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The Development Impact of Financial Regulation

Evidence from Ethiopia and Antebellum USA

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Abstract

In absence of deposit insurance, underdeveloped financial systems can exhibit a coordination failure between banks, unable to commit on safe asset holding, and depositors, anticipating low deposit repayment in bad states. This paper shows conditions under which a government can solve this failure by imposing safe asset purchases, which boosts deposits by increasing depositor repayment in bad states. In so doing, financial regulation stimulates bank profits if subsequent deposit growth exceeds the intermediation margin decline. As a result, it also promotes loans and branch installation with deposits. Two empirical tests are presented: 1) a regulation change by the National Bank of Ethiopia in 2011; 2) the introduction of bank taxes in Antebellum USA (1800–1861). Analyzing bank balance sheets and long-term branch installation, the regulation effects are isolated exploiting heterogeneity in bank size and policies introduction respectively, and find increases in branches, deposits, loans, and safe assets, with no decline in overall profits.

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The Development Impact of Financial Regulation: Evidence from Ethiopia and Antebellum USA*

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Introduction

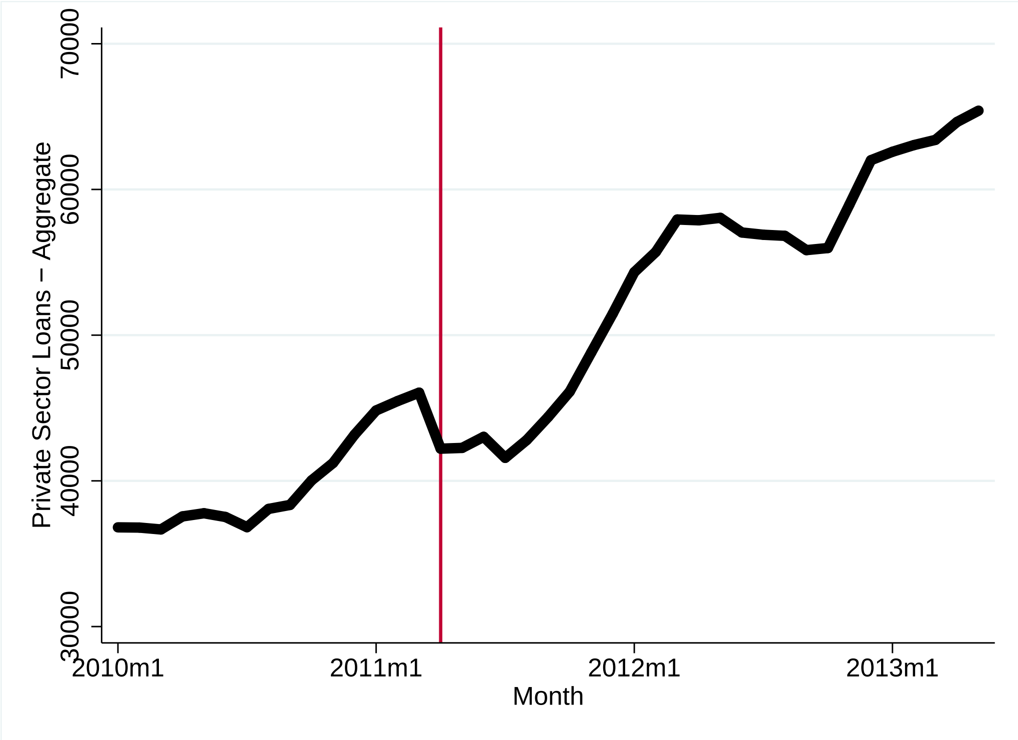
Financial development promotes poverty-reduction and investment: plenty of evidence and associated mechanisms support this claim (e.g., Beck, Levine and Loayza 2000; Burgess and Pande 2005; Demirgüç-Kunt, 2004; Kaboski and Townsend 2005, 2011, 2012; Levine 2005; Karlan and Zinman 2010; etc.). However, there remains an unanswered key question: *how* to promote financial systems in low-income countries and, in particular, financial inclusion via branch installation . In this paper, we argue that: 1) financial development is a story of banking; 2) a moderate degree of financial regulation can promote financial development and branch expansion in the context of underdevelopment. The first point is descriptive: banks manage around 90% of assets in most low- and middle-income countries, and hence understanding the determinants of banks' outreach is key.[1] Furthermore, banks play a central role in financial development for at least three reasons beyond the classical intermediation activities: 1) to invest in reaching new customers, providing a public good ("the formal economy"); 2) to introduce alternative payment systems, facilitating within-country trade; 3) to manage liquidity risk, contributing to shape macroeconomic volatility.

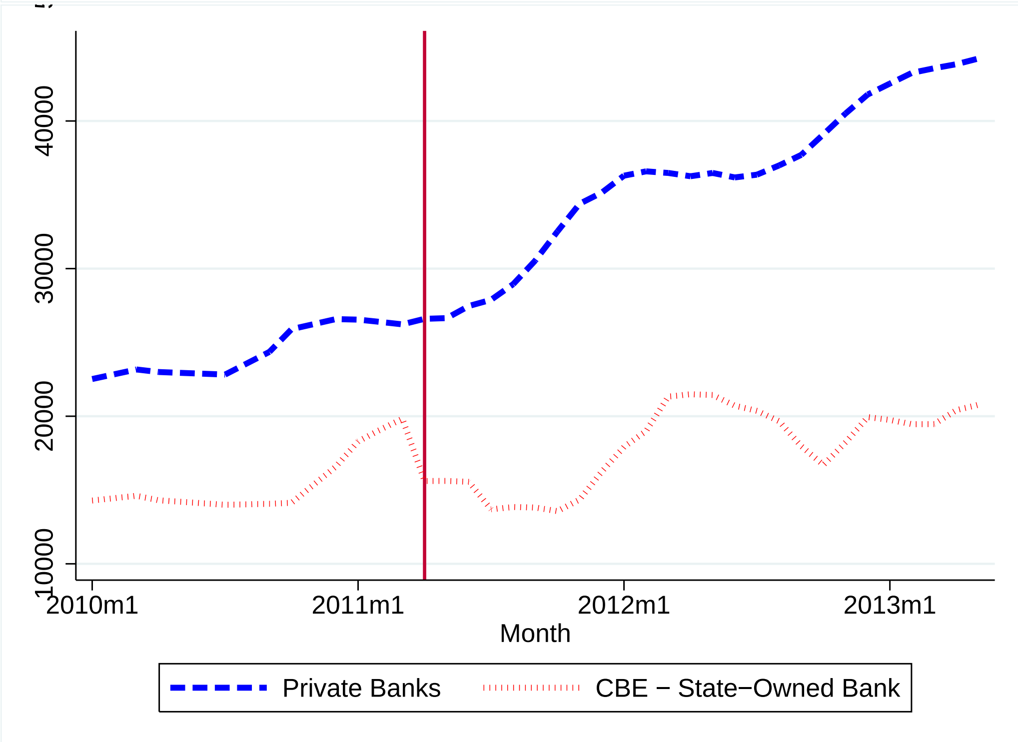
Our second, and most important, contribution links a moderate degree of regulation to the promotion of financial development and branch expansion in a context of underdevelopment. We introduce a regulation puzzle: can financial regulation, as a mandatory safe asset purchase, promote lending? Figure 1 shows the monthly volume of private sector lending by all Ethiopian banks between January 2010 and June 2013. In April 2011 (vertical line), the National Bank of Ethiopia (NBE) introduced a directive forcing all private banks to purchase 0.27 negative-yield government bonds for every birr (Ethiopian currency) of private sector lending. The upper panel shows no slowdown after this measure, while the lower panel distinguishes between private banks (affected by the policy, blue) and the state-owned bank (not affected, red). Not only does lending not decline, but there also seems to be some increase in loan volume. In the empirical section of the paper (Section 2), we give evidence of such increase in lending and other bank variables using a more rigorous identification strategy.

In the theoretical section (Section 1), we explain this phenomenon by employing a microeconomic model of banking and introducing a coordination failure. Our core intuition follows: financial regulation can stimulate bank operations, and hence profits and loans, if the deposit increase, led by improved confidence in the financial system, exceeds the decline in the profit margin of the bank. Depositors are aware that the bank finds safe assets unattractive, because these lower profits, and for this reason they expect the bank to default in bad states, transferring all losses to them through limited liability. This results in a low optimal deposit level, accounting for the probability of bank

[1] The International Monetary Fund (IMF) produces a periodic document titled *Financial System Stability Assessment* for all of its member countries, within which, for this purpose, a table "Financial System Structure" provides valuable statistical information. We summarize this finding for a few countries, as follows: in 2002, Bangladesh had 91.3% of its financial assets managed by banks, while the securities market managed 4.6%, finance companies 1.4%, and microfinance companies 2.7% (IMF 2010); Brazil had 96.2% of its financial assets managed by banks and asset managers (generally owned by banks), 0.5% by other financial institutions, and 3.6% by insurance companies (IMF 2012); in China, banks have been managing between 84% and 88% of financial assets between 2007 and 2010 (IMF 2011).

Figure 1: A Financial Regulation Puzzle





Note: This figure reports the evolution of monthly real private lending given by all Ethiopian banks between January 2010 and June 2013 in real million birr. The red vertical line shows the introduction of a financial regulation policy, which forces banks to buy a negative yield government bond for every unit of private lending. The lower panel distinguishes between private banks (in blue), which are affected by the policy, and the Commercial Bank of Ethiopia (CBE; in red), which is not affected by the policy.

default. However, if the government imposes a minimum level of safe asset holding, which has a deterministic return, this moderates both bank profits in the good state and losses in the bad state: it increases depositor repayment and stimulates more deposits. As a consequence, we show that bank profits can rise if deposit growth exceeds the decline in the intermediation margin and loan provision. In such a case, branch installation (financial development) also rises, as higher profitability leads to more branch opening and provision of additional loans. In our model, financial regulation is valuable because of the timing assumption: banks are unable to convince depositors of their safe asset investment because of profit maximization and hence the government needs to create a commitment in holding safe assets.[2] This might be oversimplistic, but could represent, in a reduced form, the inability of depositors to actively monitor the financial system, and regulation could be interpreted as a public good lowering monitoring costs.

While there exists substantial evidence on the beneficial effects of regulation on welfare (e.g., Laffont and Tirole 1993; Glaeser and Shleifer 2001), we are the first to show empirically that financial regulation can promote financial development and that enhanced bank safety is the channel through which this takes place. Such policies have been implemented in several countries over the past century.[3] However, this issue has been difficult to study for a variety of reasons. To begin with, data availability on the banking industry in low-income countries is a severe limit: with the exception of a few, yet incomplete, sources (i.e., the Bankscope database[4]), most banks are reluctant to publish any documentation that goes beyond the mere legal obligations. However, even when sources are available, they are – unsurprisingly – of low quality, generally incomplete, and only focused on a few key financial variables, with limited details on branching and geographical outreach. In addition to this, the power of the test is generally a sizable problem: most regulation policies are announced quarters/years before the implementation and only gradually brought into operations. This makes it hard to track any behavioral change or, in any case, changes with enough statistical power to study

[2]These results are generally consistent with the work of Gennaioli, Martin, and Rossi (2014), which points to a liquidity benefit of holding public bonds (Holmstrom and Tirole 1998) and hints at the concept of efficient regulation (Shleifer 2010). Recently, Begenau (2015) has presented a model with a similar intuition, showing that capital requirements can generate a lending expansion, by affecting bank debt quantity and price. In a dynamic general equilibrium model, she shows that regulation lowers the supply of bank debt, but the debt price may decline further because of households' preferences for safe assets, thus lowering the bank funding costs and hence boosting aggregate lending. The endpoint is not dissimilar from ours, with the difference that we focus on an alternative liability (deposits) and consider changes over quantities rather than their prices. Also Eden (2016) highlights the plausible optimality of an intermediation tax, though relating this to a different argument on firms purchases and excessive financing costs.

[3]The regulation of the financial sector, especially concerning the mandatory purchase of safe assets, has a long tradition. A detailed OECD report (Edey and Hviding 1995) documents the historical use of compulsory holdings of government securities across OECD countries, which was especially "important in Italy, Sweden, Norway, Australia, Belgium, Spain, Turkey and Greece". Also, New Zealand implemented a similar policy in 1973, called the reserve asset ratio, which included a wide range of compulsory requirements to hold specified levels of public sector securities and other financial assets imposed on trading banks, trustee and private savings banks, building societies, private superannuation funds, life insurance companies, and finance companies (Reserve Bank of New Zealand 1985). Also, emerging economies have been adopting similar financial sector policies. For example, Indian banks, life insurance, and pension funds are required to hold a minimum of 25% of their time deposit liabilities in government securities – the Statutory Liquidity Requirement (SLR; Wells and Schou-Zibell 2008). Also, in the mid-1990s Barbados implemented analogous policies, forcing local commercial banks to hold two-thirds of the short-term assets in government securities and over 40% of the market in longer-term securities (Williams 1995).

[4]See http://www.bvdinfo.com/en-gb/our-products/company-information/international-products/bankscope.

depositors' reactions. Finally, as our model shows, safe asset regulation has a stronger effect on depositors in riskier/infant financial systems, with few countries presenting the simultaneous strong variation in the size of regulation combined with an underdeveloped banking industry.

For this reason, we investigate the following two case studies that uniquely address the previous concerns, as they present some of the lowest levels of financial penetration, combined with policy changes that caused substantial balance sheet reallocations toward safe asset.

1. Ethiopia (2011). In mid-March 2011, the NBE announced a policy change in financial regulation forcing all private banks to start purchasing 0.27 government bonds for every unit of private sector lending by April 2011.

2. Antebellum USA (1800–1861). Between 1800 and 1850, several states non-simultaneously introduced taxes (on capital or profits) on local banks in response to a loss of seigniorage revenue.

In both case studies, the identification of the policy effects are achieved by combining the time-series shocks (one policy event in Ethiopia, and a tax "phase out" across US states) with cross-sectional variation in bank sizes (big versus small banks), because heterogeneous effect of the treatment is prescribed by the theoretical model.

In order to address the data limitations previously mentioned for the Ethiopian case study, we have constructed a variety of unique databases through which we can track the whole financial system. Through confidential contacts with the NBE, we had access to the regulation documents and could interview senior executives for all private sector banks, which provided substantial insights on how this regulation affected their business. Regarding the available datasets, we track three key indicators of bank behavior: bank balance sheets with monthly frequency; a new map covering over 90% of bank branches opened in Ethiopia between 2000 and 2015; and digitization of all annual reports in the five years around the policy change. First, we obtained access to confidential data on the monthly composition of bank balance sheets, collected and confidentially released by the NBE, which allows us to explore the effect of the policy on the key modeling variables (safe assets, deposits, loans). The high frequency of the data permits us to track tightly the policy change, which has large and clear effects, as the empirical section shows. Secondly, because we are especially interested in financial development in terms of branch expansion, we have constructed a branch map for Ethiopia for the years 2000–2015, in which we were able to observe more than 90% of all bank branches and to find their date of opening (month and year), their city and region, telephone numbers and other information. This permits us to verify what happens to the long-term trend in branch expansion and to the numbers of new towns connected by a branch, both of which show significant increases after the policy introduction. Finally, in order to test the effects on profits and other yearly variables (number of employees), we have collected annual report data for all bank between 2008 and 2013. Though the power of this test is low because the number of observations is limited, we find that profits do not seem to decline and the number of employees expands, as expected.

For the Antebellum USA case study, we developed a dataset in which we follow a repeated cross-section of more than 1,200 banks for 60 years. Several historical sources were used for this purpose, particularly the data collection work on the bank balance sheets of Warren E. Weber at the Federal Reserve Bank of Minneapolis (Rolnick and Weber 1983; Weber 2003, 2006), which were complemented with additional data on tax introduction years and policy characteristics. In this case, while we can follow the balance sheet composition and profitability, there is no information on branching. However, this is only partially a problem, because branch-opening may only be one instrument through which financial development occurs, and as long as we register an increase in deposits, which is observed, this points to the mechanism presented in this model.

We contribute to three established bodies of literature, building a simplified model of banking (Freixas and Rochet 1997) with reduced-form maturity mismatch (Diamond and Dybvig 1983) and bank liquidity choice (Allen and Gale 2000). First, this paper contributes to the literature on financial inclusion, showing that policies that promote safe assets can drive branch expansion. From a theoretical perspective, Townsend and Zhorin (2014) present an innovative framework to evaluate the trade-offs that banks face in branch installation in emerging market countries, with a special focus on geography and industrial organization. A series of applied papers have highlighted the political and economic reasons for branch expansion (Assuncao, Mityakov, and Townsend 2012; Keniston et al. 2012) and its effects on poverty, firm growth, and competition (Beck, Demirguc-Kunt, and Maksimovic 2004, 2005; Burgess and Pande 2005; Burgess, Pande, and Wong 2005). Second, we join the literature on the incentive perspective of banking regulation. Besley and Ghatak (2013), Dewatripont and Tirole (2012), and Fahri and Tirole (2012) all discuss financial regulation and/or special bank taxation as a device to counterbalance implicit bailouts, to achieve optimal managerial discipline, and to balance large-scale maturity mismatch. These conclusions are in line with the work of Kashyap, Rajan, and Stein (2008), who propose the replacement of capital requirements with a mandatory holding of government bonds. On an analogous line, Calomiris and Gorton (1991), Calomiris (1999), and Calomiris and Mason (2003) highlight the trade-off between the public finance costs of safety nets and the gains from panic elimination. Although we do not introduce a formal macroeconomic model, we also offer an argument to reconcile the radically partitioned literature on the relation between financial regulation and the macroeconomy. Roubini and Sala-i-Martin (1992, 1995), Pagano (1993), and King and Levine (1993) support a limited regulation of financial intermediation, because this would lower equilibrium growth through a lower saving rate, fewer resources for investment, less risk diversification, and screening of entrepreneurs. On a critical stance, after a cross-country empirical assessment, Dornbusch and Reynoso (1989) argue that "the beneficial effects of removing financial regulation remains open to challenge". While, on the entire opposite side of the spectrum, Stiglitz (1994) defends financial regulation as a growth-enhancing force, because by artificially lowering interest rates, it improves borrowers' incentives, reinforces firms' equities, and creates capital scarcity. In our work, we find that both views can be right and indeed financial regulation can be either welfare-enhancing or detrimental, depending on the magnitude through which it is implemented.

In Section 1, we present the essential theoretical framework, describing first the economic environment and then investigating the bank decision problem. In Section 2, we discuss empirical evidence from the policy change in Ethiopia and a variety of robustness checks. In Section 3, we adapt the theoretical and empirical framework to the Antebellum USA study and investigate the state-level bank-tax rollover. In Section 4, we present some concluding remarks.

1 Theory

1.1 Economic Environment

The economy comprises a continuum of locations on the unit line, and each point is populated by a household engaging in a saving decision. The bank decides how many branches to open, $\beta \in [0, 1]$, which is costly but allows it to reach a new locus and to interact with agents. If $\beta = 1$, then all locations are reached, while with $\beta = 0$, no branches are opened. Once a branch is installed, the bank interacts with a depositor, who chooses how much to deposit, $d \geq 0$, given a remuneration $R_D \geq 1$. These liabilities are collected and allocated in two assets: a share in risky loans, $l \in [0, 1]$, and the remainder in an inter-bank safe asset, $s = 1 - l$. There exist two states $\sigma \in \{G, B\}$: in the good state, $\sigma = G$, which occurs with probability $p \in (\underline{p}, 1)$, the bank earns on risky loans a gross rate $R_G > 1$, while in the bad state, $\sigma = B$, which occurs with probability $1 - p$, the bank earns $R_B \in [0, 1)$. In contrast, the return on the safe asset is positive, deterministic, higher than the deposit rate, and lower than the expected loan return, $R_S \in [R_D, pR_G + (1-p)R_B]$. Prices are given and therefore if G occurs, the bank earns R_S on safe assets, R_G on the remainder, and pays R_D to depositors. Given the assumptions on the rates, the good state is always profitable and the bank always repays. However, if B occurs, given safe asset choice s and limited liability, the bank pays

$$R_{DB} = \min\{R_D, sR_S + (1-s)R_B\}$$

the minimum between the deposit rate $R_D \geq 1$ and the return on the liquidated assets, composed by the sum of the gross return on safe assets, sR_S, and the return on the risky assets, $(1-s)R_B$.

This economy presents the following four stages:

1. the bank invests in financial development, deciding on the number of branches, β;
2. households reached by a branch decide how much to deposit, d;
3. the bank decides on the amount of safe assets, s;
4. the state σ is realized, the bank receives loan reimbursement, repays deposits, and collects profits, and the household consumes the repaid deposits.

The timing of the game clarifies a key intuition for the role of financial regulation: given the structure of returns, the bank is not keen to hold any safe assets. Limited liability allows it to keep the profits in the good state G, and to liquidate depositors with all that is collected in the bad state B. Depositors anticipate this and, given the constant rates, limit their deposits in the banking system. If the bank could commit to hold an amount of safe assets always securing R_D, then deposits would be higher, and profits as well. However, in a single shot game, such commitment is not credible and we delegate to regulation to solve this problem by imposing the amount of safe assets. Throughout this model, we shall switch off the possibility that prices change in response to agents' decisions: this can be interpreted as a price-taking assumption or introduced in order to be in line with the case studies we present in Section 2, in which prices are not the mechanism through which the policy affects the economy.

The game can be solved by backward induction. In terms of notation, capital letters refer to aggregate quantities at bank level, while lower-case letters refer to branch-specific quantities: l is the loan given in each branch and $L = \beta l$ is the aggregate number of loans given by the bank (analogously $S = \beta s$ and $D = \beta d$).

1.2 Bank and Safe Asset

The profits of the bank are composed by an intermediation margin, $\pi(s)$, which emerges as the difference between payments on liabilities and income on assets, times the extensive margin given by the number of branches, β, and the intensive component being the amount of collected deposits in each branch, d.

At the last stage of the game, given that the extensive and intensive margins β and d are fixed, the bank can only affect profits by changing the intermediation margin and choosing the share of safe assets to hold. The intermediation margin can be described by

$$\pi(s) = p[sR_S + (1-s)R_G - R_D] + (1-p)[sR_S + (1-s)R_B - R_{DB}].$$

In the good state, which happens with probability p, the bank earns returns R_S on the share of safe assets s, R_G on the remainder $1-s$, and pays the deposit rate R_D; in the bad state, it earns R_B and pays a deposit rate R_{DB}. In the good state, bank profits are always positive and therefore the market deposit rate, R_D, is always repaid. However, in the bad state, this is not necessarily the case and the bank may default. Because of limited liability, the corresponding deposit rate can be described through the previously introduced $R_{DB} = \min\{R_D, sR_S + (1-s)R_B\}$. Therefore, if the bank collects enough profits in the bad state, it repays depositors with the market rate R_D and keeps the positive profits $sR_S + (1-s)R_B - R_D > 0$; however, in the opposite case, the bank passes its losses on to depositors and repays them with all the recovered assets, $R_{DB} = sR_S + (1-s)R_B$. Define $\widetilde{s}$ as the safe asset level such that the bank is indifferent between repaying the market deposit rate, R_D, and liquidating its assets, $\widetilde{s} = (R_D - R_B)/(R_S - R_B)$, as $R_S > R_D > R_B$, which bounds $\widetilde{s} \in (0,1)$. As a consequence, the following holds true:

$$R_{DB} = \begin{cases} R_D & \text{if } s \geq \widetilde{s}; \\ sR_S + (1-s)R_B & \text{if } s < \widetilde{s}. \end{cases}$$

The deposit rate in the bad state, R_{DB}, equals the market deposit rate, R_D, if the safe asset share exceeds the strictly positive threshold, $s \geq \widetilde{s}$; otherwise, it is given by the liquidated assets.

Safe Asset Regulation. In the absence of regulation, the bank simply maximizes the intermediation margin with respect to the share of safe assets s, in the absence of any constraint

$$\max_{s} \pi(s) = p[sR_S + (1-s)R_H - R_D] + (1-p)[sR_S + (1-s)R_B - R_{DB}],$$

which leads to a trivial solution of $s = 0$, given that $p \in (\underline{p}, 1)$ with $\underline{p} = (R_S - R_B)/(R_G - R_B)$, and passes all losses on to depositors in the bad state, $R_{DB} = R_B$. The timing of the game makes this intuition trivial, because in the last stage, depositors cannot punish the bank for this decision. The regulation we study forces the bank to hold a level of safe assets $\rho > 0$, which adds to the previous problem the binding constraint $s^R = \rho$. Because the unregulated safe assets equal zero, the regulation raises the deposit rate in the bad state (from $R_{DB} = R_B$ to $R_{DB} = \rho R_S + (1-\rho)R_B \; if \; \rho < \widetilde{s}$ or $R_{DB} = R_D \; if \; \rho \geq \widetilde{s}$).

In the absence of a repeated game setting or other externalities, the bank has no private incentives to keep any safe asset, and it is trivial to show that the intermediation margin in presence of the regulation is unambiguously lower than otherwise. Therefore, the post-regulation margin is defined as $\pi(\rho)$, decreasing in the financial regulation parameter ρ.

1.3 Depositor Problem

In each branched location, given β, a representative household faces a two-period problem, by deciding on consumption in period 1 (i.e., the present) and in period 2 (i.e., the future), given a vector of prices $\{R_D, R_B, R_S\}$, states $\sigma \in \{G, B\}$ with probabilities p and $1-p$ and the choice of the bank's safe assets s. The household is endowed with income y only in the first period and faces financial market imperfections, which do not allow state-contingent transfers. Hence, consumption in period 2 is dependent on the state, which may be good G, with savings being remunerated R_D, or bad B, with remuneration $R_{DB}(\rho)$. The solution is a vector $\{c_1, c_{2G}, c_{2B}\}$, where each subscript number refers to the period, and G and B refer to the states of the future; such a consumption vector fully describes the deposit behavior d. We are implicitly assuming that when branched, a household always uses the banking system to deposit its savings, and several arguments in this respect have been raised in the literature. In the following problem, we adopt an additive and separable CRRA utility function:

$$\begin{aligned}
\max_{c_1, c_{2G}, c_{2B}} \quad & c_1^{\alpha} + \delta[pc_{2G}^{\alpha} + (1-p)c_{2B}^{\alpha}] \\
\text{s.t.} \quad & c_1 + \frac{c_{2G}}{R_D} = y \\
& c_1 + \frac{c_{2B}}{R_{DB}(\rho)} = y.
\end{aligned}$$

Here, $\delta \in (0,1)$ indicates the discount rate, $\alpha \in (0,1)$ indicates the relative risk aversion parameter, and p is the probability of the good state, while the state-dependent budget constraints are standard except that in the good state the discount rate is R_D and in the bad state it is $R_{DB}(\rho)$. The following saving/deposit function in locations reached by branches β emerges,

$$d(\rho) = y - c_1 = \frac{\delta^{1/(1-\alpha)}[pR_D^\alpha + (1-p)R_{DB}(\rho)^\alpha]^{1/(1-\alpha)}}{1+\delta^{1/(1-\alpha)}[pR_D^\alpha + (1-p)R_{DB}(\rho)^\alpha]^{1/(1-\alpha)}}y,$$

which is always positive and increasing in $R_{DB}(\rho)$, and hence in ρ.[5]

1.4 Financial Development and Regulation

In the first period, the bank decides how many branches to install, given the intermediation margin in each location $\pi(\rho)$ (which depends negatively on the regulation parameter ρ), the deposit level $d(\rho)$ (which depends positively on ρ), and some convex cost of branch opening $c(\beta)$. Its convexity can be justified by the fact that branch coordination costs can be larger the further a branch is from the headquarters (the locus in zero).

This financial development problem can be written as

$$\max_{\beta \geq 0} \Pi = \pi(\rho)d(\rho)\beta - \eta\frac{\beta^2}{2},$$

note that in this setting we introduce a new parameter η: this is a branch-opening technology parameter affecting both the average and marginal cost of branch opening. As clear from the solution of the branch-maximization exercises, this technological parameter maps into the overall size of a bank, in terms of installed branches. In fact, given that the marginal branch profitability is $\pi(\rho)d(\rho)$, then this leads to the solution $\beta = [\pi(\rho)d(\rho)]/\eta$, with the overall profits being $\Pi = [\pi(\rho)d(\rho)]^2/2\eta$, loan volume $L = [\pi(\rho)/\eta]d(\rho)(1-\rho)$, safe asset holdings $S = [\pi(\rho)/\eta]d(\rho)\rho$ and deposits $D = [\pi(\rho)/\eta]d(\rho)$. As a result is can be noted that a bank with a higher η parameter installs less branches, hence collects less deposits and gives less loans. From this point onward we refer to η as a technology-induced parameter of bank size.

Financial Regulation as Safe Asset Purchase. What happens to loan volume and branch installation when a positive shock to ρ occurs? Can such financial regulation policy promote loan volumes and branch expansion? The financial regulation parameter, ρ, imposes a mandatory share of safe assets s, given that $s^R = \rho$. It is clear that loan volume can increase in the financial regulation parameter, if and only if

$$\frac{\partial L}{\partial \rho} > 0 \rightarrow \epsilon_{d\rho} > \epsilon_{\pi\rho} + \epsilon_{l\rho}$$

the elasticity of deposit mobilization exceeds the sum of the elasticity of the intermediation margin and loan share with respect to the regulation parameter ρ. As shown in Appendix B, the previous

[5]The full solution to the problem can be found in Appendix A.

expression simplifies to the following

$$\frac{\alpha}{1-\alpha} y A(\rho) > \frac{\rho}{1-\rho} + \frac{1}{1-\rho[(R_G - R_S)/(R_G - R_D)]}$$

with the expression on the left-hand side embedding the deposit component, with $A(\rho)$ decreasing in ρ because of concavity; in contrast, the right-hand side reports the profit component and is increasing in ρ. For given parameter values, it is possible to show that loan volume responds to the regulation parameter with the following effect,

$$\frac{\partial L}{\partial \rho} = \begin{cases} \geq 0 & \rho \leq \widetilde{\rho}, \\ < 0 & \rho > \widetilde{\rho}; \end{cases}$$

it increases if safe asset regulation does not exceed a threshold $\widetilde{\rho} = \widetilde{\rho}(p)$ and decreases if it does. Such threshold is increasing in the probability of bad state, $1-p$. This result is intuitive: the deposit response to the regulation is higher, the safer the financial system becomes because of the regulation. Hence, it follows that a risky financial system (with a high $1-p$) experiences a stronger deposit response to regulation. This result is key to our empirical analysis and is the driver of the effects highlighted in Section 2. Note that given the definition of L and β, conditions for an increase in loans are sufficient for an increase in branches.[6]

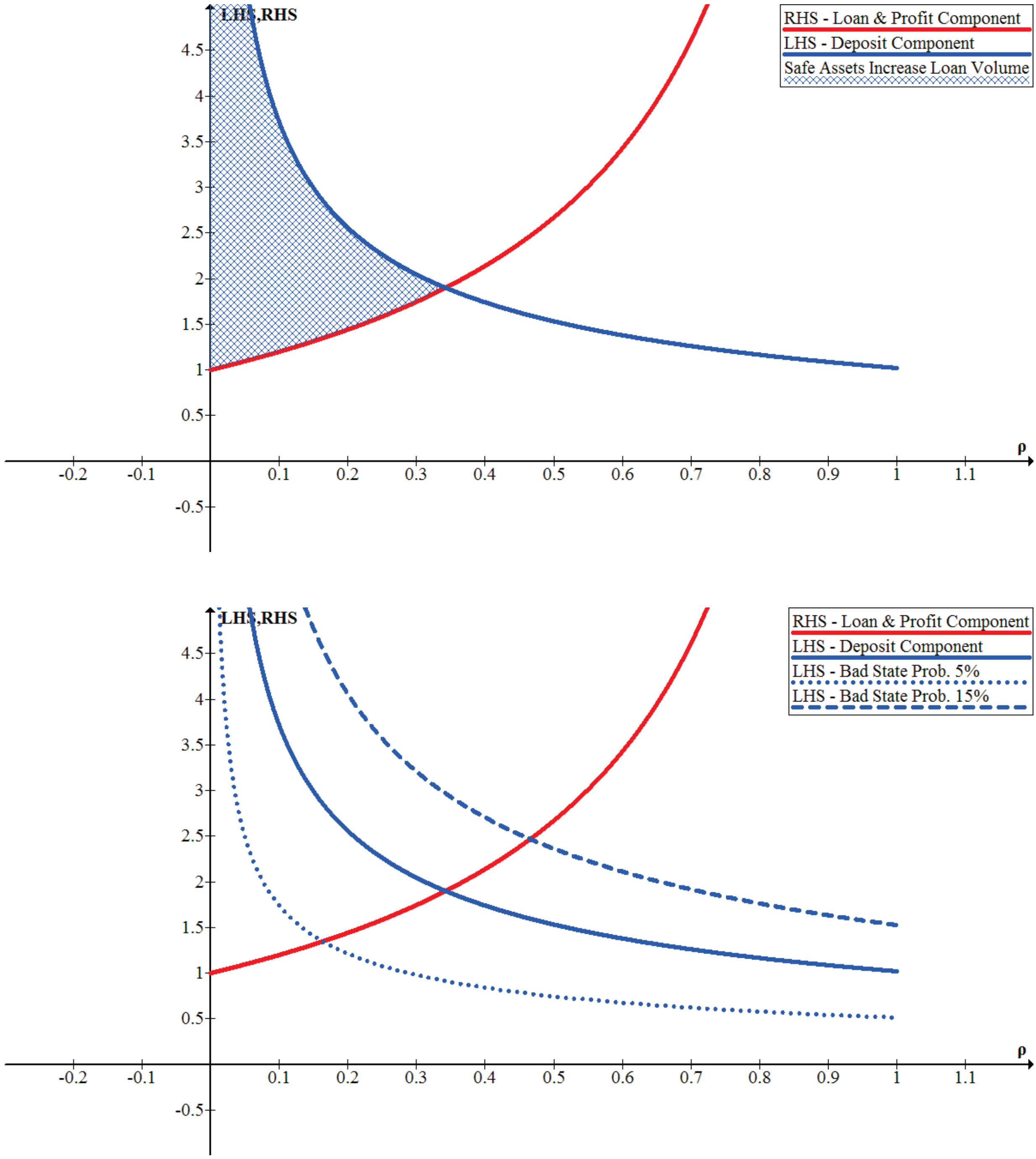
The upper panel of Figure 2 shows the right- and left-hand side expressions, with the shaded area indicating the region in which higher financial regulation promotes lending. In the lower panel, we show that such a region increases in the probability of a bad state. In the main scenario, we set $1-p$ to be 10% (solid line), which implies a threshold of $\widetilde{\rho} \simeq 0.33$. In the scenario in which this probability is brought to 15%, such a threshold correspondingly increases to $\widetilde{\rho} \simeq 0.5$, while if such a probability is reduced to 5%, the threshold follows to $\widetilde{\rho} \simeq 0.18$. In Appendix C, we report additional comparative statics with respect to both the probability of a bad state and other model parameters; however, this essential comparative statics on p shows how important the riskiness of the financial sector is for detecting a statistically significant effect.

These results can be summed up in the following proposition.

Proposition 1 *There exists a threshold in the mandatory share of safe assets, $\widetilde{\rho}(p)$, such that in the presence of unbranched locations, $\beta < 1$, $\forall \rho \leq \widetilde{\rho}(p)$ the total loan volume $L = \beta d(1-s)$, the number of branches β, deposits per branch d, total deposits $D = \beta d$, and safe assets S increase in the financial regulation parameter ρ. Such a threshold is increasing in the probability of a bad state, and hence decreasing in p.*

[6] It is also important to highlight that in the case that the financial system already presents a level of safe assets higher than or equal to $\widetilde{s}$, which guarantees depositor repayment in any state, then imposing $\rho > \widetilde{s}$ leads to the opposite effect, as deposits do not increase given that there is no repayment increase, but the intermediation margin declines and this leads to lower profits, loans, and number of branches.

Figure 2: Loan Volume Increases in Safe Assets



Note: This figure plots the conditions under which loan volume increases in the regulated share of safe assets. The x-axis reports the values of the safe asset share parameter ρ, and the y-axis reports the values of the right- and left-hand side variables. As is clear from the inequality, the left-hand side is decreasing in the parameter (reported in blue), while the right-hand side is increasing (in red). This figure assumes that the bank rates are in line with the model and calibrated with the Ethiopian economy, as from NBE (2011), and that the other parameters are in line with the literature: $R_G = 5/4$; $R_S = 21/20$; $R_B = 0$; $R_D = 1$; $\delta = 0.9$, $\alpha = 1/2$; $p = 0.9$; $y = 20$. The shaded area reports the regions in which the regulation determines an increase in loan volume. The upper panel reports the main picture with $p = 0.9$. The lower panel reports three cases: $p = 0.9$ (solid line), $p = 0.85$ (dashed line), and $p = 0.95$ (dotted line).

1.5 From Theory to Empirics

In the absence of an experimental setting for the application of this policy, we rely on a key modeling feature to identify the effect of financial regulation. Recalling the first-order condition $\beta = (\Pi/\eta)d$, both the equilibrium number of branches β and the response to the regulation policy $\partial\beta/\partial\rho > 0$ depend on the technology-induced parameter of bank size (i.e., η). This is a sufficient statistic for bank size, because it characterizes both a level effect (i.e., the number of branches before the policy) and an impact effect (i.e., the response to the policy), and we carefully combine this cross-sectional analysis to the time-series analysis. Proposition 2 updates Proposition 1 and guides it to the data.

Proposition 2 *The parameter of bank size η, measuring the technological endowment of the bank in terms of branch cost, affects negatively the optimal number of branches and the branch-installation response of the bank to financial regulation. If a set of banks is endowed with η_H and another set with η_L, with $\eta_H > \eta_L$, then the banks exhibiting η_L: 1) install more branches than the bank with η_H, $\beta(\eta_L)^* > \beta(\eta_H)^*$); 2) respond to the financial regulation policy by opening more branches than the bank with η_H, $\partial\beta(\eta_L)^*/\partial\rho > \partial\beta(\eta_H)^*/\partial\rho$).*

Therefore, all the predictions of Proposition 1 are differentially stronger for more efficient banks. This result is intuitive and is clarified in Figure 3. The more efficient bank makes more profits in every branch, because it has lower branch installation costs, and therefore it opens more branches because more are profitable (level effect), $\beta(\eta_L) > \beta(\eta_H)$. This prediction stays true also after the policy shock: both banks want to open more branches, but the more efficient bank opens more because it makes more profits in each single branch,

$$\frac{\partial\beta^*(\eta_L)}{\partial\rho} > \frac{\partial\beta^*(\eta_H)}{\partial\rho}.$$

The results of Proposition 2 can be described through the encompassing empirical model

$$v_{it} = \iota_i + \iota_t + b \cdot \eta_i \cdot \rho_t + \epsilon_{it}$$

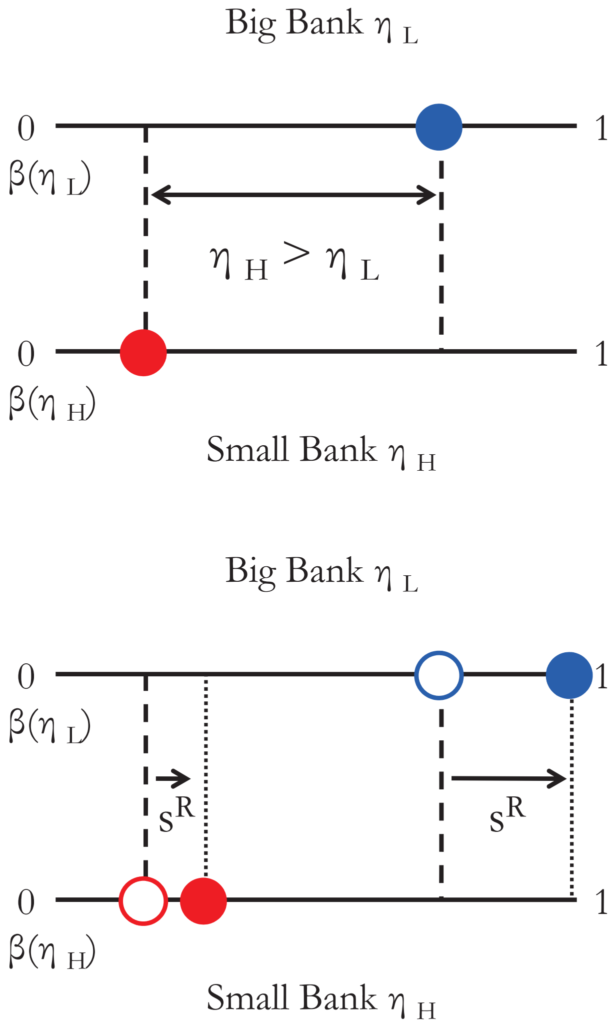
in which the variable of interest v_{it} for bank i at time t (ie., branches, deposits, loans...) is regressed over a bank and time fixed effects, ι_i and ι_t, and an interaction between the technological bank-specific parameter, η_i, and the regulation parameter, ρ_t. Proposition 2 predicts that such interaction is negative, because banks with a higher branch cost parameter grow less after the policy.

Such model can be further generalized to test for the presence of parallel trends before the policy, leading to

$$v_{it} = \iota_i + \iota_t + \sum_t c_t \cdot \eta_i \cdot \iota_t + u_{it}, \tag{1}$$

in which the variable of interest v_{it} for bank i at time t is regressed over bank and time fixed effects, ι_i and ι_t, and an interaction of time fixed effects with the bank-specific technological endowment for every period t, $\eta_i \cdot \iota_t$. Equation (1) is the empirical model that we extensively use in this paper. A particularly attractive feature is given by the interaction, c_t, which allows us to test whether banks with different technological endowments are on parallel trends before the policy, by verifying that c_t are not statistically different from zero $\forall t < \widetilde{t}$, with $\widetilde{t}$ representing the time period in which the financial regulation change takes place.

Figure 3: Heterogeneity and Identification



Note: This figure graphically depicts the identification in this empirical exercise. In the upper panel, we present the two banks assumed to be lying on two separate unit lines. One is bigger in equilibrium because it enjoys a low branch cost parameter η_L (i.e., Big Bank); the other is smaller because it enjoys a high parameter η_H (i.e., Small Bank). Here, there is a level effect in their respective branch number β, caused by the cost parameter. In the lower panel, our identification becomes clear: the time-series shock s occurs at the same time for all banks, but because of the cost parameter η it affects the Big Bank differentially more.

2 Empirics

In this section, we present empirical evidence on episodes of financial regulation, as shocks to the financial regulation parameter $s^R = \rho$. It is central to highlight that financial regulation is both an instrument of monetary and fiscal policy (i.e., it is a macro-prudential device, because it forces banks to purchase some safe assets – government bonds – for every unit of risky asset – private loan) and, at the same time, it is a special tax on banks, as it lowers the return on lending, by taxing a high-yield asset (private loan). We exploit this interchangeability and study two different contexts, as follows.

1. Ethiopia (2010–2013). In April 2011, the NBE announced the establishment of a new bond market (NBE Bill), forcing banks to purchase 0.27 birr of this bond for every birr of private lending. This can be mapped in a neat increase s.

2. Antebellum USA (1800–1861). Following the establishment of the federal government, American states lost significant revenue from seigniorage and counterbalanced this by imposing significant taxes on banks' capital or profits (Sylla, Legler, and Wallis, 1987). In section 3 we propose a slightly different theoretical framework, highlighting how these state-specific taxes mapped into an increase in s.

In both of these cases there occur the imposition of safe assets for banks: in Ethiopia this occurs directly, by mandating their purchase; in Antebellum USA, a change in the relative price of safe-to-risky assets lead to an observationally equivalent result, as highlighted in Section 3. In both contexts, our theoretical model predicts a strong positive effect of financial regulation on deposits and financial development, because both occur in underdeveloped and risky financial systems. Thus, as Figure 2 shows, these represent the experiment ideal in which the gains from regulation can be sizable (a low p parameter).

These sources of variation in s are useful in identifying the effect of financial regulation on bank behavior, and validate the results of Propositions 1 and 2. Their identification emerges from the following.

- Bank size heterogeneity in Ethiopia. The Ethiopian private banking sector seems to be traditionally divided between six very large banks and eight much smaller banks. This cross-sectional heterogeneity captured through η is combined with the time-series shock to s^R to test our model.

- Time heterogeneity in bank tax adoption and bank size across US states. This policy is not simultaneously adopted by all states, with some states being early movers (Massachusetts and Maine in 1812) and others at late stage (New York and Connecticut in 1839 and 1850). We combine the size of the bank with the policy introduction at state level.

In both cases, we exploit time-series variation, exploiting monthly data for the case of Ethiopia and yearly data for the USA, combining this with the use of a difference-in-difference analysis. The results do not seem to reject the mechanism we proposed in the previous section.

2.1 Evidence from Ethiopia

In this section, we present some empirical evidence on Ethiopia[7] and the behavior of its local private banks, exploiting the introduction of a new financial regulation measure introduced in April 2011.

[7] Ethiopia is the second-most populous country in sub-Saharan Africa with a population exceeding 90 million. It is also among the world's poorest countries: per capita income lies at \$500 (World Bank 2013), substantially lower than the regional average, yet growing steadily at more than 10% per year in the last decade. The government's role in the economy is very active, and the financial sector is not an exception. The Ethiopian banking system presents a large state-owned bank, the CBE, which accounts for 50% of the market, and 14 private commercial banks, which account for the remaining part (in 2011). This contrasts with the trend observed in sub-Saharan Africa and across

On this date, the NBE issued a directive requiring all commercial banks to hold 27% of new loan disbursements in NBE bills. Unlike many western economies, who used analogous measures to slash public debt, Ethiopia launched this regulation to promote long-term investment (IMF 2013b).

The relevant aspect of studying the so-called "27% rule" is given by the unique nature of this shock: 1) it was unexpected and was announced less than a month before implementation; 2) it caused a large mobilization in banks' assets, as shown in the next subsection.

From a theoretical point of view, this policy can be mapped as a positive shock to the $s^R = \rho$ parameter and the above conditions 1 and 2 make this ideal for our analysis.[8] It is also important to highlight that the NBE Bills are not a profitable investment, as they pay a fixed remuneration of 3% per year, lower than the minimum deposit rate, 5%, or the average lending interest, 12% (National Bank of Ethiopia 2012)[9].

In order to test the implications of Propositions 1 and 2, we collect confidential data on the monthly balance sheet of all Ethiopian private banks between 2010 and 2013, on publicly available Annual Reports data on profits between 2008 and 2013, and we build a unique city-level map of Ethiopian branches, where for every bank we know in which cities all new branches have been opened, with respective month and year between 2000 and 2015.

Propositions 1 and 2 provide two fundamental elements to test the model: a shock to s^R promotes deposit growth; and cross-sectional variation in η characterizes a differential impact to the shock. Ethiopia is an exceptional context in which to test this model because as well as a large time-series variation in s^R, we find a large cross-sectional variation in some characteristics associated with η. Figure 4 presents the total assets of the 14 Ethiopian banks on March 2011, before the policy implementation, and there emerges a natural distinction between big and small banks. Indeed, there is a large discontinuity between the sixth bank, Bank of Abyssinia (BOA), with assets close to eight

the developing world, where banking systems have much higher shares of private and foreign participation. Despite a relatively low level of financial development, the Ethiopian financial sector is stable and presents a well-capitalized banking sector, registering profitability levels well above the regional average (IMF 2013b).

[8]The theoretical model predicts a stronger effect of regulation in the presence of a low initial level of regulation (low ρ) and high riskiness of the financial system (high $1-p$). We believe that given the level of financial risk in this economy, the Ethiopian banking system meets the criterion, given the absence of any deposit insurance scheme and the simultaneous presence of a remarkable asset and liability volatility. The variation coefficients of deposits and private sector loans, which can be interpreted as an index of dispersion of such variables, stands at 14% and 18%, respectively. This indicates that roughly 15% of a bank balance sheet is withdrawn and deposited back in a year. This is extraordinarily high compared to the 2–5% recorded in the Euro Area (Deutsche Bank 2012) or the USA (PricewaterhouseCoopers 2011). This concern was expressed also by the banks themselves. Indeed, during our interviews with local bank executives, we found that this is a core problem of local banks and we found supporting evidence for our "maturity mismatch" risk assumption going through the theoretical model.

[9]Therefore this policy as well as mandating safe assets, also lowers the return on private sector lending, as banks are forced to purchase government bonds with a negative remuneration for every loan. As a consequence, this piece of financial regulation also includes a direct tax on lending. We show in Section 4 that this effect also leads to an increase in safe assets, s, by changing the relative prices of bank assets and favouring the purchase of safe assets. However in this context, the main effect comes from the mandatory purchase of NBE Bills, as reported during our extensive consultations with Ethiopian central bank executives and private bankers. At the same time, it is important to highlight that the tax element is relatively small. In fact, before the policy a unit loan would deliver a 12% return, while after it would deliver the same gross return, minus the net remuneration of this bills -2% times the amount of the purchased bills 0.27, hence $12\% - 0.27 \times 2\%$, this result in a 0.045% tax on lending returns.

billion birr, and the seventh bank, Construction and Business Bank of Ethiopia (CBB), with assets below four billion birr.

Therefore, we set the hypothesis that large banks are also endowed with lower unit cost (a better technology) than smaller banks: thus, larger banks match the η_L case and smaller banks match the η_H case. For this reason, given that the largest six banks are more than twice as large as the remaining eight, we classify these banks as "more efficient" (hence presenting a lower cost of branch opening, η_L) and we define a dummy variable "Big Bank" taking unit value for all of these. The remaining are categorized as "less efficient" (embedding the parameter η_H).[10]

Once both the time-series and cross-sectional variation is clear, we present the following tests of our proposition.

A. Main Results. In this section we verify the predictions of Proposition 1 and 2 on the following databases.

1. Balance sheet data. Using monthly data, we verify that safe asset purchases increase after the policy, that new deposits are collected in old branches, and loan volume also increases (Section 2.2.1).
2. Branch map. Using monthly data, we give evidence that branch installation increases more markedly after the policy and more cities see their first branch installed after the policy (Section 2.2.2).
3. Annual reports. Using yearly data, we show that bank profitability does not decline in absolute value and actually increases for larger banks. We also show that the number of employees grows much more after the policy, as banks start to expand further (Section 2.2.3).

B. Robustness Checks. In Section 2.3 we explore a variety of factors which might confound our estimates and verify the soundness of our results.

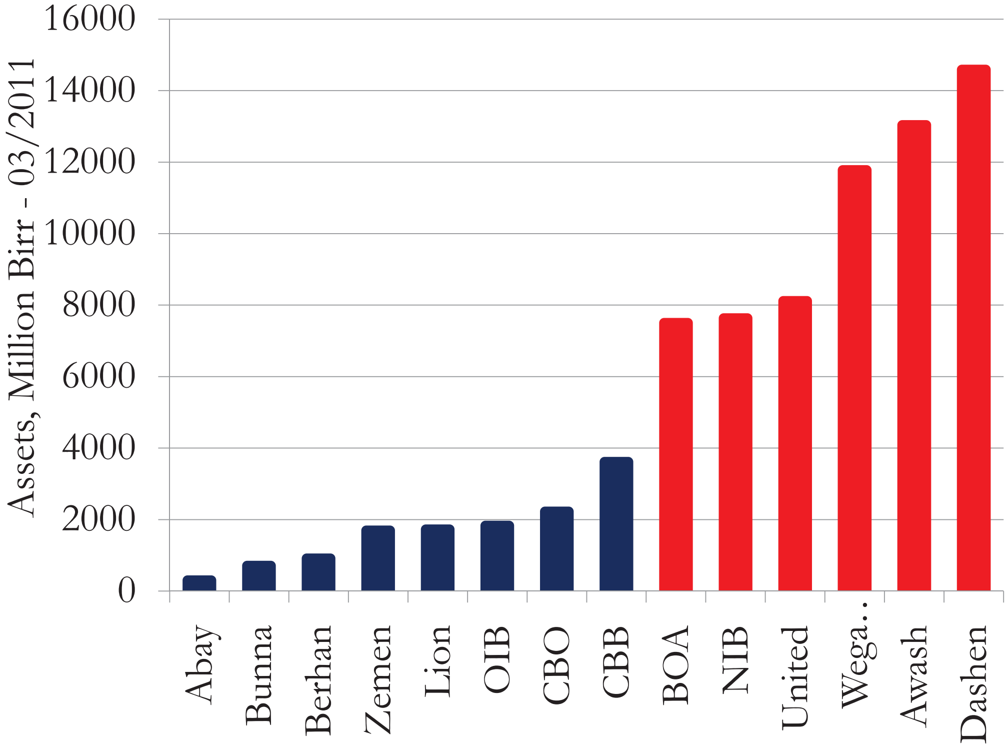
2.2 Main Results

2.2.1 Balance Sheet Evidence

The policy change creates a large exogenous variation in the aggregate s^R, and from the point of view of the theoretical model, this leads to more deposits, lending, and safe assets. Because private banks are equally affected by the policy, but respond differentially based on their parameter η, we can produce a variety of tests to study Propositions 1 and 2 empirically. The following two are performed and presented.

[10] In Appendix D, we provide a direct test of our hypothesis and show that "big banks" are not just larger, but also present 40% lower administrative costs over assets and 45% lower administrative costs over personnel. This result, though not a comprehensive test of a variation due to η, provides some evidence to support our identification.

Figure 4: Bank Assets



Note: This figure reports a bar chart reporting the total assets of all Ethiopian private banks in March 2011, one month before the introduction of the policy. There is an evident existence of a substantial discontinuity between the third largest bank, Wegagen Bank (denoted by Wega..), and the sixth largest Ethiopian bank (BOA), and also between the sixth and seventh largest banks, BOA and CBB. The six largest banks are shown in red and are those that we classify as big banks in Sections 2.1.2 and 2.1.4. In Section 2.1.3, because of limited data on the long-run branch installation, we focus within the big banks and compare Awash and Dashen as big banks with BOA, CBB, NIB, and United.

1. Within-Year Compliance. We verify that NBE bills were indeed purchased as the policy prescribes and that the policy was not applied differently between big and small banks. Appendix E reports the test and results.

2. Quarter Variation. We report the quarter evolution of the main aggregates, removing bank-specific effects and seasonal fluctuations, showing the presence of a discontinuity at the policy change introduction, differentially stronger for larger banks.

All of these tests provide empirical support for the balance sheet predictions, and offer quantitative evidence in favor of our model.

Quarterly Variation

In presenting this test, we explore all available time-series information, rather than simply presenting a pre–post estimation, as clarified in equation (1). For this reason, we verify how the average deposits, lending, NBE bills, and safe assets move during all the available quarters, and whether a differential trend is registered for big banks. The theoretical model predicts a discontinuity around the introduction of the policy, stronger for large banks, and a long-term effect following the discontinuity. For this reason we estimate the following model

$$v_{iqy} = a + \sum_{qy=1}^{13} b_{qy} \cdot d_{qy} + \sum_{qy=1}^{13} c_{qy} \cdot d_{qy} \cdot Big\ Bank_i + \iota_i + \iota_{iq} + \epsilon_{iqy}, \tag{2}$$

where the variable v_{iqy} is regressed on a dummy variable d_{qy}, which takes unit value for each quarter qy of the 13 available, an interaction of this dummy with the Big Bank dummy variable, a bank fixed effect ι_i, and a bank-quarter fixed effect ι_{iq} to account for seasonality. The coefficients c_{qy} are the core of this estimation and report the average differential evolution of the variable v_{iqy} for big banks. Note that while in equation (1) the sign of the interaction term was negative, because the theoretical model measured η, here the interactions are expected to be positive, because the big bank dummy measures the inverse of η. Such difference stays across all empirical exercises.

In Table 1, we present the coefficients c_{qy} across the available quarters; it is clear to see that until the introduction of the policy change, in Quarter 5, the coefficients on deposits, loans, NBE bills, and safe assets are not statistically different from zero, not rejecting the parallel trend hypothesis. However, in Quarter 5, deposits, NBE bills, and safe assets increase statistically more for larger banks, followed by an increase in loans taking place after six months.

Figures 5 and 6 offer a graphical portrait of the results reported in Table 1. Big banks are hit harder by the regulation because of their scale and, in period six, buy substantial NBE bills (the black line), which immediately increases from zero to 600 million birr. This is roughly 50% of the mean amount of safe assets held by a representative Ethiopian bank. By definition, overall safe assets grow almost one-to-one with the NBE bills, and banks become safer in their management of maturity mismatch. At the same time, from the upper panel of Figure 6, it is clear that many more deposits flow into big banks, slow initially and then in a measure stronger than the shock (see the blue line). It is clear that deposit accumulation discontinuously jumps in Quarter 5 and deposits double, comparing before (Quarters 2–4) and after the policy (after Quarter 5). In two periods after the policy, big banks collect 4–7% of their mean deposits and this accelerates the deposit accumulation. From Figures 5 and 6 and Table 1, it is possible to see that while the parallel trend for deposit accumulation holds before the policy, afterward it diverges and generally stays separate, with some months in which small banks' deposit accumulation jumps substantially. Analogously, loans see a discontinuity, yet only observed after one to two quarters (three to six months). Hence, as is evident from Figures 5 and 6, all variables co-move as our model predicts: safe assets grow and so do deposits and loans.[11]

[11] In Appendix F, we show the same data for Figure 5 including the confidence interval for all variables, which confirm the post-reform statistical difference for the coefficients, and we also present the same analysis performed on consecutive two-month dummies rather than quarterly ones.

Table 1: Regulation and Banks: Quarter Variation (Million Real Birr)

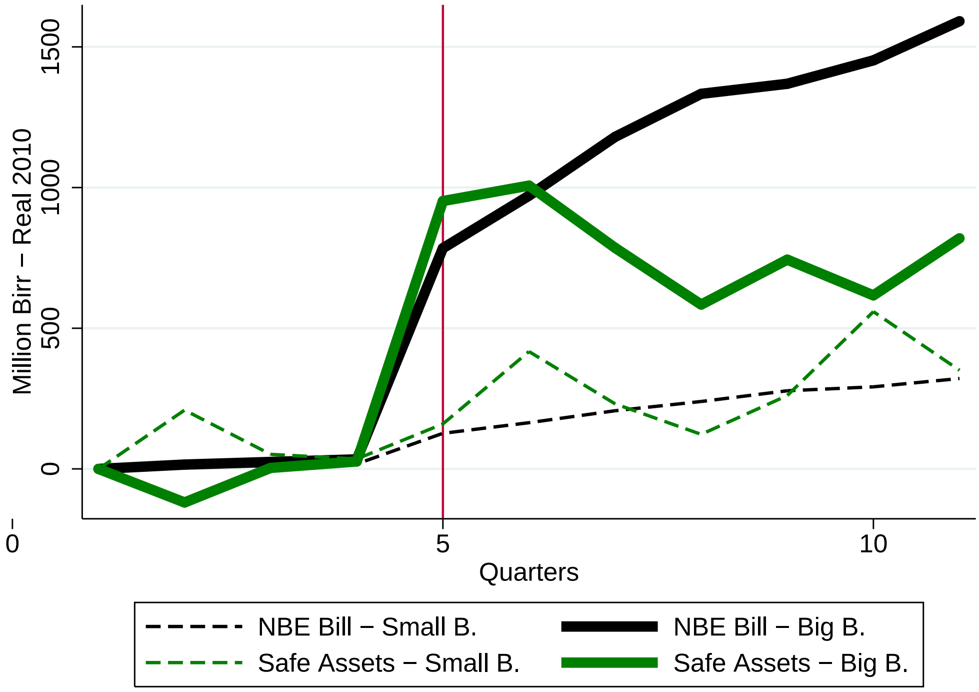
Variables	(1) Deposits	(2) Lending	(3) NBE bills	(4) Safe assets
		Small Banks		
Quarter 2	50.29	63.17	8.848	209.1
	(91.82)	(158.0)	(31.11)	(155.4)
Quarter 3	80.21	73.17	10.64	51.73
	(78.86)	(138.5)	(29.95)	(87.00)
Quarter 4	180.4**	55.65	17.67	35.45
	(78.86)	(144.6)	(28.34)	(92.50)
		Small Banks and Post-Policy		
Quarter 5	266.0***	73.49	126.6***	159.8***
	(60.12)	(57.68)	(26.09)	(36.28)
Quarter 6	362.8***	145.3	164.2***	417.2**
	(90.74)	(140.5)	(26.47)	(177.3)
Quarter 7	397.9***	182.1	206.7***	231.3**
	(81.63)	(132.7)	(28.76)	(91.24)
Quarter 8	468.6***	215.3	239.6***	122.8
	(78.46)	(136.2)	(26.85)	(99.16)
Quarter 9	597.3***	255.2***	277.7***	260.9***
	(58.59)	(55.18)	(28.03)	(39.62)
Quarter 10	696.4***	311.8**	291.7***	559.0***
	(86.38)	(148.8)	(26.78)	(192.1)
Quarter 11	730.2***	334.4**	321.3***	350.6***
	(82.00)	(140.5)	(28.73)	(86.66)
Quarter 12	935.6***	375.6**	360.1***	358.0***
	(82.30)	(145.6)	(27.91)	(95.71)
Quarter 13	1,085***	470.5***	393.2***	356.8***
	(75.50)	(65.43)	(26.90)	(40.97)
		Big Banks		
Big Bank × Quarter 2	149.3	−145.4	6.589	−328.3
	(214.4)	(225.6)	(157.5)	(232.8)
Big Bank × Quarter 3	311.2	49.33	14.12	−48.10
	(212.6)	(209.5)	(148.0)	(158.6)
Big Bank × Quarter 4	130.0	47.93	16.18	−8.906
	(228.8)	(209.4)	(145.6)	(158.8)

Table 1: (continued)

Variables	(1) Deposits	(2) Lending	(3) NBE bills	(4) Safe assets
	Big Banks and Post-Policy			
Big Bank × Quarter 5	396.8***	57.45	658.0***	792.3***
	(143.1)	(137.3)	(94.03)	(137.8)
Big Bank × Quarter 6	583.8***	102.4	807.1***	589.8**
	(193.1)	(201.6)	(128.5)	(229.0)
Big Bank × Quarter 7	600.8***	499.2**	973.5***	554.5***
	(217.3)	(217.2)	(137.7)	(159.7)
Big Bank × Quarter 8	409.2**	705.8***	1,094***	461.2***
	(208.0)	(203.3)	(133.7)	(155.1)
Big Bank × Quarter 9	337.9**	552.6***	1,091***	482.9***
	(137.0)	(138.7)	(94.22)	(130.4)
Big Bank × Quarter 10	481.3**	392.8*	1,161***	57.88
	(191.6)	(203.2)	(129.7)	(234.9)
Big Bank × Quarter 11	468.7**	568.8***	1,270***	469.2***
	(200.4)	(210.8)	(132.5)	(147.6)
Big Bank × Quarter 12	535.3**	757.0***	1,372***	634.6***
	(214.8)	(202.5)	(131.6)	(154.5)
Big Bank × Quarter 13	556.5***	677.2***	1,385***	558.7***
	(172.4)	(155.0)	(95.46)	(121.8)
Quarter FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Bank × Quarter FE	Yes	Yes	Yes	Yes
Observations	512	512	512	512
Mean Dep. Var.	3,500	2,019	527	1,278
SD Dep. Var.	3,001	1,716	621	1,071

Note: This table reports OLS estimates; the unit of observation is bank level and bank and bank × quarter fixed effects are included. Standard errors are Davidson and McKinnon (1993). Total deposits is a variable aggregating demand, saving, and time deposits at bank level; it is continuous and measured in million birr. Private lending embodies lending to the private (no financial sector, no public sector, regions, cooperatives) at bank level; it is continuous and measured in million birr. NBE bills is the amount of bills issued by the NBE at bank level; it is continuous and measured in million birr. All safe assets is the amount of liquid assets held by banks in cash, bank-to-bank deposits, and reserves at the NBE and NBE bills; it is continuous and measured in million birr. The variables are made intertemporally comparable using the core inflation figures from National Bank of Ethiopia (2012, 2013, 2014) and all figures are in real million birr, constant at 2010 prices. The means and standard deviations of these variables are reported in the last tow rows of the table. All of these variables are regressed over 13 quarter dummy variables, which span all the months in our data. The policy change occurs in Quarter 5 (April, May, and June 2011). These regressions measure the quarterly evolution, and an interaction of these dummies with the big bank dummy, to verify whether bigger banks are differentially affected more by the policy, as Proposition 2 states. The reported coefficients are only for the interaction between the big bank dummy and the period dummy; it can be seen that before the policy change, the null hypothesis of parallel trends cannot be rejected, while it is rejected afterward. Figures 5 and 6 plot all the coefficients over time. In Appendix F, we report the same exercise employing consecutive two-month dummies rather than quarters to exploit more granular data; the results are unchanged. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Figure 5: Policy Change and Trends: NBE Bills and Safe Assets

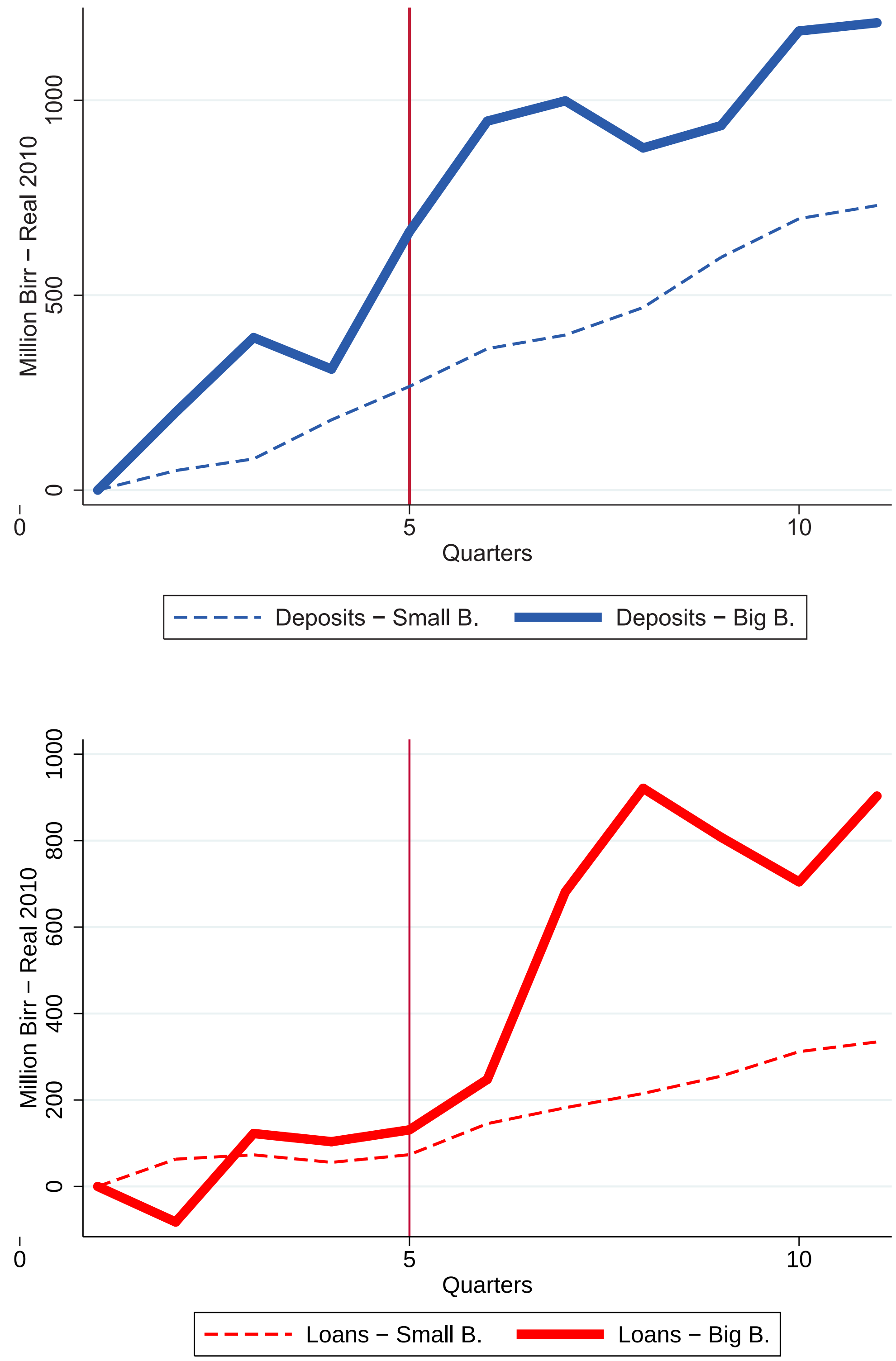


Note: This figure plots the coefficients of the overall trend exhibited by small and big banks for NBE bills and safe assets over all quarters available in the data (NBE bills in black and safe assets in green). Big banks are reported using a solid line, while small banks are reported with a dashed line. The policy is announced in mid-March 2011 and implemented in April 2011 (shown by the vertical red line). As is evident, there occurs an important discontinuity around the policy introduction (Quarter 5) and larger banks respond substantially more than smaller banks by purchasing more NBE bills and purchasing overall more safe assets, though their composition changes. As is evident from Table 1, the pre-policy trends are not statistically different from zero, while post-policy all of them are. Appendix F reports the same picture with 95% confidence intervals, also exploiting two-month dummies rather than quarters.

2.2.2 Evidence from a Branch Map of Ethiopia

In this section, we present further evidence on a key feature of Propositions 1 and 2, where we show that the 27% rule is associated with greater branch expansion. In order to test this hypothesis, we construct a map of all branches in Ethiopia, where for each bank we know all the branches installed, their region and city of introduction with the month and year of opening. Our map covers 2,023 branches, installed by all 14 banks registered until 2013 and opened between 2000 and 2015. The Annual Report by the NBE in 2014 counts 2,208, and therefore our map considers more than 90% of existing branches. Unlike the balance sheet exercise, which is based on short-run fluctuations, we are interested in verifying that long-run branch installation has changed. Thus, we focus on those banks that have been in existence since early 2000 and for which we see the evolution of monthly branch opening: these are Awash, BOA, CBB, Dashen, NIB, and United. As for our identification strategy, we shall verify the evolution of branch opening of the two largest banks, Awash and Dashen, with the remaining four, which are substantially smaller.

Figure 6: Policy Change and Trends: Deposits and Loans



Note: This figure plots the coefficients of the overall trend exhibited by small and larger banks for deposits (upper panel) and loans (lower panel) over all quarters available in the data (deposits in blue and loans in red). Big banks are reported using a solid line, while small banks are reported with a dashed line. The policy is announced in mid-March 2011 and implemented in April 2011 (shown by the vertical red line). As is evident, there occurs an important discontinuity around the policy introduction (Quarter 5) and larger banks respond substantially more than smaller banks by collecting more deposits and giving more loans. As is evident from Table 1, the pre-policy trends are not statistically different from zero, while post-policy all of them are. Appendix F reports the same picture with 95% confidence intervals, also exploiting two-month dummies rather than quarters.

In this analysis, we want to verify two features: 1) the overall number of branches increases, as the model predicts; 2) new branches are more "rural". In this case, we focus on verifying the number of branches opened in unbranched towns, as a measure of expansion into rural areas. Because our map explores all geographical features, we can see how many branches are opened in previously unbanked areas and therefore we can rely on this as the most reliably measure of bank ruralization.

For this reason, we run two tests, collapsing our branch-level database to a panel at bank level with months and year. The first test is a typical difference in difference regression

$$v_{ity} = a + b \cdot Policy_{ty} \cdot Big\ Bank_i + \iota_i + \iota_{ty} + \epsilon_{iy}, \tag{3}$$

where the number of branches and the number of branches in previously unbranched areas, v_{ity}, are regressed over bank and month-year fixed effects and the interaction between a policy dummy taking unit value after April 2011, the introduction of the 27% rule, and the big bank dummy variable.

With the second test, we run the same variables over a series of yearly dummies, ι_y, which describe the branch accumulation trend for small banks

$$v_{iy} = a + \sum_y b_y \cdot \iota_y + \sum_y c_y \cdot \iota_y \cdot Big\ Bank_i + \iota_i + i_m + \iota_y + \epsilon_{iy}, \tag{4}$$

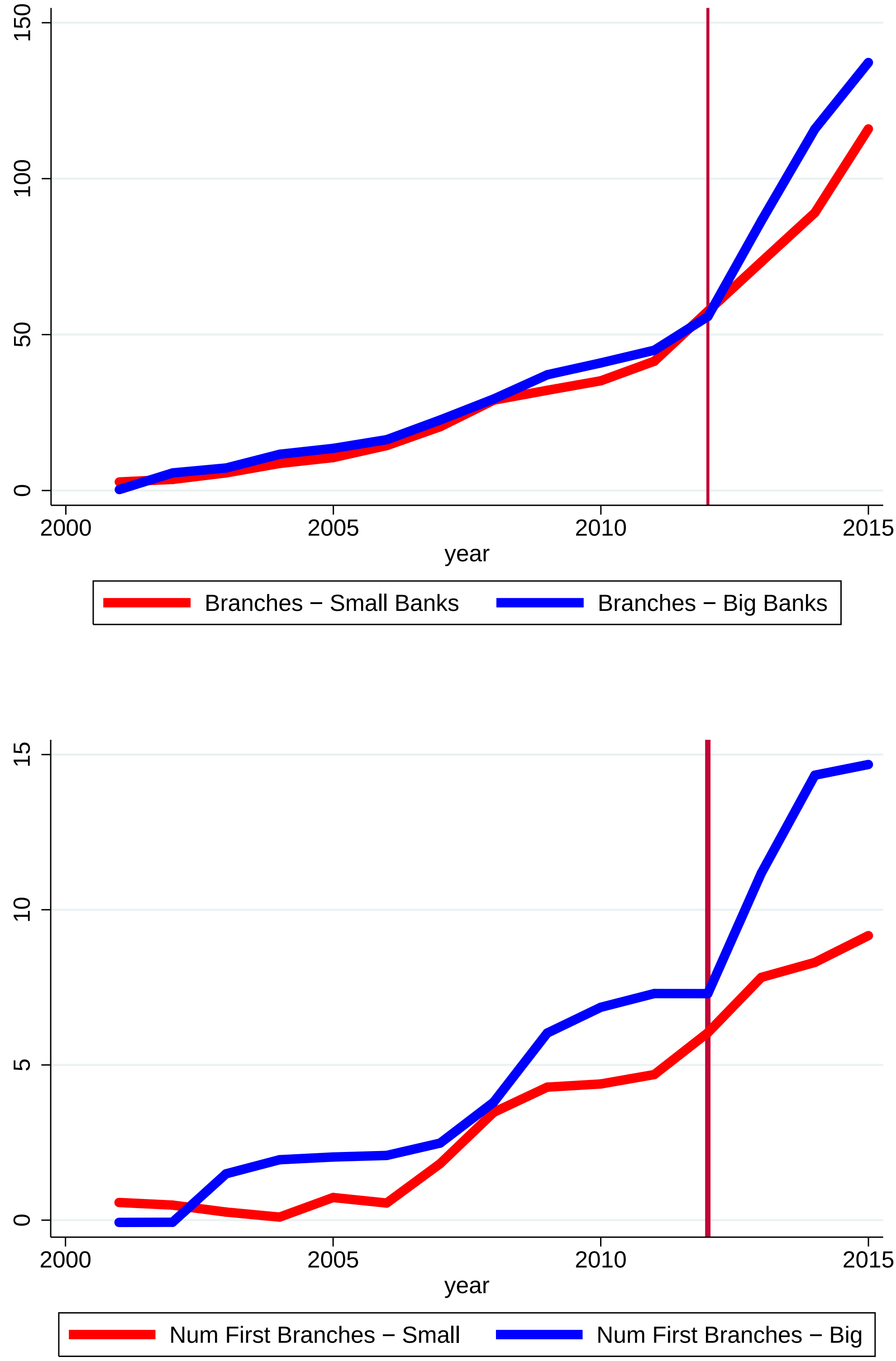
and an interaction of these with the big bank dummy, which describe the differential branch expansion of big banks. Table 2 reports that in line with our expectation, after the policy each big bank opened 10 branches more than the other banks, and they also accelerated rural branching, as big banks opened 2.5 additional branches over small banks in previously unbanked areas. Comparing these values with the mean dependent variable row, these magnitudes are substantial: branches grow for big banks 20% more than smaller banks and rural branches by almost 50%.

Figure 7 further explores this and shows the coefficients for big and small banks by describing their trends. The upper panel reports the evolution of branch installation; it is clear that up until 2012 the trends are indistinguishable, but they start to diverge after the introduction of the policy. Analogously, the lower panel shows a similar story for new branches opened in unbanked locations. Appendix F shows a test of the parallel trend hypothesis, showing that the differences between big and small banks were generally statistically different before the introduction of the policy, while after the introduction of the policy they became in line with the theoretical model.

2.2.3 Evidence from Annual Reports

In this section, we present some supporting evidence concerning the non-negative effect of a shock to s on profits and its positive effect on the number of employees, as a proxy for size. Because these aggregates are collected yearly by banks, we lack the rich within-year variation, which has been exploited in the previous sections. Also, the number of observations becomes a big limitation, because now we only face a panel with five observations at most for each bank. However, we present two tests. The first is a simple difference-in-difference regression, where we verify whether profits

Figure 7: Policy Change and Trends: Branch Installation



Note: This figure plots the coefficients of the overall trend exhibited by small and larger banks in overall branches and rural branches for big banks (blue) and small banks (red). The policy is implemented in April 2011 (shown by the red vertical line). As is evident, while branch accumulation does not differ before the policy change, afterwards big banks start to install more branches overall (upper panel) and more rural branches (lower panel). Appendix F reports the same picture, showing the difference with 95% confidence intervals.

Table 2: Branches and New Towns: Branch Map of Ethiopia

Variables	(1) Number of Branches	(2) Number of Rural Branches
Policy × Big Banks	10.19***	2.504***
	(2.640)	(0.525)
Bank FE	Yes	Yes
Non-Param. Time FE	Yes	Yes
Obs.	330	330
Adjusted R^2	0.959	0.892
Mean Dep. Var.	53.87	5.348
SD Dep. Var.	33.11	4.335

Note: This table reports OLS estimates. The unit of observation is bank level, and bank and non-parametric month fixed effects are included. Robust standard errors are reported in parentheses. The number of branches is defined as the cumulative number of branches installed by a bank, while the number of rural branches is defined as the cumulative number of branches opened in towns previously unbranched. Their means and standard deviations are reported in the final two rows. These variables are regressed over the interaction of a policy dummy taking unit value after April 2011 and a Big Bank dummy taking unit value for the Awash and Dashen Banks, while small banks are BOA, CBB, NIB, and United. The adjusted R^2 of these regressions is also reported. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

and the number of employees grow more for larger banks than for smaller banks:

$$v_{iy} = a + b \cdot Policy_y \cdot Big\ Bank_i + \iota_i + \iota_y + \epsilon_{iy}. \tag{5}$$

Here, as usual, v_{iy} is a variable under observation for bank i in year y (note that the subscript t that refers to months is dropped as we deal with annual observations); this variable is regressed over the interaction, $Policy_y \cdot Big\ Bank_i$, which accounts for the differential effect of the policy dummy in big banks. The variable $Policy_y$ takes unit value for the fiscal years during which the policy has been in place (i.e., 2012 and 2013), while $Big\ Bank_i$ takes unit value for the big banks, as presented in Figure 4. These results are reported in Table 3 and show that big banks' profits grow more rapidly after the policy and the number of employees expands at a similar faster rate.

However, because difference-in-difference regression may present severe limitations in absence of parallel trends, we take a requires a test of the parallel trend hypothesis before the policy. For this reason, we present a second test by running the following regression,

$$v_{iy} = a + \sum_y b_y \cdot \iota_y + \sum_y c_y \cdot \iota_y \cdot Big\ Bank_i + \iota_i + \iota_y + \epsilon_{iy}, \tag{6}$$

where real profits and number of employees are run over a series of yearly dummy variables, ι_y, which describe the evolution of profits and number of employees for small banks through the coefficients b_y and the interaction of yearly dummies with the big bank dummy, describing through the coefficients

Table 3: Profits, Branches and Regulation: Annual Reports

Variables	(1) Real Profits (million birr)	(2) Number of Employees
Policy × Big Bank	24.47*	393.3***
	(14.86)	(114.6)
Bank FE	Yes	Yes
Year FE	Yes	Yes
Observations	52	52
Adjusted R^2	0.938	0.971
Mean Dep. Var.	126.2	1,461
SD Dep. Var.	96.42	976.7

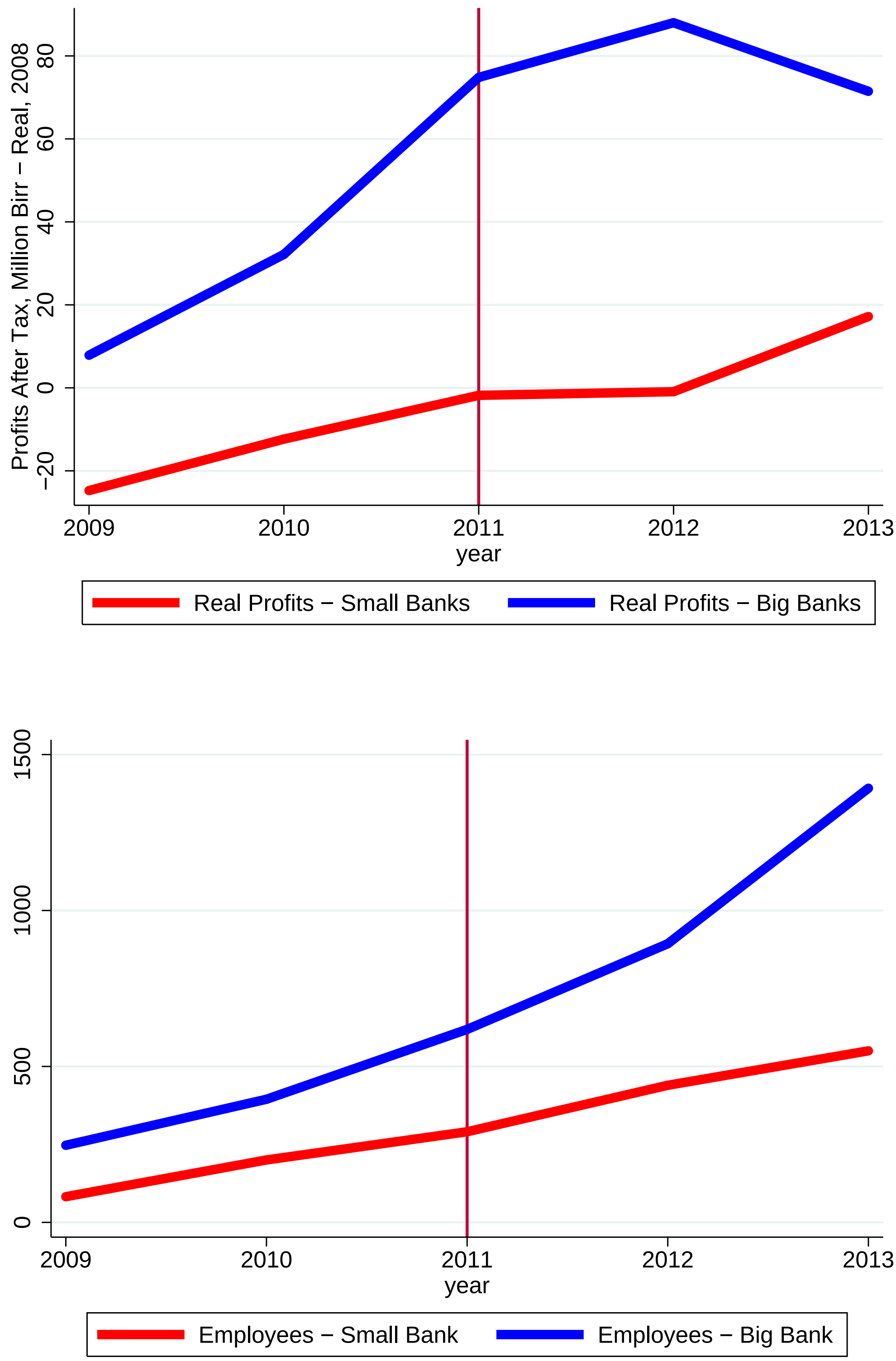
Note: This table reports OLS estimates. The unit of observation is bank level, and bank and month fixed effects are included. Davidson and McKinnon (1993) robust standard errors are reported in parentheses, which for this case are more conservative than bootstrapped bank-level clustered. Real Profits is the difference between the asset-generated income and liability-induced costs after taxes; it is continuous and measured in million birr. The number of branches denotes the total number of branches as shown in banks' annual reports. The variables are made inter-temporally comparable using the core inflation figures from National Bank of Ethiopia (2012, 2013). Their means and standard deviations are reported in the final two rows. These variables are regressed over a Policy dummy, which takes unit value after the introduction of the regulation policy and a dummy for Big Banks, taking unit value for the six banks classified as large in Figure 4. Bank and Year fixed effects are included. The adjusted R^2 of these regressions is reported in the row "Adjusted R^2". ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

c_y their differential trend. As highlighted in Figure 8, there seems to occur a discontinuity at the introduction of the policy, both in real profits (upper panel) and employee numbers, supporting the previously reported hypothesis. In the next section, we clarify how these are in line with the evolution of branch installation.

2.3 Robustness Checks

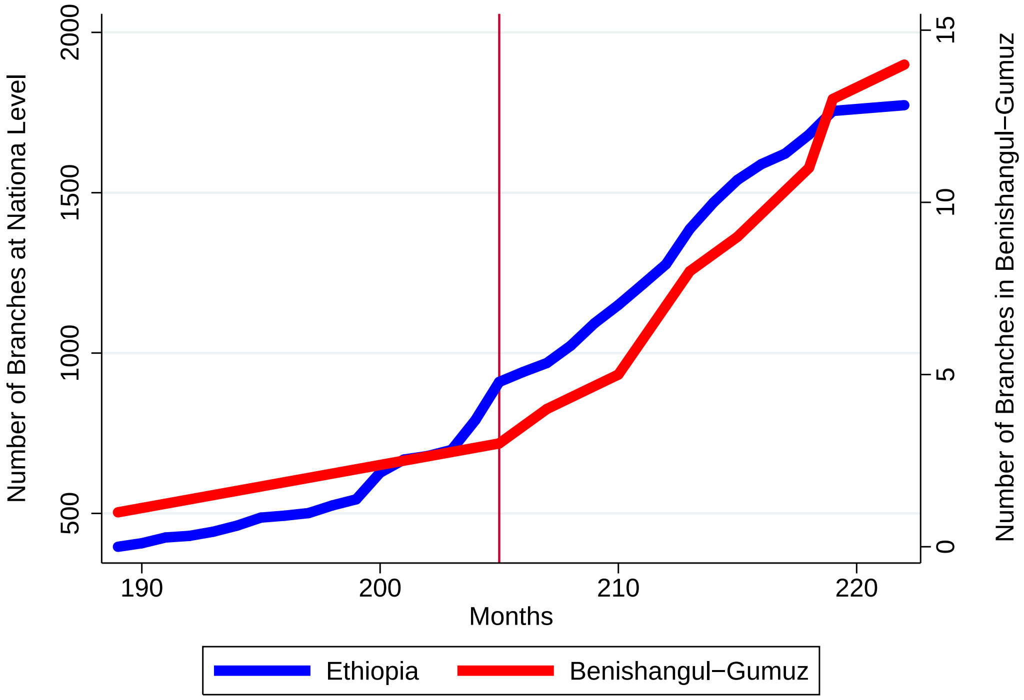
In this section, we explore possible alternative explanations, which might be related to the policy change and invalidate our inference. The most important feature, which has not been previously addressed, is the destination of the funds collected by the NBE, through this new bill. One powerful argument regarding the effects observed in Figure 6 on deposits and loans could be the following. This regulation drained substantial resources from the banking system and placed them in long-term investment in some geographical areas to which big banks had a comparative advantage in access. In a sense, leaving aside the safe asset increase verified in Figure 5, this hypothesis would identify the regulation policy as an indirect transfer of resources from small to big banks. We believe this is implausible for two reasons. First, the Ethiopian government heavily relies on its state-owned bank, CBE, which is the largest in the country, not affected by the policy and massively profitable – in 2011/12, it amassed eight billion birr of profits, corresponding to roughly 400 million US dollars (USD). If there had to be a redistribution of resources, then the two state-owned banks (CBE

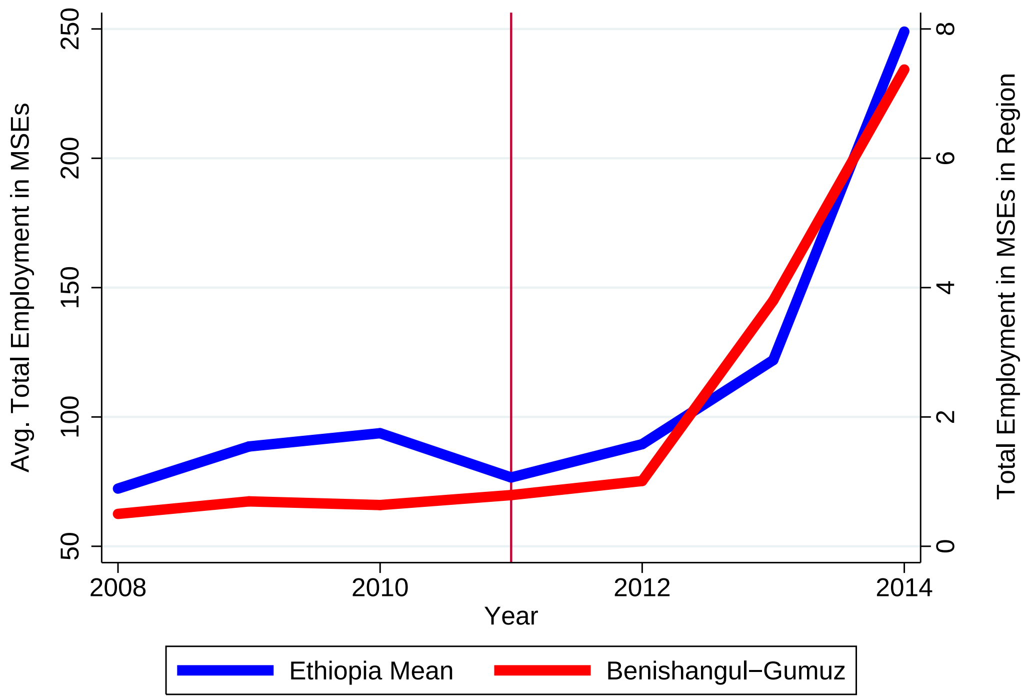
Figure 8: Policy Change and Trends: Real Profits and Number of Employees



Note: This figure plots the coefficients of the overall trend exhibited by small and larger banks in real profits and number of employees for big banks (blue) and small banks (red). The policy is implemented in April 2011 (shown by the red vertical line). As is evident, while both profits and number of employees do not differ before the policy change, afterwards big banks start to earn more (upper panel) and to hire more employees (lower panel). Appendix F reports the same picture, showing the difference with 95% confidence intervals.

Figure 9: Regional Heterogeneity

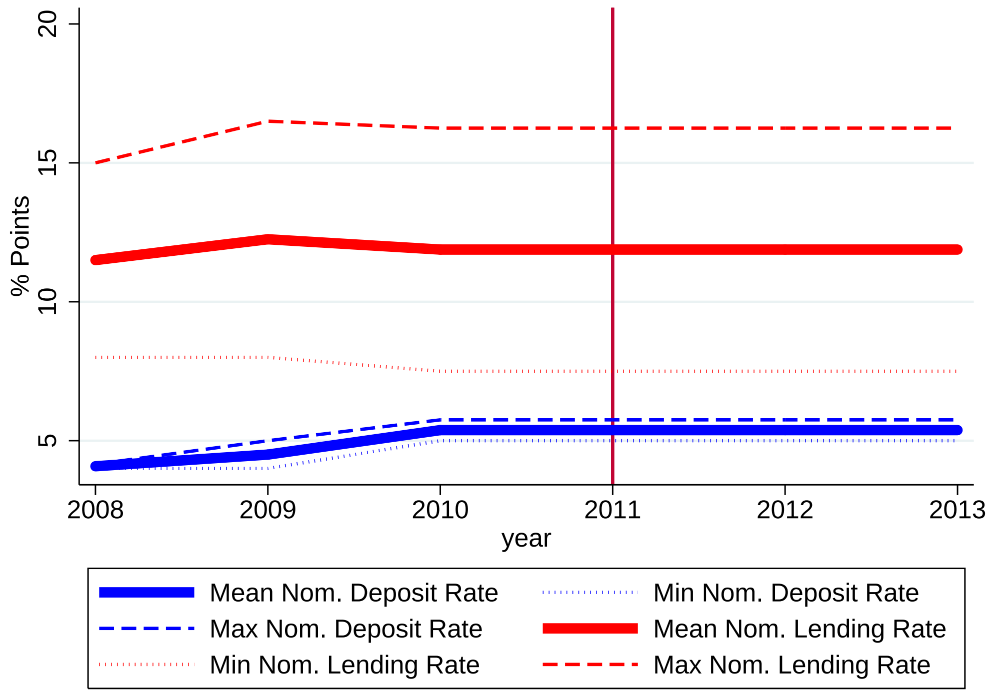




Note: This figure reports the monthly evolution of branch opening in the upper panel and the yearly total employment by medium-scale enterprises in the lower panel for the region Benishangul-Gumuz (in blue) and the other Ethiopian regions (in red). As is clear in both panels, there is no detectable difference between the rest of Ethiopia and Benishangul-Gumuz, which has been the center of substantial long-term investment in the last years. The upper panel reports the number of branches, while the lower panel gives the number of employees (in thousands). The red vertical line marks the month and year of the policy change (April 2011) in the upper panel and the year of the policy change (2011) in the lower panel.

and the Development Bank of Ethiopia, DBE) might have been the recipients, rather than private commercial banks. Secondly, if the argument given above is true, we should observe a special increase in credit and branches in those regions that were particularly targeted for long-term investment. The region that has mostly been attractive to long-term investment projects is Benishangul-Gumuz, which hosts the construction site of the Grand Ethiopian Renaissance Dam (GERD). In Figure 9, we can observe in the upper panel the branch installation and total employment by medium-scale enterprises compared to the national average. As is evident, it is difficult to argue that such a region has been the destination of most attention and, for this reason, we believe that our claim concerning the mechanism through enhanced bank safety cannot be dismissed.

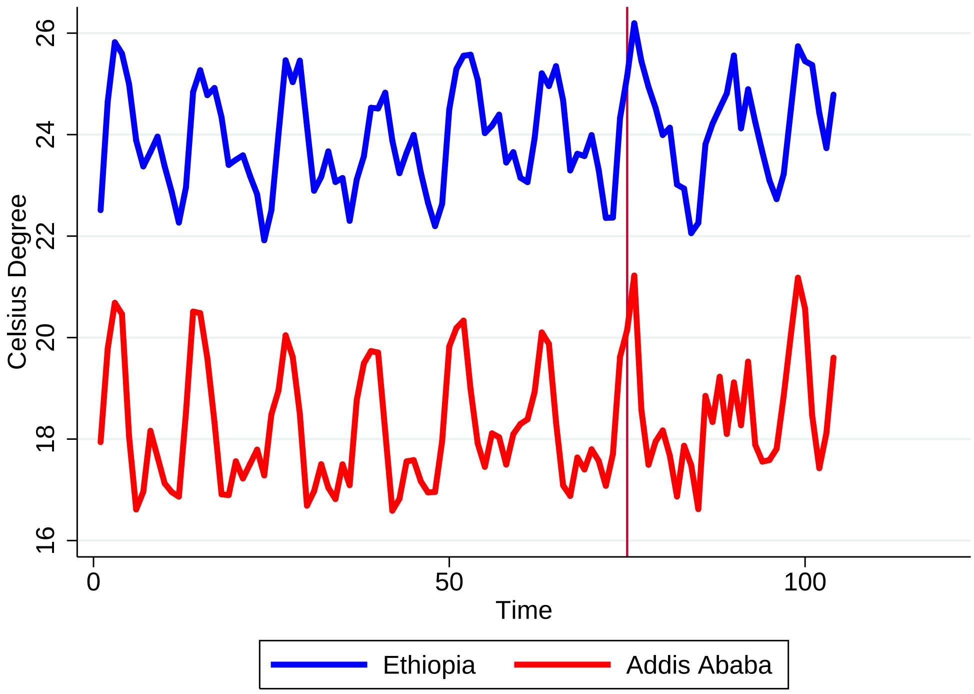
Figure 10: Policy Change and Prices: Lending and Deposit Rates



Note: This figure reports the monthly evolution of the average nominal deposit rate (blue) and lending rate (red), with their respective minimum and maximum rates. The sources are the 2012, 2013, and 2014 Annual Reports of the NBE. As described in the text, there is no detectable change in either rate in response to the policy change.

Another core element that has been omitted in the analysis is the price response of the policy. The theoretical model took prices as given and was silent on ways in which the lending and deposit rates could respond to a shock in s^R. This might create alternative channels through which the policy shapes the economic problem. For example, if the lending rate in the good state, R_G, grew in response to the policy (or the deposit rate R_D correspondingly declined), then the branch expansion effect could be entirely due to an increased profitability of the banking system, with safe assets being a negligible component of the story. We decided to leave prices constant because of anecdotal evidence from Ethiopian bankers on the lack of a price response due to competitive pressure, which was then confirmed in our data collection exercise. In fact, Figure 10 presents the mean lending and deposit rates with their respective minimum and maximum rates as published by the National Bank of Ethiopia (2013). Although some changes occurred in mid-2009, it is noticeable that over the period of the policy (2011–2013), rates are generally constant, at least in the first moment of their distributions and the respective supports. This is in line with the theoretical model, in which market prices were left constant over the policy change.

Figure 11: Climate and Policy Change

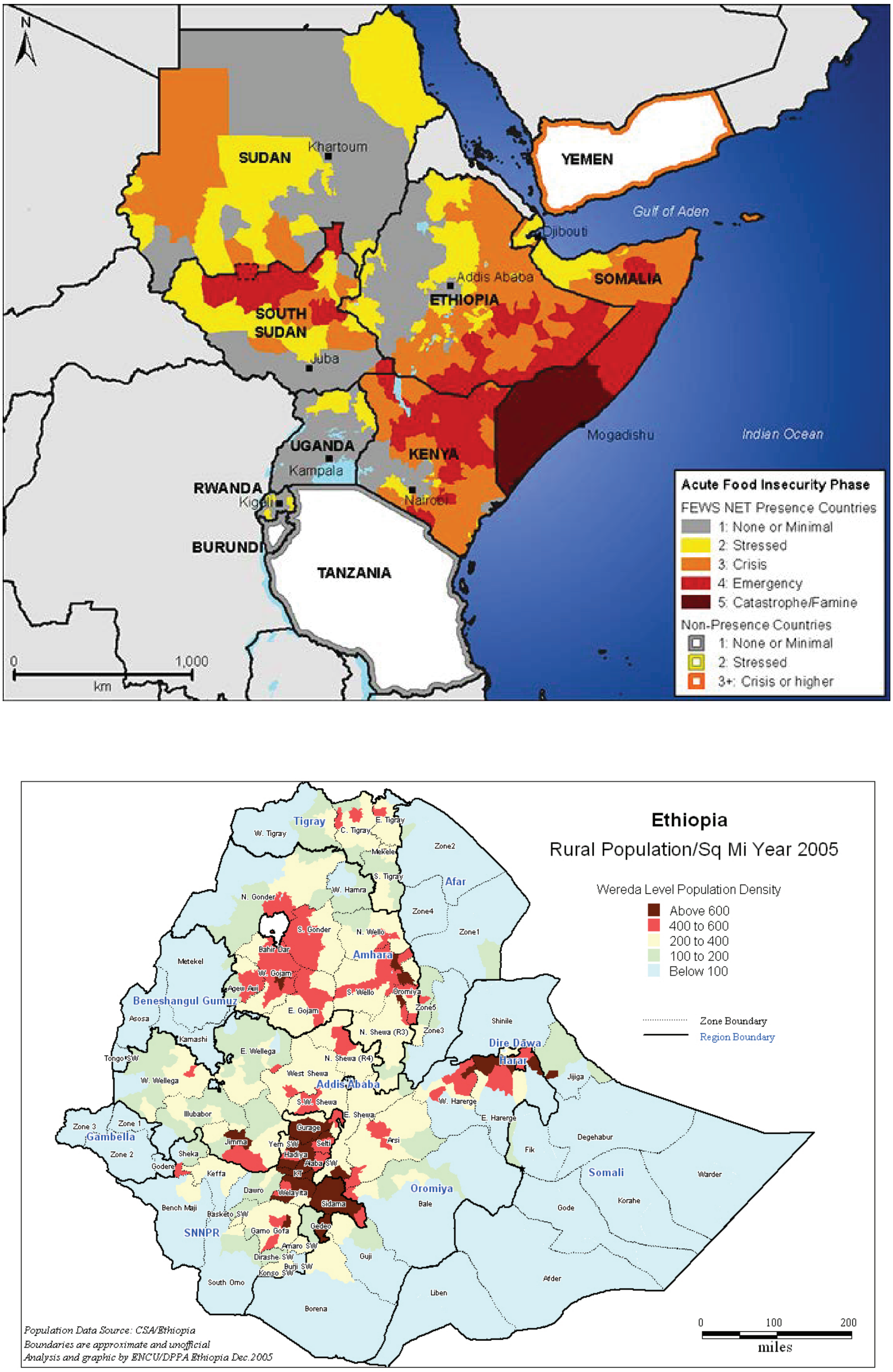


Note: This figure reports the monthly average temperature in Ethiopia (blue) and Addis Ababa (red) between January 2005 and August 2013. The policy change occurs in April 2011, Time 75, and there does not seem to be any response to weather changes. The data come from the Berkeley Earth project (`http://berkeleyearth.org/`). Alternative measures of temperatures were used from the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC), which are highly correlated with the current values (0.72 for Addis Ababa and 0.6 for Ethiopia) and highlight similar differences.

Thirdly, climate might be considered problematic, if the policy change occurred over periods of extensive temperature fluctuations, which might affect the industrial productivity and hence financial markets. Although Ethiopia is a country with a strongly heterogeneous climate, close to the equator and with strongly diverse altitudes, all of these characteristics make it suitable for important temperature fluctuations, which might be related to our study. From an analysis of average monthly temperatures for Ethiopia (blue) and Addis Ababa (red) between 2005 and 2013, as shown in Figure 11, we observe that while there is some substantial cyclical variation in temperature, there does not seem to be an exceptional increase in either the level or the volatility of temperatures over the period of the policy change.

In addition to this, natural disasters might lead to a change in the marginal value of public/private infrastructure and affect financial markets. The year of the policy change, 2011, was indeed marked

Figure 12: Drought and Population Density in Ethiopia in 2011



Note: The upper panel shows a picture of the 2011 Eastern African drought and the intensity at which countries were affected. The picture is based on the Famine Early Warning System (FEWS) and is freely available at `https://en.wikipedia.org/wiki/File:FEWS_Eastern_Africa_July-September_projection.png`. The lower panel shows a map of the population density in Ethiopia constructed by the Central Statistical Agency of Ethiopia (CSA). Comparing the two pictures, it emerges that the areas most affected by the drought were low-population density areas, mostly in the Somali and Oromiya region.

Table 4: Largest Disasters in Ethiopia

Type	(1) Date	(2) Total Deaths
Flood	13 August 2006	364
Flood	5 August 2006	498
Epidemic	September 1988	7,385
Drought	June 1987	367
Epidemic	January 1985	1,101
Drought	May 1983	300,000
Epidemic	January–December 1981	990
Drought	December 1973	100,000
Epidemic	January 1970	500
Drought	July 1965	2,000

Note: This table reports the most important disasters in Ethiopia between 1960 and 2015, from the most recent to the oldest. In recent years, Ethiopia has not experienced any disaster that could be related to the policy introduction. The data source is EM-DAT (`http://emdat.be`).

by one of the most severe droughts Eastern Africa has experienced in the past 60 years,[12] and this may be a reason for concern. As clarified by Figure 12, this disaster affected mostly Somalia, Kenya, and Ethiopia. However, this might be a limited concern for this study because while Somalia was hit in the most densely populated region of the country (around the capital city Modagishu), Ethiopia was hit in a low-density and predominantly rural area, as clarified by the lower panel of Figure 12. In particular, according to some controversial relief statistics, the number of Ethiopians affected by this disaster was between a few hundred and 700,000,[13] which is a sizable number, but limited relative to the 2011 population of 89.39 million. In Table 4, we also report a list of the major disasters that have occurred in Ethiopia since 1960, and verify that this drought does not qualify as a disaster in the Emergency Events Database (EM-DAT) definition.[14]

3 Evidence from Antebellum USA

In this section we present an analysis using data and policies from American history, in the period between late 1700 and mid 1800, known as Antebellum era. We exploit the state-level introduction of bank taxes, which gradually took place over this period. In Section 3.1, we present a slightly different version of the theoretical model in Section 2, showing that lending/profit taxes can generate an increase in safe assets equivalent to the mandatory policy. Section 3.2 gives some historical

[12]Refer to the BBC article "Horn of Africa sees 'worst drought in 60 years'", 28 June 2011, available at `http://www.bbc.co.uk/news/world-africa-13944550`.

[13]Refer to the Huffington Post article "Ethiopia: Hunger During Worst Drought In 60 Years", 17 August 2011, available at `http://www.huffingtonpost.com/2011/08/17/ethiopia-hunger-drought_n_928989.html`.

[14]The EM-DAT is maintained by the Centre for Research on the Epidemiology of Disasters (CRED) and defines a disaster as an event satisfying at least one of these characteristics: "• Ten (10) or more people reported killed. • Hundred (100) or more people reported affected. • Declaration of a state of emergency. • Call for international assistance."

background on bank taxes in Antebellum USA and a map of tax adoption and data sources, while Section 3.3 reports the empirical model and main results.

3.1 Financial Development and a Lending Tax

The model presented in Section 2 is going to be entirely used here, except a core difference in the bank profit function. Instead of taking the lending rate in the good state as given, assume now it is an increasing function of s, and hence $R_G = R_G(s)$ with $R_G^{'} > 0$. This can be justified with some monopoly power on the bank and a downward-sloping demand for loans. Recall that s is the share of deposits the bank places in safe assets, hence while $R_G(l)$ is decreasing in $l = 1 - s$. For simplicity, we make safe asset remuneration equal to the deposit rate and normalize it to 1, and hence $R_S = R_D = 1$.

These two minor changes lead to a substantially different result, which in the no-commitment case may deliver a non-zero level of safe assets. In fact, consider a case with no regulation on ρ, rather than a simple limited liability scenario where the bad state leads to always earning zero for the bank (hence R_B is low enough). Then the problem simplifies to

$$\max_{s \geq 0} p(1-s)[R_G(s) - 1],$$

leading to

$$(1-s)(R_G^{'}(s) - 1) = [R_G(s) - 1],$$

replacing a linear function $R_G(s) = As$ with $A > 1$. This allows us to back out the optimal safe asset holding

$$s^* = \frac{A}{2A-1}.$$

Now, suppose the regulator can introduce a lending or profit tax so that the maximand remains unchanged, except for $(1-\tau)R_G(s)$. Then, this solution with a tax promotes safe asset holding in equilibrium $s^* = A(1-\tau)/[2A(1-\tau)-1]$, which results in a higher depositor remuneration in the bad state as s is increasing in τ, $\partial s/\partial \tau = A/[2A(1-\tau)-1]^2 > 0$, and $R_{DB} = s(\tau)R_S + [1-s(\tau)]R_B$.

Therefore, the same intuition previously presented applies: as long as deposits in old branches respond more than the decline in the profit margin, then overall profitability can increase and a tax can unlock branch expansion. Therefore the results of Proposition 1 and 2 can be entirely translated into this study. Because there is a one-to-one mapping between bank taxes and safe asset holding, bank taxes need to imply a level of safe assets lower than the threshold highlighted in Proposition 1.

3.2 Bank Taxes in Antebellum USA

After the establishment of the federal government of the USA, local states lost a significant source of funding from seigniorage and faced the decision to introduce new taxes. Rockoff (1975) found this case to be an experiment ideal: “ [. . .] a laissez-faire policy toward financial intermediaries tends to deepen financial development and accelerate economic growth. The [. . .] decades preceding the American Civil War [. . .] witnessed something approaching a natural experiment." As Sylla, Legler, and Wallis (1987) document, various solutions were considered, from taxing incomes and properties, to introducing infrastructure fees (especially waterways). While almost all states imposed the payment of lump-sum taxes on the provision of a bank charter and invested directly in bank stocks, a variety of states also introduced substantial taxes on banks, generally on bank capital (but also profits, deposits, and dividends): New Jersey (NJ) in 1811; Massachusetts (MA) and Maine (ME) in 1812; Pennsylvania (PA) in 1813; North Carolina (NC) 1814; Maryland (MD) in 1815; Vermont (VT) in 1818; Georgia (GA) in 1821; Rhode Island (RI) and New Hampshire (NH) in 1822; New York (NY) in 1839; Connecticut (CT) in 1850.[15]

The long-term objective of these taxes was not financial regulation, but rather a classical regulation-induced revenue collection (Wallis, Sylla, and Grinath 2004) and the gains from bank levies were impressive. In the period 1836–1840, these taxes financed state revenue amounting to 82% in Massachusetts, 61% in Georgia, 57% in Delaware, and so on (Sylla, Legler, and Wallis 1987). Despite the clear public finance objective, it can be argued that the joint effect of these state initiatives with federal decisions succeeded in a rudimental regulation of a rampant financial industry.[16] In fact, it is documented that bank taxes were more effective than pure banking regulation. For example, Rockoff (1975) reports that some "banks would evade minimum capital requirements by lending investors the funds with which to buy the stock of the bank" and "this created fictitious items under loans and capital".

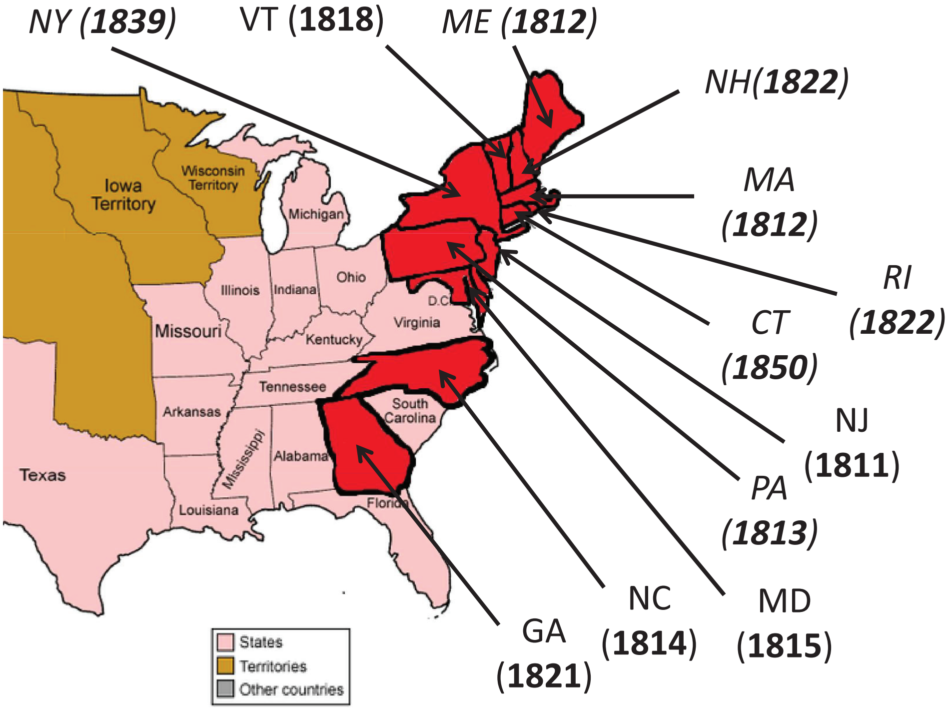
From Figure 13, it is possible to see that the north-eastern states were the states predominantly using bank taxes, while historians report that other states adopted a different approach with respect to public revenue collection.[17] The relation between regulation and bank size, especially deposit collection, is also consistent with the argument reported by Greenspan (1998), who, when discussing the introduction of a bank tax in Delaware in 1864 (outside our sample), conclude that: "an amendment to the Act in 1864 called for taxing state banks [. . .]. Many projected the National Bank Act would cause the demise of state banks. However [. . .] state banks pioneered demand deposits, and within ten years, state banks had more deposits than national banks – a lead maintained until 1943."

[15]In Table 1 of their paper, Sylla, Legler, and Wallis (1987) report the initial year of bank taxes, including the fixed fee on the bank charter. For the purpose of this paper, this is not the relevant date, because a lump-sum tax would not affect bank behavior. For this reason, in this work we are interested in variable taxes on bank activities (i.e., capital, profits, dividends, loans, etc.), which were introduced in the years reported above.

[16]As Wallis (2001) documents, only two American Banks were allowed to operate nationally in the 1810s: the First and Second Banks of the United States. However, their influence over money, credit, politics, and smaller state banks led the Congress and President Jackson not to re-charter these banks in the 1830s. Analogously, state banks were considered to be supporters of special interests, which states regulated in a variety of ways, by imposing the funding of local infrastructure or special educational programs. For example, Connecticut forced state banks to support Yale University and the Connecticut Retreat for the Insane; in New Hampshire, a Literary Fund; in Vermont, a School Construction Fund; in Virginia, the Fund for Internal Improvement and several other interests.

[17]As Wallis (2001) concludes, "frontier states were heavily dependent on the property tax" and analogously southern states generated substantial revenue by selling land rights. As a consequence "from 1835 to 1841, property tax collections on the Atlantic seaboard were only 2 percent of state revenues, in the west they were 34 percent". A significant portion of the literature postulates that geography and the difference in land endowment were the core reasons behind the different choices made by western and eastern states concerning bank taxation.

Figure 13: The Geography of Bank Tax Adoption in Antebellum USA



Note: This figure shows a map of the USA before 1848. In pink and red, we show the states under control of the federal government, yellow denotes territories free from USA jurisdiction, and gray denotes states controlled by other countries. Within the USA, we highlight in red all states that adopted bank taxes and show their names and policy adoption date (in parentheses). All the states in red are part of this analysis, but because of data limitations we only have data both before and after the policy change for six of them: MA and ME in 1812; NH and RI in 1822; NY in 1839 and CT in 1850.

In the next section, we test and verify that Antebellum USA constitutes a case in which financial regulation, in the form of bank taxes, provided incentives for the banking industry to grow larger, by encouraging safe asset purchase and stimulating deposit growth.

3.3 Main Results

In this section, we explore the balance sheets of US banks in the Antebellum era, by compiling a database using financial and policy variables. Several historical sources were used for this purpose, especially the data collection works of Warren E. Weber at the Federal Reserve Bank of Minneapolis (Rolnick and Weber 1983; Weber 2003, 2006), which were complemented by additional data on tax introduction and policy characteristics and a few papers that have analyzed this historical period; for example, Ager and Spargoli (2013) verify the impact of the free banking laws as a removal of barriers to entry in the banking system.

The sample of this analysis is composed by a repeated cross-section of 1,280 banks in 12 states between 1803 and 1860. While bank balance sheets for all states introducing this policy are observed, we only have access to both before and after data for six states (i.e., CT, MA, ME, NH, NY, and RI) and thus we present the key variation used in this analysis. For the remaining six states (VT, NJ, PA, MD, NC, and GA) we observe data only after the introduction of the policy, but these states are still retained in the sample, because they present a within-state cross-sectional variation between big and small banks.

The empirical setting is essential and we test the results of Propositions 1 and 2. We explore all available time-series and verify how the deposits, lending, safe assets, and profits move after the introduction of these policies. This analysis is possible given the non-simultaneous introduction of this tax at state level. As before, the theoretical model predicts a discontinuity around the introduction of the policy, and for this reason we propose two estimation strategies.

First, we exploit the "phase out" of these taxes and therefore

$$v_{ismy} = a_1 + b_1 \cdot policy_{smy} + \iota_i + \iota_s + \iota_m + \iota_y + \epsilon_{ismy}, \tag{7}$$

where the variable v_{ismy} is observed for bank i, in state s, in month m and year y, and is regressed over a policy dummy that takes unit value when state s introduces a tax in year y and all subsequent years. As usual, bank, state, month, and year fixed effects are included. The coefficient b_1 is the core of this estimation and reports the average evolution of the variable v_{ismy} after the introduction of the policy.

Second, in addition to equation (7), we also want to test whether big banks are affected more by these policies. For this reason, in equation (8) we replicate the model described in (7) and add an interaction between the policy variable and a dummy variable characterizing big banks:

$$v_{ismy} = a_2 + c_2 \cdot policy_{smy} \times big_{is} + \iota_i + \iota_m + \iota_s + \iota_s \times \iota_y + \epsilon_{ismy}. \tag{8}$$

As is standard in this literature, the dummy variable big_{is} takes unit value if bank i in state s is larger than the median bank in the year prior to the policy. In this last expression instead of year and state fixed effects, we introduce state and state $\times$ year fixed effects, in order to account for state-specific trends. For this reason, we are only able to measure the differential effect of the policy on big banks, hence the coefficient c_2, while the effect on big banks is completely absorbed by the state $\times$ year fixed effects. In line with Proposition 2, we attribute this difference in effect to technology, hence the η parameter previously presented. To provide a comprehensive analysis, equations (7) and (8) are tested both on levels, in Table 5, and as share of asset, in Table 6. We believe that both tables are informative: on the one hand, from Table 5, the "magnitude" effect of the policy is clear – it provides an essential million dollar figure of the policy; on the other hand, Table 6 permits us to track the balance-sheet mechanics of the policy change.

The upper panels of Table 5 and 6, in which we only exploit the phase out of the taxes, give a surprising, even if imprecise, result: taxing banks does not lead to fewer operations (loans, deposits) or less profits. Table 5 confirms the model predictions and indeed we observe an average increase in deposits, loans, safe assets, and profits. In Table 6, where figures are normalized by total assets, we learn that deposits become more relevant in the liability structure of banks and increase, on average, by 4%, and some of these resources are used to increase both safe assets and loans (by 2% and 7%).

Table 5: Taxes and Antebellum USA Banks: Levels, Real 1800

Variables	(1) Deposits (USD)	(2) Loans (USD)	(3) Safe Assets (USD)	(4) Profits (USD)
	Policy Phase Out			
Policy	85,422	31,865	47,893	7,358
	(54,124)	(64,387)	(40,700)	(9,688)
Bank FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
	Policy and Big Banks			
Policy × Big Bank	353,018***	424,086***	222,121***	50,395***
	(80,888)	(98,290)	(60,524)	(12,472)
Bank FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes
Obs.	17,958	17,958	17,958	17,958
Number of Banks	1,280	1,280	1,280	1,280
Mean Dep. Var.	299,076	969,361	223,475	53,715
SD Dep. Var.	771,046	1,528,938	677,795	126,821

Note: This table reports OLS estimates. The unit of observation is bank level, and bank, month, state, year, and state × year fixed effects are included. Standard errors are clustered at bank level. Deposits is a variable reporting the overall deposits at bank level; it is continuous and measured in USD. Safe assets is the amount of liquid assets held by banks in cash, bank-to-bank notes, real estate assets, and other private assets; it is continuous and measured in USD. Loans and Discounts embodies all lending operations at bank level; it is continuous and measured in USD. Profits and Losses is the difference between the asset-generated income and liability-induced costs after taxes; it is continuous and measured in USD. All variables are in real dollars at 1800 prices, and estimates of the consumer price index for these years are from FED Minneapolis, which are based on the Index of Prices Paid by Vermont Farmers for Family Living for 1800 to 1851 and the Consumer Price Index by Ethel D. Hoover for 1851–1890. The means and standard deviations of these variables are reported in the final two rows. The following states are included in the sample because they are treated in some year by the policy: CT, GA, MA, MD, ME, NC, NH, NJ, NY, PA, RI, and VT. However, because of data limitations we observe a bank balance sheet before and after the policy only for the following six states: MA and ME in 1812; NH and RI in 1822; NY in 1839; CT in 1850. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 6: Taxes and Antebellum USA Banks: Balance Sheet Shares

Variables	(1) Deposits % Asset	(2) Loans % Asset	(3) Safe Assets % Asset	(4) ROA % Point
		Policy Phase Out		
Policy	0.0474***	0.0730***	0.0176***	0.00418
	(0.00683)	(0.00970)	(0.00599)	(0.00350)
Bank FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
		Policy and Big Banks		
Policy $\times$ Big	0.0288***	-0.0237	0.0192**	-0.00265
	(0.00965)	(0.0155)	(0.00926)	(0.00376)
Bank FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
State $\times$ Year FE	Yes	Yes	Yes	Yes
Obs.	17,958	17,958	17,958	17,958
Number of Banks	1,280	1,280	1,280	1,280
Mean Dep. Var.	0.156	0.794	0.120	0.033
SD Dep. Var.	0.116	0.174	0.111	0.038

Note: This table reports OLS estimates. The unit of observation is bank level, and bank, month, state, year, and state $\times$ year fixed effects are included. Standard errors are clustered at bank level. Deposits is a variable reporting the overall deposits at bank level; it is continuous and measured in USD. Safe assets is the amount of liquid assets held by banks in cash, bank-to-bank notes, real estate assets, and other private assets; it is continuous and measured in USD. Loans and Discounts embodies all lending operations at bank level; it is continuous and measured in USD. Profits and Losses is the difference between the asset-generated income and liability-induced costs after taxes; it is continuous and measured in USD. The means and standard deviations of these variables are reported in the final two rows. The following states are included in the sample because they are treated in some year by the policy: CT, GA, MA, MD, ME, NC, NH, NJ, NY, PA, RI, and VT. However, because of data limitations we observe a bank balance sheet before and after the policy only for the following six states: MA and ME in 1812; NH and RI in 1822; NY in 1839; CT in 1850. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

However, banks' profitability is not harmed, given that the returns on assets are unaffected. The lower panels of Table 5 and 6 give us a richer perspective by focusing on the differential effect of these policies on big banks: we can clearly see that the figures of the upper panel (not statistically different from zero) are the average of big banks, which are positively affected, and small banks, which are almost unaffected. Indeed, by exploiting such differential within-state differences, we see that big banks grow substantially along all dimensions (deposits, loans, safe assets, profits) and in relative shares, especially in terms of safe assets and deposits.

4 Conclusion

In this paper, we show that financial regulation can promote financial development by promoting safe asset holding. This is true if the regulation does not exceed a threshold below which the elasticity of deposit mobilization to financial regulation exceeds the elasticity of the profit margin and asset loan share to financial regulation. This promotes bank lending and profits, because the decline in the profit margin is exceeded by the size of the balance sheet growth, caused by additional deposits flowing in as the financial system becomes safer. Financial regulation policies can be equivalently enacted through a macro-prudential regulation measure, which forces banks to purchase safe assets, or through a profit/lending tax, which changes the relative prices of assets.

The mechanism we describe relies on a key feature of the banking problem: the existence of a commitment problem between the bank and depositors. Depositors would like a safe bank, which fully repays their deposits; however, because they deposit before the bank decides its asset allocation and because the bank is shielded by limited liability, they anticipate that the bank would repay little in a default, and they deposit less. In the presence of this feature, a banking regulation imposing a mandatory level of safe assets generates two effects on the total loan volume and branch numbers: 1) a negative effect, which shrinks the profit margin in the branch, through the re-allocation from high yield (loans) to low yield (safe) assets; 2) a positive effect, by promoting deposits by households in existing branches, and hence expanding the assets of the bank. The positive effect can dominate the negative effect, especially if the financial sector is underdeveloped and riskier, and hence there are large gains from a "stabilization policy" for depositors. As an alternative to the commitment problem, depositors' imperfect monitoring would provide an equivalent argument and regulation could be considered as a public good to increase households' confidence in the ability of the banking sector to repay in any state of the world.

Given these theoretical results, we test the predictions of our model for two case studies with underdeveloped financial systems, in which the positive forces of regulation are predicted to dominate: the introduction of a new banking regulation in Ethiopia in April 2011, and the state roll-over of bank taxes in Antebellum USA (1800–1861). In both cases, we rely on identifying the effect of the policy by comparing small and large banks, attributing their differences to technological reasons. The Ethiopia case study presents four special features: balance sheets at monthly frequencies, which allow us to tightly track the policy change; distinct cross-sectional variation in asset size across Ethiopian banks, which contributes to a neat identification; a long-term branch map covering installations in the last 15 years; and annual report digitization for five years around the policy. In the Antebellum USA study, we combine the big-versus-small bank cross-sectional variation to the non-simultaneous introduction of taxes at state level. In this case, the number of available banks is much larger, 1,280, but the time span, though longer, comprises only yearly observations. Both cases support our theoretical predictions: banks exposed to this policy do not lose profits, accumulate more safe assets, and increase their deposits and loans.

We believe our results send two important messages. First, with regards to the economic literature on financial development, we highlight that banks, mostly neglected in the literature, should be considered of primary importance in the provision of financial development. Governments have important responsibilities to play in providing an optimal level of regulation, and striking a balance between securing profitability and the provision of extensive access. This is a field that needs further research and our paper provides some substantial reference for this. Second, we also aim to challenge the widespread idea that banking-sector deregulation in low-income countries is an optimal policy (IMF 2013a). A long history of regulation (Glaeser and Shleifer 2003; Shleifer 2005), and especially financial regulation (Barth, Caprio, and Levine 2004, 2008), in western economies shows the opposite, and our paper provides strong quantitative evidence that a moderate degree of regulation should actually be encouraged by national and international actors.

Appendix A: Deposit Decision with Different States and Remunerations

As in Section 1.3, the depositor problem can be described by

$$\begin{aligned}
\max_{c_1, c_{2G}, c_{2B}} \quad & c_1^\alpha + \delta[p c_{2G}^\alpha + (1-p) c_{2B}^\alpha] \\
\text{s.t.} \quad & c_1 + \frac{c_{2G}}{R_D} = y \\
& c_1 + \frac{c_{2B}}{R_{DB}(\rho)} = y.
\end{aligned}$$

Plugging the constraint in the maximand, we obtain

$$c_1^\alpha + \delta[p R_D^\alpha (y - c_1)^\alpha + (1-p) R_{DB}(\rho)^\alpha (y - c_1)^\alpha].$$

The first-order conditions are

$$\alpha c_1^{\alpha-1} = \alpha\delta[p R_D^\alpha (y - c_1)^{\alpha-1} + (1-p) R_{DB}(\rho)^\alpha (y - c_1)^{\alpha-1}]$$

and

$$c_1 = \frac{1}{1 + \delta^{1/(1-\alpha)}[p R_D^\alpha + (1-p) R_{DB}(\rho)^\alpha]^{1/(1-\alpha)}} y,$$

which describe the deposit decision

$$d = y - c_1 = \frac{\delta^{1/(1-\alpha)}[pR_D^\alpha + (1-p)R_{DB}(\rho)^\alpha]^{1/(1-\alpha)}}{1+\delta^{1/(1-\alpha)}[pR_D^\alpha + (1-p)R_{DB}(\rho)^\alpha]^{1/(1-\alpha)}} y.$$

This quantity is always positive and increasing in $R_{DB}(\rho)$.

Appendix B: Financial Regulation as Safe Asset Purchase

As reported in Section 1.4, it can be shown that the loan level increases in the policy parameter ρ if

$$\frac{\partial L}{\partial \rho} > 0 \rightarrow \frac{\partial \pi(\rho)}{\partial \rho}\frac{1}{\eta}d(\rho)[1-s(\rho)] + \frac{\pi(\rho)}{\eta}\frac{\partial d(\rho)}{\partial \rho}[1-s(\rho)] - \frac{\pi(\rho)}{\eta}d(\rho)\frac{\partial s(\rho)}{\partial \rho} > 0,$$

which implies that the elasticity of deposit mobilization to the regulation parameter exceeds the elasticity of the intermediation margin and loan provision to the regulation

$$\epsilon_{d\rho} > \epsilon_{\pi\rho} + \epsilon_{l\rho}.$$

Alternatively, recalling the definition of the profit margin

$$\pi(\rho) = p[(R_G - R_D) - \rho(R_G - R_S)]$$

and its first derivative with respect to ρ

$$\frac{\partial \pi(\rho)}{\partial \rho} = -p\rho(R_G - R_S),$$

we note that

$$\frac{\partial \pi(\rho)}{\partial \rho} = [\pi(\rho) - p(R_G - R_D)],$$

while the deposit function

$$d(\rho) = y - c_1 = \frac{\delta^{1/(1-\alpha)}[pR_D^\alpha + (1-p)R_{DB}(\rho)^\alpha]^{1/(1-\alpha)}}{1+\delta^{1/(1-\alpha)}[pR_D^\alpha + (1-p)R_{DB}(\rho)^\alpha]^{1/(1-\alpha)}} y.$$

Recalling that $R_{DB}(\rho) = \rho R_S + (1-\rho)R_B = \rho(R_S - R_B) + R_B$

$$d(\rho) = y - c_1 = \frac{\delta^{1/(1-\alpha)}\{pR_D^\alpha + (1-p)[\rho(R_S - R_B) + R_B]^\alpha\}^{1/(1-\alpha)}}{1+\delta^{1/(1-\alpha)}\{pR_D^\alpha + (1-p)[\rho(R_S - R_B) + R_B]^\alpha\}^{1/(1-\alpha)}} y$$

and its derivative in ρ

$$\frac{\partial d(\rho)}{\partial \rho} = \frac{\alpha}{1-\alpha} y \frac{\delta^{\frac{1}{1-\alpha}}\{pR_D^\alpha + (1-p)[\rho(R_S - R_B) + R_B]^\alpha\}^{\frac{1}{1-\alpha}-1}(1-p)[\rho(R_S - R_B) + R_B]^{\alpha-1}(R_S - R_B)}{[1+\delta^{\frac{1}{1-\alpha}}\{pR_D^\alpha + (1-p)[\rho(R_S - R_B) + R_B]^\alpha\}^{\frac{1}{1-\alpha}}]^2},$$

which can be simplified

$$\frac{\partial d(\rho)}{\partial \rho} = \frac{\alpha}{1-\alpha} y \times \frac{(1-p)(R_S - R_B)[\rho(R_S - R_B) + R_B]^{\alpha-1}}{\{pR_D^\alpha + (1-p)[\rho(R_S - R_B) + R_B]^\alpha\}[1 + \delta^{\frac{1}{1-\alpha}} \{pR_D^\alpha + (1-p)[\rho(R_S - R_B) + R_B]^\alpha\}^{\frac{1}{1-\alpha}}]} d(\rho).$$

Then, we can simplify the previous expression

$$\frac{\partial \pi(\rho)}{\partial \rho} \frac{1}{\eta} d(\rho)(1-\rho) + \frac{\pi(\rho)}{\eta} \frac{\partial d(\rho)}{\partial \rho} [1 - s(\rho)] - \frac{\pi(\rho)}{\eta} d(\rho) > 0$$

$$-\rho\pi(\rho)d(\rho) - p(R_H - R_D)(1-\rho)d(\rho) + (1-\rho)\pi(\rho)\frac{\partial d(\rho)}{\partial \rho} > 0$$

reaching the following expression

$$\frac{\partial d(\rho)}{\partial \rho} \frac{1}{d(\rho)} > \frac{\rho}{1-\rho} + \frac{1}{1 - \rho[(R_H - R_S)/(R_H - R_D)]}$$

whose left-hand side can be described by

$$\frac{\partial d(\rho)}{\partial \rho} \frac{1}{d(\rho)} = \frac{\alpha}{1-\alpha} y \times \frac{(1-p)(R_S - R_B)[\rho(R_S - R_B) + R_B]^{\alpha-1}}{\{pR_D^\alpha + (1-p)[\rho(R_S - R_B) + R_B]^\alpha\}[1 + \delta^{\frac{1}{1-\alpha}} \{pR_D^\alpha + (1-p)[\rho(R_S - R_B) + R_B]^\alpha\}^{\frac{1}{1-\alpha}}]}.$$

Therefore, we can conclude that

$$\frac{\alpha}{1-\alpha} y \frac{(1-p)(R_S - R_B)[\rho(R_S - R_B) + R_B]^{\alpha-1}}{\{pR_D^\alpha + (1-p)[\rho(R_S - R_B) + R_B]^\alpha\}[1 + \delta^{\frac{1}{1-\alpha}} \{pR_D^\alpha + (1-p)[\rho(R_S - R_B) + R_B]^\alpha\}^{\frac{1}{1-\alpha}}]}$$

$$> \frac{\rho}{1-\rho} + \frac{1}{1 - \rho[(R_G - R_S)/(R_G - R_D)]}$$

hence defining

$$A(\rho) = \frac{(1-p)(R_S - R_B)[\rho(R_S - R_B) + R_B]^{\alpha-1}}{\{pR_D^\alpha + (1-p)[\rho(R_S - R_B) + R_B]^\alpha\}[1 + \delta^{\frac{1}{1-\alpha}} \{pR_D^\alpha + (1-p)[\rho(R_S - R_B) + R_B]^\alpha\}^{\frac{1}{1-\alpha}}]}.$$

Noting that $A(\rho) > 0$ and $\partial A(\rho)/\partial \rho < 0$ and $\partial A(\rho)/\partial p < 0$, we reach the expression stated in Section 1.4

$$\frac{\alpha}{1-\alpha} y A(\rho) > \frac{\rho}{1-\rho} + \frac{1}{1 - \rho[(R_G - R_S)/(R_G - R_D)]}.$$

This expression can be used to define a threshold $\widetilde{\rho}$, such that

$$\frac{\partial L}{\partial \rho} = \begin{cases} \geq 0 & \rho \leq \widetilde{\rho}, \\ < 0 & \rho > \widetilde{\rho}. \end{cases}$$

By analyzing the previous expression, leaving prices as given, two factors stand out as central: $\widetilde{\rho} = \widetilde{\rho}(p, y)$, the probability of good state p, which has a negative relation on the threshold, and the level of income y, which has a positive effect. The first is intuitive: the higher the probability of a bad state, $1-p$, the stronger the effect of safe assets on mobilized deposits. Analogously for income, other things being equal, an increase in income creates a stronger desire to transfer resources to the uncertain period.

Calibrating the parameters to Ethiopia, setting $\alpha = 1/2$, $\delta = 0.9$, $y = 20$, and market rates in line with the assumptions, this can be simplified to $R_B = 0$, $R_D = 1$, $R_S = 21/20$, and $R_G = 25/20$, which implies $\underline{p} = (R_S - R_B)/(R_G - R_B) = 0.84$ and $p = 0.9 > \underline{p}$:

$$\frac{\alpha}{1-\alpha} y \frac{(1-p)(R_S - R_B)[\rho(R_S - R_B) + R_B]^{\alpha-1}}{\{pR_D^\alpha + (1-p)[\rho(R_S - R_B) + R_B]^\alpha\}[1 + \delta^{\frac{1}{1-\alpha}}\{pR_D^\alpha + (1-p)[\rho(R_S - R_B) + R_B]^\alpha\}^{\frac{1}{1-\alpha}}]}$$

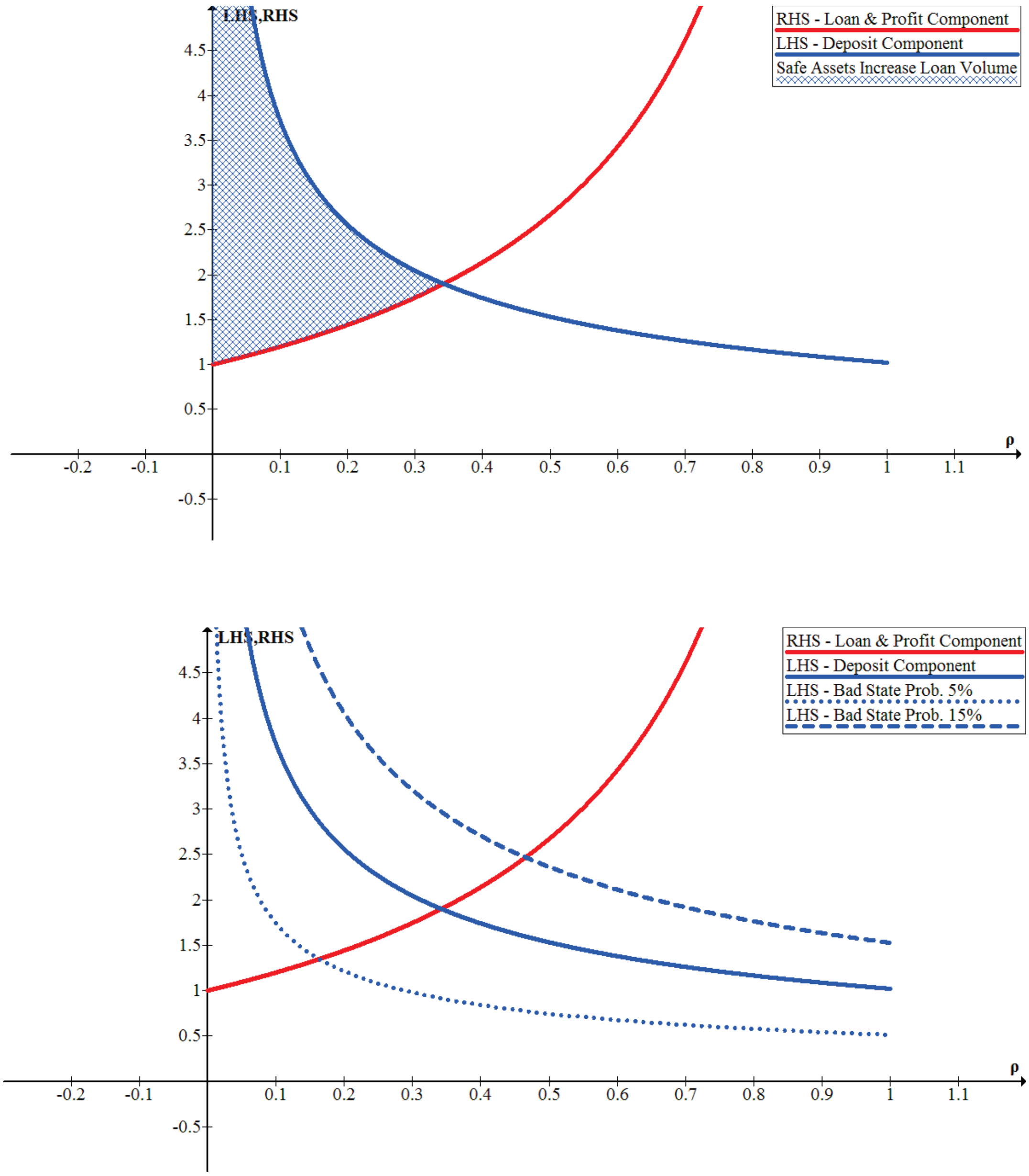
$$> \frac{\rho}{1-\rho} + \frac{1}{1 - \rho[(R_G - R_S)/(R_G - R_D)]}$$

$$5 \frac{0.1\sqrt{(21/20)}(\rho)^{\alpha-1}}{[0.9 + 0.1\sqrt{\rho(21/20)}]\left\{1 + 0.9^2[0.9 + 0.1\sqrt{\rho(21/20)}]^2\right\}} > \frac{\rho}{1-\rho} + \frac{1}{1-\rho(4/5)}$$

The picture in Section 1.4 is calibrated with these parameters, while in Appendix C, we report the same picture with changes in p and y.

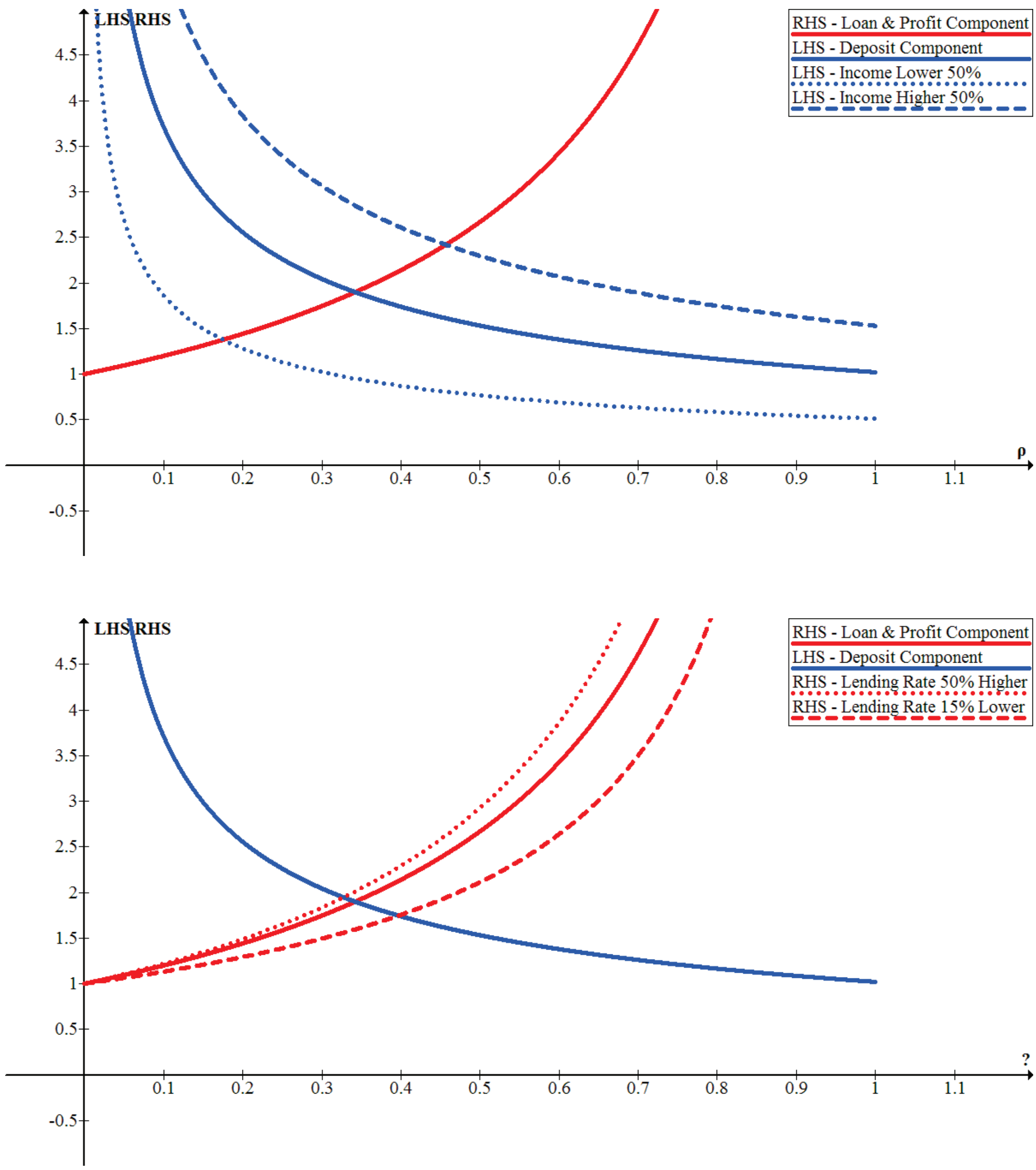
Appendix C: Comparative Statics in p

Figure C1: Comparative Statics of Threshold to p



Note: This figure plots the conditions under which loan volume increases with the regulated share of safe assets. The x-axis reports the values of the safe asset share parameter ρ, and the y-axis reports the values of the right- and left-hand side (RHS and LHS) variables. As is clear from the inequality, the LHS is decreasing with the parameter (reported in blue), while the RHS is increasing (in red). This picture assumes that the bank rates are in line with the model and calibrated with the Ethiopian economy, as from National Bank of Ethiopia (2011), and that other parameters are in line with the literature: $R_G = 5/4$; $R_S = 21/20$; $R_B = 0$; $R_D = 1$; $\delta = 0.9$, $\alpha = 1/2$; $p = 0.9$; $y = 20$. The shaded area reports the regions in which the regulation determines an increase in loan volume. The upper panel reports the main picture with $p = 0.9$. The lower panel reports three cases: $p = 0.9$ (solid line), $p = 0.85$ (dashed line), and $p = 0.95$ (dotted line).

Figure C2: Comparative Statics of Threshold to y and R_G



Note: This figure plots the conditions under which loan volume increases with the regulated share of safe assets. The x-axis reports the values of the safe asset share parameter ρ, and the y-axis reports the values of the right- and left-hand side variables (RHS and LHS). As is clear from the inequality, the LHS is decreasing with the parameter (reported in blue), while the RHS is increasing (in red). This picture assumes that the bank rates are in line with the model and calibrated with the Ethiopian economy, as from National Bank of Ethiopia (2011), and that other parameters are in line with the literature: $R_G = 5/4$; $R_S = 21/20$; $R_B = 0$; $R_D = 1$; $\delta = 0.9$, $\alpha = 1/2$; $p = 0.9$; $y = 20$. The shaded area reports the regions in which the regulation determines an increase in loan volume. The upper panel reports the main picture with $p = 0.9$. The lower panel reports three cases: $p = 0.9$ (solid line), $p = 0.85$ (dashed line), and $p = 0.95$ (dotted line).

Appendix D: Testing the Relation between Bank Size and Unit Costs

Table D1: Bank Size and Efficiency: Annual Reports

	(1)	(2)
Variables	Administrative Costs	
	on Asset	on Employee
Big Bank	−0.00446***	−0.0227***
	(0.00127)	(0.00563)
Year FE	Yes	Yes
Obs.	40	49
R^2	0.335	0.506
Adjusted R^2	0.258	0.435
Mean Dep. Var.	0.0113	0.0504
SD Dep. Var.	0.00449	0.0228

Note: This table reports OLS estimates. The unit of observation is bank level, and year fixed effects are included. Davidson and McKinnon (1993) robust standard errors are reported in parentheses, which for this case are more conservative than bootstrapped bank-level clustered. Administrative costs are defined from banks' annual reports as expenses related to the organization of the whole bank as opposed to an individual branch. These are normalized by bank assets in column (1) and by number of employees in coumn (2). Their means and standard deviations are reported in the final two rows. Big Bank is a dummy that takes unit value for the six largest Ethiopian Banks, and zero otherwise. The R^2 and adjusted R^2 of these regressions are also reported. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Appendix E: Testing Compliance of the NBE Bill Policy

This section verifies that 0.27 NBE bills were purchased for each birr of private lending and that this was no different between big and small banks. We present a simple fixed effect regression, introducing a dummy variable for the months in which the policy is in place. The following empirical model is tested:

$$v_{ity} = a + b \cdot Policy_{ty} \times Lending_{ity} + c \cdot Policy_{ty} \times Lending_{ity} \times Big\ Bank_i + \iota_i + \iota_{ty} + \epsilon_{ity}. \quad \text{(E1)}$$

Here, v_{ity} is the amount of NBE bills purchased by bank i in month t of year y, and is run over a dummy variable taking unit value after April 2011, $Policy_{ty}$, interacted with the volume of lending, $Lending_{ity}$, and then another term where we also explore whether there were systematic differences across big and small banks, $Policy_{ty} \times Lending_{ity} \times Big\ Bank_i$. The null hypothesis of these tests is $b = 0.27$ and $c = 0$. Table E.1 does not reject both of these. Indeed, column (1) shows that the point estimate of b is indeed very close to 0.27 (0.265) and even the standard errors are very small, despite using a clustered bootstrapped method (alternative procedures, such as robust, hc3 or unclustered bootstrap, provide less conservative standard errors). In column (2), we introduce an

Table E1: Compliance in Regulation: Within-Year Variation

	(1)	(2)
Variables	NBE Bills (million birr)	
Private Lending × Policy	0.265***	
	(0.0395)	
Private Lending × Policy		0.206***
		(0.0848)
Private Lending × Policy × Big Bank		0.0621
		(0.0959)
Bank FE	Yes	Yes
Month FE	Yes	Yes
Obs.	168	168
Number of Banks	14	14
R^2	0.875	0.878
Adjusted R^2	0.864	0.866
Mean Dep. Var.	625.3	625.3
SD Dep. Var.	781.8	781.8

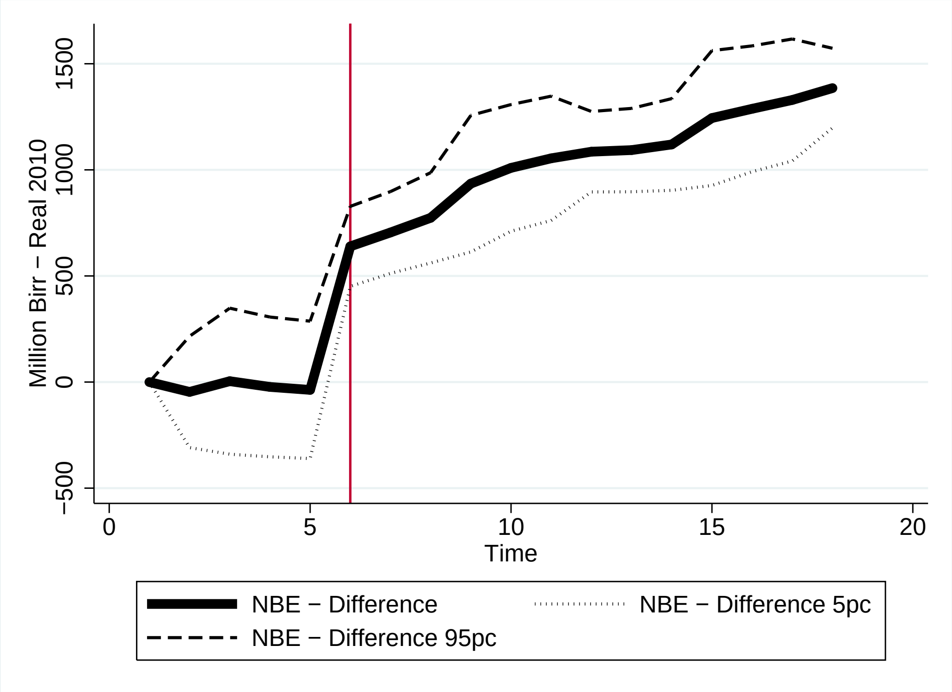
Note: This table reports OLS estimates. The unit of observation is bank level, and bank and month fixed effects are included. Standard errors are bootstrapped at bank-level cluster. NBE bills is the amount of bills issued by the NBE in million birr, and is a continuous variable. Its mean and standard deviation are reported in the final two rows. In column (1), NBE bills is regressed on the interaction between Private Lending, in million birr and a continuous variable, and the Policy dummy, taking unit value from April 2011 onward. In column (2), we also add an interaction of this variable with the Big Bank dummy, presented in Figure 4, to verify whether big banks comply differently. The null hypothesis is that in column (1) the coefficient is 0.27, as prescribed by the NBE directive, and we cannot reject this. In column (2), the null hypothesis is whether the big bank interaction is statistically different from zero, and we cannot reject this either. The R^2 and adjusted R^2 of these regressions are also reported. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

interaction and verify whether there is any differential implementation of the policy across big and small banks. Although the point estimate of b drops to 0.20 (with standard errors doubling), we can also verify that c is not statistically different from zero. This supports the hypothesis that all banks were equally affected by the policy and complied.

Appendix F: Estimation and Confidence Intervals

Bi-Monthly Variation Confidence Intervals

Figure F1: Bank Aggregates and Policy Change: 95% Confidence Intervals



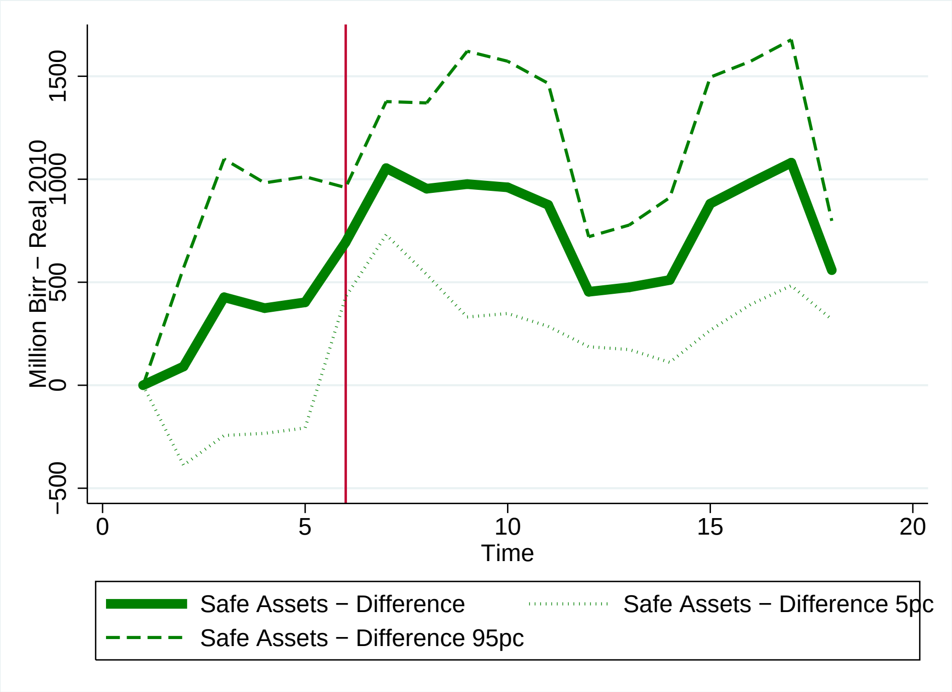
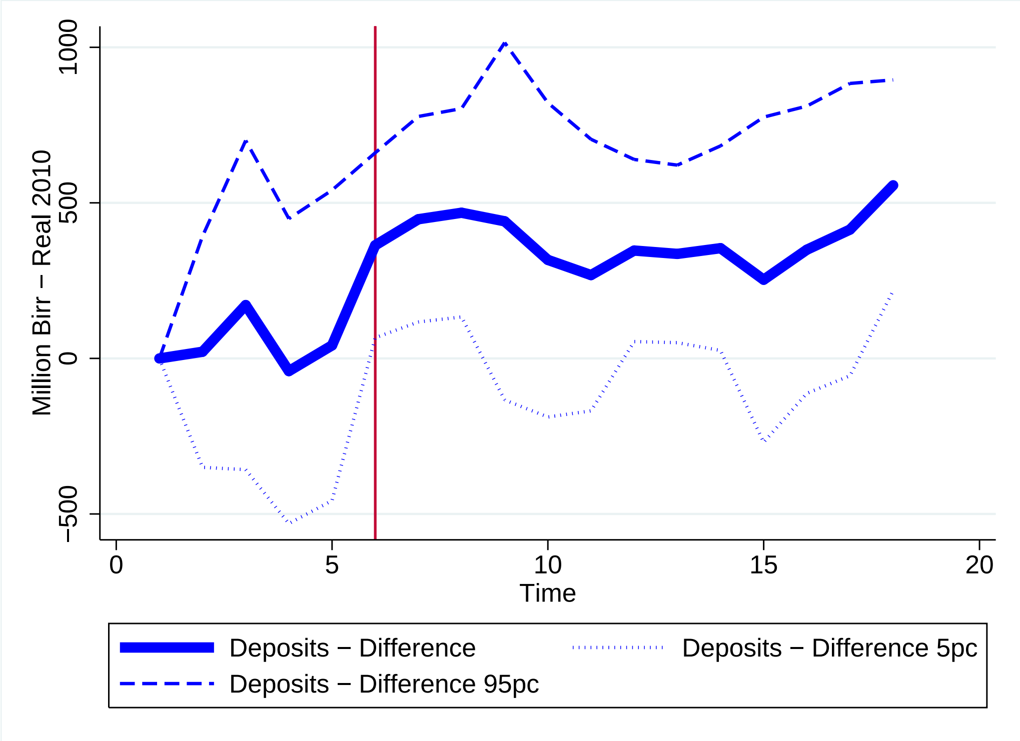
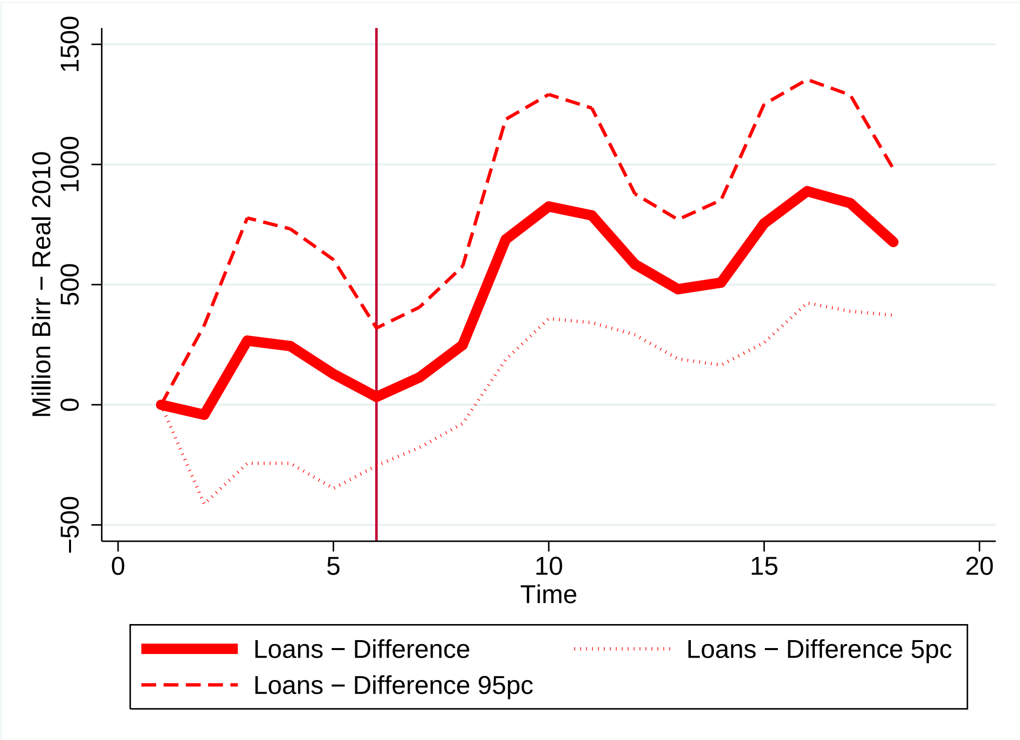


Figure F1: (continued)





Note: This figure plots the coefficients of the differential trend between big and small banks reported in Table 1, for all periods, for NBE bills (black; panel 1), safe assets (green; panel 2), deposits (blue; panel 3), and loans (red; panel 4). The policy is announced in March 2011 and implemented in April 2011 (shown by the vertical solid line). As is evident, there occurs an important discontinuity around the policy introduction for all variables except safe assets, and larger banks respond substantially more than smaller banks. Beyond purchasing more NBE bills in volume, which is true by design of the policy, they expand significantly more in deposits on the spot and from period 8 onwards also in private lending. As is evident from Table 1, the pre-policy trends are not statistically different from zero, while post-policy all of them are. The dotted lines report the 95th percentile of the effect, while the dashed lines show the 5th percentile.

Quarterly Variation Confidence Intervals

Figure F2: Bank Aggregates and Policy Change: 95% Confidence Intervals

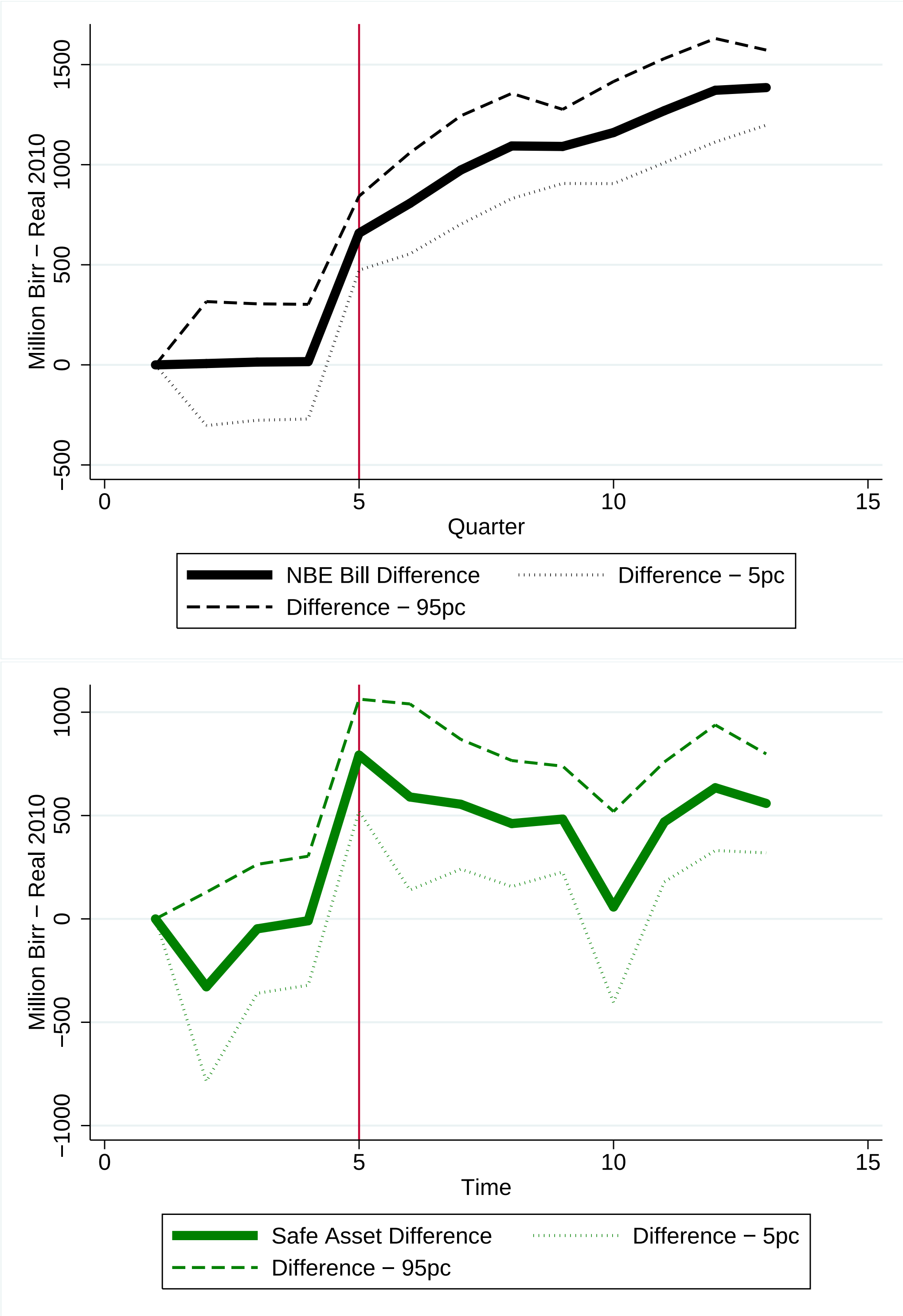
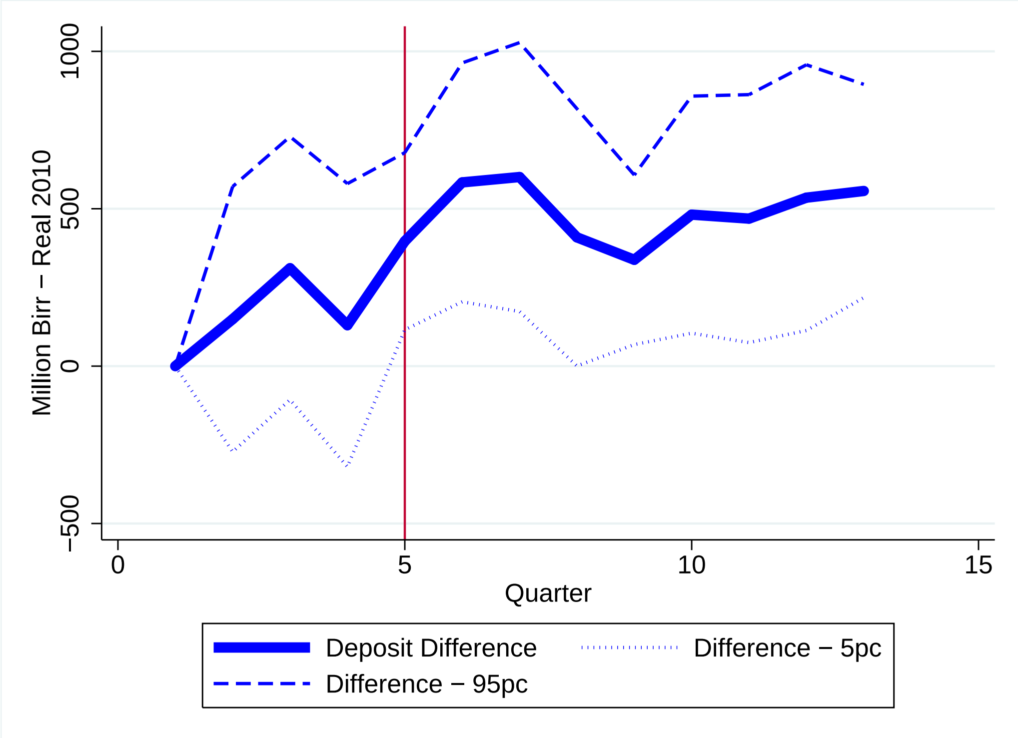
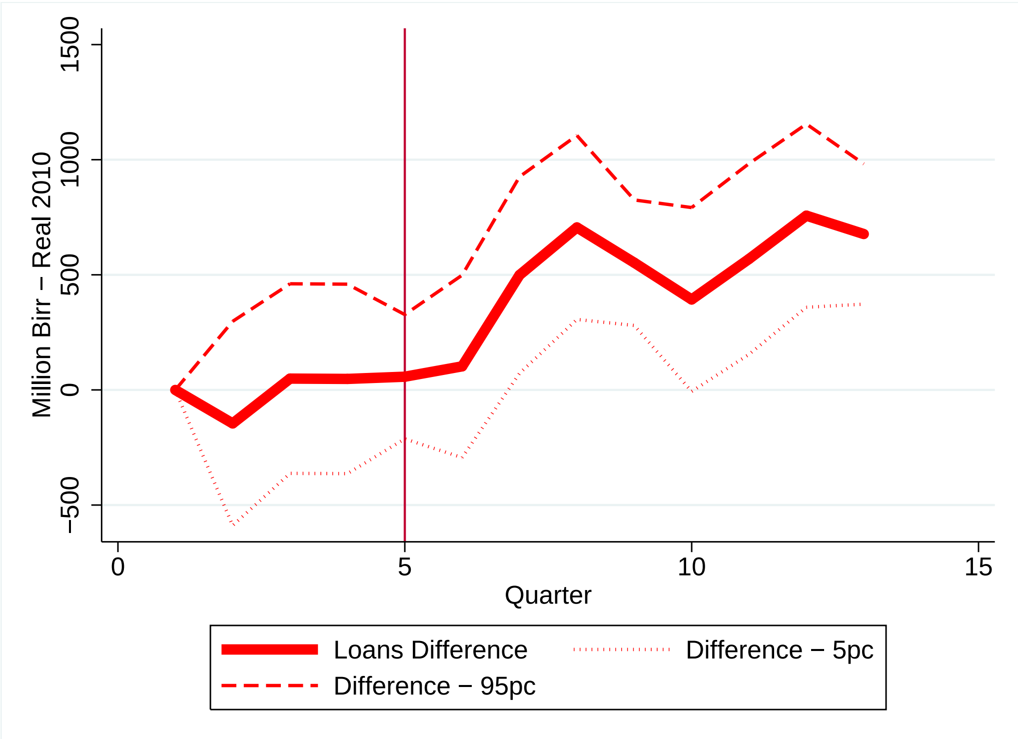


Figure F2: (continued)

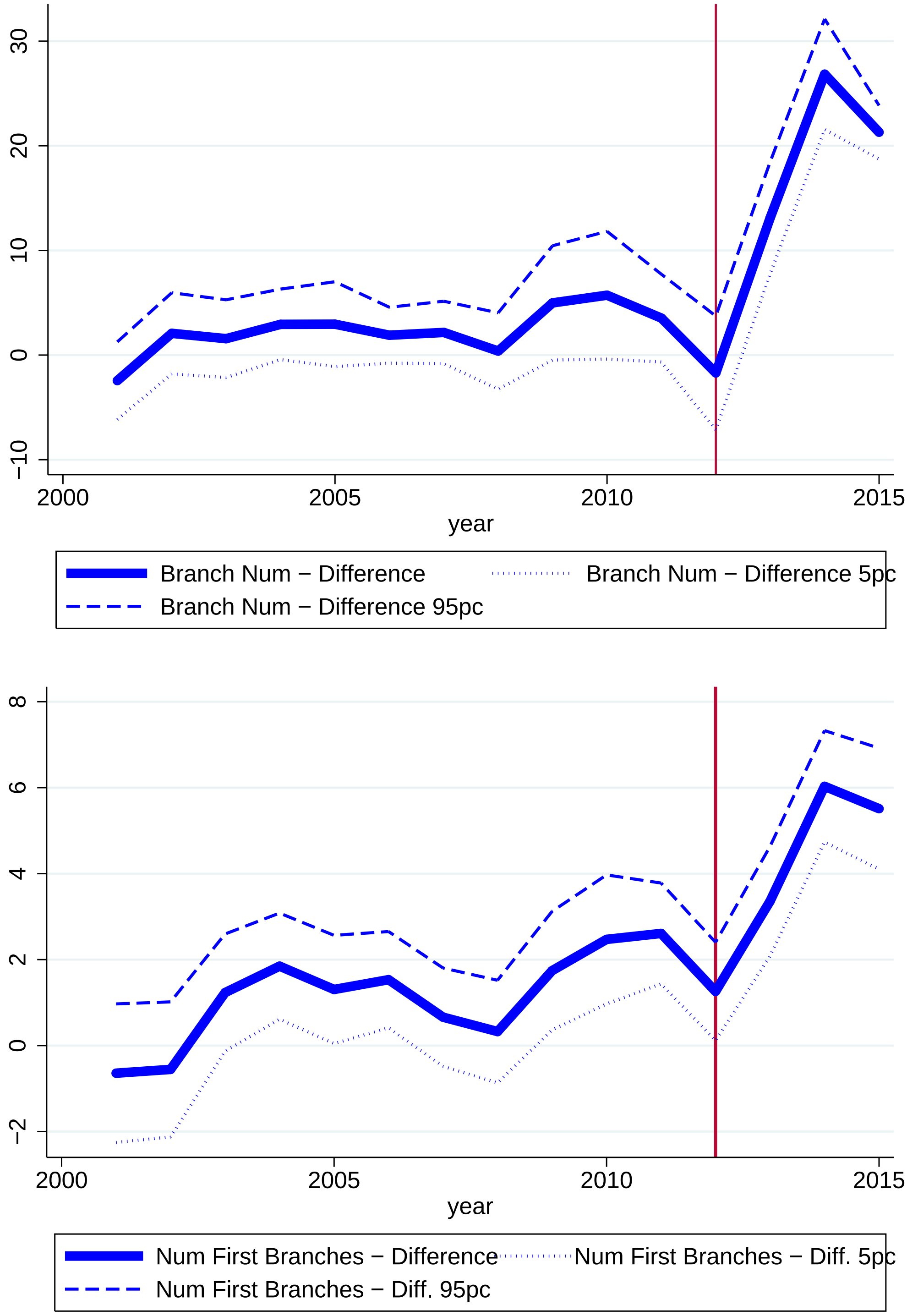




Note: This figure plots the coefficients of the differential trend between big and small banks reported in Table 1, for all periods, for NBE bills (black; panel 1), safe assets (green; panel 2), deposits (blue; panel 3), and loans (red; panel 4). The policy is announced in March 2011 and implemented in April 2011 (shown by the vertical solid line). As is evident, there occurs an important discontinuity around the policy introduction for all variables except safe assets, and larger banks respond substantially more than smaller banks. Beyond purchasing more NBE bills in volume, which is true by design of the policy, they expand significantly more in deposits on the spot and from period 8 onwards also in private lending. As is evident from Table 1, the pre-policy trends are not statistically different from zero, while post-policy all of them are. This picture reports graphically the point estimate and 95% confidence interval of the coefficients on the interaction between the quarterly dummies and the big bank dummies from Table 1, but employing quarter dummies rather than two-month period dummies. The dotted lines report the 95th percentile of the effect, while the dashed lines show the 5th percentile.

Branch Installation Confidence Intervals

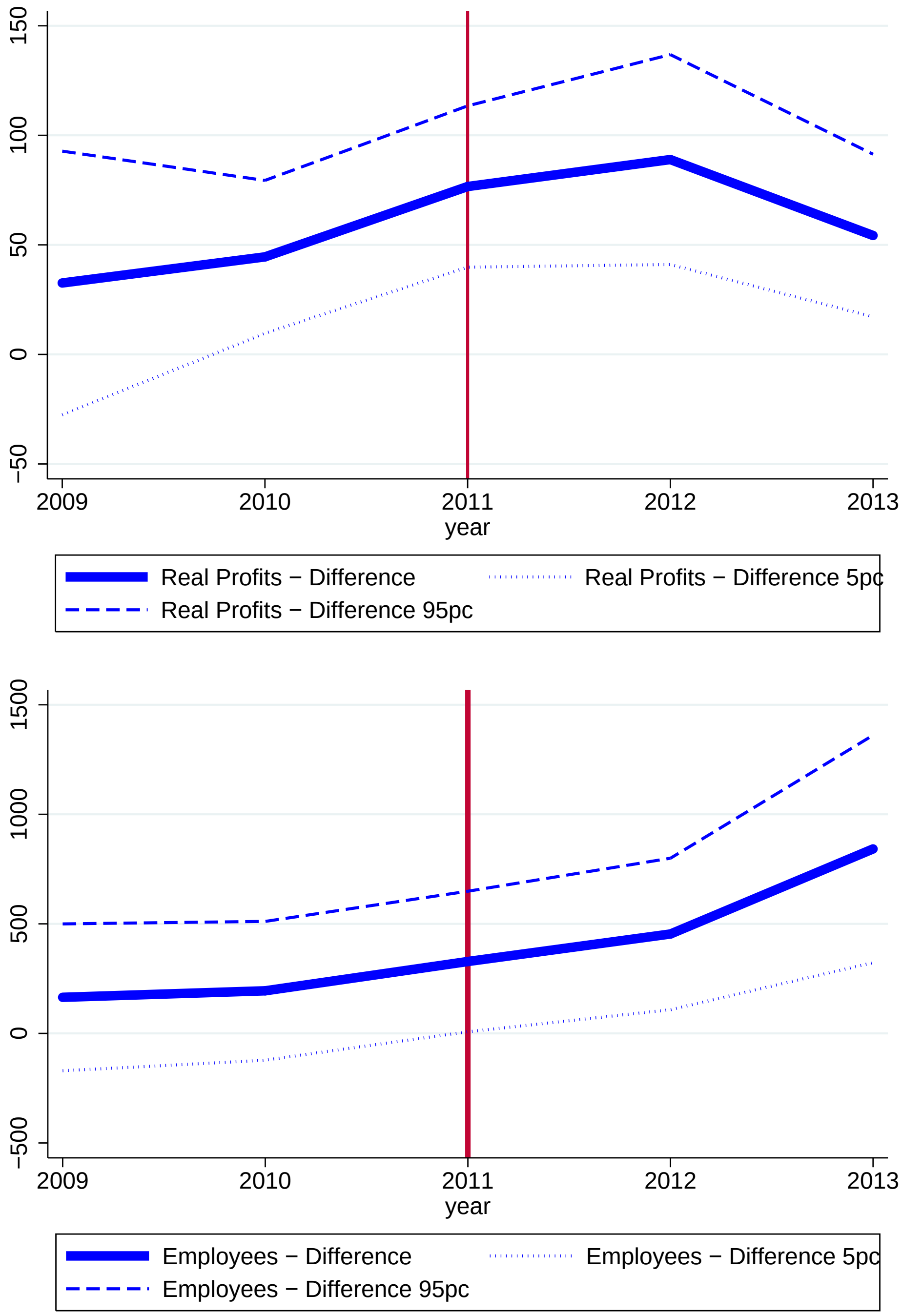
Figure F3: Branch Installation



Note: This figure plots the differential trends and 95% confidence intervals between big and small banks in overall branches (upper panel) and rural branches (lower panel). The policy is implemented in April 2011 (shown by the red vertical line). As is evident, while branch accumulation does not differ before the policy change, afterwards big banks start to install more branches overall (upper panel) and more rural branches (lower panel). The trends for big and small banks can be found in Figure 7.

Annual Reports Confidence Intervals

Figure F4: Real Profits and Number of Employees



Note: This figure plots the differential trends and 95% confidence intervals between big and small banks in real profits (upper panel) and number of employees (lower panel). The policy is implemented in April 2011 (shown by the red vertical line). As is evident, while both profits and number of employees do not differ before the policy change, afterwards there is some evidence that big banks start to earn more (upper panel) and to hire more employees (lower panel). Because of the yearly nature of the data, the power of this test is low. The trends for big and small banks can be found in Figure 8.

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