Effect of an income shock on subnational debt: Micro evidence from Mexico[*]

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Abstract

This paper examines how the debt stock of municipal governments responds to a shock that affects the distribution of revenue from the central government. The shock stems from the discrete updating of population census data that is plausibly uncorrelated with short-term financing needs. For a one-standard-deviation increase in the population shock, I find that federal transfers to Mexican municipalities increase by 2% over the first two post-census years. Using supervisory loan-level data, I show that the probability of municipalities being indebted declines by 0.1 percentage points over the same period. The response is driven by governments with relatively more own-source revenue, less dependent on transfers, which lenders perceive as more creditworthy. These findings reveal that the capacity to smooth shocks in credit markets is restricted to few governments with a diversified revenue base. In general, there is no evidence of a positive effect of grants on local debt, not even when the lender is a public bank. The additional revenue mostly goes to finance short-term, current expenditures, with limited potential to alter the path of local development.

KEYWORDS: municipal borrowing, bank lending, intergovernmental grants, local public finance, transfer dependence

JEL codes: G21, H72, H74, H77, O16

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1 Introduction

Fiscal decentralization has created a fundamental problem for local governments that have to meet expenditure requirements decided centrally with few sources of own income. Vertical imbalances in intergovernmental relations make them highly reliant on transfers from the federation. This dependence can generate large variability of local revenues when transfers are procyclical and are allocated according to discretionary and opaque criteria, as in many developing countries. In this context, local governments can gain financial autonomy and smooth income by accessing credit markets. Governments excluded from financial markets may require extraordinary transfers from the central government in periods of financial distress to avoid underprovision of some public goods.

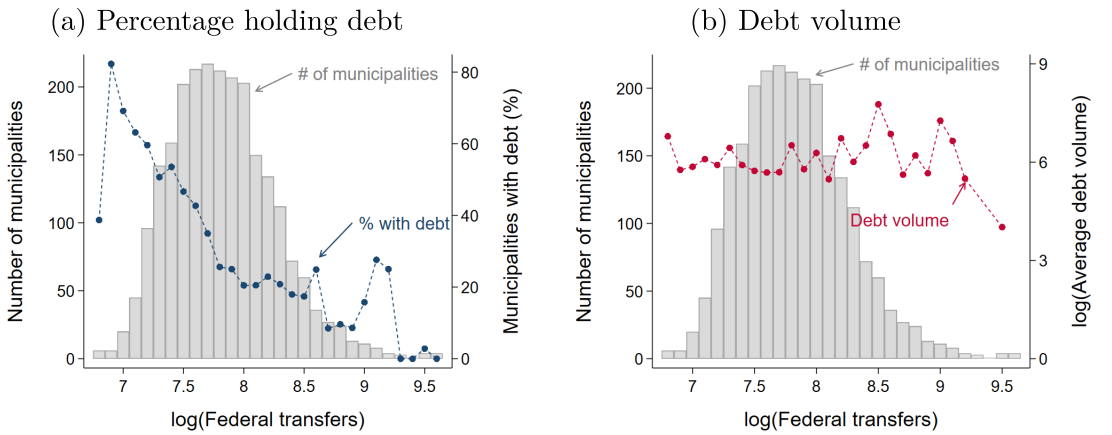
On the other hand, high levels of subnational debt have often been a source of concern—debt affects the path of future taxes and expenditures and the sustainability of local public finances.[1] Several mechanisms contribute to prevent overborrowing by targeting the demand and supply of credit. On the demand side, fiscal rules, backed by a credible commitment of no bailout from the central government, allow restricting local borrowing autonomy (Rodden 2002, Cooper et al. 2008, Dovis & Kirpalani 2020). On the supply side, the presence of financial sector regulations guarantee prudent lending by channeling resources to local governments deemed creditworthy. Creditworthiness—the technical capacity to manage debt and the financial ability to repay it—is eroded if own revenues are insufficient and intergovernmental transfers are volatile and unpredictable (Hanniman 2020).

Given this trade-off between guaranteeing access to financing and ensuring fiscal discipline, it is unclear to which extent local governments use debt to smooth income shocks intertemporally. This paper addresses this issue by providing evidence on the municipal debt response to a shock that affects the distribution of federal transfers in Mexico. Such a shock should have different effects on the demand and supply of credit. On the demand side, a negative effect, consistent with income smoothing, will arise if there is a substitution between grants and debt. This is expected in well-functioning credit markets, from governments that are not borrowing constrained. On the supply side, there should be a positive effect given that present and future grants can collateralize

[1] An extensive political economy literature documents debt cycles associated to the electoral calendar and partisan considerations. Some surveys of the literature on political budget cycles are Robert J. Franzese (2002), de Haan & Klomp (2013), Dubois (2016), Philips (2016).

debt. Figure 1 shows in panel (a) that the fraction of indebted municipalities decreases with the per capita levels of federal transfers, suggestive of a substitution between transfers and debt. Conditional on being indebted, panel (b) shows no clear relationship between the per capita volumes of municipal debt and transfers.[2]

Figure 1: Municipal debt with financial institutions by level of federal transfers



Notes. The horizontal axes shows 0.1-logarithmic-unit bins of the average federal transfers. The gray bars in the left axes show the number of municipalities in each bin. The blue dots in the right axes represent the average fraction of municipalities holding debt (panel [a]) and the logarithm of the average volume of debt (panel [b]). Values are in December 2010 Mexican pesos and are normalized by population. Data cover from August 2009 to December 2016.

Mexican municipalities provide an interesting case of study, with features common to local governments from other developing countries. First, they face large vertical imbalances; federal transfers represent 86% of total revenue. Second, to ensure financial discipline, the subnational borrowing framework comprises an explicit commitment of no bailout by the central government and financial sector regulations. It also comprises fiscal rules, but their enforcement has been weak during this period (Auditoría Superior de la Federación [ASF], 2011*a*; Hurtado & Zamarripa 2013). Third, municipalities make limited use of credit markets—less than half do not have debt and per capita debt levels are low. When available, credit mostly comes from a development bank.

A simple regression of subnational debt on federal transfers will produce biased estimates

[2]Municipal debt in Mexico experienced a steady increase since the global financial crisis, which was partly attributed to the decline in federal grants. However, debt kept increasing even after the recovery of local revenues, raising concerns about municipal overborrowing (ASF, 2012).

if the determinants of local revenue and financing needs are correlated (Knight 2002). Thus, I resort to the fact that, while Mexican states use different formulae for the allocation of grants, most depend largely on population. Upon the release of census data, municipalities with a higher intercensal population growth within a state should start receiving a higher share of federal revenues. This update in the distribution coefficients is a function of long-term, discrete changes driven by the release of census data. Importantly, it is imperfectly correlated with the short-term determinants of local financing needs, which should change continuously with current changes in population. Thus, following Gordon (2004), I define the revenue shock as the difference in population between the 2010 Census and the 2005 population count.[3,4]

The empirical analysis uses monthly supervisory data on each loan granted by every Mexican financial institution. This comprises most debt owed by municipal governments; they cannot take foreign debt and just a few issue bonds. Identification relies on a restrictive conditional independence assumption that, once permanent differences among states and lagged growth in outcomes and population are taken into account, the cross-sectional variation in population is not correlated with potential changes in revenue or financing needs. While this assumption cannot be directly verified, I test related conditions to address endogeneity concerns.

To improve pre-shock covariate balance and ensure overlap between municipalities experiencing a high and low shock, I adopt an inverse-probability weighting (IPW) estimator and trim the sample, as proposed by Angrist et al. (2013) and Crump et al. (2009) respectively. The results show that, following the release of the 2010 Census, federal transfers to municipalities with higher population growth experience a significant and persistent increase over subsequent years. For a one-standard-deviation increase in the population shock (7%), transfers increase by 2% over 2011 and 2012 relative to 2010. Other sources of municipal revenue are not affected, which means that the change in transfers is the main mechanism that mediates the effects on debt and expenditures. In turn, an equivalent increase in population reduces the probability of having debt during the same period by 0.1 percentage points (p.p.) (2.3% of municipality–bank pairs in the sample have credit relationships). This effect is temporary, lasting for two years at most, and is consistent with a prevalence of demand-side, substitution effects. For loan volume

[3]The population estimates in Mexico affect the distribution of federal transfers to local governments, which are in charge of the disbursements, but do not affect federal spending into local areas directly.

[4]Suárez Serrato & Wingender (2014, 2016) propose a shock given by the measurement error between US census counts and postcensal population estimates for non-census years. This is not suitable for Mexico where postcensal estimates are not used for the allocation of transfers.

at the intensive margin I find no significant effect.

One extension examines the role that local governments' creditworthiness has on the previous findings. To this end, I use a high (pre-shock) ratio of transfers to own-source revenue, an indicator of low financial autonomy, as a proxy for low creditworthiness. Following the shock, I find significantly stronger negative effects on debt outcomes, but not on incoming transfers, for the less transfer-dependent governments. In particular, this differential effect is estimated on the probability of being indebted during the first two years and on loan volume in subsequent years. These estimates suggest that the ex-ante more creditworthy governments, with higher financial autonomy, have higher ability to substitute between transfers and debt.

Other extensions examine if the income-shock effect depends on the characteristics of existing loans and on pre-shock debt levels. For loan volume at the intensive margin, I find a decreasing effect in the loan payment-to-revenue ratio but no differential effect in other conditions (interest rate, residual maturity, having two credit ratings, or the debt-to-revenue ratio). This means that governments with a higher burden of debt service payments reduce their debt more after a positive shock. I also examine if the shock has a differential effect on short- and long-term loans. The results weakly suggest higher substitution between transfers and short-term debt that poses greater rollover risk. In addition, I find no differential effect on municipal debt when the lender is the development rather than a private bank. Public lenders are subject to agency problems coming from political pressures, which could impair their function as liquidity providers to buffer shocks.

A key concern is that changes in population may be correlated with pre-existing trends that confound the effects of interest. Thus, I verify that the population change does not affect the relevant outcomes before the census shock. Further, the results remain unchanged when controlling for the effects of the global financial crisis on local budgets. As a placebo test, I show that the effects are reversed among municipalities from a state that has not updated their population figures after the 2010 Census. Oster's (2019) test for selection on unobservables confirms the robustness of the main results. The heterogeneous effects by transfer dependence are sensitive to omitted variables and, hence, need to be interpreted with caution. Ultimately, since the census shock is not randomized, the evidence should be only taken as suggestive.

Finally, to get a more complete understanding of how governments use the additional resources, I examine the effects on primary expenditures, that is, excluding debt service. For a one-standard-deviation increase in the census shock, primary expenditures increase by 1%.

Even though the increase in grants is permanent, what increases is short-term, current spending rather than investment in capital goods. The results on more disaggregated categories, while less precisely estimated, suggest that a positive income shock has little potential to improve long-term growth: It is spent on material, inputs, and supplies and on general services such as leasing, payroll, financial and repair services, and ceremonial expenses.

The first contribution of this paper is to test whether, in response to a revenue shock, local governments use debt to smooth income intertemporally. This complements the evidence from the public economics literature, which has focused on the effect of grants on subnational spending and taxation to determine if they are managed as predicted by models of individual choices. A second contribution is to examine the role of local governments' creditworthiness, proxied by low transfer dependence, in their debt response to a revenue shock. The extant empirical literature on fiscal decentralization focuses directly on the relationship between transfer dependence and fiscal performance. In that framework, a higher transfer dependence from subnationals gives rise to moral hazard, creating incentives to overborrow. Implicit is the assumption that transfer dependence lowers the perceived default risk and, hence, also spurs credit supply.

A third novelty is to exploit a unique data set of municipal debt for a developing country, with detailed loan characteristics.[5] Often, studies on subnational finances look at the net financial position (or deficit), which equals the yearly changes in the stock of debt. Using data on stocks rather than flows, I can compare debt status before and after the shock and can also study how the local debt response differs by borrowing conditions and across lenders. Some cross-country studies examine the fiscal balance of the general (i.e., central and subnational) government, more relevant from a macro perspective (see, e.g., Baskaran 2010 and Eyraud & Lusinyan 2013). To study local governments' behavior, however, debt outcomes should be measured at the subnational level.

2 Literature review

The paper complements the literature that examines the fiscal response of subnational governments to a grant shock. An important strand tests the prediction from rational choice models that grants are equivalent to tax reductions (Bradford and Oates 1971*a*, 1971*b*). In many set-

[5] The data include short-term loans that are otherwise unknown in Mexico, since they are not registered in the Secretariat of Finance.

tings this equivalence has been rejected empirically, leading to the conclusion that "money sticks where it hits": Federal transfers are spent in public goods rather than being returned to citizens through tax reductions.[6] Whereas this flypaper-effect literature only considers unconditional grants, potentially fungible with private income, the shock considered in this paper also affects the conditional ones, which can be committed to debt repayment.

On the one hand, some studies on the flypaper effect are consistent with the present findings that grants and debt are substitutes. First, Cascio et al. (2013) speculate that part of the increase in federal revenues may be used to reduce existing debt or build up reserves, given that it is not fully accounted for by the changes in expenditures and in local revenue. Second, when grants decrease, subnational governments do increase their own taxes to avoid cutting expenditures, as shown by Gramlich (1987), and therefore may also take more debt, as conjectured by Melo (2002), Levaggi & Zanola (2003), Sour (2013). On the other hand, Vegh & Vuletin (2015) predicts that when transfers represent more than half of total revenues, as in Mexico, higher transfers reduce the diversification of income sources, increasing governments' demand for precautionary savings and reducing debt. However, this insurance effect should be stronger for the more transfer-dependent municipalities, which contradicts this paper's findings.

The literature specifically looking at the effect of grants on subnational debt is small. Studies for the US find that the direction of the effect depends on the type of debt instrument (Martell & Smith 2004, Fisher & Wassmer 2014, Ivanov & Zimmermann 2019). Exploiting a similar census shock, Ivanov & Zimmermann (2019) find that, for low income municipalities, a decline in income increases bank financing but reduces bond issuance. Compared to the US, bank loans in developing countries represent a larger fraction of total municipal debt and are typically taken by the more rather than the less creditworthy governments. Closer to my setting is that of Besfamille et al. (2021), who estimate a debt reduction following an increase in transfers to Argentine provinces. The size of the effect depends on the volatility of the source of grants, with more volatile transfers having a larger effect. For a lower level of government, my paper adds evidence on the role that borrower creditworthiness have in the response to the shock.

The paper also relates to the literature on consumption smoothing over the business cycle. Rodden & Wibbels (2010) find that the fiscal policy of local governments from developing

[6]See, e.g., Baicker (2005), Dahlberg et al. (2008), Litschig & Morrison (2013), Cascio et al. (2013), Lundqvist (2015), Liu & Ma (2016); and for Mexico, Cárdenas & Sharma (2011), Sour (2013). A few studies that support the predictions from the theory include Knight (2002), Gordon (2004), Lutz (2010).

countries is procyclical. During booms, they cannot run surpluses because of political pressures to divert fiscal resources to rent-seekers rather than to debt repayment (Tornell & Lane 1999, Talvi & Végh 2005, Alesina et al. 2008). During downturns, balanced budget rules and credit constraints undermine the ability to borrow on credit markets (Gavin & Perotti 1997, Aizenman et al. 2000). My paper provides insights on local governments' ability to save when experiencing a positive income shock, rather than over the business cycle.

Finally, this paper contributes to the literature on the impact of fiscal decentralization on subnational finances. The theoretical work has centered on the commitment problem of the central government to abstain from local bailouts (Goodspeed 2002, Rodden 2002, Chari & Kehoe 2007, 2008, Cooper et al. 2008, Dovis & Kirpalani 2020). When the central government finances a large share of local budgets, it will face pressures to rescue local governments during a fiscal crisis. This softens budget constraints and lowers perceived default risk, which could result in overborrowing by subnational governments. Some of the empirical literature confirms that higher grants are associated to higher deficits (Rodden 2002, de Mello 2007, Eyraud & Lusinyan 2013, Koppl-Turyna & Pitlik 2018), with an exception being Baskaran (2010). Most of these studies focus on the fiscal balance of the general government and do not consider the response to a plausibly exogenous shock. Unlike the aforementioned literature, I use high transfer dependence as a proxy for low rather than high creditworthiness. Hanniman (2020) shows that transfer dependence reduces the ability to raise additional revenues during periods of financial distress, and such inability does not necessarily translate into higher bailout expectations. The volatile and unpredictable nature of grants is what has a negative effect on perceived credit risk.

3 Institutional setting and testable hypotheses

3.1 Distribution of federal transfers to municipalities

In 1995, the federal government initiated a fiscal decentralization process to transfer expenditure responsibilities to state and, to a lesser extent, municipal governments. Since then, the responsibility for the provision of basic public services is shared by the three levels of government. The federal government is mainly responsible for the budgeting and evaluation of social and infrastructure policies, whereas states and municipalities are in charge of their implementation and delivery. More than two thirds of municipal governments conduct the provision of basic services, and there is a wide variation in terms of local capacities (Armesto 2017).[7]

In that context, subnational governments have very limited financial autonomy: They yield part of their tax powers to the federation in exchange for a share in federal revenue. The own income of municipalities is restricted to the local collection of some small taxes and to revenues from duties (*derechos*). The property tax (*impuesto predial*) is the main tax and only represents 0.2% of GDP, being one of the lowest in the world (Revilla 2013). Revenues from duties correspond to fees for the provision of public services. In addition, municipalities receive intergovernmental transfers that are reimbursements of resources collected by the federal and state governments on their behalf. Most of the resources for federal transfers come from the Shared Federal Revenue (*Recaudación Federal Participable*), which includes the main federal taxes and revenues from oil and mines. The central government can only transfer funds to the municipal governments through the states, not directly. The federal transfers to municipalities can be either conditional or unconditional and the various funds are listed in Table A.1.

The **unconditional or revenue-sharing transfers** (*participaciones*, budget branch 28), over which municipalities have free disposal, are the largest ones. In practice, municipalities use them mostly for the payment of current expenditures. The two main funds (General Fund for Shared Revenues and Fund for Municipal Aid) and, since 2013, the excise taxes on gasoline and diesel can be used for payment and guarantee of municipal debt. States should distribute to municipalities at least 20% of the unconditional transfers according to a formula determined by the state legislation (Table A.1 shows the percentages). Usually, the distribution formulae include a population-based component with weights that vary across states and funds.[8] Timmons & Broid (2013) find that, between 2002 and 2007, governors deviated from the formulae and re-allocated revenue-sharing transfers according to partisan and governance criteria.

The **conditional or earmarked transfers** include contributions (*aportaciones*, budget branch 33) and reassigned resources. Contributions, the second largest transfers of the federal government to municipalities, are channeled via two funds created to compensate inequalities

[7]Their main responsibilities include urban planning and development, public order and safety, utilities (water supply and sanitation, waste disposal), local roads and public transport, street lighting, cemeteries, parks and gardens.

[8]The distribution formulae, described in Peña Ahumada (several editions), can also depend on municipal tax collection, social deprivation, and/or the amount or share of previous transfers received, among other factors. At least 70% of the resources from gasoline and diesel should be distributed on the basis of population. Transfers assigned to municipalities that participate in foreign trade, with a low share in total transfers, are the only that are not distributed according to population.

across regions. The Fund for Municipal Strengthening, earmarked to support local public finances and strengthen public security, has been used mostly to finance current expenditures (ASF, 2017*b*). The Fund for Municipal Social Infrastructure is earmarked for social basic infrastructure. Both funds can be committed as a loan collateral or to repay debts (either amortization or interest payments). The first fund should be distributed in proportion to the municipal share in the state population. The second one should be distributed according to the global poverty index but, in practice, population—a proxy for electoral importance—has played an important role in its allocation (Hernández Trillo et al. 2002, Hernández Trillo & Rabling 2007).

Other source of conditional transfers are reassigned resources, which consist on discretionary, non-recurring financing for investment in specific infrastructure programs. There is little transparency in their allocation—the lobbying efforts of the subnational governments determine how much they receive. Finally, states also make revenue-sharing transfers to municipalities with resources from tax collection, but considerably smaller than the federal ones and with even more opaque distribution criteria.

3.2 The regulatory framework for municipal borrowing

The process of fiscal decentralization in Mexico was implemented along with a reform in the framework for subnational borrowing. As a result, the latter became a hybrid between a rules-based and a market-based system (Revilla 2013). On the one hand, several rules have regulated municipal borrowing, namely: a) municipalities cannot get indebted in foreign currency or with foreign financial institutions; b) debt can only be used to finance "productive public investment" ("golden rule"); c) municipal borrowing requires local legislative approval if the loan is payable within the term of the borrowing administration, and longer-term borrowing requires both municipal and state legislative approval; and d) debt limits have been imposed at the state level, and states sometimes impose debt limits to municipalities. In practice, not all of these rules had been effectively enforced (ASF, 2011*a*; Hurtado & Zamarripa 2013).

On the other hand, a market-based system imposes other requirements on subnational borrowing. First, it requires eliminating the expectation of a federal bailout. In the past, that expectation came from the mandate (*"mandato"*) of the federal government to act as a trustee in servicing subnational debt using shared federal revenues. If a municipality did not make the agreed payments on its registered debt, the federal government would deduct those payments from its shared revenues. That mandate, perceived as a guarantee of the subnational debt, was eliminated in 2000 to ensure an explicit commitment of no bailout. Since then, local governments and lenders should make their own arrangements (trusts) to collateralize bank debt with shared federal revenues or other revenue flows. Lenders cannot request to the federation the discount of unpaid debt from shared revenues and would take any losses associated to the loan.

Second, a market-based approach also requires lenders to have sufficient information on borrowers' debt and payment capacity. Thus, municipalities should register in the Secretariat of Finance all the bank loans or securities issuances that use shared revenues as a source of payment or guarantee and that have been approved by the local congress. Unsecured short-term liabilities, contracted for up to one year, are not officially classified as public debt and therefore do not need to be registered.[9]

Third, financial sector regulations have been in place to promote prudent borrowing. In 2000, a capital risk weight of at least 20% was introduced for municipal loans. The risk weight depends on the credit ratings assigned by at least two authorized rating agencies; unrated loans received the highest weight (150%). Later on, banks also started to make reserve provisions, determined by the number of months with arrears for smaller loans and by the credit ratings for larger loans. In addition, municipal governments could no longer use the ratings of the state government but were required to have their own ratings or they would be penalized with high reserve requirements. Since the introduction of an expected loss approach to measure credit risk in December 2011, provisions also depend on the payment history and the current financial situation of each entity. Finally, banks need to provision higher reserves if the municipal debt is not collateralized. Thus, between 2008 and 2011, about 80% of the outstanding subnational debt was collateralized with shared federal revenues and the rest mostly with the future flow of local taxes (ASF, 2012).[10]

An important reform was enacted on April 2016, known as the Financial Discipline Law of the Federal Entities and Municipalities, with the purpose of strengthening the prudential rules for public financing and to improve competition in the banking sector. Under the new law, municipalities are required to contract loans with the lowest financial cost. If they resort to capital markets, they must justify its advantage over bank funding. Within the three months

[9]Registration is not required either for debt with suppliers, financial leasing, contingent liabilities (pensions, recovery from natural disasters), and medium and long-term resources committed in public-private partnerships.

[10]Since August 2011 subnational governments can use partial guarantees from Banobras both for bank debt and bond issuances (*Garantía de Pago Oportuno*). However, these guarantees have not been taken by municipal governments up until 2017.

before their replacement, officers should liquidate short-terms loans and cannot take new debt. Debt limits are established on the basis of an alert system that classifies the level of indebtedness of public institutions. The new law also establishes under which circumstances municipalities can run a fiscal deficit.

3.3 The profile of indebted municipalities and municipal loans

Municipal debt in Mexico is low, well below the levels in developed and in other developing countries. By 2010, it amounts to MX$320 (US$25) per capita (ASF, 2011*a*). According to Giugale et al. (2000), this pattern responds to two factors. First, the low creditworthiness of many local governments restrict their access to capital markets. Only larger municipalities can offer better guarantees and absorb the costs of taking loans or issuing bonds. Second, historically the federal government has transferred resources to local governments through explicit and implicit bailouts, crowding-out debt as a mechanism to balance the fiscal accounts. Even though explicit bailouts of subnational debt are not permitted after 2000, extraordinary transfers of resources that create rent-seeking incentives may persist via alternative mechanisms.

The main lender to municipal governments is a federally-owned development bank, Banobras. That bank is expected to serve local governments unable to obtain financing from private lenders, that is, the less developed, unbanked, or unrated municipalities. The second source of municipal financing are private banks and non-bank financial corporations (*Sofomes* and *Sofoles*). Since 2001 local governments can also issue securities in domestic capital markets.

To illustrate the stark contrasts between municipalities not indebted at all in a given year and those with debt in one month at least, Table 1 shows summary statistics (mean and standard deviation) of their characteristics for the period 2009–2016.[11] Relative to municipalities with outstanding debt, those not indebted have on average less population, of which a smaller share is economically active. They also have less formal employment and their formal jobs are worse paid; they have lower household income and are more likely to have high social deprivation. They receive 32% more federal transfers per capita whereas their own-source revenues are 42% lower. Primary expenditures are 24% higher in that group.

[11]The variables are extracted from various sources described in Appendix Table A.2. To identify indebted municipalities, I use monthly data from August 2009 to December 2016 extracted from regulatory reports (see section 4), which capture all the loans granted by both Banobras and private intermediaries (18 commercial banks, 7 Sofomes, and 1 Sofole). While bonds are not considered, few municipalities borrow from capital markets and, by 2010, bond issuances only represented 6% of total municipal debt (ASF, 2011*a*).

In addition, Table 1 compares municipalities with high and low dependence on federal transfers. When transfers are volatile and unpredictable, a high transfer dependence undermines local creditworthiness. On the basis of the ratio of transfers to own-source revenue in 2010, I define municipalities at the bottom twentieth percentile as the ones less dependent on transfers and the rest comprise the high-dependence group.[12] Table 1 shows that transfer-dependent municipalities have worse socio-economic indicators. While their average revenues from both federal transfers and own sources are 13% higher, their average expenditures are also higher (16%). Just a third of the transfer-dependent governments have debt versus 70% of those in the other group. Thus, a large number of the less creditworthy local governments do not even borrow from the development bank, despite its mission to solve market failures.[13]

Conditional on borrowing, municipalities more reliant on transfers may take different types of loans. Table 2 provides an overview of the debt characteristics for municipality–month pairs with outstanding debt. The average number of lenders per municipality is close to one, suggesting little diversification in funding sources. About 79% of the municipalities borrow from Banobras, and that fraction is higher in the grant-dependent group. Municipalities more dependent on transfers are less likely to have at least two credit ratings than the other group (2% versus 27%, respectively). Only 20% of the indebted municipalities have short-term loans, whereas 90% have long-term loans, and this pattern remains in both subsamples. The average loan volume is significantly lower for municipalities more dependent on grants, whereas the average interest rate is just 0.25 percentage points higher than in the other group. More transfer-dependent municipalities also have a higher fraction of fixed-rate loans (42%) but with a lower average maturity (6 years) than the other group (12% and 10 years, respectively).

Municipal debt has a low rate of default on average and that rate is lower for the transfer-dependent governments (0.3% versus 1.1% in the other group), despite being less creditworthy ex ante. The final rows report two indicators of financial vulnerability, capturing governments' ability to repay their debt. A high financial risk is not apparent: The ratios of total debt volume and of required payments over federal transfers plus own revenues are of 16% and 8%,

[12]I consider a rather narrow sample for the less dependent group because the majority of Mexican municipalities are very dependent on transfers. The median ratio of transfers to own-source revenues is 15.7, whereas the ratio used as a threshold for the definition is 4.9.

[13]Since 2000, development banks can only make new loans to municipalities when such loans qualify for registration in the Secretariat of Finance and its capital risk risk weight is less than 100%. Lending to the less creditworthy governments, with higher risk weights, is possible only if the loan includes a technical assistance package funded by a multilateral organization (Giugale et al. 2000).

respectively, and are similar across groups. In a nutshell, Tables 1 and 2 reveal that municipalities more dependent on transfers are less likely to have debt and, conditional on being indebted, have smaller loans. While their loans are more likely to be granted by the development bank and pay a slightly higher interest rate, they are not more likely to default ex post.

3.4 Testable hypothesis

The equilibrium effect of a shock to federal transfers on municipal debt is determined by multiple factors and is, therefore, an empirical question. It depends not only on formal rules that regulate municipal borrowing, but also on the enforcement of these rules. In addition, local borrowing capacity is determined by market forces that operate under a credible commitment of no bailout by the central government (Cooper et al. 2008, Dovis & Kirpalani 2020) and financial sector regulations.

In this context, I hypothesize that a revenue shock should have a *negative effect* on the *demand* for debt from municipalities that are not borrowing constrained. Before the shock, government debt already covers local financing needs and there is no underprovision of public goods. After a positive shock, higher revenues should reduce financing needs and, hence, the demand for credit. The additional resources will reduce the probability of being indebted and/or will lead to smaller loans. Conversely, following a negative revenue shock, governments should be able to resort to credit to cover any fiscal gap. In contrast, municipalities that are not creditworthy before the shock are credit rationed by banks and, therefore, will be unable to smooth income using debt.

On the other hand, a revenue shock that alters the distribution of transfers can have a *positive effect* on the *supply* of credit. Since present and future transfers can act as collateral for bank loans, more federal grants will alleviate the collateral constraints of local governments. Hence, when grants increase, we should observe an increase in the probability of being indebted and, conditional on being indebted, in loan volumes (and, conversely, local debt should decline when grants decline).

Finally, the fiscal federalism literature predicts a *positive effect* of higher grants on the *demand* for credit. According to this view, a common pool externality arises from the expectation of a federal bailout that reduces the cost of defaulting born by each municipality. That expectation is higher when the federal government is already financing most of the local spending and municipalities have little ability to raise their own revenue. However, such prediction refers to the impact of the degree of transfer dependence, rather than of a transfer shock, on fiscal performance. In this setting the proposed mechanism seems less plausible, given the explicit commitment of no bailout by the federal government since year 2000. Even in the absence of a credible no-bailout commitment, Hanniman (2020) shows that the level of transfers does not affect bailout expectations.

4 Data and sample

Data on municipal debt come from the R04 C Commercial Credit report, which is collected by the National Banking and Securities Commission (*Comisión Nacional Bancaria y de Valores,* CNBV). It contains a monthly record of the universe of commercial loans granted by financial intermediaries. I select the loans where the economic sector of the borrower corresponds to municipal governments, excluding trusts, decentralized organizations, and firms with state participation. For each loan, the data set reports detailed characteristics, including the outstanding volume, interest rate, and maturity. I aggregate the data at the municipality–bank–month level and impute zeros when no loans are registered for a given triplet. The final sample includes 25 financial intermediaries (18 private banks, 1 development bank, 5 Sofomes, and 1 Sofole) lending to municipal governments.

The data on municipal revenues and expenditures are annual and correspond to the central sector of municipal governments. They come from the "Statistics on state and municipal public finances", collected by the National Statistics Office (*Instituto Nacional de Estadística y Geografía,* INEGI). The municipal population change, described in section 5.1, is constructed using data from the 2010 census and from the 2005 population count (INEGI). The sources for the remaining variables are described in Appendix Table A.2.

For the main analysis, I restrict the sample to 1,727 of the 2,440 municipalities distributed across 30 out of 31 Mexican states. The 16 delegational governments of Mexico City are excluded since they are not enabled to have their own income. Each delegation has maintained a constant share in the income of the city, which does not depend on their own changes in population, collection, economic performance, etc. I exclude 72 municipalities from Sonora, since the state government was still using data from the 2000 census well after the release of the 2010 census (ASF, 2017*a*). Finally, I exclude 641 municipalities with missing—contemporaneous or lagged—data on the revenue or expenditure variables (Appendix Figure A.1 shows their spatial distribution).

Table 3 shows the summary statistics for the main dependent (panel [a]) and independent (panel [b]) variables used in the regressions and Appendix Table A.2 provides definitions. The sample is already trimmed using the propensity score, as described in section 5.2. Except where indicated, the variables in first differences are computed as the difference between the years 2011 and 2012, relative to 2010 (for monthly data, the baseline period is October 2010). All values are expressed in December 2010 Mexican pesos using the Consumer Price Index (INEGI). To reduce the influence of outliers, I winsorize all variables in first differences at the top and bottom 1.5 percent of the distribution. Statistics are reported for the entire sample and also for the subsamples of municipalities more and less dependent on transfers, as defined in section 3.3. For the control variables I use an inverse hyperbolic sine (IHS) transformation, which allows preserving the zeros. I define federal transfers as the sum of revenue-sharing transfers and contributions, excluding revenue-sharing state transfers and reassigned (federal and state) resources.

5 Empirical methodology

5.1 The income shock

Section 3.1 explains that states redistribute federal transfers according to different formulae that, in different degrees, depend on municipal population.[14] To determine the distribution coefficients, states should use the last official population data published by the INEGI.[15] The INEGI conducts population censuses every ten years (e.g., in 1990, 2000, 2010) and also inter-censal population counts or surveys that in practice are a mini-census (e.g., in 1995, 2005, 2015). However, it does not produce yearly estimates of municipal population. Thus, the release of new INEGI data leads to a revision of figures that are at least five years old, not of the concurrent population estimates. This implies that federal transfers to municipal governments experience discontinuous changes with the update of official population data.[16] If a particular locality ex-

[14]Only for the states of Chihuahua and Nayarit, the variables used to determine the distribution of revenue-sharing transfers are unknown.

[15]A judicial process between the INEGI and the municipality of Tultepec (Estado de México) illustrates the importance of population for the distribution of revenues. In 2013 the INEGI had to revise the population figures, after the authorities of Tultepec complained that the 2010 Census misattributed some localities to neighboring municipalities, leading to a reduction in shared revenues.

[16]Even though the National Population Council (*Consejo Nacional de Población,* CONAPO) produces yearly estimates, only official data from INEGI can be used for the allocation of federal grants. For the distribution of federal transfers to states, which also depends on population, the INEGI estimates the state population yearly in the National Survey of Occupation and Employment (*Encuesta Nacional de Ocupación y Empleo,* ENOE), using

periences abnormally high immigration, it will not start receiving higher federal resources until several years later and will not be compensated retrospectively (Arechederra & Carbajal 2017; ASF, 2011*b*).

Here I exploit such discontinuous changes in federal transfers due to changes in reported population. Other sources of local revenues and expenditures, including debt, are correlated with current population, which changes continuously. For example, municipal debt depends on local collection and financial needs, both of which are highly correlated with actual population. A similar strategy is used by Gordon (2004) to assess the impact of a federal education grant (Title I) on school districts' revenues and spending. She exploits the discrete jump in allocations that follow the release of child poverty estimates from the 1990 census. I define the change in population estimates as the difference between the logarithm of the population from the 2010 census and the 2005 intercensal count:

$$\Delta \log Pop_m = \log Pop_{m,2010} - \log Pop_{m,2005} \tag{1}$$

This change in population drives the change in the distribution of federal transfers after 2010, given that postcensal estimates had not been used for the years going from 2006 to 2009. The first year in which there might be an effect on local budgets is 2011—preliminary census numbers were released on November 25, 2010 and definitive numbers on March 3, 2011. I only consider the 2010 census shock, more likely to have been adopted upon release than the intercensal estimates of 2015.[17]

Figure 2 shows the histogram of the population change in panel (a) and of the change in federal transfers (between 2011 and 2012 relative to 2010) in panel (b). In both cases there is substantial variation across municipalities; the middle 90% of the observations experience changes between -3% and 21% (panel [a]) and between -10% and 34% (panel [b]). Whereas the means are similar (8%), the standard deviation of transfer changes is larger (8% and 14% in panels [a] and [b], respectively). Importantly, the map in Appendix Figure A.1 shows a large variation in both population and transfer changes across municipalities of the same state, which provides the variation needed to estimate the income-shock effect.

projections from the CONAPO.

[17]By 2016 some states were still using data from the 2010 Census and Sonora from the 2000 Census to distribute municipal resources (ASF, 2017*a*).

5.2 Econometric framework

Since the census shock theoretically affects all municipalities, I exploit the fact that some are more affected than others because there is no real control group. To assess the effect of the census shock on federal transfers and local debt in practice, the main identifying assumption is that, conditional on covariates, the shock should be plausibly exogenous. This approach renders the "intention-to-treat" effect on debt, since it takes into account that some municipalities may not receive higher (lower) transfers following a positive (negative) census shock.

The following specification at the municipality–bank–month×year level is estimated for debt outcomes:

$$\Delta y_{m,b,t} = \alpha_0 + \alpha_1 \Delta \log Pop_m + \alpha_2 X_{m,t-1} + \alpha_3 \Delta X_{m,t-\tau} + \alpha_4 \Delta X_{b,t-1} + \alpha_s + \alpha_b + \alpha_t + \epsilon_{m,b,t} \quad (2)$$

where the dependent variable, $\Delta y_{m,b,t}$, denotes the difference between period t (January 2011 to December 2012) and October 2010 in the debt status of municipality m with bank b. Thus, $\Delta y_{m,b,t}$ takes a value of 1 if municipality m had no debt in October 2010 (the month prior to the release of preliminary census data) and enters a credit relationship in period t, a value of 0 if there was no change in debt status between October 2010 and period t, and a value of -1 if the municipality had debt in October 2010 and repaid it by period t. Conditional on being indebted, $\Delta y_{m,b,t}$ denotes the change between period t and October 2010 in the logarithm of the loan volume that municipality m borrows from bank b. The regressor of interest, $\Delta \log Pop_m$, is the population change experienced by municipality m between 2010 and 2005. Since the population change varies at the municipality level, standard errors are clustered by municipality.

By taking first differences at the municipality level, I am controlling for time-invariant municipal characteristics. In $X_{m,t-1}$ I include a contemporaneous indicator of local elections in the next year, which has a demonstrated effect on municipal indebtedness. I also control for several indicators of local economic development, namely, the economically active population (as a percentage of total population) and formal sector employment and household income (per capita), measured as of 2010 to ensure that are not affected by the population change. $\Delta X_{m,t-\tau}$ controls for the difference between $t-1$ and October 2010 in the state unemployment rate and economic activity and the municipal formal sector employment. It also controls for lagged outcomes (the 2005–2008 and 2008–2010 changes in federal transfers and other revenues, in current and capital expenditures, and in the fiscal deficit) and for the 2000–2005 population change, since past population growth could be a predictor of future growth. $\Delta X_{b,t-1}$ denotes the change in bank characteristics (total assets and the liquidity and capital ratios) between $t-1$ and October 2010. By including state fixed effects, α_s, the comparison is restricted to municipalities within the same state, differently affected by the shock. In turn, bank fixed effects, α_b, allow obtaining a clean estimate of credit demand by removing supply-side trends at the lender level. The year–month fixed effects, α_t, control for macroeconomic conditions affecting credit demand or supply for the entire cross section of municipalities in a given period. $\epsilon_{m,b,t}$ is the error term.

A similar model is estimated for the change between 2011 and 2012 relative to 2010 in the logarithm of federal transfers, which is expected to mediate the effect on municipal debt. In this municipality–year level specification, the controls and fixed effects at the bank level ($\Delta X_{b,t-1}$ and α_b) are omitted. The standard errors are clustered at the municipality level and, given the small number of observations per cluster, are computed using wild bootstrap with 999 replications.

Conditional independence To obtain a causal interpretation of $\widehat{\alpha}_1$, I assume that once permanent differences among states and lagged growth in outcomes and population are taken into account, the census shock is as good as randomly assigned with respect to potential changes in outcomes. This is a restrictive assumption and its violation could lead to biased estimates. First, municipal governments may be able to forecast the population growth of municipalities in their state using unofficial projections. Thus, they may anticipate the change in federal transfers before the release of census data. Reverse causality could arise if local governments increase their consumption commitments ex ante and, therefore, their future financing needs when expecting a positive shock. Second, omitted variable concerns may arise as well. For instance, local governments more likely to experience a positive census shock may also be more likely to smooth income in credit markets. This could lead to a downward bias in the estimates of the shock effect on debt.

While conditional independence is not directly testable, it is possible to test related conditions to address the endogeneity concerns. First, following Angrist et al. (2013) and Suárez Serrato & Wingender (2016), I use inverse-probability weighting (IPW) to improve covariate balance. To this end, I estimate a logit model for a treatment indicator on the lagged changes in outcomes (federal transfers and other revenues, current and capital expenditures, and deficit) and on the 2000–2005 population change. The treatment indicator is built by: a) normalizing the shock, that is, subtracting the state population change over the same period from the population shock defined in (1), and b) discretizing the continuous shock, that is, defining a binary indicator that takes the value of 1 if the normalized shock is above the median and of 0 otherwise. Appendix Table A.3 presents the logit coefficients and marginal effects. Some of the regressors are significant, indicating the absence of pre-shock covariate balance. Next, I obtain a propensity score from the logit model estimated in columns 3 and 4 and compute the IPW.

To ensure common support and covariate balance, I trim the sample to observations with a propensity score within the range $[0.25, 0.75]$.[18] This implies losing 23 municipalities. Appendix Figure A.2 shows the distributions of the propensity scores before and after trimming (panels [a] and [b]). The evidence in panel (b) is consistent with overlap, where the supports for treated and control municipalities are almost the same. To estimate equation (2), I use the IPW estimator in the trimmed sample.

Appendix Table A.4 shows the results of the balancing tests. The idea is that, after weighting the observations with the inverse-probability weights and trimming the sample, there should be no significant association between the census shock and the covariates. The first column shows the estimates only controlling for the most recent changes in lagged regressors (2008-2010), where no coefficient is significant. When adding the long-term changes in covariates (2005-2008), current expenditures, deficit, and population growth are significant. In column 3, I further weight the observations using the IPW and find that the 2008-2010 deficit and the 2005-2008 current expenditures are (marginally) significant. Finally, column 4 presents the estimates of the IPW model after trimming and the recent change in deficit turns insignificant, whereas the long-term changes in other revenues become marginally significant. Identification hinges on the absence of correlation with the short-term changes in outcomes.

Another testable implication of the shock being "as if" randomly assigned, conditioned on covariates, is the absence of pre-existing time trends. If confounding factors drive the results, an association may be found even before the census release. In sections 6.3 and 7 I present evidence showing no pre-trends on transfers, debt, and expenditures generally. In section 6.5, I perform a placebo test for exogeneity and estimate equation (2) for municipalities from the state of Sonora, which has not updated the population figures used to distribute transfers after 2010. In addition, as a sensitivity analysis, I follow Oster (2019) to assess if the point estimates are

[18] Crump et al. (2009) suggest discarding observations outside the range $[0.1, 0.9]$. Since the interval for the propensity score in the sample is $[0.19, 0.87]$, I use a smaller range to achieve covariate balance in a short-term window before the shock, as discussed below.

robust to the inclusion of unobserved covariates and estimate the size of the potential omitted variable bias. Ultimately, since the shock is not randomized, some omitted variable bias cannot be fully ruled out.

6 Effects of the income shock on debt holdings

6.1 Main findings on the income shock

First I examine the effect of the census shock on federal transfers, where there should be a direct impact. I start by testing whether the relationship between population and transfers is well approximated through a linear function. In the case of unconditional transfers, a large fraction is allocated in direct proportion to the number of inhabitants, but some states' formulae also include components that introduce non-linearities.[19] The distribution of conditional transfers is linear in population for one of the funds, whereas the relationship is less clear for the other since its distribution is somewhat discretionary. Hence, I perform a test for linearity using a nonparametric regression of the change in federal transfers (between 2011 and 2012 relative to 2010) on the population change defined by equation (1). Figure 3 presents a binned scatter plot of the regression, which confirms the positive relationship between population growth and transfers, not driven by outliers. The regression function passes the test from the binscatter estimator (Cattaneo et al. 2019).

Table 4 reports the estimates of equation (2) modified for federal transfers. The first specification accounts for time and state fixed effects and for time-varying controls, excluding lagged outcomes. Column 2 adds the IPW and column 3, the benchmark specification, further controls for lagged changes in outcomes (transfers, expenditures, and deficit). Column 4 reestimates the benchmark model dropping missing values from the models for other sources of revenue (columns 5 and 6). Across specifications, the population change has a positive coefficient that is statistically significant at the 1% level, confirming that it leads to big gains for some municipalities after 2010. From column 3, a one-standard-deviation increase in the shock (7%) leads to a 2% $(28.8 \times 0.07 = 2.1)$ increase in transfers.

In the last two columns I examine whether the update of the population figures has a direct

[19] In 11 states (Aguascalientes, Baja California, Colima, Durango, Guanajuato, Morelos, Querétaro, San Luis Potosí, Sinaloa, Tlaxcala, and Zacatecas), a smaller percentage is allocated in inverse proportion to municipal population. In three other states (Chiapas, Guerrero, and Nuevo Leon), population weights other factors.

effect on other sources of local revenue. As explained in section 3.1, revenue-sharing state transfers and reassigned resources, considerably smaller than federal transfers, are allocated according to opaque and discretionary criteria. In turn, own-source revenues are expected to change continuously with changes in population and, hence, may not exhibit an immediate response to the census shock—in the medium term, local governments could adjust tax collection in response to the change in transfers. Table 4 confirms that indeed there is no significant effect either on state transfers plus reassigned resources (column 5) or on own-source revenues (column 6). In turn, Appendix Figure A.3 plots the coefficients and 95% confidence intervals estimated for a five-year window around the shock and shows no evidence of a significant effect in the medium term either. These results indicate that the census shock only impacts on federal transfers but not on other primary revenue sources.

Next, Table 5 shows estimates of equation (2) for municipal debt outcomes. Columns 1 to 3 show the results for the change in the probability that a municipality is indebted with a given bank. In the baseline specification, the coefficient on the population change is negative and significant at the 5% level, as expected if grants and debt are substitutes. Adding the IPW and the lagged outcomes successively does not alter the estimates substantially, which vary around -1.7. This implies that a one-standard-deviation increase in the shock reduces the probability of having debt by 0.1 p.p., which constitutes a 5% change relative to the percentage of municipality-bank pairs with debt (2.3%).

Finally, columns 4 to 6 present the estimates for the change in loan volume at the intensive margin using the same specifications as in columns 1 to 3. All coefficients take a positive sign, which is inconsistent with a substitution effect, but are statistically insignificant. In unreported results, I estimate the same specifications for interest rates and do not find significant effects either.[20] Thus, after experiencing an income shock, municipal debt exhibits no adjustment at the intensive margin, neither in quantities nor in prices.

6.2 Effects by municipality's degree of financial autonomy

A differential debt response to the income shock may be observed depending on municipalities' creditworthiness. To examine this conjecture, I estimate heterogeneous effects for municipalities

[20] The result for interest rates is not surprising given their low variability, which is apparent from the standard errors reported in Table 2.

with a high and low ratio of federal transfers to own-source revenue, as defined in section 3.3. A high degree of financial autonomy serves as a proxy for high creditworthiness, that is, local governments' ability and willingness to meet their financial obligations. This is in line with the view of credit rating agencies, which use different rating methodologies for credit transactions guaranteed with local tax revenues and with federal transfers. Standard & Poor's México (2010) argues that local taxes do not necessarily behave in the same way as shared federal revenues and that municipalities need their own resources to finance expenditures: Federal revenues are distributed among several entities and the distribution is biased towards some of them. Hanniman (2020) shows that agencies have an unfavorable view of volatile and unpredictable transfers.

Table 6 (columns 1 and 2) shows the results of estimating the benchmark specification for federal transfers, interacting the regressor of interest with a dummy that takes the value of 1 for municipalities with a low transfer-to-own revenue ratio in 2010 and of 0 otherwise. The results do not reveal significant differences across groups; the interaction coefficient is negative and statistically insignificant. This rules out that a positive census shock leads to greater revenue gains for municipalities less transfer dependent, which in turn could lead to a larger debt reduction.

Next, columns 3 and 4 report the estimates of equation (2) for the change in the indicator of being indebted. The interaction coefficient is negative and significant at the 5% level: For a one-standard-deviation increase in population change, the less transfer-dependent municipalities are 0.3 p.p. less likely to have a debt relationship than the more transfer dependent. This effect is economically meaningful and represents a change of 14% relative to the average fraction of indebted municipalities (2.3%). In turn, the standalone coefficient on the population shock becomes insignificant, implying that the more transfer dependent governments are insensitive to the shock. Finally, columns 5 and 6 of Table 6 show the results for debt volume at the intensive margin. The estimates with the interaction term show a negative difference that is marginally significant when the specification also controls for lagged outcomes. Thus, also at the intensive margin of debt outcomes there is (weak) evidence of heterogeneous effects by degree of transfer dependence.

6.3 Dynamic effects on transfers and debt

In this section I examine the dynamics of the population-shock effect on local transfers and debt. This allows ruling out the presence of pre-existing trends biasing the results. There could exist underlying economic trends or previous local shocks that affect both population growth and municipal budgets, giving rise to an omitted variable bias. For example, municipalities that experience faster population growth are likely to have better economic prospects and, therefore, may attract more immigration, which enables a higher tax collection. Thus, even before the release of the census data they will be able to start reducing debt thanks to higher own-source revenues.

Figure 4 plots the coefficients and 95% confidence intervals estimated for a regression of the change in federal transfers (between 2005 to 2015 relative to 2010) on the census shock interacted with year dummies.[21] I control for state and municipal characteristics (including lagged outcomes in an alternative specification), also interacted with year dummies, and for state and year fixed effects. In the absence of pre-existing trends, the population change should not affect transfers before the census has been released, that is, before 2010. Only the estimates from 2011 onward should be statistically significant. Panel (a) confirms that before 2010 the population change does not affect the distribution of federal transfers, except for some significant but small effect in 2008. After 2010, the census shock leads to a significant and persistent increase in transfers. Panels (b) plots the interaction coefficient between the population shock and the dummy for low transfer dependence. All pre-shock confidence intervals contain the zero. Two years after the shock the coefficient becomes negative and significant, indicating that the less transfer-dependent municipalities benefit less from the increase in population than the more transfer-dependent ones. This differential becomes less significant in subsequent years.

Using the same specification but including bank-level controls and fixed effects, Figure 5 plots the dynamic effects on the probability of having debt (top panels) and on debt volume (bottom panels) between period t (July 2009 to October 2015) and October 2010.[22] The top figure with the average treatment effects (panel [a]) shows that the trends are the same in the months leading up to the census release. After the shock, the coefficients are negative and the confidence intervals fall below zero in early 2011, consistent with intertemporal income

[21] All dynamic estimates drop municipalities with any missing data over the eleven-year period.
[22] I use a shorter pre-shock horizon because the credit data are only available since July 2009.

smoothing. Panel (b) shows that the estimates of heterogeneous effects for municipalities less dependent on transfers are insignificant prior to November 2010. The effect on being indebted becomes significant after the second quarter of 2011 and is no longer significant by the end of 2012. The bottom graphs for debt volume also confirm the absence of pre-trends. In addition, in panel (a) all post-census coefficients are insignificant, but in panel (b) the estimates of the interaction with the low dependence dummy are negative and significant around 2013-2014. Thus, in the medium term, the more creditworthy governments also reduce debt more than the less creditworthy at the intensive margin.

The dynamic estimates also shed light on the speed of adjustment to the shock and the temporal persistence of the effects. Figures 4 and 5 reveal an immediate response from the revenue side and from debt at the extensive margin. In turn, the effect on revenue is permanent but the one on debt is transitory, lasting for two years at most.

6.4 Effects by debt characteristics and lender type

It is possible that the debt response to the income shock at the intensive margin is affected by the characteristics of existing loans and the pre-shock debt levels. For instance, governments may be more prone to reducing debt in response to the shock when its interest rate is high. Thus, I reestimate the models for debt volume interacting the population shock with debt-related characteristics measured as of October 2010, that is, before the shock.[23] Table 7 shows that only the interaction with the payment-to-revenue ratio is statistically significant. It indicates that for a one-standard deviation increase in the payment ratio (0.48), loan volume increases by 8% less in response to a one-standard deviation increase in the population shock. That is, following a positive shock, municipalities that had a higher burden of debt service payments increase loan volumes by a smaller amount than those with a lower burden. A negative but insignificant differential effect is also estimated for residual maturity, an indicator of having at least two credit ratings, and the ratio of total debt volume to federal transfers plus own-source revenue. In turn, the interaction with the interest rate is positive but also insignificant.

An important distinction is between short-term loans, used to mitigate liquidity risk and to cover operational deficits, and long-term debt, expected to finance productive investments.

[23] In the models for the probability of having debt, loan characteristics are an outcome of the shock themselves for municipalities taking debt.

Thus, in Table 8 I examine the effects on short- and long-term debt (i.e. loans with a maturity at origination below and above one year, respectively), both at the extensive and intensive margins. The first two columns show that the population shock has a negative effect on the probability of having both short- and long-term debt, but marginally significant only for short-term debt. In the last two columns I find that only the change in the volume of short-term debt declines, even if insignificantly, in response to the shock. Thus, while the evidence is weak, the results suggest higher substitution between transfers and short-term debt. Local governments that normally have few credit lines to deal with refinancing problems may seek to reduce their short-term liabilities, which pose greater rollover risk.

Finally, I investigate if there are differences in the debt response, depending on whether it is contracted with private lenders (i.e., commercial banks or non-bank financial institutions) or with the federally-owned development bank. Development banks have a social mission, namely, lending to borrowers whose intermediation costs are high for private institutions. Since public banks are subject to agency problems coming from political pressures, their allocation of credit may be less subject to market criteria. This may result in less income smoothing by local governments and, moreover, higher transfers could even lead to higher indebtedness in the presence of overborrowing, as argued by the fiscal decentralization literature.

Appendix Table A.5 shows the estimates of the model for the change in the probability of being indebted with any private lender (columns 1 to 3) and with the development bank (columns 4 to 6). In these specifications, observations are collapsed at the municipality–period level and, hence, the bank controls and fixed effects are removed. Columns 1 and 4 show that indeed being indebted declines less following a positive income shock when the lender is the development bank. The differential, however, is small. Moreover, both coefficients are statistically insignificant, implying that the census-shock effect on debt does not persist at a more aggregate level. In other words, the probability of having debt with any private or public intermediary does not decline in response to a positive shock. Columns 1 and 4 also show that governments are significantly more likely to become indebted with a private or public lender (by 3.7 p.p. and 10.3 p.p., respectively) during the year before local elections are held. This confirms the cycle of higher debt during electoral years, when governments presumably expand public expenditures to ensure the continuity of the incumbent's political party, followed by lower indebtedness after the elections. When the mayor of the local government is aligned with the presidential party, governments are more likely to be indebted with the development bank only but not significantly.[24] In columns 2, 3, 5, and 6 I add the triple interaction of the regressor of interest with these political dummies. All interaction coefficients are negative and insignificant, revealing that political factors do not exacerbate or mitigate the income-shock effect for any lender type.

In the last three columns, the dependent variable is the change in loan volume at the intensive margin and observations preserve the bank-level variation. I add the interaction between the regressors of interest and a dummy that takes the value of 1 for loans granted by the development bank in October 2010 and of 0 otherwise. The interaction term in column 7 indicates that municipalities take larger loans in response to a positive shock from the public lender than from private ones. However, the coefficient of interest is statistically insignificant, likewise the interactions with the political dummies in columns 8 and 9. Overall, the findings in Table A.5 reveal no differential in the shock effects depending on the lender type. In particular, not even for the development bank there is evidence of a positive association between transfers and debt.

6.5 Robustness, placebo, and sensitivity tests

In Appendix Table A.6 I examine the robustness of the heterogeneous effects to the use of alternative thresholds to define transfer-dependent municipalities. In particular, I redefine the cutoff at the tenth and thirtieth percentiles of the 2010 ratio of federal transfers to own-source revenue. The results for the probability of being indebted in both cases remain similar to their benchmark in Table 6 (columns 3 and 4), which uses the twentieth percentile. The coefficient on the interaction term becomes slightly smaller as the definition of low dependence becomes looser (i.e., moves from the tenth to the thirtieth percentile). In columns 1 and 2, the coefficient of interest becomes significant at the 10% rather than 5% level, which reflects the larger standard errors.

If pre-trends are not driving the results, municipalities whose population figures have not been updated should not exhibit an increase in transfers or a decline in debt holdings following the release of census data. To examine this possibility, in Appendix Table A.7 I reestimate the benchmark specifications interacting the regressors of interest with a dummy for Sonora (see footnote 17). This state has been using population figures from the 2000 census even after the

[24] During most of 2011-2012, the presidential party was the PAN, until the PRI started a new six-year term in December 2012. Data on municipal political parties are extracted from the website of the National System of Municipal Information (http://www.snim.rami.gob.mx).

2010 census was released. The results in column 1 reveal that municipalities from Sonora have received a significantly smaller amount of transfers following an increase in population than municipalities from other states. The positive coefficient on the interaction term in column 2 indicates that they have also increased the probability of being indebted relative to other municipalities in response to a positive shock. The differential is also positive and significant in column 3 that adds the interaction with the less transfer-dependent governments. These findings support the plausibility that confounding factors are not driving the results on transfers and debt at the extensive margin. For completeness, the last two columns show the effects on loan volume that are not precisely estimated over the first two years in the benchmark models. Here, both coefficients of interest are not significant either.

An important source of concern is the 2007-2008 global financial crisis that, given its timing, could give rise to pre-trends in the estimates of the population-shock effects. Mexican governments were hit harder by this crisis in 2009, when the lower economic growth led to a decline in federal grants and this to an increase in municipal debt. As federal transfers recover in subsequent years, debt is expected to decline and this could confound the estimates. Thus, in Appendix Table A.8 I control for the 2008-2009 changes in federal transfers and fiscal deficit to capture the crisis period better—the benchmark specifications control for the 2008-2010 changes. The corresponding coefficients show that growth in transfers and debt after the census have been lower for municipalities that experienced a decline in transfers in 2009. However, across the different outcomes, the coefficients on the population shock and its interaction with the low-dependence dummy are not substantially altered when accounting for the effect of the crisis on local budgets.

Despite the inclusion of a broad array of controls in equation (2), it is not possible to fully rule out an omitted variable problem because the census shock is not randomized. Thus, I follow the approach in Oster (2019) to test for the robustness of the results and assess the magnitude of the potential omitted variable bias. This approach assumes that the relationship between the census shock and unobservables can be recovered from that between the census shock and observables. Its implementation involves computing a bias-adjusted bound, or identified set, for the census-shock effect. The set is bounded by the estimate of α_1 obtained from equation (2), only controlling for observables, and by the hypothetical α_1 obtained if unobservables were also accounted for.

I follow the proposed guidelines to obtain the hypothetical α_1 and assume that: a) the degree of selection on observed and unobserved variables is the same, that is $\widetilde{\delta} = 1$, and b) the R-squared from the hypothetical regression equals $R^2_{max} = 1.3 \times R^2$, where R^2 is the R-squared estimated with the observed controls.[25] If the unobservables move the coefficient toward zero, the estimated α_1 is considered robust when the identified set does not include zero. If the unobservables move the coefficient away from zero, the identified set should be within the 99.5% confidence interval (±2.8 standard errors) estimated for α_1. In addition, this approach allows computing the degree of selection on observables and unobservables ($\widetilde{\delta}$) such that $\alpha_1 = 0$ for the assumed R^2_{max}, that is, such that the census-shock effect is eliminated.

Appendix Table A.9 reports the benchmark results for the changes in transfers (column 1), the probability of having debt (columns 2 and 3), and debt volumes (columns 4 and 5). In all specifications, the bounding set shows that the inclusion of unobserved controls cause α_1 to move away from zero. If both observable and unobservable controls were considered, a one-standard-deviation increase in population change would lead to a 2.1% increase in federal transfers and a 0.2 p.p. decrease in the probability of being indebted. Since the bounds of the sets are inside of the 99.5% confidence intervals, the benchmark estimates (2.1% and 0.1 p.p, respectively) can be considered robust. In column 1, the finding that $\widetilde{\delta} = 17.1$ implies that the unobservables would need to be 17 times as important as the observables to produce an income shock effect of zero. In column 2, the value of $\widetilde{\delta} = -4.2$ implies that the correlation of the census shock with the unobservables should be of opposite sign as that with the observables in order to render a null coefficient. In column 4, the bounding sets are within their respective confidence intervals as well. Thus, the average treatment effects for the three outcomes can be considered robust to the presence of omitted variables.

The heterogeneous effects on debt for less transfer dependent municipalities are reported in columns 3 and 5. The identified sets for the coefficients on the interaction term are partly outside of the 99.5% confidence interval—in particular, their lower bounds fall below those from the confidence interval. From column 3, the estimate of the differential between less and more transfer-dependent municipalities declines by up to 14.4 p.p. ($-18.54+4.42 = -14.42$) when unobservables are also included. This suggests that the benchmark estimates of the heterogeneous effect are less robust and potentially underestimate its size.

[25] The assumption of $R^2_{max} < 1$ relies on the observation that outcomes cannot be fully explained, even if the full set of controls were included, because of measurement error or expected idiosyncratic variation.

7 Effects of the income shock on municipal expenditures

In order to get a broader overview of the adjustment in municipal finances, I also examine the impact of the income shock on primary expenditures, that is, current and capital expenditures (excluding debt service). Table 9 shows the estimates of equation (2) using municipality–year data and the same specifications as in columns 2 and 3 of Table 4. The first three columns report the results for the change in primary expenditures between year t (i.e., 2011 and 2012) and 2010. Across specifications, the coefficient on the census shock is positive and significant at the 1% level. The benchmark model indicates that a one-standard-deviation increase in population change leads to an increase in expenditures of 1%. Municipalities with different degrees of transfer dependence may have different propensities to consume, which could explain the differential response in terms of debt management. I examine this possibility in column 3, which shows that the less transfer-dependent governments actually increase total expenditures more than the other group, but the difference is insignificant. Thus, no differential in total spending is apparent across groups.

The income shock resulting from the change in official population estimates can be taken as permanent. Even if the population is revised again after the next census or count, the new estimates start from a different level (Ivanov & Zimmermann 2019). In response to a permanent income shock, forward-looking governments will increase expenditures on lumpy public goods that require larger disbursements (Cassidy 2020). Thus, I also estimate equation (2) for current and capital expenditures separately. Columns 4 and 5 show that the effect on current expenditures is positive and significant. In turn, columns 7 and 8 show that the effect on capital expenditures is also positive but small and insignificant. These findings suggest that either governments' response to the shock is myopic or, given the historical volatility of transfers to municipalities, the shock is not perceived as permanent. Further, I consider whether transfer dependence is associated to a less forward-looking behavior. For both current and capital expenditures, no significant differences are found between groups (columns 6 and 9). Thus, there is no evidence suggesting significantly less myopic spending decisions from the less transfer-dependent municipalities.

To assess whether there are pre-existing trends in municipal expenditures, Appendix Figure A.4 plots the dynamic effects estimated using the same specification as in Figure 4. All panels rule out the presence of pre-trends—no significant effects are estimated before 2010 generally.

Following the release of the census, panels (a) and (b) show a significant and somewhat persistent increase in total and current expenditures. They adjust slowly in response to the shock, which is consistent with the short-term decline in the probability of being indebted (debt may not decline, even in the short-term, if spending increases at once in response to a positive shock). In contrast, the estimates for capital expenditures show no significant effect after 2010.

Finally, in Table 10, I examine the effect on the main components of current and capital expenditures. For each spending category, the dependent variables are computed as the changes in its amount (in logarithm) and share in total primary expenditures. The category that increases more significantly is materials, inputs, and supplies required for administrative activities and for providing goods and services. The shock also has a marginally significant effect on the changes in levels, but not in shares, of general services (leasing, financial and repair services, official services such as ceremonial expenses, payroll and other taxes). The effect on transfers and subsidies for public and private entities, such as government-owned enterprises, are positive but statistically insignificant. Also insignificant, but negative, are the effects on wages and other remunerations of public sector employees (personal services). From capital expenditures, the share of public investment declines whereas that of movable, immovable, and intangible assets increases, but both are insignificant. These results reveal little potential of a positive income shock to improve long-term growth and welfare in the local area.

8 Conclusions

Local governments from federal countries are largely reliant on transfers of resources from the central government, usually outside their control. This study examines how a census shock that changes the distribution of these transfers affects their debt status and, hence, their ability to smooth income intertemporally. This is particularly relevant for developing countries, where local governments typically have limited access to credit and capital markets.

First, I confirm that the census shock has a positive and persistent impact on federal transfers but not on other sources of municipal revenue. In addition, such a shock reduces moderately the probability of having debt and does not affect debt volumes at the intensive margin. This reveals that local governments, on average, make a limited use of debt for intertemporal income smoothing. I also find that at both margins debt declines significantly more in response to the shock when municipalities have higher tax collection capacity and, hence, are less dependent on transfers. Since they are deemed more creditworthy, they can access credit markets when grants are low and, therefore, are able to reduce debt during good times. This result, however, should be taken with caution given that it is less robust to unobservables according to Oster's (2019) test. Finally, even though the shock should lead to a permanent increase in grants, I find that most of the additional resources are devoted to short-term, current spending that does not require lumpy investments. This reveals that an income shock has limited potential to alter the path of local economic development.

One implication for decentralization policy is the importance of diversifying the revenue base of local governments in order to enhance their use of credit markets. For the more transfer-dependent governments, perceived as less creditworthy, the inability to get indebted reinforces such dependency and reduces their financial autonomy even further. This can strengthen rent-seeking incentives: To cover their financial needs outside the financial system, local governments may demand extraordinary and discretionary transfers of resources from higher levels of government. On the other hand, the findings suggest that a market-based borrowing framework has the potential to ensure financial discipline. There is no evidence that higher grants lead to higher debt, not even when the lender is the development bank, which could raise concerns of overborrowing. This is documented when financial sector regulations for subnational lending were operating under a no-bailout commitment of the central government, well before the strengthening of the prudential rules for subnational financing in 2016.

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Table 1: Municipal characteristics by credit market participation and degree of transfer dependence

	Has debt with financial institutions						Degree of transfer dependence					
	Not indebted			Indebted			High			Low		
	Mean	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**
Total population	20,621	46,786	8,728	89,368	195,583	6,588	22,501	39,432	12,123	155,329	265,719	3,193
Economically active population in 2010 (% pop.)	33.32	6.57	8,728	36.02	5.27	6,588	33.22	6.02	12,123	39.27	4.17	3,193
Formal sector employment (% pop.)	2.83	10.44	8,728	6.41	9.14	6,588	2.47	8.88	12,123	11.59	10.95	3,193
Formal sector wages (per worker)	150.21	78.89	6,990	168.41	77.98	6,344	147.99	78.70	10,178	193.95	69.05	3,156
Per capita monthly income in 2010 (MX$)	1,460	688	8,728	1,936	933	6,588	1,418	604	12,123	2,602	927	3,193
Social deprivation in 2010 (%)	28.21	45.00	8,728	12.10	32.61	6,588	26.56	44.17	12,123	1.22	10.99	3,193
Per capita federal transfers (MX$)	3,231	1,859	8,728	2,442	1,227	6,588	3,110	1,717	12,123	2,064	1,102	3,193
Per capita own revenue (MX$)	262	475	8,728	455	603	6,588	204	307	12,123	879	832	3,193
Per capita primary expenditures (MX$)	4,171	2,941	8,728	3,366	1,818	6,588	3,940	2,673	12,123	3,388	1,961	3,193
Any loan (%)	0.00	0.00	8,728	100.00	100.00	6,588	35.82	47.95	12,123	70.31	45.70	3,193

Notes. This table presents summary statistics (mean, standard deviation, and number of observations) of municipality characteristics for the period between 2009 and 2016. Observations are at the municipality–year level and the sample is split between: a) municipalities without outstanding bank debt in a given year and with debt in one month at least (debt data cover from August 2009 to December 2016) and b) municipalities with high and low dependence on federal transfers, defined as those with a transfer-to-own revenue ratio above and below the twentieth percentile as of 2010. Data on formal sector wages (per formal worker) are extracted from the monthly administrative records of the IMSS. The indicator for very high or high social deprivation comes from CONEVAL. More details on these and the other data sources are provided in Appendix Table A.2.

Table 2: Indebted municipalities by degree of transfer dependence

	All indebted municipalities			Degree of transfer dependence					
				High			Low		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Number of lenders per municipality	1.24	0.67	60,665	1.08	0.31	38,220	1.52	0.97	22,445
Has loans with development bank (%)	79.30	40.52	60,665	85.82	34.89	38,220	68.20	46.57	22,445
Has two or more credit ratings (%)	10.83	31.08	60,665	1.57	12.44	38,220	26.59	44.18	22,445
Has short-term loans (%)	20.13	40.10	60,665	16.43	37.05	38,220	26.42	44.09	22,445
Has long-term loans (%)	90.30	29.59	60,665	89.42	30.76	38,220	91.81	27.42	22,445
Loan volume (MX$)	53.71	190.01	60,665	12.78	64.02	38,220	123.40	287.92	22,445
Interest rate (%)	7.24	1.66	60,665	7.33	1.68	38,220	7.08	1.60	22,445
Fixed rate (%)	31.07	42.77	60,665	42.09	45.80	38,220	12.32	28.52	22,445
Loan maturity at origination (years)	7.08	5.78	60,665	5.57	4.93	38,220	9.63	6.22	22,445
Non-performing loans (%)	0.60	7.25	60,665	0.32	5.56	38,220	1.06	9.44	22,445
Loan volume (% of transfers + own revenue)	16.25	64.73	60,665	15.51	80.40	38,220	17.51	17.75	22,445
Required payment (% of transfers + own revenue)	8.14	41.26	60,665	8.41	48.57	38,220	7.68	24.18	22,445

Notes. This table presents summary statistics (mean, standard deviation, and number of observations) describing the municipal debt profile for the period between August 2009 and December 2016. Observations are at the municipality–month level and the sample includes all municipality–month pairs with outstanding debt and their breakdown between municipalities with high and low dependence on federal transfers, defined as those with a transfer-to-own revenue ratio above and below the twentieth percentile as of 2010. To aggregate the data at the municipality level, the interest rate and maturity and the percentage of fixed rate and non-performing loans are volume-weighted. Debt data are extracted from the report R04 C Commercial Credit (CNBV), credit ratings from Nuñez Barba (2010), and municipal revenue from the INEGI.

Table 3: Descriptive statistics

	All municipalities			Degree of transfer dependence					
				High			Low		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Panel (a): Dependent variables									
ΔHas debt (%)	-0.014	11.765	894,918	-0.159	10.408	696,233	0.495	15.605	198,685
Δlog(Volume) (%)	6.929	114.543	14,643	10.839	124.561	8,071	2.127	100.690	6,572
Δlog(Federal transfers) (%)	7.600	13.729	2,975	7.711	13.721	2,374	7.161	13.764	601
Δlog(Other transfers) (%)	44.987	173.966	2,064	50.211	183.957	1,617	26.091	130.069	447
Δlog(Own revenue) (%)	9.652	54.232	2,064	13.549	57.144	1,617	-4.444	38.964	447
Δlog(Primary expenditures) (%)	5.419	24.141	2,975	5.367	24.867	2,374	5.623	21.049	601
Δlog(Current expenditures) (%)	5.267	24.325	2,975	4.901	25.162	2,374	6.712	20.647	601
Δlog(Capital expenditures) (%)	-6.188	93.326	2,975	-5.281	91.885	2,374	-9.770	98.811	601
Panel (b): Independent variables									
Δlog(Population)$_{10:05}$	0.082	0.072	894,918	0.074	0.065	696,233	0.107	0.087	198,685
Municipality's electoral year	0.387	0.487	894,918	0.376	0.484	696,233	0.425	0.494	198,685
Economically active population / population in 2010	0.355	0.052	894,918	0.343	0.049	696,233	0.395	0.038	198,685
IHS(Per capita formal sector employment in 2010)	0.042	0.072	894,918	0.023	0.051	696,233	0.107	0.094	198,685
log(Per capita household income in 2010) (MX$)	7.335	0.458	894,918	7.200	0.394	696,233	7.806	0.341	198,685
ΔIHS(Unemployment rate)	-0.050	0.195	894,918	-0.041	0.200	696,233	-0.083	0.171	198,685
ΔIHS(Economic activity)	0.034	0.033	894,918	0.033	0.033	696,233	0.039	0.033	198,685
ΔIHS(Per capita formal sector employment)	0.002	0.018	894,918	0.001	0.019	696,233	0.006	0.016	198,685
ΔIHS(Federal transfers)$_{10:08}$	-0.044	0.106	894,918	-0.040	0.109	696,233	-0.057	0.093	198,685
ΔIHS(Other revenue)$_{10:08}$	0.172	1.048	894,918	0.183	1.153	696,233	0.136	0.530	198,685
ΔIHS(Current expenditures)$_{10:08}$	0.039	0.253	894,918	0.039	0.266	696,233	0.036	0.203	198,685
ΔIHS(Capital expenditures)$_{10:08}$	-0.013	0.512	894,918	-0.001	0.489	696,233	-0.055	0.584	198,685

Table 3: Descriptive statistics (continued)

	All municipalities			Degree of transfer dependence					
				High			Low		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Panel (b): Independent variables (cont.)									
ΔIHS(Deficit)$_{10:08}$	6.913	20.403	894,918	7.587	20.169	696,233	4.548	21.032	198,685
ΔIHS(Federal transfers)$_{08:05}$	0.291	0.188	894,918	0.289	0.201	696,233	0.295	0.133	198,685
ΔIHS(Other revenue)$_{08:05}$	0.557	0.889	894,918	0.587	0.973	696,233	0.451	0.479	198,685
ΔIHS(Current expenditures)$_{08:05}$	0.248	0.222	894,918	0.234	0.225	696,233	0.296	0.205	198,685
ΔIHS(Capital expenditures)$_{08:05}$	0.616	0.984	894,918	0.666	1.058	696,233	0.439	0.633	198,685
ΔIHS(Deficit)$_{08:05}$	-2.662	18.621	894,918	-2.613	18.037	696,233	-2.832	20.535	198,685
Δlog(Population)$_{05:00}$	0.001	0.105	894,918	-0.010	0.103	696,233	0.040	0.103	198,685
Δlog(Assets)	0.187	0.365	894,918	0.187	0.365	696,233	0.187	0.365	198,685
ΔCapital ratio	-0.009	0.057	894,918	-0.009	0.057	696,233	-0.009	0.057	198,685
ΔLiquidity ratio	0.000	0.072	894,918	0.000	0.072	696,233	0.000	0.072	198,685
Loan interest rate in 2010 (%)	7.741	1.648	14,643	7.838	1.568	8,071	7.622	1.734	6,572
Loan residual maturity in 2010 (years)	5.177	4.898	14,643	4.130	3.845	8,071	6.462	5.683	6,572
Has two or more credit ratings in 2010	0.203	0.402	14,643	0.028	0.166	8,071	0.418	0.493	6,572
Loan volume / (transfers + own revenue) in 2010	0.156	0.165	14,643	0.110	0.101	8,071	0.212	0.206	6,572
Required payment / (transfers + own revenue) in 2010	0.109	0.481	14,643	0.018	0.072	8,071	0.221	0.697	6,572

Notes. This table presents summary statistics (mean, standard deviation, and number of observations) for all the main dependent and independent variables used in the regression analysis for the period between January 2011 and December 2012. Observations are at the municipality–bank–month level, except for revenues and expenditures in Panel (a) that are at the municipality–year level. The sample for loan volume (Panel [a]) and for other debt-related characteristics (Panel [b]) is restricted to municipality-bank pairs that are indebted in period t and in October 2010. Variables in first differences are computed between period (or year) t relative to October 2010 (or year 2010), unless a subscript indicates otherwise. Statistics are reported for all municipalities in the sample and for those with high and low dependence on federal transfers, defined as municipalities with a transfer-to-own revenue ratio above and below the twentieth percentile as of 2010. All values are expressed in December 2010 Mexican pesos. Section 4 describes the sample selection and Appendix Table A.2 describes variables and data sources.

Table 4: Estimates of the effect of the census shock on municipal revenue

Dependent variable:	Δlog(Federal transfers)				Δlog(Other transfers)	Δlog(Own revenue)
	(1)	(2)	(3)	(4)	(5)	(6)
Δlog(Population)	31.66***	28.69***	28.82***	32.60***	-25.94	8.16
	(7.46)	(6.77)	(6.99)	(6.52)	(-.47)	(.38)
Mean dep. var.	7.60	7.64	7.64	6.25	44.64	9.56
Year, state FE	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Lagged outcomes	No	No	Yes	Yes	Yes	Yes
IPW	No	Yes	Yes	Yes	Yes	Yes
Observations	2,975	2,975	2,975	2,063	2,063	2,063

Notes. This table reports the results of estimating the effect of the census shock on the change between year t (2011 and 2012) and 2010 in the logarithm of federal transfers (columns 1 to 4), revenue-sharing state transfers and reassigned resources (column 5), and own-source revenue (column 6) received by municipality m. All dependent variables are multiplied by 100. "Δlog(Population)" is the population change of municipality m between 2010 and 2005. All specifications control for year and state fixed effects and for "other controls", which include a dummy for municipality's electoral year, the economically active population (% population), the IHS of per capita formal sector employment, the logarithm of per capita household income, the changes between year t and 2010 in the IHS of the state unemployment rate and economic activity and per capita formal sector employment, and the 2000–2005 population change. "Lagged outcomes" comprise the 2005–2008 and 2008–2010 changes in federal transfers, other revenues, current and capital expenditures and deficit. Columns 2 to 6 weight the observations using the IPW described in section 5.2. Columns 4 to 6 drop observations with missing data in other transfers or own-source revenue. Section 4 describes the sample selection and Appendix Table A.2 describes variables and data sources. Cluster-robust t-statistics at the municipality level are reported in parentheses (wild bootstrap with 999 replications). *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

Table 5: Estimates of the effect of the census shock on municipal debt

Dependent variable:	ΔHas debt			Δlog(Volume)		
	(1)	(2)	(3)	(4)	(5)	(6)
Δlog(Population)	-1.79**	-1.69**	-1.66**	26.19	28.13	42.07
	(.74)	(.71)	(.70)	(51.75)	(52.13)	(53.10)
Mean dep. var.	-.01	-.01	-.01	6.93	7.19	7.19
Period, state, bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Lagged outcomes	No	No	Yes	No	No	Yes
IPW	No	Yes	Yes	No	Yes	Yes
Observations	894,918	894,918	894,918	14,643	14,643	14,643

Notes. This table reports the results of estimating equation (2) for the effect of the census shock on the change between period t (January 2011 to December 2012) and October 2010 in an indicator for being indebted (columns 1 to 3) and in the logarithm of total loan volume, conditional on being indebted in both periods (columns 4 to 6). All dependent variables are computed for municipality m, borrowing from bank b, and are multiplied by 100. "Δlog(Population)" is the population change of municipality m between 2010 and 2005. All specifications control for period, state, and bank fixed effects and for "other controls" that, in addition to those described in Table 4, include the changes in banks' characteristics (total assets and the liquidity and capital ratios). "Lagged outcomes" comprise the 2005–2008 and 2008–2010 changes in federal transfers, other revenues, current and capital expenditures, and deficit. Columns 2, 3, 5, and 6 weight the observations using the IPW described in section 5.2. Section 4 describes the sample selection and Appendix Table A.2 describes variables and data sources. Standard errors clustered at the municipality level are reported in parentheses. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

Table 6: Census-shock effects on transfers and debt by degree of transfer dependence

Dependent variable:	Δlog(Fed. transfers)		ΔHas debt		Δlog(Volume)	
	(1)	(2)	(3)	(4)	(5)	(6)
Δlog(Population) ×	-5.65	-9.35	-4.49**	-4.42**	-129.11	-177.75*
Low dependence	(-.62)	(-1.05)	(1.81)	(1.78)	(99.58)	(99.64)
Δlog(Population)	29.98***	31.41***	-.42	-.40	99.17	135.39
	(6.13)	(6.72)	(.69)	(.67)	(84.25)	(83.35)
Low dependence	1.40	1.27	.70***	.64**	13.11	22.38*
	(1.13)	(1.06)	(.26)	(.26)	(12.98)	(12.71)
Mean dep. var.	7.64	7.64	-.01	-.01	7.19	7.19
Period, state, bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Lagged outcomes	No	Yes	No	Yes	No	Yes
IPW	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,975	2,975	894,918	894,918	14,643	14,643

Notes. This table reports heterogeneous effects by degree of transfer dependence of the models estimated for federal transfers and debt outcomes in Tables 4 and 5. All columns estimate the corresponding benchmark specifications interacting "Δlog(Population)" with "Low dependence", which is a dummy that equals 1 if a municipality has a ratio of federal transfers to own-source revenues below the twentieth percentile in 2010 and 0 otherwise. Cluster-robust t-statistics at the municipality level (wild bootstrap with 999 replications) (columns 1 and 2) and standard errors clustered at the municipality level (columns 3 to 6) are reported in parentheses. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

Table 7: Census-shock effects on debt volume by borrowing conditions

Dependent variable:	Δlog(Volume)				
	(1)	(2)	(3)	(4)	(5)
Δlog(Population) × Interest rate	24.46				
	(36.74)				
Δlog(Population) × Residual maturity		-7.59			
		(9.75)			
Δlog(Population) × Credit ratings			-84.53		
			(111.64)		
Δlog(Population) × Volume/Revenue				-45.26	
				(303.04)	
Δlog(Population) × Payments/Revenue					-259.49***
					(73.16)
Δlog(Population)	-167.25	62.52	66.78	19.59	61.10
	(286.71)	(92.15)	(58.87)	(74.06)	(53.37)
Mean dep. var.	7.19	7.19	7.19	7.19	7.19
Period, state, bank FE	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes
Lagged outcomes	Yes	Yes	Yes	Yes	Yes
IPW	Yes	Yes	Yes	Yes	Yes
Observations	14,643	14,643	14,643	14,643	14,643

Notes. This table reports heterogeneous effects by pre-shock borrowing conditions of the model estimated for loan volume in column 6 of Table 5. In that model, "Δlog(Population)" is interacted with the average interest rate and residual maturity in October 2010, a dummy indicating if the municipality has at least two credit ratings in 2010, and the ratios of total debt volume and of required payments to federal transfers plus own revenue in the same year. All specifications also include the standalone terms of the borrowing conditions that are not reported. Standard errors clustered at the municipality level are reported in parentheses. $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Table 8: Census-shock effects on short- and long-term debt

Dependent variable:	ΔHas debt		Δlog(Volume)	
	short term	long term	short term	long term
	(1)	(2)	(3)	(4)
Δlog(Population)	-.87*	-.72	-97.31	39.03
	(.46)	(.59)	(159.68)	(48.54)
Mean dep. var.	.06	-.10	30.23	-2.10
Period, state, bank FE	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes
Lagged outcomes	Yes	Yes	Yes	Yes
IPW	Yes	Yes	Yes	Yes
Observations	894,918	894,918	1,607	12,696

Notes. This table reports the results of estimating equation (2) for the effect of the census shock on short- and long-term debt, that is, with a maturity at origination below and above one year. The dependent variables are the change between period t (January 2011 to December 2012) and October 2010 in an indicator for having short- and long-term debt (columns 1 and 2) and in the logarithm of short- and long-term loan volume, conditional on having each type of debt in both periods (columns 3 and 4). All dependent variables are computed for municipality m, borrowing from bank b, and are multiplied by 100. The specifications are the same as in columns 3 and 6 of Table 5. Standard errors clustered at the municipality level are reported in parentheses. $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Table 9: Estimates of the effect of the census shock on municipal expenditures

Dependent variable:	Δlog(Current+capital exp.)			Δlog(Current expenditures)			Δlog(Capital expenditures)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δlog(Population)	19.35**	18.45***	14.96*	28.24***	24.51***	22.45***	7.97	9.53	-1.94
	(2.41)	(2.77)	(1.84)	(3.46)	(3.91)	(3.13)	(.37)	(.49)	(-.09)
Δlog(Population) ×			9.83			4.00			45.52
Low dependence			(.73)			(.31)			(.99)
Low dependence			.20			1.39			-8.55
			(.10)			(.78)			(-1.17)
Mean dep. var.	5.27	5.27	5.27	5.02	5.02	5.02	-6.46	-6.46	-6.46
Year, state FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged outcomes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
IPW	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,975	2,975	2,975	2,975	2,975	2,975	2,975	2,975	2,975

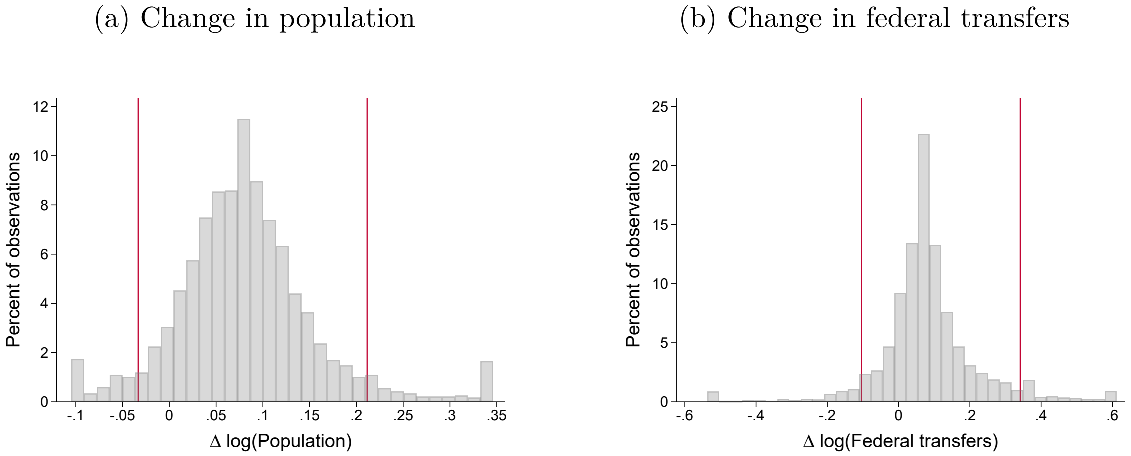
Notes. This table reports the results of estimating the effect of the census shock on municipal expenditures and its heterogeneous effects by degree of transfer dependence. The dependent variables are the change between year t (2011 and 2012) and 2010 in the logarithm of total primary expenditures (columns 1 to 3), current expenditures (columns 4 to 6), and capital expenditures (columns 7 to 9) of municipality m. All dependent variables are multiplied by 100. In columns 3, 6, and 9, "Δlog(Population)" is interacted with "Low dependence", which is a dummy that equals 1 if a municipality has a ratio of federal transfers to own-source revenues below the twentieth percentile in 2010 and 0 otherwise. The specifications are the same as in columns 2 and 3 of Table 4 and in column 2 of Table 6. Cluster-robust t-statistics at the municipality level are reported in parentheses (wild bootstrap with 999 replications). *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

Table 10: Census-shock effects on current and capital spending categories

Dependent variable:	Current expenditures								Capital expenditures			
	ΔWages		ΔSupplies		ΔServices		ΔSubsidies		ΔAssets		ΔInvestment	
	log	share	log	share	log	share	log	share	log	share	log	share
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Δlog(Population)	-.85	-3.33	32.49**	2.40**	20.77*	2.37	49.36	3.63	28.08	.05	6.98	-5.12
	(-.09)	(-1.27)	(2.32)	(2.20)	(1.78)	(1.18)	(1.32)	(1.41)	(.47)	(.04)	(.39)	(-1.40)
Mean dep. var.	8.09	.48	8.24	.25	7.01	.38	-11.37	-.89	12.07	.16	1.50	-.37
Year, state FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged outcomes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IPW	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,928	2,975	2,928	2,975	2,928	2,975	2,928	2,975	2,389	2,975	2,389	2,975

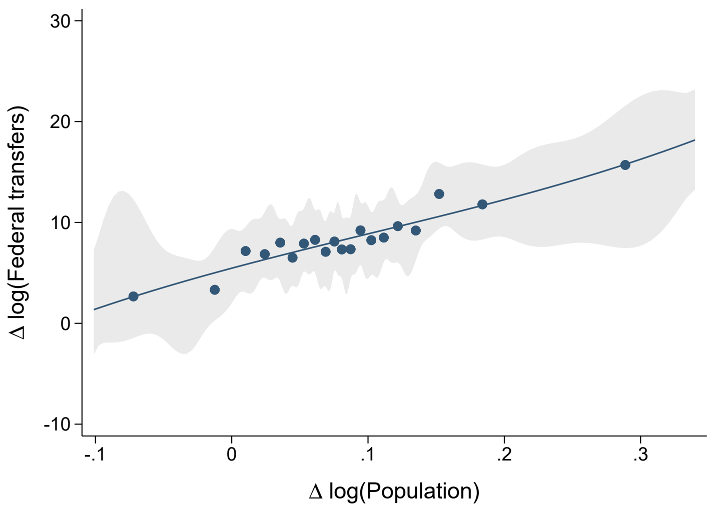
Notes. This table reports the results of estimating the effect of the census shock on the main components of current and capital expenditures. The dependent variables are the change between year t (2011 and 2012) and 2010 in the logarithm and in the share in total primary expenditures of personal services (columns 1 and 2), materials and supplies (columns 3 and 4), general services (columns 5 and 6), transfers and subsidies (columns 7 and 8), movable, immovable, and intangible assets (columns 9 and 10), and public investment (column 11 and 12) of municipality m. All dependent variables are multiplied by 100. The specifications are the same as in column 3 of Table 4. The models in the odd columns drop observations with zeros in some components of current (columns 1 to 8) or capital (columns 9 to 12) expenditures. Cluster-robust t-statistics at the municipality level are reported in parentheses (wild bootstrap with 999 replications). $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Figure 2: Histograms of the changes in population and in federal transfers



Notes. In panel (a), this figure shows a histogram of the municipal population changes between 2005 and 2010, defined as: $\Delta Pop_m = \ln Pop_{m,2010} - \ln Pop_{m,2005}$, where $\ln Pop$ is the logarithm of the population from INEGI. In Panel (b), it shows a histogram for the change in federal transfers between year t (2011 and 2012) relative to 2010, defined as: $\Delta FT_m = \ln FT_{m,t} - \ln FT_{m,2010}$, where $\ln FT$ is the logarithm of the federal transfers. The red vertical lines correspond to the 5^{th} and 95^{th} percentiles of ΔPop_m and ΔFT_m, which are winsorized at the top and bottom 1.5% of the distributions.

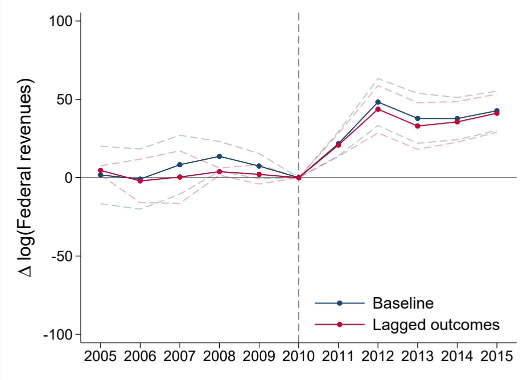
Figure 3: Changes in federal transfers and in population estimates



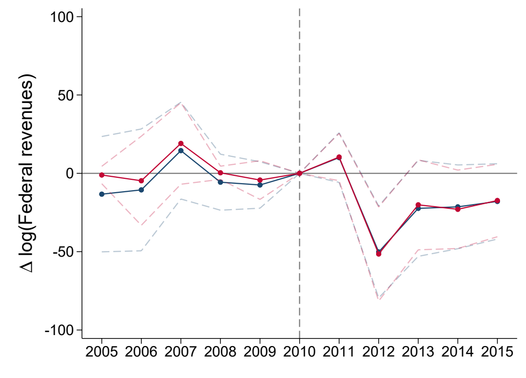
Notes. This figure presents a binned scatter plot containing the fitted values of a nonparametric regression of the change in the logarithm of federal transfers to municipalities (between 2011 and 2012 relative to 2010) on the 2005–2010 population change based on Cattaneo et al. (2019). The scatter plot is aggregated into 20 bins. A fourth order global polynomial fit and a confidence band based on a cubic B-spline estimate of the regression function are included.

Figure 4: Dynamic effects on federal transfers

(a) Average treatment effects



(b) Effects on low vs. high transfer-dependent municipalities

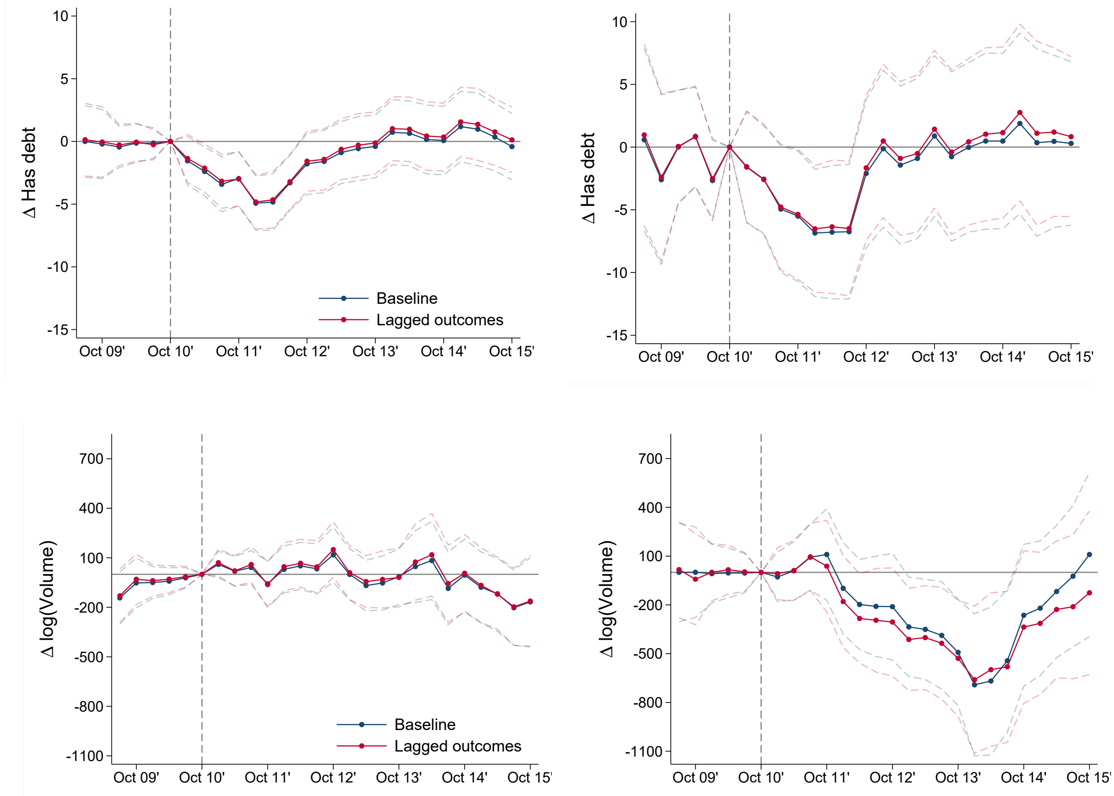


Note. In panel (a), this figure plots estimates of equation (2), modified as follows: $\Delta y_{m,t} = \alpha_0 + \alpha_{1,t} \sum t \cdot \Delta \log Pop_m + \alpha_{2,t} \sum t \cdot X_{m,t-1} + \alpha_{3,t} \sum t \cdot \Delta X_{m,t-1} + \alpha_s + \alpha_t + \epsilon_{m,t}$, where $\Delta y_{m,t}$ is the change in the logarithm of federal transfers to municipality m between year t (2005 to 2015) and 2010, t are year dummies, $\Delta \log Pop_m$ is the 2005–2010 population change, $X_{m,t-1}$ and $\Delta X_{m,t-1}$ denote the economically active population (% population), the IHS of per capita formal sector employment, the logarithm of per capita household income, the changes between year t and 2010 in the IHS of the state unemployment rate and economic activity and per capita formal sector employment, and the 2000–2005 population change, and α_s and α_t denote fixed effects for state and year. The specification that includes lagged outcomes also controls for the 2005–2008 and 2008–2010 changes in federal transfers, other revenues, current and capital expenditures and deficit, all interacted with the year dummies. Observations are weighted using the IPW described in section 5.2. Each dot corresponds to the coefficients $\widehat{\alpha}_{1,t}$ and the dashed blue lines to their 95% confidence intervals. For the same specifications, panel (b) plots the interaction coefficients of the population change with the low transfer dependence dummy (indicating a ratio of federal transfers to own-source revenue below the twentieth percentile in 2010). In both panels, the coefficient for 2010 is normalized to zero, so that estimates can be interpreted as the change in transfers relative to the year when preliminary census numbers were released (indicated with a vertical line). Only municipalities with data for the entire sample period are included. Section 4 describes the sample selection and Appendix Table A.2 describes variables and data sources. The 95% confidence intervals are computed using standard errors clustered at the municipality level.

Figure 5: Dynamic effects on the probability of having debt and debt volume

(a) Average treatment effects

(b) Effects on low vs. high transfer-dependent municipalities



Note. In panel (a), this figure plots estimates of equation (2) modified as follows: $\Delta y_{m,b,t} = \alpha_0 + \alpha_{1,t} \sum t \cdot \Delta \log Pop_m + \alpha_{2,t} \sum t \cdot X_{m,t-1} + \alpha_{3,t} \sum t \cdot \Delta X_{m,t-1} + \alpha_{4,t} \sum t \cdot \Delta X_{b,t-1} + \ldots + \epsilon_{m,b,t}$, where $\Delta y_{m,b,t}$ is the change between period t (July 2009 to October 2015) and October 2010 in an indicator for being indebted (top panels), and in the logarithm of total loan volume, conditional on being indebted in both periods (bottom panels), t are month×year dummies, and $\Delta \log Pop_m$ is the 2005–2010 population change. Fixed effects at the period, state, and bank level and "other controls", as defined in Table 5, are included. The specifications that include lagged outcomes also control for the 2005–2008 and 2008–2010 changes in federal transfers, other revenues, current and capital expenditures and deficit, all interacted with the month×year dummies. Observations are weighted using the IPW described in section 5.2. Each dot corresponds to the coefficients $\widehat{\alpha}_{1,t}$ and the dashed blue lines to their 95% confidence intervals. For the same specifications, panel (b) plots the interaction coefficients of the population change with the low transfer dependence dummy (indicating a ratio of federal transfers to own-source revenue below the twentieth percentile in 2010). The coefficient for October 2010 is normalized to zero, so that estimates can be interpreted as the change in debt relative to the period prior to the release of preliminary census numbers (indicated with a vertical line). In all panels, only municipality–bank pairs with data for the entire sample period and observations for the first month of each quarter are included in the estimates. Section 4 describes the sample selection and Appendix Table A.2 describes variables and data sources. The 95% confidence intervals are computed using standard errors clustered at the municipality level.

Effect of an income shock on subnational debt: Micro evidence from Mexico

Appendix

Mariela Dal Borgo

Table A.1: Non-earmarked and earmarked federal transfers to municipal governments

Fund's name	Funding source	% of state revenue shared	Distribution to municipalities
Non-earmarked transfers (*participaciones*, budget branch 28)			
FGP	20% of RFP	20% or more	Determined by state legislation
FFM	1% of RFP	100%	Determined by state legislation
FOFIE	1.25% of RFP	20% or more	Determined by state legislation
FOCO	18% of local gasoline tax collection	20% or more (10 states with lowest GDP per capita)	Determined by state legislation
FEXHI	0.6% of main oil royalty	20% or more (5 states that extract oil and gas)	Determined by state legislation
IEPS (gasoline & diesel)	82% of local gasoline tax collection	20% or more	Determined by state legislation (70% or more population-based)
IEPS (tobacco & beverages)	8% of tobacco; 20% of beer and alcohol sales	20% or more	Determined by state legislation
Tenencia[26], ISAN	100% of state collection after 2010	20% or more	Determined by state legislation
MFL	0.136% of RFP	Directly transferred to municipalities with foreign trade	Municipal water and property tax
DAEP	3.17% of a special oil royalty	Directly transferred to municipalities that export oil products	Municipal water and property tax
Earmarked transfers (*aportaciones*, budget branch 33)			
FISM	2.197% of RFP	100%	Poverty index
FORTAMUN-DF	2.35% of RFP	100%	Local population (% of state population)

Notes. FGP = General Fund for Shared Revenues (*Fondo General de Participaciones)*, FFM = Fund for Municipal Aid (*Fondo de Fomento Municipal*), FOFIE = Tax Enforcement Fund (*Fondo de Fiscalización*), FOCO = Compensation Fund (*Fondo de Compensación*), FEXHI = Fund for Oil Extraction (*Fondo de Extracción de Hidrocarburos*), IEPS = Special Tax on Production and Services (*Impuesto Especial sobre Producción y Servicios*), Tenencia = Tax on Possession or Use of Vehicles (*Impuesto sobre Tenencia o Uso de Vehículos*), ISAN = Tax on New Cars (*Impuesto sobre Automóviles Nuevos*), MFL = Shared Revenues to Border or Coastal Municipalities (*Participaciones para Municipios Colindantes con la Frontera o Litorales*), DAEP = Additional Revenue on Oil Extraction (*Derecho Adicional sobre Extracción de Petróleo*), FISM = Fund for Municipal Social Infrastructure (*Fondo de Infraestructura Social Municipal*), FORTAMUN-DF = Fund for Municipal Strengthening (*Fondo para el Fortalecimiento Municipal y de las Demarcaciones Territoriales del D.F.*). The table reports the funds' denominations and shares as of 2010.

[26]The federal tax on possession of vehicles was removed in 2012 and many states replaced it by a state tax.

Table A.2: Definitions of Variables

Variable	Description
Panel A: Dependent variables	
ΔHas debt	Change between period t and October 2010 in a dummy that equals 1 if municipality m has debt with bank b in period t and 0 otherwise.
Δlog(Volume)	Change between period t and October 2010 in the logarithm of total loan volume that municipality m borrows from bank b, given that it has outstanding debt both in period t and in October 2010.
Δlog(Federal transfers)	Change in the logarithm of federal transfers (revenue-sharing transfers and contributions) received by municipality m between year t and 2010.
Δlog(Other transfers)	Change in the logarithm of state transfers plus federal and state reassigned resources received by municipality m between year t and 2010.
Δlog(Own revenue)	Change in the logarithm of own-source revenues (taxes, social security contributions, user fees charged for public services, income from government assets, and other income from public services or assets) of municipality m between year t and 2010.
Δlog(Primary expenditures)	Change in the logarithm of current plus capital expenditures of municipality m between year t and 2010.
Δlog(Current expenditures)	Change in the logarithm of current expenditures (personal services, materials and supplies, general services, and subsidies and other transfers) of municipality m between year t and 2010.
Δlog(Capital expenditures)	Change in the logarithm of capital expenditures (movable, immovable, and intangible property and public investment) of municipality m between year t and 2010.
Panel B: Independent variables	
$\Delta\log(\text{Population})_{t:t-\tau}$	Change in the logarithm of the municipal population over 2010–2005 or 2005–2000, as indicated.
Municipality's electoral year	Equals 1 if there is a mayoral election in a municipality within the next 12 months and 0 otherwise.
Economically active population / population in 2010	Municipal population aged 12 years or older that are either employed or actively seeking employment over total municipal population in 2010.
IHS(Per capita formal sector employment in 2010)	IHS of municipal employment in the formal sector over total municipal population in 2010.

Table A.2: Definitions of Variables (continued)

Variable	Description
log(Per capita household income in 2010) (MX$)	Logarithm of the per capita household income in 2010 (municipality's average in Mexican pesos).
ΔIHS(Unemployment rate)	Change in the IHS of the state unemployment rate between period t-1 and October 2010. The monthly unemployment rate is a three-month moving average.
ΔIHS(Economic activity)	Change in the IHS of the state economic activity between period t-1 and October 2010. The quarterly indicator of economic activity is a seasonally-adjusted volume index with base year 2013=100.
ΔIHS(Per capita formal sector employment)	Change in the IHS of the municipal employment in the formal sector between period t-1 and October 2010.
ΔIHS(Federal transfers)$_{t:t-\tau}$	Change in the IHS of federal transfers received by municipality m over 2010–2008 or 2008–2005, as indicated.
ΔIHS(Other revenue)$_{t:t-\tau}$	Change in the IHS of other transfers and own-source revenue received by municipality m over 2010–2008 or 2008–2005, as indicated.
ΔIHS(Current expenditures)$_{t:t-\tau}$	Change in the IHS of current expenditures of municipality m over 2010–2008 or 2008–2005, as indicated.
ΔIHS(Capital expenditures)$_{t:t-\tau}$	Change in the IHS of capital expenditures of municipality m over 2010–2008 or 2008–2005, as indicated.
ΔIHS(Deficit)$_{t:t-\tau}$	Change in the IHS of the fiscal deficit of municipality m over 2010–2008 or 2008–2005, as indicated.
Δlog(Assets)	Change in the logarithm of banks' total assets between period t-1 and October 2010.
ΔCapital ratio	Change in the banks' capital ratio (total stockholders' equity over total assets) between period t-1 and October 2010.
ΔLiquidity ratio	Change in the banks' liquidity ratio (liquid assets over total assets) between period t-1 and October 2010.
Loan interest rate in 2010	Average interest rate charged to municipality m by bank b in October 2010, conditional on having debt in October 2010 and in period t.
Loan residual maturity in 2010 (years)	Average residual maturity of loans owed by municipality m to bank b in October 2010, conditional on having debt in October 2010 and in period t.
Has two or more credit ratings in 2010	Equals 1 if municipality m has at least two credit ratings in 2010 and 0 otherwise.

Table A.2: Definitions of Variables (continued)

Variable	Description
Loan volume / (transfers + own revenue) in 2010	Ratio of total loan volume of municipality m in October 2010, conditional on having debt in October 2010 and in period t, to federal transfers plus own-source revenue in 2010.
Required payment / (transfers + own revenue) in 2010	Ratio of total required payments of municipality m in October 2010, conditional on having debt in October 2010 and in period t, to federal transfers plus own-source revenue in 2010.

Notes. This table describes the main variables used in the regression analysis. The loan-level data come from the R04 C commercial credit report (CNBV). Municipal revenues and expenditures are extracted from the "Statistics on state and municipal public finances" (INEGI). Municipal population is from the 2005 population count and the 2010 Census (INEGI). The dummy for municipality's electoral year is constructed with data from the Electoral Court (*Tribunal Electoral del Poder Judicial de la Nación*). Economically active population in 2010 comes from the 2010 Population Census. Data on formal sector employment at the municipality level are extracted from the monthly administrative records of the Mexican Social Security Institute (*Instituto Mexicano del Seguro Social,* IMSS). Per capita household income in 2010 comes from the National Council for the Evaluation of Social Development Policy (CONEVAL). The state unemployment rate and the indicator of state economic activity are from INEGI. Monthly data on banks' total and liquid assets and capital come from banks' financial statements (CNBV). Data on credit ratings come from Nuñez Barba (2010).

Table A.3: Logit models for the population change

	Coefficients	Marginal effects	Coefficients	Marginal effects
	(1)	(2)	(3)	(4)
ΔIHS(Fed. transfers)$_{10:08}$	-.088	-.022	-.168	-.042
	(.331)	(.083)	(.374)	(.093)
ΔIHS(Other revenue)$_{10:08}$	-.083*	-.021*	-.082	-.020
	(.048)	(.012)	(.055)	(.014)
ΔIHS(Current expenditures)$_{10:08}$	-.051	-.013	.044	.011
	(.194)	(.048)	(.208)	(.052)
ΔIHS(Capital expenditures)$_{10:08}$	.056	.014	.076	.019
	(.080)	(.020)	(.086)	(.022)
ΔIHS(Deficit)$_{10:08}$	-.004	-.001	-.002	-.001
	(.003)	(.001)	(.003)	(.001)
ΔIHS(Fed. transfers)$_{08:05}$			.452	.113
			(.298)	(.074)
ΔIHS(Other revenue)$_{08:05}$			-.009	-.002
			(.058)	(.015)
ΔIHS(Current expenditures)$_{08:05}$			.577**	.144**
			(.231)	(.058)
ΔIHS(Capital expenditures)$_{08:05}$			-.030	-.008
			(.060)	(.015)
ΔIHS(Deficit)$_{08:05}$			.004	.001
			(.003)	(.001)
Δlog(Population)$_{05:00}$			2.907***	.727***
			(.491)	(.123)
Observations	1,792	1,792	1,792	1,792

Notes. This table reports coefficients and marginal effects estimated from logit models for the census shock. The dependent variable is a dummy that the takes value of 1 if municipality m has a 2005–2010 population change above the median and of 0 otherwise (the municipal population change is first normalized by subtracting the state population change over the same period). In columns 1 and 2, the regressors are the 2008–2010 changes in the IHS of federal transfers, other revenue, current and capital expenditures, and fiscal deficit. Columns 3 and 4 add the 2005–2008 changes of the same regressors and the 2000–2005 change in the logarithm of municipal population. Standard errors clustered at the municipality level are reported in parentheses. $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Table A.4: Tests of pre-shock covariate balance

	(1)	(2)	(3)	(4)
ΔIHS(Fed. transfers)$_{10:08}$	.000	-.007	-.002	-.006
	(.013)	(.014)	(.015)	(.015)
ΔIHS(Other revenue)$_{10:08}$	-.002	-.001	.002	.000
	(.002)	(.002)	(.003)	(.002)
ΔIHS(Current expenditures)$_{10:08}$	-.010	-.005	-.008	-.006
	(.008)	(.008)	(.009)	(.008)
ΔIHS(Capital expenditures)$_{10:08}$	.000	-.001	-.003	-.001
	(.003)	(.003)	(.004)	(.004)
ΔIHS(Deficit)$_{10:08}$	.000	.000	.000*	.000
	(.000)	(.000)	(.000)	(.000)
ΔIHS(Fed. transfers)$_{08:05}$		.013	.000	-.004
		(.012)	(.014)	(.016)
ΔIHS(Other revenue)$_{08:05}$		.004	.003	.004*
		(.002)	(.003)	(.003)
ΔIHS(Current expenditures)$_{08:05}$		.031***	.018*	.017*
		(.009)	(.009)	(.009)
ΔIHS(Capital expenditures)$_{08:05}$		-.002	-.003	-.001
		(.002)	(.003)	(.003)
ΔIHS(Deficit)$_{08:05}$		.000***	.000	.000
		(.000)	(.000)	(.000)
Δlog(Population)$_{05:00}$		.133***	.022	.028
		(.024)	(.026)	(.027)
State fixed effects	Yes	Yes	Yes	Yes
IPW	No	No	Yes	Yes
Sample trimming	No	No	No	Yes
Observations	1,792	1,792	1,792	1,757

Notes. This table reports regressions of the census shock on pre-shock changes in relevant outcomes. The dependent variable is the 2005–2010 population change and the regressors are the same as in Table A.3. All models control for state fixed effects, models in columns 3 and 4 weight observations with the IPW estimated from the logit model in column 3 of Table A.3, and the model in column 4 further drops observations with a propensity score outside the range $[0.25, 0.75]$. Standard errors clustered at the municipality level are reported in parentheses. $^*p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Table A.5: Census-shock effects on debt by lender type

Dependent variables:	ΔHas debt (private lender)			ΔHas debt (development bank)			Δlog(Volume)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δlog(Population)	-8.56	-7.10	-8.14	-4.44	-3.80	-1.92	6.36	-14.60	3.69
	(8.50)	(8.05)	(9.07)	(11.75)	(11.97)	(12.39)	(84.14)	(96.14)	(78.74)
Δlog(Population) × Electoral year		-3.91			-1.71			39.94	
		(7.44)			(9.71)			(68.26)	
Δlog(Population) × Aligned			-2.48			-14.74			42.38
			(18.16)			(27.47)			(212.93)
Δlog(Population) × Development							46.03	88.11	75.90
							(103.05)	(117.29)	(97.21)
Δlog(Population) × Electoral year × Development								-84.77	
								(85.96)	
Δlog(Population) × Aligned × Development									-134.23
									(254.22)
Electoral year	3.66***	3.98***	3.66***	10.29***	10.43***	10.28***	7.83***	-9.11	7.76**
	(.50)	(.82)	(.50)	(.70)	(1.05)	(.70)	(3.02)	(11.10)	(3.03)
Aligned	-1.02	-1.02	-.83	1.95	1.95	3.10	9.93	10.02	11.80
	(1.23)	(1.23)	(2.02)	(1.79)	(1.79)	(2.96)	(6.75)	(6.75)	(24.34)
Mean dep. var.	1.37	1.37	1.37	-3.74	-3.74	-3.74	7.71	7.71	7.71
Period, state FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	–	–	–	–	–	–	Yes	Yes	Yes
Other controls, lagged outcomes, IPW	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	36,974	36,974	36,974	36,974	36,974	36,974	14,246	14,246	14,246

Notes. This table reports the census-shock effects on the change between period t (January 2011 to December 2012) and October 2010 in an indicator for being indebted with any private bank (columns 1 to 3) and with the development bank (columns 4 to 6) and in the logarithm of total loan volume, conditional on being indebted in both periods (columns 7 to 9). All dependent variables are computed for municipality m, borrowing from bank b, and are multiplied by 100. As indicated, "Δlog(Population)" is interacted with "Electoral year" (a dummy for municipality's electoral year), "Aligned" (a dummy that equals 1 if the municipal mayor belongs to the presidential party coalition in period t and 0 otherwise), and also with "Development" (a dummy that equals 1 if the lender is a development bank and 0 otherwise). The specifications in columns 1 to 6 are the same as in column 3 of Table 5 and in columns 7 to 9 are the same as in column 6 of Table 5, except that observations are aggregated at the municipality-period level and, thus, no bank controls and fixed effects are included. All models also control for the full set of standalone and double interaction terms that are not reported. Observations with missing values in the "Aligned" dummy are dropped. Standard errors clustered at the municipality level are reported in parentheses. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

Table A.6: Alternative thresholds for the definition of transfer dependence

Low-dependence threshold:	10th percentile		30th percentile	
	(1)	(2)	(3)	(4)
Δlog(Population) $\times$ Low dependence	-4.89*	-5.01*	-3.69**	-3.54**
	(2.66)	(2.61)	(1.50)	(1.46)
Δlog(Population)	-.94	-.89	-.23	-.25
	(.66)	(.64)	(.72)	(.71)
Low dependence	1.01**	.99**	.40**	.34*
	(.45)	(.45)	(.18)	(.18)
Mean dep. var.	-.01	-.01	-.01	-.01
Period, state, bank FE	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes
Lagged outcomes	No	Yes	No	Yes
IPW	Yes	Yes	Yes	Yes
Observations	894,918	894,918	894,918	894,918

Notes. This table reports the robustness of the heterogeneous results for being indebted (columns 3 and 4 of Table 6) to alternative definitions of transfer dependence. "Low dependence" are dummies that take the value of 1 if a municipality has a ratio of federal transfers to own-source revenues below the tenth (columns 1 and 2) and thirtieth (columns 3 and 4) percentiles in 2010 and of 0 otherwise. Standard errors clustered at the municipality level are reported in parentheses. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

Table A.7: Differential effect of the population shock in Sonora

Dependent variable:	Δlog(Fed. transf.)	ΔHas debt		Δlog(Volume)	
	(1)	(2)	(3)	(4)	(5)
Δlog(Population) × Sonora	-23.69***	2.30*	.32	220.80	-255.06
	(-3.06)	(1.20)	(1.07)	(393.59)	(234.47)
Δlog(Population) × Sonora			9.29**		143.12
× Low dependence			(3.92)		(851.96)
Δlog(Population)	28.75***	-1.68**	-.40	43.20	133.08
	(6.98)	(.70)	(.67)	(52.69)	(83.03)
Mean dep. var.	7.66	-.01	-.01	7.50	7.50
Period, state FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes
Lagged outcomes	Yes	Yes	Yes	Yes	Yes
IPW	Yes	Yes	Yes	Yes	Yes
Observations	3,116	935,681	935,681	15,052	15,052

Notes. This table reports heterogeneous effects for municipalities from the state of Sonora, where no census shock is expected and are excluded from the main sample, on the models for federal transfers and debt outcomes. "Δlog(Population)" is interacted with "Sonora", which is a dummy that equals 1 if the municipality belongs to Sonora and 0 otherwise. The specifications are the same as in column 3 of Table 4, columns 3 and 8 of Table 5, and columns 4 and 8 of Table 6. Cluster-robust t-statistics at the municipality level (wild bootstrap with 999 replications) (column 1) and standard errors clustered at the municipality level (columns 2 to 5) are reported in parentheses. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

Table A.8: Effect of the population shock after controlling for the impact of the global financial crisis

Dependent variable:	Δlog(Fed. transf.)		ΔHas debt				Δlog(Volume)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Δlog(Population)	29.00***	29.31***	-1.79**	-1.79**	-.58	-.58	54.07	47.49	147.37*	136.36
	(6.88)	(7.23)	(.71)	(.71)	(.69)	(.69)	(53.96)	(53.24)	(83.70)	(84.38)
Δlog(Population) $\times$ Low dependence					-4.24**	-4.23**			-176.66*	-167.66*
					(1.79)	(1.78)			(99.78)	(99.32)
ΔIHS(Fed. transfers)$_{09:08}$		21.58***		1.04*		.97*		89.71**		88.02*
		(5.24)		(.56)		(.56)		(45.57)		(44.99)
ΔIHS(Deficit)$_{09:08}$		.02		-.00		-.00		.14		.12
		(1.43)		(.00)		(.00)		(.19)		(.19)
Low dependence					.66**	.65**			20.96	20.28
					(.26)	(.26)			(12.85)	(12.88)
Mean dep. var.	7.68	7.68	-.00	-.00	-.00	-.00	8.34	8.34	8.34	8.34
Period, state FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged outcomes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IPW	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,916	2,916	873,226	873,226	873,226	873,226	14,381	14,381	14,381	14,381

Notes. This table reports robustness tests that account for the impact of the global financial crisis in the models for federal transfers and debt outcomes. The specifications in odd columns are the same as in column 3 of Table 4, columns 3 and 8 of Table 5, and columns 4 and 8 of Table 6. In even columns, I further control for the 2008-2009 changes in the IHS of federal transfers and fiscal deficit. All specifications drop observations with missing data in any of the two additional control variables. Cluster-robust t-statistics at the municipality level (wild bootstrap with 999 replications) (columns 1 and 2) and standard errors clustered at the municipality level (columns 3 to 10) are reported in parentheses. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

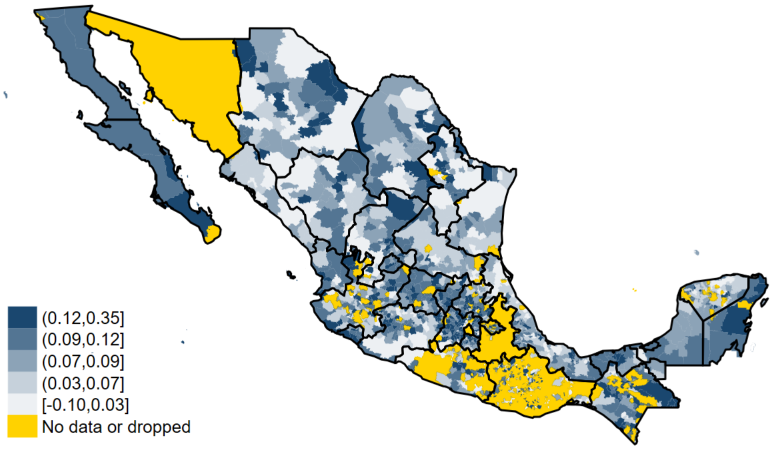
Table A.9: Testing for unobservable selection

Dependent variable:	Δlog(Fed. transf.)	ΔHas debt		Δlog(Volume)	
	(1)	(2)	(3)	(4)	(5)
Δlog(Population)	28.82***	-1.66**	-.40	42.07	135.39
	(6.99)	(.70)	(.67)	(53.10)	(83.35)
Δlog(Population) $\times$			-4.42**		-177.75*
Low dependence			(1.78)		(99.64)
Low dependence			.64**		22.38*
			(.26)		(12.71)
Identified set for $\widetilde{\delta} = 1$	[28.82, 28.95]	[-2.14, -1.66]	[-18.54, -4.42]	[42.07, 55.83]	[-3,059.32, -177.75]
99.5% conf. interval for α_1	[17.28, 40.35]	[-3.61, .29]	[-9.40, .56]	[-106.60, 190.74]	[-456.75, 101.25]
$\widetilde{\delta}$ for $\alpha_1 = 0$ given R^2_{max}	17.09	-4.17	-1.36	-8.30	3.19
R^2_{max}	.28	.02	.02	.35	.35
R^2	.21	.01	.01	.27	.27
Mean dep. var.	7.64	-.01	-.01	7.19	7.19
Period, state FE	Yes	Yes	Yes	Yes	Yes
Bank FE	–	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes
Lagged outcomes	Yes	Yes	Yes	Yes	Yes
IPW	Yes	Yes	Yes	Yes	Yes
Observations	2,975	894,918	894,918	14,643	14,643

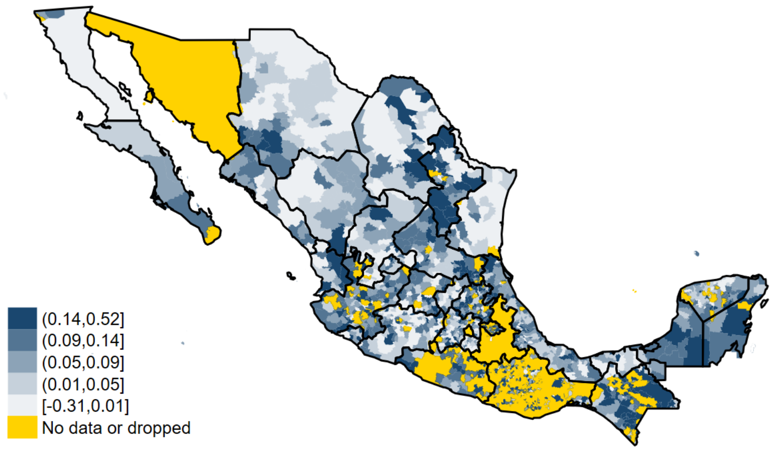
Notes. This table reports the sensitivity to the presence of unobservables, following the approach in Oster (2019), of the main results for federal transfers and debt outcomes. The specifications are the same as in column 3 of Table 4, columns 3 and 8 of Table 5, and columns 4 and 8 of Table 6. The "identified set for $\widetilde{\delta} = 1$" is bounded by $\widehat{\alpha}_1$ and by the hypothetical $\widehat{\alpha}_1$ calculated based on R^2_{max} and on $\widetilde{\delta} = 1$. The "95% confidence interval" is defined as ± 2.8 standard errors around the reported values of $\widehat{\alpha}_1$. The value of $\widetilde{\delta}$ is the one that would produce $\alpha_1 = 0$ given the values of R^2_{max} reported. R^2_{max} is set equal to $1.3 \times R^2$. Cluster-robust t-statistics at the municipality level (wild bootstrap with 999 replications) (column 1) and standard errors clustered at the municipality level (columns 2 to 5) are reported in parentheses. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

Figure A.1: Municipal census shocks and changes in federal transfers

(a) Population change



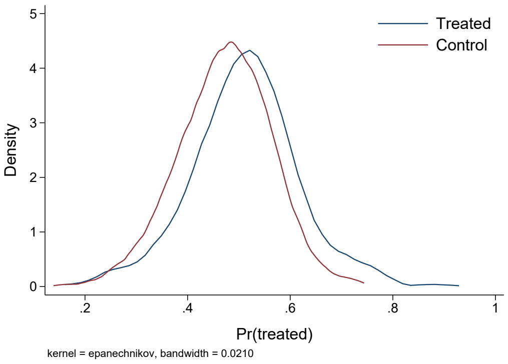
(b) Change in federal transfers



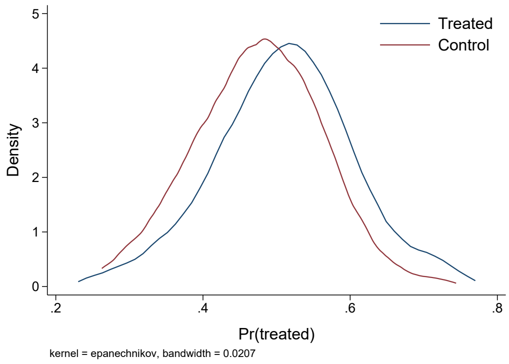
Notes. In panel (a), this figure shows the change in the logarithm of municipal population between the 2010 census and the 2005 count (INEGI). Panel (b) shows the average change in the logarithm of federal transfers of each municipality for 2011 and 2012 relative to 2010, using data from the "Statistics on state and public finances" (INEGI). The black lines represent the borders of each state and Mexico City. Municipalities colored in yellow are those with missing—contemporaneous or lagged—data on the revenue or expenditure variables used in the main regressions or those from the state of Sonora, where no census shock is expected.

Figure A.2: Density estimate for the propensity score of the income shock

(a) Before trimming



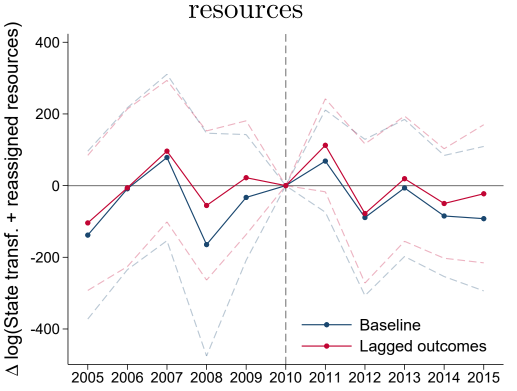
(b) After trimming



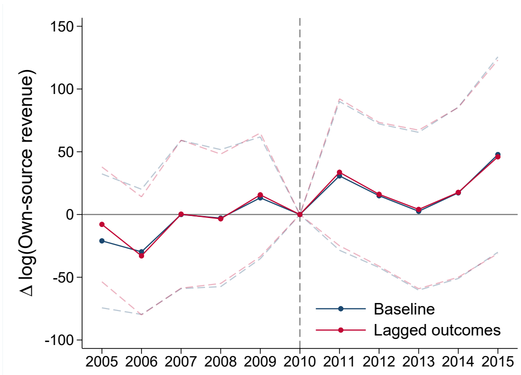
Notes. This figure presents the density of the propensity score of treated and control municipalities, before (panel [a]) and after (panel [b]) dropping observations outside the interval $[0.25, 0.75]$. The propensity score is estimated from the logit model in columns 3 and 4 of Table A.3.

Figure A.3: Dynamic effects on other sources of municipal revenue

(a) State transfers and reassigned resources

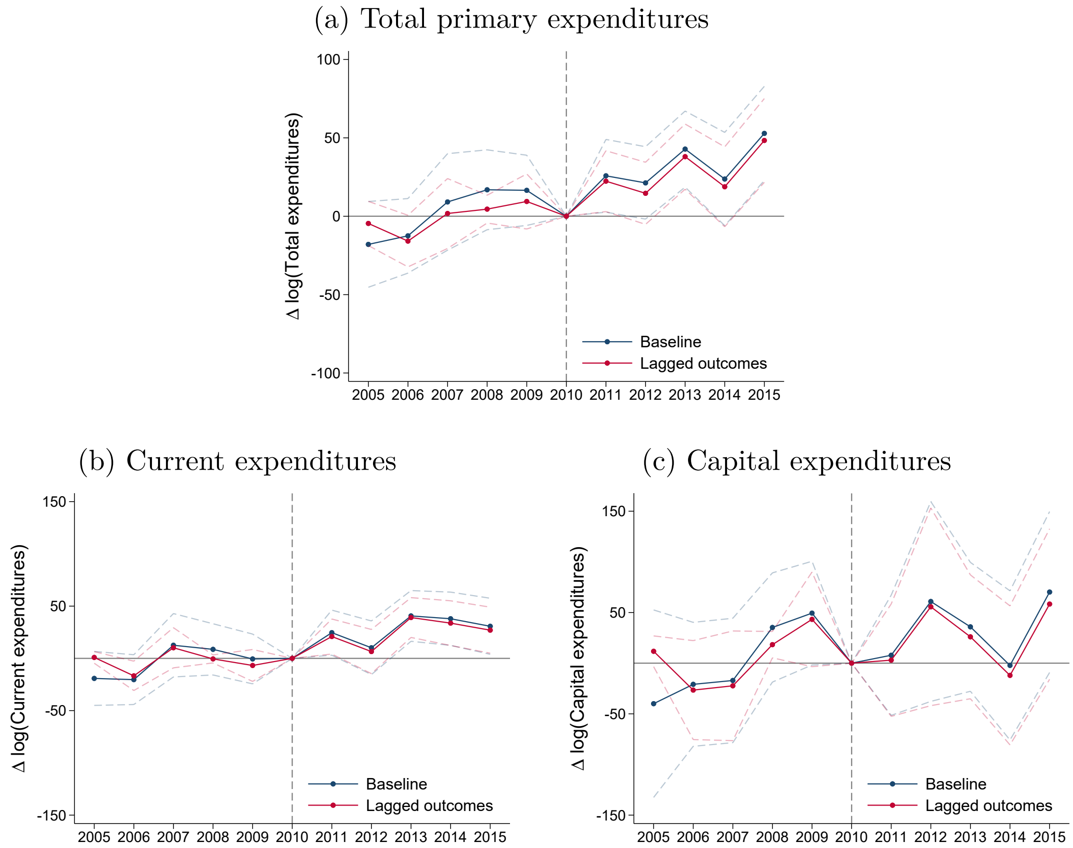


(b) Own-source revenues



Note. This figure plots estimates of the same specifications as in panel (a) of Figure 4, where $\Delta y_{m,t}$ is the change in the logarithm of state transfers plus federal and state reassigned resources (panel [a]) and own-source revenues (panel [b]) received by municipality m between year t (2005 to 2015) and 2010. Each dot corresponds to the coefficients $\widehat{\alpha}_{1,t}$ and the dashed blue lines to their 95% confidence intervals. The coefficient for 2010 is normalized to zero, so that estimates can be interpreted as the change in transfers relative to the year when preliminary census numbers were released (indicated with a vertical line). Only municipalities with data for the entire sample period are included. The 95% confidence intervals are computed using standard errors clustered at the municipality level.

Figure A.4: Dynamic effects on expenditures



Note. This figure plots estimates of the same specifications as in Figure 4, where $\Delta y_{m,t}$ is the change in the logarithm of total primary (panel [a]), current (panel [b]), and capital (panel [c]) expenditures of municipality m between year t (2005 to 2015) and 2010. Each dot corresponds to the coefficients $\widehat{\alpha}_{1,t}$ and the dashed blue lines to their 95% confidence intervals. The coefficient for 2010 is normalized to zero, so that estimates can be interpreted as the change in transfers relative to the year when preliminary census numbers were released (indicated with a vertical line). Only municipalities with data for the entire sample period are included. Section 4 describes the sample selection and Appendix Table A.2 describes variables and data sources. The 95% confidence intervals are computed using standard errors clustered at the municipality level.