Impact of Countercyclical Capital Buffers on Bank Lending and Credit Risk

Evidence from the Canadian Domestic Stability Buffer

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Contents

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Abstract

How do countercyclical capital buffers (CCyBs) impact bank lending behaviour? CCyBs are a relatively new introduction to the financial regulation handbook with Basel III being the first international agreement advocating for their use. In 2018, Canada joined the short list of countries including Switzerland, Ireland, Spain, and Slovenia which have implemented their own versions of CCyBs with the announcement of the Domestic Stability Buffer (DSB). The DSB allows Canadian regulators to implement additional, time-variant capital requirements on the largest 6 banks according to their perceived risk to financial stability. Since its introduction, the level of additional capital required by the DSB has been changed 6 times, with a period of tightening beginning in 2018 and loosening at the beginning of the COVID-19 pandemic. I use this regulatory environment to study the impact of countercyclical capital buffers on bank lending behaviour using a Difference-in-Difference (DiD) approach. The DiD estimation revealed that the DSB had little effect on the loan growth rates unless we restrict our control group to a subset of well-diversified banks which rely heavily on retail deposit funding. Among this group, we find significant evidence that banks reacted to the DSB by reducing loan growth rates and reallocating risk differentially in accordance with the regulatory risk-weights.

Introduction

Following the financial crisis of 2008, regulators began advocating for the implementation of additional macroprudential regulations to help shield the financial sector from another collapse. The shortcomings of the previous regulation, Basel I and II, were put center stage as they were unable to contain the financial contagion and subsequent credit crunch that swept markets. New regulatory measures introduced with Basel III include a framework for the implementation of numerous additional macroprudential measures, including a countercyclical capital buffer (CCyB). I will analyze the impact of a CCyB introduced in Canada, otherwise known as the Domestic Stability Buffer (DSB) on the lending behaviour of Canadian banks. I find mixed evidence of the effect of the DSB on domestic loan growth rates. Significant evidence for slowing loan growth and risk-shifting behaviour is found only among a subset of diversified banks which rely heavily on retail deposits as a funding source.

Capital requirements refer to regulation which requires banks to hold a greater amount of equity as a percentage of their total assets. These requirements decrease the probability that banks will become insolvent in the event of a large, unexpected decrease in the value of its assets. Capital, in this case, is a general term which represents the bank's own funds and is comprised principally of retained earnings and revenue from the issuance of stock. The amount of capital that a bank holds, determines its degree of leverage in its operations and thus its stability. The lower the amount of capital held, the less the fall in the value of assets must be before the bank becomes insolvent. Regulators impose a minimum value on this capital to ensure financial stability and avoid the potential costs of financial crisis and subsequent bailout.

The motivation for the imposition of capital requirements beyond the banks' own desired level is predicated on the observation that the value of the external economic losses from financial crises are typically much larger than the fall in the actual value of assets on banks balance sheets. (Reinhart and Rogoff, 2009). Following the 2008-10 financial crisis, world GDP declined by 1.6% and many advanced economies saw incomes fall by over 10% and unemployment increase by 4% (Drehmann et al., 2011). The actual value of losses on MBS instruments on the hand, was only approximately $300 Billion as of 2013 (Uhlig, 2018). Regulators have argued that the welfare benefits of capital requirements may be enormous given the value of the prevention these financial crises and subsequent economic downturns (García and Schroth, 2021; Dempster, 2015; Corbae and D'Erasmo, 2019; Admati et al., 2010). Capital requirements may be thought of as a Pigouvian tax on risk-taking in the banking sector as they internalize the potential costs of these negative outcomes (Perotti and Suarez, 2011). Bankers, on the other hand, argue that equity is a relatively expensive source of funding when compared to debt, and thus reduces the bank's ability to lend to the real economy. Equity issuance is viewed as expensive as investors must be compensated for the additional risk associated with being a shareholder vs a debt holder. Though this logic may be fundamentally flawed according to the basics of the Modigliani-Miller theorem, we know that equity may become more expensive in the presence of agency costs, signalling costs, and differential tax treatment (Modigliani and Miller, 1958).

Countercyclical capital buffers are just time-varying capital requirements that are set in addition to the current minimums in response to perceived risks to the financial system. The motivation for this being that capital constraints are effective in building up against systemic risk in "good times" but also possess the ability to contribute to instability during a financial downturn if they constrain the issuance of new credit (Jiménez and Ongena, 2017). CCyBs attempt to dampen this pro-cyclical behaviour by forcing the banking system to build up capital reserves which can be deployed in the event of a downturn. Due to this structure, the effectiveness of CCyBs depends on the ability of the regulator to identify early-warning indicators of financial distress.

CCyB effectiveness, along with most capital regulation, also depends on the ability of the regulator to identify the riskiness of different asset classes as they may be heterogeneously impacted by unknown future shocks. Capital is typically measured against risk-weighted assets (RWA) rather than their face value, allowing regulators to distinguish in capital requirement between a bank with \$100 billion in highly risky derivatives and one with \$100 billion in German Bunds. This technique may not be the best measure of a bank's stability depending on the ability of the regulator to measure the true risk of certain asset classes (Ahnert et al., 2018). It has even been shown that risk-weighted measures of capital performed significantly worse at predicting default during the 2008 financial crisis than the risk-neutral leverage ratio (King, 2016). There are two different methods in the regulatory literature for measuring the risk of an asset class: the standardized approach and the internal ratings-based (IRB) approach. Most of the largest banks use the IRB approach but we will use the standardized approach in our illustrative examples as it is easier to communicate but the same logic typically applies across both methods.

In Canada, the Office of the Superintendent of Financial Institutions (OSFI) introduced its version of the CCyB in 2018: the Domestic Stability Buffer (DSB). The DSB provides an ideal empirical environment to study the impacts of the CCyBs for a few reasons. Firstly, the fact that the DSB is only applied to institutions defined as Domestic Systemically Important Banks (D-SIBs), allows us to use a Difference-in-Difference approach to control for exogenously determined loan demand which would otherwise bias our results. Furthermore, the DSB is not set exogenously but rather according to the same set of macroeconomic risk characteristics that banks consider in their loan behaviour. The fact that the regulation is only applied to a subset of these banks allows us to use a Difference-in-Difference approach to identify these effects given that all banks react to these risks but the regulation is limited to the D-SIBs. Secondly, chartered Canadian banks vary widely in their business strategy and size, allowing us to better capture some interesting heterogeneous treatment effects using specific controls that have shown to be important in previous literature. Finally, the DSB is one of the first example of a broad-based CCyB that has been applied throughout a "boom-and-bust" cycle, which allows us to test our hypotheses across multiple macroprudential environments.

The DSB functions in a similar manner to most CCyBs with a few modifications. It stipulates that D-SIBs may be required to hold an additional 0-2.5% of Tier 1 Capital (Common stock and retained earnings) in proportion to their RWAs at any given time. This buffer is adjusted according to credit cycle growth and the perceived exposure of the large banks to these credit risks. In the event of an increase of the perceived risks or in the exposure of the banks, the buffer will be increased and vice versa for a reduction in vulnerability (OSFI, 2018). In the Canadian context, this typically means that adjustments are made in accordance with banks' exposure to consumer indebtedness and asset imbalances in the housing market. The DSB was announced by OSFI in June of 2018 with additional changes to be made on a semi-annual basis henceforth. Increases to the DSB are subject to a phase-in period of 4 months whereas decreases are effective immediately. A full timeline of changes to the DSB and their justification is included in the methods section.

Depending on how banks prefer to manage their capital ratios, the impact of the DSB could be observed through two channels. They may adjust their CET1 capital, the majority of which is made up of common stock issuance and retained earnings. This defines the numerator of the capital ratio and has been shown to be actively managed by large banking organizations to comply with regulatory minimums (Berger et al., 2008). Otherwise, banks may adjust the asset side of their balance sheet to take advantage of different risk weights on various assets or reduce their asset growth entirely; this changes the denominator of the capital ratio. For example, if RBC needed to raise their capital ratio through the first channel, it may do so by issuing new shares, reducing its dividend payment, or changing the composition of equity subordination to increase the numerator. Using the second channel, RBC could decrease the denominator of the capital ratio by selling some risky securities and purchasing Canadian T-Bills to decrease the overall risk in their portfolio. Below is included a stylized example of calculating capital ratios using the standardized approach.

Bank	Initial Capital Level ($Billions)	Mortgage Loans (35% risk weight)	Credit Card Loans (75% risk weight)	Cash (0% risk weight)	Capital Ratio
RBC	5	65	25	20	$\frac{5}{65*0.35+25*0.75+20*0} = 12.05\%$
Scotiabank	5	60	35	10	$\frac{5}{60*0.35+35*0.75+10*0} = 10.58\%$

Though changes in lending behaviour will be the focus of this paper, it has been shown that banks' do actively manage their capital ratios through share issuance and dividend policy as well. The relative merit of these two channels may depend on some specific qualities of a given bank or the environment they are operating in. Banks may wish to avoid the signalling cost of new equity issuance during a financial crisis but also are constrained in their ability to manage their asset holdings by the amount of assets maturing in a given period or else the losses attributable to selling off illiquid assets (Berger et al., 2008). The effect of the DSB on equity issuance will not be considered as it is very difficult to isolate reliably and is not concerning to the the real economy. From an effectiveness standpoint, regulators may also prefer to see the effects of capital requirement translated through lending behaviour rather than equity issuance. If banks chose to manage their capital ratios only through equity issuance and dividend policy, this would do nothing to curb undesirable or excessive credit cycles in the broader economy. Looking at lending behaviour may also provide evidence of "regulatory arbitrage" whereby assets can be reallocated to achieve the same aggregate risk profile under the new policy. This form of arbitrage has been shown to be present in the implementation of CCyBs as well as more targeted mortgage regulation in Switzerland, Spain, and Ireland (Auer et al., 2019: Aiyar et al., 2012; Acharya et al., 2021).

The approach taken in this paper differs from the previous literature in a few notable respects. Basten and Koch (2015), Basten (2019), Auer and Ongena (2019), and Behncke (2020) all use a similar Difference-in-Difference method to study the effect of a mortgage-targeted CCyB introduced in Switzerland in 2013. In their analysis, they create treated and untreated groups through different measures of perceived ex-ante "proximity" to the regulatory requirements. Basten and Koch define it as banks which are heavily concentrated in the mortgage market whereas Behncke relies on both this measure and on the level of excess capital before the policy implementation. These are good proxies for a treated group, but it does introduce a possible bias towards an underestimation of the true treatment effect. This is because large banking organizations prefer to hold capital well above regulatory minimums and actively manage their capital ratios to do so. Therefore, it is possible that banks which Behnke includes in the control group may also respond by increasing their capital ratios, leading to an underestimation of the treatment effect. This paper, on the other hand, has an actual treatment group in the form of the D-SIBs as smaller banks are not subject to the buffer. My analysis also exploits more variation in the CCyB over time as opposed to the previously mentioned studies which only look at the periods before and after the initial introduction of the CCyB. The use of a continuous treatment variable will allow for more robustness checks than in previous studies.

This paper will be structured as follows. In the next section, I will summarize the literature on the effect of CCyBs and capital regulation more broadly. I will then go on to discuss the data, regulatory environment, and empirical model in the methods section. Finally, I will present my results and conclude.

Literature Review

There is a substantial quantity of research that has been conducted on macroprudential policy in Canada, but little has focused specifically on the Domestic Stability Buffer. Most research looks at the effect of mortgage regulation which has been in particular focus in Canada since the rapid rise of house prices. Stress tests and mortgage insurance regulations introduced beginning in 2014 have been shown to be quite effective in reducing systemic risk (Allen et al., 2016; Bilyk and teNyenhuis, 2018). As for the impact of CCyBs, Chen and Friedrich (2020) and Damar and Mordel (2017) both study the effect of international capital regulation, including CCyBs, on the big six banks' foreign lending portfolios. Damar and Mordel (2017) found that Canadian banks increased lending to areas that tightened domestic capital regulation, in the case that this regulation did not apply to foreign lending (Damar and Mordel, 2018). They also found that Canadian banks increased foreign lending in response to increases in a domestic regulation index which included the DSB. Chen and Friedrich (2020) use a similar approach but look at international CCyBs implemented under Basel III which include a 'unique reciprocity rule' meaning that capital buffers apply to both foreign and domestic institutions within those countries. In this case, the authors found the opposite result as Canadian banks decreased lending to jurisdictions which raised their CCyBs (D. Chen and Friedrich, 2021). Garcia and Schroth use an analytical framework to determine the socially optimal level of capital regulation in the Canadian context. Their results indicate that there are additional welfare benefits associated with raising the DSB well above the 2.5% ceiling (García and Schroth, 2021). This paper cannot speak to the positive welfare benefits of the CCyB stemming from financial stability but does provide insight into the possible negative impacts as measured by the credit supply disruption.

As mentioned previously, my work relies most heavily on a few key studies on the introduction of a mortgage targeted CCyB in Switzerland in 2013. The buffer was implemented due to concerning asset imbalances in the real estate market following a period of low-interest, high volume mortgage loan growth due to the the global financial crisis. The buffer was set at 1% tier 1 capital as proportion of banks holdings of mortgage RWAs in 2013 with a further increase to 2% in 2014. Each study uses a similar model to analyze the impact of the CCyB on various metrics. Basten and Koch look at the impact of the CCyB on mortgage lending rates whereas Auer and Ongena (2019) evaluate the implications of the unique sectoral nature of the CCyB on the risk-shifting and regulatory arbitrage motives. Behncke (2020) is the most complete study as it is the first to disentangle the effects of the CCyB and the Loan-to-Value (LTV) regulations that were put in place at a similar time.

In these studies, the variables of interest as well as the treatment and control groups vary considerably. Auer and Ongena (2019) define the treatment group as the banks most heavily concentrated in the mortgage sector whereas Behncke (2020)and Basten and Koch (2020) consider the proximity of the banks to the capital constraint ex-ante. I will use the latter as a control in my analysis as the treatment and control groups are already defined as D-SIBs and non-D-SIBS. All of these studies found similar results in that heavily affected banks reduce mortgage lending growth rates between 1 and 2% in response the mortgage-targeted CCyB (Behncke, 2020; Auer et al., 2019; Basten and Casanova, 2015). Though this effect was significant, banks appeared to adjust the composition of the LTV ratios in the mortgage portfolios to a greater degree than the overall mortgage growth rates (Behncke, 2020). Auer and Ongena (2019) also found evidence for a risk-increasing effect in the overall composition of loans for heavily affected banks as they traded off mortgage lending for relatively riskier corporate lending.

One concern that is present in all these studies may be macroprudential leakage. The treated and untreated groups in the DiD model operate in the same market. Thus, we may be capturing a large treatment effect on the untreated as the non-affected banks become more competitive in the mortgage market. This could lead to an overestimation of the actual effect of CCyBs on lending growth rates. This leakage is a well-documented phenomenon, Aiyar et al. (2012) found that in the case of targeted capital regulation, as much as one-third of the reduction in lending growth may be offset by unaffected foreign subsidiaries. This may not be an issue if the goal of the regulation is only to limit the exposure of the domestic banking sector, however, it does limit the regulator's ability to curb dangerous credit cycles in the aggregate. Unlike the previously mentioned bias regarding banks' preference to hold capital well above regulatory minimums, this is also of concern in this analysis.

Some of the most insightful work on CCyBs comes from Jimènez et al. (2017) who use evidence from the Spanish dynamic provisioning experiment to analyze the impact of a policy that is akin to a CCyB over a whole credit cycle. The policy required that regulated banks hold additional loan loss provisions according to perceived macroeconomic risks. Though loan loss provision would be considered Tier 2 capital under the current regulation, the effect on lending behaviour should be similar to the current form of the CCyB. The authors use loan-level data and found that 1% in additional provisions curbed credit growth minimally in "good times" and resulted in 9% of additional credit provided by those banks in "bad times". Furthermore, firms that maintained lending relationships with well-capitalized banks maintained 6% more staff and had a 1% greater chance of survival during the 2008 financial crisis (Jiménez and Ongena, 2017). This study is important in two respects. Firstly, it is the first to study the impact of a CCyB-like policy over a whole credit cycle, meaning they are able to look at the impact of both the build-up and release of additional capital. Furthermore, it provides clear evidence of macroprudential leakage at the firm-bank level as firms switch to banks which are less capitalized in good times and well-capitalized in bad times. There is also evidence of risk-increasing compositional effects of these loan loss provisions in good times as affected banks lend more to riskier firms, in accordance with yield-seeking behaviour (Jiménez and Ongena, 2017).

The Canadian banking sector is historically well-capitalized compared to its international peers (CBA, 2021). This may present issues for studying the impact of capital regulation if banks' capital ratios sits well above regulatory minimums such that the regulation doesn't trigger any penalty. In the appendix is included a graphic of the initial level of capitalization of each bank in the sample in 2018. Luckily, we can draw on insights from Berger et al. (2008) who studies how large banking organizations manage their capital ratios. Large banks tend to hold excess capital well beyond regulatory minimums, and they actively manage their asset allocations and dividend policy in response to this regulation, even if they never in fact breach these minimums (Berger et al., 2008). Banks do this to avoid the regulatory and signalling costs of breaching these required levels as well as to avoid relatively expensive equity issuance during a crisis. In her study, Behncke found that mortgage lending rates and LTV distributions were significantly affected by the CCyB, even among those banks which never breached the regulatory minimums (Behncke, 2020).

Methods

Data

The data set was web scraped from individual balance sheets using OSFI's financial data portal. It contains monthly balance sheet information on all chartered Canadian banks including a structured breakdown of their loan and security holdings as well as numerous other variables of interest. The data covers 49 banks, of which 21 were removed due to inactivity during the period of interest or for data reporting issues. The period of interest was selected to be January 2017 until June 2022, or approximately 18 months before the announcement of the DSB until the present. Changes to the buffer were announced in June and December of each year except in the case of emergency changes, such as that of March 2020. Announcements of DSB changes include a timeline for which full implementation is required, typically banks have 4 months to comply with increases to the buffer whereas reductions are effective immediately. It is important to note that though we do have data going back 18 months before the announcement, we cannot control entirely for the anticipation effects. OSFI, along with many other countries, had already decided on the implementation of a 0-2.5% RWA countercyclical capital buffer in some form since the finalization of the Basel III agreement in 2017.

TABLE 1 Timeline of Macroprudential Policy

January 2017	LTV and mortgage stress test regulation implemented - beginning of sample period
January 2018	Beginning of interest rate tightening cycle
June 2018	DSB announced at 1.5% RWA in response to vulnerabilities to (i) Canadian consumer indebtedness; (ii) asset imbalances in the Canadian market; and (iii) Canadian institutional indebtedness.
December 2018	DSB increased to 1.75% RWA
June 2019	DSB increased to 2% RWA
December 2019	DSB increased to 2.25% RWA in response to vulnerability to ongoing trade tensions and additional leverage.
March 2020	DSB reduced to 1% due to the COVID-19 pandemic, freeing up $300 billion in additional lending capacity. Commitment to not increase the buffer for another 18 months.
June 2021	DSB raised to 2.5% in response to exposure to high household and corporate debt levels.

Since its introduction, the buffer has seen 6 changes, with reversals in policy (tightening vs loosening) occurring 3 times in 2018, 2020, and 2021. The buffer is limited to a maximum of 2.5% of RWA but OSFI may institute additional bank-specific requirements as part of the Pillar II regulatory requirements if necessary. Bank-specific requirement data is not available, but these are usually measures of last resort and thus are not a concern over the period in question (O. OSFI, 2020). Some research has been done into the effects of additional capital requirements beyond the 2.5% level and has shown that additional equity beyond this level may have positive welfare benefits (García and Schroth, 2021).

Environment

The Canadian financial sector is dominated by the six largest banks or D-SIBs which have a total combined asset value of $4.11 Trillion CAD which is roughly equivalent to ten times that of the next 25 banks. This disparity shrinks when we consider only domestic assets, but the difference remains stark. These largest banks are highly diversified across multiple asset classes and rely heavily on retail deposits. The remainder of the banks are more specialized and varied in their business strategies, Figure 8 in the appendix illustrates the major asset classes held by each bank in the sample. As we can see, there are a few clear outliers in business strategy such as ADS Bank, Digital Commerce Bank, Canadian Tire Bank etc. which are initially retained but will be removed from the sample in estimations further on.

On concern that is unique to the Canadian environment may be the small number of banks which operate across different asset categories. In the appendix is included figures which demonstrate that we have enough non-D-SIBs operating in similar asset classes to D-SIBs to be able to treat them as a valid control group across our estimations. This also extends to subcategories of these asset classes such as insured vs uninsured mortgage lending, allowing us to test for the presence of risk-shifting behaviour in response to the DSB. Figures 4-7 in the appendix breakdown the banks operations in the asset classes of interest for our analysis. The minimum size of the control group across specifications is 4 banks in the case of "other secured" personal loans and the maximum is 15 for uninsured mortgages. Unfortunately, this same logic excludes much of our results from banks' foreign lending behaviour, of which the large majority is dominated by the D-SIBs. Foreign lending ranges between 30 to 65% of asset value for D-SIBs, whereas only 11 of the remaining 25 banks have any foreign lending operations worthy of mention, and only 3 of which are diversified to the same degree as the D-SIBs.

The concentration of the Canadian financial sector underpins the motivation for its unique implementation of the CCyB. The logic underlying the DSB only being applied to D-SIBs rather than the remainder of the banks makes sense when we consider their charter value and integration into the financial system. The D-SIBs handle the majority of transactions in the payments system, act as financial intermediaries for OTC markets including corporate and government debt and are the main source of credit supply to the general population. Therefore, in the event of a downturn, so long as the operations of D-SIBs are uninterrupted, the whole financial system will be partially stabilized (D. X. Chen and Christensen, 2010). This means smaller banks are getting a free lunch as they can enjoy the benefits of a more stable financial system without having to foot any of the bills in terms of additional equity requirements.

Empirical Model

The basic Difference-in-Difference model has the following specification:

$$\begin{aligned}\%\Delta assetgrowth = \beta_0 + \beta_1 DSIB + \beta_2 DSB + \beta_3 DSIB * DSB + \beta_4 size \\ + \beta_5 retaildep + \beta_6 wellcap + \beta_7 intrate + \beta_8 \tau + \epsilon\end{aligned}$$

The dependent variable $\%\Delta assetgrowth$ represents the month-over-month% change in the face value of the asset class. $DSIB$ is an indicator for the treatment group and will capture the effect of being in the D-SIB group on asset growth. DSB is the level of the DSB and captures the effect of the DSB on mean asset growth overall. It is important to note that this term may also be capturing how banks are adjusting their loan portfolios in response to the macroeconomic and systemic vulnerabilities as identified by OSFI. τ is a vector of monthly time-fixed effects to control for the shocks in each period that affected all banks in a similar direction and *intrate* is the lagged interbank rate set by the Bank of Canada. The coefficient of interest for our analysis will be β_3, which attempts to capture the effect of the DSB on the difference in asset growth rates between the D-SIBs and non-D-SIBs.

Since these groups are not randomly selected, there is likely to be variation across them that may mask itself as a treatment effect in our specification. To control for this, we include multiple bank controls which capture the effect of specific business strategies. Being well capitalized in the first place allows banks to take on greater risk in their asset allocation without risking insolvency and may be the source of a heterogeneous treatment effect to an unknown shock. To control for this I include each bank's level of %CET1/RWA before the introduction of the DSB. It is expected that ex-ante well-capitalized banks should maintain higher lending growth rates overall as they are less likely to react to the new policy. This term can also be used as a robustness check further as we can employ it as further a measure of treatment intensity within the D-SIB group. We also include other variables which have shown to be relevant in previous studies including size and the concentration of retail deposit funding.

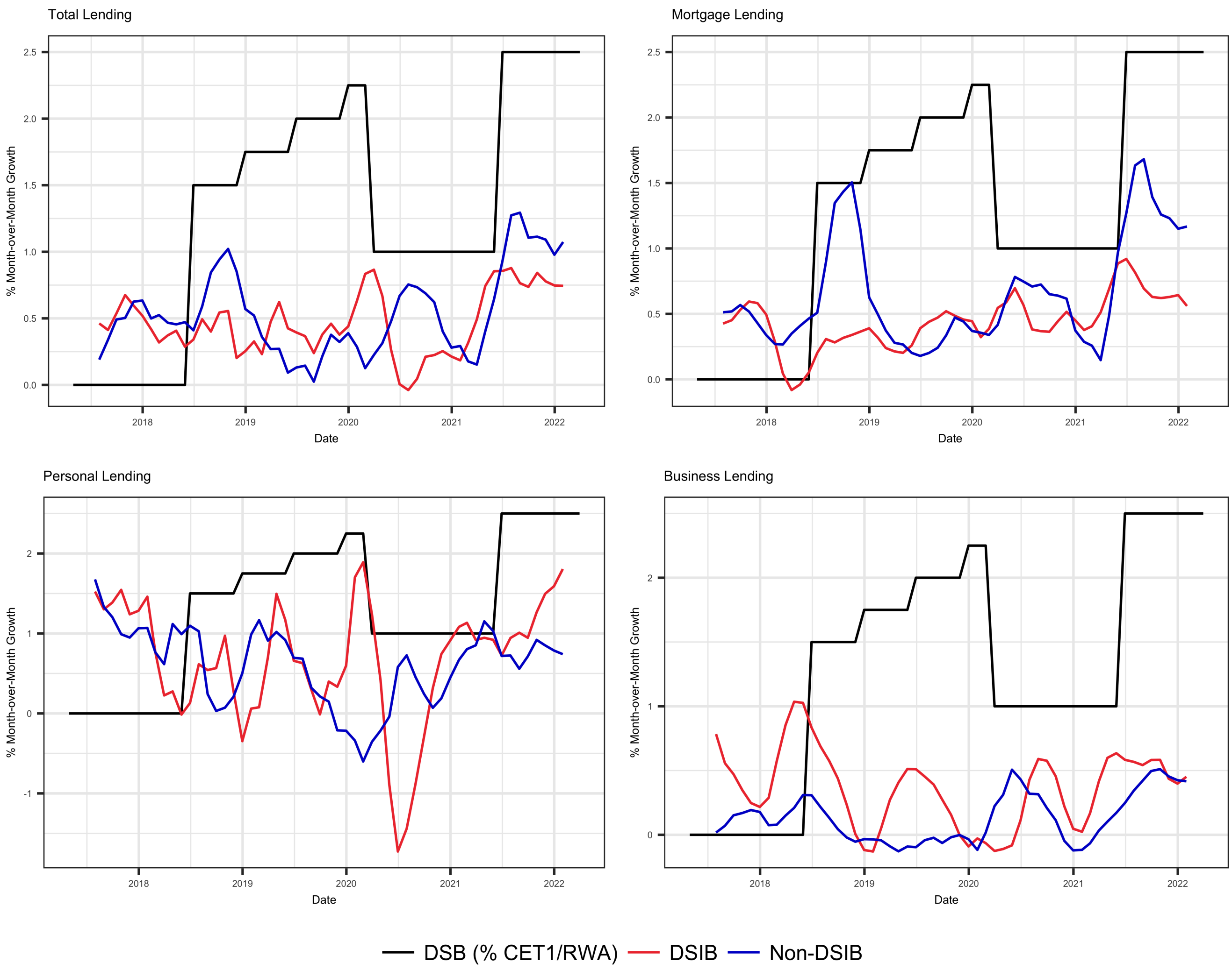
In a similar vein as Behnke (2020), we must attempt to disentangle the effects of regulatory policies which may differentially affect large and small banks: equity requirements, mortgage regulation, and overnight interest rates. The capital requirements were not the only macroprudential policy that was implemented at this time. Mortgage qualification requirements also went through a tightening period, with tougher insurance requirements and stress tests for high loan-to-value mortgages in 2016 and a similar restriction on low loan-to-value mortgages in early 2017. The target rate set by the Bank of Canada also experienced a tightening cycle beginning in 2018 and continued into the COVID crisis, rising a total of 1.25% over 5 hikes. The target rate bisects an operating band of interest rates to which only banks that maintain settlement balances at the Bank of Canada have access. Though the market interest rate generally falls within this band, having access may differentially impact some institutions over others depending on whether they are in the periphery or not. We include the overnight interest rate in our specification, but I have chosen to ignore the mortgage qualification regulation effects as they were required to be implemented 18 months before the beginning of our analysis and it is not clear how they may affect asset measures which are as aggregated as the ones reported by OSFI.

This being only a basic specification, we will need to include several additional robustness checks beyond the inclusion of controls. My checks include the use of a macroprudential environment indicator rather than the DSB level. This indicator depends only on whether the banks are in a tightening or loosening cycle instead of the level of the DSB. Since D-SIB banks already sit above regulatory minimums, they may not react to each individual policy change but rather to the expectation of future tightening, this indicator will capture this better than the DSB level. The lag on the DSB was also varied between 1 and 6 months which is inclusive of the time that banks are required to implement increases to their capital ratios after a DSB announcement. The specifications are also estimated across different 2-year horizons around large shocks in June 2018, March 2020, and June 2021 to see if we see observe consistent results. Finally, though I believe it is of less concern in this analysis than in previous studies, there may be clusters within the DSIBs that may be subject to common shocks which may mask as a treatment effect and lead to an overestimation of the significance of our effects. To test this, I use a use a bootstrap procedure to test for consistency.

As mentioned previously, there are a few large outliers in the sample of small banks that are unlikely to react to the macroeconomic environment in such a manner that we could consider them as a control group for the large banks. These include smaller banks which don't rely on retail deposits and have highly concentrated asset classes as well as banks that don't operate loan portfolios at all. It was considered whether these banks may not represent a true control group even when controlling for bank-specific characteristics and thus may be biasing the results. Therefore, the sample size of banks was reduced to only those with similar business models as D-SIBs, that being large, diversified banks with a reliance on retail deposit funding. These banks may be considered more risk-averse in general as maturity and liquidity transformation becomes more difficult. The results for this group are presented first in the results section.

Descriptive Analysis

We will focus on a few key asset categories which have shown to be actively managed in response to capital controls. Specifically, we will look at the growth and composition of mortgage loans, personal loans, and business loans. Below is an illustration of the average growth rates across these asset classes broken down by the treatment (D-SIB) and control (Non-D-SIB) groups.



Here we can see large deviations in total lending growth that are concentrated around large shocks to the level of the DSB in 2018 and 2021. This appears to be primarily driven by changes in mortgage lending growth, but we will see later that there are significant effects in subcategories of personal and business lending as well. We are less interested in banks other asset holdings such as securities or derivative positions as smaller banks are not very active in these categories.

Results

Results for selected subset of banks with similar business strategies

For the subsample of banks with large retail deposit franchises and diversified holdings we observe significant changes in lending behaviour across multiple specifications. The full regression results as well the list of banks included can be found in the appendix. I will go on to present the results for the DiD interaction term across the different loan classes, with each being broken down by risk-level and lag length.

Residential Mortgage Lending

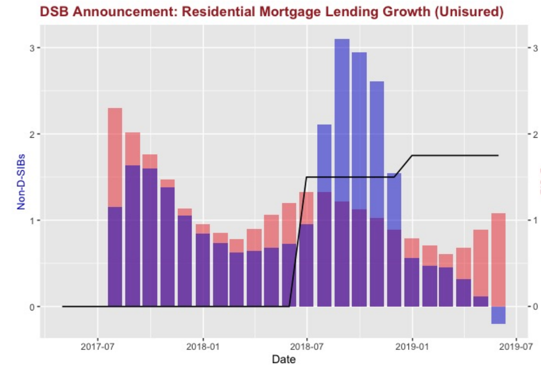
The table below displays the results for the residential mortgage lending estimation, broken down by total, insured, and uninsured mortgages. The coefficients represent the log percentage change in lending growth for D-SIBs vs Non-D-SIBs associated with a 1% point increase to the DSB. For example, in the first specification of the table, it can be seen that a 1% increase in the DSB is associated with a 0.4% decrease in overall mortgage lending growth, no effect on insured mortgage lending, and a 0.5% decrease in uninsured mortgage lending. The next specification represents the same effect, but with a 1 month delay and so forth. We can see that these effects are not very persistent with total mortgage lending and uninsured mortgage lending falling by an average of 0.28% and 0.325% respectively for 3 months and then disappearing within the 4-month compliance period. Though not persistent, the effect is quite strong, being roughly equivalent to a 30% reduction in the average loan growth during this period. It is also important to note that we have very low adjusted R^2 values. This does not affect the interpretation of the coefficients or p-values but it does mean we should not make any predictions about lending growth rates.

Table 2: Residential Mortgage Loans

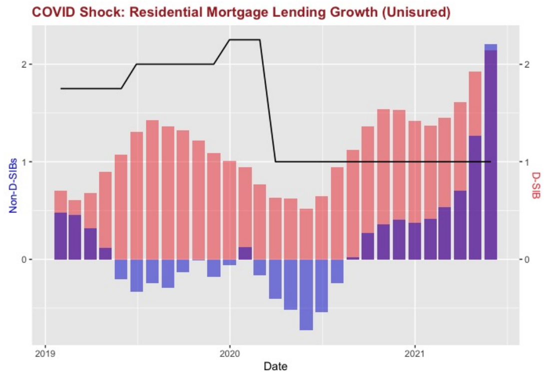
	Dependent variable:		
	Total	Insured	Uninsured
DSIB:DSB	-0.004^{***}	0.00004	-0.005^{***}
	(0.001)	(0.001)	(0.002)
DSIB:DSB(-1)	-0.003^{***}	0.0004	-0.005^{***}
	(0.001)	(0.001)	(0.002)
DSIB:DSB(-2)	-0.003^{**}	-0.0001	-0.003^{*}
	(0.001)	(0.001)	(0.002)
DSIB:DSB(-3)	-0.002^{*}	-0.0003	-0.002
	(0.001)	(0.001)	(0.002)
DSIB:DSB(-4)	-0.002	-0.00001	-0.001
	(0.001)	(0.001)	(0.002)
DSIB:DSB(-5)	-0.002	-0.0004	0.0002
	(0.001)	(0.001)	(0.002)
Observations	839	839	839
Adjusted R^2	0.043	0.159	0.070
F Statistic (df = 65; 773)	1.585^{***}	3.445^{***}	1.976^{***}
Note:			*p<0.1; **p<0.05; ***p<0.01

These results are robust to bank and time-fixed effects. Consistent results were found using the macroprudential environment indicator instead of the level of the DSB. Being in a macroprudential tightening cycle was associated with a 0.45% lower growth rate in mortgage lending for D-SIBs vs Non-D-SIBs, once again with this being entirely driven by reductions in uninsured mortgage loans. The results were also tested by only looking at periods with large shocks to the DSB. These being the 1.5% increase in June 2018, the 1.25% reduction in March 2020, and the 1.5% increase in June 2020. We expect to see consistent results across these large shocks. This is similar to the approach taken by Behncke (2020), Auer and Ongena (2019), and Basten and Koch (2015) in that we are only looking at one large shock rather than a series of changes to capital requirements. We find consistent result across the 2018 and 2021 shocks but no significant effects were found for the COVID-19 release shock.

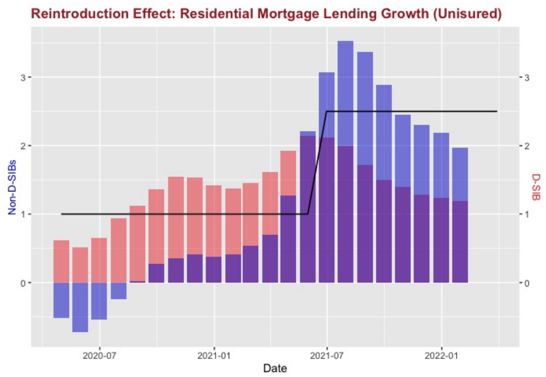
As an illustrative example of the severity of these behavioural changes, the figure below shows uninsured residential mortgage growth across these large shocks. We can see a clear divergence in lending growth between D-SIBs and Non-D-SIBs after the announcement of the DSB and its reintroduction in 2021. During COVID, we observe a similar divergence but in the opposite direction as the buffer was released. During this shock, there are simply too many simultaneous policy changes that could differentially affect D-SIBs and non-DIBs that we can't attribute any effects to the DSB.



(a) DSB Announcement



(b) COVID Shock



(c) Reintroduction in 2021

Figure 1: Robustness check across large shocks

Some interesting effects are also found for the fixed effects and controls in this specification that are shown in the appendix. Being in the DSIB group was associated with a 0.8% and 1.4% higher growth rate in total and uninsured mortgage lending. The introduction of the DSB was associated with a significant negative growth rate in total and uninsured mortgages, indicating that all banks may react at least partially to the same macroeconomic risk environment as OSFI. Finally, being well-capitalized ex-ante was associated with a slightly lower growth rate in uninsured mortgage growth which may be explained by a given bank's risk strategy overall. A bank that is more concerned about macroeconomic risks will maintain a higher capital ratio and will engage in less risky lending.

Business lending

As for business lending, significant effects are only observed for the "other secured" business lending. A 1% increase in the DSB is associated with a 0.8% decrease in new business lending. These results are robust to bank and time-fixed effects, and we observe similar results using our macroprudential indicator variable rather than the level of the DSB. Once again, we see that the reductions in lending are concentrated in assets with higher risk-weights, in accordance with capital regulation compliance behaviour. What we do not observe is consistent results across large shocks, most of the captured effect appears to be driven by the initial introduction of the DSB in 2018. We cannot conclude with a high degree of certainty that D-SIBs significantly reduced business lending due to inconsistency across shocks, however, we do find many results consistent with this hypothesis. Firstly, we observe that D-SIBs reduced business lending to a greater degree than mortgage lending, as we would expect according to their relative risk weights. We can also see that the decrease is concentrated in the "other secured" class which includes unsecured loans. These types of loans receive a higher risk weight than property secured loans for which we observe no effect.

Table 3: Loans to Individuals for Business Purposes

	Dependent variable:		
	Total	Other Secured	Property Secured
DSIB:DSB	−0.005	-0.008^{**}	−0.001
	(0.003)	(0.004)	(0.001)
DSIB:DSB(-1)	−0.005	-0.008^{**}	-0.001^{*}
	(0.003)	(0.004)	(0.001)
DSIB:DSB(-2)	−0.003	−0.006	−0.001
	(0.003)	(0.004)	(0.001)
DSIB:DSB(-3)	−0.003	−0.006	−0.001
	(0.003)	(0.004)	(0.001)
DSIB:DSB(-4)	−0.003	-0.007^{*}	−0.001
	(0.003)	(0.004)	(0.001)
DSIB:DSB(-5)	−0.003	−0.006	−0.001
	(0.003)	(0.004)	(0.001)
Observations	839	839	839
Adjusted R^2	0.037	0.049	0.003
F Statistic (df = 65; 773)	1.493^{***}	1.660^{***}	1.033
Note:			*p<0.1; **p<0.05; ***p<0.01

Personal Lending

For personal loans, we observe similar behaviour as with business and mortgage lending. D-SIBs reduced total personal lending growth by 1% and "other secured" personal loans by 0.8% relative to Non-D-SIBs in response to

Table 4: Loans to Individuals for Non-Business Purposes

	Dependent variable:		
	Total	Other secured	Property Secured
DSIB:DSB	-0.010^{**}	-0.008^{*}	-0.009
	(0.004)	(0.004)	(0.007)
DSIB:DSB(-1)	-0.010^{***}	-0.010^{**}	-0.0004
	(0.004)	(0.004)	(0.007)
DSIB:DSB(-2)	-0.009^{**}	-0.009^{**}	0.001
	(0.004)	(0.004)	(0.007)
DSIB:DSB(-3)	-0.007^{*}	-0.007^{*}	0.001
	(0.004)	(0.004)	(0.007)
DSIB:DSB(-4)	-0.007^{*}	-0.008^{*}	-0.002
	(0.004)	(0.004)	(0.007)
DSIB:DSB(-5)	-0.004	-0.004	-0.003
	(0.004)	(0.004)	(0.007)
Observations	839	839	839
Adjusted R^2	0.038	0.020	0.020
F Statistic (df = 65; 773)	1.508^{***}	1.262^{*}	1.259^{*}
Note:			*p<0.1; **p<0.05; ***p<0.01

a 1% increase in the DSB. This result is robust to bank- and time-fixed effects as well using our macro-environment indicator. We also observe consistent results across large shocks in 2018 and 2020 but not in 2021. The decrease being concentrated in the higher-risk class "other secured" category is similar to the result for business and mortgage lending. The effect is significant for up to 4 months, consistent with the amount of time provided by OSFI to comply with the DSB.

Results for Entire Sample of 28 Banks

We find no results that are both significant at traditional levels and robust effects for our variables of interest in the initial specification. The only highly significant results are found in loans to foreign governments, call and short loans to investment dealers, and property secured lending. The first two are eliminated due to having too small of a control group; very few small banks lend to broker-dealers or to foreign governments. As for property secured loans, the results were significant but were eliminated due to a violation of the parallel pre-trend assumption in Difference-in-Difference estimation and did not stand up to variation in the time horizon of the analysis.

These results were consistent when we added bank and time-fixed effects, interest rate effects, and using our macroprudential environment indicator. The time horizon was also varied to see if banks react only to large shocks to the DSB. Across these shocks we see more significant effects but very few of them being consistent across time periods. Essentially D-SIBs reacted differently to the 1.5% hike in 2018 vs the 1.5% hike in 2021, indicating that we may not be capturing the true treatment effect. It may be of note to mention that for many of these specifications, the DiD variable was significant in the expected direction at the 80-90% CI levels.

Conclusion

Among a subset of banks with similar business models, we observe that D-SIBs reduced new lending growth compared to non-D-SIBs in response to increases in the DSB. This reduction was concentrated in higher-risk loans and was robust to multiple controls and alternative specifications. This provides support to the previous literature in that higher equity requirements at least partially inhibit banks' ability to provide loans. This suggests that there are significant costs associated with equity vs debt financing for Canadian banks which could be attributable to some of the market inefficiencies identified by Modigliani Miller. Given that banks in Canada sit above the regulatory minimums yet still react to additional equity requirements, these effects may be explained by asymmetric information or signalling costs. If equity issuance is viewed as signal of a bank's instability, it may hurt their enterprise value under a scenario with asymmetric information. This interpretation concurs with Berger et al. (2008) as it provides incentive for D-SIBs to manage their lending behaviour in order to maintain capital ratios significantly above the regulatory minimums.

The size of the impact of the DSB on lending growth in Canada is similar to the previous literature, though slightly muted. A 1% increase in the DSB was associated with affected banks reducing personal loans by an average of 0.9%, business loans by an average of 0.4%, and mortgage loans by an average of 0.3% over the 4-month compliance period. If we convert this to the quarterly basis of the other literature, this would translate to a -2.7%, -1.2%, and -0.9% growth rate respectively. Behncke (2020), on ther other hand, found that a 1% increase in the mortgage-targeted CCyB led to a 2% decline in the mortgage lending rate, the equivalent of 30% reduction of the mean growth rate (Behncke, 2020).

Berrospide et al. (2019) use evidence from US stress tests and found that 1% in additional capital buffers resulted in a 1.5-2% annualized reduction in loan growth. Though these results are encouraging, sources of bias still need to be addressed.

Macroprudential Leakage / Treatment Effect on Untreated / Total Credit Supply

A concerning result manifests itself in the result that differences in behaviour appear to be largely driven by variation in the supply of credit by Non-D-SIBs rather than D-SIBs. As can be seen in Figure 1, during the introduction of the DSB, smaller banks increased their uninsured mortgage lending rates by almost 2% whereas D-SIBs only reduced their rates by approximately 0.5%. The exact same behaviour is observed for the COVID and reintroduction shocks as well. This indicates that our results may be subject to some significant treatment effect on the untreated and we cannot determine how much of this was captured by our controls. If this was the case, it would lead to an overestimation of the true treatment effect and would make interpretability for future policy difficult if the CCyB was instead applied for all institutions rather than a select subset.

This behaviour by the untreated group also represents an issue in the effectiveness of the DSB. Regulators may not only be interested in reducing the vulnerability of the financial system, but also in curbing excess credit cycles. The ability of the regulator to do so depends on their ability to control macroprudential leakage. In this case, leakage refers to the unaffected banks responding differentially to the DSB in such a manner that offsets its intended effect on credit supply. Smaller banks become more competitive as equity requirements for the D-SIBs increase and thus may respond by increasing their loan portfolios to make up for the reductions in D-SIB credit. Luckily, in our case, even though the differential response of smaller banks was significant, small banks do not represent a large enough share of credit supply to merit concerns about macroprudential leakage. Taking the uninsured mortgage lending example from earlier, given the relative size of these portfolios, a 2% increase in the supply of these loans by smaller banks offsets only about 20% of the decrease in new lending by D-SIBs. This is true of this sample but may be more concerning if we included other sources of credit such as mortgage-finance companies or credit unions which also become more competitive.

This effect of macroprudential policy on the relative competitiveness of these two groups has already been realized and studied in the Canadian context. At the beginning of the tightening cycle in 2018, smaller banks, mortgage finance companies, and private lenders began to steal market share in mortgage originations in Toronto from the big banks (Bilyk and teNyenhuis, 2018). It is difficult to determine the direct cause of this since the regulation, as is often the case, was not limited to capital requirements but also rising interest rates and Loan-To-Value requirements. If the additional equity requirements were responsible for these shifts in competitiveness, then the DSB was very effective according to its stated intention of limiting the exposure of the large banks. In the announcement of the DSB in 2018 as well as its subsequent increases, OSFI continually mentions exposure to "asset imbalances" and "consumer indebtedness" as key systemic vulnerabilities affecting the financial system (OSFI, 2018). Losing market share in hot housing markets like Toronto may be exactly the kind of exposure that was of concern to regulators.

Though the credit-to-GDP gap may be a flawed univariate predictor of financial crises, some version of it will be on OSFIs radar when setting capital buffers (Luca and Basten, 2017; Drehmann and Tsatsaronis, 2014). We can imagine the impact of the DSB on the aggregate credit ratios by examining overall loan growth. Though we have no counterfactual case to compare the credit supply growth to, we can see that, aggregate credit supply of chartered banks appears to be uninterrupted by the DSB. This aligns with a period of stagnation in the credit-to-GDP gap, but this stagnation begins in 2017 and cannot directly be attributed to macroprudential policy.

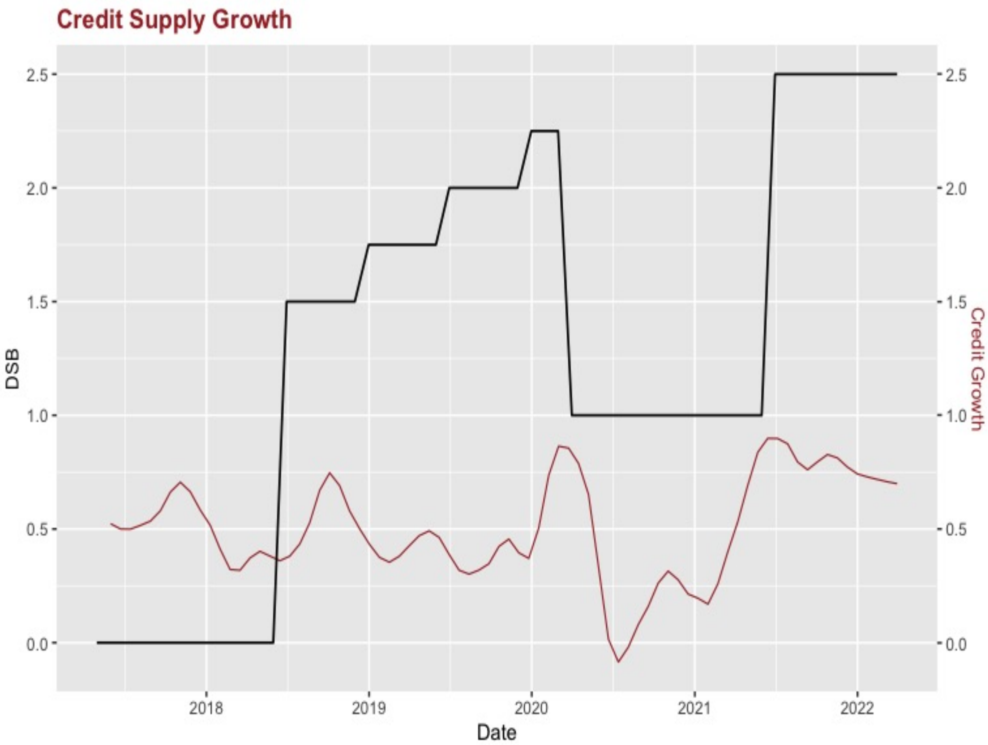


Figure 2: Loan supply of all domestic banks, smoothed with a LOESS function.

Transmission Mechanism

In the Swiss and Spanish examples, the authors all observe risk-shifting behaviour as we do in this case. Behnke (2020) and Basten et al. (2015) both observe reallocations of mortgage portfolios towards less risky loans. Auer and Ongena (2019) observe a shift from mortgage lending towards business lending which now receives a relatively lower risk-weight than before the CCyB was introduced. Given that the DSB is applied to all risk-weighted assets rather than just mortgage lending, we see it translated through other channels as well. During the 4-month compliance period of a 1% increase to the DSB, affected banks reduced personal loans by an average of 0.9%, business loans by an average of 0.4%, and mortgage loans by an average of 0.3%. All these results are driven by loans that are not secured by a residential property. Under the standardized approach to risk-weights, claims on retail products such as credit cards and small business loans receive a 75% risk-weighting unless secured by a residential property in which case this is reduced to 35%. Banks will prefer to maintain their capital ratios through unsecured lending channels as each additional marginal reduction in the face value of these loans would have more than twice the impact on their capital ratio as that of changes in property secured loans. Though large Canadian banks typically rely on IRB models rather than the standardized model, the logic will carry through using these approaches.

What this paper cannot speak to is concerning credit risk effects stemming from more more specialized changes in the composition of lending that previous studies have focused on. In the case of personal lending, banks may have traded-off credit card for auto loan growth, which may receive the same risk-weighting but have differential implications for financial stability. The same logic could be applied to highly risky business loans as in the Spanish experiment. Mortgage regulation is going to be less susceptible to this as the weight of loans with different LTV ratios and collateral are regulated to a high degree of granularity in the Basel III framework. We also can't determine how much of the potential costs of regulation were passed on to the consumer through higher interest rates or collateral requirements. This is the kind of analysis that benefits from having loan-level data so that we can observe the formation and renegotiation of loan contracts and tie them to specific firm-level characteristics (Jiménez and Ongena, 2017).

Regulatory Arbitrage

As for regulatory arbitrage, we find little concerning results in the data available. In other studies, the authors found evidence of risk-increasing compositional effects from mortgage to business loans, but our analysis shows the opposite. Overall riskiness of portfolios fell in response to the DSB as banks reduced their uninsured and non-property secured lending growth. This can be attributed to the non-targeted nature of the DSB as it is applied across all assets rather than just mortgage loans. Though this means that banks reduce their riskiness, as measured by the regulatory risk-weights, the apparent trends are concerning in the case of Canada. The most common vulnerabilities cited as motivation for increases to the DSB were consumer indebtedness and asset imbalances in the housing market. In our estimations, however, the mortgage market, arguably the largest driver of these vulnerabilities, is relatively unaffected compared to other types of loans. This was the reasoning cited by the Swiss National Bank for implementing a mortgage-targeted rather than broad-based approach to the CCyB as they were less unconcerned about asset imbalances in other markets. Therefore, though banks did reduce the overall riskiness of their loan portfolios according to the Basel III risk-weights, a more targeted approach might be required to meet more specialized goals in the future.

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Appendix

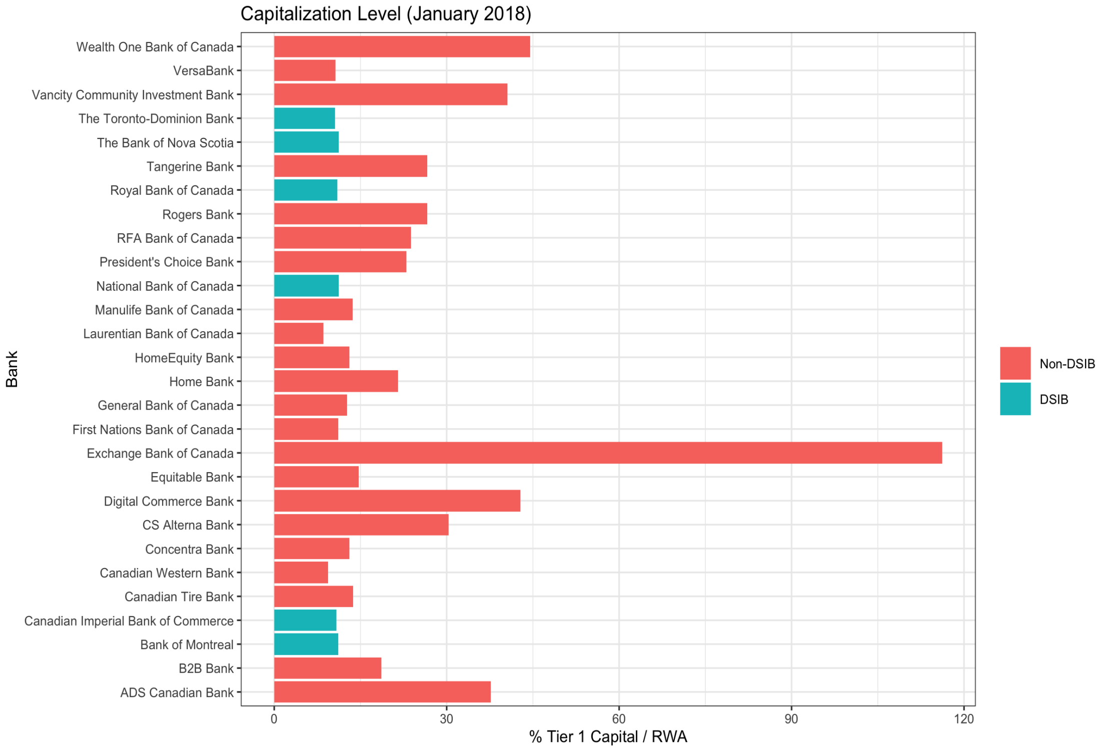

Figure 3: Pre-DSB capitalization level with blue highlighting DSIBs

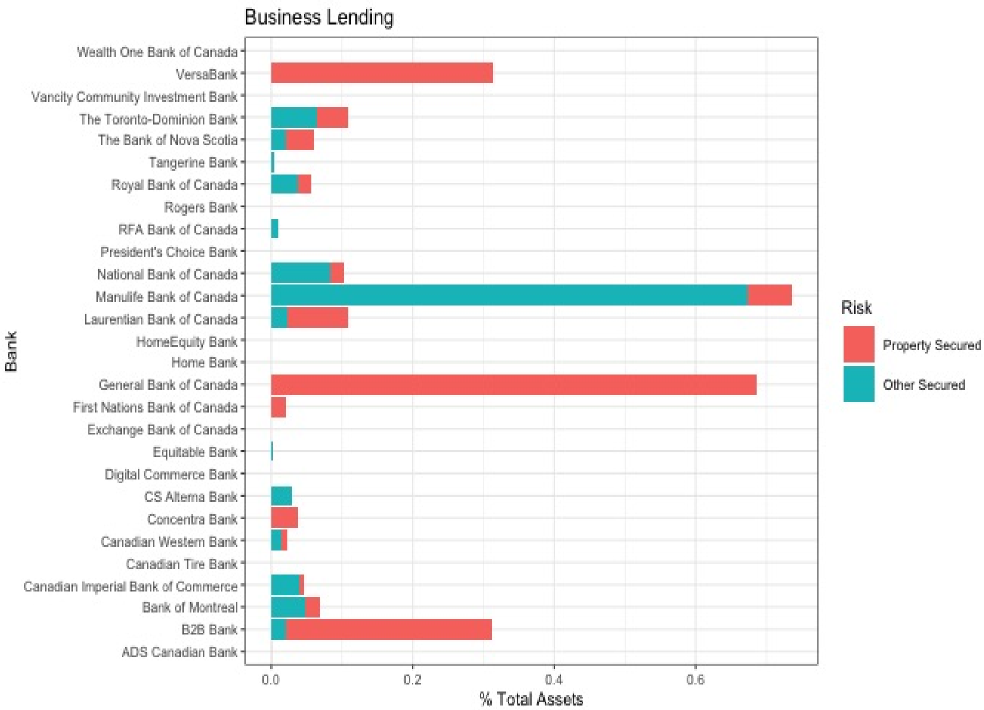

Figure 4: Illustrates size of control group in business lending

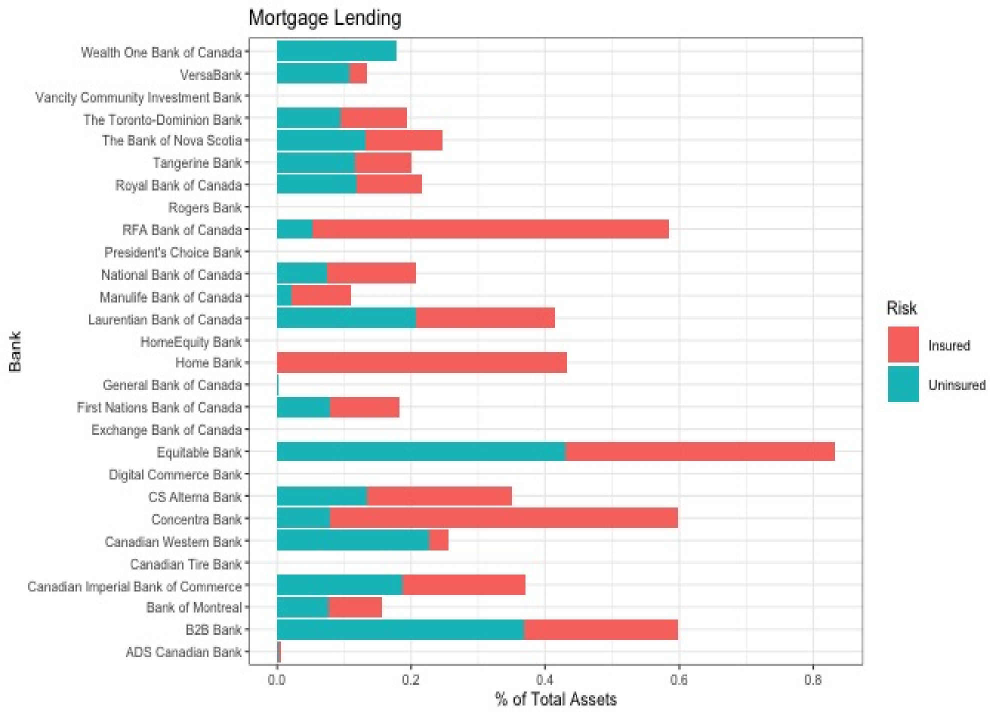

Figure 5: Illustrates size of control group in mortgage lending

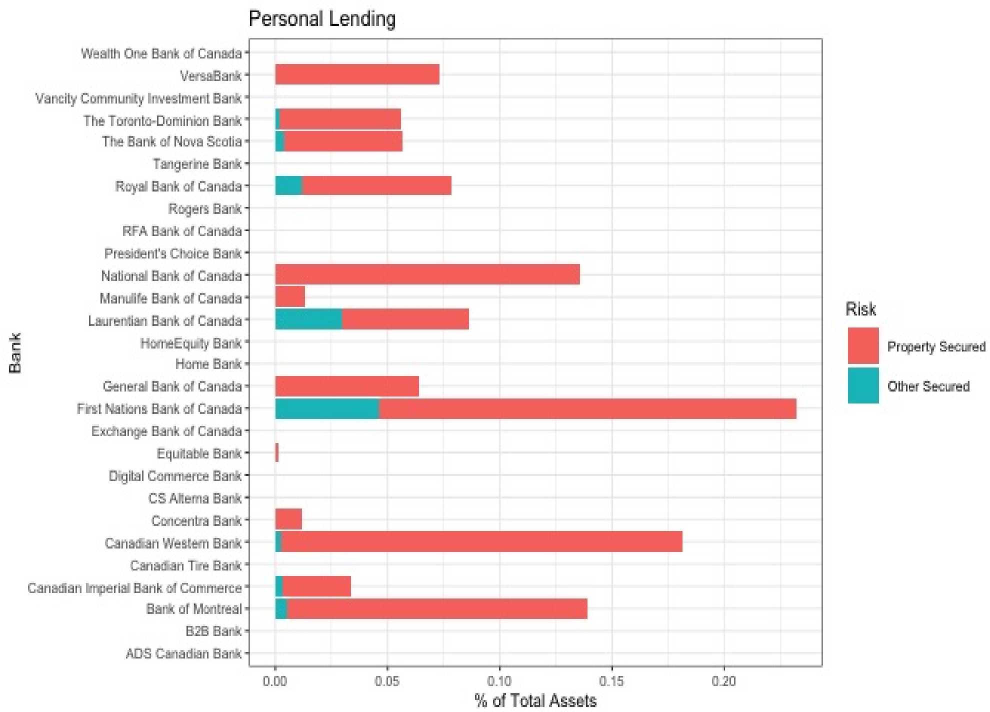

Figure 6: Illustrates size of control group in personal lending

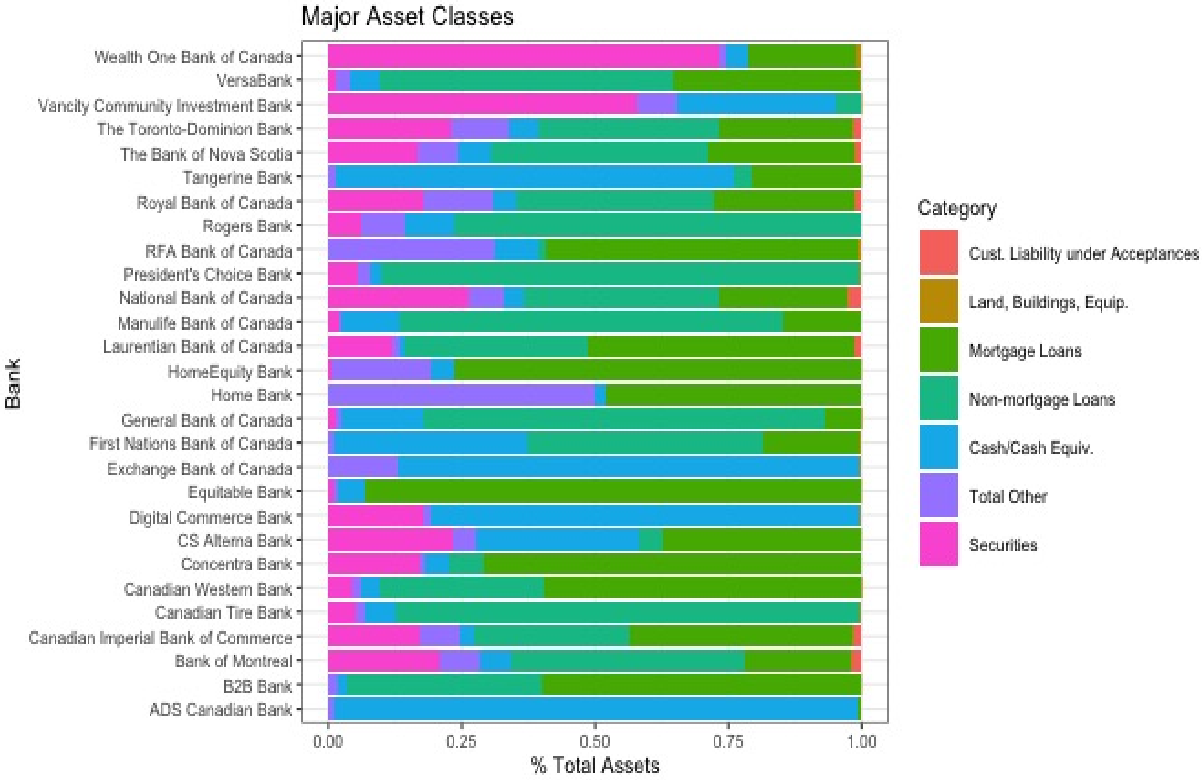

Figure 7: Major asset class holdings of all banks in sample

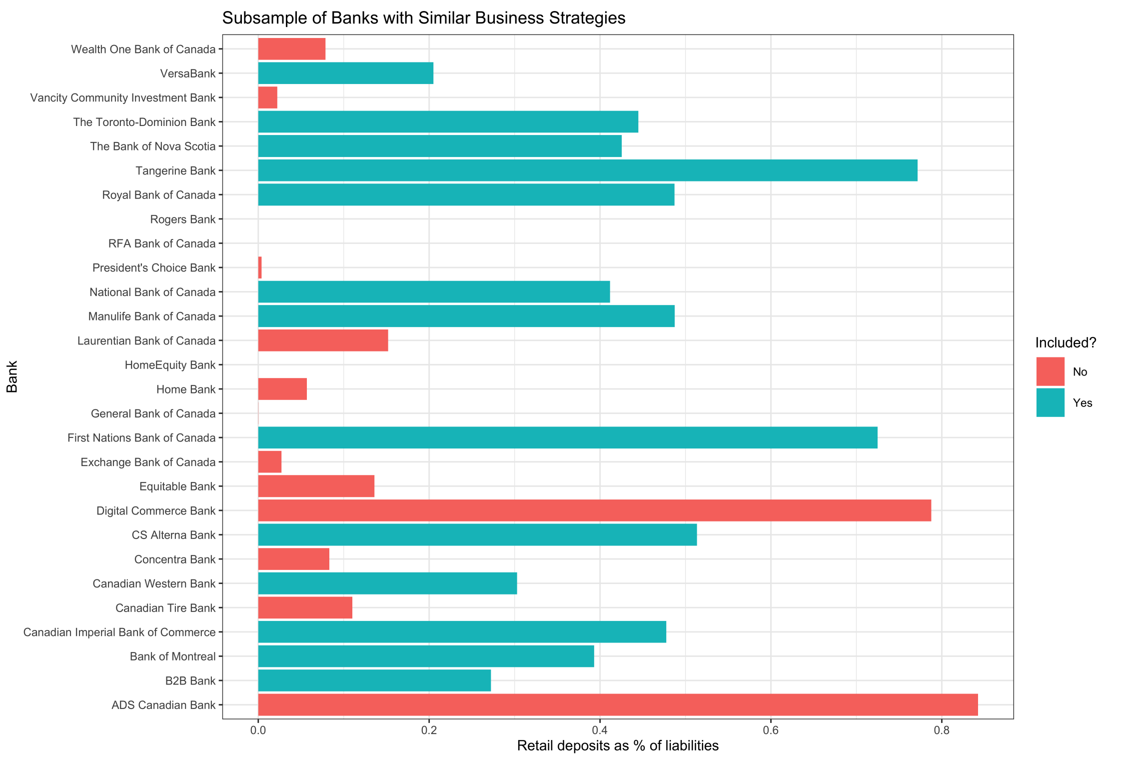

Figure 8: Included banks in subsample. ADS and Digital Commerce Bank are eliminated due to small loan portfolios.

Table 5: Descriptive Statistics

Statistic	Mean	Min	Max
Total Lending	1.091%	–110%	187%
Personal Lending	0.472%	–79%	90%
Business Lending	0.466%	–169%	221%
Residential Mortgage Lending	0.753%	–29%	187%
Initial Capital Level	22.823%	8.550%	116.230%
% $\frac{\text{Retail Deposits}}{\text{Total Assets}}$	37.751%	0.000%	1,034.650%
DSIB	21.4%	0	1

Table 6: Residential Mortgage Loans

	Dependent variable:		
	Total	Insured	Uninsured
DSIB	0.008***	0.0004	0.014***
	(0.002)	(0.001)	(0.003)
DSB(-1)	−0.010**	0.001	−0.018***
	(0.004)	(0.003)	(0.005)
size	−0.0003*	−0.001***	−0.00002
	(0.0001)	(0.0001)	(0.0002)
int_rate	−0.0002	0.001	0.001
	(0.001)	(0.001)	(0.001)
wellcap	−0.00002	−0.00000	−0.0001***
	(0.00002)	(0.00001)	(0.00003)
DSIB:DSB(-1)	−0.003***	0.0003	−0.005***
	(0.001)	(0.001)	(0.002)
Constant	0.030***	0.011**	0.045***
	(0.008)	(0.005)	(0.011)
Observations	839	839	839
R^2	0.116	0.221	0.145
Adjusted R^2	0.043	0.156	0.075
Residual Std. Error (df = 774)	0.016	0.011	0.020
F Statistic (df = 64; 774)	1.582***	3.421***	2.057***

Excluding time-fixed effects *p<0.1; **p<0.05; ***p<0.01

Table 7: Loans to Individuals for Business Purposes

	Dependent variable:		
	Total	Other Secured	Property Secured
DSIB	0.006	0.018***	0.002
	(0.006)	(0.006)	(0.001)
DSB(-1)	−0.004	−0.001	−0.002
	(0.011)	(0.012)	(0.002)
size	0.00004	0.00003	0.00003
	(0.0004)	(0.0004)	(0.0001)
int_rate	0.006**	0.006**	0.001*
	(0.002)	(0.003)	(0.001)
wellcap	−0.0001*	−0.0001	−0.00004***
	(0.0001)	(0.0001)	(0.00001)
DSIB:DSB(-1)	−0.005	−0.008**	−0.001*
	(0.003)	(0.004)	(0.001)
Constant	0.008	0.0003	0.006
	(0.022)	(0.025)	(0.005)
Observations	839	839	839
R^2	0.092	0.098	0.082
Adjusted R^2	0.016	0.024	0.007
Residual Std. Error (df = 774)	0.043	0.048	0.009
F Statistic (df = 64; 774)	1.219	1.321*	1.086

Excluding time-fixed effects — *p<0.1; **p<0.05; ***p<0.01

Table 8: Loans to Individuals for Non-Business Purposes

	Dependent variable:		
	Total	Other Secured	Property Secured
DSIB	0.015**	0.015**	0.006
	(0.007)	(0.007)	(0.012)
DSB(-1)	−0.011	0.011	−0.113***
	(0.013)	(0.013)	(0.023)
size	−0.002***	−0.001**	−0.002**
	(0.0004)	(0.0005)	(0.001)
int_rate	−0.005*	−0.004	−0.008
	(0.003)	(0.003)	(0.005)
wellcap	−0.0002**	−0.0001*	−0.0002
	(0.0001)	(0.0001)	(0.0001)
DSIB:DSB(-1)	−0.010**	−0.010**	−0.0002
	(0.004)	(0.004)	(0.007)
Constant	0.061**	−0.001	0.318***
	(0.025)	(0.027)	(0.046)
Observations	839	839	839
R^2	0.111	0.098	0.087
Adjusted R^2	0.037	0.023	0.012
Residual Std. Error (df = 774)	0.048	0.052	0.088
F Statistic (df = 64; 774)	1.507***	1.310*	1.156

Excluding time-fixed effects *p<0.1; **p<0.05; ***p<0.01