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# Problems with crisis intervention: When the government wants to restrain big banks but punishes small businesses instead

Edward Gamble [a,*], Gary Caton [a], Kelig Aujogue [b], Yen Teik Lee [c]

[a] Jake Jabs College of Business & Entrepreneurship & the Initiative for Regulation and Applied Economic Analysis, Montana State University, Bozeman, MT, United States
[b] Independent researcher, Cambridge, UK
[c] National University of Singapore, Finance Department, NUS Business School, Singapore

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ABSTRACT

Following the 2008 financial crisis, Congress passed the Dodd-Frank Act (DF) with the intent of reducing systemic risk posed by big banks to the country's financial system. We empirically show that DF negatively impacted both the numbers and dollar amounts of small business loans issued by small banks. This new finding implies an unintended, counterproductive constraint on American venturing activities, particularly in rural communities. This should be of importance to academics and policymakers alike, considering that entrepreneurial activity is generally regarded as the backbone of the U.S. economy. Without adequate financing to small ventures, the ultimate health of the U.S. economy could be stunted. Our findings offer key insights into the fields of entrepreneurial finance, regulation and economic growth.

## 1. Introduction

The optimal amount of government regulation is widely debated in both policy and academic circles (Shleifer, 2005). Perhaps more interesting is the debate on regulatory responses to significant national or international events, such as the financial crisis of 2008. This crisis started when many of the world's largest banks formed investment portfolios by buying seemingly safe securitized subprime mortgages. When mortgage defaults unexpectedly began rising, the values of these securities began to fall, exposing these banks and the entire financial system to possible collapse. Originating in the U.S., the financial crisis spread across the world due to widespread global investment in toxic mortgage-backed securities.

In response to the financial crisis, the U.S. Congress enacted the Dodd-Frank Act (DF) in 2010. DF is regarded by many as one of the most all-encompassing financial reforms in U.S. history (Acharya and Richardson, 2012). With DF, Congress intended to protect both the financial system from another outbreak of systemic risk, and consumers from risky and abusive lending practices. According to Congress's dominant narrative at the time, systemically important banks were primarily responsible for the near destruction of the U.S. financial system and they needed to be reined in. While Congress exempted smaller banks from some of the most onerous provisions of DF, the new set of regulations led to increases in compliance expenses for all banks, regardless of their size (Lee et al., 2020). Lux and Greene (2015) and (Cole, 2018) suggest that DF may have unintentionally tilted the playing field in favor of larger banks to the detriment of small banks and their customers.

* Corresponding author.
*E-mail addresses:* edward.n.gamble@gmail.com (E. Gamble), gary.caton@montana.edu (G. Caton), aujogue.kelig@gmail.com (K. Aujogue), bizlytk@nus.edu.sg (Y.T. Lee).

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**Abbreviations**

| | |
|---|---|
| DF | Dodd-Frank Act |
| FDIC | Federal Deposit Insurance Corporation |
| SCG | synthetic control group |
| SOX | Sarbanes–Oxley Act |

Using a data set obtained from the Federal Deposit Insurance Corporation (FDIC), and a cutting-edge synthetic control methodology, we examine post-DF changes in the small commercial and industrial (C&I) loan practices of small banks. Our main result reveals that DF had a negative relative impact on the number and dollar amounts of the smallest category of small C&I loans issued by small banks, but no significant relative changes in the medium and large loan categories. Apparently, DF's effect on small business lending is limited to the smallest C&I loans and to those particular borrowers.[1] Our findings complement and extend work by other scholars in the area of bank loans to small startup ventures (Bosse, 2009, Deloof et al., 2019; Lee, 2018; Pissarides, 1999), and to those interested in exogenous pressure on venture trajectory and uncertainty (Bordo and Duca, 2018; Cole, 2018; Knight, 2012; Schumpeter, 1934).

## 2. Regulation and business venturing

Regulation is often criticized for being clunky, restrictive and riddled with political motivation (Beaver, 1973; Gerboth, 1973; May and Sundem, 1976; Smith, 1776). Many business owners note that the regulatory environment determines the success or failure of their ventures (Klapper et al., 2006; Parker, 2004, 2018). Scholars have called for additional research to better understand and extend this viewpoint (Adler, 2002; Berry and Rondinelli, 1998). For example, from a venturing perspective, regulations have been shown to shape individual risk-taking behaviors (Baird and Thomas, 1985; Palmer and Wiseman, 1999) and, therefore, play a significant role in shaping business outcomes (Klapper et al., 2006; Parker, 2018). These outcomes have impacts on society (Healy and Palepu, 2001; Laeven and Levine, 2009) and the economy (Acs and Szerb, 2007; Parker, 2018). For example, Friske and Zachary (2018) show that state-level brewery regulations, such as taxes and sales restrictions, have an adverse impact on business creation. On a more macro level, both Acs and Szerb (2007) and Carland et al. (2007), find that countries with thriving business environments tend to also have stronger employment and faster gross domestic product growth. To the extent that regulation places restrictions on the vitality of the business environment, the full impact of regulations and regulatory changes must be carefully considered before they are enacted.

On the other hand, unfettered, rapid economic growth may not be the over-riding goal of every society. For these societies, regulation can help guide the economy in society's preferred direction (Shleifer, 2005; Siegel, 2009). While regulations are generally perceived as a set of guard rails for managing ventures, new regulations or changes to existing regulations necessarily come with tradeoffs which often lead to unintended, counterproductive consequences. A classic example of this is illustrated by the U.S. Food and Drug Administration's (FDA's) mission of requiring new drug therapies to be proven both safe for patient health and well-being, and effective in their intended uses (see FDA, 2018). While seemingly innocuous, the tradeoff is long gestation periods of 10 years or longer for innovative, potentially life-saving therapies.

We focus on DF's impact on small banks' small-business lending. Although the stated intent of DF was to constrain risk-taking by systemically important big banks, there may have been unintended collateral damage to smaller banks and their small-business borrowers due to a fixed component of compliance costs and lower levels of revenues (Cole, 2018). As a result, these small banks may have made changes to their business models, thereby impacting entrepreneurs. Anecdotal evidence by Ricketts (2017) suggests that small- and medium-size banks, which were not responsible for the financial crisis, bore an unnecessary cost from DF.

## 3. Data and methods

### 3.1. Data

Our primary data source is the FDIC quarterly call reports of condition and income from all U.S. banks from July 2008 through July 2013, a period which brackets the signing of DF into law. We found complete data resulting in a dataset of 96,792 bank-quarters. The FDIC defines C&I loans as loans to businesses and requires banks to separately report small C&I loans, which they define as small-business loans in amounts of less than or equal to $1 million. The FDIC also requires banks to break down these small business loans into three separate categories: Less than $100,000 (small-size loans), $100,000-$250,000 (medium-size loans), and $250,000-$1,000,000 (large-size loans). We focus on post-DF changes in these three categories of small-business loans.

McManus (2017) reports that some 62% of new ventures start with less than $50,000 in capital, while only 12% start with greater than $250,000. McManus also notes that follow-up financing comes primarily from some combination of new-venture owners' own

[1] We speculate that an underlying cause may be DF's impact on small banks' residential mortgage lending, which Marsh and Norman (2013) report has declined due to DF. Small entrepreneurial businesses use the entrepreneur's residential home as collateral to guarantee payment of the company's loans. By making loan origination and the holding mortgage loans more costly, DF may have inadvertently caused small banks to cut small C&I lending.

capital (about 53%) and bank loans (about 32%). Given these numbers and our interest in new ventures, we are most interested in examining DF's impact on the smallest loan category – those under $100,000. Moreover, following DF's bank classifications, we use total assets to partition banks into three groups. Large banks are those with assets greater than $50 billion; medium-size banks are those with assets between $10 billion and $50 billion; and small banks are those with less than $10 billion in assets. This partition of both loans and banks by size allows us to directly examine DF's effect on the small-loan portfolios of small banks.

### 3.2. Methods

We analyze discrete, quarterly time-series data of the numbers (dollar values) of small, medium and large small-business C&I loans by banks surrounding enactment of DF. Since all banks were subject to DF, a suitable control group not covered by DF is not available. Instead, we use a rigorous, cutting-edge empirical methodology that allows us to construct a synthetic control group (SCG) against which we test the post-DF evolution of small banks' small-business loan portfolios. Ballesteros et al. (2017) use this methodology to test the causal impact of corporate donations on the speed of recovery from natural disasters. Brodersen et al. (2015) use the methodology to test the causality and effectiveness of online marketing campaigns on search-related site visits. We implement the methodology by building a SCG using quarterly data of the numbers (dollar amounts) of small C&I loans from small-, medium- and large-size banks during the 12 quarters prior to enactment of DF, which we use to predict the 12-quarter post-DF evolution of the numbers (dollar amounts) of such loans issued by small banks.

In order to validate the methodology, we test the actual time-series for small banks against the SCG during the pre-DF period. This test, the results of which are included in Figs. 1–6 below, indicates that the time-series evolution of numbers (dollar amounts) of small C&I loans for small banks was not statistically different from that of the SCG in the 12-quarter pre-DF period. Consequently, the SCG is a suitable counterfactual control group for small banks in the post-DF period, which allows us to use it to predict how small banks' loan portfolios would have evolved post-DF if they had not been differentially impacted by DF. Following Ballesteros et al. (2017) and Brodersen et al. (2015), we use Bayesian structural time series (BSTS) and the evolution of the numbers (dollar amounts) of small C&I loans of medium- and large-size banks to build the post-DF SCG. This predicted post-DF evolution of the numbers (dollar amounts) of small C&I loans, then, represents the most likely time-series outcomes for post-DF small-bank C&I lending.[2] Finally, the difference between the actual and predicted small-bank small C&I loans represents the impact of DF on these loans.

## 4. Findings

Our findings address the impact of DF on small-bank lending practices to small entrepreneurs, which we present in Figs. 1–6. We standardize the numbers (and dollar amounts) of loans for each loan category and for each bank by dividing by quarterly total assets. We then normalize these ratios by dividing each of the standardized quarterly ratios by the standardized ratio observed in the third quarter of 2010, the quarter in which DF was signed into law. This process transforms numbers (dollar amounts) of small-business loans for each bank into a normalized value of 1 in the third quarter of 2010. We then consider the change in this value for small banks relative to the SCG, report this as a percent change from 1, and use Markov Chain Monte Carlo simulation to test the statistical difference between the actual small-bank loan numbers (dollar amounts) and the analogous SCG-predicted values. Note that in all six figures, the standardized number (dollar amount) of small bank lending (red line) declines post-DF. The numbers we report below are differences between actual small bank standardized values and those predicted for the SCG by our BSTS prediction methodology.

In Figs. 1–3, we investigate the evolution in the total numbers of loans in each of the three loan categories for small banks against those of the SCG in the years surrounding enactment of DF. Fig. 1 illustrates this evolution for the largest small-business loan portfolios (loans from $250,000 to $1 million). The blue line represents the time series of quarterly point predictions of the number of small-bank loans (the SCG) at each point in time; the red line plots the time series of actual quarterly numbers of small-bank loans; and the shaded area represents the range of the 95% confidence level each quarter. There are several important things to note in this and subsequent figures. First, note how closely intertwined the SCG estimates are with the actual numbers of loans over the pre-DF (prior to year 0). This near overlap of the blue and red lines is a visual representation of the validation test for SCG-model test suitability and shows, as stated in the previous section, that the SCG model predicts the actual time-series quite well. Second, note the evolution of the 95% confidence interval over the entire time interval. In the pre-DF period leading up to year 0, the confidence interval is tight, while in the post-DF period the interval increases as the time from quarter 0 increases. This makes intuitive sense. During the pre-DF period, the SCG model receives fresh, actual quarterly data on small banks for Bayesian updating implying little next-period uncertainty. But as the time drifts from the last fresh data input on small banks, which occurs in quarter 0, the BSTS model relies entirely on data from medium and large banks instead, making the SCG predictions increasingly uncertain. Third, note the SCG estimate (blue line) and actual numbers of loans (red line) begin to separate after year 0 as the regulatory changes due to DF begin to influence the actual numbers of loans. Finally, note that in this figure the actual numbers of loans (red line) never approach the expanding 95% confidence interval indicating no significant difference between the SCG and the actual loan numbers. The numbers underlying the figure tell the same story. The number of large-sized small-business loans issued by small banks increases relative to the SCG over the 12-quarter post-DF period by +5% (the red line drifts above the blue line). The 95% confidence interval for this increase is [-17%, +26%]. Since this confidence interval contains zero, which would indicate no change in the number of loans, the impact of DF on the number of the largest small-business

[2] For additional explanation of the methodology please see the appendix. For a more complete explanation, see Ballesteros et al. (2017), Brodersen et al. (2015) and Abadie et al. (2010).

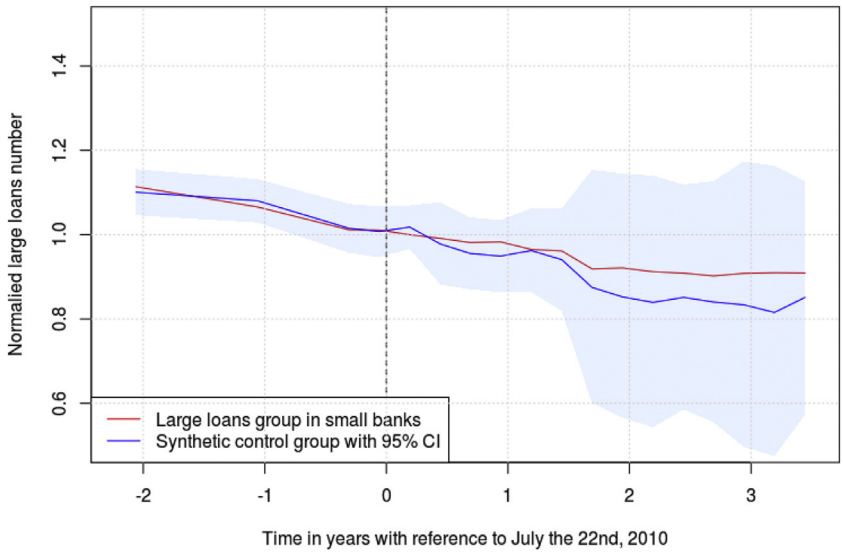


**Fig. 1.** Normalized quarterly numbers of large-size loans by small banks (red line) compared to SCG predictions of loan numbers (blue line) constructed using BSTS methodology.

loans offered by small banks is not statistically different from that predicted by the SCG (p-value = 0.327). Therefore, we conclude that DF did not have a statistically significant relative impact on the number of loans in this small-bank loan category.

We illustrate the relative impact of DF on small banks' medium-sized ($100,000-$250,000) small-business loan portfolios in Fig. 2. Note (1) the near overlap of the SCG and actual numbers of medium-sized loans in the pre-DF period indicating the suitability of the model use; (2) the tight pre-DF 95% confidence interval; (3) the post-DF expansion of the 95% confidence interval; (4) the separation of the SCG estimates (blue line) and the actual loan numbers (red line), which fall below the former; and (5) the failure of the actual time series to approach the edge of the confidence interval. Specifically, the number of post-DF medium-sized small-business loans offered by small banks (red line) showed a relative decrease of −19%. The 95% confidence interval for this value [-65%, +28%] is quite large. Since it also contains zero, however, the impact of DF on the number of medium-sized small business loans offered by small banks, while negative, is not statistically different from that predicted by the SCG (p-value = 0.213). We conclude that DF did not statistically impact the number of small banks' medium-sized small-business loans.

Fig. 3 illustrates the evolution of the number of the smallest (less than $100,000) small-business loans issued by small banks. While the pre-DF SCG and actual numbers are nearly identical, note the separation of the SCG (blue) predictions and the actual loan numbers

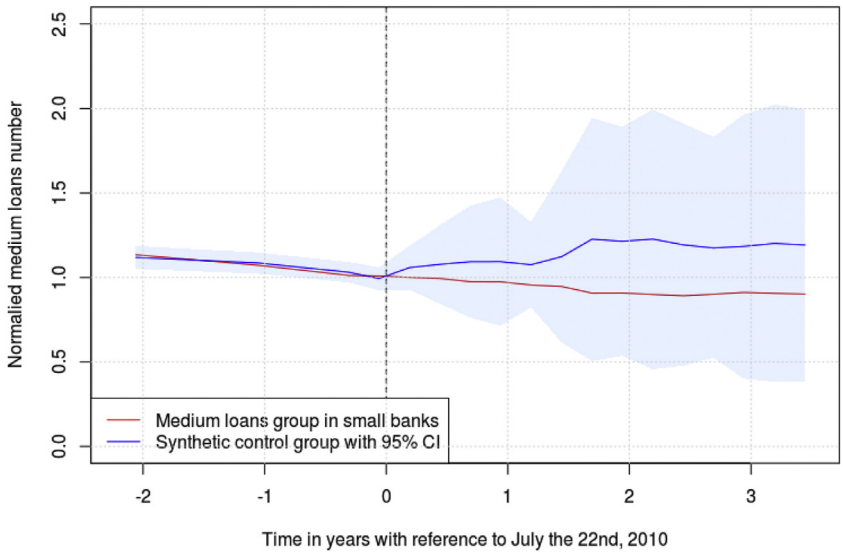


**Fig. 2.** Normalized quarterly numbers of medium-size loans by small banks (red line) compared to SCG predictions of loan numbers (blue line) constructed using BSTS methodology.

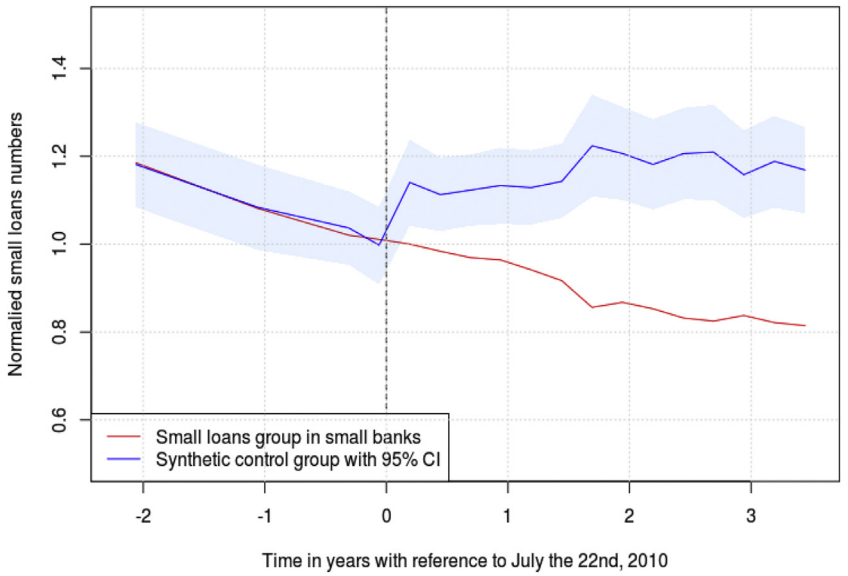


**Fig. 3.** Normalized quarterly numbers of small-size loans by small banks (red line) compared to SCG predictions of loan numbers (blue line) constructed using BSTS methodology.

(red) almost immediately after DF was enacted. Note also that the red line pierces the 95% confidence interval, indicating a statistically significant difference between the SCG and actuals loan numbers. Numerically, the number of these loans issued by small banks decreased relative to the SCG by −23%, and the 95% confidence interval for this value is [-28%, −17%]. This range does not contain zero, suggesting that the percentage decrease in the number of these loans is statistically different from that predicted by the SCG (p-value = 0). This is consistent with DF negatively impacting the number of the smallest of small-bank small C&I loans, which are largely issued to small businesses.

In Figs. 4–6 we investigate the evolution of dollar amounts of small C&I loans. Fig. 4 illustrates the evolution of dollar amounts of the largest category of small-business loans issued by small banks ($250,000 to $1 million). Note the near overlap of the SCG and actual loan amounts in both the pre- and post-DF periods. The dollar amounts of large loans from small banks increased +2% in the post-DF period relative to the SCG. The 95% confidence interval for this percentage change is [-24%, +27%] and contains zero, indicating that this small increase in the dollar amount of this category of small C&I loans is not statistically different from that predicted by the SCG (p-value = 0.447).

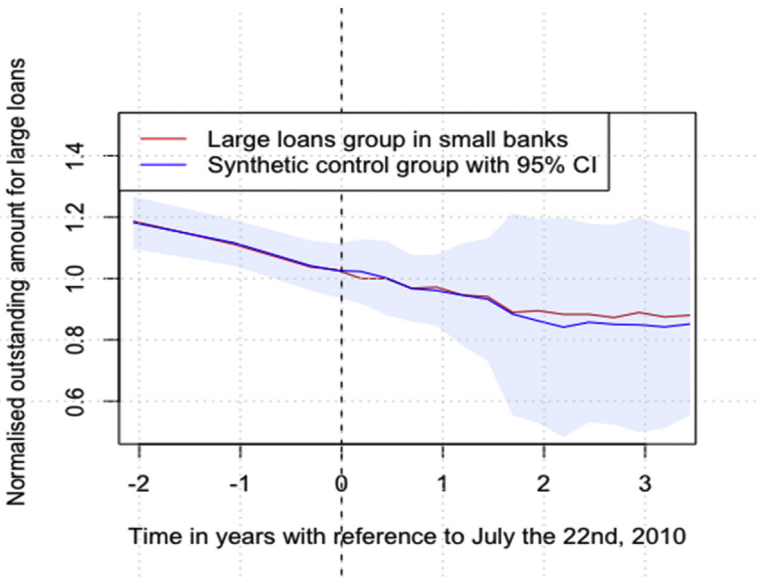


**Fig. 4.** Normalized dollar amounts of large-size loans by small banks (red line) compared to SCG predictions of dollar amounts (blue line) constructed using BSTS methodology.

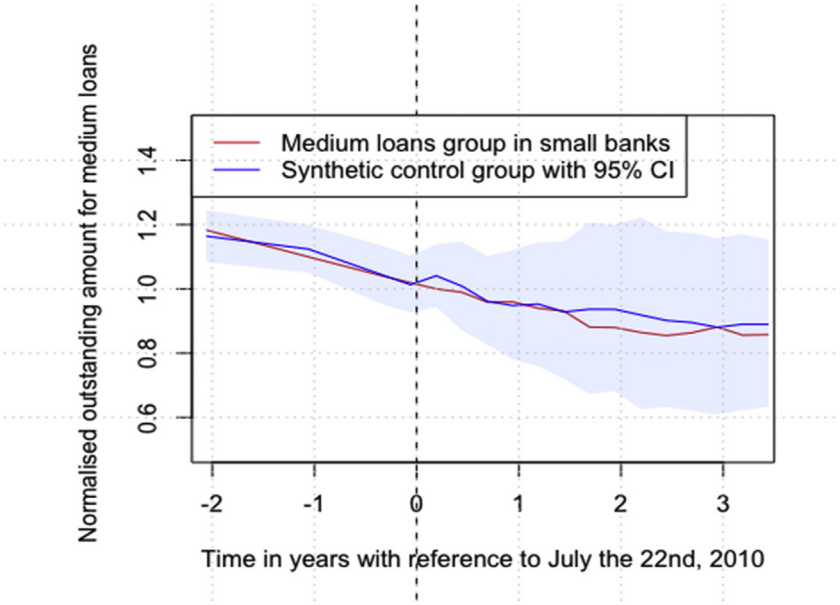


**Fig. 5.** Normalized dollar amounts of medium-size loans by small banks (red line) compared to SCG predictions of dollar amounts (blue line) constructed using BSTS methodology.

In Fig. 5, we illustrate the progression through time of the dollar values of the mid-size small- business loans issued by small banks (red, $100,000 to $250,000), which shows a decrease of −3% relative to the SCG (blue). Note how the two lines continue to be closely intertwined both pre- and post-DF. The 95% confidence interval of this percentage is [-25%, +19%], which also contains zero. Therefore, although the relative percent change of this medium-size category of small C&I loans is negative over the post-DF period, the effect is not statistically different from the predicted amount (p-value = 0.408).

Finally, we show the relative impact of DF on the dollar amounts of small banks' small-sized small-business loans (less than $100,000) in Fig. 6. The dollar amounts of these smallest of C&I loans by small banks (red) decreased −47% relative to the SCG (blue) over the post-DF period. The 95% confidence interval for this percentage change is [-92%, −2%], which does not contain zero, implying that the negative effect is statistically different from that predicted by the SCG (p-value = 0.02). This leads us to conclude that when analyzing loan dollar amounts, DF caused small banks to cut back on their C&I lending to their smallest business customers. The results in Figs. 4–6 are consistent with those for numbers of loans reported in Figs. 1–3.

In conclusion, we show that DF had a significantly negative impact on small-bank C&I lending to their smallest business borrowers

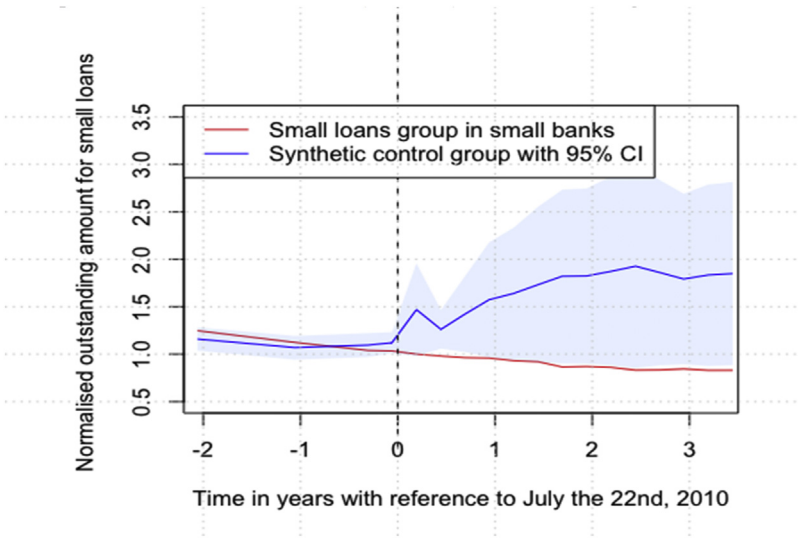


**Fig. 6.** Normalized dollar amounts of small-size loans by small banks (red line) compared to SCG predictions of dollar amounts (blue line) constructed using BSTS methodology.

when compared to the SCG. This finding holds whether we measure lending based on the total number (Fig. 3) or total dollar amount (Fig. 6) of loans. Conversely, we find that changes in post-DF small-bank medium and large small-business loans are not differentially affected by enactment of DF relative to the SCG. Importantly, notice in Figs. 3 and 6 that the statistical break between small C&I loans and the SCG occurs soon after DF was enacted and not over the prior two years. This indicates that DF enactment rather than the financial crisis, which began over two years prior to DF enactment, was the causal event for the observed reduction in small loans. Combined, our results imply that the small business lending cuts are limited to the smallest category of small C&I loans.

## 5. Discussion

Kneejerk regulation after a crisis can wreak havoc in many ways. This paper focuses on regulation after a crisis and the havoc it has wreaked on venture finance. Unfortunately, this is not the first time that reactive regulation has inflicted damage in unintended ways. For example, after a decade of damage to the U.S. venture-funding system (Iliev, 2010), policymakers recognized the Sarbanes-Oxley Act's (SOX's) harmful impact on venture funding and passed the Jumpstart our Business Startups Act, which reversed some of SOX's negative impacts on initial public stock offerings (Dambra et al., 2015). Similarly, after a decade of damage to small banks and ongoing complaints to policymakers, Congress enacted 2018's Economic Growth, Regulatory Relief, and Consumer Protection Act. This Act provides regulatory relief to small banks (Gaffney, 2018), which were not to blame for the financial crisis. Our findings support this rollback of DF.

Small businesses represent the vast majority of American entrepreneurship and is integral to the health of the U.S. economy. According to the Small Business Association (SBA, 2018), small businesses employed some 58.9 million Americans as of 2015, which represented 47.5% of all employees in the U.S. Moreover, businesses with fewer than 20 employees created 1.1 million new jobs that year. Financing is a key obstacle for entrepreneurial businesses (Dearie and Geduldig, 2013), which our work assesses directly. We complement and extend Bosse (2009) by introducing and examining the role of an additional important actor, policymakers and the regulations they impose, on the venturing ecosystem. To fully appreciate small-business governance mechanisms, and the exchange-organizing tasks involved, we contend that scholars must move beyond the simple bilateral financier-entrepreneur relationship, and include the impact of policymakers in their work.

Government regulation impacts entrepreneurs and therefore the pace of business startup activity (Shleifer, 2005). Given that small loans from small banks are important to venturing activity (Clark, 2017; FRB, 2016), we offer a related, unexpected insight – although the financial crisis was instigated by and DF was aimed at systemically important big banks, small businesses suffered unintentionally from the regulatory response. Pissarides (1999) offers a tool kit to correct for systematic failures, such as DF overreach, that can lead to unintentional obstacles for small businesses. We add to this tool kit by advocating for more effective engagement between entrepreneurs and regulators, the latter of whom may not be aware of the potential consequences of their decisions on small, dynamic firms (Pissarides, 1999). While governments have successfully supported entrepreneurs, for example, through government-supported Small Business Administration (SBA) loans (Lee, 2018), we highlight a relatively common policy contradiction: government programs are developed to counteract the detrimental impacts of government policy mistakes. In this case, SBA loan programs may need to ramp up to support ventures whose small-bank partners were forced to pull back due to DF. This points towards an obvious need for policymakers, particularly when reacting to a crisis, to use a more holistic approach to regulation, as opposed to the piecemeal approach currently used. Clearly the optimal policy process has not been achieved to date.

Deloof et al. (2019) find that the density of bank branches positively and significantly impacts the use of debt by business startups, which likely has implications for rural entrepreneurship. We feel, however, that entrepreneurship scholars could contribute more to understanding the nuances of bank debt financing for new firms, especially in the case of small rural banks and the rural ventures they support (Bordo and Duca, 2018; Cole, 2018; Deloof et al., 2019). We find surprising within-group loan variations, which implies unhealthy heterogeneity and detrimental effects on capital availability for smaller, rural entrepreneurs. This may provide an explanation for the decline of rural entrepreneurship (Buchanan, 2015; Wilmoth, 2017).

We also foresee a methodological opportunity for entrepreneurship scholars. Widespread use of Bayesian structural time-series BSTS could open new research doors. This relatively new and powerful methodology to study causality does not require randomized control trials, nor does it suffer from some of the shortcomings of other methodologies such as OLS regression (Abadie et al., 2015; Abadie and Gardeazabal, 2003; Brodersen et al., 2015).

Of course, like all other empirical work, this paper is not without limitations. First, we do not address potential variation in state-by-state effects of DF. We recognize the possibility for interaction effects between state-level bank regulation and DF. Nor do we directly address entrepreneur responses to the credit constraints created by DF, responses which are instead implied by our findings. Therefore, we invite scholars to expand on our work in this important area. We feel that understanding entrepreneurs' novel patterns, processes and forms of organizing (Schumpeter, 1934), in the face of government regulation and regulatory changes, has first-order effects on venturing success.

## 6. Conclusion

Managing small businesses is challenging enough without the unintended, counterintuitive impacts from regulation/policy changes. DF was passed in 2010 in the aftermath of the 2008 financial crisis and was aimed at reducing the systemic risk of too-big-to-fail banks. Small banks, while not systemically important, were nevertheless subject to most of DF's provisions. Using a large data set and an innovative methodology, we find a significant post-DF decline in both the numbers and dollar amounts of the smallest bank loans to entrepreneurs. Importantly, this decline did not begin in the immediate aftermath of the financial crisis, but only after DF was enacted.

This is consistent with DF, rather than the financial crisis, being the cause of this decline in small business loans. Given that regulations impact business ventures, interested scholars could more fully develop the field of entrepreneurship scholarship by considering the first-order effects of policymakers and the regulations they impose on entrepreneurship.

## Author Statement

All four authors declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere. We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us. We understand that the Corresponding Author is the sole contact for the Editorial process. He is responsible for communicating with the other authors about progress, submissions of revisions and final approval of proofs.

## Appendix

Our hypothesis requires us to test whether DF caused relative changes in the small-business lending of small banks. Randomized control trials (RCT) have long been considered the gold standard of causation studies (Gamble, 2018), particularly in the field of medical drug trials. In such a study, a large group of homogeneous subjects are randomly assigned to either treatment or control group. Individual subjects in the treatment group are then administered the treatment, e.g., a proposed drug, while individual subjects in the control group are administered a look-alike placebo. Since these two groups originally came from a single homogeneous population, the control group is assumed to control for both observed and unobserved variables, making the treatment the only difference between the post-treatment outcomes of the two groups. Most importantly, the control group proxies for the effect that would have happened to the treatment group if it had not been treated and is therefore called the counterfactual. When the post-treatment impact on the treatment group is significantly better than the placebo's effect on the counterfactual, the treatment is considered effective.

Unfortunately, RCTs are not suitable for many research questions in business and economics. For example, our research question is whether DF caused a differential impact on the small-business lending of small banks. Randomly assigning one group of small banks to the DF treatment while assigning another group of small banks to some placebo regulation treatment to construct the counterfactual would be impossible. Instead, following Brodersen et al. (2015), we employ Bayesian structural time-series (BSTS) to develop a single synthetic counterfactual, as proposed by Abadie and Gardeazabal (2003) and Abadie et al. (2015). We estimate this synthetic control group (SCG) using the pre-DF time-series behavior of the small-bank small business lending variable itself, and the pre-DF time-series behavior of the medium- and large-bank small business lending variables, the combination of which we propose are predictive of the time series of small-bank lending. This approach allows for a great degree of flexibility. BSTS is a two layered approach. The first layer considers an observation as the sum of the measure and some normally distributed noise around it. In the second layer, the observations connect to an underlying observed structure of the time series, in our case the predictors and the observed information from the medium and large banks. Finally, the post-DF SCG predictions of the small banks' time series were statistically compared to the actual small banks' time series over the same post-DF period.

Using the *CausalImpact R* package, we estimate the post-DF distribution of the time series for the counterfactual, accounting for the pre-DF time series of the small-, medium- and large-bank small business lending and the post-DF values of medium- and large-bank small business lending. The difference between the observed value of the post-DF small-bank small business lending and the counterfactual small business lending is the Bayesian posterior distribution for the causal differential impact of DF on small business lending. For inference, we use Markov Chain Monte Carlo simulation to stochastically approximate credible intervals for summary statistics of interest, such as, the average absolute effect, the average relative effect, and the cumulative effect (Brodersen et al., 2015).

The synthetic control method has several advantages for evaluating the effects of interventions such as DF. First, it offers rich contextual understanding of qualitative case studies, and provides precise inferential statistics of quasi-experiments. Second, the counterfactual is constructed to resemble the treated unit as closely as possible, making possible the comparison of the treated with a synthetically constructed counterfactual. This alleviates the concerns of possible unobserved confounders and pre-intervention selection bias. This is especially important when evaluating a complex and comprehensive intervention like DF, which calls for a granular approach. Third, the method precludes specification searches and p-hacking because access to post-intervention outcomes in the design stage is not required (Abadie, 2019). Fourth, an algorithm-based matching method is superior to model-dependent extrapolations that linear regressions (e.g., difference-in-differences) rely on because the model choice may impact the estimated economic magnitude and statistical significance of policy effects. BSTS models are superior to both ordinary least squares because the model allows for temporal variation in the coefficients and considers the posterior uncertainty about the estimated parameters (Brodersen et al., 2015), and conventional synthetic control estimators of Abadie et al. (2015) and Abadie and Gardeazabal (2003), which do not consider time-series effects and which are a special case of the BSTS model.

We argue that medium and large banks are suitable proxies for the untreated counterfactual of small banks for the following reasons. First, our hypothesis requires us to directly test the differential impact of DF on the small-business lending of small relative to larger banks. This implies that medium and large banks should be the counterfactual. Second, Brodersen et al. (2015) note that when assuming untreated control series, the use of treated control series, like medium and large banks, which are also subject to DF, would lead to *underestimated* treatment effects. In other words, a counterfactual which contains some treatment effect spillover would show bias against our hypothesis. And third, there is prior evidence that small banks suffered more than their larger counterparts from DF's elevated compliance costs and regulatory restrictions, despite being exempted from the most onerous provisions of the Act (Cole, 2018; Lee et al., 2020; Lux and Greene, 2015; Ricketts, 2017). This is because smaller banks, due to economies of scale and scope, had less slack

in their operations and were therefore less able to absorb the fixed-cost component of additional compliance costs and lower levels of revenues due to the tighter regulatory restrictions. This is the heart of our hypothesis: DF caused small banks to reconfigure their business models relative to their larger competitors, which impacted their loan portfolios more than those of larger size banks in which the loan portfolio effects would be attenuated (Meyer, 1995).

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