# Loan Guarantees and Credit Supply*

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**Abstract**

The efficiency of federal lending guarantees depends on whether guarantees increase lending supply, or simply act as a subsidy to lenders. We estimate the elasticity of lending supply to loan guarantees by exploiting notches in guarantee rate schedule for loans backed by the Small Business Administration. We find significant bunching on the side of the size threshold that carries a higher loan guarantee, and estimate an elasticity of lending supply to loan guarantees of approximately 5. We find that the excess mass is greater in years when guarantees are higher, and placebo estimates indicate no bunching in years when the guarantees notch is eliminated. **JEL Classification**: G21, G28, H81

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# 1 Introduction

Indirect loan guarantees allow the federal government to reimburse unrecovered dollars in default to private lenders and are an increasingly popular type of credit subsidy. The total amount of federal direct and guaranteed loans was $8 trillion in 2010, more than doubling since the previous decade (Lucas, 2016).[1] The justification for federal loan guarantees rests on the fact that, in the presence of information frictions, government loan guarantees may increase aggregate welfare (Gale, 1991; Stiglitz and Weiss, 1981; Smith, 1983; Mankiw, 1986) by decreasing the lenders' risk and encouraging lending. Whether this is in fact the case is ultimately an empirical question and depends on the responsiveness of lending to guarantee thresholds. Despite the large and growing volume of federally guaranteed debt, there remains relatively little work exploring the effects of federal guarantees on lending.

This paper studies how private lenders respond to federal loan guarantees. We use discontinuities in federal guarantee rules for small business loans to test whether lenders increase dollars lent in response to more generous guarantees. We find significant bunching in the loan size distribution right at a threshold where the guarantee generosity discretely decreases. This suggests lenders prefer to issue loans when guarantee rates are higher, as dollars charged-off in default are reimbursed. The generosity of federal guarantees changes each year, and we find more bunching in years when the discontinuity in the loan guarantee schedule is larger, and no bunching in time periods when the discontinuity was eliminated.

We employ a bunching estimator to measure the excess mass at the threshold, and interpret it as an elasticity of loan supply to the guarantee rate.[2] The degree of bunching identifies the elasticity of lending supply to the guarantee - if lending supply is inelastic, and lenders do not adjust loan size in response to the guarantee, we will not observe bunching. On the other hand, if lending supply is highly elastic, we will observe bunching as a significant number of loans will be moved to the side of the threshold with higher guarantees.

Whether federal guarantee programs have any effects on increasing access to credit, or simply

[1] In 2010 there were approximately $2.3 trillion in non-emergency federal loans, which are predominantly education and housing loans but also include business, farming and other loans. The federal takeover and Fannie Mae and Freddie Mac, as well as special FDIC program greatly increased the volume of federally guaranteed loans following the financial crisis.

[2] Recent papers employing bunching estimators include Kleven (2016); Best and Kleven (2018); DeFusco and Paciorek (2017); Saez (2010); Kleven and Waseem (2013).

act as a subsidy to lenders, ultimately depends on this elasticity.[3] Loan guarantees can be welfare enhancing if borrowing is inefficiently low due to information asymmetries (Stiglitz and Weiss, 1981; Mankiw, 1986). If credit supply is inelastic, guarantees will not increase the level of borrowing, and simply reimburse lenders on their losses. In this case, government loan guarantees can also crowd out more efficient private borrowing and encourage excessive risk-taking. [4]

In this paper, we focus on how guarantees specific affect the supply of credit to small businesses. Credit constraints are well-known barriers to growth for small firms, and these problems are especially severe given imperfect information and a lack of collateral (**?**Petersen and Rajan, 1994, 1995; **?**; Kerr and Nanda, 2010; **?**). We employ data from the Small Business Administration (SBA), the government agency tasked with providing assistance to small businesses. Specifically, we utilize data on loans originated under the 7(a) Loan Program. Under the SBA 7(a) Loan Program, a portion of loans from commercial lenders are insured against losses from defaults. Loans of up to \$150,000 carry a higher maximum guarantee rate than loans larger than \$150,000. This feature of the federal guarantee program leads to sharply different levels of risks for lenders originating loans above and below the threshold.

We find significant bunching directly below the threshold. The observed excess mass translates in lending supply elasticities of approximately 5. Guarantee thresholds change over time, and we find that the observed bunching is stronger is years when guarantee amounts across the threshold are higher.[5] Moreover, the guaranteed notch was eliminated during a two year period from 2009 to 2010, as part of the American Recovery and Reconstruction Act. During this period, we find no excess mass across the threshold, which serves as a placebo test to rule out the possibility that alternative factors may be changing across the threshold and driving our results.

The validity of the bunching estimate relies on two key assumptions. First, that the counterfactual distribution is smooth in the absence of a notch, which rules out something else changing

[3]For example, Smith (1983) notes that *"To be effective, it must be demonstrated that there is some impact of these policies on supply elasticities of credit."* Gale (1991) states that *"Perhaps the single most important and controversial parameter is the elasticity of supply of funds."* Finally, Lucas (2016) notes that *"The elasticity of credit supply affects the extent to which additional borrowing in government credit programs is offset by reductions in private borrowing."*

[4]While this paper focuses on the credit supply response to loan guarantees, this is not the only parameter relevant to welfare analysis. For example, Mankiw (1986) shows that the welfare effects of government loan guarantees also depend on whether the rate of return of the marginal investment exceeds the risk-free rate.

[5]We find that the elasticity varies slightly from year to year, and consistent with optimization frictions we find smaller elasticities in years immediately after guarantee notches are changed. If optimization frictions are present, this would cause us to underestimate the true structural supply elasticity.

at the notch, and second, that there exists a well defined marginal buncher. We rule out several alternative explanations or threats to identification. First, the policy environment and our placebo estimates in years when guarantee fees are eliminated make it unlikely that anything else is changing at the threshold. Second, lenders are only able to issue one loan to borrowers who have exhausted other borrowing options, according to SBA rules, which is confirmed in the data, so it is unlikely that lenders are issuing multiple loans to take advantage of guarantees. Additionally, we do not find any differences in loan terms around the threshold, and interest rates, maturities, revolving loan percentages and charge-off percentages appear similar at and near the notch. Our results are also unlikely to be demand-driven given institutional details. One potential concern is that guarantees may be passed on to borrowers through lower interest rates. This could lead to demand effects. We do not find that this is happening in the data, which is likely due to a particular institutional detail– the majority of loans in this program have binding interest rate caps, and thus there is very little room to vary the interest rate.

This paper contributes to the literature on federal lending by estimating key parameters from classic theory models. To our knowledge, this is the first empirical paper to estimate how lending supply responds to federal loan guarantees. This literature largely focuses on models, and different papers use a wide range of estimates of the elasticity of credit supply to guarantee rates for calibrations. Despite the growing volume of federal lending in recent years, the area remains underexplored relative to other credit markets. Notable exceptions include Gale (1990), Gale (1991), Smith (1983) and Lucas (2016). La Porta, de Silanes and Shleifer (2002) examine the effect of government ownership of banks, and find a positive correlation between government intervention and slower subsequent financial development which is consistent with government crowding out efficient private borrowing. Bertrand, Schoar and Thesmar (2007) examine the effect of the French Banking Act of 1985, which eliminated government subsidies to banks intended to help small and medium sized firms.

Prior theory work has shown that under information asymmetries, government interventions in credit markets such as loan guarantees and loan subsidies can increase welfare (Stiglitz and Weiss, 1981; Mankiw, 1986; Greenwald and Stiglitz, 1986). More recent work by Scharfstein and Sunderam (2018) has focused on tradeoffs between private and social costs and **?** documents that housing policies subsidizing an expansion in residential mortgage lending crowd out commercial mortgages and loans. While in theory loan guarantees can increase welfare, whether this is true in practice is ultimately an empirical and quantitative question. We show that private lending is indeed responsive to federal loans guarantees, suggesting that these programs have real effects beyond simply subsidizing lenders.

This paper also links to a literature on credit access for entrepreneurs and small firms. Financing constraints are well known to be a significant barrier to growth for small firms (Evans and Jovanovic, 1989; **?**; **?**; Kerr and Nanda, 2010; **?**; Adelino et al., 2017). Petersen and Rajan (1994), Petersen and Rajan (1995) and Darmouni (2017) show that, for small firms, close ties with institutional lenders increases the availability of credit. Darmouni and Sutherland (2018) show that lenders to small firms are highly responsive to competitors' offers. More recent work has focused on how federal programs can affect the supply of credit and entrepreneurship. Brown and Earle (2017) and **?** study the SBA program, and respectively find that access to credit has large effects on employment and that the average physical distance of borrowers from banks' branch matters for ex-post loan performance. Howell (2017) demonstrates that federal grants have large effects on future fundraising, patenting and revenue. Our paper shows that the volume of small business lending is highly responsive to loan guarantees.

The remainder of this paper is organized as follows. Section 2 discusses institutional details and economic theory surrounding SBA loans and federal guarantees, and introduces our bunching estimator. Section 3.1 describes the public SBA data used in our analysis. Section 3.2 presents the main results and demonstrates significant responsiveness to government guarantess. Section 4 concludes the paper and discusses avenues for further research.

# 2 Institutional Background and Empirical Strategy

## 2.1 Loan Guarantees

Banks receive the loan guarantee from the government and make loans to entrepreneurs. There are two key components of a federal loan guarantee program: a reimbursement rate and a fee. If a bank makes a loan that is ultimately charged-off, the government will reimburse $\gamma$ percent of the losses. In return, the bank pays a certain fee equal to $\sigma$ percent of the loan principal to the government. Given a charge-off probability $\pi$, the total expected subsidy $S_{ij}$ provided by the government on loan amount $D_{ij}$ to bank $i$ for entrepreneur $j$ is given by:

$$S_{ij} = \gamma\pi D_{ij} - \sigma D_{ij} = D_{ij}\Gamma \tag{1}$$

where $\Gamma = (\gamma\pi - \sigma)$.

We assume that there is an underlying optimal distribution of capital for the entrepreneurs given by $G(n_j)$. Facing that distribution, a given bank decides how much to lend, $D_{ij}$, to entrepreneur $j$ using the objective function which maximizes returns in $D_{ij}$:

$$\max_{D_{ij}} \; D_{ij}(1 + \Gamma + R - \pi) - F(D_{ij} - n_j) \tag{2}$$

where $R$ is the interest rate on the loan; $(1 + \Gamma + R - \pi)$ is expected return on the loan net of charge-offs and the guarantee; $n_j$ is the underlying optimal amount of capital for entrepreneur $j$ which generates heterogeneity in our model; and $F(D_{ij} - n_j)$ is a lending cost function that is increasing and convex in the funding gap.

We remain agnostic as to what fundamentals drive the convexity of $F(D_{ij} - n_j)$ - it could be due to a decrease in borrower demand and/or an increase in borrower specific default probability that occurs as the offered loan amount $D_{ij}$ deviates from the underlying loan demand $n_j$. For example, lending too much to an business that should optimally borrow $n_j$ could increase the probability of loan default, or the probability that the loan is rejected for a guarantee by the SBA. Lending too much may also decrease the probability that an entrepreneur accepts a loan offer. Despite the underlying mechanism, the convexity of $F(D_{ij} - n_j)$ controls how responsive bank lending will be to a change in the guarantee rate. As it determines the efficacy and impact of an additional dollar of public funds spent subsidizing the guarantee program, it remains a key parameter in welfare and policy analysis.

In our setting banks maximize returns with respect to loan amount, not interest rate $R$ or risk $\pi$. This is motivated by the empirical observation that banks adjust $D_{ij}$ in response to variation in the guarantee generosity, but not interest rates or risk level. Both interest rates and charge-off rates (an ex-post measure of risk) trend smoothly through the guarantee threshold, and, more importantly, a maximum interest rate cap actively binds approximately 85% of loans in the full sample, effectively constraining banks in their ability to charge differential interest rates.

For a linear guarantee function $\Gamma$, the bank's interior optimum solution satisfies the first order condition with respect to $D_{ij}$:

$$(1+\Gamma) = \pi - R + \frac{\partial F(D_{ij} - n_j)}{\partial D_{ij}} \tag{3}$$

This condition states that at the optimal lending amount $D_{ij}$, the marginal cost of lending an additional dollar $\pi - R + \frac{\partial F(D_{ij}-n_j)}{\partial D_{ij}}$ is equal to the marginal revenue $(1+\Gamma)$. It implies that the bank's optimal level of lending $D_{ij}$ is implicitly a function of the guarantee rate $\Gamma$, as well as the charge-off probability and underlying borrower type. From the government's perspective, an increase in the guarantee subsidy will impact program costs both directly through a higher guarantee rate, and indirectly through increased bank lending. While a full accounting of the welfare effects of an increase depends on a number of factors and is beyond the scope of this paper, the elasticity of credit supply to the guarantee rate is a key parameter - the government cost of generating an additional dollar of targeted lending is predicated by the bank's lending elasticity with respect to the guarantee rate. If the elasticity is very low, then a very high external social benefit from increased lending is needed to justify the distortionary cost of funding the guarantee.

### 2.1.1 Welfare Implications of Lending Elasticity

A government increase in the guarantee subsidy will impact program costs both directly through a higher guarantee rate, and indirectly through increased bank lending. Therefore, the government cost of generating an additional dollar of targeted lending is predicated by the bank's lending elasticity with respect to the guarantee rate. The bank's optimal level of lending $D_{ij}$ is implicitly a function of the guarantee rate $\Gamma$, as well as the charge off probability and underlying borrower type; we denote this implicit function as $\bar{D}(\Gamma)$.[6]Consider a very simplified setting that focuses only on the provision and funding of the guaranteed investment. Here the social planner evaluates its guarantee subsidy $\Gamma$ and tax rate $\tau$ with regards to a social welfare function $W$ that aggregates the

[6]Due to the convexity of $F(D_{ij} - n_j)$ , $\bar{D}(\Gamma)$ is increasing in $\Gamma$.

surplus generated by lending and a fixed budget constraint:

$$\begin{aligned} &\max_{\Gamma,\tau} W(\bar{D}(\Gamma), X(\tau), Y) \\ &s.t.\ R_0 = \bar{D}(\Gamma)\Gamma - X(\tau)\tau \end{aligned} \tag{4}$$

where $X$ is aggregate quantity of a taxed commodity, and $Y$ is lump sum income. Social welfare is weakly increasing in the loan volume, and decreasing in the tax rate. Lending volume is increasing in the guarantee rate, $\Gamma$, while quantity $X$ is decreasing in the tax rate. A small increase in $\Gamma$ will increase welfare by marginal social benefit from lending (MSB), $\frac{\partial W}{\partial \bar{D}}\frac{\partial \bar{D}}{\partial \Gamma}$, while also increasing expenditures by $\frac{\partial \bar{D}}{\partial \Gamma} + \bar{D}(\Gamma)$. The change in welfare coming about from a change in the lending volume captures the potential external benefits that might occur through increased lending. How large of an increase in lending occurs, $\frac{\partial \bar{D}}{\partial \Gamma}$, is the parameter we estimate. A budget neutral change requires that the government finance this increase in the guarantee rate through an increase in $t$ such that $\frac{\partial \bar{D}}{\partial \Gamma} + \bar{D}(\Gamma) = -\frac{\partial X}{\partial \tau} + X(\tau)$. This reduces social welfare by $\frac{\partial W}{\partial X}\frac{\partial X}{\partial \tau}$, the marginal cost of funds (MCF). Whether a budget neutral change will be welfare improving therefore depends on whether the marginal social benefit from lending is greater than the cost of raising the funds to finance the project:

$$\underbrace{\frac{\partial W}{\partial \bar{D}}\frac{\partial \bar{D}}{\partial \Gamma}}_{MSB} - \underbrace{\frac{\partial W}{\partial X}\frac{\partial X}{\partial \tau}}_{MCF} = \text{Net Change in Welfare} \tag{5}$$

Equation 5 shows that the ability of the guarantee to generate additional lending, $\frac{\partial \bar{D}}{\partial \Gamma}$, is a crucial parameter for welfare analysis. While a full accounting of welfare depends on a number of factors and is beyond the scope of this paper, the elasticity of credit supply to the guarantee rate is a key parameter in determining the welfare effects of loan guarantees. If the elasticity is very low, then a very high external social benefit from increased lending is needed to justify the distortionary cost of funding the guarantee.

As noted in Gale (1991), who conducts a calibrated cost-benefit analysis of federal guarantee programs, *"welfare loss [can] occur because the [guarantee] programs must be financed... [Calibrated] government costs per dollar of incremental targeted investment are extraordinarily high."* While a full welfare analysis must also take into account external benefits potentially generated by the subsidized lending, measuring the government costs provides a lower bound for how large the benefits must be to offset these welfare losses. In section 2.2 we discuss how we use a feature of a large federal guarantee program, the SBA 7(a) program, to estimate the elasticity of lending with respect to the guarantee rate.

## 2.2 SBA Loan Program

### 2.2.1 SBA 7(a) Loans

The SBA is an independent federal government agency created in 1953 with the mission of providing assistance to small businesses. We focus on the Lending Program, designed to improve access to capital for young small businesses that may not be eligible to obtain credit through traditional lending channels. The SBA Lending Programs are guarantee programs where the SBA guarantees a portion of loans originated by commercial lending institutions against losses from defaults, rather than lending directly to qualifying borrowers. We focus on the SBA's flagship loan guarantee program, the 7(a) Loan Program.

SBA 7(a) loans have several unique features which are relevant to this study. First, the maximum guarantee rate is based on a nonlinear size cutoff rule: loans up to $150,000 carry a maximum guarantee rate of 85%, which drops sharply to 75% for loans larger than $150,000. The guarantee fees also increase at the same threshold, making the overall guarantee less generous for loans larger than $150,000. We exploit this guarantee notch around $150,000 to identify our parameters of interest. Features of the SBA 7(a) program have remained relatively stable over the last decade, except during 2009-2010, when the SBA temporarily raised the guarantee rate on either size of the $150,000 threshold to 90% and waived fees with the signing of the American Recovery and Reinvestment Act of 2009.[7]

To qualify for a 7(a) loan, a borrower must meet several requirements. First, a business must be a for-profit business that meets SBA size standards.[8] In addition to the size requirement, a business must be independently owned and operated and not be nationally dominant in its field. It must also be physically located and operate in the U.S. or its territories. Lastly, small businesses must demonstrate the need for loan by providing loan application history, business financial statements,

[7] This time period provides a helpful placebo test for our analysis, since no lending response should occur in a year when there is no discrete change in the guarantee rate.

[8] Size standards vary by industry, and are based on the number of employees or the amount of annual receipts ("total income" plus "the costs of goods sold").

and evidence of personal equity investment in the loan proposal. Borrowers must exhaust other funding sources, including personal sources, before seeking financial assistance, and be willing to pledge collateral for the loan (CRS, 2018; OCC, 2014; SBA, 2015).

The 7(a) loans are disbursed through private lending institutions. This loan submission and disbursement procedure depends largely on the lender's level of authority (i.e., delegated or non-delegated) provided by the SBA. The SBA conducts its own analysis of the application and approves the originating lender's decision to lend, which can be expedited depending on a lender's experience. In practice, SBA lenders have meaningful bargaining power over credit supply. In a typical case, a borrower requests a loan to a lender, and the lender decides whether the SBA loan would be suitable for a given borrower upon reviewing the borrower's background. Given that lenders cannot provide more than one loan to a single borrower such that SBA-guaranteed loan is secured with a junior lien position, lenders have incentives to retain this bargaining power and be selective in choosing borrowers.

## 2.3 Empirical Approach

We estimate the elasticity of lending to a change in the guarantee rate using the discrete change in the level of the guarantee rate in the SBA 7(a) lending program. This approach uses the excess mass at the threshold to estimate an implied lending response to the change in the guarantee rate[9] and provide nonparametric estimates of the elasticity of credit supply, following closely the methodology outlined in Kleven and Waseem (2013). Recall that a bank $i$ decides how much to lend, $D_{ij}$, to entrepreneur $j$ using the objective function which maximizes returns in $D_{ij}$:

$$\max_{D_{ij}} D_{ij}(1 + \Gamma(D_{ij}) - \pi + R) - F(D_{ij} - n_j) \tag{6}$$

As noted earlier, the function $\Gamma(D_{ij})$ in the SBA 7(a) program decreases at the threshold $D^T = \$150,000$ from $\Gamma$ to $\Gamma - \Delta\Gamma$, creating a discrete drop in the return the bank makes on lending right above the threshold. Specifically:

[9] The studies that distinguish different bunching designs consider kink points as points where there is discrete changes in the *slope* of choice sets, and notch points as points where there is discrete changes in the *level* of choice sets (Kleven, 2016). We consider the $150,000 cutoff as the notch point. There are several advantages to using a notch as it is possible to identify structural parameters net of optimization frictions.

$$\Gamma(D_{ij}) = \begin{cases} \Gamma, & \text{if } D_{ij} \leq D^T \\ \Gamma - \Delta\Gamma, & \text{otherwise} \end{cases}$$

In the absence of a notch, we assume there would have been a smooth distribution of loans made that would satisfy the banks' first order condition.[10] The notch however creates a region directly above the threshold for a subset of loans where marginal revenue $(1 + \Gamma - \Delta\Gamma)$ is strictly lower than the marginal cost $\pi + \frac{\partial F(D_{ij} - n_j)}{\partial D}$. The *marginal* bunching loan (with underlying type $n_j = n_b$) is made at the point $D^T + \Delta D$ where the bank is indifferent between making a smaller loan under the more generous guarantee and making a larger loan under the less generous guarantee:

$$\begin{aligned} D^T(1 + \Gamma - \pi + R) - F(D^T - n_b) = \\ (D^T + \Delta D)(1 + (\Gamma - \Delta\Gamma) - \pi + R) - F(D^T + \Delta D - n_b) \end{aligned}$$

Therefore, $\Delta D$ captures the reduction in dollars lent in response to the change in the guarantee rate for this marginal buncher, and it is the key empirical parameter needed to calculate the elasticity of lending. The substantial excess mass we observe in the data at the point $D_{ij} = D^T$ comes from this region of strictly dominated lending for the bank $(D^T, D^T + \Delta D)$ directly above the notch point. This allows us to map the amount of excess mass to the loan response $\Delta D$ using the bunching methodology we discuss below in section 2.3.1.

Within the dominated region the bank can always increase its return by making smaller loans under the higher guarantee rate $\Gamma$. The size of the dominated region (and therefore the reduced form elasticity of lending the guarantee rate) relates to the slope of the marginal cost function $F(D_{ij} - n_j)$ - if a small change in $D$ generates a sharp increase in costs, there will be a small dominated region and a small elasticity of lending. If a change in $D$ has little impact on costs, then there will be a larger dominated region, more bunching at the threshold, and a larger elasticity of lending with respect to the guarantee rate.

[10] Conditional on and mapping directly to a smooth underlying distribution of loan demand, $n_j$.

### 2.3.1 Bunching Methodology

This section describes the estimation methodology in detail. Our objective is to estimate the reduced form lending elasticity with respect to the guarantee rate, or the percentage change in dollars lent that results from a corresponding percentage change in the guarantee rate

$$\varepsilon_{D,\Gamma} \equiv \frac{\Delta D}{D^T} \times \frac{(1+\Gamma^*)}{\Delta\Gamma^*} \tag{7}$$

where $\Delta\Gamma$ is the change in the marginal guaranteed return faced by the bank. We estimate the elasticity in a reduced form by noting that a notch in the marginal guarantee rate allows us to approximate the *implicit* marginal guarantee rate , $\Gamma^*$, created by the notch: $\Gamma^* \approx \Gamma + \Delta\Gamma \frac{D^T}{\Delta D}$. We can then write the reduced form elasticity as:

$$\varepsilon_{D,\Gamma} \approx \left(\frac{\Delta D}{D^T}\right)^2 \times \frac{(1+\Gamma)}{\Delta\Gamma} \tag{8}$$

We obtain the parameters for elasticity estimation from the SBA data. The threshold $D^T$ is \$150,000 for the years in our sample. We calculate $(1+\Gamma)$ as the observed ex-post return on a loan, net of realized charge-offs, guarantee fee payments, and guarantee reimbursements. As noted earlier, interest rates and ex-post charge-off rates trends smoothly through the threshold; therefore all systematic variation in returns come from changes in the generosity of the guarantee contract at the threshold. Over our time period, loans less than or equal to \$150,000 had lower guarantee fees and higher guarantee reimbursement rates than loans to the right of the threshold. Given that the generosity varies over time, we estimate the excess mass and elasticity separately by year.

To calculate $\Delta D$ empirically, we must locate the counterfactual loan amount provided to the marginal buncher; this occurs at the point where the excess mass at the threshold is equal to the missing mass to the right of the threshold. To measure the excess and missing mass we estimate the counterfactual loan distribution that would have occurred in the absence of a notch by fitting a polynomial of degree 6 with a vector of round number dummies for multiples of 1,5, 10, 25, and 50 thousand, and excluding a region at and to the right of the threshold:

$$N_j = \sum_{k=0}^{6} \beta_k (d_j)^k + \sum_{i=d_l}^{d_u} \delta_{ij} \mathbb{1}(d_j = i) + \sum_{n \in \{1k,5k,10k,25k,50k\}} \delta_n \mathbb{1}(d_j = n) + \eta_j \tag{9}$$

where $N_j$ is the number of loans in bin $j$, $d_j$ is the loan amount midpoint of interval $j$, $\{d_l, d_u\}$ is the excluded region, $\delta_{ij}$'s are dummies for bins for the excluded region, and $\delta_n$'s are dummies for multiples of prominent round numbers. For estimation, we cut the data into $500 dollar bins and restrict the loan size to be between $75,000 and $225,000 to limit the estimation range. For robustness, we repeat the estimation with $200, $1000, and $2000 bins, polynomials of degree 4, 5 and 7, and for various ranges of estimation; these results are shown in the appendix.[11] The counterfactual distribution, $\hat{N}_j$, is estimated as the predicted values from equation 9 using the $\beta_k$s:

$$\hat{N}_j = \sum_{k=0}^{6} \hat{\beta}_k (d_j)^k + \sum_{n \in \{1k,5k,10k,25k,50k\}} \hat{\delta}_n \mathbb{1}(d_j = n) \tag{10}$$

Excess mass is defined as the difference between the observed and counterfactual bin counts between the lower limit of the excluded region ($d_l$) and the threshold, $\hat{B} = \sum_{j=d_l}^{D^T} (N_j - \hat{N}_j)$, whereas the missing mass, $\hat{M} = \sum_{j=D^T}^{d_u} (N_j - \hat{N}_j)$, is defined as the same bin counts but in the range between the threshold and the upper limit of the excluded region ($d_u$). To identify this upper limit (i.e. $d_u = D^T + \Delta D$), the methodology requires the excess mass $\hat{B}$ be equal to the missing mass $\hat{M}$. Thus, the estimation procedure 1) begins with a starting value of $d_u$ right above $D^T$; 2) calculates $(\hat{B} - \hat{M})$; 3) increases $d_u$ by a step size of $500 if $(\hat{B} - \hat{M} \neq 0)$; 4) and repeats these steps until the result converges.[12]

The validity of the bunching estimate relies on two central assumptions: 1) that the counterfactual distribution would be smooth in the absence of a notch, and 2) bunchers come from a continuous set such that there exists a well defined marginal buncher. While the second assumption is technical and fairly weak, the first assumption warrants some discussion. This assumption effectively rules out that other factors are changing at the threshold, which might influences bunching. The fact that the bunching disappears completely in the placebo years when no notch exists suggests that there are no other factors generating bunching at the threshold and helps to to validate the first assumption.

The bunching technique captures intensive margin responses. If banks reject applications sim-

[11] While the results are very robust to the different bin and polynomial choices, they are sensitive to the inclusion of $50,000 within the range. Another interest rate related threshold exists at the $50,000 mark, which causes additional bunching, and therefore we excluded it from our ultimate estimation.

[12] We pool together all banks in our main estimation. However, to test whether the elasticity and bunching is driven by a specific bank we have also repeated the estimation on a conditional distribution that controls for bank fixed effects. The bunching and elasticities are very similar.

ply because they are above the threshold, this would cause us to underestimate the credit supply response to the guarantee further away from the notch, and make our estimates more sensitive to the choice of polynomial used. While these extensive margin responses are unlikely in our setting, since the bank has considerable power when deciding how much to lend and could increase returns by reducing $D_{ij}$ rather than not lending at all, we test the sensitivity of our estimates to the choice of parameters.[13] We show in table 3 that our results are robust to using a range of polynomial choices, which suggests that extensive margin responses do not play a large role in our setting.

# 3 Data and Results

## 3.1 SBA Data

We obtain the 7(a) loan data from the Small Business Administration.[14] This loan origination dataset includes basic information about the participants (i.e., the identity of the borrower and the lender, their addresses, city, zip code, and industry), non-pricing terms (i.e., loan volume, guarantee amount, or approval date), pricing term (i.e., loan spread plus base rate), ex-post loan performance, such as the total loan balance that has been charged off, and other administrative details such as the delegation status of the lender and the SBA district office that processed the loans.

For our analysis, we only consider loans originated over the last decade—2008 to 2017— under the SBA 7(a) program. We exclude SBA 7(a) Express loans and drop 22 loans that appear to be spurious (i.e., loans for which the guaranteed share is greater than 100 percent of the amount originated). This final sample covers 199,013 loans originated by 3,066 lenders to 177,049 borrowers. Table 1 presents summary statistics for the main analysis variables. A median SBA loan size is \$460,000 and the guaranteed amount is \$356,400. The median loan maturity and the interest rate at the time of origination are 10 years and 6 percent, respectively. Since the median prime rate is

[13] Kleven and Waseem (2013) show that these extensive margin responses should only occur in a region far to the right of the notch, with the intensive margin response concentrated in the area directly next to the notch. They note that extensive margin bias will mainly enter via functional form misallocation, and therefore sensitivity analysis should be conducted with respect to the polynomial.

[14] The SBA requires all participating lenders in the 7(a) program to submit loan applications (Forms 1919 and 1920) to the 7(a) Loan guarantee Processing Center ("LGPC") when they request a new loan. Delegated lenders must complete the form, sign and date, and retain in their loan file before processing a loan for faster processing. The information included in these forms are then compiled into a dataset and provided publicly pursuant to the Freedom of Information Act (FOIA).

3.25% in our sample, the maturity and interest rates are consistent with the SBA's maximum interest rate rule that loans with maturity of over 7 years with the amount greater than $50,000 can carry the maximum rate of 2.75% over the prime rate. The median charge-off amount is zero while its mean is $11,706, indicating that the share of loans that are eventually charged off is small. Panels B of table 1 report the same statistics for subsample of loans used for notch estimation, where we restrict the loan size to be between $75,000 and $225,000. One we take this restriction, there are 41,460 loans in the main analysis sample.

We use this data to estimate private lenders' responsiveness to federal loan guarantees. Our empirical analysis is meaningful for examining welfare implications to the extent that lenders cannot manipulate the lending structure in a way that they can benefit without bunching at the notch threshold by issuing multiple guaranteed loans to the same borrower. As briefly discussed in the institutional details section, the SBA prohibits lenders from originating loans with a "piggyback" structure where multiple loans are issued to the same borrower at the same time, and the guaranteed loan is secured with a junior lien position. While this policy does not prevent lenders from having a shared lien position with the SBA loans (i.e., Pari Passu), we confirm in our data that 99 percent of the borrowers receive only one loan from the same lender at the same time. As reported in 1, the average number of loans a given borrower receives from the same lender and year is 1. Thus, the SBA 7(a) program serves as an ideal laboratory to conduct a notch estimation for studying the impact of federal loan guarantees on credit supply.

## 3.2 Main Results

We begin by showing that loan guarantees do indeed vary across the $150,000 threshold. The left panel of figure 1 shows average guarantees and fees by loan amounts, as a percentage of the loan principal amount in $2,000 bins across the threshold between 2008 and 2017. Consistent with the policy rule, the guarantee benefit jumps sharply across the threshold– loans below $150,000 see a guarantee rate nearly twice as generous as loans above the threshold. Figure A.1 breaks down the guarantee benefit by the average expected guarantee fees and reimbursement rate separately.

To determine whether the guarantee benefit notch affects lending volumes, we analyze the density of borrowing. The right panel of figure 1 shows bunching directly below the threshold. The figure shows the number of loans in $2,000 bins across the threshold between 2008 and 2017.

Visual evidence indicates that there are significantly more loans at the threshold relative to other points nearby. This is consistent with banks lending fewer dollars in response to a lower guarantee rate - i.e. moving borrowers to loan volumes below the notch.[15]

Figure 3 provides additional reduced form evidence that this bunching is indeed driven by guarantees. As discussed in section 2.2, the generosity of guarantees varies over time. Figure 3 shows that bunching at the threshold closely tracks the generosity of the guarantee.[16] The figure shows the amount of bunching occurring at the $150,000 threshold against the size of the guarantee change at the threshold between 2008 and 2017, in ten bins absorbing bank fixed effects. There is a strong relationship between the guarantee rate, which affects incentives to bunch and the amount of observed bunching that occurs.[17]

### 3.2.1 Elasticity Estimates

Table 3 formalizes and scales the bunching noted above relative to the change in the size of the guarantee; it presents estimates of $\varepsilon_{D,\Gamma}$, as described in section 2.3. The first column shows the degree of the polynomial used to estimate the counterfactual distribution – we vary this to test sensitivity to the parameter choices and gauge whether extensive margin responses are playing a large role. The second column shows the estimated excess mass, $\hat{B}$, in terms of number of loans. The third column shows estimates of $\Delta D$, the distance of the marginal buncher in dollar terms from the threshold. The fourth column presents $\Delta\Gamma$, the change in the generosity of the guarantee rate at the notch.[18] The final column shows estimates of $\varepsilon_{D,\Gamma}$, the elasticity of dollars of loans made with respect to the guarantee rate.

The first row show estimates from placebo years, when the notch was eliminated as part of the American Recovery and Reinvestment Act (ARRA) stimulus of 2009. Reassuringly, we see very

[15]One possibility is that guarantees are passed through to borrowers in the form of lower interest rates. This scenario is inconsistent with the observed data. We show later in this section that there do not appear to be significant differences between loan terms at the notch relative to other points in the distribution.

[16]Here excess mass is measured in a reduced form way as the difference in the percentage of loans at the threshold relative to other round numbers. For the elasticity estimation we use the full bunching methodology to calculate the counterfactual distribution and the implied excess density at the threshold.

[17]Figure 2 presents similar results, showing annual guarantee generosity and bunching over time. Again, we see a very close relationship between incentives to bunch and the guarantee change - in the two years in which there was no change in the guarantee (the bottom row), for example, there is no excess mass at the threshold. In contrast, in years with a large change in the guarantee (the top row), there was notable excess mass.

[18]Over the years in our sample, $\Delta\Gamma$ varied between 0 and .078. For this estimate we take a weighted average of $\Delta\Gamma$ in non-zero years to pool across years; in the appendix we also list estimates by year.

little excess mass when loan guarantees are identical across the notch. This assuages potential concerns that other factors may be changing across the threshold, and is discussed further in the next subsection. Note that we cannot compute elasticity estimates in 2009 and 2010, as there is no variation in the notch.

The second row shows estimates from years when the guarantee notch was binding. The estimates of the elasticity are approximately 5.1, and range from 4.6 to 5.4 depending on the polynomial used. The estimates are highly statistically significant and we can rule out elasticities below 4 with high levels of precision. This is on the higher end of values used in many model calibrations. For example, Gale (1991) notes uncertainty around parameter values but calibrates values between between .5 and 5. This finding is consistent with elasticities used in Lucas (2016), who notes that during this time period high levels of bank reserves and loose monetary policy suggest a high elasticity of supply around 2010. This suggests that loan guarantees do indeed impact lending to small business, and do not simply act as a subsidy to lenders.

Note that we observe some loans being made in the dominated region directly to the right of the threshold; this suggests that banks face optimization frictions when trying to adjust some loan sizes. Therefore we estimate a *reduced form* elasticity that is inclusive of adjustment costs, rather than a structural elasticity.

### 3.2.2 Demand Side Concerns

One concern is that our estimates do not identify lenders' elasticity of supply to the guarantee rate, but rather borrowers' elasticity of demand. It is possible that borrowers may be more likely to apply for a smaller $150,000 loan if the guarantee is passed through via a lower interest rate or lower risk standards. However, there are several institutional details that make a demand channel unlikely: as noted earlier, lenders are unable to issue multiple loans to the same borrower under the SBA program, making manipulation of the notch unlikely. Furthermore, borrowers must have exhausted all other financing options to qualify for an SBA loan, which rules out the possibility that banks or borrowers are topping up their SBA loans with additional private funding.[19] We also find that a negligible portion (.03%) of loans are categorized as "revolving" debt - i.e. a line of

[19]The eligibility criteria listed on the SBA website specifically states that to qualify for a 7(a) loan "the business cannot get funds from any other financial lender."

credit that can be drawn down by the borrower, and could also lead to demand-driven manipulation of the notch.

Despite the fact that institutional details make a demand channel unlikely, we still check whether the notch induces borrowers to bunch at the threshold by observing whether interest rates or ex-post charge-off rates (a measure of borrower risk) change discretely at the threshold. Figure 5 shows average interest rates and the guarantee notch. Interest rates evolve smoothly despite the sharp guarantee notch. Figure 6 provides some insight as to why this may be the case– the majority of loans are priced at the cap on each side of the threshold.

Figure 7 shows that both measures trend smoothly through the cutoff, suggesting that the generosity in the guarantee is not passed on to the borrower through either an intensive margin interest rate effect or an extensive margin rationing effect. This implies that borrowers have no incentives to bunch at the threshold because requesting smaller loans to bunch at the notch only gives them less capital with no added benefits. Given this lack of incentives to bunch from the perspective of the borrowers, it is unlikely that the bunching is demand driven.

It is also possible in theory that borrowers request for smaller loans than they otherwise would have if they believed that bunching at the notch improves their odds of getting the loan approved. We argue that this is still interpretable as a supply elasticity, since it is operating through a supply side mechanism: the approval rate. If the supply side was not reducing credit supply to the right of the notch, borrowers would not modify their loan requests.

## 3.3 Bunching over Time and Placebo Estimates

The generosity of the guarantee across the notch has varied significantly over time, which allows us to explore dynamic aspects of the lending response. Consistent with the bunching being driven by loan guarantees, and not by any other factors changing across the threshold, we find higher excess mass in years when the difference in the guarantee across the threshold is greater. Figure 3 shows the relationship between share of excess mass at the threshold and the guarantee rate in each year.[20] The left panel plots the share of excess mass and the change in the guarantee at the threshold. There is a striking linear relationship between the share of excess mass and the guarantee rate. The right

[20] For this figure, we again use our reduced form measure of excess mass: we observe some bunching at round number points, as is show in figure A.2. To account for this, we calculate excess mass at the threshold relative to intervals of $50,000 between $50,000 and $300,000.

hand panel shows the relationship between the share of excess mass and guarantee rates over time. The figure shows that the observed excess mass rises and falls with the guarantee rate.[21]

Estimates of the elasticity vary over time. While estimates are relatively stable between 2008 and 2013, and similar in 2017, the estimates of $\varepsilon_{D,\Gamma}$ are about one third the size of estimates in other years in 2014 and 2015. This pattern is consistent with optimization frictions around the increase in the guarantee rate in 2014. Between 2013 and 2014, the difference in guarantee rate at the notch approximately doubled, moving from .033 to .077. If it takes lenders time to adjust to changes in the guarantee notch, then estimates of the elasticity will be temporarily attenuated due to frictions. Our estimates are consistent with these patterns– we see much lower elasticities in years immediately after the change in the guarantee notch.

It is evident graphically that the lending response drops when guarantee notches are eliminated. Between 2009 and 2010 the guarantee notch was eliminated. Following the financial crisis, in 2009 the SBA temporarily raised the guarantee rate to 90% and waived fees as part of the 2009 ARRA stimulus.[22] Figure 2 shows the excess mass by year. Between 2009 and 2010, when guarantee rates were identical across the threshold, we do not observe any excess mass. The fact that excess bunching is only present in years when the guarantee rate is discontinuous assuages potential concerns that other factors may change discontinuously across the threshold.

# 4 Concluding Remarks

The efficiency of federal credit guarantees depends crucially on how responsive the lending supply is to the subsidy. Specifically, the marginal change in costs per dollar of lending generated decreases in the elasticity of loan supply to the guarantee. This paper uses notches in SBA lending rules to provide the first estimates of the small business credit supply response to guarantees. We find that supply is responsive to loan guarantees - significantly more loans are disbursed below thresholds where guarantees are higher, and we find that this bunching is stronger in years when guarantee rates are greater, and disappears when guarantee rates are temporarily eliminated.

[21] Figure 4 looks at the raw data for a specific set of years and shows the striking contrast in bunching in 2013, when there was a small notch, and 2015, when there was a large notch.

[22] See Lucas (2016) for a discussion of the relationship between credit and fiscal policy. Lucas (2016) finds that federal credit programs had significant effects as automatic stabilizers, comparable in magnitude to the effects of the American Recovery and Reinvestment Act of 2009.

While we have shown that lending supply is responsive to guarantee rates– a key parameter when considering the welfare effects of federal credit programs– important questions remain unanswered. Perhaps most importantly, the efficiency of loan guarantees ultimately rests on the efficiency of the rate of return on marginal loans which are made, and whether this is greater than the risk free rate. Moreover, federal credit programs can have allocative effects, transferring credit from one rationed group to another. Future work should attempt to study both the allocative effects of federal credit programs, and the return of loans being made under these programs.

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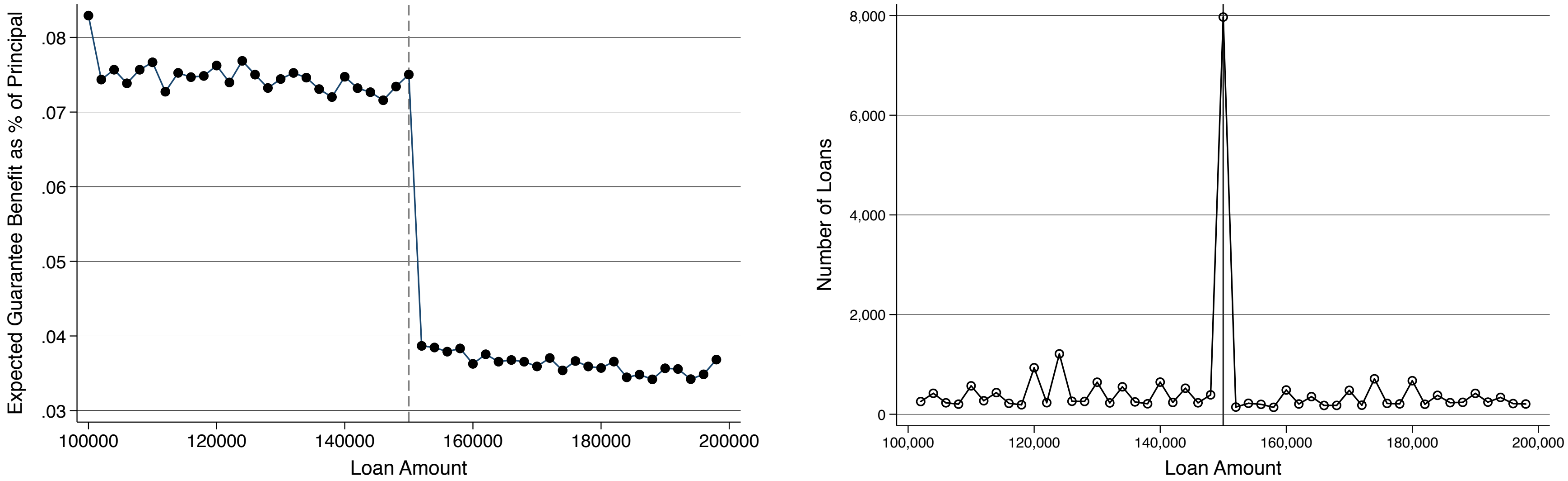
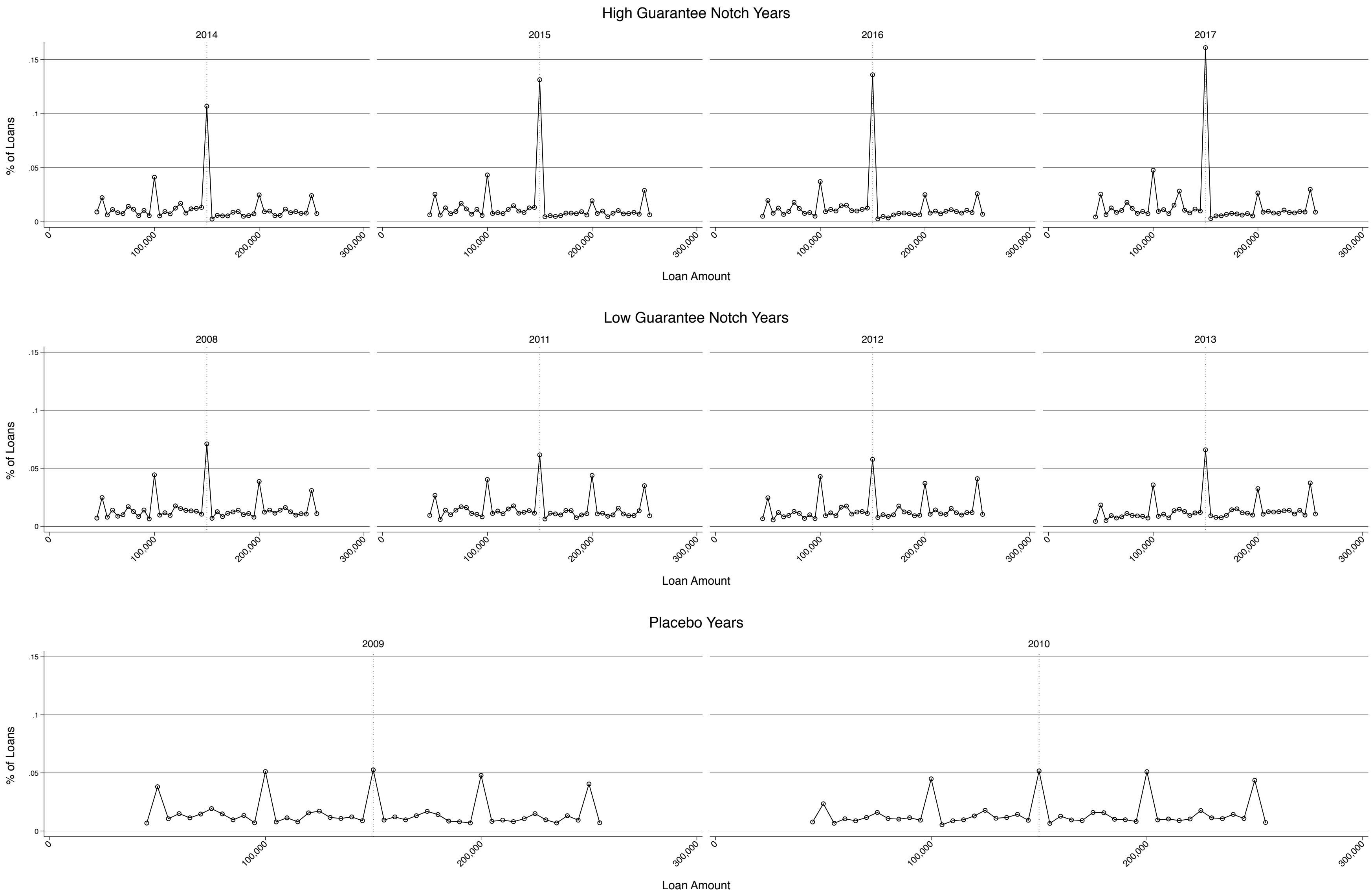
## Figure 1: Guarantees and Fees by Loan Amount

Notes: The left panel shows the average expected guarantee benefit as a percentage of the loan principal amount for discrete 2000 bins across the threshold. This net benefit is calculated as the guaranteed reimbursement on expected losses minus guarantee fees. The right panel shows the number of loans made in discrete $2,000 bins across the threshold. The figures pool over all years 2008-2017. Source: SBA.



# Figure 2: Bunching at the Guarantee Notch by Year

Notes: This figure shows the fraction of loans made in discrete $2,000 bins across the threshold by year. We divide the loans by years when the notch was either positive and above (high) or below (low) the median, or non-existent. Source: SBA.



## Figure 3: Relationship between size of notch and excess mass

Notes: The figure on the left plots the share of excess mass against the size of the guarantee rate change at the $150,000 threshold. The excess mass at the $150,000 threshold is measured in a reduced form way as the difference in the percentage of loans at the threshold relative to other round numbers. The *share* of excess mass is therefore the estimated excess mass as a share of the total number of loans in the estimation range. The figure on the right plots the share of excess mass and the size of the guarantee rate change at the threshold over time to show the tight correlation between the two measures. Both figures show that there is a positive correlation between the incentive to bunch (the size of the guarantee rate change) and the amount of bunching. Both graphs pools over all years 2008-2017 and control for bank fixed effects. Source: SBA.

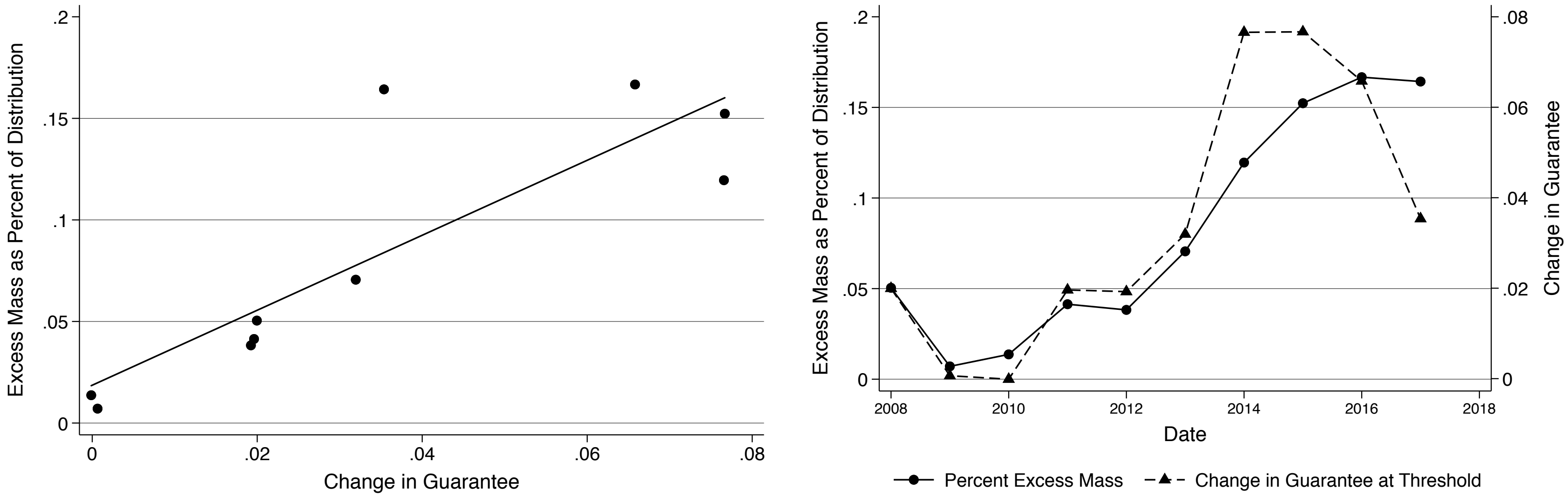


**Figure 4: Bunching at the Guarantee Notch in 2013 and 2015**

Notes: The left panel shows the number of loans made in discrete $2,000 bins made in 2013 (red) and 2015 (black). The right panel shows the change in the guarantee rate at the threshold in these two years. In 2015, when the change in the guarantee at the threshold was much larger than in 2013, there was substantially more excess mass at the threshold. Source: SBA.

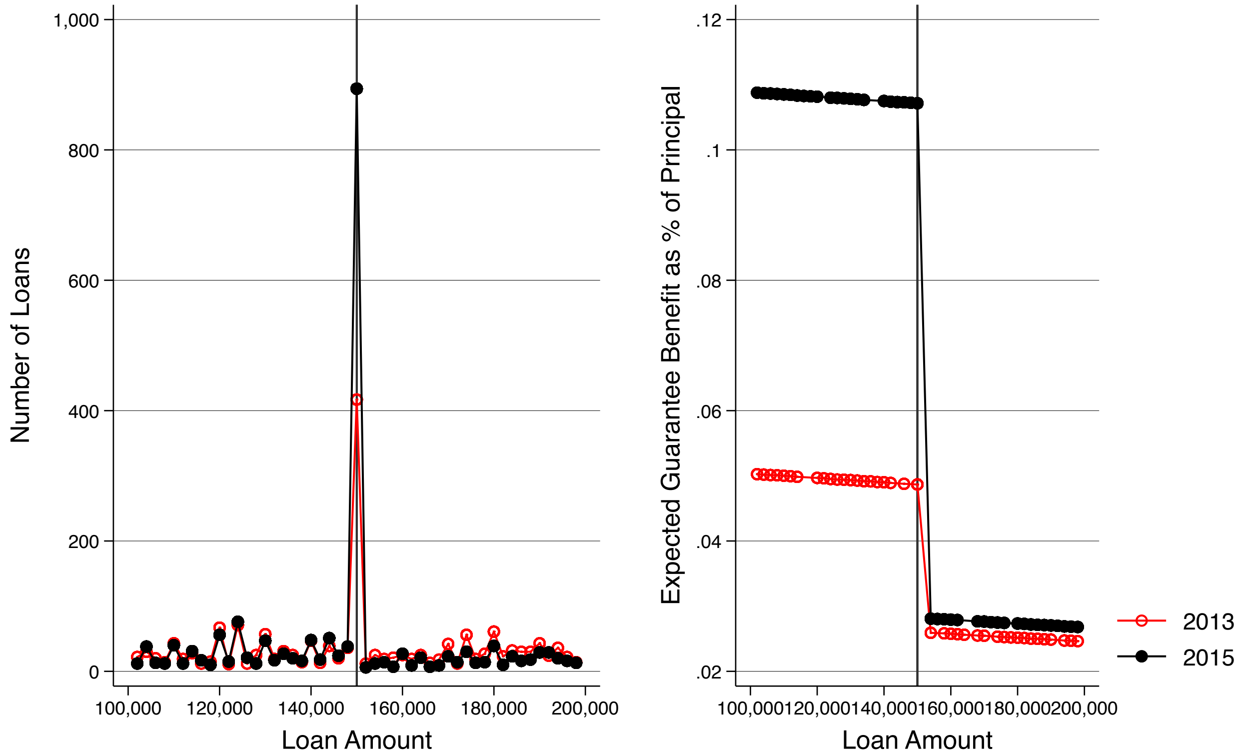


**Figure 5: Average Interest Rate and Guarantee Rate Across the Threshold**

Notes: This figure shows interest rates and guarantee rates in discrete $2,000 bins across the threshold. While the guarantee rate drops dramatically at the threshold, the interest rate remains flat. The graph pools over all years 2008-2017. Source: SBA.

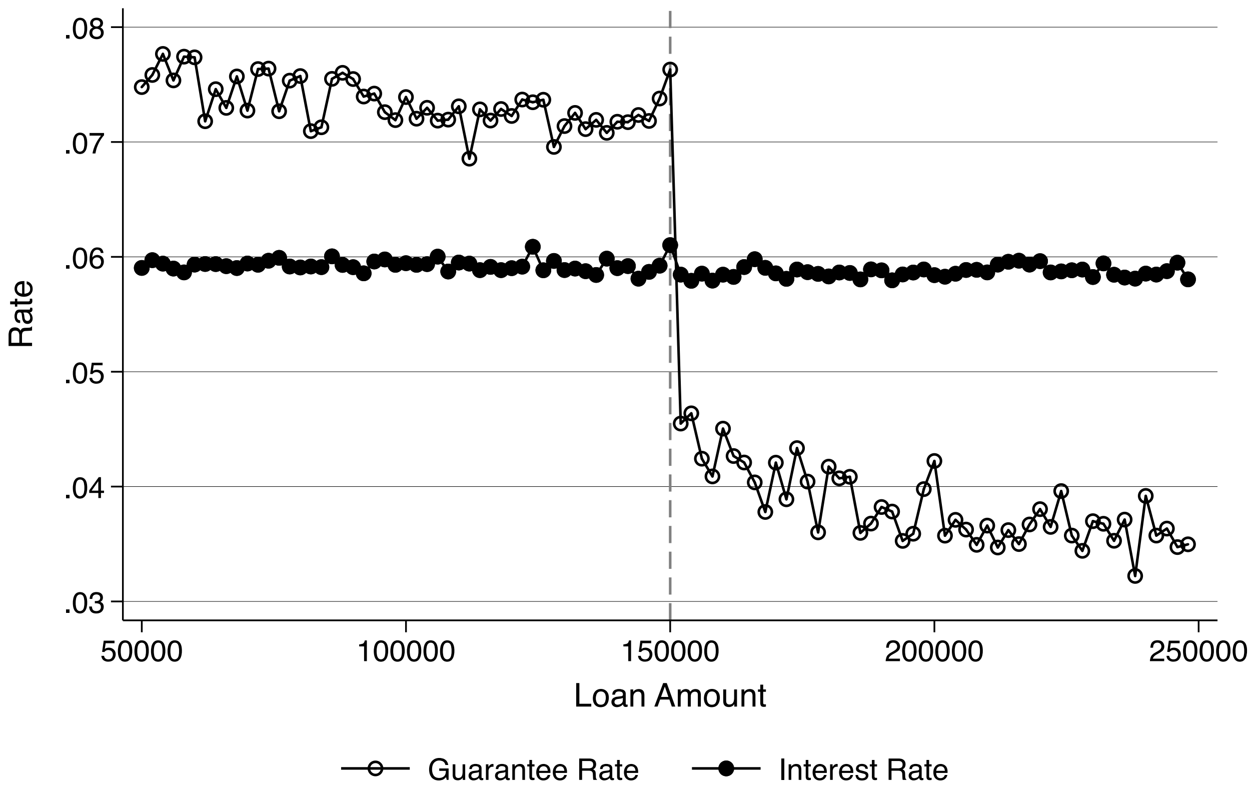
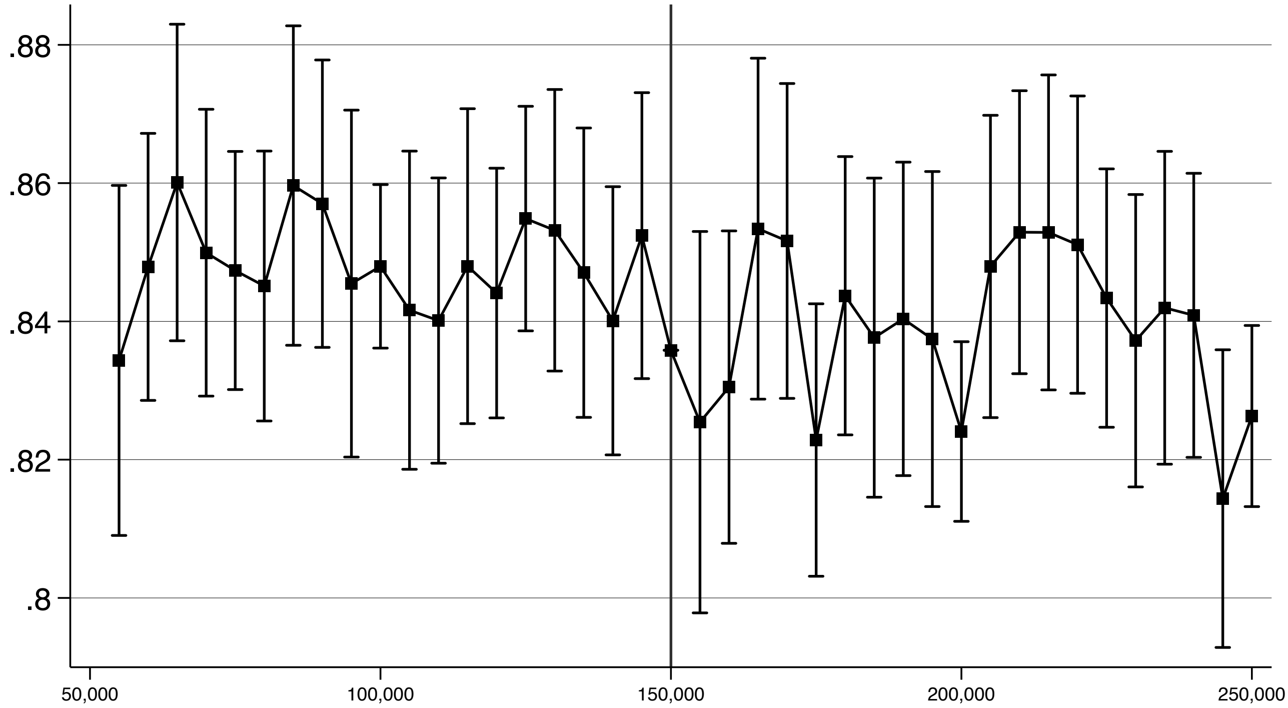


**Figure 6: Percentage of Loans at the Binding Interest Rate Maximum**

Notes: This figure shows the percentage of loans made at the maximum interest rate cap in discrete $2,000 bins across the threshold. The graph pools over all years 2008-2017. The regressions that produced these figures controlled flexibly for year-month effects and bank fixed effects. Source: SBA.



## Figure 7: Other Variables at the Guarantee Notch

Notes: This figure plots the average interest rate, revolving loan percentage, charge-off percentage, and loan term across the threshold. They are normalized with respect to the value of the variable at the threshold. There is no significant difference in initial interest rate, the percentage of revolving loans, the charge-off percentage across the threshold. Note the presence of round number bunching. The regressions that produced these figures controlled flexibly for year-month effects and bank fixed effects. Source: SBA.

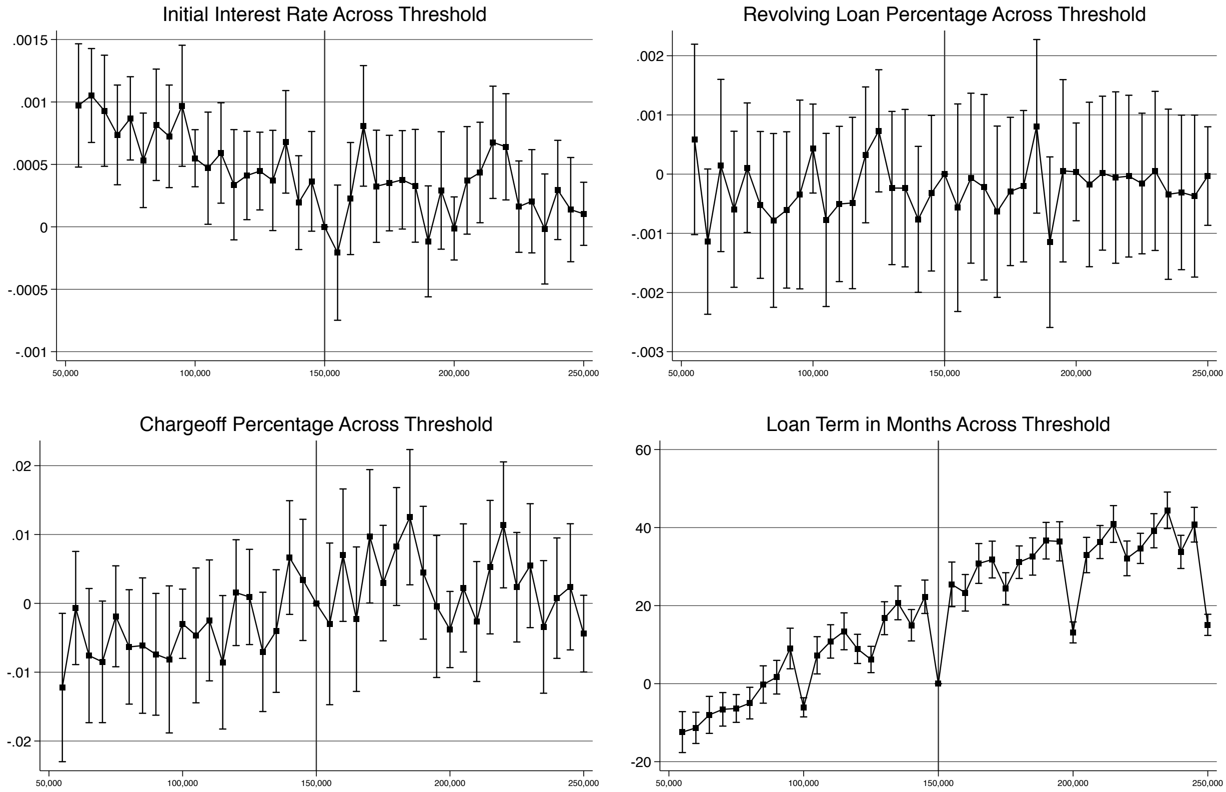


**Table 1: Summary Statistics**

Notes: This table shows summary statistics for the main analysis variables. The first two columns report the mean and the standard deviation, the third to fifth columns report the 25th, median, and the 75th percentile, respectively. Panel A reports summary statistics for full sample and panel B reports statistics for the sample of loans used in the notch estimation (loan size between \$75,000 and \$225,000). Loan amount is the size of a given loan in the sample. Reimbursement rate refers to the SBA determined reimbursement rate pooling across all years in the sample (2008 - 2017). Reimbursed amount is the guaranteed portion of the loan balance. Interest rate is the total interest rate (base plus spread) at the time of loan origination. Maturity is the length of loan terms, and charge-off amount is the total loan balance charged off, including guaranteed and non-guaranteed portion of loan. Loans per firm-lender pair reports the number of loans that a given firm borrows from the same lender in the same year. The excess mass reports an estimate of the amount of excess mass ($\hat{B}$) at the 150k notch, which we measure as the difference between the observed and counterfactual bin counts in the excluded region at and to the left of the notch. The estimate is reported as the share of bunching relative to the total number of loans in the estimation range. Excess mass is only reported in panel B, as it is estimated using the notch sample only. Source: SBA.

| Outcome | Mean | Std. Dev. | $25^{th}$ Pctile. | Median | $75^{th}$ Pctile. |
|---|---|---|---|---|---|
| | | | A. Full sample | | |
| Loan Amount (\$) | 746,107 | 826,485 | 215,000 | 460,000 | 950,000 |
| Reimbursement Rate | .80 | .06 | .75 | .75 | .85 |
| Reimbursed Amount (\$) | 574,195 | 626,519 | 168,750 | 356,400 | 735,000 |
| Interest Rate (%) | 5.73 | 0.74 | 5.25 | 5.96 | 6.00 |
| Maturity (in years) | 15 | 8 | 10 | 10 | 25 |
| Charge-off Amount (\$) | 11,706 | 85,383 | 0 | 0 | 0 |
| Loans per firm-lender pair | 1.05 | 0.27 | 1.00 | 1.00 | 1.00 |
| Observations | 199,013 | 199,013 | 199,013 | 199,013 | 199,013 |
| | | | B. Sample for notch estimation | | |
| Loan Amount (\$) | 147,359 | 41,330 | 112,000 | 150,000 | 180,000 |
| Reimbursement Rate | .84 | .05 | .85 | .85 | .90 |
| Reimbursed Amount (\$) | 120,575 | 31,354 | 93,750 | 127,500 | 141,110 |
| Interest Rate (%) | 6 | 1 | 6 | 6 | 6 |
| Maturity (in years) | 10 | 5 | 7 | 10 | 10 |
| Charge-off Amount (\$) | 6,221 | 26,704 | 0 | 0 | 0 |
| Share of Excess Mass | .08 | .06 | .04 | .05 | .16 |
| Loans per firm-lender pair | 1.03 | 0.27 | 1.00 | 1.00 | 1.00 |
| Observations | 41,460 | 41,460 | 41,460 | 41,460 | 41,460 |

## Table 2: Guarantees and Fees by Loan Amount

Notes: This table includes fees and guarantee rates for loans with maturities larger than 12 months. Fees are calculated as a percentage of the loan principal. The reimbursement rate is expressed as a percentage of charged off principal. The net benefit combines the fees and reimbursement rate to measure the average expected generosity of the guarantee, and is expressed as a percentage of the loan principal amount. This net benefit is calculated as the guaranteed reimbursement on expected losses minus guarantee fees. Loan amount smaller than $150,000 refers to loans between $0-150,000. Loan amount larger than $150,000 refers to loans between $150,000-700,000. Source: SBA

| | Loan Amount Smaller than $150,000 | | | | Loan Amount Larger than $150,000 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Fiscal Year | Yearly Fee | One Time Fee | Reimbursement Rate | Net Benefit | Yearly Fee | One Time Fee | Reimbursement Rate | Net Benefit |
| 2008 | 0.55 | 2 | 85 | 4.6 | 0.55 | 3.42 | 75 | 2.6 |
| 2009 | 0.55 | 0 | 90 | 7.4 | 0.55 | 0 | 90 | 7.4 |
| 2010 | 0.55 | 0 | 90 | 7.4 | 0.55 | 0 | 90 | 7.4 |
| 2011 | 0.55 | 2 | 85 | 4.9 | 0.55 | 3.42 | 75 | 2.9 |
| 2012 | 0.55 | 2 | 85 | 4.6 | 0.55 | 3.42 | 75 | 2.7 |
| 2013 | 0.55 | 2 | 85 | 5.8 | 0.55 | 3.42 | 75 | 2.6 |
| 2014 | 0 | 0 | 85 | 10.5 | 0.52 | 3.42 | 75 | 2.9 |
| 2015 | 0 | 0 | 85 | 10.5 | 0.52 | 3.42 | 75 | 2.9 |
| 2016 | 0 | 0 | 85 | 9.6 | 0.47 | 3.42 | 75 | 2.9 |
| 2017 | 0.55 | 0 | 85 | 6.3 | 0.55 | 3.42 | 75 | 2.7 |

### Table 3: Excess Mass and Elasticity Estimates, by Notch and non-Notch Years

This table reports estimates of excess mass for placebo years (2009 and 2010) where there was *no* change in the reimbursement rate at the 150,000 threshold and for years where a notch existed (2008, 2011-2017). Elasticity estimates are reported in the latter sample. For estimation, we restrict the loan sample with size between $75,000 to $225,000, use the step size of 500, include round number dummies for multiples of 1,5, 10, 25, and 50 thousand, and use a polynomial of degree 6. The change in the guarantee rate at the threshold for years in which a notch existed is computed as the weighted average, where the weights correspond to the number of loans across years 2008, 2011-2017. Standard errors are reported in italics and obtained by empirical bootstrap with 1,000 repetitions of resampling the distribution of loans made. Bunching estimation routine is run at every bootstrap iteration until convergence. Source: SBA.

| Year | Polynomial | Excess Mass | $\Delta$D | $\Delta\Gamma$ | Elasticity |
|---|---|---|---|---|---|
| | | *A. Placebo Years - No Notch* | | | |
| 2009-2010 | 5 | 67 | 21000 | - | - |
| | | *(21.57)* | *(14796)* | - | - |
| | 6 | 66 | 21000 | - | - |
| | | *(41.36)* | *(14285)* | - | - |
| | 7 | 0 | 9500 | - | - |
| | | *(16.76)* | *(13131)* | - | - |
| | | *B. Pooled Years - With Notch* | | | |
| 2008, 2011-2017 | 5 | 4744 | 66500 | 0.038 | 4.647 |
| | | *(98.9)* | *(1326)* | - | *(0.186)* |
| | 6 | 4710 | 69500 | 0.038 | 5.075 |
| | | *(44.38)* | *(2806)* | - | *(0.395)* |
| | 7 | 4745 | 71500 | 0.038 | 5.372 |
| | | *(102.6)* | *(1240)* | - | *(0.181)* |

**Table 4: Excess Mass and Elasticity Estimates, by Year**

This table shows elasticities for years in which a notch existed, and estimates of the excess mass for the two years (2009 and 2010) in which there was no change in the guarantee rate at the 150,000 threshold. For this estimation: the stepsize = 500, the range was limited to 75,000-225,000, we included round number dummies for multiples of 1,5, 10, 25, and 50 thousand, and we used a polynomial of degree 6. Source: SBA.

| Year | Excess Mass | $\Delta$D | $\Delta\Gamma$ | Elasticity |
|---|---|---|---|---|
| *Placebo Years - No Notch* | | | | |
| 2009 | 19.12 | 2,500 | 0 | NA |
| 2010 | 35.02 | 6,000 | 0 | NA |
| *Years With Notch* | | | | |
| 2008 | 248.39 | 52,000 | 0.02 | 5.32 |
| 2011 | 151.81 | 40,500 | 0.02 | 3.36 |
| 2012 | 132.64 | 60,500 | 0.02 | 7.62 |
| 2013 | 199.91 | 71,500 | 0.03 | 6.41 |
| 2014 | 233.02 | 62,000 | 0.08 | 2.01 |
| 2015 | 457.83 | 55,500 | 0.08 | 1.61 |
| 2016 | 564.04 | 60,500 | 0.07 | 2.24 |
| 2017 | 1,386.12 | 69,500 | 0.04 | 5.47 |

## Table 5: Robustness Tests on Elasticity Estimate Parameters

In this table we test the sensitivity of our elasticity estimates by varying key parameters. Our main estimates use a polynomial of degree 6 to estimate the counterfactual loan distribution and a step size of $500 when iterating through the routine to find the upper limit of the excluded zone. Here we vary the polynomial (top portion) to degree 5 and 7 while keeping the step size constant, and vary the step size while keeping the polynomial constant. The elasticity estimates appear quite robust to the choice of polynomial, and do not seem to have a specific direction of bias (smaller or larger) when we increase the polynomial degree. Aside from 2008 in column 1, the estimates are also quite stable when we vary the bin size.

| | Polynomial Degree 5 | | | Polynomial Degree 6 | | | Polynomial Degree 7 | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Excess Mass | $\Delta D$ | Elasticity | Excess Mass | $\Delta D$ | Elasticity | Excess Mass | $\Delta D$ | Elasticity |
| 2008 | 302.73 | 67,000 | 8.83 | 301.99 | 53,000 | 5.48 | 302.17 | 53,000 | 5.48 |
| 2009 | 19.31 | 3,500 | - | 19.12 | 3,500 | - | 19.16 | 3,500 | - |
| 2010 | 35.41 | 7,500 | - | 35.02 | 7,000 | - | 34.94 | 7,500 | - |
| 2011 | 194.49 | 46,500 | 4.56 | 195.37 | 43,500 | 3.98 | 196.40 | 46,500 | 4.56 |
| 2012 | 153.07 | 66,500 | 10.20 | 152.68 | 59,000 | 8.00 | 153.46 | 58,000 | 7.72 |
| 2013 | 238.84 | 62,500 | 4.76 | 240.31 | 72,500 | 6.43 | 240.03 | 63,000 | 4.83 |
| 2014 | 335.74 | 57,000 | 1.62 | 335.73 | 62,500 | 1.96 | 337.77 | 73,000 | 2.68 |
| 2015 | 637.79 | 61,500 | 1.96 | 637.69 | 56,500 | 1.65 | 634.36 | 54,000 | 1.51 |
| 2016 | 806.67 | 71,500 | 3.23 | 804.95 | 62,500 | 2.45 | 804.33 | 72,000 | 3.27 |
| 2017 | 2021.43 | 64,500 | 4.78 | 2031.94 | 71,000 | 5.80 | 2029.94 | 71,500 | 5.89 |
| | Bin Size = 100 | | | Bin Size = 200 | | | Bin Size = 500 | | |
| Year | Excess Mass | $\Delta D$ | Elasticity | Excess Mass | $\Delta D$ | Elasticity | Excess Mass | $\Delta D$ | Elasticity |
| 2008 | 304.17 | 71,700 | 10.13 | 302.21 | 54,200 | 5.74 | 301.99 | 53,000 | 5.48 |
| 2009 | 21.22 | 3,100 | - | 21.42 | 3,200 | - | 19.12 | - 3,500 | - |
| 2010 | 35.18 | 8,100 | - | 35.03 | 9,200 | - | 35.02 | - 7,000 | - |
| 2011 | 192.56 | 46,100 | 4.48 | 193.87 | 45,600 | 4.38 | 195.37 | 43,500 | 3.98 |
| 2012 | 147.65 | 57,300 | 7.53 | 149.66 | 57,800 | 7.67 | 152.68 | 59,000 | 8.00 |
| 2013 | 231.96 | 65,000 | 5.15 | 232.39 | 64,200 | 5.02 | 240.31 | 72,500 | 6.43 |
| 2014 | 331.94 | 62,700 | 1.97 | 331.32 | 61,200 | 1.87 | 335.73 | 62,500 | 1.96 |
| 2015 | 638.19 | 58,100 | 1.75 | 637.65 | 61,200 | 1.94 | 637.69 | 56,500 | 1.65 |
| 2016 | 794.90 | 61,100 | 2.34 | 800.34 | 61,200 | 2.35 | 804.95 | 62,500 | 2.45 |
| 2017 | 2024.25 | 69,300 | 5.52 | 2024.26 | 70,200 | 5.67 | 2031.94 | 71,000 | 5.80 |

# A Administration of the 7(a) Loan Program

The SBA achieves this mission by overseeing various assistance programs, such as the Lending Programs, Entrepreneurial Development Programs, and Federal Contracting and Assistance Programs, which provide loan guarantees to small businesses. The maximum loan size limit is capped at \$5 million, and the use of proceeds ranges widely from traditional term loan to debt refinancing. Since there is no formal limit as to how much SBA loans a given lender can underwrite, the Office of Credit Risk Management monitors lender performance and oversees the growth of loan portfolios of banks.

While loan maturity depends largely on borrower's ability to repay, loans for working capital, machinery, and equipment have a maturity of up to 5 to 10 years while loans for real estate have a maturity of up to 25 years. Lenders and borrowers can negotiate the interest rate, but it may not exceed the maximum rate set by the SBA. The maximum interest rates are based on a loan amount and maturity such that they decrease in loan amount and increase in loan maturity within two tiered maturity groups defined by a 7-year maturity mark.

A new lender that is not familiar with the SBA loan submission process uses the General Program (GP). Under this program, the lender submits a full application requesting SBA guarantee to the Loan guarantee Processing Center (LGPC). The more experienced SBA lenders are given the "delegated" lender status. Experience lenders that have met certain performance standards are eligible to use the Certified Lender Program (CLP). Under the CLP, a lender undergoes the same application process as non-delegated lenders, but the SBA expedites the loan processing and services. The most experienced lenders use the the Preferred Lender Program (PLP). PLP lenders have the authority to process, service, or close any SBA loans without SBA's prior approval.

There are benefits and costs associated with becoming an SBA lender. A key benefit is that the SBA guarantee helps lenders mitigate credit risks while allowing them to expand their customer base by serving borrowers who may not meet the conventional lending requirements. From a regulatory perspective, since the risk weight of guaranteed loans is lower than for unguaranteed loans, the 7(a) guarantee lowers a lender's risk-weighting for meeting the Basel II capital requirements. SBA loans also have the potential to receive Community Reinvestment Act (CRA) consideration if the loans meet the definition of "loans to small business."

The costs for lenders include one-time guarantee fee, annual ongoing servicing fee for each loan approved and disbursed, and other applicable fees associated with ongoing SBA oversight, late payment, or packaging and other services. The lender is required to submit the one-time guarantee fee with the loan application for loans with maturities of 12 months or less, and within 90 days of the date of the loan's approval for loans with maturities exceeding 12 months. This guarantee fee is based on the loan maturity and the guaranteed portion of the loan[23]. Lenders may pass-through this one-time guarantee to borrowers, and borrowers in turn may use loan proceeds to pay the guarantee fee in the initial disbursement. The annual ongoing servicing fee is set at the time of loan approval and based on the outstanding principal balance of the guaranteed portion of the loan. In fiscal year 2018, this fee is set to 0.55% of the outstanding balance of the SBA's share. Note that this cost structure may incentivize the lenders to not always charge the maximum allowable interest rates and guarantee rate on loans to reduce the amount of fees paid to SBA.

Table A.2 reports the industry breakdown of the borrowers that receive SBA loans. In our sample, small businesses in accommodation and food services industry receive SBA loans most frequently (i.e., 18% of all loans), and the top 10 industries make up nearly 90% of all loans originated to small businesses. Small businesses in accommodation and food services industry is over-represented in the SBA data when compared to the industry composition of small businesses at the national level, where businesses in this industry only make up 8% of all small businesses. On the other hand, businesses in professional services and construction are under-represented in the SBA sample. In other industries, SBA industry composition line up well with the industry composition at the national level.

[23] For any short-term loans with maturities of 12 months or less, the fee is 0.25% of the guaranteed portion of the loan. For loans with longer maturities, loans of $150,000 or less require 2%; loans of amount greater than $150,000 but less than $700,000 require 3%; and loans of amount greater than $700,000 but less than 1 million require 3.5%; and loans of size greater than a million require 3.75% of the guaranteed portion of the loan.

**Figure A.1: Guarantees and Fees by Loan Amount**

Notes: This figure shows the average expected guarantee fees and reimbursement rate as a percentage of the loan principal amount for discrete 2000 bins across the threshold. The graph pools over all years 2008-2017. Source: SBA.

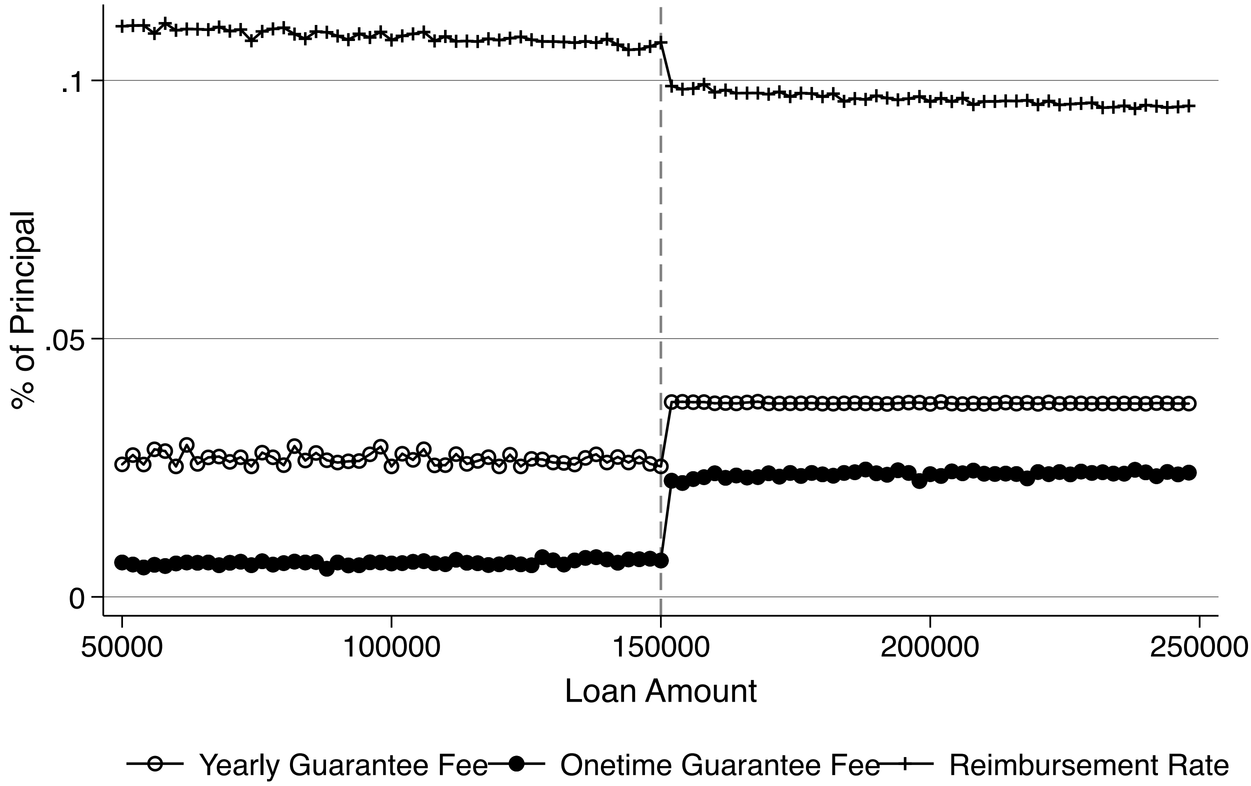


**Figure A.2: Bunching at the Guarantee Notch, Wider Axis**

Notes: This figure shows the number of loans made in discrete $2,000 bins across the threshold. The graph pools over all years 2008-2017 with an alternative wider axis. Note bunching at round numbers, which is controlled for in the elasticity estimate. Source: SBA.

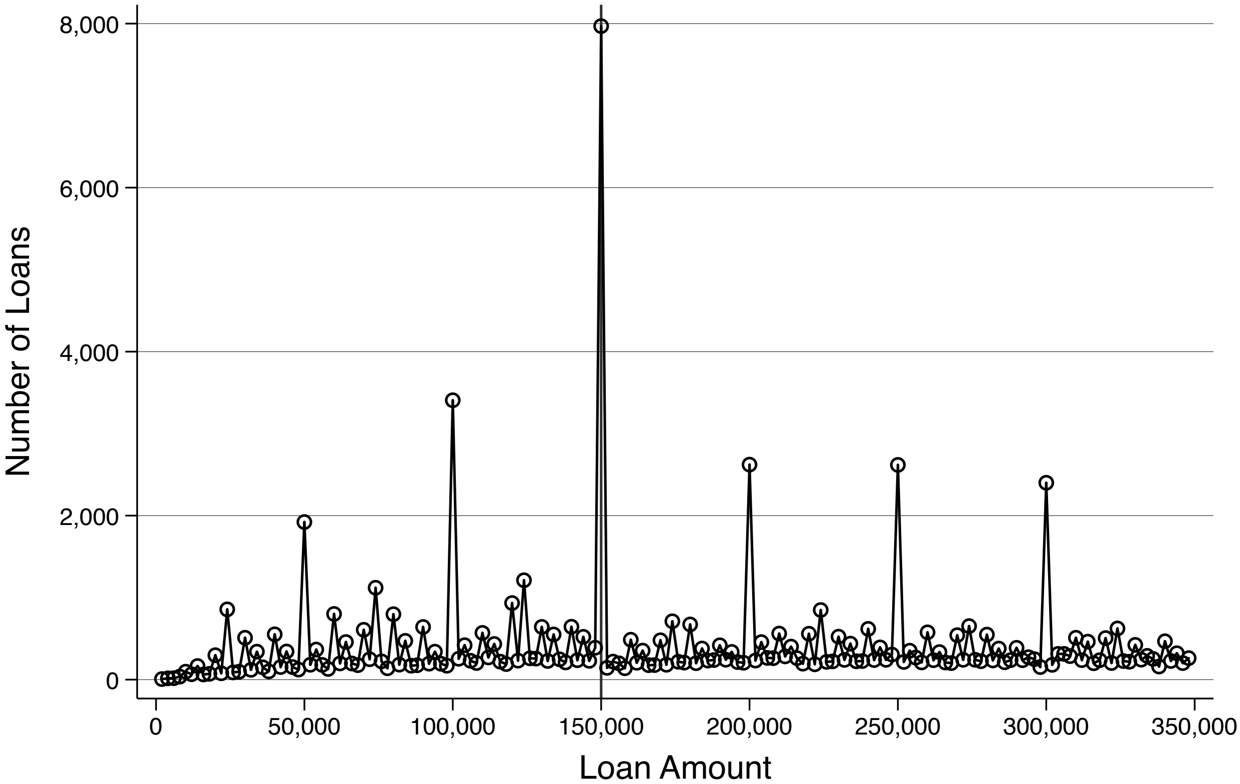


**Figure A.3: Observed and Estimated Loan Density for Elasticity Estimation, 2008 and 2009**

Notes: This figure plots the observed loan density (dark blue) and the estimated counterfactual density (green) for 2008 and 2009. A notch at the $150,000 threshold existed in 2008 and did not exist in 2009. For estimation, we restrict the loan size to be between $75,000 to $225,000. The counterfactual is estimated for each notch separately by fitting a sixth-order polynomial with round-number fixed-effects to the empirical distribution using step size of 500, and excluding data around the notch, as specified in equation 10. The missing mass at the threshold is measured as the distance between the dark blue and green points at $150,000. The red vertical line shows where the marginal buncher comes from, and the dotted vertical lines marks excluded ranges $[d_L, d_U]$. The estimation procedure identifies excess mass at the $150,000 threshold in 2008 (left) but not in 2009 (right) when incentives to bunch did not exist.

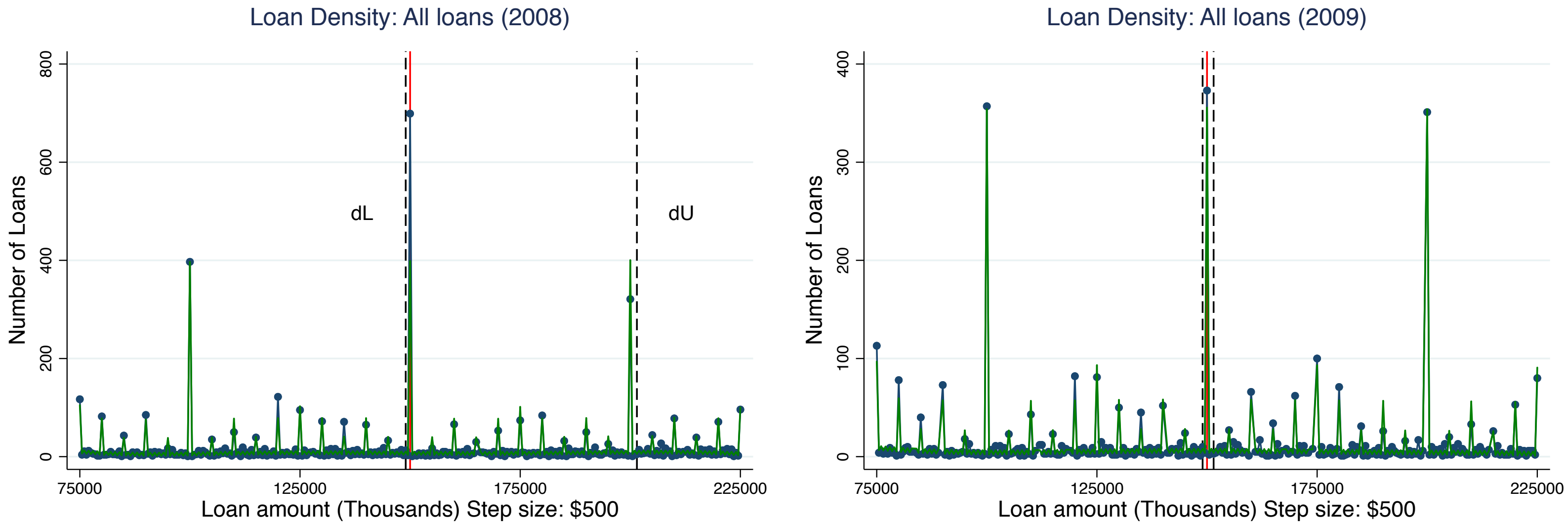


**Table A.1: Variable Descriptions**

Notes: This table reports the main analysis variables, their definitions, and source.

| Variable Name | Definition | Source |
|---|---|---|
| Loan Amount | Total loan amount in dollars. | SBA |
| Reimbursed Amount | Amount of SBA's loan guarantee. | SBA |
| Charge-off Amount | Total loan balance charged-off (includes guaranteed and non-guaranteed portion of loan.) | SBA |
| Interest Rate | Initial interest rate at the time loan was approved (base rate plus spread.) | SBA |
| Reimbursement Rate | Total guarantee rate for loans. For most years, 85% guarantee for loans of $150,000 or less; 75% guarantee for loans greater than $150,000 (up to $3.75 million maximum guarantee.) | Derived from SBA |
| Maximum Rate | Maximum interest rate a bank can charge a borrower. | SBA. LIBOR from BNY Mellon |
| Maturity | Length of loan term | SBA |
| Yearly Fee | A yearly fee that a lender must pay to SBA for each loan guaranteed under the 7(a) program. Based on the guaranteed portion of the loan and not the total loan amount. This fee cannot be passed on to the borrower. | SBA |
| One-Time Fee | One-time guarantee fee that a borrower pays the SBA to obtain a loan. | SBA |
| Average Expected Guarantee Benefit | Predicted guarantee amount as a share of loan principal net of one-time and yearly fees, assuming 100% charge-off. | Derived from SBA |
| Excess Mass | The amount of bunching at the $150,000 notch computed as the difference between the observed and counterfactual bin counts between the lower limit of the excluded region ($d_l$) and the threshold ($D^T$). | Estimated following Kleven and Waseem (2013) |
| Share of Excess Mass | Excess mass as a share of the total number of loans in the estimation range. | Estimated |

**Table A.2: Industry Breakdown**

Notes: This table reports the industry breakdown of the borrowers that received loans in the full sample. Industries are grouped by NAICS 2-digit sector code. The second and third columns report the number of loans by industry and the share of loans as a fraction of total loans in the SBA sample. The last two columns report the number of small businesses in each industry and their share as a fraction of total number of small businesses in the U.S. The data for the last two columns are obtained from the 2012 Statistics of U.S. Businesses (SUSB) reported by the Census Bureau. "Public Administration" is a newly added NAICS code not represented in the 2012 SUSB data. "N/A" represents missing industry information. Source: SBA and SUSB.

| | SBA Sample | | Population (SUSB) | |
|---|---|---|---|---|
| Industry | N of Loans | Share | N firms | Share |
| Accommodation and Food Services | 35,797 | 0.180 | 495,347 | 0.086 |
| Retail Trade | 31,748 | 0.160 | 650,749 | 0.112 |
| Health Care and Social Assistance | 23,995 | 0.121 | 640,724 | 0.111 |
| Other Services (excl. Public Admin) | 19,939 | 0.100 | 667,176 | 0.115 |
| Manufacturing | 17,173 | 0.086 | 256,363 | 0.044 |
| Professional Services | 14,729 | 0.074 | 772,685 | 0.133 |
| Construction | 10,636 | 0.053 | 640,951 | 0.111 |
| Wholesale Trade | 9,194 | 0.046 | 315,031 | 0.054 |
| Admin Support and Waste Management | 6,452 | 0.032 | 327,214 | 0.056 |
| Arts, Entertainment, and Recreation | 6,403 | 0.032 | 114,969 | 0.020 |
| Real Estate and Rental and Leasing | 5,943 | 0.030 | 270,034 | 0.047 |
| Transportation and Warehousing | 4,773 | 0.024 | 168,057 | 0.029 |
| Agriculture | 3,836 | 0.019 | 21,351 | 0.004 |
| Finance and Insurance | 3,231 | 0.016 | 234,841 | 0.041 |
| Educational Services | 2,424 | 0.012 | 84,503 | 0.015 |
| Information | 1,879 | 0.009 | 71,108 | 0.012 |
| Mining and Gas Extraction | 578 | 0.003 | 22,149 | 0.004 |
| Utilities | 135 | 0.001 | 5,973 | 0.001 |
| Management | 125 | 0.001 | 26,819 | 0.005 |
| Public Administration | 18 | 0.000 | 0 | 0.000 |
| N/A | 5 | 0.000 | 7,104 | 0.001 |

**Table A.3: Components of Main Elasticity Estimates**

This table lists the main outputs of the bunching estimation routine for each year. For this estimation: Step size = 500, the range was limited to 75,000-225,000, we included round number dummies for multiples of 1,5, 10, 25, and 50 thousand, and we used a polynomial of degree 6. We excluded years 2009 and 2010 when there was no change in the guarantee. $D_L$ refers to the lower bound of the excluded region, $D^*$ is the threshold, $D_U$ is the estimated upper bound of the excluded region, $\Delta D$ is the size of the excluded region, $B$ is the excess number of loans estimated at the threshold, and $M$ is the estimated number of missing loans in the excluded region.

| Year | $D_L$ | $D^\star$ | $D_U$ | $\Delta D$ | $\hat{B}$ | $\hat{M}$ | Step Size |
|---|---|---|---|---|---|---|---|
| 2008 | 149,000 | 150,000 | 201,500 | 52,500 | 248.39 | -335.98 | 500 |
| 2011 | 149,000 | 150,000 | 190,500 | 41,500 | 151.81 | -190.00 | 500 |
| 2012 | 149,000 | 150,000 | 210,500 | 61,500 | 132.64 | -167.35 | 500 |
| 2013 | 149,000 | 150,000 | 221,500 | 72,500 | 199.91 | -366.70 | 500 |
| 2014 | 149,000 | 150,000 | 212,000 | 63,000 | 233.02 | -269.15 | 500 |
| 2015 | 149,000 | 150,000 | 205,500 | 56,500 | 457.83 | -516.82 | 500 |
| 2016 | 149,000 | 150,000 | 210,500 | 61,500 | 564.04 | -562.26 | 500 |
| 2017 | 149,000 | 150,000 | 219,500 | 70,500 | 1386.12 | -1462.46 | 500 |