn that these reforms have encouraged the dependency on conditional and unconditional transfers while the effects on GDP remain elusive.

The fiscal reforms have occurred amid the increasing federal conditional and unconditional transfers to local governments. During the first decade of the 2000s, Mexico benefited from extraordinary revenue streams from steep hikes in oil prices. Local governments received increasing oil-related share transfers and additional financial revenues from diverse financing sources (Mendoza and Rubio, 2021): credit banks, development banks and the stock market (subnational bond issues). While oil-related inflows have reinforced their dependency on the central government, they constitute evidence for the soft budget problem (Hernández-Trillo et al., 2002). The availability of additional resources from a diverse pool of funding options has allowed subnational governments to withstand the financial stress of public finances in moments of crisis.

Recent research suggests that despite increasing subnational debt in Mexico, the market debt has yet to be employed effectively (Benton and Smith 2017; Smith and Benton 2017) where political or public management has yet to constrain local issuances. Also, Mexico fits the highly centrally regulated fiscal model with limited autonomy over its revenues and a golden fiscal rule, which can help promote fiscal and debt sustainability (Bethlendi et al., 2020). Centralization could give place to soft budget problems given the reputation of bailing out states due to a lack of fiscal discipline (Giugale et al., 2000; Hernández-Trillo et al., 2002; Cabral et al., 2021).

Several authors have warned about the existence of a soft budget problem in Mexico, arising from the willingness of the central government to bail out highly dependent subnational governments through conditional and extraordinary share transfers (Hernández-Trillo et al., 2002). A soft budget problem might translate into the laziness of subnational governments to collect local fiscal revenue, into non-productive overspending, over-indebtedness and adverse effects on regional economic growth. Fiscally and solvency troubled subnational governments, and a central government willing to bail out conforms fertile ground for a soft budget problem (Sato, 2007). In addition, the lack of solid incentives or provisions to stop overspending and over-indebtedness of local governments encourage moral hazard, project investment inefficiency and ultimately, creates adverse effects on economic growth.

However, this paper argues that not all types of debt have the same effect on growth. Various reasons can explain such differential effects of debt on growth: a) it can be the result of diverse effectiveness of financial management capacities of subnational governments; or b) the structure of debt arrangements, e.g., guaranteed by federal share transfers or by own-source revenue repayment structures; or c) the architecture and design of the fiscal federalism used to control the debt issued by the fiscal rules.

While the first of these possibilities has been addressed in previous work (Mendoza and Rubio, 2021), there is no research on the effects of differential debt on growth which leaves ample room to study and discuss the role of the fiscal environment to explain growth at the sub-national level. Ter-Minassian (1997) noted that, for developing countries with less evolved institutions, an important question is the type of debt instruments employed to finance investments. For instance, funding backed up with transfers may be an effortless option for subnational governments, while bond markets or long-term debt issuances that require specialized skilled managers and the employment of own-source revenues might be harder to access. Bond and long-term debt own tax-backed issuances could promote fiscally sound finances and have longer-term impacts on growth.

Quiroga and Smith (2019) noted that the type of debt and the institutional fiscal environment in Mexico might explain subnational economic growth. However, the literature has yet to evolve to present a theory that provides precise mechanics of the transmission channels over which subnational debt affects regional growth in developing countries.

Additionally, local congresses allow subnational debt issuance in Mexico on the condition that local governments invest monetary funds to develop infrastructure and require that debt not exceed specific thresholds to ensure the financial stability of public finances. The Mexican Constitution states that borrowing from federal and subnational governments can only be used to finance public investments (Cabral et al., 2021). This golden fiscal rule ensures that debt encourages growth and prohibits employing foreign debt to secure the stability of subnational finances.

Blanchard's (2019) argues that governments can take out more debt because the social costs of more debt distribute over longer horizons. However, to our knowledge, work has yet to examine how different types of debt available to local governments in emerging markets affect growth. We aim to provide evidence in this direction accounting for vertical fiscal imbalances, with a limited collection of local revenue, limited expenditure autonomy, and a high degree of subnational dependency. Specifically, securitization of a particular loan may or may not affect the sustainability and growth at the local level in the same way.

4. Dynamic debt-growth nexus and debt thresholds

This section presents the methods employed in this study 1) to test the nexus between debt and economic growth and 2) to determine a threshold level of debt. We test for threshold levels for different types of debt to investigate whether a benign form of debt exists. The fiscal discipline of subnational governments, the rational choice of debt and the posterior impact on regional economic growth depend upon the democratic and federal system and on the strength of institutions, policy designs, legal and enforcing systems (Ter-Minassian, 1997; Quiroga and Smith, 2019). Recent research suggests that market debt has yet to be employed effectively despite Mexico's increasing levels of subnational debt. Policy decisions have yet to be rational due to political economy restrictions (Benton and Smith, 2017; Smith and Benton, 2017).

4.1 Dynamic Modeling of the Debt-Growth Nexus

There are two views on the effect of debt on economic growth at the sub-national level. While Reinhart and Rogoff (2010) and Reinhart, Reinhart and Rogoff (2012) warn that over-indebtedness can negatively impact economic growth and debt levels below 90% of GDP do not have an impact on growth, Blanchard (2019) contends that more debt is associated with higher growth. We test the nature of the association between debt and economic growth for the case of local governments immersed in a federal system with high fiscal dependence, employing a dynamic panel approach that recognizes the possibility of debt affecting growth at different moments in time. The lack of consensus in testing this nexus is possible because of the inability of methods to control for some forms of endogeneity; e.g., Krugman (2010) noted that low economic growth could lead to high debt levels. Similar to other studies, this paper addresses endogeneity by employing GMM estimations with internal instruments. In particular, this study implements the Arellano-Bond (1991) dynamic panel data models to test the effect of debt on regional economic growth. This approach accounts for specific sources of endogeneity: unobserved heterogeneity, simultaneity, and dynamic endogeneity. Ignoring dynamic endogeneity can have severe consequences in terms of consistency. Hence modeling provides a robust method for identifying the causal effect of debt on economic growth. Schultz, Tan and Walsh (2010) show that the dynamic panel model by Arellano-Bond overcomes these problems by producing unbiased and consistent estimates, employing valid internal instruments during estimation.

Several works have previously employed the Arellano-Bond (1991) dynamic panel model with GMM to address the debt-growth nexus. This tool allows for unobserved heterogeneity and simultaneous and dynamic endogeneity (Kumar and Woo, 2010; Presbitero, 2012; Kim, Ha and Kim, 2017). Besides addressing these types of endogeneity, the Arellano-Bond approach allows control for federal fiscal shifts. The GMM specification for dynamic panel datasets produces consistent parameter estimates in endogeneity and produces unbiased and consistent estimates Schultz, Tan and Walsh (2010).

We employ different versions of the Arellano-Bond model, each concerning the different types of debt: total debt, development bank debt, commercial bank debt, bond debt and trust fund

debt. The estimations also distinguish between flow and cumulative debt as a share of GDP and guaranteed resources.

$$Growth_{i,t} = \alpha_1 Growth_{i,t-1} + \omega_1 Debt_{i,t} + \beta_1 CTrans_{i,t} + \beta_2 UTrans_{i,t} + \beta_3 Tax_{i,t} + \delta D_i + v_i + \varepsilon_{it}$$

$$i=1,\dots,N; \quad t=1,\dots,T_i \quad (1)$$

Where $Growth_{i,t}$ is GDP growth for state i in time t , the variable $Debt_{i,t}$ can take the ratio of cumulative debt to GDP during the period. The results also present a set of estimates with debt flows as a share of GDP. To control for the fiscal system forces, we include $CTrans_{i,t}$ conditional transfers (aportaciones), $UTrans_{i,t}$ Unconditional transfers (participaciones) and own-tax revenue ($Tax_{i,t}$). The models include a dummy variable D_i to capture the impact of the 2009 crisis. Lagged dependent variables regressors correlate with unobserved panel level effects (v_i). Idiosyncratic errors ε_{it} are *i.i.d.* with variance σ^2_ε . Models assume that v_i and ε_{it} are orthogonal. The parameter α_1 measures the speed of adjustment or convergence of growth to a mean equilibrium. Arellano Bond estimator controls for endogeneity of lagged dependent variables and explanatory variables with the error term by differencing and removing fixed effects. Unlike OLS or fixed effects estimates, dynamic panel GMM estimators allow debt to relate to past performance and permit using some combination of variables from a state's history as valid instruments to account for simultaneity. These "internal" instruments for current debt realizations comprise past debt values and growth, eliminating the need for "external" instruments.

Economic growth depends on debt in all periods through past economic growth effects. Still, it is independent of past debt when growth is held fixed (Arellano, 2003). The parameters are identified assuming that debt is fixed, i.e., debt is strictly exogenous relative to unobserved shift variables. Exogeneity allows us to use lagged values of corporate governance as instrumental variables in the Arellano-Bond framework. Lags in economic growth, debt and federal fiscal variables are employed as instruments to remove fixed effects (Hansen, 1982). Extensive instrument collection can overfit endogenous variables and invalidate GMM instruments. As an empirical rule of thumb, our estimations ensure that instruments are below the number of units in the panel. We employ the Sargan test to pin down overidentifying restrictions and ensure de validity of GMM estimators.

4.2 Debt threshold and growth

The nexus between debt and growth in this cross-regional panel study can be nonlinear, as explored with the dynamic panel approach above. However, it could also reveal a specific type of threshold effect. Contrary to the findings by Reinhart and Rogoff (2010) and Reinhart, Reinhart and Rogoff (2012), and more in line with the arguments of Blanchard (2019), we expect that such a threshold can signal the point after which regional economies should experience growth.

This study formalizes the modeling and estimation of a threshold effect employing the panel model with threshold effects by Seo and Shin (2016). This model allows for asymmetric effects depending on whether the threshold variable is above or below the unknown threshold. This approach overcomes the strict exogeneity assumption of covariates required by static models such as the one by Hansen (1999), which can be too restrictive. This dynamic modeling allows for lagged

dependent variables and endogenous covariates via GMM estimation. Seo and Shin (2016) extend Hansen's model to the dynamic panel model with an endogenous threshold variable and a GMM estimator that reflects a kink restriction.

In this dynamic kink model, the regression is continuous, but the slope has a discontinuity at a threshold point, hence a kink (Hansen, 2017). In contrast with regression discontinuity models that assume a known threshold, threshold regression models assume that the threshold parameter is unknown and must be estimated. Blanchard (2019) does not suggest identifying a specific threshold or kink after which debt can encourage growth. However, we expect economic growth to quicken when government debt relative to GDP exceeds a threshold level.

The dynamic threshold model is given by

$$y_{it} = x'_{it}\beta + (1, x'_{it})\delta 1\{q_{it} > \gamma\} + \mu_i + \varepsilon_{it}, \quad i = 1, \dots, n; \quad t = 1, \dots, T, \quad (2)$$

where y_{it} is the real GDP growth rate and x_{it} are covariates in state i for year t . The vector x_{it} may include lagged dependent variables, and q_{it} is the threshold variable. First differences of (2) remove unobserved individual fixed effects μ_i and the estimation of the vector of unknown parameters $\theta = (\beta', \delta', \gamma')$ through GMM. ε_{it} are zero mean idiosyncratic random disturbance. This model implies the presence of a discontinuity of the regression function captured by the term $(1, x'_{it})\delta$.

The first dynamic panel data model with debt threshold effects to explore the nexus between economic growth and the debt-to-GDP ratio is as follows:

$$y_{it} = (\phi_1 y_{it-1} + \theta_{11} Debt_{it} + \theta_{21} P_{it} + \theta_{31} A_{it} + \theta_{41} Tax_{it}) 1_{\{q_{it} \leq \gamma\}} + (\phi_2 y_{it-1} + \theta_{12} Debt_{it} + \theta_{22} P_{it} + \theta_{32} A_{it} + \theta_{42} Tax_{it}) 1_{\{q_{it} > \gamma\}} + \mu_i + \varepsilon_{it} \quad (3)$$

Where $1_{\{q_{it} \leq \gamma\}}$ and $1_{\{q_{it} > \gamma\}}$ are indicator functions, q_{it} is the transition variable and γ is the threshold parameter. In addition to examining different models by types of debt (total, government, bank and other), we control for the fiscal federalism system by including *participaciones* (P_{it} , unconditional federal transfers), *aportaciones* (A_{it} , conditional federal transfers) and local tax revenue (Tax_{it}) in each regression. This model allows for asymmetric effects depending on whether the threshold variable is above or below the unknown threshold. This approach overcomes the strict exogeneity assumption of covariates required by static models such as the one by Hansen (1999), which can be too restrictive and allows for lagged dependent variables and endogenous covariates via GMM estimation.

Seo and Shin (2016) note, however, that the discontinuity shown in model (2) may mean a kink and not a sudden jump if $(1, x'_{it})\delta = \kappa(q_{it} - \gamma)$ for some κ . This equality holds when $x_{it} = \kappa q_{it}$ and the first element of $\delta = -\gamma\kappa$. With these restrictions, model (2) becomes:

$$y_{it} = x'_{it}\beta + \kappa(q_{it} - \gamma) 1\{q_{it} > \gamma\} + \mu_i + \varepsilon_{it}, \quad i = 1, \dots, n; \quad t = 1, \dots, T, \quad (4)$$

Seo and Shin's (2016) threshold dynamic data model captures the nonlinear asymmetric dynamics and cross-sectional heterogeneity and allows the regressors to be endogenous. The estimation of the model can employ either first-differenced two-step least squares or first-

differenced GMM. The former approach is practical when the threshold variable is strictly exogenous (Seo and Shin, 2016). The exogeneity assumption is tested employing the following t-statistic for the null that GMM estimate of the unknown threshold, $\hat{\gamma}_{GMM} = \hat{\gamma}_{2SLS}$. The asymptotic distribution of the t-statistic is the normal standard under the null hypothesis of strict exogeneity of the threshold variable, q_{it} .

5. Data Analysis and Estimation Results

This section briefly describes the variables employed in the dynamic panel data regressions. We integrate a balanced panel of annual data for the 32 federal states in Mexico from 2001 to 2016. Annual data on Gross Domestic Product (GDP) and indebtedness in Mexican Pesos (MXN) by type of loans come from the local finance database maintained by the National Institute of Geography and Statistics (INEGI). The Treasury Ministry provides information on fiscal variables, e.g., federal conditional transfers, unconditional transfers and tax revenue in Pesos. In addition to employing the debt to GDP ratio as a measure of debt sustainability, we employ the ratio of debt to guaranteed resources (non-ear marked federal transfers plus own resources) from the Mexican Ministry of Finance. Rating agencies use this variable of debt sustainability to assess the state's capacity to *acquire* additional debt (Cabral et al., 2021).

Figure 1 presents the evolution of nominal debt issued by state governments for the period 2001-2016. In addition to the steep rise of total debt from 2010, when it grew from five billion Mexican Pesos to nearly 20 billion, we observe that commercial debt started to play a much more significant role, departing from almost no share to more than 30% of total debt. Before 2009, capital markets debt issues backed up with federal transfers were the primary source of subnational debt (more than 80% every year); after that date, this type of debt represented somewhat above one-third of total debt. Despite this, the share of bond financing issues still amounts to around one-third of total debt and remains a significant financing source for state governments in Mexico.

Figure 2 presents the mean evolution of state debt as a share of GDP, a rapid accumulation from 0.20% in 2001 to an average share of 4.10% in 2016. As a share of guaranteed resources, debt went from 29.3% in 2001 to an average of 64.2% in 2016. The fiscal reforms in 1999 opened the possibility of indebtedness from 2001 (Giugale et al., 2000). Then, after 2008, the debt curve presented a higher gradient, possibly related to the impact of the Global financial crisis. The steep ascent of debt is likely due to liquidity injections via development banks. Debt shares present a higher variability than GDP growth, as shown in Table 1.² Figure 3 shows the ranking of states' debt in 2016 as a share of GDP and guaranteed resources.

Figure 4 reveals a highly nonlinear association between debt GDP ratio and economic growth. The overall mean distribution of data suggests that while the relation is negative at low levels, higher debt shares encourage economic growth after a threshold point of cumulative debt when the effect begins to be positive. The positive association between debt and growth at the median level is not uniform. The nexus between debt and growth turns negative for states in the extreme quantiles of the distribution for the lowest and highest developed states. The ratio of debt to guaranteed

² The appendix shows descriptive statistics employing the ratio of debt to guaranteed resources (non-ear marked federal transfers plus own resources) from the Mexican Ministry of Finance.

resources reveals a similar pattern. However, in this case, the effect of debt on growth, after a given breakpoint of guaranteed resources, becomes harmful only for states with the lowest growth.

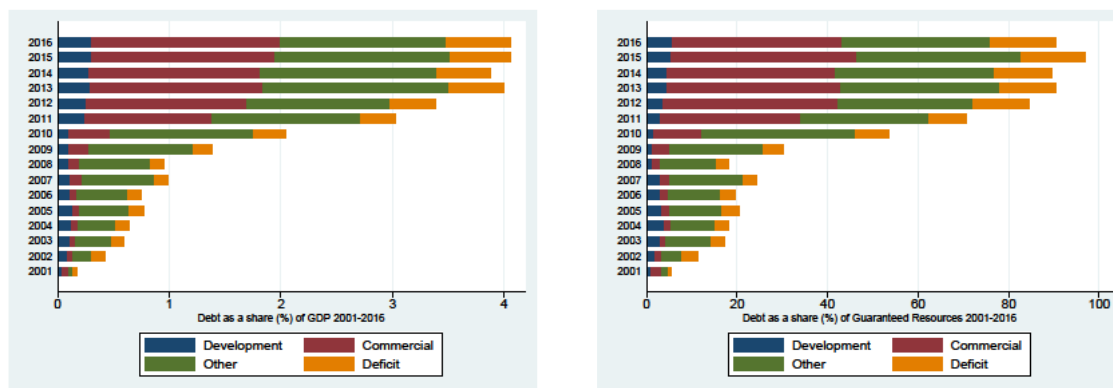


Figure 1. Evolution of state debt as a share of GDP and guaranteed resources.

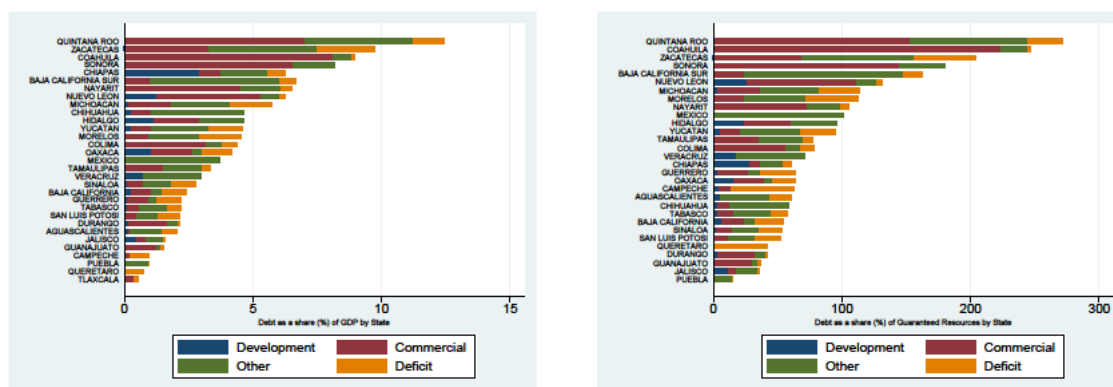


Figure 2. Cumulative debt as a share of GDP and guaranteed resources in 2016.

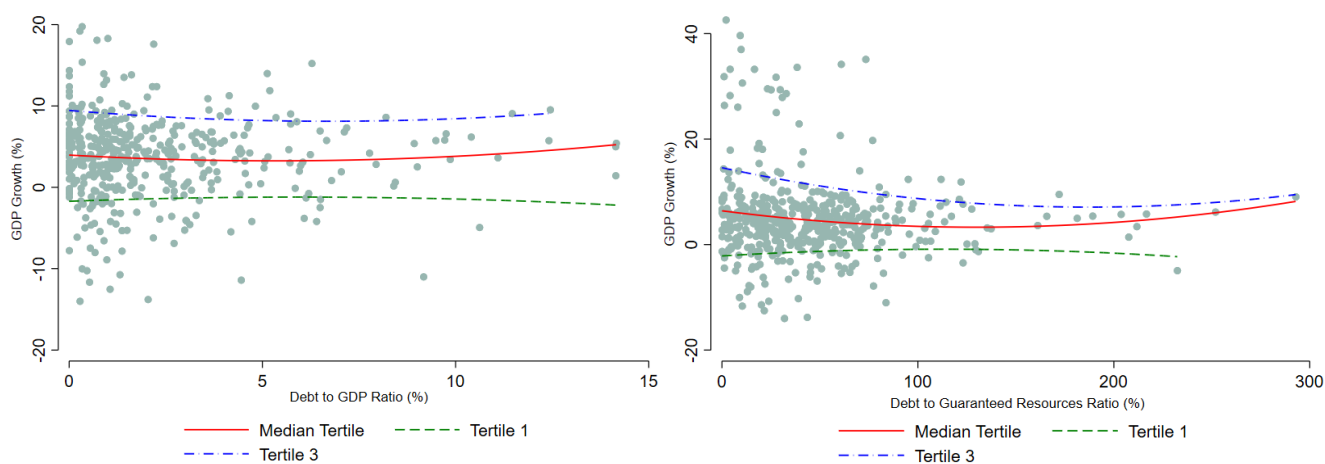


Figure 3. Debt to GDP and Debt to Guaranteed resources ratio to economic growth.

Mexican states with greater economic dynamism have higher average values and volatility, which is detrimental to economic growth (see Table 1 and Table 1). In per capita terms, mean conditional transfers (*aportaciones*) are higher and slightly more volatile than non-conditional transfers (*participaciones*). Local revenues are both small and highly variable, confirming the high dependence on local governments. However, while the description of the data between the groups of states is informative, it does not allow examining the dynamic behavior of the variables and fiscal interaction of the federal system. In the following sections, we report the estimates of dynamic panels to investigate the nexus between debt and GDP and estimate a debt threshold.

5.1 Hypothesis 1. More significant subnational debt leads to more economic growth in countries with high verticality, dependence and weak tax revenues

The Mexican Constitution provides the golden fiscal rule in which federal and subnational governments can only borrow to finance public investment (Cabral et al. 2021). The first hypothesis of this study states that greater debt should lead to greater economic progress in highly centralized federal systems, with a limited collection of tax revenue and high dependence on federal transfers. In particular, policymakers' optimizing objectives in local governments should comply with this golden rule, and debt tends to favor investment and infrastructure projects that encourage local economic growth. Nonetheless, the quality of debt matters and exerts distinct effects on growth.

The Arellano-Bond estimates in Table 2 below show the effects of different types of debt (ω_1) on economic growth. The estimates show that total debt, bank debt, particularly development bank debt and capital market debt, all have a fragile but significant positive effect on economic growth (see models 2 and 4). In contrast, employing the debt ratio to GDP (see appendix A.2), we observe a positive effect of debt on GDP growth from commercial banks and total bank debt, but not development banks nor capital market debt.

Table 1. Descriptive Statistics debt-to-guaranteed resources ratio.

Variable		Mean	Std. Dev.	C. V.	Skewness	Kurtosis	Min.	Max.	Obs.
<i>Financial</i>	Overall	47.68	62.66	1.31	3.09	14.75	0.00	430.25	N = 491
	Between		34.30				11.79	149.36	n = 32
	Within		52.82				-101.68	328.58	T-bar = 15.34
<i>Government</i>	Overall	0.13	0.81	6.21	8.22	76.39	0.00	8.83	N = 491
	Between		0.45				0.00	2.32	n = 32
	Within		0.67				-2.19	6.64	T-bar = 15.34
<i>Bank debt</i>	Overall	19.18	45.74	2.38	5.03	33.94	0.00	422.65	N = 491
	Between		26.92				0.00	142.05	n = 32
	Within		37.33				-122.87	299.78	T-bar = 15.34
<i>Development Bank</i>	Overall	3.20	7.40	2.32	3.59	17.63	0.00	53.02	N = 491
	Between		5.64				0.00	23.23	n = 32
	Within		4.78				-19.56	32.99	T-bar = 15.34
<i>Commercial Bank</i>	Overall	15.99	45.50	2.85	5.25	35.93	0.00	422.65	N = 491
	Between		27.44				0.00	142.05	n = 32
	Within		36.65				-126.07	296.58	T-bar = 15.34
<i>Other debt</i>	Overall	20.75	27.47	1.32	3.03	19.45	0.00	270.70	N = 491
	Between		17.58				0.00	59.87	n = 32
	Within		21.48				-39.12	231.84	T-bar = 15.34

a. Guaranteed resources include non-ear marked federal transfers plus own resources.

An exciting feature of the Arellano-Bond model is the dynamic effect of debt on growth, for which the coefficient α_1 governs the speed of adjustment. The mean reversion of growth can help describe the extent of competition among local governments. A small α_1 , as obtained from our estimations, suggests that states' economic growth possesses minimal persistence and low competition while maintaining the fiscal environment constantly. These parameter estimates are significant in all models when employing debt to guaranteed resources ratio (revenues plus non-earmarked federal transfers) in table 2. However, they have no significant speed of adjustment when employing debt to GDP (see Table A.2).

Table 2. Arellano-Bond Model (Debt as a share of Guaranteed Resources ratio).

Variables	GDP Growth Rate				
	(1)	(2)	(3)	(4)	(5)
<i>Government Debt</i>	-0.0029 (0.0192)				
<i>Comercial Bank Debt</i>		0.0005* (0.00003)			
<i>Development Bank Debt</i>			0.0032*** (0.0012)		
<i>Capital Market Debt</i>				0.0010* (0.0005)	
<i>Deficit</i>					0.0004 (0.0010)
<i>GDP Growth_{t-1}</i>	-0.1192*** (0.0379)	-0.1266*** (0.0378)	-0.1393*** (0.0385)	-0.1102*** (0.0386)	-0.1226*** (0.0378)
<i>Participaciones</i>	-0.0666 ** (0.0321)	-0.0857*** (0.0311)	-0.0733** (0.0296)	-0.0832*** (0.0321)	-0.0634** (0.0307)
<i>Local Revenue (Taxes)</i>	0.0008 (0.0049)	-0.0008 (0.0048)	0.0011 (0.0048)	0.0013 (0.0050)	0.0013 (0.0049)
<i>Aportaciones</i>	-0.1037*** (0.0189)	-0.0965*** (0.0183)	-0.0962*** (0.0183)	-0.0987*** (0.0186)	-0.1070*** (0.0195)
<i>2009 Crisis Dummy</i>	-0.0129 (0.0098)	-0.0247** (0.0111)	-0.0172* (0.0096)	-0.0287** (0.0131)	-0.0109*** (0.0114)
<i>_cons</i>	-0.0880** (0.0414)	-0.1066*** (0.0403)	-0.0967** (0.0393)	-0.1152*** (0.0440)	-0.0831*** (0.0402)
<i>Arellano-Bond Test Statistic</i>					
<i>1st Order</i>	-5.2900 [0.0000] ^a	-5.2100 [0.0000] ^a	-5.1900 [0.0000] ^a	-5.3100 [0.0000] ^a	-5.2500 [0.0000] ^a
<i>2nd Order</i>	-0.4500 [0.6520] ^a	-0.1700 [0.8690] ^a	-0.1400 [0.8880] ^a	-0.0080 [0.9400] ^a	-0.4800 [0.6300] ^a
<i>Sargan Test</i>	420.93 [0.0000] ^b	426.04 [0.0000] ^b	423.78 [0.0000] ^b	405.45 [0.0000] ^b	429.04 [0.0000] ^b
<i>N</i>	431	431	431	431	431
<i>Instruments</i>	64	70	70	70	70<

Standard errors in parentheses. Notes: *Aportaciones*, *Participaciones* and *Local Revenues* are per capita values in log form. Parameters estimated using an Arellano-Bond dynamic panel-data estimation and the command *xtabond* in Stata v.16. Notes: ^a Prob > z. ^b Prob > chi2. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Each model includes federal transfers and own-tax revenue to capture the effect of the intergovernmental fiscal environment in Mexico. Interestingly, share transfers, e.g., the federal unconditional and conditional transfers, adversely affects GDP growth. Interestingly, contrary to what is expected, own-tax revenue does not significantly relate to GDP growth. The shift dummy estimate that captures the change of debt gradient after the great crisis indicates a significant adverse effect on average economic growth after the great crisis. The size of this slope estimate is similar for both, i.e., employing debt to guaranteed resources ratio or debt to GDP ratio.

5.2 Hypothesis 2. More debt leads to greater GDP growth after a given debt threshold

Reinhart and Rogoff (2010) have argued that economic growth tends to slow down when the level of government debt as a share of GDP exceeds a given threshold. Using a long-span time series from 1792 to 2009, Hansen (2017) finds evidence for the United States that high debt ratios, those above 44% of GDP, induce a moderate slowdown in expected GDP growth rates. In addition, some local congresses in Mexico require that subnational debt does not exceed specific thresholds to keep the financial stability of local governments. To consider the capacity of local governments to obtain increased funding, as well as the particular federal fiscal setup in Mexico, we investigate the presence of a debt threshold employing the ratio of the debt-to-guaranteed resources. In our view, guaranteed resources are a better measure of the dimension of local governments and provide a much clearer picture of the sustainability of public finances (Cabral, et al., 2021). We test whether increasing levels of subnational debt as a ratio of guaranteed resources or GDP lead to more economic growth after an unknown threshold of debt levels, as suggested by Blanchard, et al. (2019).

We employ the balanced panel of the 29 states described above over 2001-2016 and work with a small sample of 416 observations. Table 3 presents the results of the asymmetric effects continuous threshold model (3) for low and high debt regimes employing different types of debt as threshold variables (models 1 to 6). The results confirm the existence of a threshold in a wide range between 0.1429% (deficit debt) and 67.93% (total debt), implying that between 55.42% and 97.92% of observations fall into the lower debt-to-guaranteed resource ratios regime, respectively.

In line with the claims of Reinhart and Rogoff (2010), when the capital market and commercial bank debt are taken as threshold variables (models 3, 4 and 5), local economies grow in lower debt regimes. However, after the estimated threshold is surpassed (14.91% and 2.45%, respectively), growth negatively responds to increasing debt levels. In turn, the results employing total bank debt and development bank debt as threshold variables suggest that before the threshold, low debt regimes negatively relate to growth and higher debts surpassing the threshold relate to more growth, consistent with the arguments by Blanchard (2019). The impact of federal transfers on growth is mixed depending on the regime and type of debt. Except for total bank debt, unconditional transfers (*participaciones*) exert a negative effect on growth in low-debt regimes but a slightly positive effect on growth in high-debt regimes. Likewise, conditional transfers (*aportaciones*) have some negative effect on growth in low-debt regimes but a positive influence on growth in high-debt regimes. With few exceptions, local revenue taxes harm growth in either debt regime. However, when

the threshold variable is debt to GDP we find that local revenues encourage growth in high debt regimes.

The continuous threshold model results imply the presence of a discontinuity of the regression function. However, the discontinuity may not be a jump but a kink. Table 4 presents the estimations of the kink model (4) by Seo and Shin (2016). In this regression kink model, the regression function is continuous, but the slope has a discontinuity at a threshold point, hence the *kink* (Lien, Hu and Liu, 2017). The kink slopes and threshold parameters (γ) are statistically significant in most cases. Threshold levels change significantly, and the kink slope is positive and negative depending on the type of debt. The impact of commercial debt on growth is positive, adding strong support to the arguments by Blanchard (2019) on the soothing effect of debt on economic growth. The thresholds of the ratio of the debt-to-guaranteed resources go from 1.71% with commercial debt to 65.47% with total debt. Table A.3 in the appendix shows that this threshold reaches most 3.25% of the debt-to-GDP ratio. The fiscal environment measured by conditional and unconditional transfers discourages growth. However, this time there is a significant favorable influence of own-tax revenue collection on GDP growth independent of the threshold variable.

5.3 Kink or continuous threshold regression models?

Because there is little guidance from economic theory on the choice between kinks and jump models, we rely on robust inference on the threshold and slope parameters of the model to decide the convenience of one of the models over another (Hidalgo, Lee and Seo, 2019). To enhance our results' robustness, we now test for threshold effects, employing the testing procedure of Hansen (1996) with 1,000 bootstrap replications. The null hypothesis of no unknown threshold effects is rejected in all the estimations observed in the bootstrap p-value from non-standard limiting distribution in Tables 3, 4, A.3 and A.4.

Table 3. Continuous debt threshold model (debt to guaranteed resources).^a

Variables	GDP Growth Rate					
	(1)	(2)	(3)	(4)	(5)	(6)
Total Debt_b	-0.0008 (0.002)					
Total Debt_d	0.0006 (0.002)					
Bank Debt_b		-2.970* (1.534)				
Bank Debt_d		2.970* (1.535)				
Other Debt_b			0.025*** (0.009)			
Other Debt_d			-0.026*** (0.009)			
Development Bank_b				-3.738* (1.924)		
Development Bank_d				3.737* (1.924)		

<i>Commercial Bank_b</i>					0.685***	
					(0.135)	
<i>Commercial Bank_d</i>					-0.686***	
					(0.135)	
<i>Deficit_b</i>						-16.213
						(10.695)
<i>Deficit_d</i>						16.215
						(10.694)
<i>Lagged GDP Growth_b</i>	-0.317***	1.044	0.379	-0.633***	-0.557**	-0.809***
	(0.063)	(4.190)	(0.323)	(0.178)	(0.238)	(0.139)
<i>Lagged GDP Growth_d</i>	0.331*	-1.088	-0.572	0.379	0.619**	0.633***
	(0.169)	(4.327)	(0.356)	(0.235)	(0.268)	(0.182)
<i>2009 Crisis Dummy_b</i>	-0.051	0.000	0.043	-0.065**	-0.236	-0.059
	(0.035)	(0.479)	(0.153)	(0.027)	(0.228)	(0.227)
<i>2009 Crisis Dummy_d</i>	0.231**	-1.366***	-0.012	0.084	0.142	0.042
	(0.103)	(0.506)	(0.185)	(0.051)	(0.754)	(0.224)
<i>Participaciones_b</i>	-0.050	8.524***	-0.232	-0.282**	-0.625*	-0.496***
	(0.058)	(2.523)	(0.338)	(0.131)	(0.368)	(0.124)
<i>Participaciones_d</i>	0.144	-8.734***	-0.455	0.090	0.763**	0.328**
	(0.192)	(2.408)	(0.389)	(0.249)	(0.367)	(0.129)
<i>Aportaciones_b</i>	-0.331**	-9.415***	0.023	-0.069	0.148	0.085
	(0.146)	(2.664)	(0.122)	(0.081)	(0.142)	(0.069)
<i>Aportaciones_d</i>	0.360***	9.299***	-0.141	-0.033	-0.206	-0.204***
	(0.109)	(2.699)	(0.143)	(0.098)	(0.146)	(0.072)
<i>Local Revenue (Taxes)_b</i>	0.033	0.056	-0.003	0.023***	-0.036**	-0.0003
	(0.023)	(0.619)	(0.022)	(0.005)	(0.017)	(0.007)
<i>Local Revenue (Taxes)_d</i>	-0.054***	-0.042	0.009	-0.009	0.032*	0.006
	(0.019)	(0.619)	(0.026)	(0.009)	(0.017)	(0.008)
<i>cons_d</i>	0.074	-7.235*	-0.595	0.326	1.427**	0.405
	(0.245)	(3.957)	(0.495)	(0.253)	(0.672)	(0.252)
<i>r</i>	67.928**	1.467***	14.905***	0.419***	2.451***	0.143***
	(27.508)	(0.483)	(4.707)	(0.066)	(0.299)	(0.017)
<i>N</i>	29	29	29	29	29	29

Aportaciones, Participaciones y Local Revenue are percentages in log form. se in parentheses.

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

Table 4. Kink Debt Threshold Model with debt-to-guaranteed resources ratio.

Variables	GDP Growth Rate			
	(1)	(2)	(3)	(4)
<i>Total debt</i>	-0.0019***			
	(0.0004)			
<i>Commercial</i>		0.4856***		
		(0.0542)		
<i>Other type</i>			-0.1617	
			(0.1132)	
<i>Dev. Bank</i>				7.7388
				(12.9251)
<i>GDP Growth_{t-1}</i>	-0.1503***	-0.4424***	-0.1419***	-0.1080***
	(0.0133)	(0.0335)	(0.0187)	(0.0254)
<i>2009 Crisis Dummy</i>	0.0026	0.0000	0.0450***	0.0258***
	(0.0099)	(0.0096)	(0.0023)	(0.0050)
<i>Participaciones</i>	-0.0321	-0.0656*	0.0140*	0.0662**

	(0.0325)	(0.0338)	(0.0075)	(0.0335)
<i>Aportaciones</i>	-0.1168***	-0.1348***	-0.0921***	-0.1037***
	(0.0057)	(0.0111)	(0.0068)	(0.0072)
<i>Local Revenue (Taxes)</i>	-0.0034***	0.0069***	0.0008	0.0134***
	(0.0012)	(0.0019)	(0.0012)	(0.0009)
<i>Kink Slope</i>	0.0022***	-0.4844***	0.1619	-7.7356
	(0.0004)	(0.0543)	(0.1133)	(12.9251)
<i>R</i>	65.4722***	1.7116***	2.5346*	0.0419
	(5.9003)	(0.1370)	(1.0635)	(0.0718)
<i>N</i>	29	29	29	29

. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ a. Dynamic kink model with debt threshold, estimated from equation (2.b) in section 3.2. b. Standard error in parenthesis.

6. Discussion and conclusion

This study tests two hypotheses. First, driven by the opposing conclusions of Reinhart, Reinhart and Rogoff (2012) and Blanchard (2019), we investigate whether more debt is associated with greater growth in local governments within a highly centralized federal system prone to both problems of soft budget constraints and low own source tax revenue. Second, we test for threshold levels for different types of debt to evaluate whether the financing source matters for local growth. Recent research suggests that despite the increasing levels of subnational debt in Mexico, debt has not been employed effectively to encourage growth and policy decisions need to be better designed to channel financial resources to ensure growth (Benton and Smith 2017; Smith and Benton 2017). Nonetheless, this study finds a significant threshold level and evidence of a positive relation between debt-to-GDP and debt-to-guaranteed resources ratios on economic growth.

The empirical evidence in this and previous studies suggests the nexus between debt and growth is highly non-linear and requires analytical methods that account for this nonlinearity. This study has examined this nexus employing two non-linear approaches. First, we tested the association between debt and economic growth employing Arellano Bond dynamic panel models that recognize the prospect of debt affecting growth at different moments in time. While accounting for the nonlinearity of the nexus, this method allows to control for some forms of endogeneity, e.g., unobserved heterogeneity, simultaneity, and dynamic endogeneity. This nonlinear approach provides a first insight into the causal effect of debt on economic growth. A second approach employed in this paper allows to examine the nonlinear nature of this nexus by estimating a debt threshold after which growth would change. The approach is open to the possibility of growth slowing down after the given threshold, as proposed by Reinhart and Rogoff (2010), or the chance of increasing growth as suggested by Blanchard (2019).

While studying national debt, Reinhart and Rogoff (2010) argue that debt levels above a threshold of 90% are associated with a lower GDP growth rate. In this study, controlling for federal transfers, we find much lower subnational threshold levels at the regional level in a highly fiscally centralized country. Depending on the type of discontinuity assumed, the threshold for total debt lies at most at 3.52% of GDP, the point after which greater debt would negatively affect economic growth. Such a finding would help address the question of debt sustainability in subnational governments. Employing the debt ratio to guaranteed resources (revenue plus non-earmarked federal transfers),

which has been used in the literature to assess the capacity to acquire additional debt, confirms the positive association of debt with economic growth. We also find that the threshold for total debt lies at most 65.47% of guaranteed resources. This finding would help address the question of the sustainability of the debt in subnational governments.

Continuous threshold models suggest threshold points below 1% depending on the type of debt, after which debt would encourage regional economic growth. Blanchard (2019) has recently suggested that more debt can benefit a country's growth. According to Blanchard, such an increase in debt is possible because the social costs could extrapolate over longer time horizons. In this study, we extend this possibility to identify the type of debt to which economic growth in the regions of federal systems respond more, namely commercial bank and development bank debt. Government debt usually comes with guarantees, and the fiscal environment creates the right incentives for more effective use of funds to encourage growth. If such a positive effect exists, it should not be taken as a 'carte blanche' to encourage more debt. The results indicate that the provisions and rules associated with commercial and development bank debt (fiscal, regulatory and normative) may provide the right incentives to promote growth.

The kink model regression suggests that more significant tax revenues relate to economic growth. Our results suggest a balance between good tax collection to meet debt expenses while promoting growth. Fiscal authorities and local governments should ensure this is the case: i.e., public finances can meet capital and interest payments of local debts while promoting growth (Smith et al, 2019). Development and commercial bank debt potentially encourage growth more than other instruments.

Mexico fits the highly centrally regulated fiscal model with limited revenue autonomy and a golden fiscal rule, which can help promote fiscal and debt sustainability (Bethlendi et al., 2020). However, this high centralization could give place to soft budget problems, given documented evidence of direct and indirect bailing out of states in Mexico due to a lack of fiscal discipline (Giugale et al., 2000; Hernández-Trillo et al., 2002; Cabral et al., 2021). We believe an explanation for the negative impact of federal share transfers on growth might be found within the soft budget problem, which could distract federal resources from other non-productive activities or increase financial management inefficiency (Mendoza and Rubio, 2019). According to the kink model, local revenue taxes and unconditional transfers (*participaciones*) can encourage growth, implying more commitment of local governments than when these are ear-marked resources (*aportaciones*).

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Appendix

Table A.1. Descriptive Statistics Debt-to-GDP ratio and fiscal variables.

Variable		Mean	Std. Dev.	C. V.	Skewness	Kurtosis	Min.	Max.	Obs.
<i>GDP Growth</i>	Overall	0.05	0.11	2.17	5.24	63.38	-0.49	1.46	N = 480
	Between		0.01				0.03	0.09	n = 32
	Within		0.11				-0.52	1.43	T = 15
<i>Total Debt</i>	Overall	2.11	2.42	1.15	2.24	8.94	0.00	14.16	N = 512
	Between		1.21				0.25	5.48	n = 32
	Within		2.07				-3.50	10.66	T = 16
<i>Government Debt</i>	Overall	0.01	0.09	7.68	9.33	90.26	0.00	0.91	N = 512
	Between		0.05				0.00	0.27	n = 32
	Within		0.07				-0.26	0.65	T = 16
<i>Bank Debt</i>	Overall	0.85	1.66	1.97	3.32	15.49	0.00	11.26	N = 512
	Between		0.88				0.00	3.95	n = 32
	Within		1.37				-3.15	8.11	T = 16
<i>Development Bank Debt</i>	Overall	0.18	0.47	2.61	4.27	24.63	0.00	3.53	N = 512
<i>Commercial Bank Debt</i>	Between		0.33				0.00	1.20	n = 32
	Within		0.31				-1.03	2.50	T = 16
	Overall	0.67	1.62	2.42	3.77	18.59	0.00	11.26	N = 512
<i>Other Debt</i>	Between		0.88				0.00	3.95	n = 32
	Within		1.31				-3.32	7.94	T = 16
	Overall	0.94	1.09	1.16	1.71	6.13	0.00	5.65	N = 512
<i>Participaciones</i>	Between		0.70				0.00	2.80	n = 32
	Within		0.83				-1.48	4.38	T = 16
	Overall	0.33	0.10	0.31	1.28	5.25	0.15	0.69	N = 512
<i>Aportaciones</i>	Between		0.09				0.22	0.64	n = 32
	Within		0.06				0.17	0.49	T = 16
	Overall	0.49	0.16	0.32	0.38	2.80	0.08	0.91	N = 512
<i>Local Revenue (Taxes)</i>	Between		0.10				0.22	0.70	n = 32
	Within		0.12				0.18	0.91	T = 16
	Overall	0.04	0.05	1.30	4.48	28.44	0.0003	0.41	N = 512
	Between		0.04				0.009	0.25	n = 32
	Within		0.02				-0.04	0.19	T = 16

Notes: *Participaciones* and *Aportaciones* per capita.

Table A.2. Arellano Bond Model Results (debt to GDP ratio)

Variables	GDP Growth Rate					
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Total Debt</i>	0.0042*** (0.0009) ^d					
<i>Government debt</i>		-0.0355 (0.0447)				
<i>Bank debt</i>			0.0071** (0.0022)			
<i>Dvlpmnt Bankdebt</i>				0.0029 (0.0138)		
<i>Commercial Debt</i>					0.0073*** (0.0022)	
<i>Other Debt</i>						0.0062 (0.0053)
<i>GDP Growth_{t-1}</i>	-0.0051 (0.0127)	-0.0010 (0.0122)	-0.0085 (0.0141)	-0.0048 (0.0128)	-0.0080 (0.0121)	-0.0060 (0.0113)
<i>Participaciones</i>	-0.1300***	-0.121***	-0.131***	-0.121***	-0.130***	-0.124***

	(0.0106)	(0.0108)	(0.0083)	(0.0122)	(0.0076)	(0.0107)
<i>Taxes^a</i>	-0.0022	-0.0017	-0.0019	-0.0009	-0.0022*	-0.0023
	(0.0012)	(0.0011)	(0.0015)	(0.0014)	(0.0010)	(0.0012)
<i>Aportaciones</i>	-0.0911***	-0.1030***	-0.0948***	-0.102***	-0.0980***	-0.0965***
	(0.0053)	(0.0054)	(0.0055)	(0.0060)	(0.0044)	(0.0075)
<i>D₂₀₀₉^b</i>	-0.0272***	-0.0163***	-0.0268***	-0.0193***	-0.0251***	-0.0227***
	(0.0036)	(0.0023)	(0.0037)	(0.0033)	(0.0031)	(0.0042)
<i>Constant</i>	-0.163***	-0.1570***	-0.164***	-0.151***	-0.166***	-0.162***
	(0.0128)	(0.0143)	(0.0089)	(0.0139)	(0.0105)	(0.0139)
Autocorrelation ^c						
<i>1st Order</i>	-2.9585	-3.0512	-3.005	-2.9905	-2.9920	-2.9916
	[0.0031] ^e	[0.0023]	[0.0027]	[0.0028]	[0.0028]	[0.0028]
<i>2nd Order</i>	-0.5007	-0.6193	-0.4907	-0.7333	-0.4800	-0.5460
	[0.6166]	[0.5357]	[0.6237]	[0.4634]	[0.6312]	[0.5851]
<i>Sargan Test</i>	31.3924	31.4447	31.4234	31.2478	31.5594	31.4918
	[1.0000]	[1.0000]	[1.0000]	[1.0000]	[1.0000]	[1.0000]
<i>N</i>	416	416	416	416	416	416

Notes: ^a Prob > z. ^b Prob > chi2. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. a. Own-state-tax-revenues. b. Dummy variable with 1 for dates from 2009 and zero otherwise. c. *Arellano-Bond Test Statistic*. d. Standard errors in parentheses. e. Autocorrelation and *Sargan* tests show p-values in brackets. *Aportaciones*, *Participaciones* and *Local Revenues* per capita in logs. Parameters were estimated using an Arellano-Bond dynamic panel-data estimation and the command *xtabond* in Stata v.16.

Table A. 3. Continuous debt threshold model, Debt to GDP.^a

Variable	GDP Growth Rate (GDP _t)				
	(1)	(2)	(3)	(4)	(5)
<i>Total Debt_t_b</i>	-11.60***				
(θ_{11})	(2.153) ^b				
<i>Total Debt_t_d</i>	11.59***				
(θ_{12})	(2.157)				
<i>Bank_t_b</i>		5.832***			
(θ_{11})		(1.037)			
<i>Bank_t_d</i>		-5.804***			
(θ_{12})		(1.039)			
<i>Other Debt_t_b</i>			-0.226		
(θ_{11})			(0.161)		
<i>Other Debt_t_d</i>			0.0880		
(θ_{12})			(0.171)		
<i>Devel. Bank_t_b^a</i>				14.25***	
(θ_{11})				(3.556)	
<i>Devel. Bank_t_d</i>				-14.48***	
(θ_{12})				(3.571)	
<i>Comm. Bank_t_b</i>					10.18***
(θ_{11})					(1.220)
<i>Comm. Bank_t_d</i>					-9.963***
(θ_{12})					(1.223)
<i>GDP_{t-1}_b</i>	-1.131**	-0.199***	-0.417***	-0.492***	-0.369***
	(0.357)	(0.0455)	(0.0349)	(0.0547)	(0.0352)
<i>GDP_{t-1}_d</i>	1.078**	-0.546*	-0.0332	0.485***	-0.229
	(0.350)	(0.262)	(0.0911)	(0.108)	(0.143)
<i>D₂₀₀₉_b</i>	1.051	-0.181***	-0.0398	-0.0984	-0.0915

	(0.539)	(0.0330)	(0.0539)	(0.0702)	(0.0798)
<i>D_{2009_d}</i>	-1.112*	0.155	0.111	0.0297	0.0224
	(0.547)	(0.0834)	(0.0617)	(0.223)	(0.288)
<i>Particip_b</i>	1.406	-0.321*	-0.244	-0.206**	-0.379***
	(1.120)	(0.142)	(0.181)	(0.0756)	(0.0734)
<i>Particip_d</i>	-1.366	-0.287	0.715***	0.299	0.261
	(1.130)	(0.265)	(0.126)	(0.235)	(0.212)
<i>Aportaciones_b</i>	-0.680	-0.0734	-0.123*	-0.144**	0.0643
	(1.683)	(0.126)	(0.0547)	(0.0481)	(0.0567)
<i>Aportaciones_d</i>	0.571	-0.234	0.0986	0.0692	-0.379***
	(1.686)	(0.203)	(0.0560)	(0.0798)	(0.103)
<i>Local Taxes_b</i>	-0.602**	-	-0.0006	0.0207***	-0.0154
	(0.217)	(0.0318)	(0.0044)	(0.00381)	(0.0126)
<i>Local Taxes_d</i>	0.602**	0.137***	0.0003	-0.0147	0.0711***
	(0.216)	(0.0364)	(0.0065)	(0.00769)	(0.0199)
<i>cons_d</i>	-0.318	0.399	0.967***	0.198	-0.213
	(0.447)	(0.348)	(0.145)	(0.440)	(0.417)
<i>Threshold</i>	0.364***	0.255*	0.978	0.0921	0.147
<i>γ</i>	(0.0307)	(0.109)	(0.806)	(0.0553)	(0.0765)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ a. Dynamic panel data model with debt threshold effects, estimated from equation (3) in section 3.2 b. Standard error in parenthesis.

Table A.4. Kink Debt Threshold Model with Debt to GDP Ratio

Variables	GDP Growth Rate (GDP _t)				
	(1)	(2)	(3)	(4)	(5)
Total Debt	0.190***				
	(0.0127)				
Bank Debt		1.678***			
		(0.296)			
Other Debt			0.254***		
			(0.0425)		
Dev. Debt				-52.58	
				(727.5)	
Com. Debt					19.41*
					(8.948)
GDP _{t-1}	-0.178***	-0.258***	-0.0216	-0.454***	-0.291***
	(0.0238)	(0.0225)	(0.0176)	(0.0137)	(0.0211)
2009 Crisis	-0.0610***	-0.0856***	0.0660***	0.00468	-0.205***
	(0.0131)	(0.0208)	(0.00783)	(0.00980)	(0.0318)
Participation es	-0.109	-0.375***	-0.101**	-0.0251	-0.647***
	(0.0645)	(0.0160)	(0.0329)	(0.0428)	(0.0332)
Aportaciones	-0.217***	-0.263***	-0.131***	-0.312***	-0.161***
	(0.0170)	(0.0126)	(0.0123)	(0.0176)	(0.0191)
Taxes per Cap	0.0224***	0.0204***	0.00297	0.0334***	0.0167***
	(0.00191)	(0.00251)	(0.00193)	(0.00209)	(0.00248)
Kink Slope	-0.236***	-1.857***	-0.321***	53.42	-19.47*
	(0.0132)	(0.303)	(0.0364)	(727.5)	(8.957)
r	3.252***	0.534***	1.045***	0.00781	0.0490*
	(0.202)	(0.0732)	(0.134)	(0.106)	(0.0217)

. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ a. Dynamic kink model with debt threshold, estimated from equation (2.b) in section 3.2. b. Standard error in parenthesis.