The effects of supervisory stress testing on bank lending: examining large UK banks

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Abstract
In this paper, we study the effects of supervisory stress test exercises on 19 UK banks over the 2005–2018 period. The novelty of our approach is that we include two stress testing timelines from two banking supervisory authorities. Using a difference-in-difference methodology, in a first step, we analyse the effects of the Bank of England’s stress tests on the lending behaviour of large UK banks. In a second step, for robustness, we also examine the stress tests administered by the European Banking Authority. Our main result is that banks that failed the stress tests reduced lending. Additionally, we show that the effectiveness of the stress tests exercises remained unchanged throughout the period.

Keywords Stress test · Macroprudential policy · UK banking system · Bank lending · Credit risk

JEL Classification G21 · G20 · G28

Introduction
The 2008–2009 global financial crisis has caused severe economic repercussions around the world due to the mismanagement of subprime mortgages. At the time of the crisis, banks undertook several steps to remain solvent. This included a reduction in lending to mitigate credit risk, a boost in capital levels which acted as a loss-absorbing buffer and accumulated highly liquid assets to ensure banks did not face runs on their deposits. Furthermore, amid the global financial crisis, a reduction in bank lending exacerbated the crisis which amplified negative effects that were detrimental to economic growth (Fraisse et al.) [1]. As a consequence, regulators and policymakers have taken important actions to enhance financial stability by enforcing tighter regulatory requirements on banks.

More recently, the COVID-19 pandemic has renewed interest in the banking system’s resilience to a health related-global economic shock, in particular because banks had to play a major role in providing loans to struggling businesses and simultaneously adapting to significant operational challenges at a time of government imposed national/local lockdowns.1

The global financial crisis spurred the need for new prudential measures to assess the resilience of the banking system. In particular, the inception of supervisory stress tests has been at the cornerstone of new regulations to improve financial stability and restore public confidence. A supervisory stress testing exercise is applied by regulatory authorities to assess the resilience of individual banks and the banking system as a whole to withstand a potential adverse shock. The main objective of the stress testing exercise is to provide information to banks, regulatory authorities and market participants on the ability of a bank to survive an adverse shock by evaluating its capital position.

This paper focuses on the effects of stress testing on bank lending, as a reduction in lending can amplify and exacerbate a financial crisis. We make three main contributions to the literature. First, we examine the effects of stress testing on bank lending for the UK banking system. It is important to note that the extant literature on the effects of stress testing on bank lending has been limited.2

1 See the joint letter by the BoE Governor, Chancellor of the Exchequer, and FCA Chief, stressing the importance of the function of banks to continue lending. https://www.gov.uk/government/publications/joint-letter-to-the-uk-banks-from-hm-treasury-the-bank-of-england-and-the-fca.
testing on bank lending is scarce as there exist only a few studies that examine the effects of the Fed’s stress tests on the US banking system. Moreover, we use the methodology adopted by of Acharya et al. [2], namely the difference-in-difference model. By employing the same approach, we can compare our results to the literature and establish whether stress tests across different jurisdictions have similar or time-varying effects. This is a critical regulatory issue and adds to the ongoing policy debate on the effects of stress testing, as it is well-documented in the banking literature that supervisory stress tests across different jurisdictions differ in terms of effectiveness [10]. Therefore, we add to this stream of the literature by assessing how UK banks behave following the stress tests exercises, to which they have been subject since 2010 [14]. Second, we address the effects of two stress testing timelines by two supervisory authorities, namely the Bank of England (BoE) and the European Banking Authority (EBA). The key novelty of our paper is that we address two different supervisory timelines for the UK banking system which has been so far unexplored in the extant literature.

Our third contribution is that we complement existing studies on the U.S. banking system and the EU banking system (see, for example, Acharya et al. [2] and Borges et al. [7] by exploiting a much longer stress testing period (2010–2018). This enables us to empirically dig deeper into the UK banking system, as four banks are included in both the BoE’s and EBA’s stress tests exercises. This is an important contribution to the literature as existing academic research suggests that the effectiveness of the stress tests exercises has declined over time. Neretina et al. [37] examine the effects of the U.S. stress tests on the stock market and find the strongest effect for the 2009 stress test. In contrast, Borges et al. [7] examine three stress tests for EU banks, namely the 2010, 2011, and 2014 stress test. They find that while the effects of the 2010 stress test on the stock market have been negligible, the 2011 and 2014 stress tests have been significant.

From a regulatory perspective, the motivation to explore the effects of stress testing on bank lending is related to one of the constraints laid out within the BoE’s stress testing methodology:

Bank staff analysis also took into account the extent to which banks could take certain ‘strategic’ management actions to cushion the impact of the stress scenario on their balance sheets …… A core objective of capital regulation from a macroprudential perspective is to ensure that the banking system is sufficiently capitalised to be able to maintain the supply of bank lending in the face of adverse shocks. The FPC agreed a general principle that management actions proposed by banks to reduce the size of their loan books would not be accepted, unless these were driven by changes in credit demand [4], p. 5

The rule highlights the actions that are restricted to the participating banks. Accordingly, this restriction is envisaged by the BoE which states that banks cannot restrict lending and should be lending during the period of an adverse shock throughout the time horizon.

In this paper, we examine the effects of stress testing on bank lending within the context of the UK banking system. For our purposes, we build on the work of Acharya et al. [2], by using a difference-in-difference research design to examine two groups of banks (stressed banks and non-stressed banks) over two different periods (pre-stress testing and post-stress testing). The motivation to adopt the difference-in-difference research design is that non-stress tested banks substitute stress-tested banks as documented in prior research (e.g. [17, 34]).

Our major finding is that the effect of the stress testing exercises on bank lending is significant for consumer loans. Interestingly, we depart from existing studies, as our results for the UK banking system, do not highlight major differences between stress-tested banks and non-stress tested banks. This may suggest that the stress testing exercises do not have an influential impact on bank lending and the results for the UK banking system may vary depending on the structure of each stress test, which often is revised year by year [24]. Candelon and Sy [10] document that the stress tests that are administered by the EBA and the Fed are inherently different in the design and methodology, thus leading to different results. Therefore, the results may not be comparable because of differences in jurisdictions.

However, notably, when we control for the effects of banks failing the stress test, the results show that failed banks reduce lending relative to banks that pass the stress test. The most plausible explanation for this finding is that failed banks reduce lending to manage credit risk [2]. Furthermore, our results align with the papers that examine the U.S banking system that failed banks, or banks with a large capital shortfall are affected negatively [7, 34]. Specifically, failed banks reduce their total loans and mortgage loans which is also in line with [9].

It is important to note that there exists a long-standing academic debate in the banking and finance literature on the effectiveness of stress testing. In this regard, some scholars argue that stress testing exercises have been most effective in reducing bank lending during the earlier periods [9].

2 The literature on stress testing also consider the effects of the exercise on market reactions and find that earlier stress tests were more effective in affecting the banks’ stock prices in comparison with the latest stress tests [10].
each stress testing period, there is no evidence to suggest that the effectiveness of supervisory stress test declines over time. This finding is significant for the UK banking system, as our evidence shows that the exercises are more effective relative to the Fed’s stress tests on the U.S. banking system. Taken together, our empirical estimates clearly show that failing the stress test can lead to a decline in bank lending. A plausible explanation of this finding is the introduction of post-financial crisis regulation. Indeed, certain loan types such as mortgage lending might have been impacted by the implementation of the new prudential regulation related to Basel III, which have been enforced in the aftermath of the subprime mortgages crisis. These findings may suggest that stress-tested banks (typically the largest banks) are being affected the most by new regulations which reduce lending [35].

Our analysis also generates important policy implications. In fact, our empirical evidence provides support to the notion that the stress testing exercises effectively fulfill their primary role of ensuring financial stability by assessing banks’ capital adequacy of banks to an adverse shock. Moreover, failed banks reduce lending to ensure they mitigate credit risk, thus contributing to the overall stability of the banking system. Furthermore, as compared to the Fed’s stress tests which were most effective in the earliest exercises, the stress tests exercises conducted by the BoE are significantly effective in influencing bank lending for both the earliest and the latest stress tests. Hence, this suggests that the supervisory exercises aimed at maintaining and improving financial stability are still relevant for the supervisory authorities’ toolkit.

A first policy recommendation is that the BoE and other central banks should carefully consider the methodology of the stress test for the banking system. Our results clearly show that the effects of the BoE’s stress tests on UK banks are significant for the earliest and latest stress tests. In contrast, the results for the EBA stress tests on UK banks are insignificant. We argue that these differential effects pertain to the methodology design in each timeline. As a specific example of this notion, Georgescu et al. [24] show that the weakness of certain EBA stress tests is mostly attributable to their methodological characteristics. Furthermore, this finding is consistent with Candelon and Sy [10] who find that the effects of stress tests on banks behaviour vary across different jurisdictions such as the U.S. and the EU banking system.

A second policy recommendation concerns the effectiveness of stress tests for each year. Although our evidence demonstrates that the BoE stress tests are effective for nearly all years, our results also show that the stress tests have lost somewhat traction in more recent years. Acharya et al. [2] find direct evidence of weaker effectiveness of the most recent US stress tests, in contrast to the 2009 stress tests [10]. In summary, our findings highlight important discontinuities among stress tests, as differences emerge due to the structure of the methodology and testing procedures. Consequently, the evidence in this paper underscores the importance for the BoE and other central banks to preserve the efficacy of the supervisory stress tests as a macroprudential surveillance tool for financial stability.

The rest of the paper is structured as follows. The “Literature review” section reviews the extant literature on stress testing. The “Data and methodology” section describes the data and the methodology. The “Results” section presents the main empirical results. The “Robustness tests” section provides additional robustness checks. The “Conclusion” section concludes.

**Literature review**

Studies on the effects of stress testing have typically considered the role of disclosure policy to ensure market discipline. Several papers have explored the effects of stress testing on capital markets by investigating the reaction to the stress testing results. For the European-Union the effects of stress testing on the credit default swap (CDS) market and stock market show mixed effects and tend to differ in each stress testing period [25, 31]. Additionally, Neretina et al. [37] show that the earliest stress tests had a strongest effect on the market. Notice that the effects of the stress testing exercises are also not comparable for different jurisdictions such as the European Banking Authority’s EBA’s exercises and the Fed’s exercises. This is due to the inherent differences between the design of the frameworks [10]. An important factor in the implementation and assessment of the stress tests is to identify the banks that fail a stress test. Borges et al. [7] document that failing a stress test is often associated with a negative market reaction.

Our paper is mostly related to a few papers that examine the impact of U.S. stress tests on U.S. banks. Acharya et al. [2] show that the stress testing exercises affect lending volumes, and document that the stress-tested banks in the U.S. reduce lending. Moreover, they also find that this reduction in lending is quantitatively more important for safer banks relative to riskier banks. Calem et al. [9] show that the stress testing exercise has led to the reduction in loans in the jumbo mortgage market. Likewise, they find that this reduction is more pronounced for the banks that fail the stress tests and have a larger capital gap. Calem et al. [9] document that the earlier stress test (2011 Comprehensive Capital Analysis and Review) had a greater impact on lending. Cortés et al. [17] find that stress-tested banks reduce lending to small businesses and this relationship is stronger for riskier borrowers. Furthermore, if stress-tested banks do not have a good understanding of the local market conditions, the banks will...
either reduce lending or exit the local market. This results in smaller-sized banks replacing the stress-tested banks as they have better information due to their closer consumer relations. Hence, smaller banks become the primary lenders to small businesses, which means aggregate lending is not affected [17, 33]. Bassett and Berespide [5] show that stress testing of U.S. banks increases bank lending which depends on the capital shortfall estimation of the banks’ internal stress test results and the supervisor’s stress test results for the individual banks.

Our work also relates to a stream of work that explores the behaviour of banks that fail and pass the supervisory stress tests. Connolly [15] documents that stress testing affects the syndicated loan market and that banks that pass the stress test are more resilient which allows them to increase their lending. Shapiro and Zeng [44] find that the supervisory choice to impose capital constraints (failing a bank) or not (passing the bank), can influence the bank’s decision to lend or restrict lending. The design of the stress test can also impact lending negatively, as Flannery et al. [20] show that supervisory authorities produce a stress testing macro-scenario that indicates an increase in credit risk for a specific loan portfolio. A sharp increase in credit risk may affect a bank’s behaviour and the bank may act strategically to reduce lending for a specific loan type. Liu et al. [32] study the effects of monetary policy on bank lending and find that an expansionary monetary policy leads to an increase in bank lending (although the increase in bank lending varies amongst stress-tested banks). Stress-tested banks that comfortably pass the stress test (defined by a higher capital post-stress test ratio above the threshold) will lend more significantly to foreign countries than banks with thinner capital buffers. The composition of a bank’s balance sheet before a stress test can have an influential role in the outcome of the stress test. Gambetta et al. [23] show that a weak balance-sheet structure is a factor that can cause banks to fail the stress test. On the other hand, stronger bank balance sheets can help banks in passing the stress tests [45]. Cornett et al. [16] find that banks manipulate their balance sheet before a stress test to pass the exercise, and often seek a political intervention to support the banks. This analysis, thus, suggests that stress-tested banks behave differently from non-stress-tested banks. Osborne et al. [39] show that before a crisis, bank capital and lending are positively correlated. Francis and Osborne [22] find that capital requirements set by the supervisory authority can influence loan growth and if banks are over-capitalized, the bank will expand lending [27, 28]. Carlson et al. [11] show that the banks that are marginally above the required capital threshold will lend more relative to the banks that are significantly above the capital threshold. Košák et al. [30] provide evidence that different measures of capital can affect bank lending: for example, high-quality capital in the form of tier 1 capital is associated with greater bank lending relative to Tier 2 capital. Furthermore, the authors argue that there should be a larger composition of Tier 1 capital on a bank’s balance sheet, as this capital type supports banks in times of crisis. Roulet [41] examines the changes in capital levels in the European banking system and finds that an increase in capital leads to a decrease in bank lending. Naceur et al. [36] show that an increase in capital requirements leads to a reduction in lending in Europe. By contrast, the increase in capital requirements is positively related to lending for the U.S. economy. Nos and Toffano [38] show that during an expansionary economic cycle, the growth of regulatory capital in the UK leads to a decrease in lending. Fraisse et al. [21] document that the increase in capital leads to a decrease in lending that causes a domino effect for firms. Yet, they also find that firms that cannot borrow, tend to reduce their investments. Deli and Hasan [18] suggest that capital regulation which is enforced on banks can harm loan origination and argue that if banks are adequately capitalized, they could counteract the impact of capital regulation. Morris-Levenson et al. [35] show that banks that are subject to different regulations reduce mortgage originations compared to less regulated banks. Nevertheless, there is no reduction in the overall mortgage originations for the economy because when larger banks cut back on mortgages, smaller banks that are less regulated become primary lenders [17, 33].

Data and methodology

For the group of banks that are part of the sample, we collect publicly available data from Orbis Bank Focus (formerly known as BankScope). For identification purposes, we removed the subsidiary banks from the sample of banks. This is to ensure that banks represent the highest level of consolidation [14]. Also, we select banks that are above the 10 billion threshold, thereby controlling for banks that are similar in size [16]. To control for mergers and acquisitions, we include the lead bank [3]. Our final sample includes 19 UK banks, that are commercial banks, building societies, bank holding companies, and co-operative banks which were included at least once in the BoE’s exercise. We collect the set of macro-economic variables from the Office for National Statistics and the BoE. Consequently, the sample spans from 2005 to 2018, as 2005 is the first year of implementation of the IFRS accounting standards for the UK financial institutions [46]. All the variables are deflated by using the 2005 GDP deflator. For the dependent variables,

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3 The Co-operative bank was included once in the 2014 stress test and then dropped for the subsequent years. We exclude Co-operative bank in our sample and include it as a control bank.
which are the types of loans growth, we remove outliers and drop observations that are above 300% \cite{42,43}. All variables are also winsorized at the 1st and 99th percentile and include robust standard errors. The variables are defined in Table 1 which also provides the summary statistics. Table 2 reports the correlation matrix for the variables.\footnote{We also test the correlation matrix by substituting the other dependent variables. The results show no high multicollinearity between variables. We do not report for brevity.}

| Table 1 Summary statistics |
|----------------------------|
| **Dependent variables**    |
| Total loans change         | For the Total loans change, we use the percentage change between the current year and the previous year | 211 | 5.28 | 22.91 | –33.07 | 120.94 |
| Loans to banks change      | For the Loans to banks change, we use the percentage change between the current year and the previous year | 200 | 1.39 | 42.10 | –77.36 | 157.54 |
| Mortgage loans change      | For the Mortgage loans change, we use the percentage change between the current year and the previous year | 188 | 8.57 | 25.27 | –14.13 | 165.02 |
| Consumer loans change      | For the Consumer loans change, we use the percentage change between the current year and the previous year | 162 | 0.88 | 35.49 | –94.83 | 165.52 |
| Corporate loans change     | For the Corporate loans change, we use the percentage change between the current year and the previous year | 173 | 5.02 | 39.53 | –85.30 | 254.84 |
| **Independent variables**  |
| Size                       | Ln Total Assets = The natural log of total assets | 229 | 11.17 | 1.84 | 8.54 | 14.40 |
| Profitability              | ROA = The return on assets, which is profit over total assets for each year | 229 | 0.25 | 0.67 | –2.21 | 2.06 |
| Credit risk                | NPL Ratio = The non-performing loan ratio is used to measure credit risk. The variable is calculated by impaired loans divided by gross total loans | 204 | 2.53 | 2.22 | 0.13 | 10.35 |
| Efficiency                 | Cost to Total Assets = To calculate bank efficiency, the operating expenses is divided by total assets | 229 | 1.56 | 1.03 | 0.32 | 5.19 |
| Capital                    | CET1 Ratio = The CET1 ratio is applied by CET1 capital over Risk Weighted Assets | 210 | 13.42 | 5.75 | 4.73 | 33.22 |
| Economic conditions        | Real GDP growth rate = For the economic conditions or the macro-economic conditions, the real GDP growth rate is used | 229 | 1.52 | 1.71 | –4.19 | 3.10 |
|                            | Bank rate = The official Bank rate (base rate) set by the BoE’s Monetary Policy Committee | 229 | 1.39 | 1.72 | 0.25 | 5.50 |
| **Stress testing terms**   |
| Stressed bank BoE          | Dummy variable designated as 1 for the 7 UK stress tested banks (treatment group) and 0 for the 12 remaining banks (control group) | 230 | 0.43 | 0.50 | 0 | 1 |
| Stressed bank EBA          | Dummy variable designated as 1 for the 4 UK stress tested banks (treatment group) and 0 for the 15 remaining banks (control group) | 230 | 0.24 | 0.43 | 0 | 1 |
| Post-stress period BoE     | Time dummy variable designated as 1 for 2014–2018 (post-stress test) and 0 for 2005–2013 (pre-stress test) | 230 | 0.41 | 0.49 | 0 | 1 |
| Post-stress period EBA     | Time dummy variable designated as 1 for 2010–2018 (post-stress test) and 0 for 2005–2009 (pre-stress test) | 230 | 0.70 | 0.46 | 0 | 1 |
| Failed bank BoE            | Dummy variable designated as 1 for banks that failed the stress test at least once and 0 for banks that have never failed. The variable is analogous to the alternative failed stress test variable by Acharya et al. \cite{[2]} | 230 | 0.24 | 0.43 | 0 | 1 |
| Passed bank BoE            | Dummy variable designated as 1 for banks that passed all the stress tests and 0 for banks that have failed at least once | 230 | 0.18 | 0.39 | 0 | 1 |
| Bailed out bank            | Dummy variable designated as 1 for banks that were bailed out and 0 otherwise | 230 | 0.12 | 0.33 | 0 | 1 |
| Post-bailout               | Dummy variable designated as 1 for the 2008–2018 period and 0 for the 2005–2007 period | 230 | 0.83 | 0.38 | 0 | 1 |
The effects of supervisory stress testing on bank lending: examining large UK banks

To assess the effects of stress testing on bank lending, we apply a difference-in-difference methodology which is used to analyse the effects between two groups in two different periods. For the main specification, we address the effects of the BoE’s stress test exercises. The motivation is that the BoE includes a larger number of banks compared to the EBA, and most importantly the BoE’s stress testing framework fails banks across its exercises. We account for the effects of failing the stress test with the BoE’s stress testing timeline which is not possible with the EBA’s stress testing timeline, as the authority does not fail UK banks during its earliest stress testing exercises. Therefore, the effects of the EBA’s stress testing exercises serve as additional robustness checks.

Subsequently, the BoE coordinated the stress testing exercises with the EBA in 2009, but first began its national stress testing framework in 2014. Therefore, we consider 2014 as the starting year of the treatment period. For our main specification, we use 7 banks as the treatment banks and 12 alternative banks as the control banks. The 7 banks that are included in the BoE stress test to date are: HSBC, Barclays, Lloyds Banking Group, Royal Bank of Scotland, Standard Chartered, Santander UK, and Nationwide Building Society.

For the EBA’s stress testing specification, 4 banks are part of the treatment banks and 15 banks are in the control group. Furthermore, the start of the EBA’s treatment period is 2010. The 4 banks that are included in the EBA’s stress tests are: HSBC, Barclays, Lloyds Banking Group, and Royal Bank of Scotland.

We employ standard variables that control for loan demand and loan supply that are widely used in the banking literature. We also control for the size of the bank by including the natural logarithm of total assets. The size of a bank can influence its lending decisions, and to a certain extent, an increase in size leads to a reduction in lending due to smaller banks having more information about local firms [17, 36]. However, notice that the size can lead to positive effects for those banks labelled as “too big to fail”, meaning the banks will increase lending as they increase in size [8]. We use the return on assets as a proxy for bank’s profitability. We expect a positive relationship between bank profitability and bank lending [2, 17, 29]. We use non-performing loans ratio as measure of credit risk. It is well-known that an increase in credit risk is often followed by a reduction in lending [41], [2, 17, 29]. The efficiency variable is used to measure bank efficiency and we hypothesise that banks that are more efficient will increase lending [2, 26]. Moreover, we use the CET1 capital ratio as a capital proxy. The variable is included as one of the capital ratios that is generally used as a threshold by the BoE and the EBA for their stress testing framework [19]. Moreover, note that the capital ratio has ambiguous impacts on bank lending. In fact, equity capital can either increase or decrease bank lending [36]. Banks that also have sufficient capital levels will increase lending relative to the banks that have low capital levels [11]. The first macroeconomic variable we use is real GDP growth. As the GDP

Table 2 Correlation matrix

|                      | Total loans change | Size | Profitability | Credit risk | Efficiency | Capital | Economic conditions (GDP growth) | Economic conditions (Bank rate) |
|----------------------|--------------------|------|---------------|-------------|------------|---------|----------------------------------|-------------------------------|
| Total loans change   | 1.00               |      |               |             |            |         |                                  |                               |
| Size                 | – 0.12             | 1.00 |               |             |            |         |                                  |                               |
| Profitability        | 0.31               | 0.02 | 1.00          |             |            |         |                                  |                               |
| Credit risk          | – 0.23             | 0.20 | – 0.39        | 1.00        |            |         |                                  |                               |
| Efficiency           | 0.07               | – 0.16 | 0.16 | 0.08        | 1.00      |         |                                  |                               |
| Capital              | – 0.01             | – 0.38 | 0.07 | – 0.25      | – 0.03 | 1.00 |                                  |                               |
| Economic conditions (GDP growth) | – 0.05 | – 0.05 | 0.02 | – 0.11      | 0.13 | 0.11 | 1.00 |                               |
| Economic conditions (Bank rate) | 0.35 | 0.06 | 0.20 | – 0.27      | – 0.06 | – 0.45 | 0.15 | 1.00 |

The table reports the correlation matrix of the variables used. The dependent variable is total loans change. The explanatory variables are the following: the size of the bank proxied by the natural log of total assets, the profitability variable measure by the return on total assets (ROA). The credit risk measure is the non-performing loan ratio, which is divided by the non-performing loans over gross loans. The efficiency of the bank is defined by the total cost of the bank divided by the banks’ total assets. The capital variable is defined by the CET1 capital ratio. The macro-variables are the GDP growth rate and the Bank rate for the UK. All values are rounded to two decimal points. Table 1 defines and presents the summary statistics for all the variables.

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growth of the country rises, the lending rate will also rise [8]. The official bank rate set by the BoE is the second control variable. The main variable of interest in our model is the difference-in-difference variable which is applied to examine the effects of stress testing. To implement the difference-in-difference approach, we use two dummy variables that represent the treatment group and the treatment period.

Equation (1) describes the main econometric model for the BoE’s stress testing exercise. The \( B_3 \) coefficient is the variable of interest that captures the difference-in-difference interaction. All other explanatory variables are lagged by one time period, and the Loan Type Growth dependent variable is substituted with the different loan types. The EBA’s stress testing exercise is shown in Eq. (2).

\[
\text{Loan Type Growth}_i, t = \beta_0 + \beta_1 \text{Bank Specific Variables}_{i, t-1} + \beta_2 \text{Macro Variables}_{t-1} + B_3 \text{Stress Tested Bank BoE}_i * \text{Post Stress Period BoE}_i + \alpha_1 \text{Bank Fixed Effects}_i + \alpha_2 \text{Time Fixed Effects}_i + \epsilon_{i, t} \tag{1}
\]

\[
\text{Loan Type Growth}_i, t = \beta_0 + \beta_1 \text{Bank Specific Variables}_{i, t-1} + \beta_2 \text{Macro Variables}_{t-1} + B_3 \text{Stress Tested Bank EBA}_i * \text{Post Stress Period EBA}_i + \alpha_1 \text{Bank Fixed Effects}_i + \alpha_2 \text{Time Fixed Effects}_i + \epsilon_{i, t} \tag{2}
\]

The BoE fails several participating banks during the stress tests. We control for the effects of failing and assess if the failure of the stress test by a bank leads to a reduction in loan growth. Equation (3) captures the effect with the \( \beta_4 \) coefficient [2].

\[
\text{Loan Type Growth}_i, t = \beta_0 + \beta_1 \text{Bank Specific Variables}_{i, t-1} + \beta_2 \text{Macro Variables}_{t-1} + B_3 \text{Stress Tested Bank BoE}_i * \text{Post Stress Period BoE}_i + B_3 \text{Stress Tested Bank BoE}_i * \text{Failed Bank BoE}_{i, t-1} + \alpha_1 \text{Bank Fixed Effects}_i + \alpha_2 \text{Time Fixed Effects}_i + \epsilon_{i, t} \tag{3}
\]

Results

We first discuss the effects of the BoE’s stress test as shown in Tables 3, 4, 5, 6 and 7. Columns 1–4 report the inclusion of the difference-in-difference terms. We also present different specifications of the econometric model in which we categorize the banks into two groups (treatment and control). We then discuss the effect of models (1) and (2) as they include bank and year fixed effects, similar to Acharya et al. [2], and Bassett and Berrospide [5].

Table 3 reports the effects of stress testing on the five dependent variables. For total loans growth, model (1) shows that there are no significant differences between stress-tested banks and non-stress tested banks. Notably, our results differ from the main findings of Acharya et al. [2] who find that stress-tested banks reduce lending. Bassett and Berrospide [5] do not find significant effects on total loans for banks above 10 billion USD in total assets. However, when analysing banks of similar size, by removing the largest banks from the sample, the effect of stress tests on total lending is negative and statistically significant, which is in line with Acharya et al. [2]. The results for the U.S. banking system indicate that stress-tested banks reduce lending compared to banks that do not participate in the stress tests exercises. In contrast, strikingly, our empirical evidence suggests that the introduction of the supervisory stress tests has not led to a reduction in lending by the stress-tested banks. Thus, this suggests that specific stress testing frameworks across financial jurisdictions could lead to differences in results.

Next, we include the effects of failing the stress test by the triple difference in model (2). Our findings show that the effect of stress testing for total loans is significant for banks that fail the stress tests. Specifically, the results show that banks that fail the stress tests will reduce lending by approximately 8 p.p. of total loans relative to banks that pass the stress tests. Therefore, importantly, our evidence indicates that banks will decrease their lending relative to the banks that pass the stress tests. The effect of failing is assumed to be detrimental to the banks and is in line with research that analyses the effects of banks failure and large capital gaps of the banks post-stress tests, measured by the stock market reaction [34]. Acharya et al. [2] document the effects of the stress tests on the U.S. banking system and show that failing the stress tests does not affect bank lending. While Bassett and Berrospide [5] also consider total loans, the limitation of their analysis is that they do not control for the effects of stress test failure. Hence, we cannot compare our findings directly to their results.

Acharya et al. [2] and Bassett and Berrospide [5] examine several lending variables such as mortgage loans. However, in our baseline analysis, we depart from Acharya et al. [2] as we focus on the impact on loans to banks, which to our
knowledge, has not been explored yet in the extant literature. Yet, although we control for the effects of stress testing for loans to banks, we find no statistically significant results following the introduction of the stress tests or for banks that fail the stress tests.

We turn now our discussion to the effects of stress testing on mortgage lending with respect to loan types shown in Table 5. The results from models (1) and (2) illustrate that the effects of stress testing are insignificant. However, we also find that failing the stress test is significant and impacts mortgage lending negatively. Specifically, we provide evidence that banks that fail the stress test will reduce mortgage lending by approximately 10 p.p. relative to banks that have passed the stress test. Surprisingly for the U.S. banking system, Acharya et al. [2] find no significant effects of stress testing on mortgage lending, neither do they find the

| Table 3 | The effects of the BoE’s stress tests on UK bank lending |
|---------|----------------------------------------------------------|
| Total loans change % | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Size | −17.54** | −18.15** | −18.15** | −16.50** | −8.04*** | −8.99*** | −4.23* | −2.10 |
| Profitability | 2.46* | 2.05* | 2.05* | 2.24 | 10.12*** | 11.19*** | 0.98 | 1.57 |
| Credit risk | 1.61 | 1.49 | 1.49 | 0.99 | 1.59* | 1.67* | −2.08*** | −2.67*** |
| Efficiency | −5.53 | −5.28 | −5.28 | −3.67 | 8.39*** | 8.22** | 1.48* | 1.57** |
| Capital | −0.25 | −0.31 | −0.31 | 0.03 | −0.02 | −0.43 | 0.27 | 0.32** |
| Economic conditions (GDP growth) | 15.98 | 11.86 | −0.28 | −0.20 | 0.23 | −0.06 | −0.92 |
| Economic conditions (Bank rate) | −3.48 | −2.23 | 3.98** | 4.12*** | −7.76 | 0.22 | −0.59 |
| Stress bank BoE * post-stress period BoE | −1.05 | 3.26 | 3.26 | 5.25 |
| Stress bank BoE * post-stress period BoE * failed bank BoE | −7.98** | −7.98** | −8.35** |
| Constant | 180.74 | 195.60 | 222.28** | 187.46** | 84.55*** | 108.05*** | 42.99* | 25.50 |
| Observations | 184 | 184 | 184 | 184 | 85 | 85 | 99 | 99 |
| R2 | 0.29 | 0.30 | 0.30 | 0.26 | − | − | − | − |
| Number of banks | 19 | 19 | 19 | 19 | 7 | 7 | 12 | 12 |
| Bank fixed effects | Yes | Yes | Yes | Yes | − | − | − | − |
| Time fixed effects | Yes | Yes | Yes | − | Yes | − | Yes | Yes |
| Treatment banks | Yes | Yes | Yes | Yes | Yes | − | − | − |
| Control banks | Yes | Yes | Yes | Yes | − | − | Yes | Yes |
| Model used | FE | FE | FE | FE | FGLS | FGLS | FGLS | FGLS |

The table reports the effects of the BoE’s stress tests on bank lending. The dependent variables are total loans growth, loans to banks growth, mortgage loans growth, consumer loans growth, and corporate loans growth. All explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions variables (proxied by Real GDP growth and Bank Rate). The Stressed Bank BoE variable is a dummy variable designated as 1 for 7 banks and 0 for the remaining 12 banks. The Post-Stress Period BoE is a time dummy variable and is designated as 1 for 2014–2018 and 0 for 2005–2013. The Failed Bank BoE variable is a dummy variable that is designated as 1 for the banks that failed and 0 for the banks that have passed the stress test. Model (1) includes all the explanatory variables and the difference-in-difference interaction. Model (2) includes all the explanatory variables, the difference-in-difference interaction, and the triple difference to control for the effects of failing the stress test. The sample period of the results is from 2005 to 2018. Bank fixed effects and time fixed effects are controlled for in all the models, but are not reported. All models include robust standard errors which are reported in the parentheses. Table 1 reports the description and summary statistics for all the variables Robust Standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1
effect of failing the stress test an important factor in driving up loan growth for mortgages. One paper that is closely related to mortgage lending is Calem et al. [9] who examine the effects of stress testing on the jumbo mortgage market. In this respect, our evidence does not speak to the size of the mortgage due to the granularity of data. Therefore, we are unable to compare or match the results. However, the analysis by Calem et al. [9] aligns with the results shown in Table 5, as they find that stress-tested banks reduce lending. The results show a decrease in mortgage lending. It is important to note that government programmes in the U.S. have led to an increase in mortgage lending in contrast to the UK banking system. Chakraborty et al. [12] emphasise that post-global financial crisis, the Fed undertook quantitative easing programmes such as mortgage-backed securities (MBS) and treasury assets purchases. Nevertheless,
The effects of supervisory stress testing on bank lending: examining large UK banks

The authors document that while the MBS purchases by the Fed lead to an increase in mortgage lending by banks, there have been inadvertent consequences that have caused a change in bank behaviour lending. Chakraborty et al. [12] suggest that as mortgage lending increases due to MBS purchases, commercial lending to firms has been reduced. Their results show that the composition of lending has changed due to this policy. Additionally, they show that a reduction in commercial lending has led to a contraction in investments by firms, which adversely affects the level of economic activity. Bassett and Berrospide [5] find no significant effects of stress testing on mortgage lending, and this holds for all the specifications and robustness tests. The results for the U.S. banking system are more comparable to Acharya et al. [2] because of the similar methodology we adopt.

Table 5  The effects of the BoE’s stress tests on UK bank lending

| Mortgage loans change % | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|-------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Size                    | − 16.50 | − 17.32 | − 17.32 | − 15.99 | − 3.96** | − 4.51** | − 5.72 | − 1.75 |
| (12.14)                 | (12.01) | (12.01) | (11.24) | (1.86) | (1.95) | (3.76) | (3.29) |
| Profitability           | 1.96 | 1.22 | 1.22 | 0.35 | − 1.49 | − 0.75 | 2.60 | 2.92 |
| (2.84)                  | (2.76) | (2.76) | (1.83) | (3.15) | (3.02) | (2.31) | (2.06) |
| Credit risk             | 1.84 | 1.66 | 1.66 | 1.70 | 1.57* | 2.03** | − 0.88 | − 1.56** |
| (2.38)                  | (2.24) | (2.24) | (1.49) | (0.89) | (0.95) | (0.88) | (0.73) |
| Efficiency              | 1.49 | 1.72 | 1.72 | 1.44 | 4.00 | 2.89 | 3.01 | 3.39* |
| (10.52)                 | (10.47) | (10.47) | (8.71) | (3.02) | (3.36) | (1.91) | (1.96) |
| Capital                 | − 0.14 | − 0.22 | − 0.22 | − 0.29 | 0.28 | − 0.02 | 0.53** | 0.54** |
| (0.72)                  | (0.74) | (0.74) | (0.55) | (0.38) | (0.52) | (0.25) | (0.25) |
| Economic conditions (GDP growth) | − 6.11 | − 8.54 | − 1.52* | − 1.50*** | − 0.66 | − 0.91 | − 0.90 |
| (53.79)                 | (53.26) | (0.82) | (0.58) | (1.07) | (0.56) | (0.74) |
| Economic conditions (Bank rate) | 1.94 | 2.68 | 2.04 | 4.46*** | 7.07 | − 0.62 | − 0.95 |
| (14.90)                 | (14.82) | (1.24) | (0.95) | (21.13) | (1.16) | (1.42) |
| Stress bank BoE * post-stress period BoE | 1.18 | 6.46 | 6.46 | 6.23 |
| (9.36)                  | (9.50) | (9.50) | (4.61) |
| Stress bank BoE * post-stress period BoE * failed bank BoE | − 10.18* | − 10.18* | − 10.99** |
| (5.21)                  | (5.21) | (4.84) |
| Constant                | 197.70 | 212.83 | 198.42 | 187.32 | 40.41* | 52.02* | 52.01 | 16.04 |
| (217.92)                | (216.03) | (138.93) | (131.87) | (23.79) | (27.20) | (36.84) | (32.43) |
| Observations            | 172 | 172 | 172 | 172 | 84 | 84 | 88 | 88 |
| R²                      | 0.16 | 0.17 | 0.17 | 0.14 | − | − | − | − |
| Number of banks         | 18 | 18 | 18 | 18 | 7 | 7 | 11 | 11 |
| Bank fixed effects      | Yes | Yes | Yes | Yes | − | − | − | − |
| Time fixed effects      | Yes | Yes | Yes | Yes | − | Yes | Yes | Yes |
| Treatment banks         | Yes | Yes | Yes | Yes | Yes | Yes | − | − |
| Control banks           | Yes | Yes | Yes | Yes | − | − | Yes | Yes |
| Model used              | FE | FE | FE | FE | FGLS | FGLS | FGLS | FGLS |

The table reports the effects of the BoE’s stress tests on bank lending. The dependent variables are total loans growth, loans to banks growth, mortgage loans growth, consumer loans growth, and corporate loans growth. All explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions variables (proxied by Real GDP growth and Bank Rate). The Stressed Bank BoE variable is a dummy variable designated as 1 for 7 banks and 0 for the remaining 12 banks. The Post-Stress Period BoE is a time dummy variable and is designated as 1 for 2014–2018 and 0 for 2005–2013. The Failed Bank BoE variable is a dummy variable that is designated as 1 for the banks that failed and 0 for the banks that have passed the stress test. Model (1) includes all the explanatory variables and the difference-in-difference interaction. Model (2) includes all the explanatory variables, the difference-in-difference interaction, and the triple difference to control for the effects of failing the stress test. The sample period of the results is from 2005 to 2018. Bank fixed effects and time fixed effects are controlled for in all the models, but are not reported. All models include robust standard errors which are reported in the parentheses. Table 1 reports the description and summary statistics for all the variables. Robust Standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.11
The results in this section show that the stress-tested banks do increase consumer lending. Our findings show that stress-tested banks increase their loan origination to consumer lending. Furthermore, the effect of failing the stress test does not quantitatively influence consumer lending. In contrast, Acharya et al. [2] find that consumer loans (credit card loans) decrease. Moreover, as shown in Table 6, the results for the failure of the stress tests are insignificant. Note that this also aligns with the findings for the U.S. banking system [2]. Moreover, our results mimic those documented by Bassett and Berrospide [5], who show that the effects of stress testing are positively and significantly related to consumer loan lending. While Acharya et al. [2] and Bassett and Berrospide [5] consider the effects
239

The effects of supervisory stress testing on bank lending: examining large UK banks

As shown in Table 7, stress testing reduces corporate loans by stress-tested banks relative to non-stress tested banks by approximately 26 p.p. However, when we include the effects of failing the stress tests in model (2) and (3), the results become statistically insignificant. Acharya et al. [2] use two corporate loan types. They find that for commercial real estate loans, stress testing leads to a growth in lending, and banks that fail the stress test increase lending. The second loan type similar to corporate loans are commercial and industrial loans. For this type of loans, Acharya et al. [2] find evidence that failing the stress test causes a reduction in lending for commercial and industrial loans. Cortés et al.

Table 7 The effects of the BoE’s stress tests on UK bank lending

| Corporate loans change % | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Size                     | −16.84 | −16.38 | −16.38 | −18.37 | −12.47*** | −12.91*** | −4.05 | −8.92 |
|                          | (13.69) | (13.96) | (13.96) | (12.84) | (3.44) | (3.45) | (9.24) | (10.70) |
| Profitability            | −17.08 | −16.68 | −16.68 | −14.81 | 2.72 | 5.96 | −5.03 | −5.73 |
|                          | (12.51) | (12.36) | (12.36) | (13.30) | (5.27) | (5.31) | (4.98) | (5.38) |
| Credit risk              | 1.84 | 1.97 | 1.97 | 0.49 | 3.54*** | 3.16** | −2.44 | −1.16 |
|                          | (1.79) | (2.08) | (2.08) | (1.66) | (1.34) | (1.49) | (2.04) | (2.41) |
| Efficiency               | 8.43 | 8.15 | 8.15 | 16.70 | 16.70*** | 13.79*** | 3.01 | 1.23 |
|                          | (12.92) | (13.45) | (13.45) | (16.47) | (5.99) | (6.22) | (3.58) | (4.22) |
| Capital                  | −0.53 | −0.48 | −0.48 | 0.62 | −0.20 | −1.79 | −0.55 | −0.89 |
|                          | (1.10) | (1.10) | (1.10) | (0.77) | (1.04) | (1.34) | (0.46) | (0.59) |
| Economic conditions (GDP growth) | −190.52 | −189.77 | −1.14 | −1.44 | 0.01 | −0.43 | −1.12 |
|                          | (117.23) | (118.81) | (1.29) | (1.17) | (2.12) | (2.12) | (1.90) |
| Economic conditions (Bank rate) | 61.62* | 61.30 | 8.91* | 8.57*** | 29.87 | 3.16 | 5.47* |
|                          | (35.14) | (35.49) | (4.68) | (2.13) | (43.84) | (2.01) | (2.89) |
| Stress bank BoE * post-stress period BoE | −26.33* | −30.56 | −30.56 | −16.67 |
|                          | (13.18) | (21.52) | (21.52) | (17.83) |
| Stress bank BoE * post-stress period BoE * failed bank BoE | 7.86 | 7.86 | 7.48 |
|                          | (20.13) | (20.13) | (19.99) |
| Constant                 | 520.09* | 512.60 | 200.89 | 179.30 | 127.63** | 150.87*** | 40.31 | 82.68 |
|                          | (293.83) | (298.81) | (159.10) | (159.84) | (51.25) | (56.70) | (99.02) | (114.77) |
| Observations             | 154 | 154 | 154 | 154 | 81 | 81 | 73 | 73 |
| $R^2$                    | 0.29 | 0.29 | 0.29 | 0.24 | – | – | – | – |
| Number of banks          | 16 | 16 | 16 | 16 | 7 | 7 | 9 | 9 |
| Bank fixed effects       | Yes | Yes | Yes | Yes | – | – | Yes | Yes |
| Time fixed effects       | Yes | Yes | Yes | Yes | – | – | Yes | Yes |
| Treatment banks          | Yes | Yes | Yes | Yes | – | – | Yes | Yes |
| Control banks            | Yes | Yes | Yes | Yes | – | – | Yes | Yes |
| Model used               | FE | FE | FE | FE | FGLS | FGLS | FGLS | FGLS |

The table reports the effects of the BoE’s stress tests on bank lending. The dependent variables are total loans growth, loans to banks growth, mortgage loans growth, consumer loans growth, and corporate loans growth. All explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the non-performing loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions variables (proxied by Real GDP growth and Bank Rate). The Stressed Bank BoE variable is a dummy variable designated as 1 for 7 banks and 0 for the remaining 12 banks. The Post-Stress Period BoE is a time dummy variable and is designated as 1 for 2014–2018 and 0 for 2005–2013. The Failed Bank BoE variable is a dummy variable that is designated as 1 for the banks that failed and 0 for the banks that have passed the stress test. Model (1) includes all the explanatory variables and the difference-in-difference interaction. Model (2) includes all the explanatory variables, the difference-in-difference interaction, and the triple difference to control for the effects of failing the stress test. The sample period of the results is from 2005 to 2018. Bank fixed effects and time fixed effects are controlled for in all the models, but are not reported. All models include robust standard errors which are reported in the parentheses. Table 1 reports the description and summary statistics for all the variables. The table reports the effects of the BoE’s stress tests on bank lending. The sample period of the results is from 2005 to 2018. Bank fixed effects and time fixed effects are controlled for in all the models, but are not reported. All models include robust standard errors which are reported in the parentheses. Table 1 reports the description and summary statistics for all the variables.
### Table 8: The effects of the BoE’s stress tests on UK bank lending—effect of each year

|                                      | Total loans growth % | Loans to banks growth % |
|--------------------------------------|----------------------|-------------------------|
|                                      | (1) | (2) | (1) | (2) |
| Stressed bank BoE * 2014 stress period | 5.10 | 9.14 | 21.13 | 17.06 |
|                                      | (7.81) | (8.09) | (13.77) | (19.71) |
| Stressed bank BoE * 2015 stress period | −3.96 | 2.01 | 4.35 | 31.22 |
|                                      | (6.28) | (6.36) | (22.49) | (29.32) |
| Stressed bank BoE * 2016 stress period | −0.21 | 0.09 | 11.00 | 14.46 |
|                                      | (5.90) | (7.25) | (16.21) | (22.38) |
| Stressed bank BoE * 2017 stress period | −1.32 | 2.15 | 9.82 | 10.47 |
|                                      | (6.62) | (7.47) | (17.37) | (22.72) |
| Stressed bank BoE * 2018 stress period | −5.37 | 2.55 | 21.22 | 14.22 |
|                                      | (6.96) | (6.82) | (24.59) | (10.34) |
| Stressed bank BoE * 2014 stress period * failed bank BoE | −7.36** | 7.25 | (2.74) | (15.22) |
| Stressed bank BoE * 2015 stress period * failed bank BoE | −10.85*** | −47.20* | (3.73) | (23.62) |
| Stressed bank BoE * 2016 stress period * failed bank BoE | −0.99 | −5.98 | (5.89) | (19.60) |
| Stressed bank BoE * 2017 stress period * failed bank BoE | −6.51 | −1.24 | (5.45) | (22.57) |
| Stressed bank BoE * 2018 stress period * failed bank BoE | −14.53** | 12.39 | (6.53) | (39.34) |
| Constant (180.93)                    | 250.11 | 270.49 | 298.50 | 280.19 |
| Observations 184                     | (176.62) | (369.52) | (354.50) |
| R² 0.30                             | 0.30 | 0.31 | 0.26 | 0.28 |
| Number of banks 19                   | 19 | 19 | 18 | 18 |
| Bank fixed effects Yes               | Yes | Yes | Yes | Yes |
| Time fixed effects Yes               | Yes | Yes | Yes | Yes |
| Bank characteristics Yes             | Yes | Yes | Yes | Yes |
| Macro-characteristics Yes            | Yes | Yes | Yes | Yes |
| Treatment banks Yes                  | Yes | Yes | Yes | Yes |
| Control banks Yes                    | Yes | Yes | Yes | Yes |
| Model used FE                        | FE | FE | FE | FE |

The table reports the effect of each stress testing exercise by the BoE for each year since 2014. The dependent variables are total loans growth, loans to banks growth, mortgage loans growth, consumer loans growth, and corporate loans growth. All explanatory variables are lagged by one period. The explanatory variables include: Size (measured as the natural log of total assets), Profitability (proxied by the Return on Assets), Credit Risk (the nonperforming loan ratio), Efficiency (defined as operating expenses over total assets), Capital (measured as the CET1 ratio), and Economic conditions variables (proxied by Real GDP growth and Bank rate). The Stressed Bank BoE variable is a dummy variable designated as 1 for 7 banks and 0 for the remaining 12 banks. The Stress Period is a time dummy variable and is designated as 1 for each year and 0 otherwise. The Failed Bank BoE variable is a dummy variable that is designated as 1 for the banks that failed and 0 for the banks that have passed the stress test. Model (1) includes all the explanatory variables and the difference-in-difference interaction. Model (2) includes all the explanatory variables, the difference-in-difference interaction, and the triple difference to control for the effects of failing the stress test. The sample period of the results is from 2005 to 2018. Bank fixed effects and time fixed effects are controlled for in all the models, but are not reported. In addition, for brevity the explanatory variables are included but are not reported. All models include robust standard errors which are reported in the parentheses. Table 1 reports the description and summary statistics for all the variables.

Robust Standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1
The effects of supervisory stress testing on bank lending: examining large UK banks

It is important to note that due to data availability, we cannot control for the loan size of corporate lending. However, the most related loan type is corporate lending reported in Table 7. In contrast, Cortés et al. [17] document that banks that are stress-tested will cut lending if they do not have...
information on the geographical location of their branch. This allows smaller banks that have more detailed information to replace stress-tested banks and increase lending. We do find statistical evidence of the effect of stress testing on corporate loans but only for model (1). We present a t test between stress-tested banks and non-stress tested banks in Table 10. Interestingly, the results show that during and after the stress testing period, non-stress tested banks increase lending for total loans, and mortgage loans which are statistically significant. The analysis provided in Table 10 suggests that stress-tested banks will reduce lending as documented by Cortès et al. [17], and the stress-tested banks will be replaced by non-stress tested banks which may indicate that aggregated lending is not reduced [33]. Chen et al. [13] find that when the largest banks reduce lending, smaller banks, and finance companies replace the largest banks and provide lending to small businesses. Their findings, however, indicate that when the largest banks reduce lending, there is a time lag for small banks to enter the market. In other words, small banks and finance companies do not immediately replace the largest banks. As noted by Chen et al. [13], the largest banks reduce lending due to competition.

Acharya et al. [2] propose two different hypotheses to explain the behaviour of the banks. The first is the Risk Management Hypothesis, which posits that banks will reduce lending following a stress test exercise. The second hypothesis is the Moral Hazard Hypothesis which states that banks increase lending after a stress test. Overall, our results lend support to the Risk Management Hypothesis and show that banks that fail the stress test will reduce lending to manage credit risk. A possible explanation for our results is that the reduction in lending is due to the introduction of new regulations after the financial crisis. Indeed, supervisory stress testing exercises are a part of the regulations that may have led to a reduction in lending. Furthermore, tighter regulations may have a larger impact mainly on larger banks. Morris-Levenson et al. [35] find that post-global financial crisis tighter regulation has led to a reduction in lending, which is more pronounced for mortgage lending. Notice that this does not mean that the aggregate amount of mortgage lending is being reduced since regulated banks may replace the largest banks and fill the gap by providing lending. Also, tighter financial regulation for the stress-tested banks is a continuous process. Therefore, if banks fail the stress tests, the Prudential Regulation Authority or the Financial Policy Committee will evaluate if further action is needed to preserve financial stability. Specifically, the Prudential Regulatory Authority requires failed banks to increase their equity capital buffers if they fail the stress test [4].

Moreover, the composition and strength of the balance sheet is another factor that may drive the results. Kapan and Minou [27] show that the size and composition of the balance sheets are important to analyse and explain that effects on bank lending. Our evidence suggests that banks must have strong balance sheets to provide lending, which can be assessed by the quantity and quality of capital that banks hold. Table 11 reports the estimated results of the t test between banks that passed the stress test and those that failed. We see that during the period of the stress testing exercises (2014–2018), banks that passed the stress test had greater capital relative to failed banks which is measured by the CET1 ratio. Notice that this difference in CET1 ratios is statistically significant. A notable implication of our results is that capital shortfalls can influence the lending behaviour of banks. Moreover, note that the failure of the banks in the BoE’s model specification is due to banks failing below the set threshold in each stress testing exercise. Therefore, the reductions in equity capital are attributable to the balance sheet of the banks being assessed against a more stringent stress test exercise.

Neretina et al. [37] and Calem et al. [9] provide further evidence that the earliest stress testing exercises have had the strongest impact on bank lending. We report the main empirical findings in Tables 8 and 9.

Overall, we find evidence of a mixed pattern. When considering the effects of stress testing on total loans in each year, we can see that the implementation of the stress tests is insignificant. We then focus on the effects of failure and confirm that failing the stress test reduces lending relative to the banks that pass the stress test. We can observe lending falls by approximately 7 p.p., 11 p.p. and 15 p.p. for the 2014, 2015, and 2018 stress test exercises. Surprisingly, the effects of stress testing are quantitatively stronger. Acharya et al. [2] examine the effects of each stress testing period by the Fed. Interestingly, they find that the effect of stress testing on total loans is negative and statistically significant for the whole period, which indicates that stress-tested banks have been reducing lending relative to non-stress tested banks since the implementation of the stress tests. Additionally, the effect of failing the stress test for total loans is significant for the latest stress testing exercises and for the earliest stress test which contradicts the evidence for the U.S. banking system [37]. The results also diverge from the findings for the UK banking system.

For loans to banks, the results are significant and show a decrease in bank lending in 2015 when including the effect of a bank failure. We see that the effect of failing can reduce lending to banks by approximately 47 p.p. This can be viewed as one of the earliest stress tests. Moreover, loans to banks are insignificant as shown in Table 4. However, when we consider the dynamics of loan growth for each year, the effects of stress testing on bank lending are time-varying. Regarding the effects of stress testing on mortgage lending, we find no statistically significant results since the implementation of the stress tests. We also show that the effects of failing a stress test on mortgage lending are
Bassett and Berrospide [5] document that the effects of stress testing diminish post-stress test. For example, testing on bank lending for the U.S banking system show that failed banks by approximately 8 p.p. for the 2015 stress test, 10 p.p. for the 2017 stress test and 13 p.p. for the 2018 stress test. Acharya et al. [2] find mixed results for the implementation of the stress tests, with the earliest stress tests leading to an increase in lending, and the successive stress tests show a reduction in mortgage lending. However, the effect of failing the stress test is insignificant. Moreover, Calem et al. [9] show that the earliest stress testing exercises by the Fed (2011 Comprehensive Capital Analysis and Review stress test) have also determined a reduction in mortgage lending. However, notice that the findings of Calem et al. [9] are driven by jumbo mortgages, which focuses on a specific subset of mortgages which is related to the size of the loan.

We can also see from model (1) that the change in consumer loans growth is positive and statistically significant for both the 2014 and the 2017 stress tests years, when lending increases by 24 p.p. and 26 p.p., respectively. Acharya et al. [2] find opposite results for the US banks and show that the stress tests cause a decrease in lending which is significant for all the stress testing periods.

Finally, the effects of corporate loans are negative and statistically significant for the 2015 period, as model (1) shows that corporate lending diminishes by approximately 26 p.p. for the group of stress-tested banks. Note, however, that the results are significant only for the earliest stress tests.

Shapiro and Zeng [44] show that banks that fail the stress test will reduce bank lending and those that pass the stress test will increase lending. Although their work is based on the decision made by the regulatory authority, we also find evidence that banks failing the stress tests reduce lending, while those that pass the stress tests do increase lending. Furthermore, a noteworthy result is that failed banks will reduce lending for loan types such as total loans and mortgage loans, which suggests that the loan type is an important factor. Most importantly, Shapiro and Zeng [44] focus on the feedback effect of a bank failing the stress test. Yet, in our analysis we miss out the feedback effect of an individual bank failing the stress test, and how this may affect the lending decisions made by other banks that participate in the stress test.

Several recent articles that address the effects of stress testing on bank lending for the U.S banking system show that bank lending diminishes post-stress test. For example, Bassett and Berrospide [5] document that the effects of stress testing on bank lending is significant and positive. The differences in the results are attributable to the construction of the stress testing variable. In our analysis, we use a difference-in-difference approach, while Bassett and Berrospide [5] assess the effect of stress testing by calculating the difference between the capital levels of the internal banks’ stress testing exercise and the supervisory authorities stress test. Due to data availability, we cannot estimate the capital gap as banks do not publicly disclose the internal stress tests results.

Robustness tests

In this section, we present a set of robustness tests to evaluate the effects of the EBA’s stress testing exercises on UK bank lending.7 As discussed earlier, we focus on 4 UK banks that are subject to the EBA’s stress testing exercises as opposed to the 7 banks that are stress-tested by the BoE. We, therefore, our model a slightly modified difference-in-difference term compared to the variable reported in Tables 3, 4, 5, 6, 7, 8 and 9. The treatment period starts in 2010 and we analyse 4 banks with 15 banks in the control group. The results for the effects of stress testing are statistically insignificant. Moreover, we evaluate whether our results are consistent with the findings of Acharya et al. [2], who show that stress testing reduces loan growth. However, our evidence does not lend support to the Risk Management Hypothesis, that banks reduce lending post-stress test. As in the main BoE specification, we also test for the effect in each year of the sample period. Notice that for the majority of the loan types, we find insignificant results, except for loans to banks for the 2010 stress test period and the 2014 stress test period, when the stress-tested banks increase loans by approximately 48 p.p. for the 2010 stress test and approximately 37 p.p. for the 2014 stress test. Candelon and Sy [10] and Georgescu et al. [24] find that the effects of stress testing in the same year...
jurisdiction for each year change, and this is essentially attributable to the methodology and structure of the stress test.

We also obtain very similar results, due to the methodological differences between the BoE’s stress test and the EBA’s stress test, driven by the insignificant variables. We can conclude that differences between both stress testing timelines may be driving the results as shown in the literature. For example, Petrella and Resti [40] document that differences between the 2010 and 2011 EU stress tests may influence the banks’ stock price, as the 2011 stress test was more articulated and robust (compared to the 2010 stress test). Furthermore, the evidence provided by Borges et al. [7] confirms the finding that different stress tests may also impact on the stock market. This was the case with the 2010 EU stress test which had a small impact on the stock market compared to successive stress tests. Furthermore, this confirms that stress tests behave differently within the same jurisdiction and among jurisdictions. Candelon and Sy [10] find that the U.S. stress tests were stronger than the stress tests administered by the EBA for the EU. This could be primarily explained by the structure of the stress test. The differences in results are novel to the literature on the effects of stress testing on bank lending for UK banks, as we find that certain stress testing frameworks can have an influential impact on banks, which largely depends on methodological differences. Hence, we can conclude that the BoE stress testing framework has had a noteworthy impact on the lending behaviour of banks.

It is important to note that a limitation of our analysis is that we are unable to apply a triple difference specification (bank failing the stress test), akin to the BoE’s model. Notice that under the EBA’s stress testing exercises, no UK bank had failed or was below the respective hurdle rate set by the EBA for its stress testing exercises. Nevertheless, a related paper by Mésonnier and Monks [33] examines the effects of the EBA capital exercise and document that undercapitalized banks (can otherwise be interpreted as banks that fail a stress test) reduce their loan growths relative to banks that have sufficient capital levels. A major reason for this impact is that banks adopt strategies to improve capital ratios while simultaneously reducing lending [6]. Notice also that the findings of Mésonnier and Monks [33] align with the main results from the BoE’s stress specification, which clearly shows that banks who fail will reduce lending. We, therefore, hypothesize that if we could capture the effects of failing or passing via a triple difference specification, banks that fail the stress tests exercises will reduce their lending. Yet, a limitation of the analysis of Mésonnier and Monks [33] is that the effects on lending is analysed only at the aggregate level. Borges et al. [7] document that for the EU banking system, failing the stress test results in a stronger negative stock market reaction. Taken together, the results for the UK banks which failed the EU stress tests, are statistically significant. This implies a reduction in bank lending as shown in Tables 3 and 5 for total loans and mortgage loans, respectively.

Conclusion

There is limited research on the specific effects of stress testing on bank lending, with only a few empirical studies focused on the U.S. banking system. In this paper, we contribute to the literature by examining the effects of stress testing on bank lending by analysing the UK banking system. We depart from existing studies by including the effects of two stress testing timelines. We analyse the effects of the BoE’s stress testing exercises on UK bank lending, and the effect of EBA’s stress testing framework which includes UK banks in its EU-wide stress test.

We employ a difference-in-difference methodology to assess the impact of stress testing. We find that the effects of the exercise are statistically insignificant. However, it turns out that the impact of banks failing the stress test is significant. This means that banks that fail the stress test tend to reduce loans, and banks that pass, tend to increase loan growth for the majority of the lending types relative to banks that fail the stress tests. Notably, our baseline results align with the studies on the U.S banking system that document that banks that fail stress tests cut back substantially on lending.

There is abundant evidence in the literature that the earlier stress tests were most effective [10, 37]. Acharya et al. [2] find that the earliest stress tests were effective in reducing bank lending. We, therefore, further investigate this impact and scrutinize each stress test exercise for each year since its inception. Our evidence clearly shows that there are no noticeable differences between the earlier and the most recent stress tests. In other words, the effects of stress testing on bank lending is of the same magnitude as the earliest and the most recent stress testing exercises. Notably, these results contrast with the findings documented for the U.S. banking system, for the earliest stress tests that had the most meaningful negative impact on lending.

The literature documents that the stress testing exercises for the U.S banking system have become less effective over time. In contrast, we provide clear evidence that the effectiveness of the stress testing exercises remains unchanged over time. Specifically, we show that for the earliest and more recent stress tests banks failing the stress tests do reduce lending. This is an important result that diverges from the results seen for the U.S. banks stress tests. Most

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8 For example, one difference is the assumptions about the structure of the banks’ the balance sheet, as the BoE allows a dynamic change for the balance sheet and the EBA sets a strict static assumption.
The effects of supervisory stress testing on bank lending: examining large UK banks

importantly, we find that the specific structure of the stress tests adopted by different regulators may have differential effects on the treated banks.

An important policy implication of our results concerns the underlying assumptions and robustness of the methodology used in the stress testing exercise by the BoE as this may affect the overall quality and effectiveness of the assessment. While our evidence clearly shows significant results for the banks failing the stress tests for nearly all the periods, the effectiveness of the stress tests may weaken in the future as shown by the current case for the US stress testing framework.

Our main findings also highlight two policy recommendations for supervisory authorities. First, the effectiveness of the stress test framework depends crucially on the design of the methodology, as this can have important implications on bank lending behaviour. In fact, our results show that the two stress testing timelines from the BoE and EBA produce different effects. These results are possibly linked to the differences in the methodology of the stress tests employed by both supervisors. Differences in the assumption of balance sheet or time horizon of the shock, for example, could have important consequences on banks. We, therefore, provide clear evidence that the structure of the stress test is a key factor affecting bank lending.

The second policy implication concerns the decision to fail a stress-tested bank or not. In line with Shapiro and Zeng [44], the choice made by regulators to either fail or pass the banks in question may cause unintended knock-on effects such as reduced bank lending. Do regulators prefer to fail banks and reduce lending, or pass vulnerable banks and allow them to lend while simultaneously hampering financial stability?.

Overall, our results may help the relevant supervisory bodies to develop more focused and articulated stress testing surveillances practices specifically formulated with a view towards an application to large, internationally active banks in their respective jurisdictions.

We attempt to fill the gap in the literature by focusing on the UK banking system and show that banks that fail the stress tests will reduce lending. However, the purpose of the supervisory stress testing exercises is to assess a banks’ capital adequacy to an adverse shock and whether the bank remains above the regulatory capital threshold. We can conclude that the BoE supervisory stress tests meet their goal of enhancing financial stability, as the banks that fail will reduce lending to mitigate credit risk.

Nevertheless, there are several limitations in our analysis. A major limitation is that we cannot isolate the effects of failing the stress tests for the EBA specification. As no UK banks fail the stress tests administered by the EBA during our sample, we cannot control for the effect failure as in the case of the BoE specification. Therefore, we have been unable to discriminate between banks that fail and those that pass the stress tests. Consequently, future research could build on the insights of this paper to examine the effects of stress testing on bank lending also for the EU jurisdictions. As the EBA fails other EU banks as a part of their framework, it would be interesting to study the effects of failing the stress test and how this affects bank lending for the EU banking sector. Although the analysis of our paper is suggestive that stress testing is important, much more work is needed to understand the implications of stress testing on bank lending more fully. In particular, it would be worth investigating the banks’ exposure to stress testing adverse scenarios and its impact on bank lending. We hope to pursue these lines of research in future work.

Appendix

See Tables 10 and 11.
Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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