Deposits at War:

How Outside Deposit Competition in Crisis Times Affects Banks

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Abstract

How does deposit competition from outside the commercial banking sector affect banks during a crisis and beyond? In the Netherlands, depositors could hold an account at the central bank, and these balances rose sharply in the panic at the outbreak of WWI. Banks' exposure depended on the share of their branches in cities with a central bank deposit office. Banks' branch networks developed independently of these offices: banks could borrow from the central bank in virtually every city. Controlling for other differences between cities, this paper finds that fully exposed banks raised demandable deposit rates during the crisis by about 40 basis points more than non-exposed banks. Deposits returned once the crisis subsided. Yet in the following years, fully exposed banks relied 30% less on deposits and grew 20% less. Their deposit rates were no longer higher, indicating that the deposit slowdown was bank-driven, not depositor-driven. Even short-lived deposit competition during a crisis can thus persistently lower the value of banks' deposit franchise.

Keywords: Banking, financial stability, financial history, deposit competition

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"*In normal times, a wide range of assets may be accepted as money. In a crisis, central bank money is the ultimate means of payment and store of value.*"

– Mervyn King, former Governor of the Bank of England (2016)

Retail deposits are commercial banks' cheapest and most stable source of funding. Even though depositors can leave, banks with deposit market power operate a deposit franchise, which allows them to price deposits below market rates (Drechsler et al., 2017, 2021, 2026). Outside deposit competition, i.e. depositing alternatives *outside* the commercial banking sector, such as stablecoins and central bank digital currencies, threatens banks' deposit franchise. Such competition can benefit depositors through higher rates offered by banks, but it can also raise banks' funding costs and reduce their credit supply. This paper studies how outside deposit competition affects banks' deposit pricing and funding structure.

It is unclear ex ante how outside deposit competition affects banks. Retail depositors are known to be sticky and slow to switch (Drechsler et al., 2017; Fleckenstein and Longstaff, 2024; Yankov, 2024). If outside options are not remunerated and offer no extra services, as in most stablecoin regulation and CBDC design proposals, commercial banks may remain more attractive to depositors. In normal times, depositors likely prioritize returns and convenience over the safety of an alternative means of payment with little or no credit risk. During crisis times, safety concerns may dominate. A crisis can trigger a flight to safety toward outside options initially designed as a means of payment, which then unintentionally become a store of value.

Empirically, changes in deposit competition are rarely exogenous to bank or local economic conditions, making causal identification difficult. Moreover, empirical and theoretical evidence of deposit competition during crisis times, when it matters most, is largely absent. Identifying the causal effect of outside competition on banks requires an exogenous shock to deposit markets and a safe outside option with convenience similar to a bank deposit. This paper studies a historical setting that had both.

Leveraging a unique daily dataset of newspaper advertisements of Dutch banks, this paper shows how banks responded to central bank deposit competition triggered by the outbreak of the First World War. The Dutch central bank (DNB) historically accepted retail deposits, without remuneration or holding limits. Because deposit markets were local, otherwise similar banks differed in their exposure to central bank competition, measured as the share of their branches located in a city with a central bank deposit office. More exposed banks increased their demandable deposit rate by an additional 40 basis points and were four times as likely to invert their deposit term structure. The price response disappeared once the crisis subsided. Despite deposits returning to the

banks within months, more exposed banks relied less on deposits for their funding in the following years.

DNB accepted retail deposits in an attempt to transform the Dutch payment system from cash to a credit transfer system (*giro*).[1] Because deposits at DNB carried a fee and earned no interest, the accounts were mainly used by banks for making payments. The First World War changed this. Although the Netherlands remained neutral, the outbreak on 28 July 1914, the Amsterdam stock market closure on 29 July, and the Dutch mobilization on 31 July, led to a widespread, but short-lived panic across the country. The threat of war triggered an outflow of deposits at commercial banks and a flight to safety to the central bank. DNB abolished its depositing fee and received an inflow of 30 million guilders ($f.$), equivalent to 15% of the commercial banks' demandable deposits pre-war (Van Riel, 2021).[2] During the course of 1914 the threat of war diminished and the Dutch economy benefited substantially from its neutral status during the war (Petram, 2016; 't Hart et al., 1997).

This paper exploits this setting using a difference-in-differences design with continuous treatment based on the share of commercial banks' branches located in cities with a central bank office. The outbreak of the war in 1914 was an exogenous shock, unrelated to economic conditions or bank fundamentals. The exposure to the central bank was fixed decades earlier and plausibly exogenous in both directions. The Bank Act of 1863, before most commercial banks were founded, required DNB to open at least one branch in every province. By 1914, 20 cities had a central bank deposit office, while several cities of similar size did not. Commercial banks, in turn, had little reason to locate near a central bank office: DNB had about 80 smaller offices where banks could borrow against collateral, but where no deposit accounts could be opened.

The results are threefold, corresponding to the short, medium and long run. In the short run (the panic of July-August 1914), banks with more branches located in a central bank city raised their demandable deposit rates more following the shock. Banks set a single rate across all branches. Compared to a non-exposed bank, a fully exposed bank (with all branches overlapping with central bank offices) increased its deposit rate by about 40 basis points in the weeks after the shock. Since the pre-war average demandable rate was 2.88%, this is a sizeable effect. The effects are robust when controlling for bank characteristics or location differences. More exposed banks were also more likely to adopt

[1] Central bank retail deposits are not unique to the Dutch financial system: historically, many central banks accepted retail deposits. See Anitipa et al. (2026) for an overview.

[2] Notably, deposit outflows at commercial banks exceeded the inflows at the central bank, since many depositors preferred cash to central bank accounts. The central bank account was not a perfect substitute for cash: it allowed large balances to be held safely and could be used for giro payments. What matters for the identification is not who preferred central bank deposits over cash, but that a DNB account was an additional outside option for depositors in a city with a central bank office.

an inverted term structure, offering higher rates on shorter deposits than on longer ones. The probability of inversely pricing deposits rose by about 26 percentage points, or by a factor of four compared to a pre-war mean of 5%.

In the medium run when the war threat diminished (from September 1914 until the end of 1915), deposits returned to both less and more exposed banks. The stock exchange reopened in February 1915, which provided banks another non-deposit funding means again: collateralized repo borrowing in the money market. Once the repo transactions — frozen at the outbreak of the war — could be settled again in July 1915, the rate gap between more and less exposed banks disappeared.

In the long run (adjustment, 1914-1918), more exposed banks relied less on deposit funding. A fully exposed bank's deposit share was almost a third lower than a non-exposed bank's share, relative to before the war. Since this deposit slowdown was not fully compensated by other sources of funding, more exposed banks grew more slowly in size. More exposure to the central bank is also correlated with slower lending growth, though the paper cannot isolate loan demand from loan supply. The slowdown in lending is driven by illiquid loans, which is consistent with the idea that more exposed banks adjusted their portfolio away from loans that are harder to liquidate when deposit withdrawals occur.

The results show that even a short-lived episode of outside deposit competition can reshape how commercial banks fund themselves. More exposed banks attracted fewer deposits in the long run, but did not raise their rates once the crisis had faded. As in models of deposit market power (Chiu et al., 2023), lower deposit volumes at unchanged rates indicate a shift in banks' supply of deposits (the value banks attach to deposit funding), rather than a shift in depositors' demand. The results are therefore consistent with banks revaluing their deposit franchise. Before the war, banks saw deposits as both cheap and stable. During the crisis, with the money market closed, deposits could not be replaced, and more exposed banks raised their deposit rates to retain the deposits that could leave for the central bank. After the crisis, those deposits were worth less to the banks: deposits might have to be defended again, and other funding became available. More exposed banks therefore relied less on deposits.

The findings have policy implications for CBDC designs. First, the paper shows that central bank retail deposits, even when designed as a means of payment, can unintentionally become a store of value in times of crisis. Second, while most literature has focused on the retail adoption of CBDC and corresponding deposit outflows, this paper provides a new perspective: commercial banks might also lower the value they attach to their deposit franchise, even when deposits return. Similar to current proposals, the DNB accounts were not remunerated. Unlike current proposals, DNB did not impose holding limits. Credible holding limits of CBDC put a cap on the outflow of deposits to

the central bank, but the counterfactual is not obvious: in 1914, many depositors moved into cash. Holding limits keep large balances out of CBDC, but not inside banks: in a crisis, they are likely to go to other means of payment, such as cash or stablecoins, instead.

Related Literature. This paper adds to three strands of literature. First, the paper contributes to the fast-growing literature on deposit competition. This literature mostly studies competition *within* the banking sector, initiated by papers showing banks' market power in local deposit markets (Drechsler et al., 2017, 2021). Follow-up literature shows how banks compete for depositors: by branch expansion (Begenau and Stafford, 2025), targeted advertisements and sign-up bonuses (Benetton et al., 2026), by differentiating rates within the bank based on the market power in the local market (Drechsler et al., 2017), or differentiating between different types of depositors (Basten et al., 2026; Fleckenstein and Longstaff, 2024). Outside options enter through market rates: when the policy rate rises, depositors move to higher-yielding assets (Drechsler et al., 2017), especially depositors who already have access to market-priced savings (Basten et al., 2026). This paper instead studies competition from *outside* the banking sector, during a crisis, when in general deposit competition intensifies (Ahn and Brei, 2024).

Drechsler et al. (2026) show that the deposit franchise is in itself a source of fragility: it depends on depositors staying in the bank. My paper documents a revaluation of the deposit franchise, but in a setting where the franchise was revalued by banks rather than destroyed by depositors. Depositors returned within months, yet more exposed banks relied less on deposit funding for years. The contribution of this paper is therefore not just that outside deposit competition raises rates, but that short-lived outside competition can persistently alter how banks value their deposit franchise.

Second, competition in crises is also central to the literature on flight to safety and CBDC. Since Caballero and Krishnamurthy (2008), recent empirical work examines the flight-to-safety toward large banks (Cipriani et al., 2024), money market funds with central bank access (Gurrieri et al., 2025), bank deposits in general during geopolitical shocks (Anastasiou et al., 2025) and banks with the most credible deposit insurance (Bonfim and Santos, 2023). This paper provides empirical evidence on flight directly to central bank deposits.

Since only a few countries have implemented a CBDC so far, the literature is mostly theoretical: see Ahnert et al. (2022) for an overview. Theory predicts that outside competition for bank deposits from central banks can lead to instability and disintermediation (Bidder et al., 2024; Keister and Sanches, 2023; Whited et al., 2023). Williamson (2022b) shows that banking panics are more likely to occur under CBDC, while Keister and Mon-

net (2022) argue that a central bank may be better placed to intervene in a run.[3] This paper turns to history to provide one of the first empirical contributions on central bank competition for retail deposits in times of crisis.

Other papers show that the impact of CBDC on banks depends on its design (Agur et al., 2022; Bidder et al., 2024; Kim and Kwon, 2023; Williamson, 2022a). Brunnermeier and Niepelt (2019) show that central bank retail deposits can be neutral if the central bank passes deposits it receives back to commercial banks. Anecdotal evidence suggests that commercial banks that were more exposed to the central bank and faced outflows tapped the discount window more often.

On banks' deposit pricing response, Ahnert et al. (2025) show that banks offer more attractive deposit contracts to retain depositor funding. Andolfatto (2021) and Chiu et al. (2023) show that the existence of a CBDC as an outside option forces banks with market power to raise their deposit rates, which expands deposits but does not reduce lending. These papers align with the finding that banks more exposed to the central bank raised their deposit rates more. Contrary to these models, however, in this paper more exposed banks relied less on deposits and saw slower lending growth. This difference can be explained by a perceived run risk, which is absent in steady-state models.

Finally, this paper adds to the financial history literature on central bank retail deposits. Anitipa et al. (2026) provide an overview of central banks that accepted retail deposits in the past.[4] Related to this research are three papers documenting depositor behavior during crises when central banks accepted retail deposits. Antipa and Rieder (2026) study the Bank of England during the Overend & Gurney crisis in 1866, Jorge-Sotelo (2026) focuses on Banco de España during the political regime change in 1931 and Baubeau et al. (2021) look at the Banque de France during the French banking crisis of 1930-1931. My paper finds a similar flight to safety of retail deposits to the central bank during a crisis, but focuses on the response of commercial banks. The Dutch central bank did not actively compete for deposits. I can therefore study how commercial banks respond to the *mere existence* of a central bank alternative when an exogenous shock suddenly raises its attractiveness.

The rest of the paper is structured as follows. The first section describes the historical background. Section 2 covers the hand-collected dataset, while Section 3 explains the

[3]Both in theoretical and empirical settings, disentangling the role of central bank retail deposits as means of payment or store of value is not straightforward. I will not attempt to isolate one of the two functions of money here.

[4]Grodecka-Messi and Zhang (2023, 2025) use the note-issuance monopoly of the central banks of Canada and Sweden, respectively, to illustrate the potential effects of central bank competition on the commercial banking sector.

empirical approach. Section 4 presents the empirical results, Section 5 reconciles the findings in a conceptual framework and Section 6 concludes.

1 Historical Background

The Dutch central bank, *De Nederlandsche Bank* (DNB), was founded in 1814 in Amsterdam by King William I as a private institution with a note-issuance monopoly.[5] Until 1860, DNB was the largest financial institution in the Netherlands. Both financial and non-financial institutions could borrow from the central bank after official approval, either via discounting bills of exchange ("*wissels*") at the discount window, collateralized short-term borrowing with securities as collateral ("*beleeningen*"), or collateralized overdrafts on current account ("*voorschotten in rekening-courant*"). Most commercial banks ("*handelsbanken*") were founded after 1860, yet their initial growth was slow and their credit provision overly cautious (De Jong, 1967a). Only in the early twentieth century did multi-branch networks of commercial banks begin to develop (Jonker, 1995). See Appendix A for more details on the development of DNB and the commercial banks before 1914.

1.1 The Central Bank Offices

Until 1864, DNB was located only in Amsterdam. The Bank Act of 1863 changed this: it obliged DNB to open at least one deposit office ("*agentschap*") in each of its provinces. As a result, between 1864 and 1867, 14 deposit offices opened across the Netherlands, making DNB the first Dutch bank with a national branch network (Kymmell, 1992; Van Riel, 2021).[6] From 1889 onwards, the offices accepted retail deposits in current accounts. In 1914, DNB had 20 deposit offices. The last one was opened a decade before, in 1903. No offices were closed in the meantime. Figure B.1 shows the 20 DNB deposit offices and their corresponding responsible regions ("*ressorts*").

Importantly, DNB did not open a deposit office in every large city.[7] The selection of locations for offices was only partly dependent on the economic circumstances at the

[5] In nearly all other European countries in the nineteenth century, central banks coexisted with other note issuing banks. DNB was the first institution in the Netherlands to issue banknotes. Although its charter did not assign it a legal monopoly, DNB de facto had the note-issuance monopoly.

[6] The head office had existed since 1814 and was located in Amsterdam. The offices were located in Alkmaar, Almelo, Arnhem, Dordrecht, Groningen, The Hague, 's-Hertogenbosch, Leeuwarden, Maastricht, Meppel, Middelburg, Rotterdam, Utrecht and Zwolle. DNB opened an office in Leiden and Nijmegen in 1897; in Tilburg in 1892; and in Deventer in 1903. Enschede was an auxiliary office from 1889 until 1915.

[7] Haarlem, Eindhoven and Breda are notable examples of cities that did not have a DNB branch.

time: some cities in which a DNB branch opened had no substantial trade or industry, though the population was wealthier than the national average.[8] The location of DNB offices was thus partly determined by historical administrative decisions dating back to 1864. Still, the cities with a DNB branch were on average much larger than cities without a DNB branch. The four largest cities (Amsterdam, Rotterdam, The Hague and Utrecht) do not have a counterfactual: there are no cities of comparable size *without* a central bank office. Using common support and matching procedures, the paper shows that results hold when controlling for city size and other economic characteristics.

The central bank was free to open other regional correspondent offices ("*correspondentschappen*") at its discretion. The correspondent offices offered only part of the offices' services: discount window borrowing and exchange of specie and banknotes. Importantly, they did not accept deposits. In 1914, there existed around 80 correspondent offices across the Netherlands. Commercial banks could thus borrow in virtually every city, but depositors could only go to the twenty offices to deposit money.

1.2 Depositing at the central bank

DNB was initially not allowed to accept deposits or money from any individual or institution other than the state (De Jong, 1930). One of the reasons for refraining from (retail) deposits was to avoid competition with the "*cashiers*" in Amsterdam, which were bank-like institutions that primarily acted as safe-keepers for merchants, but also engaged in exchanging money, making payments and extending credit (Kymmell, 1992). The renewal of DNB's charter in 1838 changed this, when a deposit account ("*rekening-courant*") could be opened by anyone introduced to the bank. From 1889 onward, DNB offices also accepted retail deposits. Balances could be withdrawn on demand, but the accounts paid no interest and charged a small depositing fee (1/2 ‰, lower than that of the *cashiers*).

DNB opened its current accounts to non-banks mainly to modernize the payment system. Around 1900, payments in the Netherlands were still largely made in cash: cheques were rarely used because of stamp duty, and the large cities each relied on their own cashiers' receipts (Vanthoor, 2005).[9] From 1889, DNB encouraged firms and individuals to open accounts at its offices, expecting that transfers between account holders, booked between

[8] Arnhem and The Hague are examples of cities with little economic activity but wealthy inhabitants. In 1889, Leiden was promoted from regional correspondent to auxiliary office despite having no borrowers at the discount window (apart from the regional correspondent itself) (Fase and Mooij, 2000). While the regional correspondent, a cashier, might have been to blame for the absence of discounting, the new borrowers in the year after Leiden became an auxiliary office were still minimal (Fase and Mooij, 2000).

[9] Unlike the Reichsbank and the Austro-Hungarian Bank, whose giro systems offered free transfers between its offices, or the Banco de España, which introduced inter-branch transfers in the 1880s, the Netherlands had no national giro system before 1918 (Anitipa et al., 2026).

branch ledgers, would create an efficient national payment network. Lack of interest and opposition from the Amsterdam cashiers, who dominated payments, stalled these plans (Van Der Werf, 1988). While transfers between DNB accounts were possible, a national giro system was only realized in 1918 with the giro postal system (De Jong, 1967b).

Very few non-financial firms and individuals deposited their money at DNB: in 1864, the total current accounts balance was a meager $f.$ 415,000, or 0.39% of notes in circulation and 0.13% of DNB's balance sheet (De Jong, 1930). From 1889 onward, the number of current account holders at DNB increased, albeit at a much slower rate compared to commercial bank account holders. Reasons for the reluctance to open a current account at DNB were 1) the depositing fee and 2) no remuneration, while commercial banks offered between 1 and 4 percent interest. Not surprisingly, the average total balance of all current account holders at DNB remained very modest: before the outbreak of the war it fluctuated around $f.$ 6 million.[10] Commercial bank deposits, on the other hand, consisted of around $f.$ 200 million in deposits, and another $f.$ 300 million in savings and current accounts, which made up about 40% of their total assets (Van Riel, 2021). Thus, the current accounts at DNB were not widely used beyond the financial sector before the outbreak of the war (De Jong, 1967b).

Similar to current CBDC proposals, DNB wanted to ensure the smooth functioning of the payment system. At the same time, DNB wanted to prevent outflows of deposits from commercial banks to the central bank (Kymmell, 1992; Vanthoor, 2005). It therefore kept the terms deliberately unattractive. The Dutch setting thus shows how commercial banks respond to the *mere existence* of a central bank alternative when an exogenous shock suddenly raises its attractiveness.

1.3 The outbreak of the First World War

On 28 July 1914, Austria-Hungary declared war on Serbia. The outbreak of the First World War triggered an unprecedented global financial panic, and the Netherlands was no exception.[11] The Amsterdam Stock Exchange closed on 29 July, soon followed by emergency government measures: on 31 July the gold standard was suspended and military mobilization was announced (Jongman, 1960). Railroad traffic was disrupted or

[10] Around 1% of its balance sheet size, and never more than 2% of the notes in circulation. National Archive, The Hague, De Nederlandsche Bank (DNB), 2.25.68, yearly balance sheets, 101380-101382.

[11] For the closures of the New York and London Stock Exchange, see Silber (2007) and Roberts (2013), respectively.

completely shut down until 3 August, and followed an adjusted timetable from 4 August onward, making travel between cities complicated and time-consuming.[12]

DNB implemented crisis interventions too. To ensure the continuation of the payment system, it removed the depositing fee for its current accounts on 31 July.[13] DNB saw substantial inflows of money on its private current account. Figure 1 panel (a) shows the total daily current account balance at all DNB deposit offices around the end of July as a percentage of its pre-war balance sheet size. Once the war broke out, the current account balances started increasing rapidly with an inflow of $f.$ 30 million (or 15% of demandable commercial bank deposits; Van Riel (2021) and own calculations).[14] The share of current accounts to the total size of DNB's balance sheet increased from around 1% to a maximum of 10% on August 27 (see Figure 2 for the composition of the liability side of the balance sheet).

Mostly firms and households opened new accounts. Figure 1 panel (b) breaks down the number of current account holders in financial institutions and non-financial account holders (see Appendix Figure B.2 for a breakdown by branch and Figure B.3 for a breakdown by sector).[15] The number of financial institutions also doubled from 379 to 768, but they mostly borrowed from the current account rather than deposited money (De Jong, 1967b).

On the inflow of deposits at the central bank in 1914, the president of DNB even wrote in the Economic Journal:

"*A fresh phenomenon has therefore appeared during the war; less and less credit is in demand from the bank of issue; its discounts and loans are reduced to unprecedented figures;* ***the public commences, on the contrary, to give the Bank a credit it did not ask for****, but which it must be open to receive as the central institution enjoying the confidence of all and sundry. The Bank becomes the great keeper of the reserves which*

[12] Arnhemsche courant, 31-07-1914; Nieuwe Rotterdamsche Courant, 02-08-1914, p. 8. DNB mentions in its yearly report over 1914 that circulation of banknotes was being hindered by the railroad disruptions. Van Oss Binnenland 1915-1916, p. 189.

[13] De Telegraaf, 31 July 1914, p.5. The depositing fee previously stood at 1/2 ‰. See Appendix A.3 for other war measures.

[14] The inflow at DNB also contained discount window borrowing balances: since 31 July, half of each new DNB advance had to be credited to the current account. This rule was in place until 28 Sep 1914. However, the inflow at DNB's current account started already in the days before: the current account figure increased from $f.$ 3.1 mln to $f.$ 12.0 million from 27-31 July. Moreover, it is unlikely that banks that faced withdrawals would leave the discount window balances at DNB for long.

[15] Note that account holders can be both borrowers and lenders. Financial institutions still dominated the number of current accounts at DNB before the war. At the end of 1914, however, the number of households and firms still holding an account at DNB had increased fivefold to more than 1,500. Many depositors had left again before that time, making the actual number substantially larger. The number of account holders during the crisis was about twice as large. DNB Namelist of current account holders, NL-HaNA, DNB, 2.25.68 - 16431.

the public is forced to lay aside for the time being, under the obligation, however, to place it at the disposal of the lenders at a moment's notice."[16]

The inflow of retail deposits at DNB deposit offices was widespread and documented in the yearly reports of every branch.[17] The DNB president in his yearly report wrote that the withdrawals at commercial banks were "ungrounded" (De Nederlandsche Bank, 1915) (p.3). The most illustrative example comes from the Maastricht branch of DNB:

"Persons, who previously would not have thought of opening an account at the Nederlandsche Bank, have foregone interest in favor of certainty to unconditionally be able to have their money at their disposal."[18]

At the same time, there was also a substantial flight into cash.[19] In August 1914, DNB's balance sheet increased by 47%, of which 80% was due to banknotes and only 18% due to an inflow of deposits at DNB.[20] The inflow of deposits at the central bank shows that these accounts were not perfect substitutes for cash. There are at least three reasons for that: diversification, a means of payment for larger distances, and a safer store of value compared to cash held at home (Anitipa et al., 2026). What matters for the identification in this paper is not *who* preferred central bank deposits over cash, but that the DNB account was an additional outside option for depositors in a city with a central bank office.

1.4 Commercial bank runs in 1914

The threat that the neutrality of the Netherlands would not be honored and the consequent mobilization led to a widespread panic across the Netherlands. In this crisis, many depositors withdrew their money from the commercial banks (De Nederlandsche Bank, 1915).[21] Four of the five largest commercial banks of the country together lost more than

[16]Vissering (1917), p.168, emphasis added.

[17]The agent of the Enschede branch wrote in the 1914-1915 report to the head office that "More than ever before have current-account holders used the Nederlandsche Bank" and depositors have "temporarily foregone the benefits of interest remuneration on their deposits at other banks". The agent in Deventer wrote that "Many withdrew their money from deposit-taking institutions and deposited in current account at DNB". A branch close to the war border reported that "several individuals have deposited substantial amounts at the Bank, since they lost trust in other bankers or institutions, despite foregoing interest on their accounts." NL-HaNA, DNB, 2.25.68, 706: Enschede, 1914-1915, p.5; 137: Deventer, 1914-1915, p.13; 104: Arnhem 1914-1915, p.14, respectively.

[18]NL-HaNA, DNB, 2.25.68, 206: Maastricht, 1914-1915, p.26, author's own translation.

[19]Banknotes in circulation rose from $f.$ 310 million on 25 July to $f.$ 369 million on 31 July and $f.$ 461 million on 7 August 1914, $f.$ 120 million above the previous record (Van Oss Effectenboek 1915/16 I. Binnenland, p. 189).

[20]NL-HaNA, DNB, 2.25.68 - 100103: DNB daily balance sheets, 1914-1915.

[21]I am grateful to Philip Fliers for sharing the DNB yearly reports from 1914-1916.

$f.$ 90 million in deposits during the first days of the crisis, a quarter of their balance sheet size of 1913.[22]

Commercial banks had at most four instruments at their disposal to deal with outflows: increasing their deposit rates, using cash reserves, borrowing from the central bank, or, as a last resort, suspending payments. The stock exchange closed during the panic, so banks could neither sell securities nor call in money-market loans. It is also unlikely that the interbank market was still functioning, since all banks faced deposit outflows and likely preferred to hold on to their reserves to meet their own withdrawals.

Virtually all commercial banks raised their deposit rates in the first days of August to combat the outflow of deposits. They advertised their higher deposit rates in both national and regional newspapers (see Figure B.5 for an example). Some banks went beyond raising rates and published announcements to try to calm depositors. For example, the Utrechtsche Bankvereeniging published in a regional newspaper on 23 August:

"Following rumors, that bankers would have refused to pay out deposits, we declare, that ALL of the demandable and matured deposits have since the start of the crisis been DIRECTLY PAID OUT BY US."[23]

Monthly balance sheets of a subset of banks show that they drew on their cash reserves to meet withdrawals: when deposits declined by a fifth, cash holdings fell by a third between June and September 1914. Banks also rediscounted bills, most likely at DNB, as their bill portfolios shrank roughly one-for-one with deposits. DNB's discount and advance ledgers show that commercial banks borrowed heavily at the outbreak of the war.[24]

One DNB branch reported that it had to assist one of the commercial banks to counteract the outflow of deposits after the one-month suspension of payments. This anecdotal evidence suggests that banks experiencing a run went to the central bank.[25] Borrowing from DNB was always more expensive than attracting deposits: Figure 3 shows that the

[22]Excerpts from the yearly reports of AB (p.111), Rotterdamsche Bankvereeniging (p.228) and Incasso Bank (p.137) in Van Oss' Effectenboek 1915-1916 Binnenland. Twentsche Bank outflows are computed based on monthly balance sheets published in newspapers (accessed via Delpher).

[23]Utrechtsch Provinciaal en Stedelijk Dagblad, 23-08-1914, author's own translation, with original emphasis.

[24]The Twentsche Bankvereeniging borrowed up to $f.$ 14 million through advances and rediscounting in late July and early August 1914, while the Nederlandsch-Indische Discontomaatschappij and Lippmann, Rosenthal & Co. each rediscounted $f.$ 750,000 on 31 July. NL-HaNA, DNB, 2.25.68, current account administration 1914-1915, 101585–101588.

[25]DNB branch Maastricht presents the outflow of deposits at the Limburgsche Credietvereeniging next to that bank's discount window borrowing and concludes: "The well-known interaction between deposits and the outstanding balance of bills of exchange appears from the previous mentioned figures." NL-HaNA, DNB, 2.25.68, 206, author's own translation.

DNB discount window rate increased to 6% following the outbreak of the war, compared to the average demandable deposit rate of 3.5% (the maximum was 5%).[26]

Finally, banks that were severely liquidity constrained even published joint statements in regional newspapers that they would only pay out the amounts "necessary for living costs" or suspended payments for a month.[27]

The deposit withdrawals during the bank run were temporary: the largest commercial banks mentioned earlier had higher end-of-year deposit balances in 1914 compared to 1913.[28] Similarly, several central bank deposit offices mentioned in their yearly report over 1914 that many retail depositors had subsequently withdrawn their money again to find "a more profitable way for investing their excess cash".[29] DNB started lowering its discount rate and other lending rates on 20 August when it perceived the most acute phase of the panic to be over (De Nederlandsche Bank, 1915). The total discount window lending reached its peak of $f.$ 186 million in November 1914. The stock market reopened on February 9, 1915, providing another source of funding again for banks. Finally, the repos frozen at the closure of the stock market were by regulation allowed to be settled from 1 July 1915 onwards (Jongman, 1960), freeing up additional liquidity for banks.

1.5 External validity

The Dutch historical setting allows for identifying the causal effect of competition from central bank deposits on commercial banks. Safe alternatives to bank deposits with payment functions are rare today, and none have been available at scale during a crisis. Historical settings thus provide the only direct evidence. There are two important differences between the historical setting and today. These differences likely provide a lower bound on the effects.

First, in 1914, moving money into a central bank account required withdrawing it from one's bank and depositing it in person at a central bank deposit office. This was much slower and costlier than moving money into a digital safe asset today. This paper leverages the location of commercial banks' branches relative to the central bank offices to identify exposed banks. When depositors can move their money around digitally, the physical

[26]Contrary to consensus nowadays that the central bank should lend freely at pre-crisis market conditions, at the time the central bank also had the gold standard to adhere to. To prevent outflows of gold, DNB increased its rates, with a maximum 7% for current account borrowing. The discount (bank) rate in London even spiked to 8% (10%) on 31 July. The high borrowing rates led to a lot of complaints from the Dutch commercial banks and the discount window rate was brought back to 5% once the "largest panic of the first days" was over (De Nederlandsche Bank, 1915).

[27]Nieuwsblad van Friesland, 05-08-1914; Limburger Kourier, 01-08-1914, accessed via Delpher.

[28]Van Oss Binnenland 1915-1916 contains annual reports of banks mentioning that all withdrawals have returned (see Appendix A.2).

[29]NL-HaNA, DNB, 2.25.68, 4: 's Gravenhage, 1914-1915, p.12, author's own translation.

branches become less relevant. Even though depositors still bank close to home nowadays (Sakong and Zentefis, 2023), moving deposits is not limited by distance any longer: Silicon Valley Bank depositors moved a record $41 billion out by wire transfer in a single day, and 87% of the bank's outflows in March 2023 left by wire (Chu et al., 2026). Since a digital account is faster and cheaper to access than a DNB account in 1914, the effects documented here are likely a lower bound.

Second, the Netherlands had no deposit insurance. Depositors bore the full risk and were incentivized to monitor their bank closely (Calomiris and Jaremski, 2019). Depositors in 1914 were mostly wealthy households and firms, comparable to today's uninsured depositors, who make up around 43% of the average EU and US commercial bank's total deposits.[30] The lower bound estimates therefore link most directly to the uninsured depositor base.

For insured deposits, the effect is likely smaller, but need not be zero: even in the presence of deposit insurance, central bank accounts can offer additional convenience. The credibility of deposit insurance (Bonfim and Santos, 2023) and delays in settlement following bank failures might still lead to depositors preferring to move (some of) their deposits to the central bank, especially in crisis times.

2 Data

This paper draws on a combination of archival sources covering the period 1910-1918. They differ in frequency (daily, monthly and yearly) and are discussed by order of relevance for the paper.

2.1 Historical Newspapers

The first source consists of historical newspapers from the years 1914-1915. Delpher is a Dutch online newspaper database consisting of more than 2 million newspapers from 1618–1995. The newspapers are both regional and national and include advertisements of Dutch commercial banks. These banks announced, with varying frequency, changes in their deposit rates, balance sheets and opening of new branches. I hand-collect any deposit rate advertisements for 77 banks from 47 different newspapers. This yields deposit rates by maturity—demandable, weekly, monthly, quarterly, and annual—for 77 banks,

[30] EBA Report on deposit coverage as a response to the European Commission's Call for Advice, December 2023: `https://www.eba.europa.eu/publications-and-media/press-releases/increase-current-deposit-coverage-level-eur-100000-would-have`; St. Louis Fed Banking Analytics Blog, 17-04-2026: `https://www.stlouisfed.org/on-the-economy/2026/apr/banking-analytics-uninsured-deposit-ratio-back-prepandemic-level`, respectively.

of which 39 report both a demandable and a weekly rate. In total, 76 banks have a short-term (on demand, daily or weekly) rate advertised and are included in the main sample.[31] For a subsample of only 14 banks, the newspapers contain monthly or quarterly deposit statements, allowing for higher-frequency analysis of deposit dynamics around the outbreak of the First World War.

Figure B.5 is an example of an excerpt from one of the national newspapers, Algemeen Handelsblad on 1 September 1914. This page is one of the hits with an OCR search on Delpher for "deposito" and "Twentsche" (marked in yellow) for 1914. The advertisements show that commercial banks often printed on the same page as their competitors: the page includes 5 distinct banks. The advertisements included the deposit tenors (depending on which types of deposits the bank offered), the rate and sometimes the locations of its branches.

Two things stand out in the advertisements. First, there is substantial heterogeneity among banks in their deposit rates. For example, despite the bank runs having subsided in September 1914, the Credietvereeniging Amsterdam still paid 4% interest on demandable deposits, compared to 3% at the other banks. Second, the example shows that all banks except the Nederlandsch-Indische Handelsbank offered an equal or higher rate for a shorter deposit tenor. Credietvereeniging Amsterdam again stands out as it offered 4.5% for a 1-month term deposit, while it offered 4% for a 3-month term deposit. This indicates that a bank especially needed liquidity in the short term. In the empirical analysis I use the inverted term structure of deposits as an outcome variable to proxy for financial distress.

2.2 Central bank archive

The second source is the archive of DNB, available at the Dutch National Archive. The historical records provide daily aggregate balance sheets, including current account balances and end of year lists of current account holders. Together, these records allow me to track the evolution of (non-)bank accounts at the central bank at both the aggregate and deposit office level. Moreover, it lets me distinguish different types of depositors—individuals, firms, government bodies, and financial institutions.

[31] Of the 76 banks, 67 advertise both before and after the outbreak of the war. Four banks do not advertise before the war, and 5 banks do not advertise after the war. The DiD estimate is thus determined by 67 banks.

2.3 Commercial banks' balance sheets

Third, the paper uses digitized and standardized commercial banks' balance sheets for 75 depositing banks from 1910-1930 from several sources: Van Oss Effectenboek, depositories at the DNB archive and commercial banks' individual archives.[32] Appendix C.1 shows an example of a standardized balance sheet. The sample in the regression analysis runs from 1910-1918, as the effects of central bank exposure after the First World War will likely be conflated with post-war deflation and the Dutch banking crisis in the 1920s.

2.4 Register of financial institutions

Fourth, I use the 1914 Financieel Adresboek (Financial Address book) to identify the locations of all banks and financial institutions that appear among DNB's current account holders. Moreover, this source is used to create a local competition measure based on the number of financial institutions active in a city. This financial yearbook contains all (self-reported) financial actors, from deposit banks and brokers, to mortgage banks and insurance agents. The book reports for each bank and firm the founding year, its locations, its representatives, whether it has access to a stock exchange (membership was required to be allowed to trade on the exchange), and for public entities the names of the directors. I manually search for matches with the DNB current account holder lists and create a dummy that equals one if a person or institution appears in the book. The address information is essential for constructing the geographic proximity measure central to the identification strategy.

2.5 Regional economic variables

Finally, to obtain pre-shock regional characteristics, I collect data from the 1909 census ("*Beroepstelling*"). While the census is very granular in terms of coverage of occupations and geographical coverage (municipal level), it does not include regional GDP. Instead, I use total population of each municipality and the unemployment in each region. The 1909 census does not measure unemployment as a share of the labor force, but as the number of *all* people without an occupation ("*Beroepsloozen*"). I therefore define the unemployment rate as the share of the total population not working, which also includes children, the elderly and most women (especially after marriage). This explains the high average (61%), but it is consistent across regions and serves as a proxy for local economic activity.

[32] I thank Remo Oostdam for the collaboration in constructing the standardized Dutch bank-level dataset used in this paper.

2.6 Summary Statistics

Figure 4 shows the evolution of commercial bank average deposit rates with different tenors from 1914-1915. The figure looks similar for median deposit rates. I collect any tenor that banks advertised but standardize them into six categories: The demandable deposit rates (in red) include 0 and 1 day maturity, weekly deposit rates have a tenor between 8-15 days, monthly rates have a monthly tenor, quarterly rates are 2 and 3 months combined, and semi-annual and annual are 6 and 12 months tenors, respectively. Not surprisingly, the deposit rates for longer-tenor deposits are on average higher than those for shorter deposits. One exception to this is the demandable deposit rate around the outbreak of the war: on average the demandable deposit rate reaches a similar level to the monthly rate.

The longer deposit tenors are nearly flat and identical for virtually all banks. In general, the longer the maturity, the less variation in the average deposit rate: the annual rate is consistently around 4%. Table 1 shows the smallest standard deviation for the annual rate (0.23), and Figure 4 shows little variation in the deposit tenors above 3 months. It thus appears that deposit competition via rates was mostly done on the shortest deposit tenors. The shortest deposit tenors are likely the closest substitute to central bank retail deposits, which also were demandable.

To put bank deposit rates into perspective, they should be compared to alternative sources of bank funding. Figure 3 plots the evolution of the shortest-tenor deposit rate (in red) with the money market repo rate (in grey) and the central bank discount window borrowing rate. While demandable bank deposit rates reach their highest levels after the shock, deposits are still the cheapest source of funding for commercial banks. DNB's discount window rate briefly stood at 6%, was lowered to 5% on 20 August and remained at that level until far into the summer of 1915.

Together with the Amsterdam Stock Exchange, the money market was closed from 29 July 1914 until 8 February 1915. During this period, the money market rate was kept artificially high, first at 7% and from the end of August at 6%. The most accessible alternative to deposit funding was thus borrowing at the discount window of the central bank. Once the stock market reopened on February 9, 1915, the money market rate quickly dropped again, and the average deposit rate followed. The lowest money market rate of this sample period was reached in July 1915, when the repos frozen during the closure were allowed to be settled. This is consistent with the idea that when other means of funding become available again, banks choose to lower their deposit rates and diversify their funding.

Table 1 reports the summary statistics of the deposit rate sample. What stands out from the table is that the on-demand, short-term and weekly rate are very similar in terms of distribution. To maximize the sample size, I will therefore use the short-term rate for the main analysis, which I denote as the demandable deposit rate. The demandable rate is the rate that each bank offers for its shortest deposit tenor available. To ensure comparability, this variable is restricted to 15 days or less. The number of banks varies with each variable due to data availability and the type of deposit rates each banks offered. The regressions will mostly focus on the 76 banks that advertise a demandable rate.

On average, commercial banks had close to three branches across the Netherlands (median is one). These branches covered most areas of the Netherlands and did not solely operate in the central bank cities (see Figure 5). Cities have on average 29 commercial bank branches (median is 23). The overlap between commercial bank branches and central bank offices was on average 74%, meaning that banks on average had three quarters of their business in the same location as a safe haven alternative. This relies on the simplistic assumption that all branches were equally large in terms of their deposit ratios. This cannot be tested due to a lack of branch-level deposit data.[33] High central bank (CB) exposure is a dummy that equals 1 if a commercial bank has all its branches in the same location as central bank deposit offices. This is the case for 61% of the banks in the sample.

The total population served by a bank, which is the combined population of all its branch locations, is skewed. The median bank operated in a city the size of The Hague (about 270,000 inhabitants in 1909), but the sample also includes banks in towns of a few thousand inhabitants (1st percentile: about 5,000), while banks with large networks covered up to 3.7 million inhabitants (99th percentile). Even though cities vary substantially in size, the economic activity measured by the unemployment rate does not vary much across cities (SD of 1.66 for a mean of 61).[34]

3 Empirical Approach

The empirical analysis is split into three horizons: short, medium and long term. All specifications analyze the effect of central bank exposure: the outcome variable differs by horizon.

[33]The results are robust when using a population-weighted, or population-competition weighted exposure measure.

[34]Note that the average unemployment rate of 61% is artificially high since it includes not only the workforce, but the entire population. It serves as a proxy for economic activity and is consistently measured across cities.

3.1 Short Term: Deposit Rates

In the short run, I analyze the causal effect of a central bank depositing alternative on the deposit-rate setting behavior of commercial banks. I use a difference-in-differences setting where the share of a commercial bank's branches located in a city with a central bank deposit office is the continuous treatment measure. The identifying assumption is that banks located near and far from a central bank office would have followed similar trends in their deposit rates and funding conditions absent the outbreak of the war. Before the war, this can be tested: Figure 6 confirms parallel trends in the pre period.

Moreover, identification comes from depositors storing their money at a bank in their (nearest) city. Deposit markets at the time were local, and this is still the case today (Sakong and Zentefis, 2023). Across 1913-1914, 78% of account holders were located in the same city as the central bank branch where they deposited, and 89% were within 20 kilometers of the branch. Figure B.4 shows the geographical spread of account holders before and after the outbreak of the war, respectively. The number of retail depositors increased at almost every central bank office in 1914, indicating that across the country, an account at DNB became attractive only once depositors were seeking a safer place to deposit their money. Moreover, Figure B.4 shows that few accounts are opened by depositors located outside of a central bank city.

The identification strategy thus relies on the assumption that the geographic proximity between commercial bank branches and central bank deposit offices is orthogonal to unobserved determinants of changes in deposit competition. This assumption is plausible for three reasons. First, DNB established its branch network in 1864 with minor changes until 1903, decades before 1914, primarily to facilitate national payments rather than deposit-taking. Second, commercial banks selected their locations based on local economic conditions, not in response to a central bank deposit facility that was dormant. The central bank discount facility was also available at the smaller regional correspondent offices, which did not have the deposit facility. Should commercial banks have feared central bank competition for deposits, they would have located *away* from the central bank's deposit offices. Third, the sudden deposit flight triggered by the outbreak of the First World War was unanticipated by both commercial banks and the central bank.

3.1.1 Covariate balance of high- and low-exposed banks with deposit rates

Table 2 compares observations of banks with high and low geographical exposure to central bank deposit offices before the outbreak of the war. High-exposed banks are the fully exposed banks (all branches in a central bank city); low-exposed banks are all others. By design, the continuous measure of central bank exposure is higher for high-exposed

banks. The overlap of bank branches with central bank offices for low-exposed banks is on average 30%. While for all deposit tenors, the rate offered by high-exposed banks is on average slightly lower, this difference is not statistically significant. Not surprisingly, low-exposed banks have more than twice as many branches as high-exposed banks, and this difference is significant. Almost mechanically, more branches lead to lower overlap with the central bank and thus lower CB exposure. In the regression analysis the number of branches is included as a control variable.

For the balance sheet characteristics pre-war, high- and low-exposed banks are on average comparable in size. High-exposed banks have ex ante slightly more deposits and capital than low-exposed banks. Finally, low-exposed banks are more often located closer to the war border (though this difference is not significant), which could affect run dynamics during the war. Note that the balance sheet data are only available for 42 banks in the rates sample. Only unsecured funding differs before the shock: high-exposed banks have on average 15% of funding unsecured, compared to 25% for low-exposed banks (significant at 10%). Unsecured funding consists almost entirely of creditors, which at several banks include clients' current-account balances; deposits and unsecured funding combined are similar for both groups (51% vs 57%).

Nevertheless, it is possible that a confounding factor is driving the deposit rate response, rather than the central bank exposure. Central banks were located in cities that were on average larger, and had more economic activity. Table 2 shows that banks that were fully exposed to the central bank have a higher population in their headquarters. This difference is statistically significant. However, when looking at the total population served by a bank (the sum of population at all branches), the difference is still substantial, but less significant. In Section 4.1.3 population is included as a control and Figure B.7 shows that the results are robust when including different regional fixed effects, population controls, using only banks in the common support or matching on city size.

3.1.2 Difference-in-Differences specification

The DiD specification is as follows:

$$Y_{i,t} = \beta_1 CB\ exposure_i \times Post_t + \Gamma_1' X_{i,1909} \times Post_t + \Gamma_2' X_{i,1913} \times Post_t + \kappa_i + \eta_t + \lambda_{g,t} + \epsilon_{i,t} \quad (1)$$

Where $Y_{i,t}$ is either the deposit rate, or a dummy for an inverted term structure of bank i at week t. $CB\ exposure_i$ is the treatment intensity of bank i: the fraction of bank i's branches located in a CB city. $Post_t$ is a dummy equal to 1 for all weeks from 27 July 1914 onward. $X_{i,1909}$ is a vector of control variables on the municipality level from the 1909 census (i.e. before the shock), such as log(population) and the unemployment rate. $X_{i,1913}$

is a vector of control variables on the bank-level, which include the average competition for bank i across cities (measured as the average number of competing banks for bank i, population-weighted over its branches) and importantly, the number of branches of a bank before the shock.[35]

The regressions also include bank (κ_i), week (η_t) and region-time ($\lambda_{g,t}$) fixed effects to account for unobserved heterogeneity in bank-specific circumstances, war-related developments that vary by week and regional differences that might affect the deposit business of banks. Region fixed effects are defined as either 4 regions of the Netherlands (north, middle, south and center, or 'Randstad') or the 20 ressorts that the central bank deposit offices were divided into: see Figure B.1. The regional fixed effects are preferably interacted with monthly rather than weekly fixed effects to preserve sufficient within-group variation.[36] Standard errors are clustered on the commercial bank level.

3.1.3 Banks' branch network size as control

The number of branches a bank has before the shock matters for three reasons. First, $CB\ \ exposure_i$ is a *share*, so it is mechanically related to the geography of a bank's network. A single-branch bank located in a central bank city takes the value one by construction, whereas a bank with branches spread across towns with and without a DNB deposit office cannot. By design, mean CB exposure falls monotonically in network size, from 0.86 among single-branch banks to 0.33 among banks with four branches, and 36 of the 43 fully exposed banks in the rate sample operate a single branch. Table 2 shows that low-exposed banks have significantly more branches. Absent the branch network control, β_1 would conflate the effect of central bank proximity with the effect of operating a concentrated network.

Second, the bank branch network serves as a proxy for bank size. Large banks may have responded differently to the August 1914 liquidity shock for reasons unrelated to central bank proximity: wider access to interbank funding, greater name recognition among depositors, and a more diversified deposit base. Third, a multi-branch bank can reallocate liquidity internally across its branches when a single location comes under pressure (Quincy, 2024). Such an internal capital market is itself a partial substitute for access to the discount window, so network size proxies for a competing liquidity technology rather than for scale alone.

[35] Both vectors are interacted with the $Post_t$ dummy since they are time-invariant and would otherwise be absorbed by the bank fixed effects.

[36] Using region $\times$ week fixed effects does not alter the coefficients substantially, but reduces the statistical power in some specifications. Appendix Table C.2 shows that the coefficients are very stable irrespective of the fixed effects used.

Conditioning on $Branches_i \times Post_t$ sharpens the interpretation of β: it compares banks operating the *same number of branches* that differ in the share of those branches located in central bank cities.[37] Because both variables are determined by branch-location decisions taken well before 1914 and are fixed within bank throughout the sample, the control is pre-determined with respect to the shock.

3.1.4 Deposit rates at the reopening of the stock exchange

For the medium term, I look at the rate setting behavior of banks around the reopening of the stock market on 9 February 1915. The goal is to test whether more exposed banks significantly lower their rates once the money market has reopened and another funding alternative has become available. Instead of one post dummy, I use three separate time dummies: the closure of the stock exchange (29 July 1914 - 8 February 1915), the reopening (9 February - 30 June 1915) and the settlement of previously frozen repos (1 July - 31 December 1915). All three dummies are interacted with the continuous treatment.

3.2 Long Term: Banks' Balance Sheets

For the long term (1914-1918), I look at bank balance sheet outcomes by central bank exposure. Balance sheets are available on the yearly level. Similar to equation 1, I regress several bank balance sheet variables on $CB\ exposure_i \times Post$. In this case, $Y_{i,t}$ is either a funding composition variable (deposits, (un)secured funding, total equity), a profitability measure (net interest margin), or a lending variable (total lending, liquid and illiquid lending, securities lending) or a measure for liquidity (liquid assets). All outcome variables are weighted by total assets pre-war, using 1913 total assets as denominator. Post is now a dummy that equals one if the period is 1914 or later. 1914 is included in the post period because banks report their balance sheets at the end of each year. Time fixed effects are yearly. The balance-sheet regressions control for $Branches_i \times Post_t$ and the logarithm of the total yearly population of the bank's pre-war branch locations. Unemployment is only observed in 1909 and the number of competing banks in 1914; Tables C.7, C.10 and C.12 add them.

[37] Omitting the control biases β *downward*. Banks with larger networks raised rates more ($\hat{\gamma} = 0.049$, SE 0.014), and network size is negatively correlated with CB exposure (bank-level correlation -0.265), see Table 2.

3.2.1 Covariate balance of high- and low-exposed banks with balance sheets

Table 3 shows the balancing table using annual banks' balance sheets. Compared to the deposit rate sample, the average low-exposed bank is *less* exposed for the balance sheet sample: 30 % against 26%. Figure B.6 shows that the balance sheet sample also contains substantial geographic variation.

The low(high)-exposed banks in the balance sheet sample are serving smaller (larger) cities compared to the rate sample. The regression analysis will include a time-varying natural logarithm of total population as a control variable. The number of banks in a city is also higher in this sample (40 compared to 34) for high-exposed banks, but the number of branches per bank is very similar to the rate sample. The analysis will include both as control variables.

Commercial banks in this sample relied on deposits for approximately 30% of their funding. This is comparable for both high- and low-exposed banks. This relatively low number compared to deposit-taking banks nowadays – around 55% in the EU and 75% in the US[38] – can be explained by the higher capital buffers that banks at the time voluntarily held: the average bank had 27% of its liabilities in capital and retained earnings. The findings of this paper can thus be seen as a lower bound: the response to central bank competition would likely be even stronger if banks rely more on deposits. The repo market was seen as a liquid and safe investment before the closure of the stock market. Banks engaged in both lending and borrowing in the repo market, with repo lending making up 12% of total assets.

4 Results

This section presents the empirical results in three phases: short, medium and long-term. The short term covers the crisis phase, which is the period right after the outbreak of the war (July - August 1914). The medium term focuses on the period after the initial panic, which includes the reopening of the Amsterdam Stock Exchange (September 1914 - December 1915). The long term focuses on the years during the war (1914-1918).

[38]EBA Risk Assessment Report, June 2025:
https://www.eba.europa.eu/publications-and-media/publications/liabilities-funding-and-liquidity-1;
FED Statistical Release Asset and Liabilities of Commercial Banks in the United States, 13-02-2026:
https://www.federalreserve.gov/releases/h8/current/h8.pdf, respectively.

4.1 Crisis phase

4.1.1 Commercial banks' demandable deposit rates

Figure 6 plots the weekly coefficients over the full period 1914-1915. The figure can be split into four periods: the period before the outbreak of the war (1 January – 26 July 1914), the war period when the Amsterdam Stock Exchange was closed (27 July – 8 February 1915), the war period when the stock exchange was reopened (9 February – 30 June 1915) and the war period when the DNB lowered its discount window rate again and frozen repurchase agreements were allowed to be settled (1 July – 31 December 1915). Note that the specification underlying this plot uses region × week fixed effects (on top of bank and week fixed effects) to absorb any regional unobserved characteristics that could influence banks' rate setting behavior.

Before the outbreak of the war, the difference between the rates of more and less exposed banks is small and stable, in line with the pre-war balance in Table 2. Once the war broke out, more exposed banks offered significantly higher demandable deposit rates for three weeks. They kept offering higher rates during the closure of the exchange, though with more variation across banks. After the reopening of the stock exchange, the rate differential declined gradually, and once the frozen repos were settled and the money market functioned normally again, more exposed banks offered slightly lower rates than less exposed banks. Outside the first weeks of the crisis, none of these differences are statistically significant.

Figure 7 confirms the strongest effects in the crisis period. The figure shows the weekly coefficients for the shortest deposit rate offered by the banks. In the ten weeks (starting mid-June) before the war, the difference in deposit rates between high- and low-exposed banks is indistinguishable from zero. In the week of the war outbreak and the Dutch mobilization, the difference becomes positive and significant. Despite substantial standard errors, the effect remains significant throughout August, after which the deposit rates gradually declined again. The results are robust when including additional fixed effects or controls (see Appendix Figure B.7).

Table 4 shows the regression results for a single coefficient. Column (1) shows that after the outbreak of the war, the demandable deposit rates increased by 31 basis points across all banks. However, banks more exposed to central bank deposit competition raised their demandable deposit rates more aggressively with an additional 46 basis points. When including week (column (2)) and region × month (3) or ressort (4) fixed effects, the coefficient ranges between 37 and 46 basis points.

Since the variable *CB exposure*$_i$ measures the fraction of a bank's branches located in a central bank city, the estimates of column (3) imply that a fully exposed bank raises its demandable deposit rate by approximately 0.37 percentage points (or 37 basis points) more than a non-exposed bank during the peak of the crisis. Compared to an average pre-war demandable deposit rate of 2.88%, this is a substantial effect.

When controlling for the number of branches of the commercial banks pre-war (column (5)-(7)), the coefficient increases to 54-62 basis points. Because *CB exposure*$_i$ is a share of a bank's branches, it is mechanically related to network size (Section 3). Conditioning on the number of branches compares banks with equally large networks. Column (6) is therefore the preferred specification: a fully exposed bank increased its demandable deposit rate by an additional 54 basis points compared to a non-exposed bank. The direct comparison of fully exposed with non-exposed banks gives 37–39 basis points (Table C.17); the introduction uses this more conservative number.

The effect is concentrated in the acute crisis period. Table C.3 shows that for the entire data sample 1914-1915, all banks increased their deposit rates after the shock, on average by 44 basis points (column (1)). For the demandable deposit rate, the interaction between *CB exposure*$_i$ and the *Post* dummy is insignificant over the full 1914–1915 period, turns positive for 1914 alone, and becomes significant when restricting the sample to the crisis months July-August 1914.

4.1.2 Term structure of deposits

Since the central bank retail deposits are demandable and do not offer remuneration, one might expect that the results should fade out over the maturity of the deposits.[39] Indeed, Table 5 shows that the effects are concentrated on the shortest tenors (demandable and weekly), which are the most comparable to the central bank retail deposit accounts. The coefficient for central bank exposure remains positive across all tenors, but declines in magnitude beyon the weekly tenor. Deposits with a longer maturity than a week are not significantly higher for more exposed banks. These results suggest that only the deposits most sensitive to central bank competition received higher remuneration after the shock.

Banks that were more exposed to the central bank were also more likely to adopt an inverted term structure of their deposit pricing. That is, more exposed banks more frequently offered a weekly remuneration above a monthly remuneration, or a demandable remuneration that was higher than the rate on weekly or monthly tenors.

[39]Even though banks might have preferred to attract deposits for longer, it is unlikely that depositors would commit to longer maturities during the war. Moreover, since the maximum deposit rate in the sample is 5%, and the annual term deposits were on average 4% pre-shock, there appears to have been little leeway for increases before discounting at DNB became more attractive.

Table 6 shows that, during the crisis months, a fully exposed bank was about 20-26 percentage points more likely to adopt such an inverted pricing scheme than a non-exposed bank. Before the war, the probability of inverted pricing of deposits was around 5%, so the increase is four to five times the pre-war probability. The inverted term structure of a bank's deposit pricing suggests that this bank was especially liquidity constrained and in need of short-term funding. More exposed banks were not just more responsive to central bank rate hikes in general: the inverted term structure shows that they did not consistently raise all their rates. The inversion result is, however, sensitive to the size of a bank's local markets. Once the population of a bank's branch locations is controlled for, the coefficient falls to about 0.15 and is no longer statistically significant (Appendix Table C.4).

4.1.3 Regional variation

One concern could be that the results are driven by exposure to large, or in other ways, important cities. High- and low-exposed banks were comparable before the outbreak of the war (Table 2), but the cities they are located in were not. Even though in normal times the difference in location did not drive rate differentials, this might be different during a crisis. Depositors in larger cities may be more attentive: they may be wealthier or more financially sophisticated. The panic might also be more severe or more contagious in larger cities if news spreads faster. This section discusses several specifications that show that the exposure to the central bank remains relevant when controlling for economic conditions and the market structure of the local deposit market. The point estimates are also stable when excluding the largest cities from the sample, but the reduced samples limit precision in the narrowest window.

4.1.4 City characteristics

The regional controls city size (population) and unemployment describe the local markets a bank operates in rather than the bank itself. Each is measured at the city level and then aggregated over the bank's branch locations, using the same branch denominator that defines $CB\ Exposure_i$. Because both are measured once before the shock, their levels are absorbed by the bank fixed effects and they enter only interacted with $Post_t$.

Table 7 shows the results when controlling for different regional characteristics. The estimate is 0.538 when branch network size is included in column (1), but falls back to 0.340 when population served is added in column (2), and remains at 0.350 in columns (3) and (4) (significant at 10%). Population served is itself significant in this window (0.111, s.e. 0.055): in the six weeks around the shock, banks serving larger markets raised their

rates more. The two effects are not cleanly separable at this sample size — the difference between 0.538 and 0.340 is roughly one standard error — but the central bank coefficient remains positive, stable and significant throughout.

Columns (6) to (9) take the dominant sector of each city into account and show that the effect, if anything, becomes stronger. Column (6) replaces region × month with sector × month fixed effects, and the coefficient rises to 0.597; with the regional controls it is 0.373 (column (7)). Column (8) excludes the cities with agriculture as the dominant sector, since only low-exposed banks reside there. This drops the number of banks by 9 to 67; the coefficient is 0.637 without and 0.473 with the regional controls (column (9)).

4.1.5 Deposit market structure

A second possibility is that the result reflects the competitive structure of the local deposit market rather than proximity to the central bank: banks in crowded markets may have to bid more aggressively for deposits, and crowded markets are also where central bank deposit offices are. I measure local competition as a count of all deposit-taking institutions in a city, and the variable is the population-weighted average of this count across a bank's branch locations.

Column (4), (5), (7) and (9) of Table 7 add # Banks$_i$ × Post$_t$. The coefficients are close to zero and when the control is added alone (column (4)), the central bank exposure estimate is unaffected. The number of competing deposit-takers in a bank's markets thus has no detectable effect on how much it raised rates after the shock, and does not absorb the central bank effect.

4.1.6 Large vs. small cities

The composition of the local economy is a related concern, since a bank's depositors differ across an agricultural town and an industrial one. Table 7 uses only the banks that are comparable in terms of city size. The four largest Dutch cities (Amsterdam, Rotterdam, The Hague and Utrecht, each above 100,000 inhabitants) all have a central bank deposit office and have no counterfactual: there is no comparably sized Dutch city without a central bank office. If the estimated effect is really a big-city effect, it should disappear once those cities are removed.

I trim the sample to the common support in log average market population between high- and low-exposed banks, which retains 41 banks whose local markets are comparable in size. Column (6) of Table 7 gives a coefficient of 0.361, which is very stable in magnitude compared to column (3) - (5) but no longer significant. Since the specification only has

349 observations, the window might be too short and the sample too small to estimate the effect precisely. Table C.5 confirms that the crisis window lacks power with only 41 banks: for the full 1914 time period (1,974 observations), the coefficient is 0.345 and significant at 5% level.

Table C.6 addresses the city size dispersion in a different way, by excluding the largest 4 cities. The triple interaction is 0.079 (s.e. 0.678), close to zero and very imprecisely estimated, so there is no evidence that the repricing response was concentrated in the largest cities. Column (3) of Table C.6 instead drops every bank with any branch in a B4 city, which removes 41 of the 76 banks and more than half the observations. The estimate on the remaining 35 banks is 0.383 (s.e. 0.151), close to the full-sample estimate of 0.417 in column (2) and still significant at the five percent level. In the July to August window the same exclusion leaves only 279 observations and the estimate falls to 0.220 (s.e. 0.156); the point estimate remains positive and of similar order, but the window is too short and the sample too small to sustain inference.

Taken together, the size-based tests point the same way as the municipal controls. The effect survives dropping the four largest cities, and trimming to comparable market sizes, with point estimates varying in the 0.22 to 0.36 range against a full-sample baseline of 0.54. Where it loses significance it does so in the narrow July to August window, where the trimmed samples fall to a few hundred observations, rather than in the specifications that retain power. The results thus show that central bank exposure affected deposit rate setting, even when controlling for city size, workforce and sectoral composition. Moreover, the mechanism appears to be central bank exposure and not generic competitive pressure: a bank in a town with fifteen other banks and no central bank office behaved no differently from a bank in a town with three.

4.2 Return of deposits and reopening of the stock market

Deposits returned to the banks within the year. Figure 8 shows the evolution of deposits for banks that reported deposits at a higher frequency (either monthly or quarterly, published in newspapers). While it only covers 14 banks, it provides suggestive evidence for two things. First, deposits returned to pre-war levels at the end of 1914. The coefficient plot in Figure 11 confirms that with yearly data. It shows that the 1914 coefficient is not significantly different from the years before the shock. Second, the high-exposed banks that published their statements in newspapers seem to have experienced a larger outflow of deposits compared to low-exposed banks in the months after the shock.

The Amsterdam Stock Exchange reopened on 9 February 1915. From that moment onward, banks had an additional funding channel at their disposal again: collateralized

borrowing via the repo market. Immediately after the reopening, the money market rate dropped to the lowest value of the sample period in July 1915 (Figure 3). The outstanding repos before the outbreak of the war had been frozen while the stock exchange was closed, and were only allowed to be settled after 1 July 1915. Only in the summer of 1915 were banks thus completely unconstrained again in managing their balance sheet.

Figure 9 splits the central bank exposure effect into three phases relative to the pre-war period: the closure of the stock exchange (29 July 1914 – 8 February 1915), its reopening (9 February – 30 June 1915), and the release of the frozen repos (from 1 July 1915). Both panels compare groups of banks that are balanced on central bank exposure. Panel A splits the 41 banks with a 1913 balance sheet by their pre-war repo exposure (both the asset and liability side). Once the stock market reopened, especially banks with more repo exposure ex ante lowered their rates. After the release of the frozen repos, exposed banks in both groups lowered their rates. The banks relying less on repos caught up (-86 basis points); with about 20 banks per group, the differences between the groups are not statistically significant. This indicates that from July 1915 onward, when the money market was completely functioning again, banks more exposed to the central bank lowered their rates more.

Panel B of Figure 9 splits all banks by size. Small banks drove the rate increase, which lasted until the summer of 1915 (41 and 31 basis points during the closure and after the reopening), whereas large banks drove the decline after the release of the frozen repos (-67 basis points). The difference between large and small banks is significant at the 10% level after the reopening and after the release. This pattern is consistent with larger banks having better access to non-deposit funding once the money market functioned again. Because the release of the frozen repos coincided with a 50 basis point cut in the DNB discount rate, the decline in the final phase cannot be attributed to the repo market alone.

The medium-term results are consistent with banks exposed to outside competition moving away from deposit funding, rather than depositors moving away from the exposed banks. Deposits flow back at the end of the year and once alternative means of funding became available, exposed banks no longer paid a premium to attract deposits. The lower deposit rates of more exposed banks implies that they valued their deposit franchise less.

4.3 Long-term effects on commercial banks' balance sheets

4.3.1 Bank funding

The natural follow-up question after commercial banks raised their deposit rates is what happens to their funding structure, and ultimately, their lending portfolio. Due to the annual nature of banks' balance sheet variables, it is impossible to quantify the exact outflow of deposits at the time of the crisis. However, yearly balance sheets allow for a comparison in the years after the war to test whether banks adjusted their balance sheet once alternative means of funding became available again.

Figure 10 plots the simple averages of the log of total assets and total deposits, by high- and low-exposed banks. It shows that while all banks grew in size and attracted more deposits, high-exposed banks grew more slowly. It suggests that more exposed banks lost some of their deposit franchise during the crisis phase, and it took them longer to recover.

Figure 11 formally tests the difference between more and less exposed banks. It shows that banks more exposed to the central bank competition experienced slower deposit growth in the years after the outbreak of the war. In 1914, both more and less exposed banks had a similar level of deposits compared to pre-war, in line with the anecdotal evidence that at least the largest banks saw deposits at levels comparable to the preceding year at the end of 1914. However, the years 1915-1918 show that the banks more exposed to central bank competition in the 1914 crisis grew significantly more slowly than banks less exposed. This is consistent with a salience shock for exposed banks, who reassess the cost of deposit funding after the shock. Figure B.8 shows that the results are robust when including additional control variables, fixed effects, or using (matched) common support.

Table 8 shows that more exposed banks grew more slowly: relative to 1913 total assets, a fully exposed bank's deposits grew 0.43 less than a non-exposed bank's, against an average increase of 0.38, and its total assets 0.41 less. Table 9 divides each liability by current total assets. The deposit share of a fully exposed bank fell by 9 percentage points relative to a pre-war mean of 31%, and its total assets grew about 20% (23 log points) less: exposed banks both grew more slowly and shifted their funding mix away from deposits.[40] Their equity also grew less (Table 8 column (5)), consistent with a smaller deposit franchise requiring less capital. The change in funding composition is not offset by additional secured or unsecured funding. Table C.12 shows that the effect on deposits is smaller, but more precisely estimated among the 48 banks with comparable city size. The effects on total assets and lending are larger in Table C.12. With sector × year fixed

[40] Van Riel (2021) mentions a pre-war average of 40% of deposits in commercial banks' total assets. The difference is likely due to the sample of banks used.

effects in logs, the deposit effect holds (−0.52 to −0.60), while total assets is estimated less precisely (−0.20 to −0.25; Appendix Table C.9).

4.3.2 Bank lending

Since banks that rely less on deposit funding have seen an increase in their funding costs (see Figure 3), they may have altered their lending portfolio accordingly. Table 10 provides evidence that the more exposed banks grew more slowly in their lending, in about the same magnitude as their slower deposit growth. This is concentrated in illiquid lending. The decomposition of the total lending into liquid, illiquid and repo (or marketable) lending shows that there is a lot of variation between banks in altering their lending portfolio. More exposed banks did not hold significantly more liquid assets after the shock. The lending results hold with sector × year fixed effects: in logs, total lending falls by 0.37–0.40 and illiquid lending by 0.27–0.29 for a fully exposed bank (Appendix Table C.11).

The lending results are consistent with a fall in the deposit franchise value. A stable deposit base is what allows banks to hold illiquid, long-term loans (Drechsler et al., 2021). Once the deposits of more exposed banks proved run-prone, that franchise was worth less, and these banks expanded their illiquid lending less. The regressions hold local loan demand constant as far as bank-level data allow, by controlling for the characteristics of each bank's branch locations. Loan-level data would allow within-borrower (Khwaja and Mian, 2008) or within-industry (Degryse et al., 2019) comparisons. Without them, the lending results are best read as consistent with a supply response.

More exposed banks' net interest margin did not change significantly (Appendix Figure B.9), although the estimates are too imprecise to detect small changes. A stable net interest margin is consistent with more exposed banks passing through any higher funding costs they incurred from reliance on non-deposit funding. This would suggest that the slower lending growth might be driven by loan supply at higher rates. Loan rate data would be required to separate loan demand from supply.

4.3.3 Small vs. large banks

Since the outbreak of war represents an aggregate shock unrelated to bank fundamentals, there is no obvious reason why total bank size (as opposed to a bank's branch network) would affect deposit rate responses to DNB competition independently of exposure intensity. Consistent with this, bank size is weakly correlated with treatment intensity in this sample (correlation = 0.053 for the binary measure, 0.225 for the continuous measure;

see Table 2 for the equal average bank size for high- and low-exposed banks), suggesting size does not capture additional variation beyond what the treatment variable central bank exposure already measures. While previous literature has documented size-related differences in deposit rate setting in other contexts (Anyfantaki et al., 2026; Begenau and Stafford, 2025; Drechsler et al., 2017), these findings reflect equilibrium pricing differences in normal times rather than responses to aggregate shocks.

If larger banks can more easily substitute lost deposits with alternative funding sources such as interbank borrowing or securities lending, the effect of deposit outflows on their lending portfolio may be uneven across bank size. It is potentially also easier for larger banks to issue additional capital or bonds, after the reopening of the stock exchange. For this reason, I run a triple DiD with a large bank dummy as a third interaction:

$$\begin{aligned} Y_{i,t} = \beta_1 CB\ exposure_i \times Post_t + \beta_2 Large\ bank_i \times Post_t \\ +\beta_3 CB\ exposure_i \times Post_t \times Large\ bank_i + \kappa_i + \eta_t + \lambda_{g,t} + \epsilon_{i,t} \end{aligned} \tag{2}$$

Where the outcome variable $Y_{i,t}$ is again one of the bank balance sheet items. $Large\ bank_i$ is a dummy that equals one if a bank is above median size in 1913, and 0 otherwise. The same set of fixed effects apply as before and standard errors are clustered on the commercial bank level.

Table 11 shows that there is little evidence for heterogeneity in bank size driving the decline in deposits and lending. Both the deposits coefficient in column (2) and the lending coefficient in column (4) are significant for the main interaction variable of central bank exposure and post, which now reflects the coefficient for the small banks. However, the coefficient for the large banks ($CB\ exposure_i \times Post_t \times Large\ bank_i$) in column (2) is positive but insignificant. The total effect (last row) is also negative and significant for large banks.

The slower growth in size and illiquid lending seems to be concentrated among small banks. For banks below median size, a fully exposed bank's total assets grew 0.65 less (column (1)) and its illiquid lending 0.30 less (column (5)) than a non-exposed bank's, relative to 1913 total assets. For large banks, the total effects are smaller (-0.17 and -0.11) and not statistically significant. However, the triple interactions are not significant either, so the paper cannot reject that the effects are the same for small and large banks. A plausible explanation is that large banks could more easily replace lost deposits with other funding after the reopening of the stock exchange, and therefore did not need to shrink their balance sheet. The availability of alternative funding can also explain why larger banks may not need to refrain from illiquid loans.

4.4 Robustness

4.4.1 War border exposure

A concern for the identification is that the results are driven not by a nearby safer central bank retail deposit alternative, but by the direct threat of war. Banks located in provinces bordering belligerent countries may have faced stronger deposit outflows regardless of their proximity to a DNB deposit office. To mitigate these concerns, I control for the war threat in Table C.13. I include a war exposure dummy that is equal to one if a bank has at least one branch in a war border province. Across all specifications in the narrow time window, the *CB exposure*$_i$ interaction remains significant and of similar magnitude to the baseline estimates, while the war exposure interaction is generally insignificant and small. The results thus suggest that it is proximity to the central bank, not proximity to the war border, that drives the competitive response in deposit pricing.

4.4.2 Unit banks

The continuous treatment measure requires aggregating locations and aligning bank-level controls that are defined at the head quarter level, such as the region (ressort). Moreover, the continuous measure assumes that deposits are spread equally over the branches. To show that these assumptions do not affect the findings, I restrict the sample to banks that have only one branch. These so-called unit banks have only binary exposure (either they are located in a central bank city or not) and the treatment effects are for that reason expected to bite most: those banks cannot rely on other, non-exposed branch locations to attract depositors. Unit banks have the additional benefit that they price their deposits for only one local market.

Table C.14 shows that the number of branches matters for the demandable deposit rate. When restricting the sample to only unit banks, the exposed commercial banks increased their demandable deposit rate by an additional 70 basis points after the shock. Not surprisingly, the effect for unit banks is much larger and stronger than for multi-branch banks, which had the possibility to attract deposit funding in locations without a central bank deposit office. The multi-branch banks also increased their demandable deposit rates, yet the effect is much smaller and not significant. The probability of pricing deposits in an inverted manner is of the same magnitude for both unit and multi-branch banks that were exposed to the central bank, both significant at the 5% level.

4.4.3 Exposure to stock market closure

Table C.15 shows that when excluding the banks that have any branch located in Amsterdam, the results still hold and are of similar magnitude as before. Since the central bank exposure measure is correlated with city size (most large cities have a central bank deposit office), it is difficult to disentangle the two. One main concern is that the closure of the Amsterdam Stock Exchange has different effects on banks exposed to Amsterdam, which might be driving the results. Banks needed to have a branch in Amsterdam in order to become a member of the exchange. However, when excluding any bank with Amsterdam exposure, the results still hold.

4.4.4 Binary vs. continuous treatment

In the baseline specification, $CB\ exposure_i$ is the fraction of a bank's branches located in a central bank city. Its distribution has most mass at 0 and 1: of the 76 rate banks, 10 are non-exposed, 46 are fully exposed and 20 in between. With a continuous treatment, standard parallel trends identifies the effect of exposure relative to no exposure; interpreting the coefficient as a dose-response additionally requires that banks with different exposure would have responded alike at the same exposure, which cannot be tested (Callaway et al., ming). I therefore re-estimate the main results with alternative definitions of exposure. Table C.16 uses a dummy for full exposure, so that partially exposed banks join the comparison group. The deposit-rate coefficient is slightly smaller but still positive and significant in the narrow time window (0.35 with branch controls); the effect on the inverted term structure is positive but smaller and not significant.

Figure B.10 and Table C.17 compare each exposure group directly with non-exposed banks. Figure B.10 shows that pre-trends are flat in every specification. In Table C.17, the deposit results are robust to every definition: banks with any exposure lose deposits worth 0.40 of 1913 total assets relative to non-exposed banks, fully exposed banks 0.45, and among exposed banks alone the gradient is the same (-0.36). The rate response is driven by fully exposed banks ($+0.38$), but it also rises with exposure: banks with less than half of their branches in a central bank city did not raise rates relative to non-exposed banks, whereas banks with at least half did ($+0.21$). A full-exposure dummy therefore misses part of the variation, which supports the continuous measure. Because the response is not linear, the continuous estimate (0.54) lies somewhat above the direct comparison of fully exposed and non-exposed banks (0.37–0.39), which is less precise because only 10 banks are non-exposed.

5 Conceptual Framework

This section provides a simple framework to interpret the results. The goal is to separate depositors' demand for deposits from banks' supply of deposits. Combining deposit rates with deposit volumes tells the two apart, and shows why the deposit franchise of exposed banks declined.

Set-up. In the model, each bank is a price-setter in its local market. A bank has a single office located either in a city with a central bank office (type H, $e_H = 1$) or in a city without one (type L, $e_L = 0$). The banks are otherwise identical. There are three periods: $t = 0$ (before the war), $t = 1$ (the crisis at the outbreak of the war), and $t = 2$ (after the crisis).

The key friction is Δ_t, a random variable that measures how important central bank competition is. It reflects the depositors' demand for safety at the central bank: the additional value of holding an account at the central bank rather than a deposit at a commercial bank. It only matters for depositors in cities with a central bank office.

Banks. Each bank has local market power over its depositors. The profit function is a simplified version of Drechsler et al. (2017), where bank j maximizes its profit in each period t:

$$\Pi_{j,t} = (r_t + r_a)\, A_{j,t} \;-\; (r_t + s_t)\, W_{j,t} \;-\; r_{j,t}\, D_{j,t}, \qquad A_{j,t} = D_{j,t} + W_{j,t} \tag{3}$$

Assets A (the bank's loan portfolio) earn the market rate r_t plus a lending spread r_a. Non-deposit funding W consists of money-market borrowing (*prolongaties*) and borrowing at the central bank, at the market rate plus a spread s_t.[41] Deposits D cost the deposit rate $r_{j,t}$ set by the bank.[42]

Since lending opportunities are limited, one more guilder of deposits either funds an additional loan or replaces a guilder of non-deposit funding. The value of a deposit guilder to the bank is then

$$m_t = r_t + \min(r_a,\, s_t) \tag{4}$$

[41] During the closure of the stock exchange (29 July 1914 – 8 February 1915) the money market did not operate and outstanding *prolongaties* were frozen; borrowing at the central bank's rate was the only marginal source of non-deposit funding, and it was expensive, so s_1 is large. Central bank borrowing was available to all banks, in cities with and without a central bank office. After the reopening, money-market funding was available again, which was cheaper, so s_2 is small.

[42] Operating costs per deposit guilder (salaries, branches, advertising) are the same for all banks and are omitted; they lower the value of a deposit equally for H and L.

If non-deposit funding is more expensive than the lending spread ($s_t \geq r_a$), the bank does not borrow and deposits fund lending. If it is cheaper ($s_t < r_a$), the bank borrows as long as the marginal asset return exceeds the cost of borrowing, and an additional deposit replaces non-deposit funding (Appendix D).

Deposit demand. Bank j faces the deposit demand

$$D_{j,t} = \bar{D}\left[1 + b\left(r_{j,t} - v_{j,t}\right)\right] \tag{5}$$

where $\bar{D}$ is the bank's depositor base[43], and b measures how strongly depositors respond to the deposit rate.[44] Both are the same for H and L.

Outside option. Depositors keep funds at bank j if the deposit rate exceeds the outside option at that bank, $r_{j,t} \geq v_{j,t}$:

$$v_{j,t} = v_t + e_j\,\Delta_t \tag{6}$$

where v_t is the value of the alternatives available to all depositors, such as cash. Δ_t is the additional value of the central bank account, available only to depositors in cities with a central bank office ($e_L = 0$; $e_H = 1$).

Demand for safety. $\Delta_t \geq 0$ is a random variable. Depositors' demand for safety at the central bank is low in normal times, and it rises in a crisis, when the safety of commercial bank deposits is in doubt.

In each period, a flight to safety occurs with probability p_t, so the expected demand for safety, $\mathbb{E}_t[\Delta_{t+1}]$, rises with p_t. Before the war, retail deposits at the central bank existed but were rarely used, and the probability of a flight to safety at the central bank was negligible: $\Delta_0 = 0$ and $\mathbb{E}_0[\Delta_1] \approx 0$. The outbreak of the war was an unexpected shock that raised depositors' demand for safety, $\Delta_1 > 0$.[45]

Optimal deposit rate. Maximizing (3) subject to (5) gives

$$r^*_{j,t} = \omega\, v_{j,t} + (1-\omega)\Big(m_{j,t} - \frac{1}{b}\Big). \tag{7}$$

[43] $\bar{D}$ scales with the number of bank depositors, and equals D when the deposit rate equals depositors' outside option.

[44] Attachment is the source of the bank's market power: a lower deposit rate only drives away the least attached depositors. Appendix D.1 derives this demand from depositors' heterogeneous attachment to their bank.

[45] Only the expected value of Δ_t matters for predictions, so the distribution is unrestricted.

The bank sets its rate between the depositors' outside option and its own value of a deposit, net of a markdown $\frac{1}{b}$ that reflects its market power. ω is the pass-through of the outside option to the deposit rate.[46]

Equation (7) is at the core of the framework. Everything else equal, a better outside option $v_{j,t}$ raises the deposit rate, but by less than one-for-one, so deposits fall. When deposit rate and volume move in opposite directions, that is a sign of a shift in depositor demand. A lower value of a deposit to the bank ($m_{j,t}$) lowers both the deposit rate and the volume. When both rate and volume move in the same direction, this indicates a shift in bank supply (Drechsler et al., 2017).

The bank earns a margin $m_{j,t} - r^*_{j,t}$ on each deposit guilder. From the first-order condition, this margin equals $D^*_{j,t}/(\bar{D}b)$, and the deposit franchise is

$$F_{j,t} \equiv \left(m_{j,t} - r^*_{j,t}\right) D^*_{j,t}. \tag{8}$$

Two variables drive the value of the franchise: the margin the bank earns on each deposit, and the amount of deposits it holds.[47] Outside options can lower both.

Exposed versus non-exposed banks. With the same depositor base $\bar{D}$ and attachment b, and the same value of a deposit m_t, H and L banks differ only through Δ_t. From (5) and (7):

$$r^*_{H,t} - r^*_{L,t} = \omega\, \Delta_t, \qquad D^*_{H,t} - D^*_{L,t} = -\,\bar{D}b\,(1-\omega)\,\Delta_t. \tag{9}$$

The markdown $\frac{1}{b}$ is the same for both types and drops out. Shocks common to all banks (the market rate, the cost of non-deposit funding, depositors' common outside option) move all deposit rates alike and are absorbed by time fixed effects in the empirical analysis. Proofs are in Appendix D.

Before the war ($t = 0$). Retail deposits at the central bank existed but were rarely used ($\Delta_0 = 0$), so by (9) banks of both types set the same deposit rates and held the same deposits (Table 2).

[46] In this linear model, $\omega = \frac{1}{2}$: the value of a deposit does not depend on the bank's size. With diminishing returns to lending and non-deposit funding that becomes more expensive the more a bank borrows, as in Drechsler et al. (2017), a bank that loses deposits values the remaining ones more, and the pass-through lies in $[\frac{1}{2}, 1)$ (Appendix D). All predictions below hold for any ω in this range.

[47] In Drechsler et al. (2017) and Drechsler et al. (2021), the deposit franchise arises from banks' market power over their depositors. I assume that market power is the same for banks of type H and L, so that differences in the franchise between exposed and non-exposed banks arise only from the central bank option, not from differences in market power. In the empirical analyses, I control for differences in local deposit market structure.

The crisis ($t = 1$). The outbreak of the war increases depositors' demand for safety. The stock exchange closes, so non-deposit funding is only available at the central bank's discount window, at a higher rate ($s_1 > s_0$). All deposit rates rise.

Proposition 1 (The crisis)**.** *If $\Delta_1 > 0$, exposed banks raise their deposit rates more than non-exposed banks, $r^*_{H,1} - r^*_{L,1} = \omega\Delta_1 > 0$, but by less than the improvement in their depositors' outside option ($\omega < 1$), so they lose deposits: $D^*_{H,1} - D^*_{L,1} < 0$.*

After the crisis ($t = 2$). The reopening of the stock exchange lowers the value of a deposit for all banks, and more so for banks with better access to the money market (lower $s_{j,2}$).[48] Once the acute crisis is over, depositors' demand for safety at the central bank falls back ($\Delta_2 < \Delta_1$), but it is not necessarily zero: Δ_t is a random variable, and the central bank option remains available. Since deposits are sticky, a guilder a bank attracts today is still on its books if depositors' demand for safety rises again. In that case, the bank has to match the improved outside option. For an exposed bank, holding a deposit guilder at $t = 2$ therefore carries an expected cost $\omega\,\mathbb{E}_2[\Delta_3]$, even if depositors do not use the central bank option. The value of a deposit becomes

$$m_{j,2} = m_2 - \omega\, e_j\, \mathbb{E}_2\big[\Delta_3\big]. \tag{10}$$

This expected cost is negligible in peacetime but not during the war. In the spirit of Drechsler et al. (2021) and Drechsler et al. (2026), the central bank option makes the deposits of exposed banks less sticky, and their deposit franchise more run-prone. With (10), the difference between exposed and non-exposed banks at $t = 2$ is

$$\begin{aligned} r^*_{H,2} - r^*_{L,2} &= \omega\,\Delta_2 - (1-\omega)\,\omega\,\mathbb{E}_2[\Delta_3], \\ D^*_{H,2} - D^*_{L,2} &= -\,\bar{D}b\,(1-\omega)\,\big(\Delta_2 + \omega\,\mathbb{E}_2[\Delta_3]\big). \end{aligned} \tag{11}$$

Depositors' current demand for safety (Δ_2) widens the rate gap: if they still value the DNB account somewhat, the bank has to pay a higher rate to keep them. The bank's exposure to a renewed flight to safety ($\mathbb{E}_2[\Delta_3]$) shrinks the rate gap: each deposit guilder may have to be defended later, at a higher cost. This makes deposits worth less to the bank today, so it competes less for them.

Proposition 2 (After the crisis)**.** *Exposed banks hold fewer deposits than non-exposed banks. They pay higher deposit rates only if depositors' current demand for safety outweighs the bank's expected cost of a future flight to safety, $\Delta_2 > (1-\omega)\,\mathbb{E}_2[\Delta_3]$.*

[48] this channel is unrelated to central bank exposure, as access to the money market was similar for exposed and non-exposed banks.

The deposit rate can thus tell apart a bank-driven channel (lower rates, lower deposits) from a depositor-driven channel (higher rates, lower deposits). In both cases, lower deposits by themselves decrease the value of the deposit franchise. Since a bank's margin is proportional to deposits, $m_{j,t} - r^*_{j,t} = D^*_{j,t}/(\bar{D}b)$, an exposed bank also earns a lower margin on each deposit guilder, which decreases the franchise value.

The lost deposits that lower the franchise of exposed banks also slow their growth. Deposits fund lending, and non-deposit funding replaces lost deposits only when it is cheaper than the lending spread:

Proposition 3 (Lending)**.** *If non-deposit funding is more expensive than the lending spread ($s_t \geq r_a$), lending moves one-for-one with deposits: $A_{H,t} - A_{L,t} = D^*_{H,t} - D^*_{L,t} < 0$. If it is cheaper ($s_t < r_a$), non-deposit funding replaces lost deposits and lending is unaffected.*

Proposition 2 shows that if it was only depositors' demand for safety that persisted, exposed banks would have paid higher deposit rates while holding fewer deposits. Instead, exposed banks held fewer deposits without paying higher rates. The franchise of exposed banks became run-prone (Drechsler et al., 2026): the central bank option lowered the value of their deposits even when depositors did not use it any longer. Exposed banks grew more slowly in both deposits and total assets, with little replacement by other funding: having lost part of their deposit franchise, they also lent less.

6 Conclusion

Potential alternatives for commercial bank deposits, such as stablecoins and central bank digital currencies, are increasingly being adopted. Such outside competition for bank deposits affects banks' funding and lending decisions and has consequences for monetary policy pass-through and credit provision. It is therefore crucial to understand the effects of outside competition for bank deposits. This paper uses the outbreak of the First World War as an exogenous shock to show that times of heightened uncertainty can trigger a flight to safety of retail deposits from commercial banks to the central bank. I use the overlap between locations of the central bank offices and commercial bank branches to define treatment intensity. Banks with more exposure to the central bank raised their deposit rates more and were more likely to adopt an inverted term structure of deposit pricing following the outbreak of the war. This effect is concentrated in the months after the outbreak of the war and subsides afterwards. More exposed banks lost part of their deposit franchise: in the years after the shock they relied less on deposits, grew more slowly, and extended less illiquid loans that a stable deposit base funds. The results

suggest that the change in the funding structure slowed credit provision of more exposed banks, concentrated in illiquid loans.

This paper informs the current policy debate on central bank digital currencies (CBDCs) and their potential effects on commercial banks. Similar to the contemporary proposals for CBDC, the deposit accounts at the Dutch central bank paid no interest and were intended as a means of payment, rather than a store of value. However, I show that when a central bank retail deposit account is designed as a means of payment, it can unintentionally become a store of value during crisis periods. Moreover, even when a crisis with corresponding deposit outflows at commercial banks is short-lived, these banks might revalue their deposit franchise and diversify away from deposits in the longer term. I provide suggestive evidence that such lower reliance on deposits can slow down the provision of credit to the real economy. A temporary flight to safety can thus have persistent consequences for credit provision.

Unlike current proposals, the Dutch central bank imposed no holding limits. Credible holding limits of CBDC can limit the outflow of deposits from commercial banks, but the counterfactual is not obvious: in 1914, many depositors moved into cash. Nowadays deposits might also find another store of value, such as money market funds, government bonds or stablecoins. Holding limits may therefore redirect a flight to safety rather than prevent it. Since a digital account is faster and cheaper to access than a physical account in 1914, the effects documented here are likely a lower bound.

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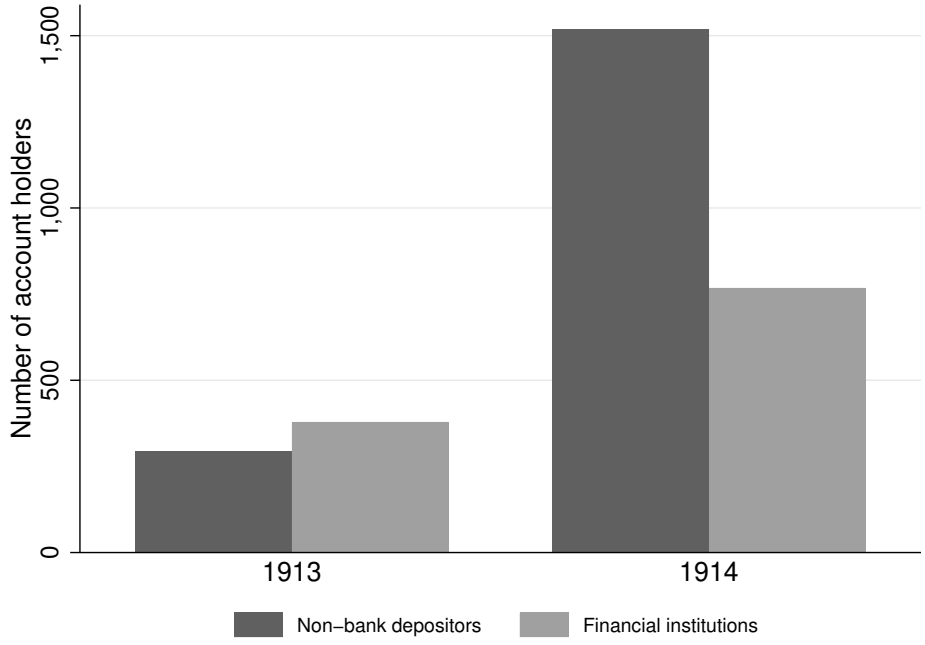
Figures

Figure 1: Inflow of retail deposits at the central bank

(a) Daily current account balances

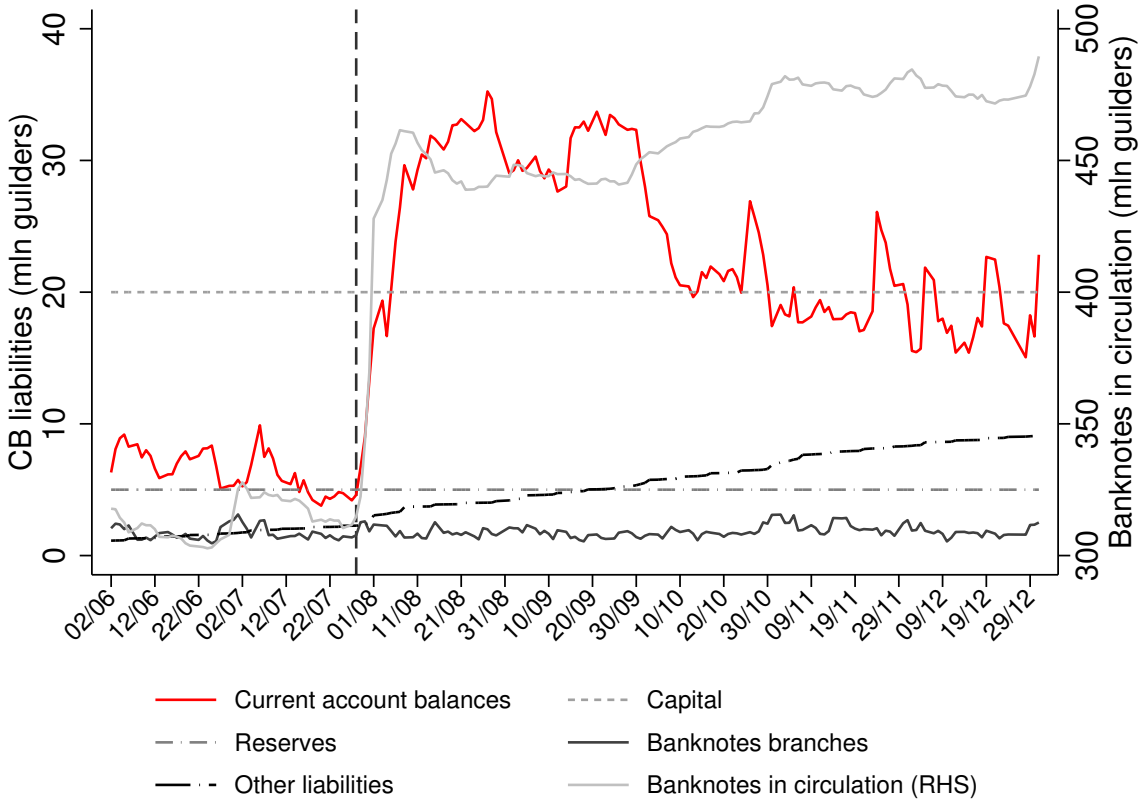


(b) Composition of current account holders



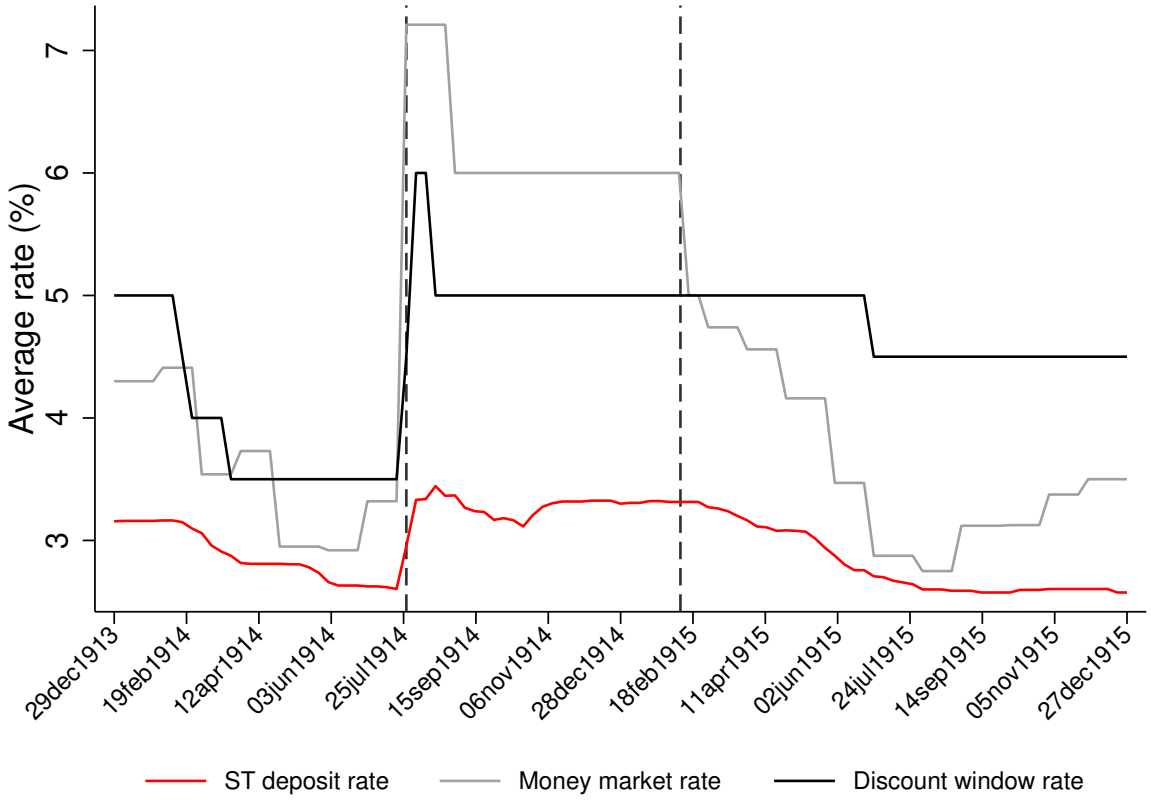
Note: Figure (a) shows the daily balance of current account holders (both banks and non-banks) at DNB from 20 July 1914 - 3 October 1914. The current account holders' balance is weighted by the size of the balance sheet before the outbreak of the war (*f*. 346 million on 20 July 1914). The vertical line reflects the outbreak of the war (28th of July 1914). Figure (b) shows the count and composition of the current account holders of DNB in 1913 and 1914. Names are manually matched to the Financial Address 1914 yearbook to identify financial institutions. Sources: DNB daily balance sheets, NL-HaNA, DNB, 2.25.68 - 100103; DNB Namelist of current account holders - 16431; Financieel Adresboek 1914.

Figure 2: DNB liabilities



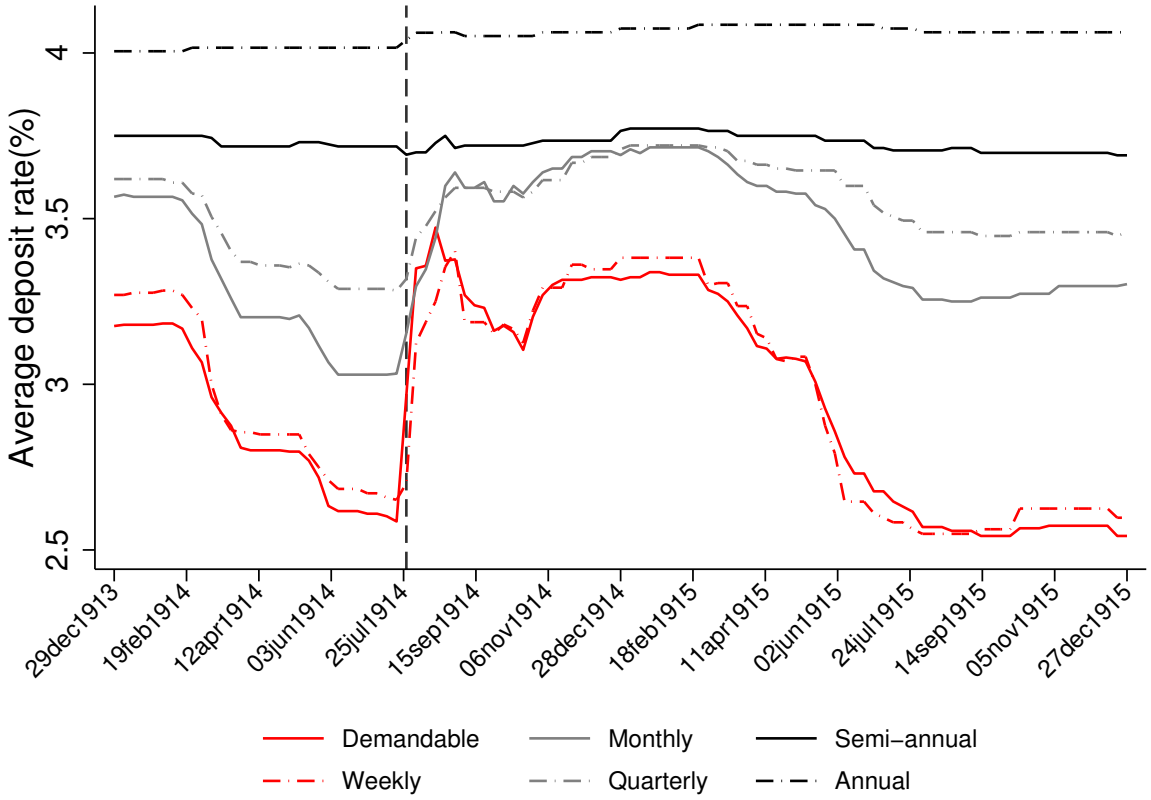
Note: This figure shows the daily breakdown of the liability side of DNB's balance sheet. All amounts are in million guilders. The vertical line reflects the outbreak of the war (28th of July 1914). Bank notes in circulation are displayed on the right-hand side axis for visibility. Source: DNB daily balance sheets, NL-HaNA, DNB, 2.25.68 - 100103.

Figure 3: Average bank funding rates



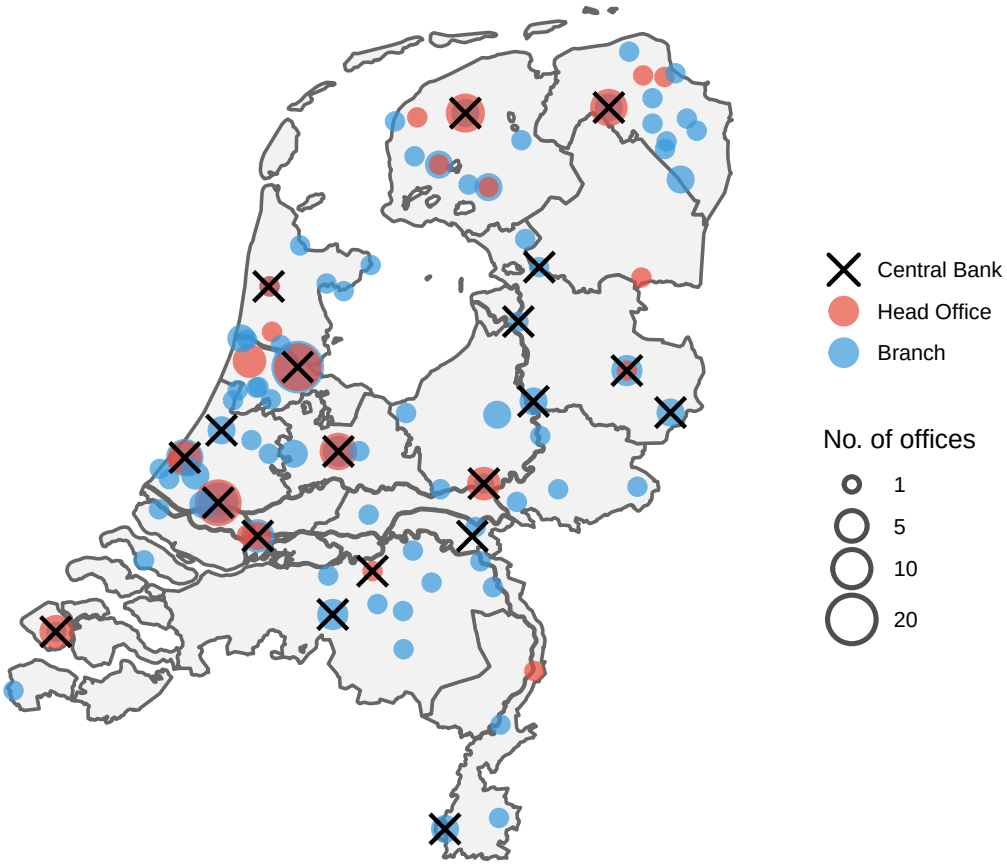
Note: This figure shows the weekly average short-term commercial bank deposit rate (red), the monthly repo market rate (grey) and the central bank discount window rate (black). The short-term commercial bank deposit rate is the simple average of the shortest rate offered by each commercial bank in the sample (only if a banks has demandable, daily or weekly). The vertical lines reflects the period that the stock market was closed (29th of July 1914 - 9 February 1915) and where the money market rate was artificially kept at 7/6%. Source: Delpher Digital Newspaper Archive, author's own computations; NL-HaNA, DNB, 2.25.68, 7146; Tabellenboeken 1914-1915.

Figure 4: Average commercial bank deposit rates



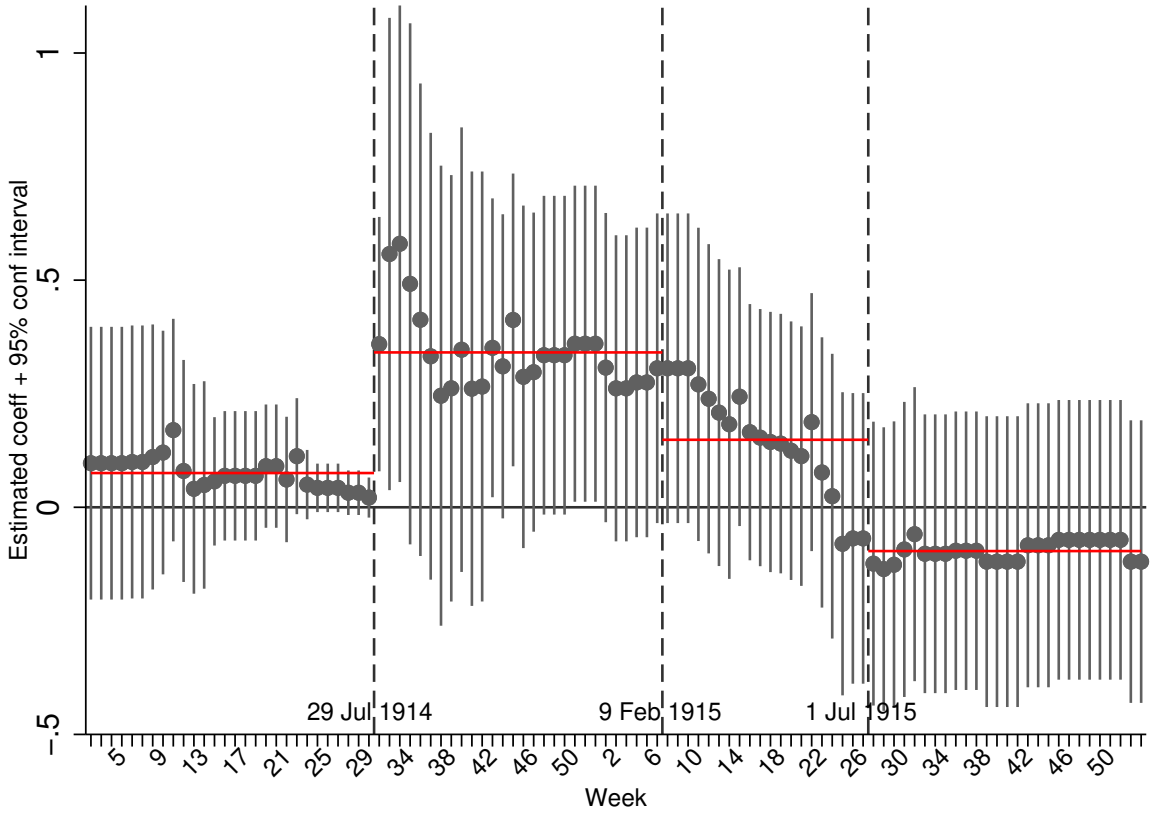
Note: This figure shows the weekly average deposit rate for the six most commonly used deposit tenors: demandable (0/1 day), weekly (8-14 days), monthly, quarterly(2-3 months), semi-annual and annual. All rates are simple averages across the sample of commercial banks from 1914-1915. The vertical line reflects the outbreak of the war (28th of July 1914). Source: Delpher Digital Newspaper Archive, author's own computations.

Figure 5: Geographical variation of commercial- and central bank branches



Note: This map shows the location of all commercial bank and central bank branches. The black crosses indicate the 20 central bank branches, the red dots are the locations of head offices of the commercial banks, and the blue dots are the location of commercial bank branches. Note that one dot can contain more than one bank located in the respective city. Includes all banks of the rate sample. Source: Financieel Adresboek 1914.

Figure 6: Weekly coefficient plot 1914-1915

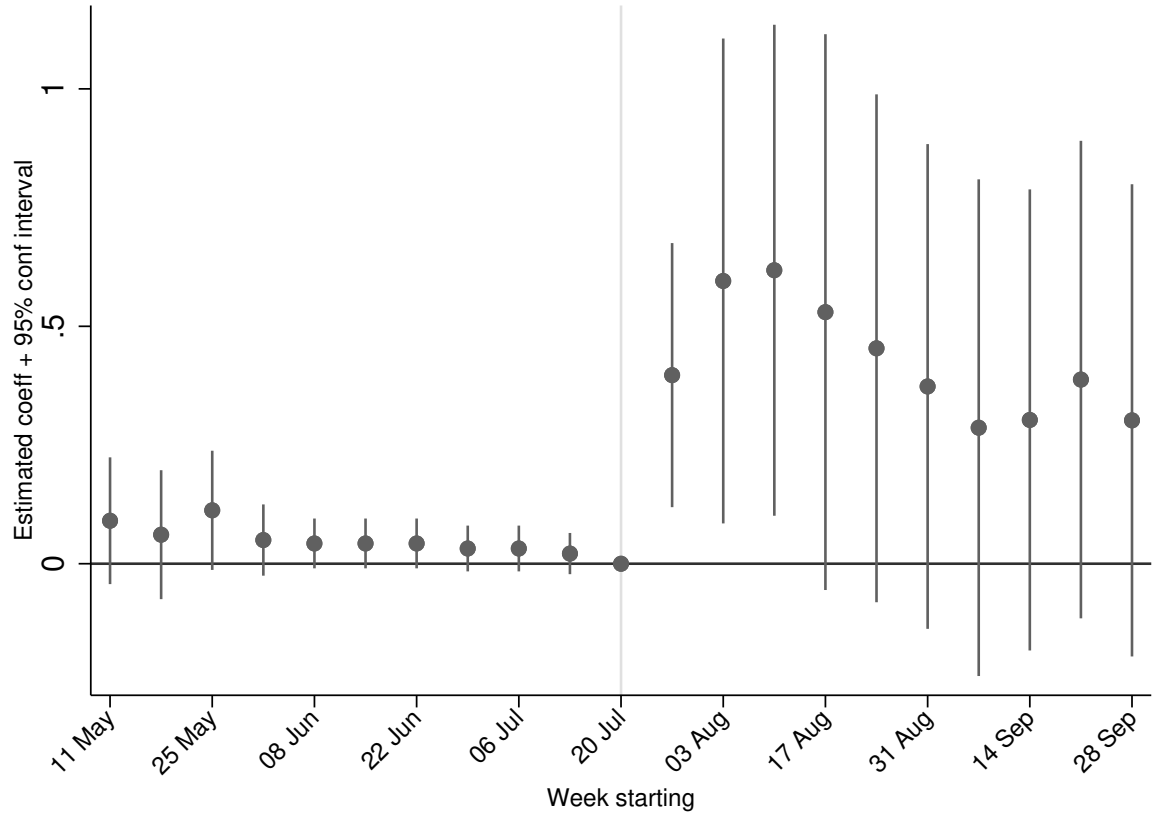


Note: This figure shows β coefficients of the following specification:

$$Y_{i,t} = \sum_{t=1914w1}^{t=1915w52} \beta_t \; CB \; Exposure_i \times D_{week=t} + \gamma Branches_{i,1913} \times Post_t + \kappa_i + \eta_t + \lambda_{g,t} + \epsilon_{i,t} \tag{13}$$

Where $Y_{i,t}$ is the short-term deposit rate of bank i in week t, $CB\ Exposure_i$ is the fraction of bank's i branches that are located in a city that has a central bank office, $D_{week=t}$ is a dummy equal to 1 for week t, where week 30 (the last week before the shock takes place) is left out to avoid the dummy variable trap. The period covered is all weeks in 1914-1915. The control variable Branches_i is the number of offices bank i operated before the shock. Both CB exposure_i and Branches_i are time-invariant and are therefore absorbed by the bank fixed effects α_i; only their interactions with Post_t are identified. Bank i, week t and region $\times$ week g, t fixed effects are included, and standard errors are clustered on the bank level. The short-term commercial bank deposit rate is the simple average of the shortest rate offered by each commercial bank in the sample (only if a banks has demandable, daily or weekly). The vertical dashed lines reflect the Monday of the weeks of the outbreak of the war (28 July 1914), the reopening of the Amsterdam Stock Exchange (9 February 1915) and the settlement date for frozen repos (1 July 1915). Each dashed line is drawn at the start of the week that contains the event. Source: Delpher Digital Newspaper Archive, author's own computations.

Figure 7: Parallel trends: weekly coefficients of short-term deposit rate May-September 1914

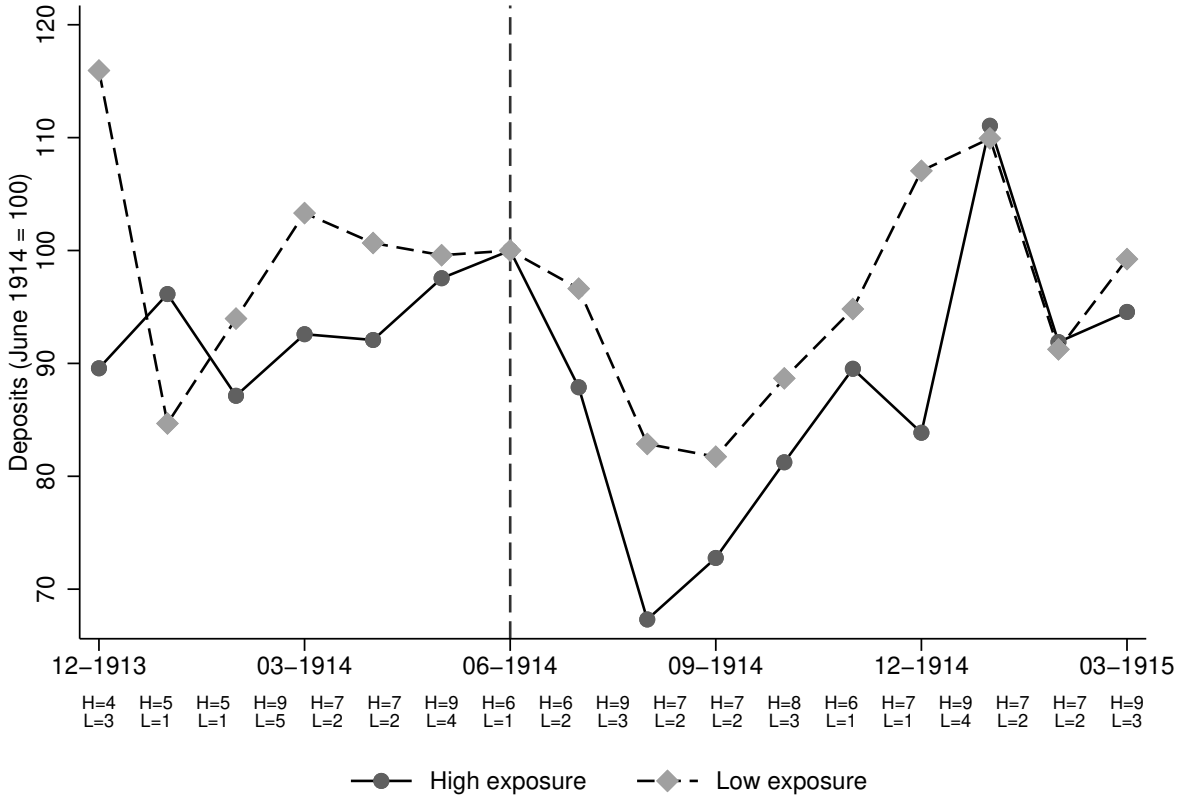


Note: This figure shows β coefficients of the following specification:

$$Y_{i,t} = \sum_{t=1914w20}^{t=1914w40} \beta_t \; CB \; Exposure_i \times D_{week=t} + \gamma Branches_{i,1913} \times Post_t + \kappa_i + \eta_t + \epsilon_{i,t} \tag{15}$$

Where $Y_{i,t}$ is the short-term deposit rate of bank i in week t, $CB\ Exposure_i$ is the fraction of bank's i branches that are located in a city that has a central bank office, $D_{week=t}$ is a dummy equal to 1 for week t, where week 30 (the last week before the shock takes place) is left out to avoid the dummy variable trap. The period covered is from mid-May - September 1914. Bank and week fixed effects are included. The control variable Branches_i is the number of offices bank i operated before the shock. Both CB exposure_i and Branches_i are time-invariant and are therefore absorbed by the bank fixed effects α_i; only their interactions with Post_t are identified. Standard errors are clustered on the bank level. The short-term commercial bank deposit rate is the simple average of the shortest rate offered by each commercial bank in the sample (only if a banks has demandable, daily or weekly). The vertical line reflects the outbreak of the war (28th of July 1914). Source: Delpher Digital Newspaper Archive, author's own computations.

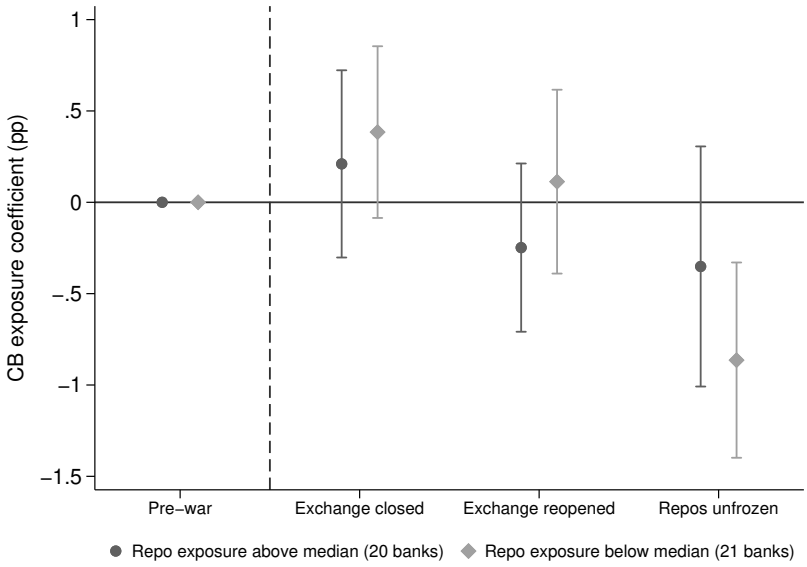
Figure 8: Deposits return to banks within the year



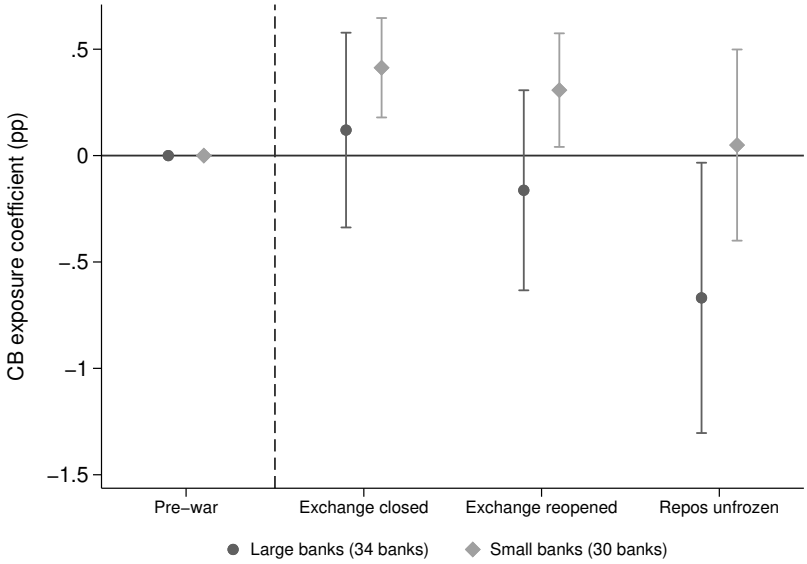
This figure shows the unweighted average of bank-level deposit indices for high- (full) and low-exposed banks. Each bank's index is set to 100 for the last pre-war statement. The vertical dashed line marks the last observation before the shock. Deposits are from monthly and quarterly statements of banks who published those in newspapers. Each point averages over the banks that published a statement in that month. Only few banks did so; the number per data point is provided below the horizontal axis. One bank (Noord-Hollandsch Landbouwcrediet) published the exact same quarterly financial statement for June and September 1914 and is therefore excluded. Source: Delpher Digital Newspaper Archive, author's own computations.

Figure 9: Central bank exposure and deposit rates, by repo exposure and bank size

(a) Above- vs. below-median repo market exposure



(b) Large vs. small banks

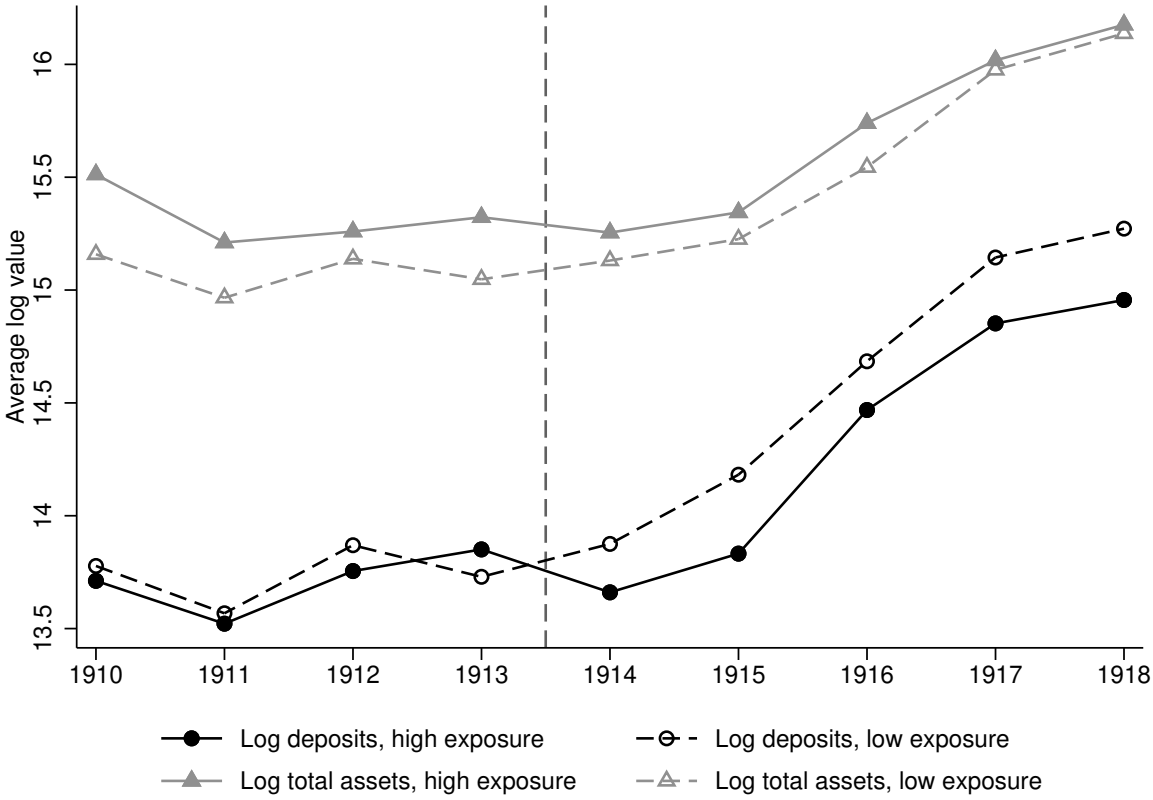


Note: This figure shows β_p coefficients of the following specification, estimated separately for each group of banks:

$$Y_{i,t} = \sum_p \beta_p \, CB \; Exposure_i \times Phase_{p,t} + \sum_p \gamma_p \, Branches_i \times Phase_{p,t} + \kappa_i + \eta_t + \epsilon_{i,t}$$

where $Y_{i,t}$ is the demandable deposit rate of bank i in week t and $Phase_{p,t}$ is a dummy for each of three phases: the closure of the Amsterdam Stock Exchange (29 July 1914 – 8 February 1915), its reopening (9 February – 30 June 1915), and the release of the frozen repos (from 1 July 1915; the DNB lowered its discount rate by 50 basis points in the same week). Each coefficient is measured against the pre-war weeks (5 January – 20 July 1914), plotted at zero. $CB \; Exposure_i$ is the fraction of bank i's branches located in a city with a central bank office; $Branches_i$ is the number of offices the bank operated before the shock. Bank and week fixed effects are included. The sample covers 1914–1915 and banks observed both before and after the shock. Panel A: the 41 banks with a 1913 balance sheet, split at the median of repo exposure, defined as the average of repo lending (prolongaties) and repo borrowing, each over 1913 total assets; a repo item not reported on the balance sheet counts as zero. Panel B: 64 banks, split by 1913 total assets above or below the median; where no balance sheet is available, size is hand-coded from other sources. Mean CB exposure does not differ significantly between the groups (Panel A: 0.69 vs. 0.72; Panel B: 0.77 vs. 0.71). Bars show 95% confidence intervals based on standard errors clustered at the bank level. Source: Delpher Digital Newspaper Archive, bank balance sheets, author's own computations.

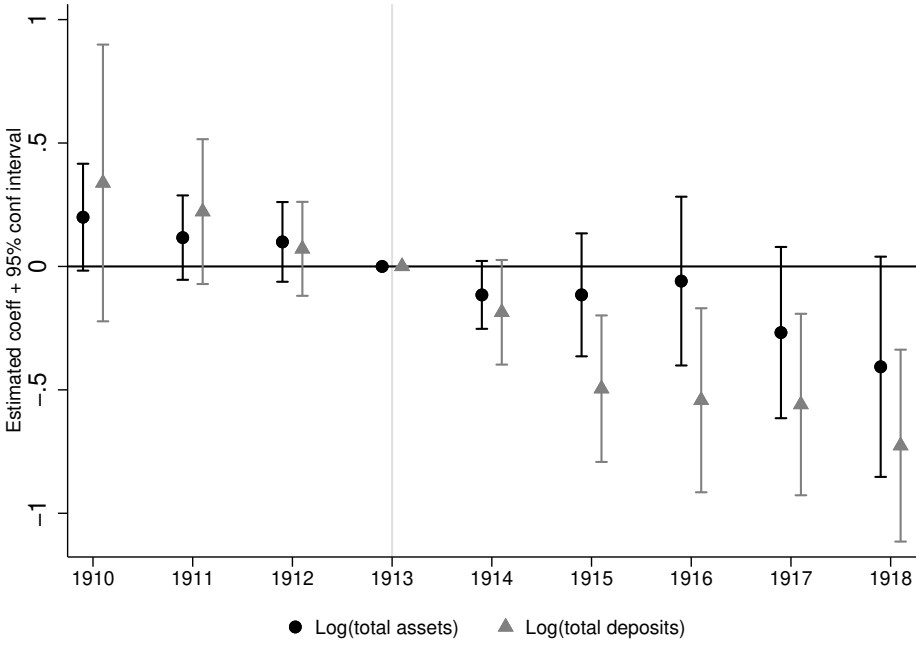
Figure 10: Deposits and total assets over time by central bank exposure



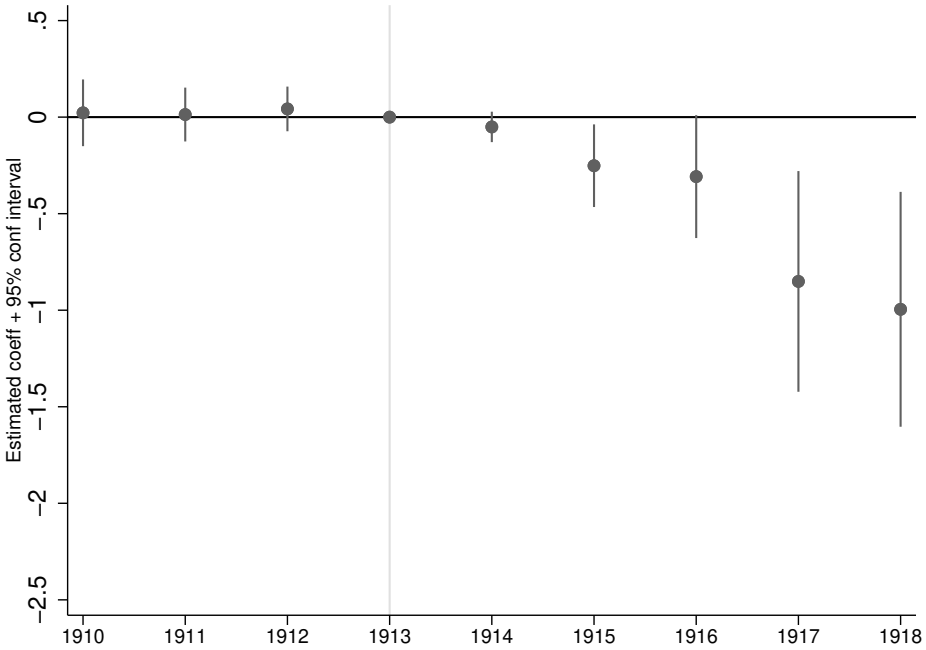
Note: This figure shows the unweighted yearly average of log total deposits (black) and log total assets (grey) for high-exposed (solid) and low-exposed (dashed) commercial banks in the balance sheet sample. High-exposed banks are fully exposed to the central bank, meaning all their branches are located in a city with a DNB office. Low-exposed banks have one or more branches located outside a central bank city. Each average includes all banks that report the item in that year: 28 to 41 high-exposed and 18 to 28 low-exposed banks per year. The vertical dashed line separates the last pre-war balance sheets (1913) from 1914 onward. Source: DNB archive, Dutch commercial balance sheets, author's own computations.

Figure 11: Yearly balance sheet coefficients of banks more exposed to the central bank

(a) Log(total assets) and Log(deposits)



(b) Deposits/total assets 1913



Note: This figure shows β coefficients of the following specification:

$$Y_{i,t} = \sum_{t=1910}^{1918} \beta_t \, CB \; Exposure_i \times D_{year=t} + \gamma \, Branches_i \times Post_t + \delta \ln(Pop_{i,t}) + \kappa_i + \eta_t + \mu_{r,t} + \epsilon_{i,t} \tag{17}$$

Where $Y_{i,t}$ is log(total assets), log(deposits) (panel a) or the deposit ratio over pre-war (1913) total assets (panel b) of bank i in year t, $CB\ Exposure_i$ is the fraction of bank's i branches that are located in a city that has a central bank office, $D_{year=t}$ is a dummy equal to 1 for year t, where 1913 (the last year before the shock takes place) is left out to avoid the dummy variable trap. The period covered is 1910-1918. $Branches_i$ is the number of offices bank i had before the war, interacted with $Post_t$, a dummy equal to 1 from 1914 onwards. $\ln(Pop_{i,t})$ is the log of the yearly population of bank i's pre-war office locations. Bank, year and CB ressort $\times$ year fixed effects are included, and standard errors are clustered on the bank level. Source: DNB archive, Dutch commercial balance sheets, author's own computations.

Tables

Table 1: Summary statistics

	Mean	SD	P1	P50	P99	N	Banks
Panel A: deposit rate sample (bank-weeks, 1914–1915)							
Short-term rate	2.95	0.80	1.00	3.00	4.00	7414	76
Demandable rate	2.95	0.81	1.00	3.00	4.00	6795	68
Weekly rate	2.96	0.80	0.75	3.00	4.50	3840	39
Monthly rate	3.42	0.73	1.25	3.50	5.00	4639	50
Quarterly rate	3.53	0.55	2.25	3.50	4.50	4609	48
Yearly rate	4.05	0.23	3.50	4.00	5.00	4714	48
Inverted term structure	0.08	0.26	0.00	0.00	1.00	7444	77
CB exposure	0.74	0.38	0.00	1.00	1.00	7579	79
High CB exposure	0.62	0.49	0.00	1.00	1.00	7579	79
War exposure	0.19	0.36	0.00	0.00	1.00	7579	79
# branches	2.73	3.03	1.00	1.00	16.00	7579	79
Log(population HQ)	11.61	1.43	8.23	11.69	13.25	7369	77
Log(total population)	12.12	1.54	8.57	12.51	15.12	7579	79
Unemployment rate	61.01	1.66	55.28	60.92	66.77	7579	79
# Banks	29.06	20.73	1.00	23.00	62.00	7579	79
Panel B: balance sheet sample (bank-years, 1910–1918)							
Total assets	1.31	0.87	0.49	1.00	5.17	522	70
Log(total assets)	15.43	1.64	12.47	15.06	19.55	530	72
Deposits	0.51	0.58	0.00	0.38	2.39	523	70
Secured funding	0.12	0.19	0.00	0.04	0.88	523	70
Unsecured funding	0.25	0.36	0.00	0.11	1.72	523	70
Equity	0.32	0.22	0.03	0.27	1.23	510	69
Other liabilities	0.12	0.29	0.00	0.02	1.67	492	68
Total lending	0.92	0.66	0.06	0.78	3.60	523	70
Liquid lending	0.16	0.27	0.00	0.06	1.41	523	70
Illiquid lending	0.63	0.55	0.00	0.53	2.57	523	70
Repo lending	0.13	0.19	0.00	0.04	0.85	523	70
Liquid assets	0.06	0.08	0.00	0.03	0.45	523	70
Large bank	0.53	0.50	0.00	1.00	1.00	518	68

Note: This table reports summary statistics for the weekly deposit rate panel of commercial banks, 1914–1915 (Panel A), and for the annual balance sheet panel used in the funding and lending regressions, 1910–1918 (Panel B). N is the number of bank-week (Panel A) or bank-year (Panel B) observations. Short-term rate is the shortest rate available for each bank that is either demandable, daily or weekly. Demandable rate is the deposit rate for deposits with a tenor of 0 or 1 day. The weekly rate includes deposit tenors of 8, 10 and 14 days. Monthly, Quarterly and Yearly rates refer to one month, 2-3 months and 12 months deposit tenors. Inverted term structure is a dummy that equals 1 if a bank remunerates a shorter tenor at a higher rate than a longer tenor, and 0 otherwise. CB exposure is the continuous fraction of commercial bank branches that is located in a city with a central bank office. High CB exposure is a dummy that equals 1 if a bank is fully exposed, i.e. all its branches are located in CB cities. War exposure is the fraction of commercial bank branches that are located in a province bordering countries at war. # branches is the number of offices a bank has pre-shock. Log(population HQ) is the natural logarithm of the 1909 population of the city of a bank's head office. Log(total population) is the natural logarithm of the total population a bank serves, i.e. the sum of the 1909 inhabitants of every branch location. Unemployment rate is the population-weighted average percentage unemployed across a bank's branches. # Banks is the population-weighted average number of banks in a bank's branch locations. In Panel B, all balance sheet variables are divided by the bank's 1913 (pre-war) total assets, as in the regressions; Log(total assets) is the natural log of current total assets. Total deposits include current account balances; Secured funding is short-term collateralized borrowing (repo and bills of exchange); Unsecured funding is interbank borrowing, creditors and long-term borrowing; Equity is capital and retained earnings; Other liabilities is the residual on the liability side. Liquid lending consists of bills of exchange, Illiquid lending of credit lines and long-term loans, and Repo lending of collateralized loans on securities; Liquid assets include cash and cash equivalents and Dutch government bonds. Large bank is a dummy that equals 1 for banks above the median 1913 total assets.

Table 2: Bank balancing table: deposit rates sample

	Low CB exposure			High CB exposure			Pairwise t-test	
	N	Mean	SD	N	Mean	SD	N	t-statistic
Panel A: exposure and pre-war deposit pricing								
CB exposure	29	0.300	(0.284)	43	1.000	(0.000)	72	-16.218***
War exposure	29	0.265	(0.400)	43	0.128	(0.326)	72	1.596
# branches	29	4.241	(3.280)	43	1.791	(2.455)	72	3.624***
Log(population HQ)	29	10.947	(1.462)	41	12.160	(1.155)	70	-3.873***
Log(total population)	29	11.729	(1.692)	43	12.446	(1.380)	72	-1.973*
# Banks	29	20.639	(19.062)	43	34.908	(20.298)	72	-2.997***
Short-term rate	29	2.911	(0.500)	43	2.858	(0.517)	72	0.428
Demandable rate	23	2.942	(0.493)	41	2.842	(0.519)	64	0.756
Weekly rate	15	3.046	(0.421)	23	2.877	(0.400)	38	1.250
Monthly rate	19	3.333	(0.344)	26	3.228	(0.384)	45	0.949
Quarterly rate	18	3.499	(0.350)	26	3.382	(0.343)	44	1.101
Yearly rate	20	4.025	(0.112)	26	4.004	(0.134)	46	0.553
Inverted term structure	28	0.048	(0.195)	43	0.050	(0.195)	71	-0.042
Panel B: 1913 balance sheets								
Log(total assets)	18	15.719	(1.624)	24	15.865	(1.427)	42	-0.309
Deposits/total assets	18	0.306	(0.131)	24	0.359	(0.203)	42	-0.961
Secured funding/total assets	18	0.144	(0.153)	24	0.158	(0.183)	42	-0.269
Unsecured funding/total assets	18	0.259	(0.190)	24	0.152	(0.173)	42	1.907*
Total equity/total assets	18	0.256	(0.105)	23	0.269	(0.092)	41	-0.451
Repo lending/total assets	18	0.159	(0.199)	24	0.123	(0.149)	42	0.670
Liquid assets/total assets	18	0.026	(0.014)	24	0.032	(0.029)	42	-0.773

Note: The balancing table compares low-exposed and high-exposed banks before the outbreak of the war. N is the number of banks. Panel A uses the banks in the deposit rate sample that quote a short-term rate before 27 July 1914, i.e. the banks that identify the deposit rate regressions: each bank's weekly observations before that date are first averaged, so every bank counts once and standard deviations are across banks. High CB exposure is a dummy that equals 1 if a bank is fully exposed to the central bank, i.e. all its branches are located in CB cities. CB exposure is the continuous fraction of commercial bank branches that is located in a city that has a central bank office. War exposure is the fraction of commercial bank branches that are located in a province bordering countries at war. # branches is the number of offices a bank has pre-shock. Log(population HQ) is the natural logarithm of the 1909 population of the city of a bank's head office; Log(total population) sums the 1909 population over all of a bank's office locations. Two banks with a head office in Batavia have no HQ population. # Banks is the population-weighted average number of banks in a bank's office locations. Short-term rate is the shortest rate available for each bank that is either demandable, daily or weekly. Demandable rate is the deposit rate for deposits with a tenor of 0 or 1 day. The weekly rate includes deposit tenors of 8, 10 and 14 days. Monthly, Quarterly and Yearly rates refer to one month, 2-3 months and 12 months deposit tenors. Inverted term structure is the share of pre-war weeks in which a bank remunerated a shorter tenor at a higher rate than a longer tenor. Panel B uses the 1913 balance sheets of the same banks, where available; all balance sheet variables are weighted by total assets. The last column reports the t-statistic of a two-sided test of equal means.

Table 3: Bank balancing table: balance sheet sample

	Low CB exposure			High CB exposure			Pairwise t-test	
	N	Mean	SD	N	Mean	SD	N	t-statistic
CB exposure	28	0.258	(0.271)	40	1.000	(0.000)	68	-17.363***
War exposure	28	0.162	(0.338)	40	0.088	(0.271)	68	0.997
# branches	28	4.179	(3.345)	40	1.975	(2.665)	68	3.019***
Log(population HQ)	28	10.808	(1.464)	38	12.290	(0.970)	66	-4.945***
Log(total population)	28	11.586	(1.588)	40	12.630	(1.278)	68	-2.999***
# Banks	28	19.724	(20.147)	40	40.292	(20.228)	68	-4.133***
Log(total assets)	28	15.048	(1.622)	40	15.323	(1.463)	68	-0.729
Deposits/total assets	28	0.327	(0.204)	40	0.349	(0.236)	68	-0.393
Secured funding/total assets	28	0.144	(0.166)	40	0.140	(0.163)	68	0.110
Unsecured funding/total assets	28	0.242	(0.232)	40	0.185	(0.245)	68	0.963
Total equity/total assets	28	0.277	(0.128)	38	0.262	(0.126)	66	0.495
Liquid lending/total assets	28	0.103	(0.143)	40	0.106	(0.138)	68	-0.062
Illiquid lending/total assets	28	0.592	(0.231)	40	0.482	(0.277)	68	1.710*
Repo/total assets	28	0.129	(0.179)	40	0.121	(0.149)	68	0.202
Liquid assets/total assets	28	0.029	(0.020)	40	0.027	(0.026)	68	0.287

Note: The balancing table compares the pre-war (before 1914) annual variable means of low-exposed and high-exposed banks. The balancing table covers banks observed in the pre-period. High CB exposure is a dummy that equals 1 if a bank is fully exposed to the central bank, i.e. all its branches are located in CB cities. CB exposure is the continuous fraction of commercial bank branches that is located in a city that has a central bank office. # branches is the number of offices a bank has pre-shock. Log(population HQ) is the natural logarithm of the 1909 population of the city of a bank's head office; Log(total population) sums the 1909 population over all of a bank's office locations. # Banks is the population-weighted average number of banks in a bank's office locations. Log(total assets) is the natural log of a bank's total assets in 1913. Total deposits is the total deposits and current account outstanding balances, Secured funding is all short-term collateralized borrowing (repo and bills of exchange), Unsecured funding is the sum of interbank borrowing, creditors and long-term borrowing, Equity is the sum of capital and retained earnings. Liquid lending consists of bills of exchange, while illiquid lending contains credit lines and long-term loans. Liquid assets include cash and cash equivalents and Dutch government bonds. All balance sheet variables are 1913 values weighted by total assets. War exposure is the fraction of commercial bank branches that are located in a province bordering countries at war. N is the number of banks. The last column reports the t-statistic of a two-sided test of equal means.

Table 4: Commercial bank short-term deposit rates and central bank exposure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Demandable deposit rate						
Post	0.309*						
	(0.163)						
CB exposure * Post	0.459**	0.458**	0.372*	0.423**	0.618***	0.538***	0.551***
	(0.203)	(0.204)	(0.197)	(0.211)	(0.191)	(0.185)	(0.197)
# branches * Post					0.060***	0.057***	0.048***
					(0.022)	(0.016)	(0.016)
Observations	640	640	640	640	640	640	640
R-squared	0.582	0.610	0.636	0.669	0.621	0.646	0.676
Within R-sq	0.281	0.025	0.017	0.022	0.052	0.043	0.041
Banks	76	76	76	76	76	76	76
Period	Jul-Aug 1914						
Bank FE	Y	Y	Y	Y	Y	Y	Y
Week FE	N	Y	Y	Y	Y	Y	Y
Region-Month FE	N	N	Y	N	N	Y	N
Ressort-Month FE	N	N	N	Y	N	N	Y

Note: This table presents estimates for the demandable deposit rates of commercial banks in the month before (July) and the month after (August) the shock. The dependent variable is the shortest deposit rate available for each bank (max weekly rate). Post is a dummy that equals 1 if the period of observation is after 26th of July 1914. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. All columns include bank fixed effects. Column (1) includes no time fixed effects, so that the Post coefficient is identified; columns (2)-(7) include week fixed effects. Columns (3) and (6) also include region x month fixed effects, where the regions are north, middle, south and 'Randstad' (North- and South-Holland). Columns (4) and (7) include central bank office region (see Figure B.1) x month fixed effects. Columns (5)-(7) control for the number of branches, the number of offices a bank has pre-shock, interacted with Post. Table C.3 in the appendix reports the same estimates over 1914 and 1914-1915. Clustered standard errors on the bank level are in parentheses. Wild cluster bootstrap p-values (Rademacher weights, 9,999 replications) for CB exposure x Post range from 0.007 to 0.079 across columns. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table 5: Commercial bank deposit rates by tenor and central bank exposure

	(1) Demandable	(2) Weekly	(3) Monthly	(4) Quarterly	(5) Annual
CB exposure * Post	0.538***	0.637***	0.183	0.183	0.032
	(0.185)	(0.197)	(0.245)	(0.149)	(0.033)
# branches * Post	0.057***	0.054	0.038	0.017	-0.001
	(0.016)	(0.037)	(0.025)	(0.017)	(0.002)
Observations	640	330	403	400	409
R-squared	0.646	0.690	0.721	0.735	0.878
Within R-sq	0.043	0.041	0.019	0.017	0.007
Banks	76	39	50	48	48
Period			Jul-Aug 1914		
Bank FE	Y	Y	Y	Y	Y
Week FE	Y	Y	Y	Y	Y
Region-Month FE	Y	Y	Y	Y	Y

Note: This table presents estimates for the deposit rates of commercial banks in July and August 1914 by different deposit tenors. Column (1) includes only the shortest deposit rate available (max tenor is weekly). Column (2), the weekly rate, includes deposit tenors of 8, 10 and 14 days. Columns (3)-(5) show results for monthly, quarterly and annual deposit tenors, respectively. All columns control for the number of branches, the number of offices a bank has pre-shock, interacted with Post. Post is a dummy that equals 1 if the period of observation is after 26th of July 1914. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. All columns include bank, week and region x month fixed effects, where the regions are north, middle, south and 'Randstad' (North- and South-Holland). Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table 6: Central bank exposure and inverted term structure of deposit pricing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Inverted term structure						
Post	0.033						
	(0.039)						
CB exposure * Post	0.191***	0.192***	0.201***	0.169**	0.242***	0.261***	0.225***
	(0.067)	(0.067)	(0.071)	(0.069)	(0.073)	(0.079)	(0.074)
# branches * Post					0.019	0.021*	0.021*
					(0.013)	(0.012)	(0.012)
Observations	643	643	643	643	643	643	643
R-squared	0.599	0.603	0.612	0.625	0.608	0.618	0.631
Within R-sq	0.136	0.021	0.022	0.015	0.034	0.038	0.031
Banks	77	77	77	77	77	77	77
Period	Jul-Aug 1914						
Bank FE	Y	Y	Y	Y	Y	Y	Y
Week FE	N	Y	Y	Y	Y	Y	Y
Region-Month FE	N	N	Y	N	N	Y	N
Ressort-Month FE	N	N	N	Y	N	N	Y

Note: This table presents estimates for inverted term structure of deposit rates by commercial banks in the month before (July) and the month after (August) the shock. Inverted term structure is a dummy that equals 1 if the remuneration is higher for shorter-maturity deposits (demandable rate is higher than weekly rate and/or weekly rate is higher than monthly, or demandable rate is higher than monthly rate), and 0 otherwise; banks that quote only one of these tenors are coded 0. Post is a dummy that equals 1 if the period of observation is after 26th of July 1914. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. All columns include bank fixed effects. Column (1) includes no time fixed effects, so that the Post coefficient is identified; columns (2)-(7) include week fixed effects. Columns (3) and (6) also include region x month fixed effects, where the regions are north, middle, south and 'Randstad' (North- and South-Holland). Columns (4) and (7) include central bank office region (see Figure B.1) x month fixed effects. Columns (5)-(7) control for the number of branches, the number of offices a bank has pre-shock, interacted with Post. Table C.3 in the appendix reports the same estimates over 1914 and 1914-1915. Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table 7: Central bank exposure, regional controls and comparable banks, demandable deposit pricing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Demandable rate								
CB exposure * Post	0.538***	0.340*	0.350*	0.350*	0.361	0.597***	0.373**	0.637***	0.473***
	(0.185)	(0.184)	(0.191)	(0.189)	(0.246)	(0.132)	(0.152)	(0.149)	(0.158)
# branches * Post	0.057***	0.030	0.033*	0.033	0.066***	0.054**	0.010	0.056**	0.022
	(0.016)	(0.019)	(0.019)	(0.023)	(0.021)	(0.022)	(0.033)	(0.022)	(0.033)
Log(population) * Post		0.111**	0.105*	0.101			0.179		0.134
		(0.055)	(0.054)	(0.102)			(0.122)		(0.122)
Unemployment rate * Post			-0.059	-0.058	-0.068		-0.018		-0.014
			(0.043)	(0.039)	(0.041)		(0.036)		(0.035)
# Banks * Post				0.000	0.004		-0.002		-0.001
				(0.007)	(0.006)		(0.007)		(0.007)
Observations	640	640	640	640	349	640	640	583	583
R-squared	0.646	0.650	0.652	0.652	0.688	0.650	0.657	0.653	0.657
Within R-sq	0.043	0.054	0.060	0.060	0.088	0.043	0.063	0.048	0.061
Banks	76	76	76	76	41	76	76	67	67
Period	Jul-Aug 1914								
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Week FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region-Month FE	Y	Y	Y	Y	Y	N	N	N	N
Sector-Month FE	N	N	N	N	N	Y	Y	Y	Y
Common support	N	N	N	N	Y	N	N	N	N
Excl. agriculture	N	N	N	N	N	N	N	Y	Y

Note: This table presents estimates for the demandable deposit rates of commercial banks with regional controls and restricted to comparable banks, in the month before (July) and the month after (August) the shock. Table C.5 in the appendix reports the same estimates for all of 1914. The dependent variable is the shortest deposit rate available for each bank (max weekly rate). Post is a dummy that equals 1 if the period of observation is after 26th of July 1914. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. Column (1) controls for the number of branches; columns (2)-(4) add the other controls one at a time. # branches is the number of offices a bank has pre-shock. This excludes branches outside of the Netherlands (3 banks have an office in London or Batavia). Log(population) is the natural logarithm of the total population that a bank serves, i.e. the sum of all city inhabitants of every branch location. Unemployment rate is the population-weighted average percentage unemployed across a banks' branches. # Banks is the average number of banks (population-weighted) in its branch locations. All controls are interacted with Post. Column (5) includes only banks in the common support of log average population across the branches, i.e. between the larger of the minima and the smaller of the maxima of the high- and low-exposed groups. Columns (6)-(9) include dominant sector x month fixed effects instead of region x month fixed effects; columns (8) and (9) exclude the sector that only has low-exposed banks (agriculture). Columns (1)-(5) include region x month fixed effects, where the regions are north, middle, south and 'Randstad' (North- and South-Holland). All columns include bank and week fixed effects. Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table 8: Central bank exposure and commercial banks' funding mix

	(1) Total Assets	(2) Deposits	(3) Secured funding	(4) Unsecured funding	(5) Equity	(6) Other liabilities
CB exposure * Post	-0.414*	-0.426***	0.001	0.027	-0.125**	0.140*
	(0.224)	(0.147)	(0.048)	(0.077)	(0.059)	(0.071)
# branches * Post	0.014	-0.002	-0.001	0.008	0.004	0.011
	(0.031)	(0.011)	(0.006)	(0.012)	(0.006)	(0.012)
Pre-shock mean	0.943	0.306	0.122	0.196	0.272	0.054
Post-shock mean	1.617	0.681	0.111	0.305	0.368	0.170
Observations	522	523	523	523	510	492
R-squared	0.670	0.786	0.697	0.738	0.657	0.535
Banks	70	70	70	70	69	68
Period				1910-1918		
Bank FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y	Y	Y
Population control	Y	Y	Y	Y	Y	Y

Note: This table presents annual bank balance sheet items for 1910-1918. Six banks in the balance sheet sample do not report deposits in more than one year and therefore drop out of the deposits column. Post is a dummy that equals 1 if the year is 1914 or later. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. All dependent variables are weighted by their 1913 (pre-war) total assets. Total Asset is thus the total assets of a bank i in year t over total assets of 1913. Total deposits is the total deposits and current account outstanding balances, Secured funding is all short-term collateralized borrowing (repo and bills of exchange), Unsecured funding is the sum of interbank borrowing, creditors and long-term borrowing, Equity is the sum of capital and retained earnings, and Other Liabilities reflects a residual term on the banks' balance sheet. All columns control for the log of the yearly population of the bank's pre-war office locations and for the size of its branch network interacted with Post. All columns include bank, year and region x year fixed effects, where the regions are north, middle, south and the Randstad (North- and South-Holland). Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table 9: Central bank exposure, bank size and funding composition

	(1)	(2)	(3)	(4)	(5)	(6)
	Size	Share of total assets				
	Log(total assets)	Deposits	Secured funding	Unsecured funding	Equity	Other liabilities
CB exposure * Post	-0.228*	-0.094**	0.023	0.036	0.003	0.032
	(0.134)	(0.036)	(0.037)	(0.030)	(0.035)	(0.033)
# branches * Post	0.013	0.003	-0.005	-0.000	0.001	0.002
	(0.017)	(0.005)	(0.005)	(0.002)	(0.004)	(0.005)
Pre-shock mean	15.207	0.309	0.134	0.224	0.284	0.049
Post-shock mean	15.601	0.404	0.076	0.184	0.255	0.081
Observations	517	517	517	517	517	517
R-squared	0.975	0.878	0.788	0.899	0.790	0.704
Banks	71	71	71	71	71	71
Period	1910-1918					
Bank FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y	Y	Y
Population control	Y	Y	Y	Y	Y	Y

Note: This table presents annual bank balance sheet items for 1910-1918. Six banks in the balance sheet sample do not report deposits in more than one year and are therefore excluded from all columns. Column (1) is the natural log of total assets. Columns (2)-(6) divide each liability item by the bank's total assets in the same year; Other liabilities is the residual, so the five shares sum to one and their coefficients sum to zero. All columns use the same sample of bank-years in which deposits, equity and total assets are observed. Post is a dummy that equals 1 if the year is 1914 or later. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. Total deposits is the total deposits and current account outstanding balances, Secured funding is all short-term collateralized borrowing (repo and bills of exchange), Unsecured funding is the sum of interbank borrowing, creditors and long-term borrowing, Equity is the sum of capital and retained earnings. All columns control for the log of the yearly population of the bank's pre-war office locations and for the size of its branch network interacted with Post. All columns include bank, year and region x year fixed effects, where the regions are north, middle, south and the Randstad (North- and South-Holland). Clustered standard errors on the bank level are in parentheses. Wild cluster bootstrap p-values (Rademacher weights, 9,999 replications) for CB exposure x Post, by column: (1) 0.112; (2) 0.016; (3) 0.573; (4) 0.251; (5) 0.945; (6) 0.335. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table 10: Central bank exposure and commercial banks' lending portfolio

	(1) Total lending	(2) Liquid lending	(3) Illiquid lending	(4) Repo lending	(5) Liquid assets
CB exposure * Post	-0.403**	-0.129	-0.222**	-0.052	-0.015
	(0.163)	(0.119)	(0.090)	(0.069)	(0.020)
# branches * Post	-0.003	-0.009	0.011	-0.004	0.002
	(0.017)	(0.006)	(0.013)	(0.004)	(0.004)
Pre-shock mean	0.683	0.097	0.474	0.112	0.030
Post-shock mean	1.130	0.221	0.771	0.139	0.077
Observations	523	523	523	523	523
R-squared	0.682	0.631	0.745	0.679	0.634
Banks	70	70	70	70	70
Period			1910-1918		
Bank FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y	Y
Population control	Y	Y	Y	Y	Y

Note: This table presents annual bank balance sheet items for 1910-1918. Post is a dummy that equals 1 if the year is 1914 or later. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. All dependent variables are weighted by their 1913 (pre-war) total assets. Total lending the sum of all credit lines, repo lending, short term collateralized loans (bills of exchange) and long-term loans. Liquid lending consists of bills of exchange, while illiquid lending contains credit lines and long-term loans. Liquid assets include cash and cash equivalents and Dutch government bonds. All columns control for the log of the yearly population of the bank's pre-war office locations and for the size of its branch network interacted with Post. All columns include bank, year and region x year fixed effects, where the regions are north, middle, south and the Randstad (North- and South-Holland). Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table 11: Banks' balance sheets and central bank exposure: Heterogeneity by bank size

	(1) Total assets	(2) Deposits	(3) Equity	(4) Total lending	(5) Illiquid lending	(6) Repo lending
CB exposure * Post	-0.649**	-0.505**	-0.130*	-0.515**	-0.302**	-0.075
	(0.277)	(0.204)	(0.068)	(0.215)	(0.129)	(0.087)
Large bank * Post	-0.179	0.047	-0.035	0.093	-0.114	0.025
	(0.344)	(0.229)	(0.065)	(0.245)	(0.114)	(0.083)
CB exposure * Large bank * Post	0.477	0.108	0.027	0.139	0.192	0.026
	(0.411)	(0.245)	(0.095)	(0.292)	(0.161)	(0.092)
# branches * Post	0.005	-0.009	0.006	-0.015	0.010	-0.007
	(0.035)	(0.014)	(0.007)	(0.019)	(0.014)	(0.004)
Large banks: CB exposure * Post + triple	-0.173	-0.397***	-0.104	-0.376*	-0.111	-0.049
	(0.331)	(0.140)	(0.068)	(0.207)	(0.099)	(0.058)
Observations	517	518	505	518	518	518
R-squared	0.666	0.788	0.634	0.673	0.734	0.680
Banks	68	68	67	68	68	68
Period				1910-1918		
Bank FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y	Y	Y
Population control	Y	Y	Y	Y	Y	Y

Note: This table presents annual bank balance sheet items for 1910-1918. Six banks in the balance sheet sample do not report deposits in more than one year and therefore drop out of the deposits column. Post is a dummy that equals 1 if the year is 1914 or later. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. Large bank is a dummy that equals 1 for banks above the median 1913 size. All dependent variables are weighted by their 1913 (pre-war) total assets. Total Assets is thus the total assets of a bank i in year t over total assets of 1913. Total deposits is the total deposits and current account outstanding balances, Equity is the sum of capital and retained earnings. Total lending the sum of all credit lines, repo lending, short term collateralized loans (bills of exchange) and long-term loans. Illiquid lending contains credit lines and long-term loans. CB exposure * Post is the effect for banks below the median size; the last row reports the total effect for large banks, the sum of CB exposure * Post and the triple interaction, with its standard error. All columns control for the log of the yearly population of the bank's pre-war office locations and for the size of its branch network interacted with Post. All columns include bank, year and region x year fixed effects, where the regions are north, middle, south and the Randstad (North- and South-Holland). Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

A Historical Background

A.1 De Nederlandsche Bank

De Nederlandsche Bank (DNB) was established in 1814 via royal decree to "lift up commerce from its deplorable state [...] in order to be able to nourish a justified hope for the return of that prosperity which our fathers have enjoyed" (Kymmell, 1992, p. 61). That is, DNB's primary function was to boost trade by extending credit via discounting and collateralized lending. Contrary to most central banks at the time, DNB was not set up as a 'bank for the state': its charter did not allow for extending unsecured credit, not even to the government (Vanthoor, 2005). The charter lasted 25 years and was renewed several times until DNBs nationalization in 1948.

The Bank Act of 1863 mandated DNB to open at least one deposit office in every province. The offices were all headed by an 'agent' who had to pay in some of his own wealth and was personally liable for damages at the office (Mooij and Prast, 2003). The offices were not independent on the head office in Amsterdam: they needed approval before accepting firms or individuals to their discount window and underwent daily checks of their books.[49]

The expansion of DNB's office network boosted commercial credit provision across the country (Vanthoor, 2005). Financial institutions accepted to the discount window could expand their business and loosen their credit conditions. In most regional offices, cashiers, bankers and brokers would discount paper on behalf of firms and individuals, and Van Der Werf (1988) even claims that the regional banking sector could not survive without DNB's discounting facilities. DNB was thus very much a complement rather than a substitute to the commercial banks. According to Kymmell (1992), DNB became the bankers' bank in the provinces after the opening of the deposit offices. Indeed, DNB presidents consistently opposed attracting retail deposits from the banking sector. President Willem Mees (1863–1885) argued that deposit-taking was solely the business of banks and cashiers, and his successor Nicholaas Pierson (1885–1891) shared the view that it should never be the Bank's aim to take away deposits from other banks (Vanthoor, 2005).

Moreover, since its establishment DNB acted as the general lender to the financial system when it faced liquidity shortages (Vanthoor, 2005). It is not straightforward to pinpoint an exact moment when the Bank could be considered a lender of last resort, as it never had to perform the function widely before 1914. The secretary (and soon to be president) of DNB in 1863, Mees, mentions the role the bank played to prevent liquidity crises in the previous decade (Wijtvliet, 1993). Jonker (1996) states that DNB becomes more of

[49] One exception was the Rotterdam office ("*Bijbank*"), the largest office outside of Amsterdam, which was a more stand-alone DNB office and did not require Amsterdam approval for extending credit.

lender of last resort when commercial banks started to emerge in the 1860s. Capie (1994) argue that DNB adopted the lender of last resort role in the 1870s, while Mooij and Prast (2003) mention that while the Bank Act of 1903 did not explicitly mention it, DNB was de facto the lender of last resort. According to Vanthoor (2005), DNB had definitely lost its role as lender to trade and industry in 1914, laying the foundation for it's dual function as the national bankers' bank and lender of last resort.

DNB's retail deposit facilities also evolved over this period. In 1838, the renewal of its charter allowed retail depositing in a current account, but without the option to overdraft. From 1889, current account holders at DNB's head office (*Hoofdbank*) could overdraft their accounts, but only with appropriate collateral. In the offices, depositing in current account was also allowed from 1889 onward.

A.2 Commercial banks in the Netherlands

Commercial banks' deposits started increasing from 1890s onwards, when the banks actively tried to attract deposits by advertising and offering interest. Since 1875, commercial banks gradually adopted current accounts (credit lines) as one of the main forms of providing credit (Van Der Werf, 1988). Clients could also deposit money in the current accounts, and they functioned in a similar way as demandable deposits (and offered a comparable rate). This paper includes the liability side current account balances at commercial banks as a part of total bank deposits.

Despite this growth, the Netherlands had a low share of deposits as a percentage of the money supply M1 compared to other European countries: 34%, compared to 66% in Belgium, and 85% in the UK (Van Riel, 2021; Vanthoor, 2005). A reason for the relatively low level of deposits is the large money market existing at the time. Anyone could, via a bank or broker, invest in *prolongaties*, 1 month loans collateralized with any type of security listed on the Amsterdam Stock Exchange, with a haircut of minimum 10%. These repurchase agreements (repo)-like instruments were preferred to bank deposits since they provided a higher return than a 1 month bank deposit, while being considered as liquid and could be indefinitely rolled over (Van Ketel and Verbiest, 1923). The repo market amounted to $f.$ 400 million, or 15% of 1914 GDP (Van Riel, 2021).

The closure of the stock market in 1914-1915 led to a complete freeze of the repo market (see the next section), while commercial banks simultaneously received an inflow of deposits after the short-lived bank run subsided. Whether the increasing importance of deposits for banks' funding is caused by the repo market breakdown of 1914 cannot be causally identified. Few losses materialized after the stock market was reopened in

February 1915, due to the increasing returns on mainly US stocks (Jongman, 1960). The repo market became more volatile but remained widely used until after World War II.

A.3 War measures by the government and DNB

After the outbreak of the First World War on 28 July, the Dutch government implemented several emergency measures: closing the stock exchange, initiating general mobilization and, most importantly, suspending the Gold Standard. On 3 August, the official metal-cover ratio was by law allowed to deviated from 40 to 20 percent, thus officially suspending gold convertibility.[50] The demand for banknotes and especially silver by the public was unprecedented (gold exports were prohibited) and could not be met with the available minted silver coins. The government therefore authorized the issuance of up to $f.$ 25 million in "zilverbons" (silver certificates) to counteract silver outflows. These certificates were a temporary means of payment that could be exchanged to silver in the future (Vanthoor, 2005).[51] By October 1914, the metal-cover ratio had fallen to its lowest point of 32.59 percent before stabilizing.

DNB set up support syndicate with a large group of commercial banks and bankers' houses to provide liquidity to those affected by the closure of the Stock Exchange. Many brokers, dealers and banks had substantial volume of repo contracts (*prolongaties*) outstanding before the war: around $f.$ 400 million, which was twice the size of term deposits by banks (Van Riel, 2021). The entire repo market froze once the Stock Exchange closed, leaving many investors short of liquidity. The support syndicate was initially $f.$ 25 million with the idea that the Stock Exchange would reopen the day after, but was quickly increased to $f.$ 200 million when the reopening was postponed.[52] DNB was responsible for the first $f.$ 40 million of the syndicate, and above that commercial banks would guarantee 20% of the additional loans required by the market, up to the maximum of their voluntary commitment.

[50]The metal-cover ratio (*metaaldekking*) was by law set to 40%, meaning DNB had to hold 40% of its demandable debt (banknotes in circulation and current accounts) in gold.

[51]The zilverbons had to be withdrawn as soon as DNB had enough silver coins available to the government. The certificates were given legal tender and were very popular: the maximum amount to be issued expanded to $f.$ 40 million in 1916 and $f.$ 100 million in 1918 (Vanthoor, 2005).

[52]Eventually, the stock market reopened on February 9, 1915.

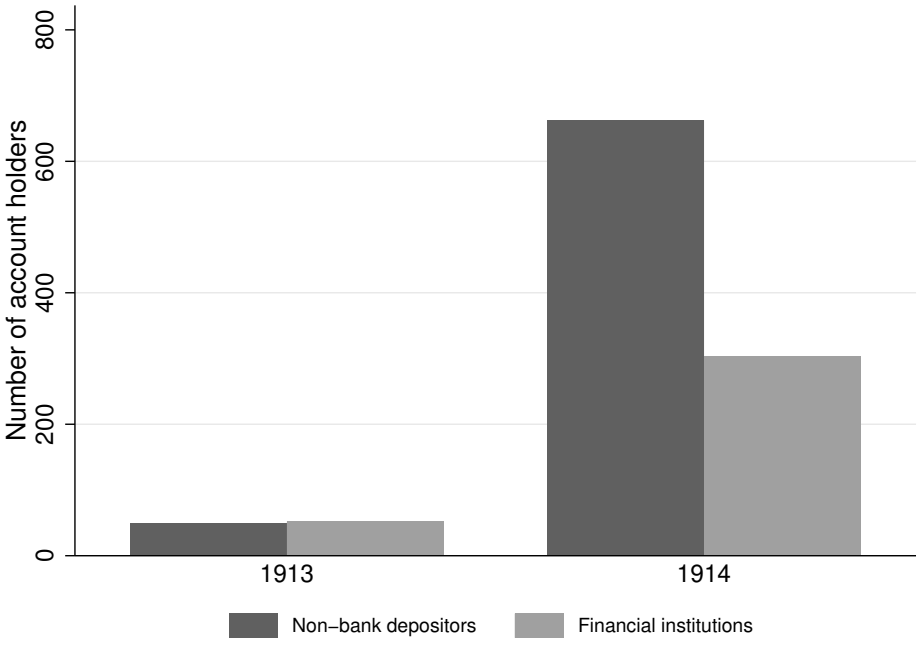
B Appendix Figures

Figure B.1: DNB Office Network in 1914

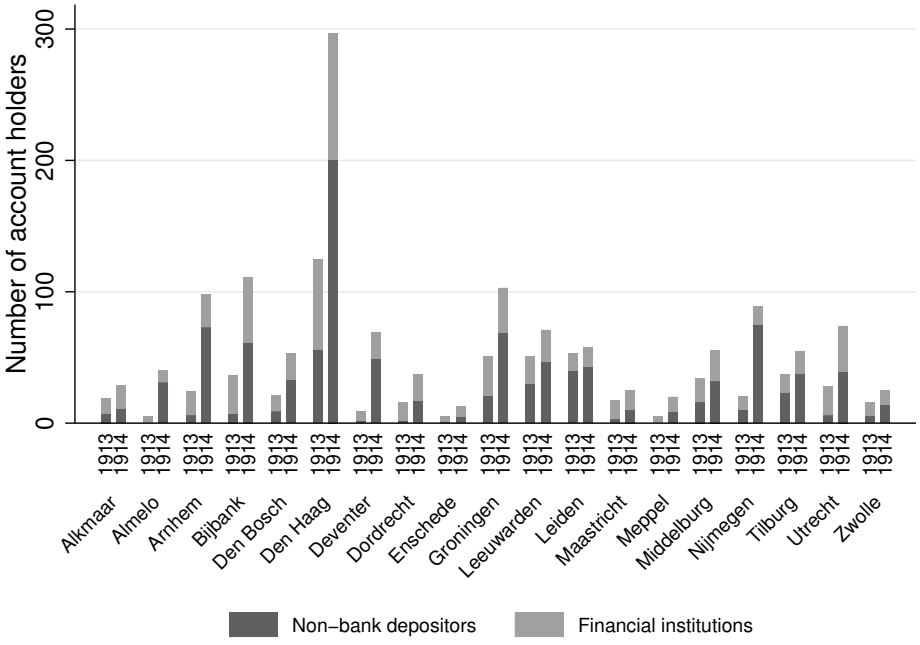


Note: This map shows all the DNB branches in 1914 (circled in blue), and their corresponding areas (bordered in red). Source: NL-HaNA, DNB, 2.25.68, 16158: "Vaststelling en wijziging van de ressorten van Bijbank en agentschappen, de grenzen daarvan en de daarbinnen vallende correspondentschappen 1890 - 1981." Red drawn borders are author's own adjustments to 1914 situation.

Figure B.2: DNB current account holders by office



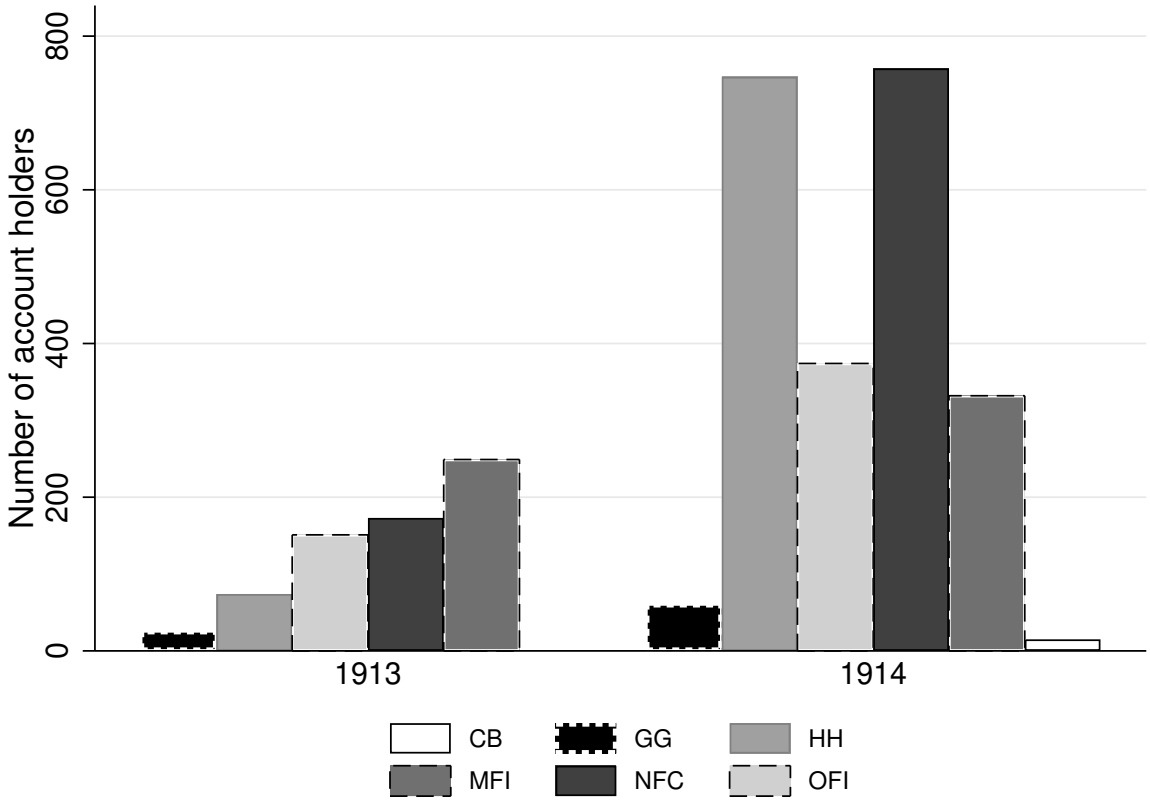
(a) Amsterdam Head Office



(b) DNB offices

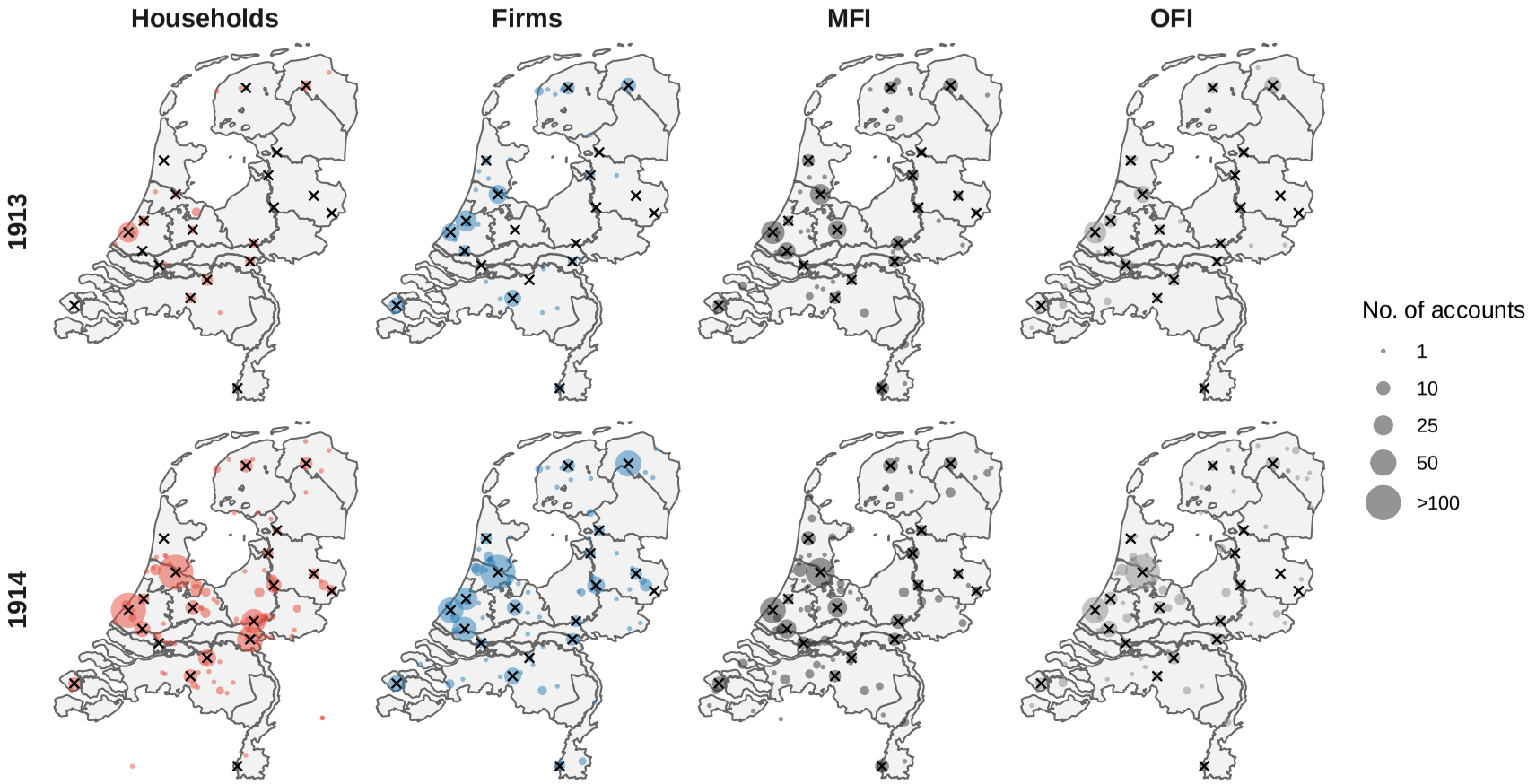
Note: Figure (a) shows the count and composition of the current account holders of DNB at the head office in Amsterdam in 1913 and 1914. Figure (b) shows the count and composition of the current account holders at all DNB deposit offices in 1913 and 1914. Names are digitized from DNB's yearly list of account holders and manually matched to the Financial Address 1914 yearbook to identify financial institutions. DNB Namelist of current account holders, NL-HaNA, DNB, 2.25.68 - 16431; Financieel Adresboek 1914.

Figure B.3: DNB current account holders by sector



Note: this figure shows the count and composition of the current account holders at all DNB deposit offices in 1913 and 1914 into sectors. CB covers all central bank offices, MFI include all banks that accepted deposits, OFI include brokers, insurance companies, real estate investment companies, and other institutions that appear in the Financial Addressbook of 1914. GG is national and local governments, NFC are all firms, and HH are all individuals.. Names are digitized from DNB's yearly list of account holders and manually matched to the Financial Address 1914 yearbook to identify financial institutions. DNB Namelist of current account holders, NL-HaNA, DNB, 2.25.68 - 16431; Financieel Adresboek 1914.

Figure B.4: Geographical variation of DNB account holders, 1913 and 1914



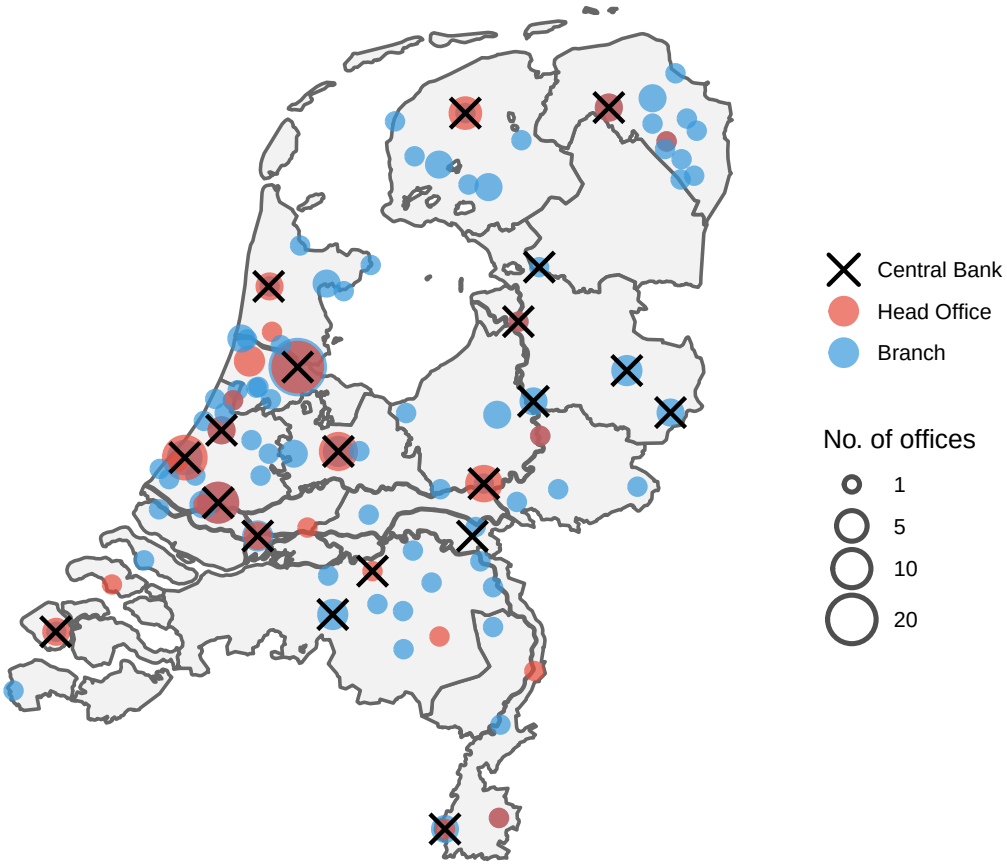
Note: This map shows the location of all unique current account holders at the DNB deposit offices, by sector (columns) and year (rows: 1913 above, 1914 below). Accounts are divided into households (red), non-financial companies (blue), banks (MFI, dark grey) and other financial intermediaries such as brokers, mortgage banks, insurance companies and savings banks (OFI, light grey). Bubble size is the number of unique accounts held in a town, on a common scale across all panels, capped at 100. The black crosses indicate the location of the 20 DNB deposit offices. Source: DNB Namelist of current account holders, NL-HaNA, DNB, 2.25.68 - 16431.

Figure B.5: Excerpt from bank advertisements in Algemeen Handelsblad



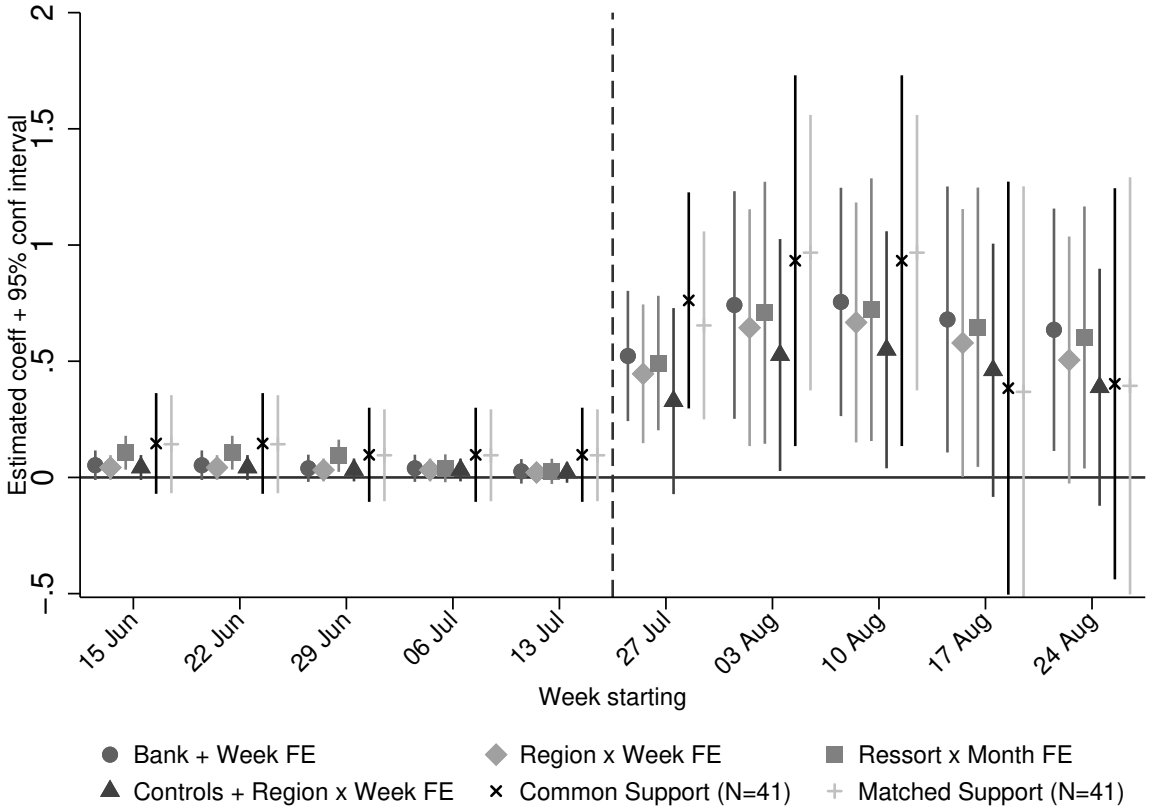
Note: this is a screenshot from the Dutch national newspaper Algemeen Handelsblad from September 1, 1914. The newspaper can be accessed via Delpher (https://www.delpher.nl/nl/kranten) using the following search terms: "Twentsche" AND "deposito".

Figure B.6: Geographical variation of bank branches, banks in balance sheet sample



Note: This map shows the location of all commercial bank branches and central bank offices. The black crosses indicate the 20 central bank deposit offices, the red dots are the locations of headquarters of the commercial banks, and the blue dots are the location of commercial bank branches. Note that one dot can contain more than one bank located in the respective city. Includes all banks of the balance sheet sample. Source: Financieel Adresboek 1914.

Figure B.7: Robustness in parallel trends: weekly coefficients are not significantly different before the shock

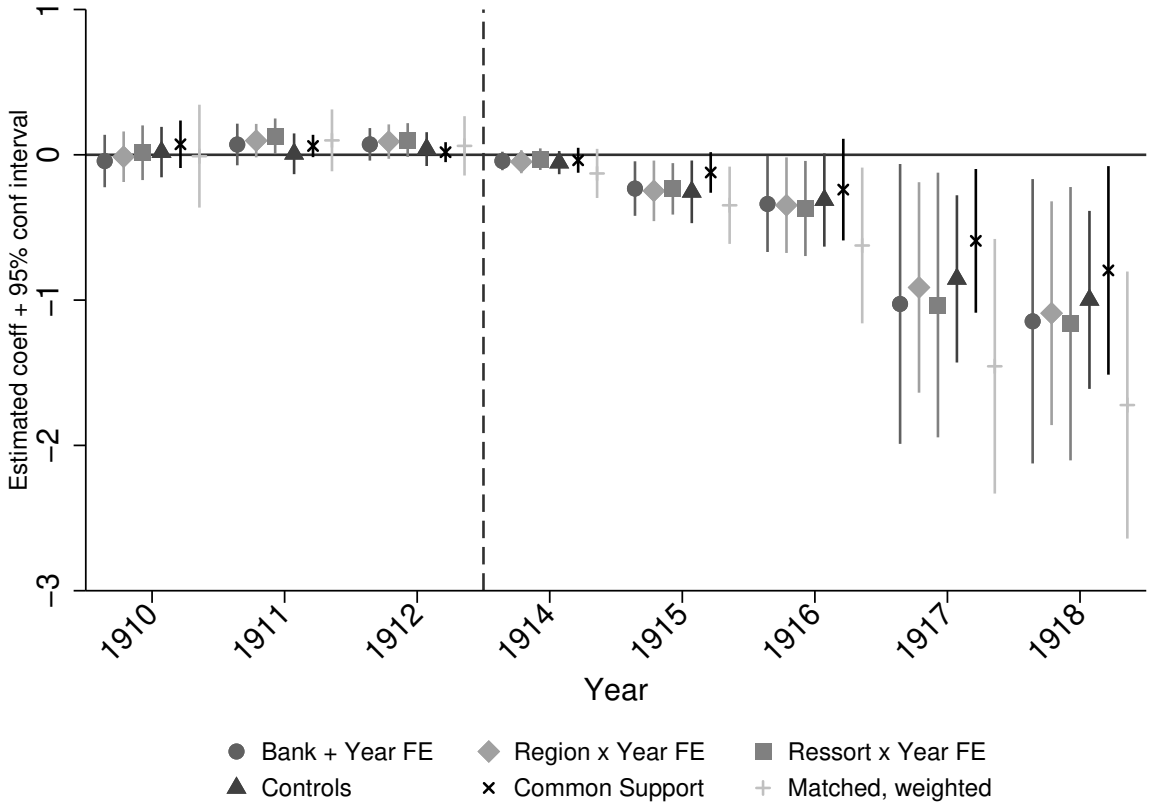


Note: This figure shows β coefficients of the following specification:

$$Y_{i,t} = \sum_{t=1914w25}^{t=1914w35} \beta_t \; CB \; Exposure_i \times D_{week=t} + \gamma Branches_{i,1913} \times Post_t + \Gamma' X_{i,1909} \times Post_t + \kappa_i + \eta_t + \epsilon_{i,t} \qquad (2)$$

Where $Y_{i,t}$ is the short-term deposit rate of bank i in week t, *CB Exposure*$_i$ is the fraction of bank's i branches that are located in a city that has a central bank office, $D_{week=t}$ is a dummy equal to 1 for week t, where week 30 (the last week before the shock takes place) is left out to avoid the dummy variable trap. The period covered is from June – August 1914. Bank and week fixed effects are included in all specifications, as well as the control variable Branches$_i$, which is the number of branches bank i operated before the shock. Both CB exposure$_i$ and Branches$_i$ are time-invariant and are therefore absorbed by the bank fixed effects α_i; only their interactions with Post$_t$ are identified. Standard errors are clustered on the bank level. The other specifications include region × week fixed effects (diamond), central bank ressort × month fixed effects (square), or the region × week fixed effects plus additional control variables population, number of competing banks and unemployment rate (triangle). Two other specifications have a reduced sample of 41 banks: the common support (cross), comparing only banks that are similar in terms of city size, and matched support (plus), comparing treated banks only to the nearest 10 banks in terms of city size. The short-term commercial bank deposit rate is the simple average of the shortest rate offered by each commercial bank in the sample (only if a banks has demandable, daily or weekly). The vertical line reflects the outbreak of the war (28th of July 1914). Source: Delpher Digital Newspaper Archive, author's own computations.

Figure B.8: Robustness in parallel trends: yearly coefficient for banks' deposits

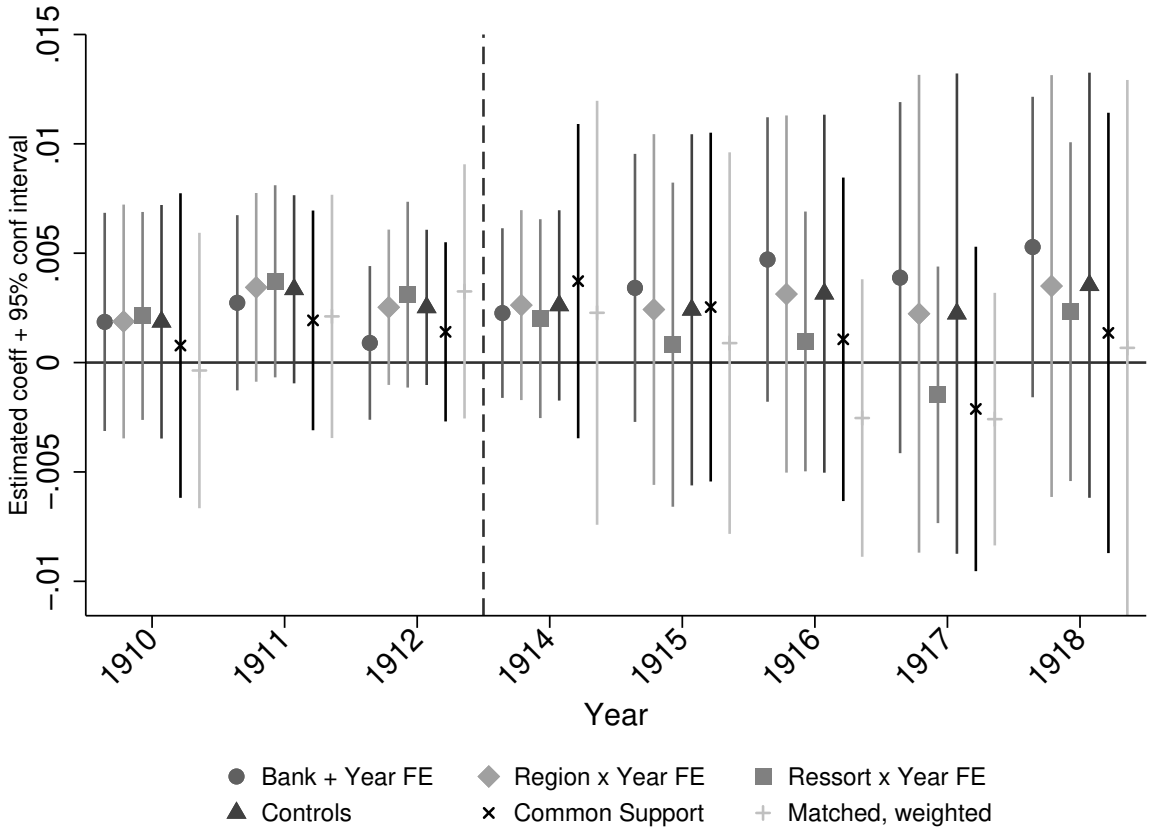


Note: This figure shows β coefficients of the following specification:

$$Y_{i,t} = \sum_{t=1910}^{t=1918} \beta_t \; CB \; Exposure_i \times D_{year=t} + \gamma Branches_{i,1913} \times Post_t + \Gamma_1' X_{i,1909} \times Post_t + \kappa_i + \eta_t + \epsilon_{i,t} \qquad (4)$$

Where $Y_{i,t}$ is deposits of bank i in year t weighted by pre-war total assets (1913), $CB\ Exposure_i$ is the fraction of bank's i branches that are located in a city that has a central bank office, $D_{year=t}$ is a dummy equal to 1 for year t, where 1913 (the last year before the shock takes place) is left out to avoid the dummy variable trap. The period covered is 1910-1918. Bank and year fixed effects are included in all specifications, as well as the control variable Branches_i, which is the number of branches bank i operated before the shock. Both CB exposure_i and Branches_i are time-invariant and are therefore absorbed by the bank fixed effects α_i; only their interactions with Post_t are identified. Standard errors are clustered on the bank level. The other specifications include region × year fixed effects (diamond), central bank ressort × year fixed effects (square), plus additional control variable yearly population served of bank i. Two other specifications have a reduced sample of 51 banks: the common support (cross), comparing only banks that are similar in terms of city size, and matched support (plus), comparing treated banks only to the nearest 10 banks in terms of city size. The vertical dashed line reflects the year of the shock, 1914.

Figure B.9: Stable yearly coefficients for banks' net interest margins

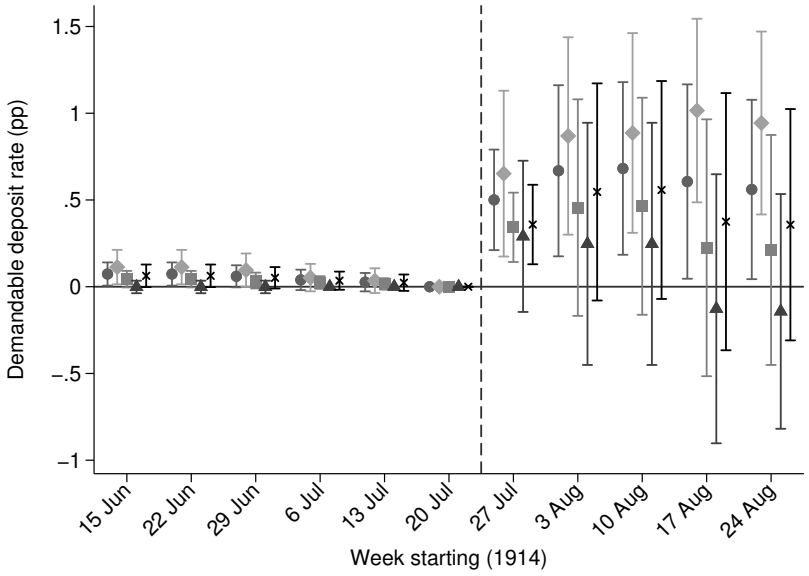


Note: This figure shows β coefficients of the following specification:

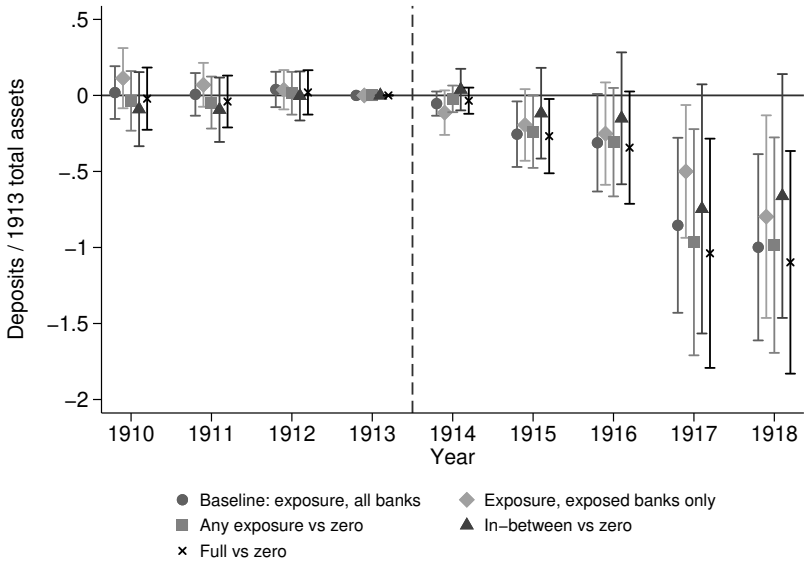
$$Y_{i,t} = \sum_{t=1910}^{t=1918} \beta_t \; CB \; Exposure_i \times D_{year=t} + \gamma Branches_{i,1913} \times Post_t + \Gamma_1' X_{i,1909} \times Post_t + \kappa_i + \eta_t + \epsilon_{i,t} \qquad (6)$$

Where $Y_{i,t}$ is the net interest margin of bank i in year t weighted by current total assets, $CB\ Exposure_i$ is the fraction of bank's i branches that are located in a city that has a central bank office, $D_{year=t}$ is a dummy equal to 1 for year t, where 1913 (the last year before the shock takes place) is left out to avoid the dummy variable trap. The period covered is 1910-1918. Bank and year fixed effects are included in all specifications, as well as the control variable Branches_i, which is the number of branches bank i operated before the shock. Both CB exposure_i and Branches_i are time-invariant and are therefore absorbed by the bank fixed effects α_i; only their interactions with Post_t are identified. Standard errors are clustered on the bank level. The other specifications include region × year fixed effects (diamond), central bank ressort × year fixed effects (square), plus additional control variable yearly population served of bank i. Two other specifications have a reduced sample of 51 banks: the common support (cross), comparing only banks that are similar in terms of city size, and matched support (plus), comparing treated banks only to the nearest 10 banks in terms of city size. The vertical dashed line reflects the year of the shock, 1914.

Figure B.10: Continuous-treatment parallel trends by treatment group



(a) Deposit rates



(b) Deposits

Note: This figure shows event-study coefficients for five definitions of central bank exposure. *Baseline*: CB exposure (the fraction of a bank's branches located in a city with a central bank office) interacted with period dummies, all banks. *Exposed banks only*: the same, estimated on banks with CB exposure > 0. *Any exposure vs zero*: a dummy for CB exposure > 0 interacted with period dummies. *In-between vs zero* and *full vs zero*: dummies for $0 <$ CB exposure < 1 and for CB exposure $= 1$, interacted with period dummies and estimated in one regression, with zero-exposure banks as the base group. Panel A: weekly short-term deposit rate, 15 June – 24 August 1914, base week 20 July 1914 (the last week before the shock); bank, week and region × month fixed effects; the number of pre-war branches × Post as a control. Between 8 June and 20 July 1914 no zero-exposure or in-between bank changed its rate, so the in-between coefficients for 6 and 13 July are exactly zero; they are shown at zero without a confidence interval. Panel B: deposits over 1913 total assets, 1910–1918, base year 1913; bank, year and region × year fixed effects; the log of the yearly population of the bank's pre-war office locations and the number of pre-war branches × Post as controls. Vertical dashed lines mark the outbreak of the war. Bars show 95% confidence intervals based on standard errors clustered at the bank level. Source: Delpher Digital Newspaper Archive, bank balance sheets, author's own computations.

C Appendix Tables

Table C.1: Standardized balance sheet of commercial banks

Assets	Liabilities and equity
Total lending	**Deposits**
Liquid lending	Demand and short-term deposits
Short-term collateralized lending (bills of exchange)	Long-term deposits
Rediscounted bills (gross reporting only)	Advances in current account (payables)
Illiquid lending	**Secured funding**
Credit lines (current account receivables)	Securities borrowing (repo)
Long-term lending (mortgages and loans)	Short-term collateralized borrowing
Repo lending	Accepted bills
Securities lending (repo)	Rediscounted bills (gross reporting only)
Liquid assets	**Unsecured funding**
Cash and cash equivalents	Interbank borrowing
Dutch government debt	Creditors
Interbank lending	Long-term borrowing
Balances at other banks	**Equity**
Securities investments	Capital (net of unissued capital)
Equity investments	Retained earnings: reserves
Corporate bonds	Retained earnings: net profit
Long-term investments	**Other liabilities** (residual)
Participations	
Underwriting	
Fixed assets	
Real estate	
Other assets	
Other assets	
Net loss (if present)	
Total assets (net of unissued capital)	**Total liabilities and equity**

Note: This example balance sheet illustrates the standardized items to aggregate the published balance sheets of commercial banks. Bold rows are the aggregates used in the analysis; indented rows are the standardized categories they consist of. Total lending is the sum of liquid, illiquid and repo lending. Unissued capital is deducted from both total assets and capital. Secured funding is securities borrowing plus short-term collateralized borrowing; unsecured funding is interbank borrowing, creditors and long-term borrowing. Other liabilities are the residual between total assets and deposits, secured and unsecured funding, and equity. Rediscounting a bill at the central bank is an outright sale, so the bill leaves liquid lending. Some banks report rediscounted bills gross, keeping them in liquid lending with an offsetting liability (*in herdisconto gegeven*), which is recorded as short-term collateralized borrowing.

Table C.2: Central bank exposure and deposit pricing under region x week fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Demandable rate				Inverted term structure			
CB exposure * Post	0.201	0.425***	0.336	0.471**	0.155*	0.168*	0.193**	0.201*
	(0.142)	(0.130)	(0.208)	(0.185)	(0.079)	(0.098)	(0.075)	(0.111)
# branches * Post		0.067***		0.049**		-0.005		-0.002
		(0.017)		(0.022)		(0.012)		(0.016)
Log(population) * Post		-0.091		0.050		0.058		0.125*
		(0.079)		(0.105)		(0.058)		(0.066)
Unemployment rate * Post		0.010		-0.087*		-0.018		-0.021
		(0.030)		(0.048)		(0.017)		(0.019)
# Banks * Post		0.003		-0.002		-0.004		-0.006*
		(0.005)		(0.007)		(0.003)		(0.004)
Observations	3,702	3,702	640	640	3,731	3,731	643	643
R-squared	0.710	0.722	0.646	0.661	0.573	0.577	0.622	0.636
Within R-sq	0.009	0.050	0.014	0.055	0.018	0.028	0.020	0.059
Banks	76	76	76	76	77	77	77	77
Period	1914		Jul-Aug		1914		Jul-Aug	
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y
Week FE	Y	Y	Y	Y	Y	Y	Y	Y
Region-Week FE	Y	Y	Y	Y	Y	Y	Y	Y

Note: This table repeats the baseline specifications with region x week instead of region x month fixed effects. The dependent variable is the shortest deposit rate available for each bank (max weekly rate) in columns (1)-(4) and the inverted term structure dummy in columns (5)-(8). Columns (1), (2), (5) and (6) cover 1914; columns (3), (4), (7) and (8) include only the month before (July) and the month after (August) the shock. Columns (2), (4), (6) and (8) add the number of branches, the log of the population served, the population-weighted unemployment rate and the population-weighted number of banks in a bank's branch locations, each interacted with Post. Post is a dummy that equals 1 if the period of observation is after 26th of July 1914. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. Region x week fixed effects are the finer counterpart of the region x month fixed effects used in the main tables, and match the granularity of the weekly observations; they nest the week fixed effects. The regions are north, middle, south and 'Randstad' (North- and South-Holland). Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table C.3: Short-term deposit rates, inverted term structure and central bank exposure: longer windows

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Demandable deposit rate				Inverted term structure			
Post	0.440***				0.067			
	(0.094)				(0.067)			
CB exposure * Post	-0.127	0.202	0.206	0.199	0.055	0.132*	0.157**	0.108
	(0.114)	(0.129)	(0.139)	(0.154)	(0.085)	(0.068)	(0.078)	(0.071)
Observations	7,414	3,702	3,702	3,702	7,444	3,731	3,731	3,731
R-squared	0.634	0.687	0.707	0.733	0.412	0.558	0.570	0.593
Within R-sq	0.058	0.009	0.010	0.008	0.034	0.014	0.019	0.008
Banks	76	76	76	76	77	77	77	77
Period	1914-1915		1914		1914-1915		1914	
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	N	N	N	Y	N	N	N
Week FE	N	Y	Y	Y	N	Y	Y	Y
Region-Month FE	N	N	Y	N	N	N	Y	N
Ressort-Month FE	N	N	N	Y	N	N	N	Y

Note: This table repeats the estimates of Tables 4 and 6 over longer windows. In columns (1)-(4) the dependent variable is the shortest deposit rate available for each bank (max weekly rate); in columns (5)-(8) it is the inverted term structure, a dummy that equals 1 if the remuneration is higher for shorter-maturity deposits (demandable rate is higher than weekly rate and/or weekly rate is higher than monthly, or demandable rate is higher than monthly rate), and 0 otherwise; banks that quote only one of these tenors are coded 0. Post is a dummy that equals 1 if the period of observation is after 26th of July 1914. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. Columns (1) and (5) cover 1914-1915 and include year fixed effects. Columns (2)-(4) and (6)-(8) include all 1914 observations and week fixed effects. Columns (3) and (7) also include region x month fixed effects, where the regions are north, middle, south and 'Randstad' (North- and South-Holland). Columns (4) and (8) include central bank office region (see Figure B.1) x month fixed effects. All columns include bank fixed effects. Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table C.4: Central bank exposure and regional controls, inverted deposit pricing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Inverted term structure of deposit pricing									
CB exposure * Post	0.157**	0.170**	0.141	0.140	0.154	0.201***	0.261***	0.148	0.146	0.156
	(0.078)	(0.081)	(0.095)	(0.095)	(0.095)	(0.071)	(0.079)	(0.103)	(0.105)	(0.103)
# branches * Post		0.004	-0.000	-0.000	-0.007		0.021*	0.005	0.005	-0.006
		(0.007)	(0.009)	(0.009)	(0.012)		(0.012)	(0.013)	(0.014)	(0.016)
Log(population) * Post			0.018	0.019	0.064			0.064*	0.065*	0.135**
			(0.033)	(0.033)	(0.055)			(0.033)	(0.033)	(0.062)
Unemployment rate * Post				0.002	-0.014				0.012	-0.011
				(0.022)	(0.017)				(0.023)	(0.018)
# Banks * Post					-0.004					-0.006
					(0.003)					(0.003)
Observations	3,731	3,731	3,731	3,731	3,731	643	643	643	643	643
R-squared	0.570	0.570	0.571	0.571	0.574	0.612	0.618	0.624	0.625	0.629
Within R-sq	0.019	0.020	0.021	0.021	0.028	0.022	0.038	0.053	0.055	0.066
Banks	77	77	77	77	77	77	77	77	77	77
Period			1914					Jul-Aug		
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Week FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region-Month FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note: This table presents estimates for inverted term structure of deposit rates by commercial banks including regional controls. Inverted term structure is a dummy that equals 1 if the remuneration is higher for shorter-maturity deposits (demandable rate is higher than weekly rate and/or weekly rate is higher than monthly, or demandable rate is higher than monthly rate), and 0 otherwise. Post is a dummy that equals 1 if the period of observation is after 26th of July 1914. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. Columns (1)-(5) cover 1914, while columns (6)-(10) include only observations in the month before (July) and the month after (August) the shock. # branches is the number of offices a bank has pre-shock. This excludes branches outside of the Netherlands (3 banks have an office in London or Batavia). Log(population) is the natural logarithm of the total population that a bank serves, i.e. the sum of all city inhabitants of every branch location. Unemployment rate is the population-weighted average percentage unemployed across a banks' branches. # Banks is the average number of banks (population-weighted) in its branch locations. All specifications include bank, week and region-month fixed effects, where the regions are north, middle, south and 'Randstad' (North- and South-Holland). Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table C.5: Central bank exposure, regional controls and comparable banks, demandable deposit pricing: 1914

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Demandable rate								
CB exposure * Post	0.355**	0.409***	0.408***	0.395***	0.345**	0.449***	0.429***	0.453***	0.458***
	(0.138)	(0.128)	(0.130)	(0.129)	(0.165)	(0.138)	(0.129)	(0.144)	(0.127)
# branches * Post	0.049***	0.057***	0.056***	0.063***	0.051***	0.049***	0.062***	0.050***	0.073***
	(0.014)	(0.016)	(0.016)	(0.017)	(0.014)	(0.014)	(0.022)	(0.014)	(0.023)
Log(population) * Post		-0.033	-0.033	-0.076			-0.076		-0.118
		(0.051)	(0.050)	(0.075)			(0.100)		(0.100)
Unemployment rate * Post			0.002	0.018	0.004		0.020		0.027
			(0.027)	(0.028)	(0.029)		(0.026)		(0.025)
# Banks * Post				0.004	0.000		0.007		0.008
				(0.005)	(0.004)		(0.006)		(0.006)
Observations	3,702	3,702	3,702	3,702	1,974	3,702	3,702	3,326	3,326
R-squared	0.717	0.718	0.718	0.718	0.715	0.720	0.721	0.710	0.712
Within R-sq	0.046	0.047	0.047	0.049	0.079	0.051	0.056	0.054	0.062
Banks	76	76	76	76	41	76	76	67	67
Period					1914				
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Week FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region-Month FE	Y	Y	Y	Y	Y	N	N	N	N
Sector-Month FE	N	N	N	N	N	Y	Y	Y	Y
Common support	N	N	N	N	Y	N	N	N	N
Excl. agriculture	N	N	N	N	N	N	N	Y	Y

Note: This table presents estimates for the demandable deposit rates of commercial banks with regional controls and restricted to comparable banks, over all of 1914; Table 7 reports the July to August window. The dependent variable is the shortest deposit rate available for each bank (max weekly rate). Post is a dummy that equals 1 if the period of observation is after 26th of July 1914. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. Column (1) controls for the number of branches; columns (2)-(4) add the other controls one at a time. # branches is the number of offices a bank has pre-shock. This excludes branches outside of the Netherlands (3 banks have an office in London or Batavia). Log(population) is the natural logarithm of the total population that a bank serves, i.e. the sum of all city inhabitants of every branch location. Unemployment rate is the population-weighted average percentage unemployed across a banks' branches. # Banks is the average number of banks (population-weighted) in its branch locations. All controls are interacted with Post. Column (5) includes only banks in the common support of log average population across the branches, i.e. between the larger of the minima and the smaller of the maxima of the high- and low-exposed groups. Columns (6)-(9) include dominant sector x month fixed effects instead of region x month fixed effects; columns (8) and (9) exclude the sector that only has low-exposed banks (agriculture). Columns (1)-(5) include region x month fixed effects, where the regions are north, middle, south and 'Randstad' (North- and South-Holland). All columns include bank and week fixed effects. Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table C.6: Central bank exposure and exposure to the largest cities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Demandable deposit rate					Inverted term structure				
		All	Without B4	All	Without B4		All	Without B4	All	Without B4
CB exposure	0.166			0.050		-0.066			-0.078	
	(0.181)			(0.209)		(0.054)			(0.063)	
Large city	-0.082			0.018		0.136*			0.114	
	(0.194)			(0.204)		(0.080)			(0.099)	
CB exposure * Post	0.180	0.417***	0.383**	0.393**	0.220	0.122*	0.220**	0.210*	0.223***	0.116
	(0.155)	(0.135)	(0.151)	(0.178)	(0.156)	(0.072)	(0.098)	(0.121)	(0.077)	(0.096)
Large city * Post		-0.195					0.642			
		(0.676)					(0.521)			
CB exposure * Large city * Post		0.079					-0.677			
		(0.678)					(0.519)			
# branches * Post	0.033*	0.048***	0.040**	0.043**	0.040*	0.003	0.002	0.000	0.020	0.000
	(0.017)	(0.014)	(0.016)	(0.018)	(0.023)	(0.007)	(0.008)	(0.007)	(0.012)	(0.004)
Observations	3,702	3,702	1,612	640	279	3,731	3,731	1,641	643	282
R-squared	0.252	0.718	0.768	0.305	0.719	0.080	0.574	0.637	0.130	0.705
Within R-sq	0.036	0.047	0.047	0.066	0.022	0.025	0.029	0.071	0.048	0.023
Banks	76	76	35	76	35	77	77	36	77	36
Period		1914			Jul-Aug		1914			Jul-Aug
Bank FE	N	Y	Y	N	Y	N	Y	Y	N	Y
Week FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region-Month FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note: This table presents estimates for demandable deposit rates (1)-(5) and inverted deposit pricing by commercial banks (6)-(10), with and without exposure to the largest cities. Columns (1)-(3) and (6)-(8) cover 1914; columns (4), (5), (9) and (10) include only the month before (July) and the month after (August) the shock. Columns (3), (5), (8) and (10) exclude any bank that has exposure to the largest four cities (B4), i.e. any branch located in Amsterdam, Rotterdam, The Hague or Utrecht (which all have above 100k inhabitants). Demandable rate includes the shortest deposit rate available for each bank (max weekly rate). Inverted term structure is a dummy that equals 1 if the remuneration is higher for shorter-maturity deposits (demandable higher than weekly and weekly higher than monthly), and 0 otherwise. Post is a dummy that equals 1 if the period of observation is after 26th of July 1914. CB exposure is a continuous fraction of branch overlap between a commercial bank and the central bank. Large city is the share of branches that is located in one of the largest cities. All columns include week and region-month (north, south, middle and 'Randstad' (North- and South-Holland)) fixed effects. All specifications also control for the size of a bank's branch network interacted with Post, so that the estimated effect of central bank exposure is not picking up the difference between a one-branch and a ten-branch bank. The number of branches is time-invariant and is absorbed by the bank fixed effects wherever those are included. The levels of CB exposure and large-city exposure are time-invariant and are therefore only identified in the columns without bank fixed effects. Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table C.7: Central bank exposure and total assets: controls, comparable banks and sector fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					Total assets				
CB exposure * Post	-0.453*	-0.718***	-0.705***	-0.672**	-0.430	-0.560*	-0.737**	-0.591*	-0.721**
	(0.235)	(0.255)	(0.263)	(0.270)	(0.316)	(0.320)	(0.350)	(0.321)	(0.337)
# branches * Post	0.011	-0.019	-0.020	-0.041	0.017	-0.011	-0.124***	-0.023	-0.120**
	(0.030)	(0.037)	(0.037)	(0.046)	(0.032)	(0.030)	(0.047)	(0.030)	(0.054)
Log(population) * Post		0.120	0.127	0.238			0.486**		0.429*
		(0.102)	(0.108)	(0.167)			(0.209)		(0.256)
Unemployment rate * Post			0.013	-0.008	0.010		0.042		0.074
			(0.062)	(0.055)	(0.051)		(0.050)		(0.052)
# Banks * Post				-0.010	-0.003		-0.019*		-0.015
				(0.008)	(0.006)		(0.011)		(0.012)
Pre-shock mean	0.943	0.943	0.943	0.943	0.944	0.943	0.943	0.917	0.917
Observations	522	522	522	522	364	522	522	407	407
R-squared	0.631	0.634	0.634	0.637	0.615	0.674	0.691	0.693	0.711
Banks	70	70	70	70	48	70	70	55	55
Period					1910-1918				
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y	Y	N	N	N	N
Sector-Year FE	N	N	N	N	N	Y	Y	Y	Y
Common support	N	N	N	N	Y	N	N	N	N
Both-groups sectors only	N	N	N	N	N	N	N	Y	Y

Note: This table presents annual bank balance sheet items for 1910-1918 with regional controls, restricted to comparable banks and under sector fixed effects. It mirrors the deposit rate Table 7 exactly, column by column, and therefore uses the same pre-war (1909) controls interacted with Post, rather than the yearly population of the bank's office locations used in the other balance sheet tables. The dependent variable is total assets over 1913 (pre-war) total assets. Post is a dummy that equals 1 if the year is 1914 or later. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. Column (1) controls for the number of branches; columns (2)-(4) add the other controls one at a time. # branches is the number of offices a bank has pre-shock. Log(population) is the natural logarithm of the total 1909 population that a bank serves, i.e. the sum of all city inhabitants of every branch location. Unemployment rate is the population-weighted 1909 unemployment rate across a bank's branches. # Banks is the population-weighted average number of banks in its branch locations. All controls are interacted with Post. Column (5) includes only banks in the common support of log average population across the branches, i.e. between the larger of the minima and the smaller of the maxima of the high- and low-exposed groups. Columns (6)-(9) include dominant sector x year fixed effects instead of region x year fixed effects, where the dominant sector is the largest 1909 occupational sector across a bank's branch locations; columns (8) and (9) include only banks in a dominant sector that contains both high- and low-exposed banks, which excludes agriculture (only low-exposed banks) and transport (only high-exposed banks). Columns (1)-(5) include region x year fixed effects, where the regions are north, middle, south and the Randstad (North- and South-Holland). All columns include bank and year fixed effects. Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table C.8: Central bank exposure and deposits: controls, comparable banks and sector fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
					Deposits				
CB exposure * Post	-0.486***	-0.553***	-0.544**	-0.533**	-0.289**	-0.589*	-0.532*	-0.595*	-0.503*
	(0.173)	(0.197)	(0.208)	(0.213)	(0.133)	(0.298)	(0.307)	(0.302)	(0.286)
# branches * Post	-0.005	-0.012	-0.013	-0.020	0.004	-0.015	-0.041	-0.020	-0.023
	(0.012)	(0.024)	(0.024)	(0.027)	(0.008)	(0.021)	(0.029)	(0.022)	(0.033)
Log(population) * Post		0.030	0.035	0.076			0.128		0.031
		(0.072)	(0.064)	(0.086)			(0.132)		(0.158)
Unemployment rate * Post			0.008	0.000	0.004		0.032		0.029
			(0.041)	(0.043)	(0.025)		(0.053)		(0.060)
# Banks * Post				-0.004	-0.000		-0.008		-0.004
				(0.004)	(0.002)		(0.006)		(0.007)
Pre-shock mean	0.306	0.306	0.306	0.306	0.275	0.306	0.306	0.294	0.294
Observations	523	523	523	523	364	523	523	408	408
R-squared	0.676	0.676	0.676	0.677	0.720	0.701	0.707	0.697	0.700
Banks	70	70	70	70	48	70	70	55	55
Period					1910-1918				
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y	Y	N	N	N	N
Sector-Year FE	N	N	N	N	N	Y	Y	Y	Y
Common support	N	N	N	N	Y	N	N	N	N
Both-groups sectors only	N	N	N	N	N	N	N	Y	Y

Note: This table presents annual bank balance sheet items for 1910-1918 with regional controls, restricted to comparable banks and under sector fixed effects. It mirrors the deposit rate Table 7 exactly, column by column, and therefore uses the same pre-war (1909) controls interacted with Post, rather than the yearly population of the bank's office locations used in the other balance sheet tables. The dependent variable is total deposits and current account outstanding balances over 1913 (pre-war) total assets. Six banks in the balance sheet sample do not report deposits in more than one year and therefore drop out. Post is a dummy that equals 1 if the year is 1914 or later. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. Column (1) controls for the number of branches; columns (2)-(4) add the other controls one at a time. # branches is the number of offices a bank has pre-shock. Log(population) is the natural logarithm of the total 1909 population that a bank serves, i.e. the sum of all city inhabitants of every branch location. Unemployment rate is the population-weighted 1909 unemployment rate across a bank's branches. # Banks is the population-weighted average number of banks in its branch locations. All controls are interacted with Post. Column (5) includes only banks in the common support of log average population across the branches, i.e. between the larger of the minima and the smaller of the maxima of the high- and low-exposed groups. Columns (6)-(9) include dominant sector x year fixed effects instead of region x year fixed effects, where the dominant sector is the largest 1909 occupational sector across a bank's branch locations; columns (8) and (9) include only banks in a dominant sector that contains both high- and low-exposed banks, which excludes agriculture (only low-exposed banks) and transport (only high-exposed banks). Columns (1)-(5) include region x year fixed effects, where the regions are north, middle, south and the Randstad (North- and South-Holland). All columns include bank and year fixed effects. Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table C.9: Central bank exposure, bank size and deposits: sector fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Log(total assets)					Log(deposits)				
CB exposure * Post	-0.267**	-0.255*	-0.248*	-0.203	-0.236	-0.624***	-0.599***	-0.531**	-0.519**	-0.602***
	(0.134)	(0.132)	(0.148)	(0.149)	(0.145)	(0.150)	(0.147)	(0.202)	(0.202)	(0.200)
# branches * Post	0.009	0.009	0.002	0.001	-0.010	0.005	0.006	-0.001	-0.010	-0.014
	(0.016)	(0.017)	(0.014)	(0.014)	(0.012)	(0.017)	(0.018)	(0.016)	(0.017)	(0.017)
Log(population), yearly		1.927***	2.228***	2.540***	3.074***		2.923***	3.327***	4.236***	4.148***
		(0.658)	(0.549)	(0.480)	(0.436)		(1.048)	(0.950)	(0.718)	(0.886)
Observations	530	530	530	530	413	529	529	529	529	413
R-squared	0.973	0.974	0.976	0.977	0.981	0.958	0.959	0.962	0.965	0.967
Banks	72	72	72	72	57	72	72	72	72	57
Period	1910-1918									
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region-Year FE	Y	Y	N	Y	Y	Y	Y	N	Y	Y
Sector-Year FE	N	N	Y	Y	Y	N	N	Y	Y	Y
Both-groups sectors only	N	N	N	N	Y	N	N	N	N	Y

Note: This table presents annual bank balance sheet items for 1910-1918. Columns (1)-(5) show the natural log of total assets and columns (6)-(10) the natural log of total deposits, i.e. total deposits and current account outstanding balances. Post is a dummy that equals 1 if the year is 1914 or later. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. Within each block, the first column controls for the size of the branch network interacted with Post; the second adds the log of the yearly population of the bank's pre-war office locations (the main specification); the third replaces region x year fixed effects with dominant sector x year fixed effects; the fourth includes both; and the fifth restricts the fourth to banks in a dominant sector that contains both high- and low-exposed banks, which excludes agriculture (only low-exposed banks) and transport (only high-exposed banks). The dominant sector is the largest 1909 occupational sector across a bank's branch locations. The regions are north, middle, south and the Randstad (North- and South-Holland). Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table C.10: Central bank exposure and bank lending: adding control variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Total lending				Illiquid lending			
CB exposure * Post	-0.435**	-0.403**	-0.481***	-0.369**	-0.251**	-0.222**	-0.287***	-0.254**
	(0.171)	(0.163)	(0.158)	(0.185)	(0.112)	(0.090)	(0.087)	(0.114)
# branches * Post	-0.004	-0.003	-0.007	-0.004	0.009	0.011	0.007	0.008
	(0.017)	(0.017)	(0.015)	(0.016)	(0.013)	(0.013)	(0.012)	(0.012)
Log(population), yearly		3.964***	4.033***	4.229***		3.605***	3.663***	3.723***
		(0.976)	(0.879)	(0.802)		(0.674)	(0.606)	(0.586)
Unemployment rate * Post			-0.034	-0.051			-0.028	-0.033
			(0.040)	(0.039)			(0.025)	(0.026)
# Banks * Post				-0.005				-0.001
				(0.003)				(0.002)
Pre-shock mean	0.683	0.683	0.683	0.683	0.474	0.474	0.474	0.474
Observations	523	523	523	523	523	523	523	523
R-squared	0.656	0.682	0.683	0.685	0.715	0.745	0.747	0.747
Banks	70	70	70	70	70	70	70	70
Period	1910-1918							
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y	Y	Y	Y	Y

Note: This table presents annual bank balance sheet items for 1910-1918, adding control variables step by step. Columns (1)-(4) show total lending and columns (5)-(8) illiquid lending, each over 1913 (pre-war) total assets. Within each block, the first column controls for the size of the branch network interacted with Post, the second adds the log of the yearly population of the bank's pre-war office locations, the third adds the population-weighted 1909 unemployment rate interacted with Post, and the fourth adds the population-weighted number of banks in the bank's branch locations interacted with Post. The second column is the main specification. Total lending is the sum of all credit lines, repo lending, short term collateralized loans (bills of exchange) and long-term loans; illiquid lending contains credit lines and long-term loans. Post is a dummy that equals 1 if the year is 1914 or later. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. All columns include bank, year and region x year fixed effects, where the regions are north, middle, south and the Randstad (North- and South-Holland). Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table C.11: Central bank exposure and bank lending: sector fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Log(total lending)					Log(illiquid lending)				
CB exposure * Post	-0.283*	-0.267*	-0.399**	-0.368**	-0.403**	-0.143	-0.128	-0.293*	-0.276*	-0.266*
	(0.151)	(0.148)	(0.161)	(0.160)	(0.157)	(0.143)	(0.134)	(0.156)	(0.154)	(0.144)
# branches * Post	-0.008	-0.007	-0.009	-0.010	-0.024*	0.009	0.010	0.003	0.003	-0.010
	(0.016)	(0.016)	(0.014)	(0.015)	(0.013)	(0.018)	(0.018)	(0.014)	(0.015)	(0.012)
Log(population), yearly		1.915***	1.947***	2.261***	2.680***		1.935***	1.814***	2.023***	3.100***
		(0.646)	(0.666)	(0.587)	(0.500)		(0.683)	(0.668)	(0.730)	(0.661)
Observations	531	531	531	531	415	525	525	525	525	409
R-squared	0.952	0.953	0.956	0.957	0.958	0.911	0.912	0.921	0.923	0.923
Banks	72	72	72	72	57	72	72	72	72	57
Period	1910-1918									
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region-Year FE	Y	Y	N	Y	Y	Y	Y	N	Y	Y
Sector-Year FE	N	N	Y	Y	Y	N	N	Y	Y	Y
Both-groups sectors only	N	N	N	N	Y	N	N	N	N	Y

Note: This table presents annual bank balance sheet items for 1910-1918. Columns (1)-(5) show the natural log of total lending, the sum of all credit lines, repo lending, short term collateralized loans (bills of exchange) and long-term loans, and columns (6)-(10) the natural log of illiquid lending, credit lines and long-term loans. Post is a dummy that equals 1 if the year is 1914 or later. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. Within each block, the first column controls for the size of the branch network interacted with Post; the second adds the log of the yearly population of the bank's pre-war office locations (the main specification); the third replaces region x year fixed effects with dominant sector x year fixed effects; the fourth includes both; and the fifth restricts the fourth to banks in a dominant sector that contains both high- and low-exposed banks, which excludes agriculture (only low-exposed banks) and transport (only high-exposed banks). The dominant sector is the largest 1909 occupational sector across a bank's branch locations. The regions are north, middle, south and the Randstad (North- and South-Holland). Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table C.12: Central bank exposure and bank balance sheets: full sample and common support

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Full sample				Common support			
	Total assets	Deposits	Total lending	Illiquid lending	Total assets	Deposits	Total lending	Illiquid lending
CB exposure * Post	-0.414*	-0.426***	-0.403**	-0.222**	-0.450*	-0.294***	-0.563***	-0.316**
	(0.224)	(0.147)	(0.163)	(0.090)	(0.224)	(0.104)	(0.130)	(0.129)
# branches * Post	0.014	-0.002	-0.003	0.011	0.015	0.003	-0.011	0.003
	(0.031)	(0.011)	(0.017)	(0.013)	(0.031)	(0.008)	(0.016)	(0.013)
Pre-shock mean	0.943	0.306	0.683	0.474	0.944	0.275	0.711	0.498
Post-shock mean	1.617	0.681	1.130	0.771	1.600	0.560	1.134	0.771
Observations	522	523	523	523	364	364	364	364
R-squared	0.670	0.786	0.682	0.745	0.623	0.720	0.621	0.666
Banks	70	70	70	70	48	48	48	48
Period	1910-1918							
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Region-Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Population control	Y	Y	Y	Y	Y	Y	Y	Y

Note: This table presents annual bank balance sheet items for 1910-1918. Six banks in the balance sheet sample do not report deposits in more than one year and therefore drop out of the deposits columns. Columns (1)-(4) use the full balance sheet sample; columns (5)-(8) include only banks in the common support of average market population, i.e. banks whose log average population across their branch locations lies within the range covered by both high- and low-exposed banks. All dependent variables are weighted by their 1913 (pre-war) total assets. Total lending is the sum of all credit lines, repo lending, short term collateralized loans (bills of exchange) and long-term loans; illiquid lending contains credit lines and long-term loans. Post is a dummy that equals 1 if the year is 1914 or later. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. All columns control for the log of the yearly population of the bank's pre-war office locations and for the size of its branch network interacted with Post. All columns include bank, year and region x year fixed effects, where the regions are north, middle, south and the Randstad (North- and South-Holland). Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table C.13: Central bank exposure and First World War exposure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Short-term rate				Inverted term structure			
CB exposure * Post	0.212	0.444**	0.388*	0.424**	0.150**	0.187***	0.203***	0.170**
	(0.140)	(0.208)	(0.199)	(0.211)	(0.075)	(0.068)	(0.072)	(0.069)
War exposed * Post	0.075	-0.114	0.166	0.064	-0.087	-0.037	0.020	0.023
	(0.129)	(0.196)	(0.159)	(0.171)	(0.060)	(0.086)	(0.101)	(0.123)
Observations	3,702	640	640	640	3,731	643	643	643
R-squared	0.707	0.611	0.637	0.669	0.572	0.604	0.612	0.625
Within R-sq	0.011	0.027	0.021	0.022	0.024	0.022	0.023	0.015
Banks	76	76	76	76	77	77	77	77
Period	1914		Jul-Aug		1914		Jul-Aug	
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y
Week FE	Y	Y	Y	Y	Y	Y	Y	Y
Region-Month FE	Y	N	Y	N	Y	N	Y	N
Ressort-Month FE	N	N	N	Y	N	N	N	Y

Note: This table presents estimates for demandable deposit rates (1)-(4), and inverted term structure of deposit pricing by commercial banks (5)-(8). Demandable rate includes the shortest deposit rate available for each bank (max weekly rate). Inverted term structure is a dummy that equals 1 if the remuneration is higher for shorter-maturity deposits (demandable rate higher than the weekly or monthly rate, or weekly rate higher than the monthly rate), and 0 otherwise. Post is a dummy that equals 1 if the period of observation is after 26th of July 1914. CB exposure is a continuous treatment variable capturing the fraction of a bank's branches located in the same city as a CB office. War exposure is a dummy that equals 1 if a bank has at least one branch in a province that borders one of the countries at war, and zero otherwise. All columns include week and bank fixed effects. Columns (1) and (5) include all 1914 observations, Columns (2)-(4) and (6)-(8) include only observations in the month before (July) and the month after (August) the shock. Columns (1), (3), (5), and (7) also include region-time fixed effects, where the regions are north, middle, south and 'Randstad' (North- and South-Holland). Columns (4) and (8) include central bank office region x month fixed effects. (central bank office region (see Figure A.1) x month). Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table C.14: Central bank exposure and bank branches

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Demandable deposit rate				Inverted term structure			
	All		Unit	Multi-branch	All		Unit	Multi-branch
CB exposure	0.127				0.007			
	(0.186)				(0.039)			
# branches	0.050***				0.016*			
	(0.017)				(0.009)			
CB exposure * Post	0.283	0.551**	0.701***	0.289	0.179**	0.121	0.226**	0.236**
	(0.182)	(0.210)	(0.143)	(0.346)	(0.068)	(0.102)	(0.097)	(0.112)
# branches * Post		0.060		0.078***		-0.011		0.033*
		(0.043)		(0.025)		(0.014)		(0.016)
CB exposure * # branches * Post		-0.004				0.044		
		(0.051)				(0.028)		
Observations	640	640	351	289	643	643	354	289
R-squared	0.299	0.646	0.637	0.658	0.116	0.621	0.595	0.671
Within R-sq	0.058	0.043	0.041	0.070	0.033	0.046	0.019	0.079
Banks	76	76	42	34	77	77	43	34
Period	Jul-Aug							
Bank FE	N	Y	Y	Y	N	Y	Y	Y
Week FE	Y	Y	Y	Y	Y	Y	Y	Y
Region-Month FE	Y	Y	Y	Y	Y	Y	Y	Y

Note: This table presents estimates for demandable deposit rates (1)-(4) and inverted deposit pricing by commercial banks (5)-(8) over the period July-August 1914, for banks with single and multi-branch networks. Columns (3) and (7) include only unit banks, i.e. commercial banks with only one branch, while columns (4) and (8) include only multi-branch banks. Demandable rate includes the shortest deposit rate available for each bank (max weekly rate). Inverted term structure is a dummy that equals 1 if the remuneration is higher for shorter-maturity deposits (demandable higher than weekly and weekly higher than monthly), and 0 otherwise. Post is a dummy that equals 1 if the period of observation is after 26th of July 1914. CB exposure is a continuous fraction of branch overlap between a commercial bank and the central bank. # branches is the number of branches that a commercial bank has pre-war. Branches outside of the Netherlands are excluded from the count (3 banks have an office in London or Batavia). All columns include week and region-month (north, south, middle and 'Randstad' (North- and South-Holland)) fixed effects. Columns (4) and (8) additionally control for the number of branches interacted with Post; columns (3) and (7) hold the number of branches fixed by construction, since every bank in them has exactly one branch. The levels of CB exposure and the number of branches are time-invariant and are therefore only identified in the columns without bank fixed effects. Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table C.15: Central bank exposure and exposure to Amsterdam

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Demandable deposit rate					Inverted term structure				
		All	No AMS	All	No AMS		All	No AMS	All	No AMS
CB exposure	0.204			0.126		-0.009			-0.006	
	(0.160)			(0.193)		(0.046)			(0.046)	
Amsterdam	-0.334*			-0.295*		0.032			-0.085	
	(0.172)			(0.167)		(0.115)			(0.092)	
CB exposure * Post	0.185	0.360***	0.378***	0.405**	0.394*	0.130*	0.184**	0.164*	0.235***	0.223**
	(0.152)	(0.135)	(0.134)	(0.174)	(0.201)	(0.072)	(0.085)	(0.094)	(0.077)	(0.085)
Amsterdam * Post		0.772					1.019			
		(1.373)					(1.118)			
CB exposure * Amsterdam * Post		-0.778					-1.055			
		(1.428)					(1.141)			
# branches * Post	0.033*	0.048***	0.043***	0.044**	0.043*	0.004	0.003	-0.001	0.021*	0.002
	(0.017)	(0.014)	(0.015)	(0.018)	(0.023)	(0.007)	(0.007)	(0.006)	(0.012)	(0.008)
Observations	3,702	3,702	2,662	640	460	3,731	3,731	2,691	643	463
R-squared	0.272	0.718	0.756	0.316	0.659	0.067	0.572	0.594	0.127	0.641
Within R-sq	0.060	0.046	0.041	0.082	0.023	0.011	0.024	0.030	0.046	0.036
Banks	76	76	56	76	56	77	77	57	77	57
Period		1914		Jul-Aug			1914		Jul-Aug	
Bank FE	N	Y	Y	N	Y	N	Y	Y	N	Y
Week FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region-Month FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note: This table presents estimates for demandable deposit rates (1)-(5) and inverted deposit pricing by commercial banks (6)-(10). Columns (1)-(3) and (6)-(8) cover 1914; columns (4), (5), (9) and (10) include only the month before (July) and the month after (August) the shock. Columns (3), (5), (8) and (10) exclude any bank that has exposure to Amsterdam, i.e. where at least one branch is located in the city. Demandable rate includes the shortest deposit rate available for each bank (max weekly rate). Inverted term structure is a dummy that equals 1 if the remuneration is higher for shorter-maturity deposits (demandable higher than weekly and weekly higher than monthly), and 0 otherwise. Post is a dummy that equals 1 if the period of observation is after 26th of July 1914. CB exposure is a continuous fraction of branch overlap between a commercial bank and the central bank. Amsterdam exposure is the share of commercial bank branches that is located in Amsterdam. All columns include week and region-month (north, south, middle and 'Randstad' (North- and South-Holland)) fixed effects. All specifications also control for the size of a bank's branch network interacted with Post, so that the estimated effect of central bank exposure is not picking up the difference between a one-branch and a ten-branch bank. The number of branches is time-invariant and is absorbed by the bank fixed effects wherever those are included. The levels of CB exposure and Amsterdam exposure are time-invariant and are therefore only identified in the columns without bank fixed effects. Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table C.16: Binary central bank exposure and commercial bank deposit rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Demandable rate				Inverted term structure			
CB exposure * Post	0.125	0.166	0.345**	0.242*	0.090	0.049	0.102	0.075
	(0.101)	(0.150)	(0.143)	(0.143)	(0.065)	(0.083)	(0.083)	(0.095)
# branches * Post			0.061***	0.052***			0.018	0.016
			(0.017)	(0.016)			(0.012)	(0.012)
# Banks * Post				0.008*				0.002
				(0.004)				(0.002)
Observations	3,702	640	640	640	3,731	643	643	643
R-squared	0.706	0.632	0.642	0.649	0.566	0.604	0.608	0.610
Within R-sq	0.006	0.006	0.033	0.051	0.011	0.002	0.013	0.018
Banks	76	76	76	76	77	77	77	77
Period	1914		Jul-Aug		1914		Jul-Aug	
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y
Week FE	Y	Y	Y	Y	Y	Y	Y	Y
Region-Month FE	Y	Y	Y	Y	Y	Y	Y	Y

Note: This table presents estimates for demandable deposit rates (1)-(4) and inverted term structure of deposit pricing by commercial banks (5)-(8), over 1914 in columns (1) and (5) and over July-August 1914 in columns (2)-(4) and (6)-(8). Demandable rate includes the shortest deposit rate available for each bank (max weekly rate). Inverted term structure is a dummy that equals 1 if the remuneration is higher for shorter-maturity deposits (demandable higher than weekly and weekly higher than monthly), and 0 otherwise. Post is a dummy that equals 1 if the period of observation is after 26th of July 1914. CB exposure here is a dummy that equals 1 if a bank is fully exposed to the central bank, i.e. all its branches are located in CB cities, and zero otherwise. # branches is the number of branches that a commercial bank has pre-war. Branches outside of the Netherlands are excluded from the count (3 banks have an office in London or Batavia). # Banks is the average number of banks (population-weighted) in its branch locations. All columns include week, bank and region-month (north, middle, south and 'Randstad' (North- and South-Holland)) fixed effects. Clustered standard errors on the bank level are in parentheses. ***, ** and * indicate significance at 1, 5 and 10% level, respectively.

Table C.17: Continuous-treatment checks: deposit rates and deposits

	(1) Continuous	(2) Any exposure	(3) Binned	(4) Two bins	(5) No zero group	(6) Full vs zero
Panel A: demandable deposit rate, July–August 1914						
CB exposure * Post	0.538***				0.824***	
	(0.185)				(0.201)	
Any CB exposure * Post		0.275				
		(0.234)				
In-between exposure * Post			0.040			
			(0.264)			
Exposure in (0, 0.5) * Post				-0.250		
				(0.261)		
Exposure in [0.5, 1) * Post				0.206		
				(0.289)		
Full CB exposure * Post			0.371	0.379*		0.394*
			(0.228)	(0.225)		(0.230)
# branches * Post	0.057***	0.036*	0.059***	0.071***	0.064***	0.060***
	(0.016)	(0.019)	(0.019)	(0.018)	(0.017)	(0.018)
Wild bootstrap p, exposure	0.014	0.282	0.155	0.142	0.001	0.143
p-value: full = in-between			0.050			
p-value: (0, 0.5) = [0.5, 1)				0.041		
Observations	640	640	640	640	568	471
Banks	76	76	76	76	66	56
Panel B: total deposits / 1913 total assets, 1910–1918						
CB exposure * Post	-0.426***				-0.356**	
	(0.147)				(0.156)	
Any CB exposure * Post		-0.403**				
		(0.163)				
In-between exposure * Post			-0.220			
			(0.203)			
Exposure in (0, 0.5) * Post				-0.323*		
				(0.184)		
Exposure in [0.5, 1) * Post				-0.156		
				(0.246)		
Full CB exposure * Post			-0.454***	-0.449***		-0.423**
			(0.168)	(0.168)		(0.169)
# branches * Post	-0.002	0.011	-0.002	0.001	-0.002	0.027**
	(0.011)	(0.010)	(0.014)	(0.012)	(0.009)	(0.011)
Log(population), yearly	7.261***	7.155***	7.227***	7.249***	-0.510	7.639***
	(1.354)	(1.360)	(1.325)	(1.292)	(1.421)	(0.951)
Wild bootstrap p, exposure	0.001	0.006	0.003	0.003	0.024	0.006
p-value: full = in-between			0.095			
p-value: (0, 0.5) = [0.5, 1)				0.416		
Observations	523	523	523	523	438	395
Banks	70	70	70	70	58	53

Note: Continuous-treatment checks following Callaway, Goodman-Bacon and Sant'Anna. Column (1) is the baseline: CB exposure (share of a bank's offices in a DNB city) x Post. Column (2) compares banks with any exposure to banks with zero exposure. Columns (3) and (4) split exposure into groups, with zero exposure as the base group: in-between ($0 <$ exposure < 1) and full exposure in column (3); exposure in (0, 0.5), in [0.5, 1) and full exposure in column (4). Column (5) repeats column (1) on banks with exposure > 0 only. Column (6) compares fully exposed with non-exposed banks, dropping in-between banks. Panel A: Jul–Aug 1914, bank, week and region x month fixed effects. Panel B: 1910–1918, bank, year and region x year fixed effects, with the log of the yearly population of the bank's pre-war office locations as a control. Standard errors clustered by bank in parentheses; stars use these. Wild bootstrap p: wild cluster bootstrap (Rademacher weights, 9,999 replications) for the exposure coefficient of each column (full exposure in columns (3) and (4)). ***, ** and * indicate significance at the 1, 5 and 10% level.

D Conceptual Framework: Derivations and Proofs

This appendix derives the results of Section 5 and proves the propositions in the linear model. Appendix D.5 then extends the model to diminishing returns to lending and rising costs of non-deposit funding, as in Drechsler et al. (2017). I drop the subscripts j, t wherever possible.

D.1 Deposit demand

There are N depositors with one guilder each. Depositor i has an attachment $\xi_i \sim U[\xi_{lo}, \xi_{hi}]$ to the bank and keeps funds there if $r_j \geq v_j - \xi_i$, with v_j from (6). At an interior solution,

$$D = N\,\frac{\xi_{hi} - (v_j - r_j)}{\xi_{hi} - \xi_{lo}} = \bar{D}\left[1 + b\,(r_j - v_j)\right], \qquad \bar{D} = \frac{N\,\xi_{hi}}{\xi_{hi} - \xi_{lo}}, \quad b = \frac{1}{\xi_{hi}},$$

which is (5). The distribution of attachment is the same in H and L cities, so $\bar{D}$ and b are the same for both types.

D.2 The linear model

Value of a deposit. Lending earns $r_t + r_a$ up to the bank's lending opportunities $\bar{A}$. If $s_t \geq r_a$, the bank does not borrow at the margin and deposits fund lending ($\partial A/\partial D = 1$). If $s_t < r_a$, the bank borrows up to $\bar{A}$ and deposits replace non-deposit funding ($\partial W/\partial D = -1$, $\partial A/\partial D = 0$). Hence $m_t = r_t + \min(r_a, s_t)$, which is (4). It does not depend on the bank's deposits. Before and during the crisis, it is the same for all banks, $m_{j,t} = m_t$. After the crisis, it differs across banks, but not because of their deposits: it is lower for exposed banks, which may have to defend their deposits in a future flight to safety (Appendix D.3), and for banks with cheaper access to the money market (a lower $s_{j,2}$).

Deposit rate. The part of profit (3) that depends on r_j is $(m - r_j)\,D(r_j)$. The first-order condition is

$$\frac{d\Pi}{dr_j} = (m - r_j)\,\bar{D}b - D = 0.$$

Using $D/(\bar{D}b) = 1/b + r_j - v$ gives $r_j^* = \frac{1}{2}v + \frac{1}{2}(m - 1/b)$, which is (7) with $\omega = \frac{1}{2}$. The second-order condition is $-2\bar{D}b < 0$.

Margin and franchise. The first-order condition gives $m - r_j^* = D^*/(\bar{D}b)$, so the franchise (8) is $F = (D^*)^2/(\bar{D}b)$.

D.3 Sticky deposits

A deposit guilder attracted at t remains with the bank at $t+1$. If the demand for safety takes the value Δ_{t+1}, an exposed bank must pay $\omega\Delta_{t+1}$ more to keep it, by (7). The expected cost lowers the value of a deposit today, $m_{j,t} = m_t - \omega\, e_j\, \mathbb{E}_t[\Delta_{t+1}]$, which is (10) at $t = 2$. The common part of the future outside option (v_{t+1}) is the same for all banks and drops out of the differences between H and L.

D.4 Proofs

The proofs use the linear model of the main text. Appendix D.5 shows that they hold for any pass-through $\omega \in [\frac{1}{2}, 1)$.

Equations (9) and (11). H and L banks share r_t, r_a, s_t, $\bar{D}$ and b. They differ in the outside option, $v_{H,t} - v_{L,t} = \Delta_t$, and at $t = 2$ in the value of a deposit, $m_{H,2} - m_{L,2} = -\omega\, \mathbb{E}_2[\Delta_3]$. By (7) and (5),

$$r^*_H - r^*_L = \omega\,(v_H - v_L) + (1-\omega)\,(m_H - m_L), \qquad D^*_H - D^*_L = \bar{D}b\,\big[(r^*_H - r^*_L) - (v_H - v_L)\big],$$

which gives (9) for $t \leq 1$ and (11) for $t = 2$. The markdown $1/b$ drops out. Shocks common to all banks (to r_t, s_t or v_t) change m and v equally for H and L and drop out as well.

Proposition 1. By (9) with $\Delta_1 > 0$ and $\omega < 1$.

Proposition 2. By (11) with $\Delta_2, \mathbb{E}_2[\Delta_3] \geq 0$, not both zero: the deposit gap is negative, and the rate gap is positive if and only if $\Delta_2 > (1-\omega)\,\mathbb{E}_2[\Delta_3]$. Conversely, fewer deposits without a higher rate require $\mathbb{E}_2[\Delta_3] > 0$.

Franchise. Since $m - r^* = D^*/(\bar{D}b)$ for both types, $F_H - F_L = (D^*_H - D^*_L)(D^*_H + D^*_L)/(\bar{D}b)$, which has the sign of the deposit gap.

Proposition 3. In the linear model, $\partial A/\partial D = 1$ if $s_t \geq r_a$ and 0 if $s_t < r_a$; apply this to the deposit gaps.

D.5 Diminishing returns and the pass-through

Following Drechsler et al. (2017), profit (3) becomes

$$\Pi = \Big(r_t + r_a - \tfrac{l_1}{2}A\Big)A - \Big(r_t + s_t + \tfrac{h}{2}W\Big)W - r_j\, D, \qquad A = D + W,$$

with $l_1, h > 0$. The linear model is the limit $l_1, h \to 0$.

Non-deposit funding. The first-order condition for W, $r_t + r_a - l_1 A = r_t + s_t + hW$, gives

$$W^* = \frac{r_a - s_t - l_1 D}{l_1 + h}, \qquad \frac{\partial W^*}{\partial D} = -\frac{l_1}{l_1 + h}, \qquad \frac{\partial A^*}{\partial D} = \frac{h}{l_1 + h}.$$

Replacement of lost deposits is partial. If $W^* = 0$, lending moves one-for-one with deposits.

Value of a deposit. A deposit guilder is worth the marginal return on lending, which at W^* equals the marginal cost of the non-deposit funding it replaces:

$$m(D) = r_t + s_t + hW^* = M - \gamma D, \qquad M \equiv r_t + s_t + \frac{h\,(r_a - s_t)}{l_1 + h}, \qquad \gamma \equiv \frac{l_1 h}{l_1 + h} > 0.$$

A bank that loses deposits values the remaining ones more. After the crisis, M is lowered by $\omega\, e_j\, \mathbb{E}_t[\Delta_{t+1}]$ (Appendix D.3).

Deposit rate. Since W is chosen optimally, its adjustment has no first-order effect on profit (envelope theorem), and the first-order condition for r_j is again $(m - r_j)\,\bar{D}b - D = 0$, now with $m = m(D)$. Substituting $m(D)$ and (5), and defining $k \equiv \gamma \bar{D} b$,

$$r_j^* = \omega\, v + (1 - \omega)\Big(\bar{m} - \frac{1}{b}\Big), \qquad \omega = \frac{1 + k}{2 + k} \in \big[\tfrac{1}{2}, 1\big), \qquad \bar{m} \equiv M - \gamma \bar{D},$$

which is (7). The second-order condition is $-2\bar{D}b - \gamma(\bar{D}b)^2 < 0$. The pass-through exceeds $\frac{1}{2}$ because a bank that falls behind its depositors' outside option loses deposits and so values the remaining ones more.

Comparative statics. With $D^* = \bar{D}b\,(1/b + r^* - v)$:

Shock	∂r^*	∂D^*
Outside option v	ω	$-\bar{D}b\,(1 - \omega)$
Market rate r_t	$1 - \omega$	$\bar{D}b\,(1 - \omega)$
Funding spread s_t (if $W^* > 0$)	$(1 - \omega)\,\frac{l_1}{l_1 + h}$	$\bar{D}b\,(1 - \omega)\,\frac{l_1}{l_1 + h}$
$\mathbb{E}_t[\Delta_{t+1}]$ (type H only)	$-(1 - \omega)\,\omega$	$-\bar{D}b\,(1 - \omega)\,\omega$

Unlike in Drechsler et al. (2017), a higher market rate raises deposits, since depositors' alternatives include bonds and money market funds, which earn the market rate. In that case, a higher market rate improves their outside option and deposits flow out. In the 1914 setting, depositors' outside option is cash and the central bank account, whose

value does not move with the market rate. The market rate therefore acts only through the value of a deposit to the bank. If the outside option moved with the market rate, $dv/dr_t = \theta$, the effect on deposits would be $\bar{D}b\,(1-\omega)(1-\theta)$, which is zero for $\theta = 1$.

The propositions. The proofs in Appendix D.4 carry over with $\omega \in [\frac{1}{2}, 1)$ and $\bar{m}$ in the place of m: the gaps (9) and (11) and the franchise depend only on (7), (5) and the first-order condition $(m - r_j)\,\bar{D}b = D$, which hold in both models. For Proposition 3, replacement is partial: $A_H - A_L = \frac{h}{l_1+h}(D_H^* - D_L^*)$.