Collateral Value and Strategic Default: Evidence from Auto Loans

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May 29, 2018

Abstract

This paper identifies the link between collateral value and strategic default incentives. Using novel auto loan performance data, I examine how unanticipated changes in vehicle import taxes and changes to loan-to-value restrictions impact borrowers' strategic behavior incentives. These shocks affect the value of the underlying asset but are not related to underlying borrower characteristics or their ability to repay. Using a difference-in-difference strategy, I estimate that a 10% drop in the collateral value corresponds to a 44% increase in default rate. Consistent with the strategic default hypothesis, I find that the collateral value has a stronger effect for borrowers with higher outstanding loan balances and no significant impact on the prepayment rate.

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Introduction

Economic theory predicts strategic default–borrower decision to maximize wealth by withholding payments–when the collateral value drops sufficiently (Klein, 1996; Hart and Moore, 1998; Hart, 2009, 2017; Foster and Van Order, 1984; Kau et al., 1987; Titman and Torous, 1989; Campbell and Cocco, 2015). However, due to countervailing non-financial factors, borrowers may opt to repay loans though financial incentives suggest default is optimal (Bursztyn et al., 2015; Guiso et al., 2013; Bhutta et al., 2017).[1] Therefore, whether collateral value affects the borrowers' default decision is a challenging empirical question having material implications in policy and contract design. Yet, no compelling empirical evidence has emerged on the causal effect of collateral value on strategic default due to confounding factors. Using policy-induced variation in collateral value and rich auto loan microdata, this paper estimates the causal effect of collateral value on strategic default.

The greatest challenge facing empirical identification of collateral-value effect on default is finding a source of variation in collateral value that is otherwise uncorrelated with borrowers' ability to pay and unobserved borrower characteristics. To the extent these unobserved factors are correlated with the collateral value, failure to control for these factors can introduce omitted variable biases that preclude causal inference. Controlling for borrower ability to pay is sufficient to isolate general strategic default (Mayer et al., 2014; Yannelis, 2017; Gerardi et al., 2017). For instance, an unobserved local demand shock may impair both financial incentives to repay and the ability to pay, and controlling for ability isolates defaults that are not driven by borrowers' inability. However, controlling for borrowers' ability is not sufficient to isolate strategic defaults driven by changes to collateral value. Other unobservable borrower characteristics, such as the cost of default forming part of borrowers' wealth calculation, likely correlate with other factors

[1] Non-financial factors may include moral aversion to default (Bursztyn et al., 2015; Guiso et al., 2013), emotional attachment (Guiso et al., 2013; Bhutta et al., 2017), fear over the perceived consequences of default (White, 2010; Seiler et al., 2012), people's subjective expectations (Kuhnen and Melzer, 2017), inattention (Andersen et al., 2015; Agarwal et al., 2015) and financial illiteracy (Burke and Mihaly, 2012).

that determine collateral value such as type of collateral, level of maintenance, and time of purchase. Therefore, in order to achieve a clean identification, variation in collateral value should be uncorrelated with both the borrowers' ability to pay and other unobservable factors that are part of borrowers' wealth calculation.

In this paper, I overcome the identification challenge by exploiting policy changes that varied vehicle import tax rates and maximum loan-to-value ratios for auto loans in Sri Lanka.[2] These unanticipated policy changes affected the secondary market values of vehicles already pledged as collateral. My identification strategy hinges on the notion that while these changes to the value impact borrowers' incentives to strategically default, those are not correlated with unobserved borrower characteristics or their ability to pay. Furthermore, these changes impacted secondary market values of certain classes of vehicles only, allowing me to use comparable unaffected vehicle types as control samples in a difference-in-difference setting.

The empirical analysis features two sections. First, the impact of change in collateral value on strategic default is estimated using three unanticipated vehicle import tax rate changes during the sample period: a November 2014 import tax rate cut for cars with an engine capacity less than 1L (henceforth, smaller-engine cars) and two import tax rate hikes for new 3-wheelers in November 2015 and April 2016.[3] As expected, I find that the decrease (increase) in import tax rates on smaller-engine cars (3-wheelers) led to a decrease (increase) in the secondary market value of used vehicles in affected category by decreasing (increasing) the relative demand for used vehicles. Using these tax rate changes as *treatments*, I apply the standard difference-in-difference methodology to loan-month observations, to estimate the effect of collateral-value change on strategic default. *Treated* loans are those financing vehicle types affected by a tax rate change and originated

[2]Vehicle imports are taxed heavily in Sri Lanka. Taxes are one-off and should be paid by the importer before the vehicle is cleared from the Sri Lanka Customs Department.

[3]3-wheelers are also known as auto-rickshaws, tuk-tuks or trishaws. These are motorized vehicles with three wheels mainly used as taxis in Sri Lanka.

prior to that respective tax rate change. In the case of the tax rate cut on smaller-engine cars, cars with engine capacity greater than 1L (henceforth, larger-engine cars) serve as the control sample. When analyzing the impact of tax rate on 3-wheeler loans, to ensure that my control group is comparable, I construct matched samples using loans offered for other types of vehicles based on similar borrower profiles and type of vehicle use.[4] I expect, the default rate to increase for smaller-engine car loans originated prior to the tax rate cut in comparison to the default rate for the unaffected larger-engine car loans. Likewise, the default rate of 3-wheeler loans is expected to drop relative to the control sample, following tax rate hikes. Throughout the analysis, I include loan fixed effects to account for unobserved time-unvarying borrower characteristics and district-month fixed effects absorb any time-varying differences across borrowers at the district level.

The second section examines the impact of loan-to-value ratio (LTV) cap changes on default rates. In Sri Lanka, auto loans originated prior to 2017 were subject to an LTV cap of 70%. In January 2017, the Central Bank of Sri Lanka revised the LTV caps applicable for auto loans financing *new* vehicles based on vehicle type– rising for some and decreasing for others. Specifically, the LTV cap for financing new trucks and busses was raised to 90% while LTV cap for a new passenger vehicle (cars, SUVs, and vans) was cut to 50%. The LTV cap for a new 3-wheeler was cut to 25%. LTV cap for *used vehicle* loans remained unchanged at 70%. As shown later in the paper, these changes affected the secondary market values of used vehicles. Consider cars, whose LTV cap was reduced. This tighter LTV cap raises down-payment requirements to buy a new car, forcing some borrowers into used-vehicle market. The down-payment requirement for a used car is then much lower since a higher LTV cap of 70% (as opposed to 50%) applied to lower valuations. With the emerging higher demand for used cars, the value of those pledged before the reform will thus rise, curbing borrower incentives to strategically default. Similarly, for

[4] 3-wheelers are mainly used as a productive asset (as opposed to a consumption asset) and one of the control samples is restricted to loans used to finance the purchase of vehicles that are used for productive purposes

vehicle types where LTV cap is increased, borrower incentives to strategically default would rise. In this setting, a generalized difference-in-difference approach with dummy variables indicating loan-months of each vehicle type after new LTV rules was used. This study's sample comprised loan-month observations before and after the rule change and all loans were originated prior to the rule change.

Using a large proprietary database of auto loan performance from a major non-bank financial institution in Sri Lanka, first, I present evidence supporting the baseline hypothesis that tax-LTV policy changes exert significant impact on secondary market values of affected vehicles already pledged as collateral. Next, I estimate the impact of these policy changes on the default rate. I find strong evidence for the significant effect of collateral-value changes on borrower default decisions. Default rate of smaller-engine car (3-wheeler) loans rose (fell) by 0.4% (0.3%) who experienced a 10% drop (increase) in collateral value following tax changes. The unconditional probability of default prior to the tax change was 0.9% (1.7%) and the estimated effect corresponds to a 44% (24%) higher(lower) probability of default. Evidence from LTV cap changes presents similar effects from collateral value: vehicle types with newly increased LTV caps, which curbed used-vehicle demand, lead to increased default rates; vehicle types with newly lowered LTV caps saw a drop in default rate.

Main threat to my identification is the violation of the parallel trends assumption. Graphical evidence suggests that, though differ prior to the treatment, default rates still moved in parallel–providing support for the parallel trend assumption. Placebo tests simulating the reforms at earlier dates confirm that the results are not driven by preexisting trends inherent to specific vehicle types.

A second identification concern regards liquidity-constrained borrowers. In the case of smaller-engine cars, liquidity-constrained borrowers with positive equity would have prepaid loans in the absence of a tax rate cut. However, after tax rate cuts, drop in value may have wiped out the positive equity and thus some of these borrowers may have opted

to default. In this case my results would have been driven by liquidity constraints. Likewise, some 3-wheelers borrowers who would have normally defaulted might have striven to prepay loans secured with increased collateral value. Though valid, such concern is likely mitigated by severe (up to 25%) prepayment penalties facing Sri Lankan borrowers. In fact, during my sample period only 0.16% of the loans were prepaid. Nonetheless, I use difference-in-difference estimates to confirm that tax changes did not have a significant impact on the prepayments. Further, I find that the impact of collateral value is stronger for borrowers with higher outstanding loan balances, which is also consistent with the strategic default hypothesis.

One final concern I address is equity extraction. If liquidity-constrained borrowers could extract increased equity in the form of a secondary loan following gains in collateral value, then my results would be picking up the impact of relaxed liquidity constraints. Detailed monthly level data allowed tracking of total loan balances from month to month and no increase in loan balance was observed. Also, regulations do not allow borrowers to pledge the same asset as the collateral for a secondary loan with another lender. In private conversations, management of the lender further confirmed no equity extractions following any collateral value gains.

My findings contribute to two strands of literature. First, I contribute to the household finance literature by empirically identifying the effect of collateral value on strategic default. I present evidence that borrowers respond strategically to changes in collateral value through the default decision, and this has policy implications not just for auto loan market, but also for mortgage, student loan and credit card loan markets. Though many papers demonstrate default more likely for borrowers facing larger drops in collateral value, other things being equal, (e.g., Deng et al. (2000), Bajari et al. (2008), Foote et al. (2008), Scharlemann and Shore (2016)) a causal interpretation is not possible due to omitted variable bias. One exception has been Palmer (2015) who used long-run regional variation in house-price cyclicality as an instrument for house price declines. He shows that the price

declines causally explain the disproportionate share of subprime defaults that came from mortgages originated in 2006-2007. My paper also complements the literature of general strategic default. A recent set of studies shows that borrowers strategically default in response to loan modifications (Mayer et al., 2014), foreclosure moratoriums (Artavanis and Spyridopoulos, 2018), bankruptcy exemptions and wage garnishments (Yannelis, 2017), and changes to future income (Blouin and Macchiavello, 2017).

Second, my study contributes to the empirical literature on contractual imperfections and defaults by examining how contractual defaults respond to unanticipated changes in market conditions (Chiappori and Salani, 2003). In theoretical models, strategic default occurs when market conditions change sufficiently to place a business relationship outside its self-enforcing range (Klein, 1996; Hart, 2009). In my setting, this is the result of borrowers engaging in 'hold-up' when large and unanticipated changes occur in collateral value.

In addition, this paper also adds to the sparse literature on determinants of auto loan default. Agarwal et al. (2008) and Agarwal et al. (2007) study the relationship between borrower consumption choices and future auto loan performance. Heitfield and Sabarwal (2004), Ghulam and Hill (2017) and Wu and Zhao (2016) look at the determinants of auto loan default.

1. Theoretical and Institutional Background

1.1 Role of Collateral Value in Strategic Default

Economic theory predicts strategic default when the collateral value drops. Household finance literature has traditionally modeled individual loan default using option pricing theory, where borrowers default when the expected utility of continued loan repayment falls below that of default (Foster and Van Order, 1984; Kau et al., 1987; Titman and Torous, 1989). In these models, default arises from borrowers' unwillingness, rather

than inability, to repay. These defaults are called strategic defaults or ruthless defaults. Option-theoretic models suggest that borrowers strategically default when collateral values pledged to lenders drop below a crucial threshold, *ceteris paribus*. Different contract terms cause changes in incentives to default strategically. In contract theory, strategic default is the result of borrowers engaging in 'hold-up' if large and unanticipated changes occur in collateral value (Klein, 1996; Hart, 2009).

Some studies, however, have suggested that borrowers strategically default less often than their financial incentives suggest. Foote et al. (2008) find that only 6.4% of "underwater" mortgage borrowers in Massachusetts chose to strategically default in early 1990s. Bhutta et al. (2017) show that borrowers serviced home loans until falling deeply underwater. Gerardi et al. (2017) note that 96% of low equity borrowers with ability to pay remained current on their mortgages. This is likely due to countervailing non-financial factors–such as moral aversion to default (Bursztyn et al., 2015; Guiso et al., 2013), emotional attachment (Guiso et al., 2013; Bhutta et al., 2017), fear over the perceived consequences of default (White, 2010; Seiler et al., 2012), people's subjective expectations (Kuhnen and Melzer, 2017), inattention (Andersen et al., 2015; Agarwal et al., 2015) and financial illiteracy (Burke and Mihaly, 2012)–that may cause borrowers to continue repaying loans regardless of collateral value. Under this complex incentive matrix, the net effect of collateral value on default has remained obscure.

Isolating default due to collateral value is important for contract design, ex-ante policy issues (e.g: maximum loan-to-value ratio restrictions, underwriting standards, and mortgage insurance) and ex-post remedies (e.g: loan modification and foreclosure moratorium). If collateral value does not play an important role in borrowers' default behavior, then it limits the scope for credit market regulations such as loan-to-value restrictions or stricter underwriting standards. Understanding the role of collateral value in borrowers' default decision is important in gauging the cost of moral hazard in potential ex-post policy responses. Despite policy relevance, it remains unclear the extent to which borrowers

respond to changes in collateral value. Although many papers demonstrate that default more likely *ceteris paribus*, for borrowers who experience a larger drop in collateral value, (Deng et al., 2000; Bajari et al., 2008; Foote et al., 2008; Scharlemann and Shore, 2016) a causal interpretation is not possible due to omitted variable bias.

The main challenge in identifying strategic default due to collateral value changes is controlling for unobservable factors that correlate with both collateral value and borrowers' probability of default. For example, local job market conditions, which has a direct impact on borrowers ability to pay, are likely co-move with the demand for collateral. While controlling for borrowers' ability to pay is sufficient for identifying strategic default in general as in Mayer et al. (2014), Yannelis (2017), Artavanis and Spyridopoulos (2018) and Gerardi et al. (2017),[5] it is not sufficient to prove the causal link between collateral value and strategic default. There could be other unobserved factors that are part of borrowers financial incentive calculation that correlate with the collateral value. For example, borrowers' cost of default likely correlate with factors such as the type of collateral, level of maintenance and time of purchase. To isolate strategic defaults *caused by changes in collateral value*, we need variation in collateral value that is not related to both borrowers' ability to pay and unobserved factors in borrowers' financial incentive calculation.

1.2 Auto Finance Market in Sri Lanka

This section details the Sri Lankan auto finance market. Due to severe import tax rates ($\approx 200\%$), vehicles are very expensive and often considered a luxury in Sri Lanka. New compact sedans, like the Honda Civic, were priced at nearly LKR 7 million ($\approx$ USD

[5]These papers have examined repayment incentives unrelated to borrowers' ability to pay to gauge borrower strategic behavior in general. Mayer et al. (2014) find that households who were aware of the announcement of a large scale mortgage modification program responded by defaulting, despite the ability to pay. Yannelis (2017) shows that removing bankruptcy protection and increasing wage garnishment reduced defaults on student loans. Artavanis and Spyridopoulos (2018) use a foreclosure moratorium to identify strategic defaults. Gerardi et al. (2017) use detailed data on borrower income, employment status and consumption to control for borrowers' ability to pay.

47,000) in 2014. Popular small cars, such as Maruti Altos, cost around LKR 2 million (≈ USD 14,000). According to Household Income and Expenditure Survey, the mean annual Sri Lankan household income for 2012-13 was LKR 550,000 (≈ USD 3,700) and therefore a vehicle comprises a large fraction of a vehicle owner's wealth. This also means that both the auto loan liabilities and monthly repayment amounts are significant fractions of their balance sheets and monthly cash flow respectively.

In Sri Lanka, Non-Bank Finance Institutions (NBFI) is the leader in the auto finance market. NBFIs are regulated by the Central Bank of Sri Lanka. Regulatory requirements include minimum capital adequacy ratios and listing on the Colombo Stock Exchange. This NBFI segment is a key player in Sri Lanka's financial sector holding 13% of total assets among depository institutions. By year-end 2014, there were 56 NBFIs and many of which are involved predominantly in auto loan business. As of December 2014 auto loans represented more than 70% of the NBFI sector lending portfolios. These institutions attract higher risk borrowers unable to obtain an auto financing from commercial banks. Auto loans through NBFIs are processed promptly, often within hours as opposed to a few weeks for a commercial bank, and borrowers are charged a high interest rate. NBFIs enlist aggressive collection practices to minimize losses. A typical auto loan is a fixed rate with a four- to six-year maturity and a severe prepayment penalty.

The Credit Information Bureau of Sri Lanka (CRIB) provides credit information on current and prospective borrowers to lending institutions. Data include borrower identification, information regarding current and past credit facilities such as mortgages, auto loans and credit cards and payment histories. The CRIB report is one of the first documents analyzed by loan officers, before processing a request to finance any individual loan.

1.3 Policy Changes

In this paper, I use two types policy changes to generate variation in collateral value that is unrelated to unobserved borrower characteristics or their economic conditions. Variation in collateral value comes from policy changes that varied vehicle import taxes and maximum LTV ratios.

1.3.1 Import Tax Changes

Three unanticipated import tax changes were used: a November 2014 tax cut on cars with engines under 1L (smaller-engine cars) and November 2015 and April 2016 tax hikes on 3-wheeler imports

Tax Cut on Smaller-Engine Cars. In national budget proposals for 2015, it was proposed in November 2014, that import taxes for smaller-engine cars be reduced. The proposal came into effect the day after the announcement. This change came as a surprise to many since there was no dialogue regarding this change prior to November 2014. As the red line in Figure 1 depicts, this triggered a price drop of about 25% for smaller-engine cars imported after the tax reduction. Prices for car imports with engines exceeding 1L (larger-engine cars) had no effect (black line). The tax cut posed an indirect negative effect on the demand for used smaller-engine cars when these new imports became more affordable. This resulted in a drop in secondary market values of smaller-engine cars imported prior to the tax cut (formal evidence is presented later in the paper). Therefore, we expect borrowers who purchased smaller-engine cars to default more following the tax cut, relative to the borrowers who purchased larger-engine cars.

Tax Hikes on 3-wheeler Imports. 3-wheelers, serving mainly as taxis, on Sri Lankan roads increased steadily from about 400,000 in 2007 to over one million in 2015. This rapid rise raised concerns regarding increased air pollution, traffic and road accidents caused by 3-wheelers. As a part of Sri Lankan government efforts to reduce the growth in 3-wheelers, the import tax was increased in two separate occasions: in November 2015 and April 2016. As a result, new 3-wheeler price rose from LKR 505,000 to 610,000 in November 2015 and to LKR 638,600 in April 2016. Each tax hike went into effect the day after the announcement. This rise in new 3-wheeler pricing caused an increase in secondary market values of existing 3-wheelers in the country. Demand for new three-wheelers dropped while demand for used counterparts increased their secondary market values. Figure 2 plots the mean price of a new Bajaj (the most popular brand) imported from India in each month and the value of used 3-wheeler originally imported in 2012-2014. After each tax hike, values for used 3-wheelers increases by about 10%. It is clear from Figure 3 that the tax hikes were not foreseen since the volume of new 3-wheelers purchases did not spike prior to the announcement. The sharp post-announcement rise reflects sale of dealer inventory imported before the tax hikes.

1.3.2 Changes in Maximum Loan-to-Value Ratio

In a bid to curtail the vehicle imports weighing on the country's balance of payment, on 14 September 2015, the Central Bank of Sri Lanka decreed a maximum LTV to 70% per vehicle for all types of vehicles.

In November 2016, the government proposed that maximum LTVs be revised again in its 2017 national budget proposals. In January 2017, the Central Bank of Sri Lanka issued a directive clarifying the budget proposals for lender compliance, dramatically reducing maximum LTVs to 25% for 3-wheelers and 50% for motor cars, SUVs and vans from the previous 70% blanket cap. Moreover, maximum LTVs for trucks and buses were revised

upwards to 90%. The order applied only to new vehicles, leaving cap of 70% for older ones intact. Panels A through C in Figure 4 show changes in LTV ratios for each new vehicle type. The bunching at the LTV caps suggests that the new LTV restrictions are binding. Therefore it is likely to spark significant impacts on used vehicle values. For example, this means that many post-restriction borrowers who wanted to purchase a new car, SUV, van or a 3-wheeler would not be able to afford the high down payment and would be forced to the used vehicle market. The down-payment requirement for a used vehicle in these categories would be much lower due to higher maximum LTV and lower valuations. Opposite is true for trucks and buses.

The key implication of this reduction in maximum LTV for new cars, SUVs, vans and 3-wheelers was that it cut the demand for new vehicles in these categories while increasing the demand for similar used vehicle types. Thus, the secondary market value of vehicles already pledged as collateral rose (formal evidence presented later). Secondary market value of used trucks and buses dropped with the demand for new (used) trucks and buses rising (falling) after the recent loosening in maximum LTVs up to 90%.

2. Data and Sample Construction

2.1 Data

I obtained access to the internal records of one of the five largest non-bank financial institutions (NBFI) in Sri Lanka, representing, in 2014, more than 10% of the total assets of NBFI. This data set includes a wide span of loan-level data at origination, including the amount, vehicle valuation, term, interest rate, and borrower characteristics for each loan issued by this NBFI from January 2012 to August 2017 (comprising 396,551 loans). The data set also includes month-by-month stream of payments made by the borrower, while also indicating whether (and, if so, when) the loan is in default. 3-wheelers make up 55% of the NBFIs portfolio, motorcycles account for 15%, cars amount to 11%, vans

comprise 5%, and trucks constitute 4% of the total number of loans.

2.2 Sample Construction

This paper's empirical analysis deploys three primary data sets constructed from the above data set. For the first set of results, which uses tax cut for smaller-engine cars in November 2014 as the *treatment*, data is restricted to only those loans used to purchase vehicles before May 2014 (five months before the tax cut) and where the final payment came due after April 2015 (five months after the tax cut). Smaller-engine cars are the *treated* sample and larger-engine cars with valuation less than LKR 3 million are the *control* sample. Larger-engine cars were not impacted by the tax cut (*treatment*) and larger-engine cars with valuations greater than LKR 3 million were excluded to ensure that the control group would be comparable to the treatment group. The sample consists of loan-month observations five months surrounding the tax cut in November 2014 and the main outcome variable is whether the loan is in default in a particular month. Summary statistics for these samples are given in the first two columns of Table 1. Both treatment and control groups are similar based on the observable borrower and loan characteristics, with the exception of the fraction of brand new vehicles.

Second set of results uses November 2015 and April 2016 tax hikes for 3-wheeler imports as *treatments*. Two separate samples were constructed using loan-month observations within a period of five months surrounding each tax hike. The data is restricted to loans initiated for the purchase of vehicles before May 2015 (five months before the first tax hike), where the final payment date came after September 2016 (five months after the second tax hike). Here, 3-wheelers are the *treatment* sample and, in the baseline regression, all other types of vehicles are considered the *control* sample. I also construct control samples by matching borrower characteristics and the 'type of vehicle use' to ensure control samples are comparable to the treatment sample. 'Type of vehicle use' indicates whether the underlying vehicle is used for personal use (i.e. as a consumption

good) or as a productive asset that generates income. The summary statistics of this sample are given in columns (3) and (4) in Table 1. Compared to other types of vehicles, loans for 3-wheelers have a shorter term, higher interest rates, and higher LTV, while also yielding more brand new vehicles.

Third set of results uses the change in maximum LTV in January 2017 as the treatment. This sample is restricted to auto loans originated before July 2016, with a maturity date after June 2017, and it consists of loan-month observations from August 2016 to April 2017. Summary statistics for this sample are reported in the last three columns of Table 1. Compared to other types of vehicles, cars, SUVs and vans have longer terms and significantly lower interest rates.

3. Empirical Methodology

The goal of this paper is to identify whether borrowers respond strategically to changes in collateral value. The primary challenge when estimating the effect of collateral value on rates of default is that a number of omitted variables are associated with both collateral value and a borrowers default risk. Therefore, a naïve regression of the decision to default on the value of the collateral is unlikely to indicate a clear causal path. Ideally, we want random shocks to the value of the collateral, shocks without a relationship to unobserved borrower characteristics or their economic conditions. But in the absence of such ideal circumstances, this research relies on policy-induced variation in vehicle import taxes and maximum LTVs to generate exogenous variation in collateral value. This section of the paper details how I exploit each policy change to estimate the causal effect of collateral value on the decision to default.

3.1 Import Tax Changes

For this study, I use three unanticipated import-tax rate changes as quasi-experiments: In November 2014, import taxes for smaller-engine cars were reduced and import tax rates for 3-wheelers were increased on two separate occasions, in November 2015 and April 2016 (see section 1. for more details). In the case of smaller-engine cars, tax reduction increased the demand for *new* vehicles while reducing the demand for *used* ones. As a result, we would expect secondary market values of smaller-engine cars to drop relative to the secondary market value of cars unaffected. Similarly, in the case of 3-wheelers, we would expect the secondary market value to increase relative to that of other vehicles that were not affected.

First, to verify the hypothesis–that tax changes had an impact on secondary market values of treated vehicles (i.e., smaller-engine cars and 3-wheelers)–I rely on auto-loans initiated to finance the purchases of *used* vehicles within the five months surrounding each tax change. Lenders require all used vehicles to be appraised by third-party licensed valuers before they will process any auto-loan requests, and I use this appraisal value as my dependent variable in the following specification. The central idea is to test whether the valuations of used smaller-engine cars (3-wheelers) dropped (increased) after the tax change(s). I estimate this specification separately for each tax change. In the case of smaller-engine cars, I use small larger-engine cars as the control sample, and for 3-wheelers I use all the other types of vehicles as the control sample.

$$log(valuation)_{ivtd} = \alpha_v + \alpha_{td} + \sum_m \beta_m \ Treated \ Vehicle_i \times m + \epsilon_{ivtd} \tag{1}$$

where i,v,t and d represent borrower, vehicle model-manufacturing year, month of loan origination, and district, respectively. *Treated Vehicle* is a dummy variable that takes the value of one if the underlying vehicle is a treated vehicle (i.e., a smaller-engine car or a 3-wheeler). m is a dummy variable representing the number of months since the tax

change, meaning m is negative for months before the tax change and positive for months after. This regression includes vehicle model-manufacturing year and district-month fixed effects. The coefficients of interest are β_ms, where β_m estimates the difference between the value of a used *treated* and a used *control* vehicle in month m relative to the same at $m = -5$, the beginning of the sample period. We expect β_m to be zero when $m < 0$ and negative (positive) when $m > 0$ in the case of smaller-engine cars (3-wheelers).[6]

To estimate the impact of the tax rate changes on the default behavior of borrowers, I implement standard difference-in-difference research designs for each change in tax rate that uses the above conditions as the treatments. In the smaller-engine car sample, I use larger-engine cars as the control group. For 3-wheelers, I use other types of vehicles as the control group in the baseline specification.[7] I use loan-month observations for loans that originated five months before the treatment and that have maturity dates five months after the treatment in both *treated* and *control* samples. The sample begins five months before the treatment and ends five months after the treatment. Specifically, I estimate the following equation:

$$Y_{imd} = \alpha_i + \alpha_{md} + \beta\ I(m > 0) \times \textit{Treated Vehicle}_{imd} + e_{imd} \tag{2}$$

where Y_{imd} stands for the outcome variable for loan i in month m in district d. In the baseline specification Y_{imd} is a dummy variable that indicates whether the loan i is in default in month m, while m represents the number of months since the treatment. The period prior to the treatment is indicated by negative values. Y_{imd} is equal to one if the loan is in default in month m and zero otherwise. Loan level fixed effects (α_i) are included to capture any time-invariant characteristics of the borrower. $District - Month$ fixed effects (α_{md}) account for common shocks across all loans in a given district. $I(m > 0)$ is a dummy variable equal to zero for the period before the tax change and one after the tax

[6] A zero β_m when $m < 0$ provides support for the parallel trends assumption.
[7] I construct matched control samples in later tests

change. *Treated Vehicle*$_{imd}$ is a dummy variable equal to one for treated vehicle type and zero for the control sample. The coefficient of interest is β, which captures the difference in the default rate between treated and control samples after the treatment and relative to the same prior to the treatment. I expect the β to be positive for smaller-engine cars and negative for 3-wheelers.

3.2 Loan-to-Value (LTV) Restrictions

The second quasi-experiment I use concerns changes to the maximum LTV ratios for new vehicles imports. In January 2017, the Central Bank of Sri Lanka revised the maximum LTV allowed for new vehicles. Prior to 2017, all auto loans, used to finance purchases both new and old vehicle purchases, were subject a maximum LTV of 70%. But according to the revised limits, a person buying a new car, SUV, or van can only obtain financing up to 50% of the value of the vehicle, while the maximum LTV was reduced to 25% for new 3-wheelers. For new trucks and buses, lenders are allowed to finance up to 90% of the value.

As a result of the unanticipated changes to the maximum LTV requirements, the values of used cars, SUVs, vans, and 3-wheelers should increase as buyers who would have bought a new vehicle would now forced to buy a used vehicle. Similarly the values of used trucks and buses should decrease. We expect the default rates of vehicle types whose maximum LTV requirement decreased to increase and vice versa in response to changes in collateral value.

To verify that the LTV restrictions indeed had an impact on the valuations of vehicles previously pledged as collateral, I implement the following specification. As I did before, I rely on auto loans initiated to finance the purchase of *used* vehicles originated five months

surrounding the policy change in January 2017.

$$log(valuation)_{ivmd} = \alpha_v + \alpha_{md} + \sum_p \beta_p \; I(m > 0)_i \times I(type = p)_{imd} + \epsilon_{ivmd} \qquad (3)$$

where i,v,m, and d represent borrower, model-year of the vehicle, month of origination and district respectively. The dummy variable m represents the number of months since the rule change, meaning it is negative for months before the rule change and positive for months after. Dummy variable $I(m > 0) \times I(type = p)_{imd}$ takes the value one for auto loans to finance vehicle type p (where $p \in$ *(3-wheeler, bus/truck, car/SUV/van)*) after the rule change and zero otherwise. This specification includes model-year fixed effects and origination month-district fixed effects. We expect β_p to be positive when $p \in$ *(3-wheeler, car/SUV/van)* and negative when $p =$ *bus/truck*.

Next, I implement the following specification to understand the effect of changes to LTV on default rate.

$$Y_{imd} = \alpha_i + \alpha_{md} + \sum_p \sum_q \; \beta_{pq} \; I(type = p)_{itd} \times I(m \in q)_{itd} + e_{itd} \qquad (4)$$

where for loan i, in month m, and in district d, this regresses Y_{itd}–a dummy variable that indicates whether the loan i is in default in month m–on a dummy variable which equals one only if vehicle type equals p (where $p \in$ *[3-wheeler, bus/truck, car/SUV/van]*) and m is in period q. q indicates whether m is before the announcement (i.e., $m <$ November 2016), before the implementation (i.e., December 2016 $< m <$ January 2017), or after the implementation (i.e., $m >$ February 2017). Coefficients of interest are β_{pq} which measure the difference-in-differences– that is, the change in the default rate difference between vehicle type p and omitted group in time period q relative to the omitted time period. Omitted vehicle type is xxxxxx and omitted time period is period before the announcement (i.e. $m <=$ November 2016). Loan level fixed effects (α_i) are included to

capture any time-invariant characteristics of the borrower. $District \times Month$ fixed effects (α_{md}) capture monthly effects that affect all borrowers in a particular month m in a given district d.

4. Empirical Results

This section documents how unanticipated changes in vehicle import taxes (subsection 4.1) and changes to loan-to-value restrictions (subsection 4.2) impact borrowers default behavior. First, I verify that each change had significant impact on the secondary market values of vehicles pledged as collateral. Next, I provide evidence that borrowers respond strategically to these changes.

4.1 Impact of Import Tax Changes on Collateral Value and Default

4.1.1 Tax Cut on Smaller-Engine Car Imports

This section looks at the effects of tax cut on smaller-engine car imports. First, I estimate equation 1 to evaluate the impact on secondary market values of smaller-engine cars. Smaller-engine cars are the treated sample and larger-engine cars are used as the control sample. Samples consist of auto loans initiated to finance the purchase of *used* vehicles within the five months surrounding each tax change. Figure 5 presents the results. This figure plots the estimated β_m for each m. After the treatment (i.e., when $m > 0$), a significant drop in β_m is observed. This drop is in line with the prediction that the tax cut triggered a drop in secondary market values of smaller-engine cars relative to secondary market values of larger-engine cars. Estimates suggest that the value of used smaller-engine cars dropped by about 10% following the tax cut. Furthermore, insignificant β_m before the tax cut (i.e., when $m < 0$) suggests that secondary market values of both

smaller-engine cars and larger-engine cars moved in parallel before the tax cut.

Having established that tax cut had a negative significant impact on the secondary market value of smaller-engine cars, I next turn to the impact on default. Table 2 presents these results. Here, smaller-engine car loans are the *treated* sample, while the *control* sample consists of loans initiated to finance purchases of larger-engine cars. Both samples consist of loan-month observations five months surrounding the tax cut. Column (1) presents results from estimation of equation 2. Column (2) includes loan-level and borrower-level control variables, but does not include loan fixed effects. Estimates suggest that default rate for cars with engines increased by 0.4% to 0.6% following the tax cut. This translates to an approximately 44% to 66% increase in the default rate compared to the 0.9% default rate prior to the tax cut. Control variables in column (2) have the expected sign. The high R^2 value in column (1) is due to the loan fixed effects.

Identification using difference-in-difference method relies on the parallel trend assumption. Under this assumption, default rates of both treated and control groups would have trended similarly if there were no tax cut in the treatment sample. To test for the parallel trends assumption, I estimates the following equation:

$$Default_{itd} = \alpha_i + \alpha_{md} + \sum_m \beta_m \ Treated \ Vehicle_i \times m + \epsilon_{ivmd} \tag{5}$$

where i,m, and d represent borrower, month and district respectively. Dummy variable m represents number of months since the tax hike and a negative m indicates months prior to tax hike. This regression includes loan (α_i) and district-month (α_{md}) fixed effects. Figure 6 presents the estimates of β_m in equation 5 graphically. Y-axis plots the estimates of β_m against m. Vertical lines indicate 95% confidence intervals. Insignificant estimates of β_m when $m < 0$ provides support for the parallel trends assumption. As such, the difference in the default rate between treatment and control groups are not different from the rates seen at the beginning of the period.

4.1.2 Tax Hikes on 3-wheeler Imports

To verify that November 2015 and April 2016 tax hikes impacted the secondary market values of 3-wheelers, I implement equation 1 using loans initiated to finance the purchase of *used* vehicles five months surrounding each tax hike. I expect the valuations of used 3-wheelers (treated group) to increase after each tax hike relative to the valuations of other vehicles (control group), meaning that β_m to be positive and significant when $m > 0$. Results of this estimation is presented graphically in Figure 7. Panel A and B show the impact after November 2015 and April 2016 tax hikes respectively. Y-axis plots the estimated β_m coefficient with the 95% confidence interval. These figures suggest that, relative to other vehicle types, value of the used 3-wheelers increased by about 10% following each tax hike. The figure also suggests that values of all used vehicles moved in parallel prior to tax hikes.

Table 3 looks at the impact of increase in import taxes for new 3-wheelers on the default rate of loans initiated to finance the purchase of 3-wheelers prior to the tax hikes. This table implements the difference-in-difference specification 2 where 3-wheeler loans are the treated sample and other types of vehicles are the control sample. Loans in all the samples were originated prior to May 2015 (five months before the first tax hike). Columns (1) and (2) use November 2015 tax hike as the treatment, while the treatment in columns (3) and (4) is the April 2016 tax hike. Samples consist of loan-month observations five months surrounding each tax hike. Column (3) and (4) excludes loans to purchase cars from the control sample since in April 2016 there was an amendment to the import tax structure of the cars as well. The estimated coefficient of interest, which is the one on $I(m > 0) \times \textit{Treated Vehicle}_{imd}$, is negative and significant across all specifications. These results suggest that the monthly default rate of 3-wheeler loans originated prior to tax hikes reduced by 0.3% and 0.5% compared to other types of vehicles after November 2015 and April 2016 tax hikes respectively. Given the mean default rate of 1.7%, this

reduction is highly economically significant. Thus, this result indicates that thee default rate reduced by 18% to 29% following the tax hike.

Columns (2) and (4) of Table 3 show that results are robust to the inclusion of loan and borrower related controls. Samples in these columns were constructed using the same restrictions. In these regressions I include loan origination month fixed effects to control for difference in the time of loan origination.

One possible concern with my methodology is that other vehicle type borrowers are not an adequate control group because they are too different from 3-wheeler borrowers. One key difference is that 3-wheelers are purchased by less affluent borrowers while other types of vehicles, like cars, are purchased by more affluent borrowers. Thus, one may worry about the possibility that an unobserved shock affected less affluent borrowers at the time of the tax hikes. To address this concern, I use a matched sample of motorbikes as the control sample. Unlike in the more developed countries, motorbikes in Sri Lanka are purchased mainly by less affluent borrowers who cannot afford cars. Matching was based on borrower characteristics, district and loan origination month using propensity score matching. Descriptive statistics of the samples before and after are given in the Appendix [xxx]. Results of this exercise are reported in columns (1) and (3) in Table 4. Interestingly, results in this sample are much stronger than the results shown in Table 3.

Another concern may be that 3-wheeler owners are systematically different from other vehicle owners as the collateral is a productive asset for the owners and other vehicle types, such as cars, are mostly consumption goods. As such, it is not implausible that some unobservable shock affected only entrepreneurial borrowers around the tax hikes. To address this concern, I compare default rates of 3-wheelers with matched mini-trucks in columns (2) and (4) in Table 4. Mini-trucks are very small trucks with small engines used to transport small loads. As is the case with 3-wheelers, mini-trucks generate the main source of income for many mini-truck owners. I select mini-truck borrowers who listed their occupation as "self-employed" or "business" so that they are comparable to

the 3-wheeler borrowers in terms of the source of income. Matching is based on the same procedure as above. Descriptive statistics of the samples before and after are given in the Appendix x. Coefficients remain negative and highly statistically significant.

Having established that 3-wheeler default rates decreased following import tax hikes, I next look at whether already defaulted 3-wheeler borrowers self-cure more in response to the tax hikes. If a borrower's previous default was strategic–i.e. if the borrower was in default despite having the ability to pay–this borrower is more likely to self-cure following the tax hikes. Loan i, is defined as a self-cure in month m, if the loan is current in month m, conditional on the loan being in default in month $m-1$. Samples were constructed for each month $m-1$, using the loans are in default in that month. The self-cure rate is defined as the fraction of loans that are not in default in month m for 3-wheelers and other types of vehicles separately. Figure 9 shows that the self-cure rate of 3-wheeler borrowers increases sharply following the tax hikes. Table 5 Panel A presents the difference-in-difference estimates for the self-cure rates. Following the November 2015 tax hike the self-cure rate increases by 12.3% and self-cure rate increases by 8.1% following the April 2016 tax hike in 3-wheeler loans. Table 5 Panel B shows that the increase in self-cure was not temporary. This table looks at how many borrowers who self-cured just after the tax hikes re-default at any point in the future. While for other types of vehicles, a sizable fraction of the self-cured borrowers re-defaulted subsequently, almost no 3-wheeler borrowers who self-cured re-defaulted afterward. As such, this is consistent with the idea that borrowers who self-cured in response to tax hikes had the ability to pay when they defaulted before the tax hikes.

4.2 Impact of Changes to Maximum Loan-to-Value Ratios on Collateral Value and Default

Results in this section look at changes to borrowers' default behavior in response to changes to the maximum LTVs. In January 2017, the Central Bank of Sri Lanka reduced the maximum LTV for *new* cars, SUVs and vans to 50% and for 3-wheelers to 25%. For buses and trucks, the LTV was increased to 90%. Prior to this directive, all the vehicles had the same maximum LTV restriction of 70%. After this regulation was implemented, only new vehicles were affected and the maximum LTV for used vehicles remained at 70%. This change was initially proposed in late November 2016.

In Table 6, I provide evidence that changes to the LTVs had an impact on the valuations of used vehicles. Results in this table indicate that values of *used* trucks and buses dropped by about 20% relative to the values of used 3-wheelers, cars, SUVs and vans. The sample uses auto loans initiated surrounding the rule change to purchase used vehicles.

Table 7 presents the results of regression specification in equation 4, which estimates the magnitude of borrowers' response to changes in the LTVs. The unit of observation is loan-month. Column (1) includes loan level fixed effects and district-month fixed effects. Column (2) employs the full set of borrower/loan level controls and vehicle type, district-month and origination month fixed effects. The dummy variable $I(type = p)_{imd} \times I(m \in \{Feb2017, Mar2017, Apr2017\})$ captures the difference in default rate between a given vehicle type p, where $p \in \{Car/SUV/Van, Truck/Bus\}$, and the excluded vehicle type (3-wheelers) after the new regulations came in to effect relative to the period before new requirements were announced (i.e., before Dec 2016). The dummy variable $I(type = p)_{imd} \times I(m \in \{Dec2016, Jan2017\})$ captures the change in default rate after the announcement but before implementation.

Under these conditions, I expect the default rates of loans to finance purchases of

trucks and buses to increase relative to 3-wheelers after the new regulations came into effect. As both personal vehicles (cars, SUVs and vans) and three wheelers were subject maximum LTV cuts, it is not clear if the default rate of personal vehicles should increase or decrease relative to the 3-wheelers. According to the estimates, there is a positive and significant increase in default rates of trucks and buses relative to 3-wheelers after the implementation of new LTV requirement(i.e,. after February 2017) and a decrease in default rate for cars, SUVs and vans relative to 3-wheelers. Coefficients are not significant in the post-announcement period of Dec 2016 to Jan 2017.

This pattern is consistent with the idea that decreasing the maximum LTV for new vehicles increased the value of used vehicles, which in turn reduced the probability of default. The estimate of 0.005 for trucks and buses indicates that default rates increased by 0.5%, approximately a 10% increase in the pre-reform default rate. For cars, SUVs and vans a decrease in default rate of about 0.1% compared to 3-wheelers can be observed. Although the down-payment requirement for 3-wheelers increased by 50% compared to the 25% increase for personal vehicles, similar response among borrowers of both personal vehicles and 3-wheelers can be observed. This indicates that, compared to 3-wheeler borrowers, personal vehicle borrowers are more sensitive to changes in collateral value.

In addition, Figure 10 shows the same result graphically. As demonstrated in this figure, insignificant β_m before the treatment supports my hypothesis that the parallel trends assumption is satisfied.

5. Placebo Tests

Regarding results reported in the previous section, a potential concern centers on the notion that results may be driven by different borrower types who are selecting into different vehicle types. In difference-in-difference, it does not matter if borrowers who select in to different types of vehicle have different default behavior as long as they move

in parallel before the treatment, meaning that there were no preexisting trends in default behavior. Graphical evidence presented earlier shows that the parallel trends assumption is likely to be satisfied for untreated periods. In this section, I provide further evidence of the identifying the assumption by simulating placebo policy changes before the actual policy change date, aimed at testing whether the results are driven by preexisting trends. If the previous results are driven by preexisting trends, then these simulations should also generate similar effects on default.

First, I simulate the tax hike for 3-wheeler imports in April 2015, before the actual dates of both tax hikes. 3-wheeler loans are considered the treated sample, while other types of vehicles are considered the control sample. Loan-month observations five months surrounding April 2015 (simulated date) constitute the sample. The dummy variable $I(m > 0)$ takes the value one if the loan-month observation is after the simulated tax change. Table 8 reports the results of this exercise where column (1) implements the equation 2 and column (2) includes control variables. Non-significant results in both columns suggest that there were no preexisting trends in default behavior. Thus, this exercise provides support for my identifying assumptions.

Next, I simulate the maximum LTV restrictions, which were implemented in January 2017, in August 2016. Sample was constructed using loan-month observations five months before and after August 2016. Observations after August 2016 are considered as treated observations and the estimation results of the specification (2) is given in Table 9 column (1). Column (2) includes controls with fixed effects. Statistically not significant coefficients in both columns suggest that the identification assumption is valid.

6. Robustness

6.1 Prepayment

When a borrower is liquidity constrained, she has two options: prepay the loan by selling the collateral or default on the loan. If the net outcome of the prepayment is positive, the borrower would prepay instead of defaulting and vice versa. One concern with my analysis is that liquidity constrained borrowers may change their behavior in response to changes in the collateral value. In the case of the tax cut for smaller-engine cars, it is possible that the net positive benefit in prepayment is wiped out by the drop in the vehicle value following the tax cut. Therefore, liquidity constrained borrowers who were planning on prepaying their loan by selling the vehicle may now decide to default. My results could be simply capturing this change in response type by liquidity constrained borrowers, not strategic default. Similarly, following the value increases of 3-wheelers following tax hikes liquidity-constrained borrowers may decide to prepay their auto loans, instead of defaulting.

Yet, I note that this is unlikely to be the case due to severe prepayment penalties applicable to auto loan borrowers. If borrowers prepay, they are typically required to pay 75% of future interest in addition to the balance outstanding. As a result, prepayments are not common in auto loans. During my sample period, only 0.16% of the auto loans were prepaid. Regardless, I run a robustness test to rule out this alternative explanation.

As with the previous regressions, I run the equation 2 with Y_{imd} indicating prepayment by borrower i in district d in month m. I include loan fixed effects and district-month fixed effects. Results reported in Table 10 suggest that prepayments did not increase significantly following the tax increases.

As an additional test, I split the sample into three subsamples based on the loan origination date: The first sample includes loan originated between July 2013 and December 2014, the second sample includes loans originated between June 2013 and January 2012

and the third sample includes loans originated before January 2012. Most recently originated loans have the highest outstanding balance at the time of tax increase. As such, incentives to strategically default should be strongest in this sample. Results of this exercise are reported in Table 11 displaying the strongest effect coming from most recently originated loans. This behavior is more consistent with the strategic default hypothesis.

6.2 Equity Extraction

Another concern revolves around the idea that if liquidity-constrained borrowers are able to extract their equity in the form of a secondary loan following the increases in collateral value, my results may reflect the impact of relaxed liquidity constraints. Detailed monthly level data allows me to track the total loan balance from month to month. In this data, I do not observe any increase in loan balance after value increases and regulations do not allow borrowers to use the same asset as the collateral for a secondary loan with another lender. In addition, in private conversations, management of the lender also confirmed that there were no equity extractions following the collateral value increases.

7. Conclusion

This paper presents new evidence that auto loan borrowers respond strategically to changes in the value of the collateral. I use several policy changes in Sri Lanka to generate exogenous variation of collateral value that is unrelated to borrowers' unobservable characteristics and their ability to pay. Results show that following a drop (increase) in collateral value default rate rose (fell) by 44% (25%). The self-cure rate increased three fold after a 10% increase in the collateral value.

I take a number of steps to mitigate the scope for alternative interpretations of my evidence. I simulate regulation changes in earlier dates to confirm that these results are not driven by preexisting trends. I also match the control sample to treatment sample to

address concerns about selection bias.

The findings in this paper contribute to the academic debate on the importance of borrowers' financial incentives on their default decisions and have direct policy implications. This finding is particularly relevant for ex-ante policies aimed at reducing future default rates. Economically significant impact of the collateral value can be used to justify some of the credit market regulations such as maximum LTVs or mortgage insurance.

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Figure 1: Price of New Cars

This figure plots the prices of new cars with engine capacity less than 1L (solid red line) and greater than 1L(dashed black line). Import tax rate was cut in November 2014 for cars with engine capacity less than 1L.

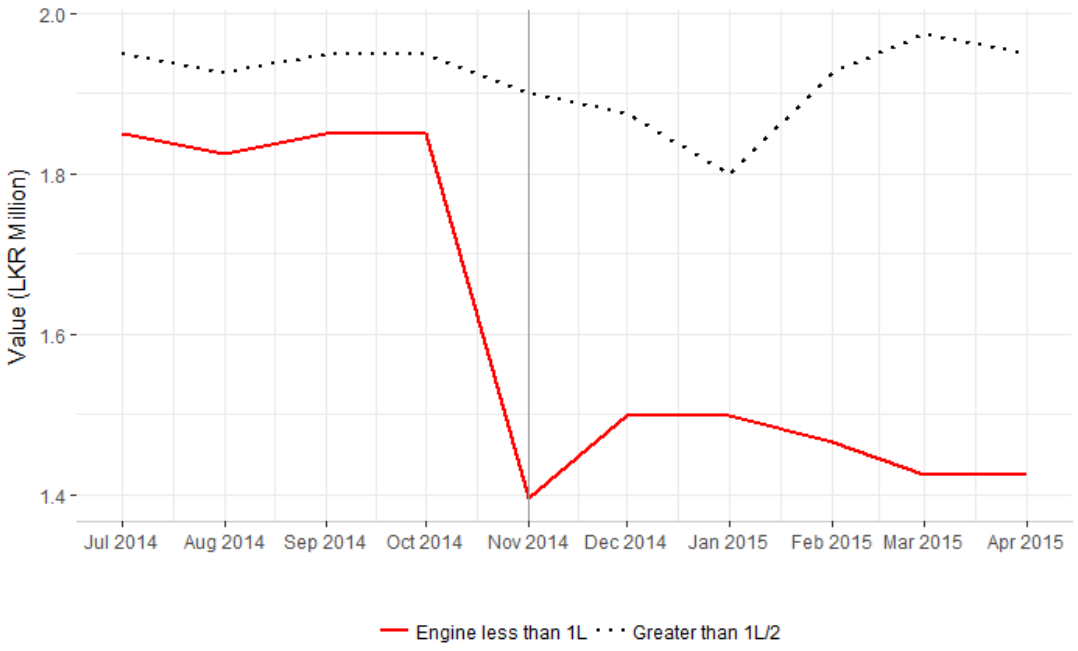


Figure 2: Value of New and Used 3-wheelers

This figure shows the monthly price of a new 3-wheeler (solid red line) and values of used 3-wheelers in each month. Dashed black lines plot the mean values of used 3-wheelers made 2012-2014. Gray line is the value of a used small car (2013 Honda Fit). Import tax rate was raised for 3-wheelers in November 2015 and April 2016.

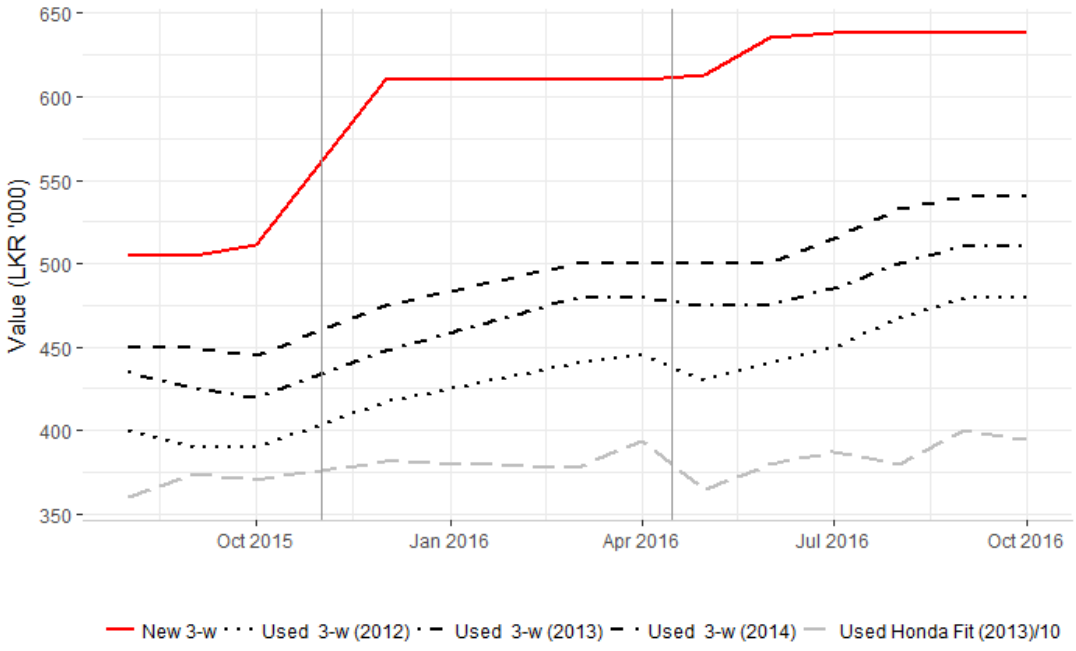


Figure 3: Number of 3-wheelers Purchased

This figure plots the monthly number of loans originated by the lender for new (solid red line) and used (dashed black line) 3-wheelers. Notable spikes just after the tax increases in November 2015 and April 2016 reflect sales of dealer inventory previously imported to the country.

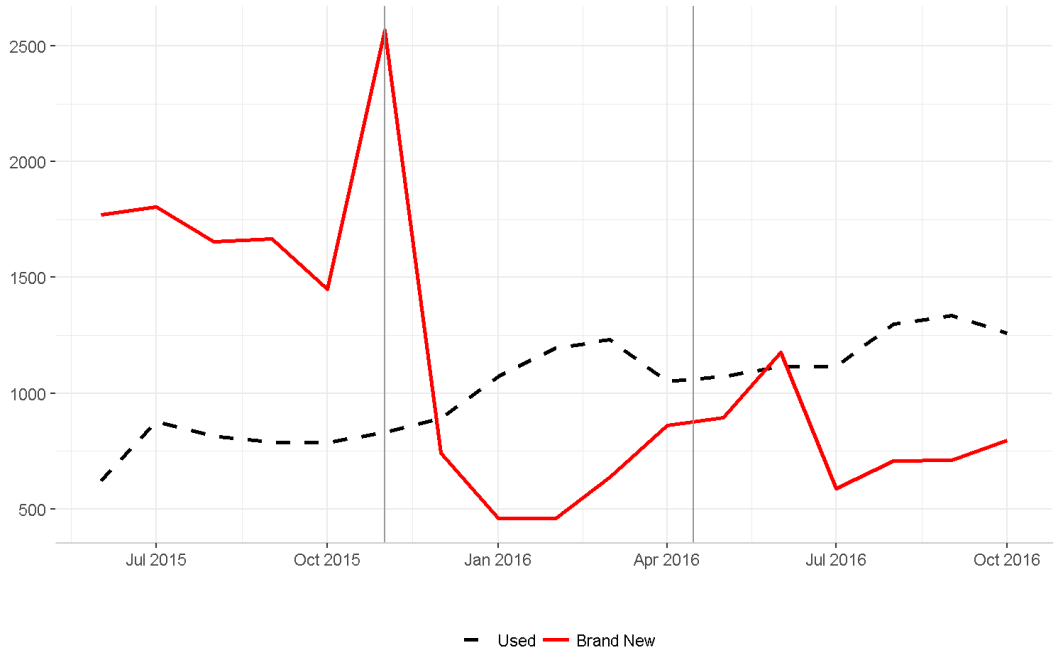


Figure 4: Loan-to-Value Ratios for New Vehicles

This figure shows the changes to maximum loan-to-value ratios for different types of *new* vehicles. Red solid line represents the median, and gray dashed lines represent first and third quartiles. Maximum loan-to-value ratio was restricted to 70% for *all* auto loans beginning December 2015. After January 2017, specific vehicle types were subject to different maximum loan-to-value ratios. The January 2017 revision applied only to loans for purchase of a new vehicle.

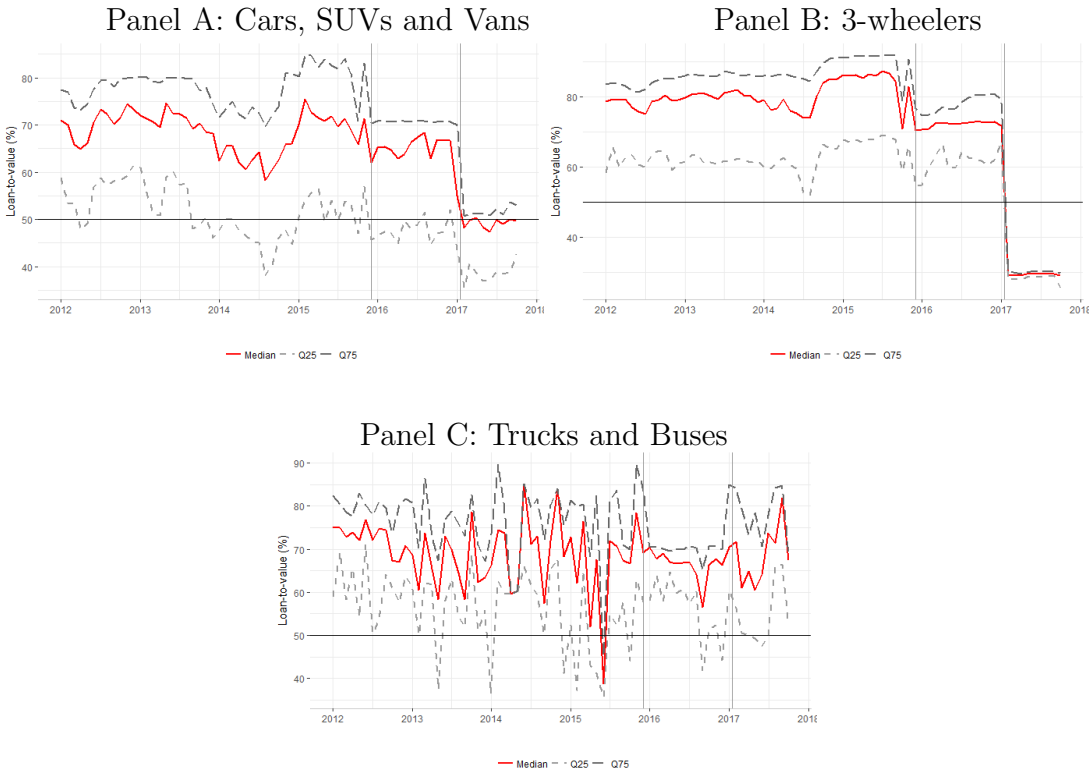


Figure 5: Effect of Tax Cut on the Value of Used Smaller-Engine Cars

This figure shows the impact of November 2014 import tax cut on the secondary market value of used smaller-engine cars (with engine capacity less than 1L). November 2014 tax cut applied only to new imports of smaller-engine cars. The Y-axis plots β_m: the difference in value between used smaller engine car and larger-engine cars (with engine capacity above 1L) in month m relative to the value difference at the beginning of the sample period. β_m is estimated from the equation below where i, v, m, and d represent borrower, vehicle model, months since the tax cut, and district respectively. Sample consists of auto loans initiated to purchase used cars five months before and after the tax cut.

$$log(valuation)_{ivmd} = \alpha_v + \alpha_{md} + \sum_m \beta_m \times \ smaller\text{-}engine\ car_i \times m + \epsilon_{ivmd}$$

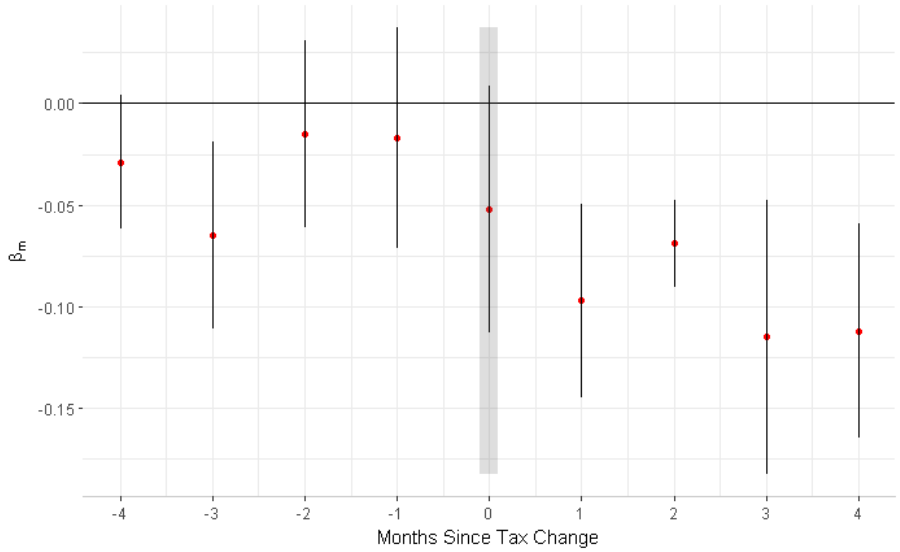


Figure 6: Effect of Tax Cut on Smaller-Engine Car Loan Default

This figure shows the impact of November 2014 import tax cut on the default rate of auto loans secured by smaller-engine cars (with engine capacity less than 1L). November 2014 tax cut applied only to new imports of smaller-engine cars. The Y-axis denotes the coefficient estimate β_m from the equation below for months since each tax increase, m. Subscripts i, m, and d represent borrower, months since tax cut, and district respectively. β_m estimates the difference between the default rate of smaller-engine and larger-engine car loans relative to the default rate difference at the beginning of the period. Sample consists of loan-month observations five months before and after the tax cut.

$$Default_{imd} = \alpha_i + \alpha_{md} + \sum_m \beta_m \times \textit{smaller-engine car}_i \times m + \epsilon_{ivmd}$$

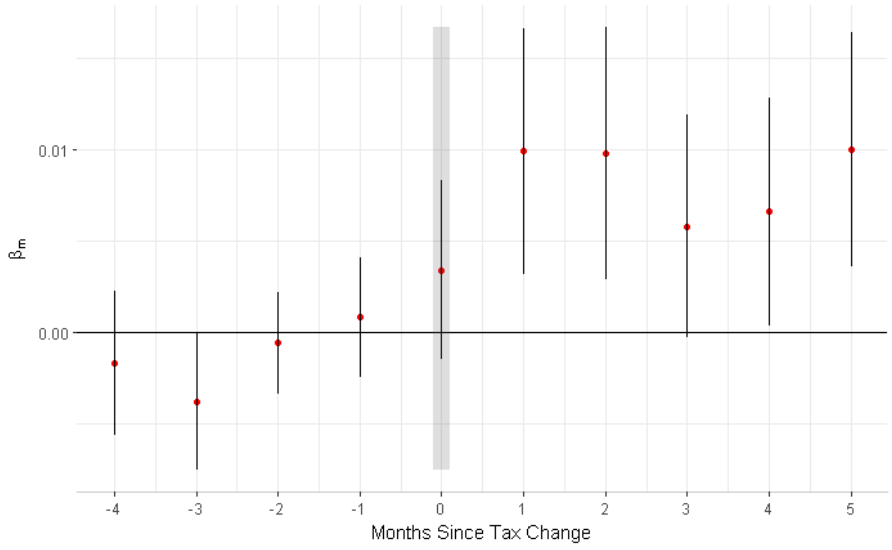
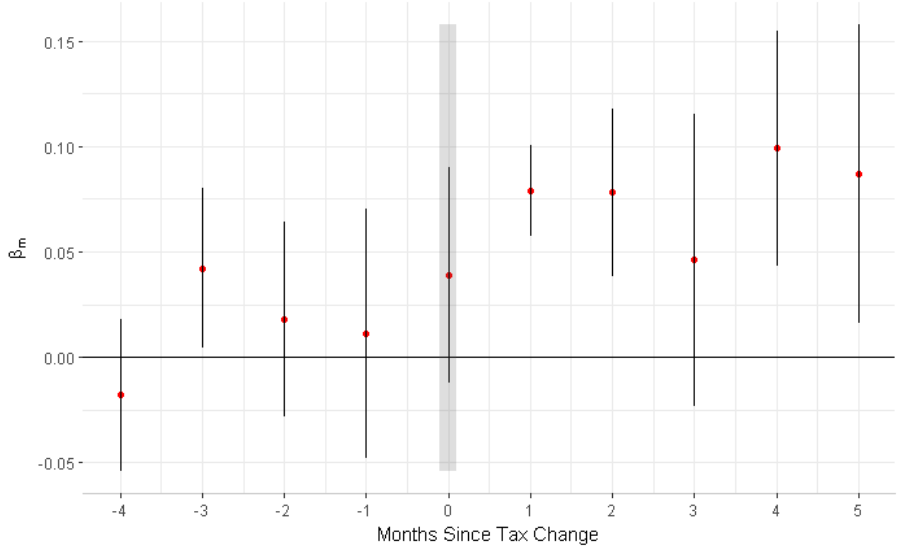


Figure 7: Effect of Tax Hikes on Used 3-wheeler Value

This figure shows the impact of November 2015 and April 2016 import tax hikes on the secondary market value of used 3-wheelers. These tax hikes applied only to new 3-wheeler imports. The Y-axis plots β_m: the difference in value between used 3-wheelers and other types of vehicles in month m relative to the value difference at the beginning of the sample period. β_m is estimated from the equation below where i,v,m, and d represent borrower, vehicle type, months since each tax hike, and district respectively. Samples consist of auto loans initiated to purchase used vehicles five months before and after each tax hike. Panel A and Panel B plot the effects of November 2015 and April 2016 tax hikes respectively.

$$log(valuation)_{ivmd} = \alpha_v + \alpha_{md} + \sum_m \beta_m \times \ \textit{3-wheeler}_i \times m + \epsilon_{ivmd}$$

Panel A: Value after November 2015 Tax Hike



Panel B: Value after April 2016 Tax Hike

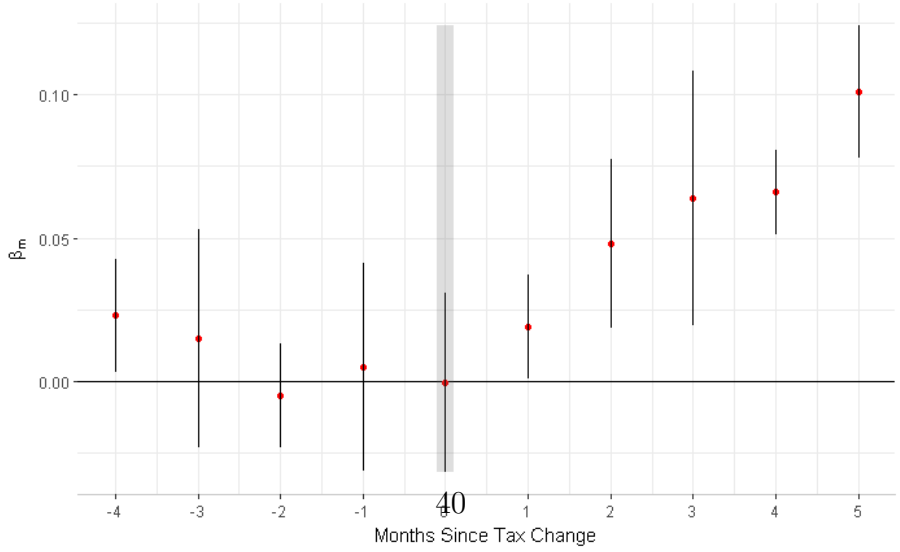
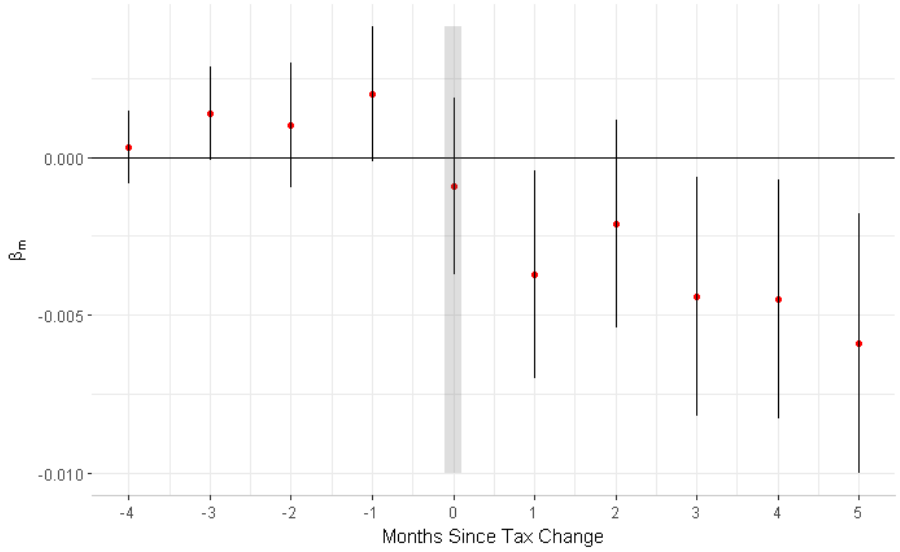


Figure 8: Effect of Tax Hikes on 3-wheeler Loan Default

This figure shows the impact of November 2015 and April 2016 import tax hikes on the default rate of auto loans secured by 3-wheelers. These tax hikes applied only to new 3-wheeler imports. The Y-axis denotes the coefficient estimate β_m from the equation below for months since each tax hike, m. Subscripts i, m, and d represent borrower, months since tax cut, and district respectively. β_m estimates the difference between the default rate of 3-wheeler and other vehicle loans relative to the default rate difference at the beginning of the period. Samples consist of loan-month observations five months before and after each tax hike. Panel A and Panel B plot the effects of November 2015 and April 2016 tax hikes respectively.

$$Default_{imd} = \alpha_i + \alpha_{md} + \sum_m \beta_m \times \ \mathit{3\text{-}wheeler}_i \times m + \epsilon_{imd}$$

Panel A: November 2015 Tax Hike



Panel B: April 2016 Tax Hike

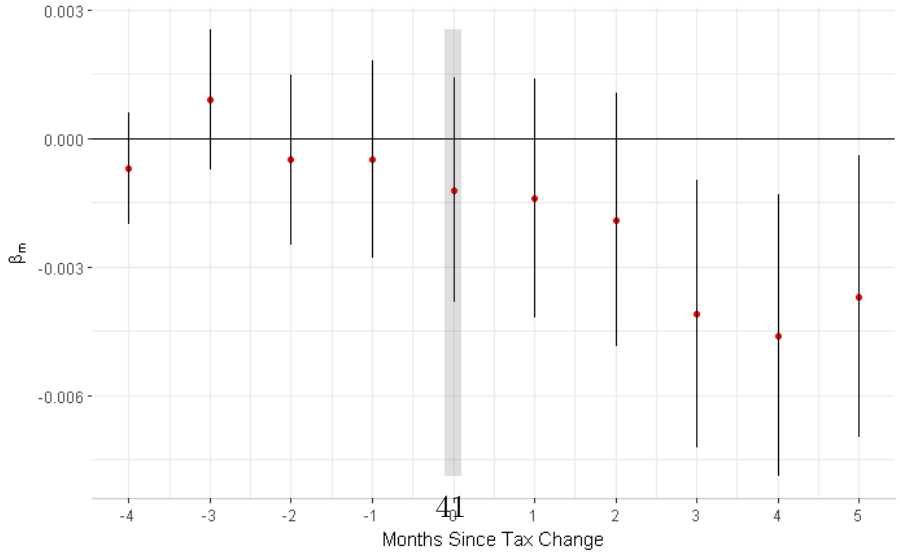


Figure 9: Monthly Self-Cure Rates for 3-wheeler Loans

This figure plots the monthly difference in mean self-cure rates for 3-wheelers and other vehicles from October 2015 through August 2016. Loan i is defined as a self-cure in month m when current in month m, after being in default at month $m-1$. Samples for each month $m-1$ comprise loans in default for that month. Import taxes for new 3-wheeler imports were increased in November 2015 and April 2016.

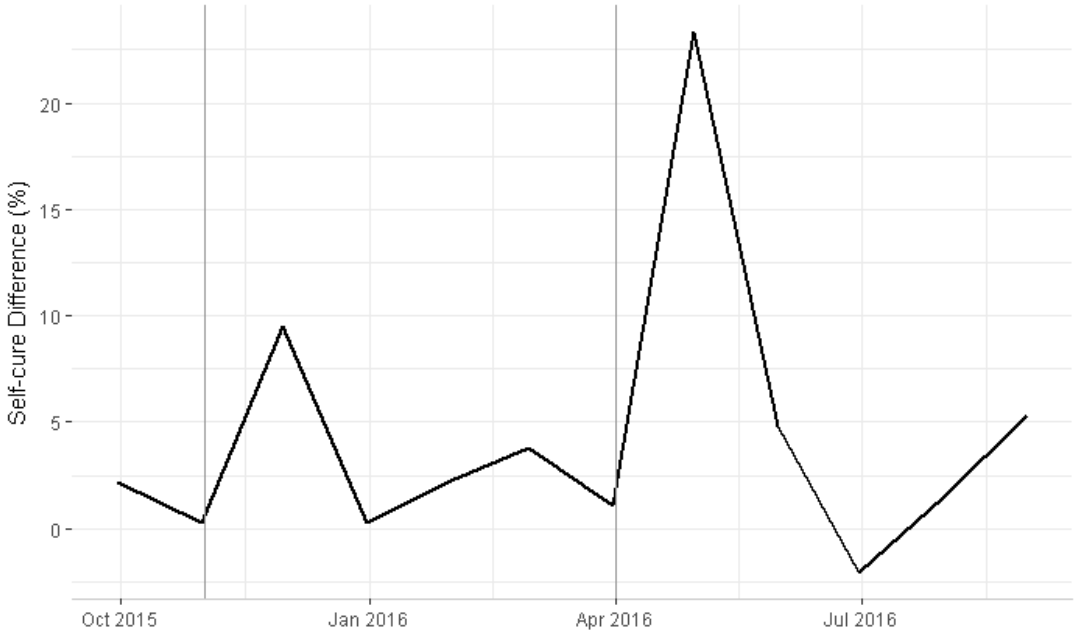


Figure 10: Effect of Loan-to-Value Changes on Monthly Default Rates

This figure plots the monthly mean default rate for each vehicle type in each month from August 2016 through April 2017. Changes to maximum loan-to-value ratios were proposed late November 2016 and implemented mid January 2017. Maximum loan-to-value ratio was cut to 50% for cars, SUVs and vans while dropping to 25% for 3-wheelers. The bus-truck maximum loan-to-value ratio was increased to 90%.

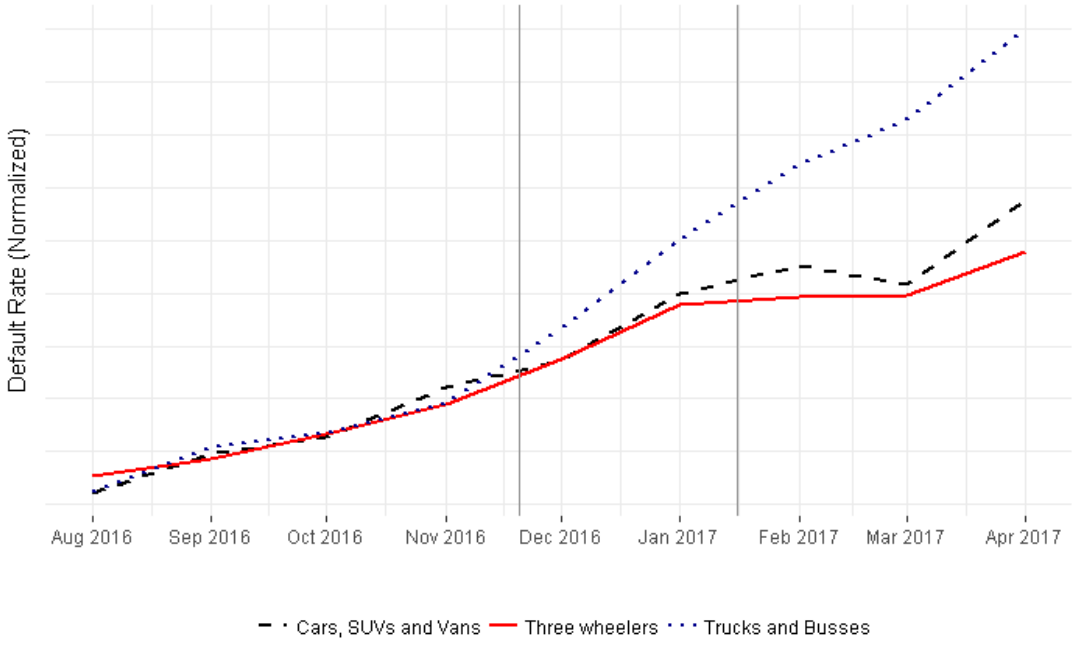


Table 1: Summary Statistics

This table shows sample means and standard deviations of key variables for each sample used. First two columns provide summary statistics separately for treatment and control samples used in the first set of tests that use unanticipated tax cut for new imports of smaller-engine cars (cars with engine capacity less than 1L) as the treatment. Third and forth columns provide summary statistics for 3-wheeler and other vehicle samples used in the second set of tests. Last three columns provide summary statistics for different vehicle types used in the third set of results, which uses maximum loan-to-value restrictions. Standard deviations are given in parenthesis.

	Tax Change Samples				LTV Restriction Sample		
	Three Wheelers *(Treatment)*	Other Vehicles *(Control)*	Cars with <1L engines *(Treatment)*	Cars with >1L engines *(Control)*	Cars, SUVs and Vans	Trucks and Buses	Three Wheelers
N	29,224	9,025	1,451	880	17,673	3,098	37,254
Loan Year	2013.53	2013.44	2014.44	2014.19	2015.12	2015.17	2015.06
	(0.77)	(0.86)	(0.88)	(0.84)	(0.69)	(0.73)	(0.67)
Loan Amount (LKR)	382,403	750,191	934,179	1,063,925	1,474,508	1,239,012	432,351
	(127,737)	(493,155)	(388,069)	(510,546)	(1,430,583)	(1,200,029)	(152,641)
Valuation (LKR)	419,294	1,030,202	1,300,993	1,646,840	2,290,953	1,950,972	473,238
	(95,637)	(666,554)	(495,619)	(552,988)	(2,077,911)	(1,555,818)	(116,372)
LTV (%)	75.38	74.06	64.99	60.66	63.68	61.45	73.72
	(20.74)	(51.51)	(30.46)	(26.89)	(54.44)	(39.08)	(20.17)
Interest Rate (%)	26.74	23.19	15.55	17.39	15.58	17.46	23.48
	(5.78)	(6.45)	(3.58)	(3.91)	(2.41)	(3.03)	(5.83)
Loan Term (months)	42.94	44.98	53.30	50.66	50.87	43.59	44.51
	(9.93)	(10.66)	(9.09)	(9.43)	(10.41)	(9.91)	(11.69)
Brand New	0.62	0.53	0.44	0.07	0.22	0.04	0.69
	(0.48)	(0.50)	(0.50)	(0.25)	(0.41)	(0.20)	(0.46)
Male	0.80	0.78	0.72	0.73	0.76	0.81	0.80
	(0.40)	(0.41)	(0.45)	(0.44)	(0.43)	(0.39)	(0.40)
Married	0.65	0.67	0.74	0.76	0.75	0.73	0.72
	(0.48)	(0.47)	(0.44)	(0.43)	(0.43)	(0.44)	(0.45)
Borrower Age	35.97	36.57	37.17	38.95	39.23	40.27	36.51
	(10.79)	(11.02)	(11.04)	(11.15)	(11.27)	(11.32)	(11.02)

Table 2: Effect of Tax Cut on Smaller-Engine Car Loan Default

This table shows the impact of November 2014 import tax cut on the default rate of smaller-engine car loans initiated prior to the tax cut. Smaller-engine cars (with an engine capacity less than 1L) were affected by the tax cut. The dependent variable is a dummy variable equal to one when borrower i is not current in month m (otherwise zero). The dummy variable $I(m > 0)$ denotes a loan-month observation after the tax cut. Dummy variable *Smaller-engine* is equal to one when the vehicle type received the treatment (i.e. a smaller-engine car). Larger-engine cars (with an engine capacity greater than 1L) formed the control sample. Column (1) reports the estimation results of equation 2 and column (2) includes controls. Samples consist of loan-month observations five months pre- and post- the tax cut. Standard errors are clustered at loan level and reported in parentheses below coefficient estimates. I use *,**, and *** to denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)
$I(m > 0)$ × Smaller-engine	0.004*	0.007***
	(0.002)	(0.003)
Smaller-engine		-0.009*
		(0.005)
Loan Age	-0.0002	-0.001
	(0.001)	(0.002)
Loan Age^2	0.000	-0.00001
	(0.000)	(0.000)
LTV		0.007**
		(0.004)
Interest Rate		0.002**
		(0.001)
Married		0.001
		(0.003)
Male		-0.002
		(0.004)
Borrower Age		-0.0002
		(0.000)
log(Valuation)		-0.0002
		(0.007)
Brand New		0.001
		(0.006)
Other Deposits		-0.002
		(0.002)
Loan FE	✓	✗
District × Month FE	✓	✓
Origination Month FE	✗	✓
Observations	18,943	18,943
Adjusted R^2	0.705	0.077

Table 3: Effect of Tax Hikes on 3-Wheeler Loan Default

This table shows the impact of November 2015 and April 2016 import tax hikes on the default rate of 3-wheeler-loans initiated prior to respective tax hike. New 3-wheeler imports were affected by the tax hikes. The dependent variable is a dummy variable equal to one when borrower i is not current in the month m (otherwise zero). The dummy variable $I(m > 0)$ denotes a loan-month observation after respective tax hike. Dummy variable *3-wheeler* is equal to one if the vehicle type received the treatment (i.e. a 3-wheeler). Other vehicle types formed the control sample. Columns (1) and (3) report the estimation results of equation 2 and columns (2) and (4) include controls. Samples consist of loan-month observations five months pre- and post-respective tax hike. Standard errors are clustered at loan level and reported in parentheses below coefficient estimates. I use *,**, and *** to denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	Nov 2015 Tax Hike		Apr 2016 Tax Hike	
	(1)	(2)	(3)	(4)
$I(m > 0)$ × 3-wheeler	-0.003**	-0.004***	-0.005***	-0.006***
	(0.001)	(0.001)	(0.002)	(0.002)
Loan Age^2	-0.00002***	-0.00004***	0.000	-0.00003***
	(0.000)	(0.000)	(0.000)	(0.000)
LTV		0.00003		0.00003
		(0.000)		(0.000)
Interest Rate		0.002***		0.002***
		(0.000)		(0.001)
Married		0.006***		-0.0001
		(0.001)		(0.002)
Male		-0.005***		-0.009***
		(0.002)		(0.002)
Borrower Age		-0.0004***		-0.0003***
		(0.000)		(0.000)
log(Valuation)		0.007**		0.008
		(0.004)		(0.006)
Brand New		-0.015***		-0.010**
		(0.004)		(0.005)
Other Deposits		-0.002		-0.003
		(0.003)		(0.006)
Loan FE	✓	✗	✓	✗
District × Month FE	✓	✓	✓	✓
Origination Month FE	✗	✓	✗	✓
Vehicle Type FE	✗	✓	✗	✓
Observations	378,837	378,837	226,462	226,462
Adjusted R^2	0.742	0.026	0.803	0.019

Table 4: Effect of Tax Hikes on 3-Wheeler Loan Default: Matched Difference-in-Difference

This table shows the impact of November 2015 and April 2016 import tax hikes on the default rate of 3-wheeler-loans initiated prior to respective tax hike. New 3-wheeler imports were affected by the tax hikes. The dependent variable is a dummy variable equal to one when borrower i is not current in the month m (otherwise zero). The dummy variable $I(m > 0)$ denotes a loan-month observation after respective tax hike. Dummy variable *3-wheeler* is equal to one if the vehicle type received the treatment (i.e., a 3-wheeler). The control sample in columns (1) and (3) consists of matched motorbike-loans and control sample in columns (2) and (4) consists of matched mini-truck-loans. Samples consist of loan-month observations five months pre- and post-respective tax hike. Standard errors are clustered at loan level and reported in parentheses below coefficient estimates. I use *,**, and *** to denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	Nov 2015 Tax Hike		Apr 2016 Tax Hike	
Control Sample	Motorbikes	Mini-Trucks	Motorbikes	Mini-Trucks
	(1)	(2)	(3)	(4)
$I(m > 0) \times$ 3-wheeler	-0.004***	-0.006***	-0.008***	-0.003***
	(0.002)	(0.002)	(0.002)	(0.001)
Loan Age^2	-0.00002**	-0.00003***	-0.00004***	-0.00002***
	(0.000)	(0.000)	(0.000)	(0.000)
Loan FE	✓	✓	✓	✓
District $\times$ Month FE	✓	✓	✓	✓
Observations	98,904	102,703	100,930	95,094
Adjusted R^2	0.8	0.808	0.752	0.791

Table 5: Effect of Tax Hikes on 3-wheeler Loan Self-Cure

Panel A of this table compares the self-cure rates of 3-wheeler and other-vehicles loans before and after the November 2015 and April 2016 import tax hikes for new 3-wheeler imports. Loan i is defined as a self-cure in month m when the loan is current in month m after being in default at month *m-1*. The final row in Panel A reports the difference-in-difference estimate for each tax hike. Panel B reports the percentage of borrowers redefaulted subsequent to self-curing in the month after the tax hikes.

Panel A: Self-Cure Rate

	Nov 2015 Tax Increase		April 2016 Tax Increase	
	t=Nov-15	t=Dec-15	t=Apr-16	t=May-16
3-wheelers	4.86%	36.87%	9.79%	19.84%
Other Vehicles	6.17%	25.88%	8.26%	10.17%
Difference-in-difference	12.30%		8.14%	

Panel B: Redefault Rate

	Nov 2015 Tax Increase	April 2016 Tax Increase
3-wheelers	0.27%	0.00%
Other Vehicles	16.94%	7.45%

Table 6: Effect of Maximum Loan-to-Value Ratio Changes on Used Vehicle Values

This table shows the impact of changes to maximum loan-to-value ratios on secondary market values of used vehicles. Maximum loan-to-value ratio was increased for new trucks and buses after January 2017, and maximum LTV was lowered for cars, SUVs, vans and 3-wheelers. This table reports the estimation results of the equation below where i, v, m, p and d represent borrower, vehicle model, months since the change, vehicle type, and district, respectively. The dummy variable $I(m > 0)$ indicates a loan initiated after the rule change. Sample consists of loans to purchase *used* vehicles five months pre- and post-rule change. Standard errors are clustered at loan level and reported in parentheses below coefficient estimates. I use *,**, and *** to denote statistical significance at the 10%, 5%, and 1% levels, respectively.

$$log(valuation)_{ivmd} = \alpha_v + \alpha_{md} + \sum_p \beta_p \; I(m > 0)_i \times I(\textit{Vehicle Type} = p) + \epsilon_{ivmd}$$

	(1)
$I(m > 0)$ × Cars, SUVs and Vans	-0.040
	(0.024)
$I(m > 0)$ × Trucks and Buses	-0.200***
	(0.011)
Model FE	✓
Manufacturing Year	✓
District × Month FE	✓
Observations	21,379
Adjusted R^2	0.729

Table 7: Effect of Maximum Loan-to-Value Ratio Changes on Default

This table shows the impact of changes to maximum loan-to-value ratio on default.Maximum loan-to-value ratio was increased for new trucks and buses after January 2017, and maximum LTV was lowered for cars, SUVs, vans and 3-wheelers. These changes were first announced in November 2016. This table reports the estimation results of equation 4. The dependent variable is a dummy variable equal to one when borrower i is not current in the month m (otherwise zero). The dummy variables *Feb 2017-Apr 2017* and *Dec 2016 - Jan 2017* denotes loan-month observations in post-implementation and post-announcement(and pre-implementation) periods, respectively. Dummy variables *Trucks and Buses* and *Cars, SUVs and Vans* denote respective vehicle types. Samples consist of loan-month observations from September 2016 through April 2017. Standard errors are clustered at loan level and reported in parentheses below coefficient estimates. I use *,**, and *** to denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)
Feb 2017 - Apr 2017 × Trucks and Buses	0.005**	0.005***
	(0.002)	(0.002)
Feb 2017 - Apr 2017 × Cars, SUVs and Vans	-0.001	-0.001*
	(0.001)	(0.001)
Dec 2016 - Jan 2017 × Trucks and Buses	0.0004	0.001
	(0.001)	(0.001)
Dec 2016 - Jan 2017 × Cars, SUVs and Vans	0.000	0.000
	(0.001)	(0.000)
Loan Age^2	0.000	0.000
	(0.000)	(0.000)
Loan-to-Value		0.003***
		(0.001)
Interest Rate		0.001***
		(0.000)
Married		0.00002
		(0.001)
Male		-0.001
		(0.001)
Borrower Age		-0.0002***
		(0.000)
Valuation		-0.000***
		0.000
Brand New		-0.001
		(0.001)
Loan FE	✓	✗
Month × District FE	✓	✓
Vehicle Type FE	✗	✓
Origination Month FE	✗	✓
Observations	394,767	394,767
Adjusted R^2	0.729	0.009

Table 8: Placebo Test: Effect of Simulated Tax Hike on 3-wheeler Default Rate

This table simulates a 3-wheeler tax hike in April 2015 and estimates equation 2. The table shows the impact of simulated import tax hike on the default rate of 3-wheeler-loans initiated prior to the simulated tax hike. The dependent variable is a dummy variable equal to one when borrower i is not current in the month m (otherwise zero). The dummy variable $I(m > 0)$ denotes a loan-month observation after the simulated tax hike. Dummy variable *3-wheeler* is equal to one if the vehicle type received the treatment (i.e., a 3-wheeler). Other vehicle types formed the control sample. Samples consist of loan-month observations five months pre- and post-simulated tax hike. Standard errors are clustered at loan level and reported in parentheses below coefficient estimates. I use *,**, and *** to denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)
$I(m > 0) \times$ 3-wheeler	0.001	0.001
	(0.001)	(0.001)
Loan Age^2	-0.0001***	-0.0001***
	(0.000)	(0.000)
Loan-to-Value		0.0004***
		(0.000)
Interest Rate		0.002***
		(0.000)
Married		0.012***
		(0.001)
Male		-0.004**
		(0.002)
Borrower Age		-0.0004***
		(0.000)
log(Valuation)		0.000
		0.000
Brand New		-0.014***
		(0.003)
Other Deposits		-0.001
		(0.001)
Loan FE	✓	✗
Month $\times$ District FE	✓	✓
Vehicle Type FE	✗	✓
Origination Month FE	✗	✓
Observations	298,910	298,910
Adjusted R^2	0.802	0.028

Table 9: Placebo Test: Effect of Simulated Maximum Loan-to-Value Ratio Changes on Default

This table simulates the maximum loan-to-value changes in August 2016 and reports the estimation results of equation 4. Maximum loan-to-value ratio was increased for new trucks and buses after January 2017, and maximum LTV was lowered for cars, SUVs, vans and 3-wheelers. This table reports the estimation results of equation 4. The dependent variable is a dummy variable equal to one when borrower i is not current in the month m (otherwise zero). The dummy variables *Sep 2016 - Nov 2016* denotes a loan-month observations in post-simulated period. Dummy variables *Trucks and Buses* and *Cars, SUVs and Vans* denote respective vehicle types. Samples consist of loan-month observations from May 2016 through November 2017. Standard errors are clustered at loan level and reported in parentheses below coefficient estimates. I use *,**, and *** to denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)
Sep 2016 - Nov 2016 × Trucks and Buses	0.002	0.001
	(0.001)	(0.001)
Sep 2016 - Nov 2016 × Cars, SUVs and Vans	0.000	0.000
	(0.001)	(0.001)
Loan Age^2	-0.00001***	-0.00001*
	(0.000)	(0.000)
Loan-to-Value		-0.00000**
		0.000
Interest Rate		0.001***
		(0.000)
Married		-0.001
		(0.001)
Male		-0.001*
		(0.001)
Borrower Age		-0.0001***
		(0.000)
log(Valuation)		-0.000***
		0.000
Brand New		0.000
		(0.001)
Loan FE	✓	✗
Month × District FE	✓	✓
Vehicle Type FE	✗	✓
Origination Month FE	✗	✓
Observations	317,356	317,356
Adjusted R^2	0.677	0.008

Table 10: Effect of Tax Hikes on 3-wheeler-loan Prepayment

This table shows the impact of November 2015 and April 2016 import tax hikes on the prepayment rate of 3-wheeler-loans initiated prior to respective tax hike. New 3-wheeler imports were affected by the tax hikes. The dependent variable is a dummy variable equal to one if borrower i prepays the loan in full in the month m (otherwise zero). The dummy variable $I(m > 0)$ denotes a loan-month observation after respective tax hike. Dummy variable *3-wheeler* is equal to one if the vehicle type received the treatment (i.e. a 3-wheeler). Other vehicle types formed the control sample. Samples consist of loan-month observations five months pre- and post-respective tax hike. Standard errors are clustered at loan level and reported in parentheses below coefficient estimates. I use *,**, and *** to denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	November 2015 Tax Hike	April 2016 Tax Hike
	(1)	(2)
$I(m > 0) \times$ 3-wheeler	0.0004	0.0001
	(0.000)	(0.000)
Loan Age^2	0.000	0.000
	(0.000)	(0.000)
Loan FE	✓	✓
District $\times$ Month FE	✓	✓
Observations	378,837	226,462
Adjusted R^2	0.647	0.953

Table 11: Effect of Tax Hikes on 3-wheeler Default Rate by Origination Year

This table shows the impact of November 2015 and April 2016 import tax hikes on the default rate of 3-wheeler-loans initiated prior to respective tax hike. New 3-wheeler imports were affected by the tax hikes. I divide my sample in to three subgroups based on the whether the loans were originated between July 2013 and December 2014, between January 2012 and June 2013 or before January 2012. The dependent variable is a dummy variable equal to one when borrower i is not current in the month m (otherwise zero). The dummy variable $I(m > 0)$ denotes a loan-month observation after respective tax hike. Dummy variable *3-wheeler* is equal to one if the vehicle type received the treatment (i.e. a 3-wheeler). Other vehicle types formed the control sample. Samples consist of loan-month observations five months pre- and post-respective tax hike. Standard errors are clustered at loan level and reported in parentheses below coefficient estimates. I use *,**, and *** to denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	November 2015 Tax Hike			April 2016 Tax Hike		
	Jul 13-Dec 14	Jan 12-Jun 13	<Jan 12	Jul 13-Dec 14	Jan 12-Jun 13	<Jan 12
	(1)	(2)	(3)	(4)	(5)	(6)
$I(m > 0)$ × 3-wheeler	-0.014***	-0.01	0.001	-0.009**	-0.004	-0.003
	(0.004)	(0.006)	(0.001)	(0.004)	(0.004)	(0.003)
Loan Age^2	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Loan FE	✓	✓	✓	✓	✓	✓
District × Month FE	✓	✓	✓	✓	✓	✓
Observations	51,610	29,452	220,390	70,185	43,935	86,742
Adjusted R^2	0.767	0.804	0.736	0.815	0.816	0.770