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Private money and money market integration: The role of payments infrastructure in nineteenth-century Switzerland

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Summary:

We use newly collected discount rate data for six Swiss cities to study money market integration over the period 1846-1893. Having ruled out traditional explanations such as transport and information costs, we use a novel counterfactual to show that structural issues associated with free banking prevented integration until public regulation of the payments infrastructure occurred in 1881.

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Abstract

Using newly collected discount rate data for six Swiss cities from 1846 to 1893, we find no evidence of increasing integration during a 30-year period of lightly regulated free banking. We attribute this to two structural issues: banks had incentives to ward off competitors by protecting their local monopolies or forming cartels, and there was always a risk (which varied across banks) that banknotes were not accepted or converted at par. We use a novel counterfactual to show that these issues increased discount rate dispersion, and argue that as a result, public regulation of payments infrastructure was necessary for money market integration.

KEYWORDS
nineteenth century, discount rates, financial integration, monetary union, money market, Switzerland

JEL CLASSIFICATION
E43, E44, F33, F45, N13, N23

I | INTRODUCTION

An integrated money market is key for economic development. Indeed, transaction frictions between various means of payments may hamper trade and therefore limit economic activity.[1] By contrast, a widely accepted means of payment facilitates trade and therefore bolsters economic activity. In the case of decentralized money creation under free banking, banknotes are often not widely accepted as a means of payment. However, Selgin and White argue that free banking will eventually lead to the universal acceptance of banknotes and therefore an integrated money market, if transaction and transport costs are low.[2] Specifically, they argue that each bank has an incentive to accept the notes from other banks in an effort to increase the circulation of their own notes.

We consider the case of Switzerland in the second half of the nineteenth century where the establishment of the modern Swiss Confederation in 1848 was followed by the introduction of Swiss franc coins, but there was no central bank and minimal regulation of note issuance. This period of 'unfettered' free banking lasted about 30 years following the introduction of the Swiss franc until note issuance was uniformly regulated in 1881 with the passing of the Banknote Act. This makes Switzerland a perfect environment to study whether an integrated money market can develop in the presence of private money without central state intervention.

We use newly collected daily discount rate data for six Swiss cities to study the integration of the Swiss money market from 1846 to 1893. The data are collected from banks' annual reports, newspapers, and exchange sheets. We use the regional dispersion in these rates to measure market integration: when discount rates are more similar, we consider the market to be more integrated. We find that integration did not happen as a gradual process in Switzerland, as one might expect if traditional explanations for market integration, such as gradual improvements in communication and transport networks, were at play. Instead, integration remains roughly constant throughout the free-banking period after the new Swiss franc became the dominant denomination of banknotes, followed by a dramatic increase in integration that coincides with the passing of the Banknote Act in 1881, which effectively ended unregulated free banking in Switzerland.

The lack of integration before this Act is all the more surprising given that transport and transaction costs were low in Switzerland at this time. However, we identify two structural issues with unfettered free banking which the private sector was not well-placed to address. First, the competitive nature of banknote issuance gave banks an incentive to create their own brand, or form agreements with other banks to establish networks or cartels within which their banknotes circulated freely. Whilst banknotes were usually converted at par within a cartel as suggested by Selgin and White, this was not the case across different cartels.[3] Banks that branched across regions were fought by local incumbents, protecting their local monopolies by refusing to convert competitors' notes at par. Second, unfettered free banking brought with it conversion risk: the risk that in the event of a panic, a bank would have to convert large amounts of notes into metallic coin, exhausting its reserves. This risk varied across banks and could be mitigated by increasing the discount rate and thus reducing the ratio of notes in circulation to reserves, leading to discount rate dispersion. Both issues increased the transaction costs of banknotes and led to a fragmented money market with discount rate dispersion.

[1] Xu and Yang, *Real Effects of Supplying Safe Private Money*.

[2] Selgin and White, *The Evolution of a Free Banking System*.

[3] Selgin and White, ibid.

We argue that the Banknote Act of 1881 addressed both of these issues. That Act was designed to reduce inefficiencies in the payments infrastructure laid bare by the financial crisis that followed the outbreak of the Franco-Prussian war in 1870. It required banknotes to be accepted at par and regulated note-issuing banks, ending the period of unfettered free banking. In addition, it established common reporting standards, which reduced information frictions, as well as liquidity and capital provisions, which reduced conversion risk. We argue that this Act forced an end to local monopolies and cartels in note issuance, which had otherwise been successfully defended by incumbents, and by reducing the incentive to run on a bank, homogenized conversion risk and reduced discount rate dispersion.

To quantify the effect of these two factors, we use a novel counterfactual.[4] Norway was similar economically and in its monetary regime to Switzerland, but since the Norges Bank held the monopoly on note issuance, there were no local cartels and conversion risk was homogenous across regions. However, regional branches of the Norges Bank could apply their own discount rates. We show that, on average, discount rate dispersion in Switzerland was materially higher than in Norway in the period of unfettered free banking but was identical in the period after the Banknote Act.

Overall, we find little evidence that, left to its own devices, the private sector would have generated an integrated money market. This is an important finding given the recent rise of new forms of private money in the shape of stable coins, which, similar to banknotes in free banking, are frequently pegged to a relatively stable unit of account. Free banking examples have been used to argue in favour of regulation for these new forms of private money[5] and to discuss the benefits of public over private money.[6] In addition, recent theoretical work has shown that purely privately issued fiat currency may fail to implement an efficient allocation of resources.[7] We add to this discussion by arguing that, in the case of Switzerland at least, public intervention in the form of bank regulation was necessary in order to develop a widely accepted means of payment and an integrated money market.

We contribute to three other strands of the literature. First, several studies use interest rate dispersion to measure financial integration in other countries,[8] often attributing the lack of integration to transaction costs. This fits with Selgin and White's argument that universal bank note acceptance will naturally occur in free banking if transaction and transportation costs are low.[9] For instance, Nogues-Marco et al. argue that improvements in roads and the postal service reduced transaction costs in Spain before the advent of railways,[10] whilst Mitchener and Ohnuki, and Klovland and Øksendal give a central role to advances in communications in driving

[4] We quantify the overall effect of the two factors. As the legislation was introduced in one single act, we cannot empirically disentangle the relative importance of banknote and financial stability regulation.

[5] Gorton and Zhang, *Taming Wildcat Stablecoins*.

[6] Bordo, *Currency competition in Switzerland*.

[7] Fernández-Villaverde and Sanches, *Can currency competition work?*

[8] Examples include Klovland and Øksendal, *The decentralized central bank*, for Norway (1850–92); Mitchener and Ohnuki, *Institutions, Competition*, for Japanese prefectures (1884–1925); Nogues-Marco et al., *The Making of a National Currency*, for the Spanish money market (1825–74); and Good, *Financial Integration*, for nineteenth-century Austria. For the United States, in the antebellum period: Bodenhorn *Capital Mobility and Financial Integration*; and postbellum: Davis, *The Investment Market*; Sylla, *Federal Policy;* Smiley, *Interest Rate Movement*; James, *The Development of the National Money Market;* Choi and Dupont, *Revisiting Structural Change*; Xu and Yang, *Real Effects of Supplying Safe Private Money*.

[9] Selgin and White, *The Evolution of a Free Banking System*.

[10] Nogues-Marco et al., *The Making of a National Currency*.

integration in Japan and Norway, respectively.[11] In contrast, we show that these transaction costs were already relatively low in Switzerland in the 1850s and certainly by the 1860s, but that segmentation persisted. Indeed, we argue that other structural factors, specifically, the protection of local monopolies and cartels, as well as differences in conversion risk, were more important drivers of segmentation.

Second, the role of legislation is central to the discussion of integration of interest rates in the postbellum US literature. Several authors argue that regulations on national banks under the Banking Act of 1864 created barriers to entry that slowed the narrowing of interest rate differentials across regions of the US.[12] In this study we also argue that banking regulation can play a key role in financial market integration, however, contrary to these studies, we find that regulation was an important driver of integration in Switzerland.

Third, the extant literature also emphasizes the importance of the Swiss Banknote Act of 1881 in shaping the financial system. This literature has identified several negative consequences of the Act, in particular, the risk of over-issuing, the lack of a flexible banknote supply, and drainage of metallic reserves of note issuing banks located near the border. Pointing to a weak exchange rate and contemporary accounts of movements of specie to France of 'phantastic dimensions',[13] Neldner articulates the prevailing view that the Banknote Act had a destabilizing effect by creating a free-rider problem that led to over-issuance of banknotes and an undervaluation of the exchange rate.[14] Herger develops testable hypotheses on the basis of the model of Miron and argues similarly.[15]

We do not challenge the findings of these studies, which are both intuitive and convincing. Instead, we focus on a different impact of the Banknote Act: its effect on money market integration. To our knowledge, no previous study has considered this aspect. Indeed, whilst the above literature identifies negative impacts of the Act, our analysis suggests that it also played a positive role from the perspective of economic integration, as it created a unified monetary system in Switzerland. Interestingly, the mechanism that Neldner and Herger believe led to over-issuance – the reduced incentive for customers to discriminate between notes – is one key element which we argue led to a more integrated money market.

The remainder of the paper is structured as follows. In the next section we provide a brief historical background, detailing free banking in Switzerland from the introduction of the Swiss franc through the periods of unfettered and regulated free banking. We then present our data and our strategy for quantifying dispersion in section III. In section IV we discuss structural issues which prevented market integration under unfettered free banking and the mechanisms through which the Banknote Act addressed these issues, and in section V we use the counterfactual of Norway to attempt to quantify the importance of these structural issues in causing discount rate dispersion. Section VI concludes.

[11] Mitchener and Ohnuki, *Institutions, Competition, and Capital Market Integration* and Klovland and Øksendal, *The decentralized central bank*.

[12] See Sylla, *Federal Policy*; Smiley, *Interest Rate Movement*; James, *The Development of the National Money Market*; and Choi and Dupont, *Revisiting Structural Change*. An alternative hypothesis, put forward by Davis, *The Investment Market*, and Smiley, *Interest Rate Movement*, argues that the development of a national commercial paper market helped overcome geographical and institutional barriers such as restrictions on branch banking, leading to market integration.

[13] Jöhr, *Die Schweizerischen Notenbanken*, p. 240, translated by Neldner, *Lessons from the free banking era*.

[14] See two works by Neldner: 'Lessons from the free banking era' and 'Competition Necessarily Tends to Produce Excess'. See also Meyer, *Les banques d'émission Suisses*, for an early contribution.

[15] Herger, *Unregulated and regulated free banking* and Miron, *Financial Panics*.

II | HISTORICAL BACKGROUND: FROM UNFETTERED TO REGULATED FREE BANKING

The first Swiss banknotes were issued by the *Deposito-Cassa* of the city of Bern in 1825. Since there was no national currency at the time, the banknotes were backed by various metallic coins, often denominated in foreign currency[16] whose value customers found difficult to judge and costly to exchange. Thus by 1850, banknotes rarely circulated outside the immediate sphere of their bank of issue.[17]

Following the foundation of the modern Swiss Confederation in 1848, Swiss franc coins were introduced in 1850.[18] The new Swiss currency was designed as a pure silver currency with the same parity as the French franc.[19] The introduction of the franc was successful in standardizing the currency and by 1852 the replacement of predecessor currencies was mostly complete.[20] As a result, banknotes were generally denominated in Swiss Francs thereafter, with a few short-lived exceptions.[21]

However, the issuance of banknotes remained a competitive business. The Confederation did not regulate banknote issuance and thus it was left to the cantons to determine rules for note-issuing banks. As a result, they were lightly regulated, causing the period to be referred to as one of 'unfettered free banking'.[22] Indeed, Fick noted that 'nowhere in Switzerland are bank laws in place in the sense of regulations for the control of existing and the permission of new banks'.[23] This situation had changed a little by the late 1870s. Five cantons had some form of regulation by about 1880. Zurich and Fribourg had requirements relating to the reserve ratio, whilst Schaffhausen and Zurich required approval from the local government for note issuing. In addition, Solothurn and Neuchâtel only gave their cantonal banks the right to issue notes.[24] In addition, six other cantons had a banknote tax of at most 1 per cent of the circulating notes' face value. However, there was no uniformity across the Confederation, and regulation was generally very limited and was often easily circumvented by banks.[25]

Despite the lack of regulation, the period is frequently considered an example of stable free banking. Weber argues that there was no overissuing and there were almost no failures amongst the note-issuing banks.[26] Indeed, Herger notes that between 1826 and 1907, there were just two panics, one in 1859 at the *Banque Générale Suisse* and the second in 1869 at the *Eidgenössische*

[16] See, for example, Nyborg, *Wie Banknoten Bargeld wurden*, p. 94.

[17] Nedwed, *Notenbankenfreiheit*, p. 318.

[18] For a recent, detailed discussion of the history of the Swiss franc, see Chiarelli, *Le franc suisse*.

[19] See Baltensperger and Kugler, *Swiss Monetary History*, p. 27. See also, Halbeisen and Müller, *Die schrittweise Nationalisierung des Geldes*, for a detailed discussion of the origins and initial development of the Swiss monetary system.

[20] Niederer, *Der Münzumtausch von 1851/52 in der Schweiz*.

[21] Weber, *Free banking in Switzerland*, p. 198.

[22] Herger, *Unregulated and regulated free banking*.

[23] Fick, *Die Schweizerische Bankgesetzgebung*, p. 87 as translated by Fink, *Free banking as an evolving system*, p. 5.

[24] Banks in these cantons are not in our sample. See Fink, ibid, for a detailed discussion of regulations.

[25] See Giddey, *Histoire de la régulation des banques en Suisse*, for a discussion. For instance, in the canton of Ticino, a law that affected savings accounts caused banks to rename these 'deposit accounts'.

[26] Weber, *Currency competition in Switzerland*, p. 204.

Bank, and one failure (*Banque Cantonal du Valais*) in 1870, but that no banknote holder suffered losses as a result.[27]

On the other hand, in a report to the National Monetary Commission of the US Senate, Landmann argues that during this period, 'disregarding all banking principles, [the banks] entered into every conceivable transaction for the sole purpose of bringing the largest possible amount of their notes into circulation'[28] and that 'not without reason'[29] the public doubted the security of banknotes issued. Either way, it is generally recognized that the market remained fragmented: banknotes were not standardized in form or quality, and as a result monitoring costs were high[30] and banknotes were generally illiquid.

During the 1860s, and 1870s the number of note-issuing and other banks increased strongly.[31] The founding of commercial banks was linked to the codification of laws regarding trade and bills of exchange. Although Switzerland did not mint its own gold coins, it was member of the Latin Monetary Union, which meant that French gold coins were readily used in daily transactions and the Confederation elevated French gold coins to legal tender in 1860.[32] Because of its membership in the Latin Monetary Union, and because of the bad reputation of Swiss banknotes, gold coins were the preferred way to settle large transactions during the 1860s.

Problems in the payment infrastructure were laid bare during the Franco-Prussian War. At the start of the war, France raised the discount rate, prohibited gold exports, and suspended banknote convertibility. For Switzerland, which did not mint its own gold coins, the resulting liquidity shortage led to the *Geldcrisis* of 1870. Swiss banks could not meet payments obligations or extend credit and some cantons had to impose a general payments moratorium.[33] The crisis only eased when the authorities declared the English sovereign and the US dollar legal tender, enabling Swiss banks to obtain currency by transferring holdings of bills drawn on these currencies into coin.[34] This eased the liquidity crisis considerably, and also because the war ended quite quickly, the period of monetary crisis was in the end relatively brief.

Nonetheless, the serious deficits that the *Geldcrisis* uncovered in the payments infrastructure had significant ramifications for the Swiss financial sector. It had proven impossible for the Confederation authorities to negotiate a joint solution amongst the banks to deal with the liquidity shortage. Banks refused to accept notes issued by their competitors as this would drain their reserves.[35] Indeed, Nyborg suggests that most bilateral accords between note-issuing banks to convert their notes at par were suspended during this episode.[36]

[27] Herger, *Unregulated and regulated free banking*.

[28] Landmann, *The Swiss Banking Law*, p. 19.

[29] Ibid, p. 11.

[30] Herger, *Unregulated and regulated free banking*.

[31] See Ritzmann, *Die Entwicklung des schweizerischen Geld- und Kreditsystems*, and *Die Schweizer Banken*, ch. 2.

[32] Ritzmann, *Die Entwicklung des schweizerischen Geld- und Kreditsystems*.

[33] Baltensperger and Kugler, *Swiss Monetary History*, p. 32.

[34] Ibid.

[35] It also highlighted the lack of a lender of last resort. This issue was not resolved until the founding of the Swiss National Bank in 1907.

[36] Nyborg, *Wie Banknoten Bargeld wurden*, p. 169.

At the same time, however, banknotes were increasingly used during the 1870s.[37] Ritzmann suggests that whilst the public did not trust paper money and the notes often circulated only in the region where the emitting bank was active, during this time the price of silver fell relative to gold, meaning that clunky silver coins of the Latin Monetary Union replaced gold coins in daily transactions.[38] The public therefore increasingly used banknotes to settle large transactions, because transaction costs were lower compared with silver coins, but still higher compared with gold coins.

Against this backdrop, in 1874, an amendment to the Federal Constitution gave the Confederation authority to pass legislation governing the issue and redemption of banknotes, but explicitly ruled out cantonal or federal monopolies on issuing banknotes.[39] It took considerable time to finally pass legislation. The initial version of the legislation, aimed at improving the convertibility of banknotes and financial stability, was voted down in a popular referendum in 1876.[40] The law was rejected for various reasons. For some, it was an undue intrusion in individual economic liberties. For others, who favoured more centralization and cantonal or federal monopolies on banknote issuance, the law did not go far enough.[41] However, for contemporaries it was clear that a widely accepted means of payments was desirable and that it should fulfil stricter standards than the existing banknotes.[42] A commentary in the Neue Zürcher Zeitung (NZZ) newspaper in April 1876 lamented that banknotes issued in Fribourg were not of use in St. Gallen. In addition, the soundness of relatively unknown regional banks was difficult or impossible to assess by the wide public. The article in the end even compares the wide variety of banknotes with the *Münzwirrwarr*, when trade was hampered by the multitude of coins in use before the Swiss franc was introduced with the constitution of 1848.

The deliberations for a new law in parliament took a long time because the council of states defended cantonal interests and the more liberal national council was more sympathetic to the private banks' interests.[43] Thus, it took until 1881 until the Banknote Act was finally passed. This brought in several requirements to improve the payments infrastructure in addition to the acceptance of notes at par, including metal reserve and equity capital requirements, the standardization of banknotes in terms of size and denomination, and federal regulation of note issuers with regular reporting requirements.

Combined with the scarcity in failures of note-issuing banks, the Act was successful in making banknotes widely accepted. In 1898, the *Banque du Commerce de Genève* stated in its annual report

[37] See also Gerlach and Kugler, *Money demand under free banking*, for a discussion of the composition of M1 money since 1850.

[38] Ritzmann, *Die Entwicklung des schweizerischen Geld- und Kreditsystems*. The cantonal bank in Bern even ran out of banknotes to emit and had to resort to payments in silver coins. In an annual report in 1873, the board also recognized that banknotes were relatively more useful to settle transactions than silver coins, which was the predominant type of precious metal that banks held as reserves (see Egger, *Kantonalbank von Bern*, p. 65).

[39] This was part of a total revision of the Constitution, which gave more democratic rights to the electorate.

[40] Ritzmann, *Die Schweizer Banken*, p. 94.

[41] See 'Was soll nun mit dem Banknotenwesen geschehen?' in Der Bund, 29 April 1876. Viewed through this lens, political fragmentation, combined with the fact that there were direct democratic instruments to reject legislation, ultimately delayed the passage of the Banknote Act and therefore a more integrated Swiss money market.

[42] One important worry by opponents of bank legislation was that this would ultimately lead to a banknote monopoly (see, for example, 'Banknotenmonopol und Bundesrevision' in *NZZ*, 5 October 1880).

[43] Ritzmann, *Die Schweizer Banken*, p. 95.

that notes 'circulate without distinction',[44] whilst Jöhr states 'indeed, the ordinary man, in course of the years, ceased to differentiate between the notes of the various banks. If the notes carried the name and signatures of this or that bank, was no longer taken into consideration'.[45] This anecdotal evidence suggests that the Banknote Act led to a more integrated money market. However, the effect of the Act on integration has not previously been quantified. We next turn to this issue.

III | QUANTIFYING DISCOUNT RATE DISPERSION

We measure money market integration by discount rate dispersion of major note-issuing banks. Exchange rates between banknotes of different banks would be a more direct measure. Although there is evidence that banknotes were not converted at par (see appendix A), there exists no high-frequency exchange rate series between banknotes of various issuers. We therefore resort to a novel daily dataset of discount rates for six note-issuing banks.[46] Lower discount rate dispersion is indirect evidence for a more integrated money market, because banknotes are a more efficient means to arbitrage away interest rate differences than precious metal, in particular, heavy silver coins used during the 1870s.[47]

We assembled daily discount rate data for seven note-issuing banks from 1846 to 1893. The start date coincides with the foundation of two of the banks in our sample, the *Banque Cantonal Vaudoise* (with headquarters in the city of Lausanne) and the *Banque du Commerce de Genève*. The other banks in our sample are in Basel, Bern, St. Gallen, and Zurich. All banks were large within their region and all were important note issuers. The end date of our analysis, 1893, coincides with the announcement of a single discount rate by the note issuing banks for all of Switzerland.[48] In general, we attempted to collect discount rates for 'high quality' short-term bills, although we cannot verify this in all cases.[49] A full list of sources is provided in appendix B – briefly, the data are collected from annual reports, newspapers, and daily exchange sheets. In general, we obtained data for the same bank throughout the sample. The exception is in Zurich where, because the *Bank in Zürich* stopped announcing discount rates and withdrew from the banknote business, we spliced together data for two banks. We discuss the case of Zurich further below.

In contrast to existing work by Jöhr, we collected discount rates for two more cities (Bern and Lausanne, in addition to Basel, Zurich, St. Gallen, and Geneva), another bank type (state-backed cantonal banks in Bern and Lausanne, in addition to private banks) and at a higher frequency (daily rather than annually).[50] This allows us to identify changes in discount rate dispersion at

[44] Debes, Banque du Commerce de Genève.

[45] Jöhr, *Die Schweizerischen Notenbanken*, p. 203. Translations reported by Neldner, 'Lessons from the free banking era'.

[46] There were banks that discounted bills of exchange without issuing banknotes. For example, the *Schweizerische Kreditanstalt* was key to finance the extension of the Swiss railway network in the second half of the nineteenth century (see Ritzmann, *Die Schweizer Banken*, p. 63). It also discounted bills of exchange, but it never issued its own banknotes.

[47] Assuming free capital movements and no transaction costs, it follows from covered interest parity that riskless nominal returns are equal across regions that use a common currency.

[48] In practice, note-issuing banks deviated from the publicly announced rate. Although Hauzenberger et al., *What Drives Long-Term Interest Rates?*, assembled data on a 'private rate' that is a commonly agreed lower limit for discounts, we have no information on the rates applied by the individual note-issuing banks.

[49] The maturity is usually less than 3 months.

[50] Jöhr, *Die Schweizerischen Notenbanken*. This work reports annual averages and the number of discount rate changes. We cross-checked our daily data with his annual statistics for four cities and find very similar results.

high-frequency. Adding an additional bank-type is important because cantonal banks enjoyed some degree of public backing and usually had several branches throughout the canton. For example, in the canton of Bern there were three branches in 1860,[51] whereas in Vaud, there were 18 throughout the canton in 1855.[52] In addition, the two cantonal banks in our sample were active in rural cantons, in contrast to the large city banks in Geneva, Basel, and Zurich.

How representative are the six banks for the entire money market? Due to free entry, and the expansion of the banking sector during the 1860s and 1870s, there were at times more than 36 note-issuing banks. In addition, some banks exited the market whilst others entered. We assembled data in 5-year intervals on the number of banks, banknotes in circulation, and precious metal reserves. We collected these data individually for the six banks in our sample and a total for all note-issuing banks in Switzerland. In 1850, our sample represents almost 80 per cent in terms of the number of banks (see figure C1 in appendix C). In terms of banknote circulation and reserves, the share is over 90 per cent. Over time, our sample becomes gradually less representative. From 1880 to 1895, we only cover around 20 per cent of note-issuing banks. However, in terms of notes in circulation and bank reserves, we usually cover more than 40 per cent of the market. This highlights, first, that we cover a relevant share of the market throughout the sample, and second, that our sample is tilted to larger, more important, and more successful banks.

The discount rate data are presented in figure 1. For the analysis, we aggregate the data to a weekly frequency.[53] This reduces measurement error arising from the fact that, depending on when in the day a rate change announcement was made and how many editions a newspaper might print, the public announcement may or may not lag by a few days. Whilst there is a broadly similar pattern across the cities during the period, this alignment is not perfect. For instance, whilst discount rates in all cities increase in the aftermath of the Franco-Prussian war, the route to normalization is different across cities.

It is notable that discount rates in Lausanne and Bern change less frequently than elsewhere, particularly in the early part of the sample. Both of these are cantonal banks, raising the question of whether rate-setting behaviour at cantonal banks was different from other banks.[54] To consider this further, we compare data for our two banks in Zurich, one of which is a private bank (*Bank in Zürich*) and the other a cantonal bank (*Zürcher Kantonalbank*). For these banks we have overlapping data between December 1870 and February 1882.[55] As is evident in figure 2, they set very similar rates during this time: the correlation coefficient between the series is 0.97, the medians of the two series are the same, and the means are within 10 basis points of each other. Thus, it does

[51] See Regierungsrath des Kantons Bern, *Bericht des Regierungsrathes*, p. 191.

[52] See BCV, *Rapport pour l'année 1855*.

[53] The results are robust when using data at daily or monthly frequency.

[54] Nyborg, *Wie Banknoten Bargeld wurden*, p. 184–6, suggests that cantonal banks were not that different in the sense that they were competitors in bank note issuance. The *Eidgenössische Bank* in Bern competed with the cantonal bank in Bern. The *Bank in St. Gallen* operated at the same time as the cantonal bank in St. Gallen. Also, as discussed, the *Bank in Zürich* operated, for some time, at the same time as the cantonal bank of Zurich. Finally, in the canton of Fribourg, we found evidence of four note-issuing banks, including the cantonal bank (SHAB, *Wochensituation der schweizerischen Emissionsbanken*). However, there were political currents in several cantons that aimed to establish a cantonal banknote monopoly (e.g. in Bern and Zurich). Cantonal banks were also founded to eliminate competition of local private banks (e.g. in St. Gallen and Glarus). In Zurich, a popular initiative that attributes the banknote monopoly to the cantonal bank was even accepted in 1877, suggesting that some monopoly on banknote issuance was in fact popular. However, this law was deemed inconsistent with federal legislation, which explicitly ruled out banknote monopolies.

[55] The final Zurich series used in the analysis relates to the *Bank in Zürich* from 1846 until data from the *Zürcher Kantonalbank* becomes available at the end of 1870.

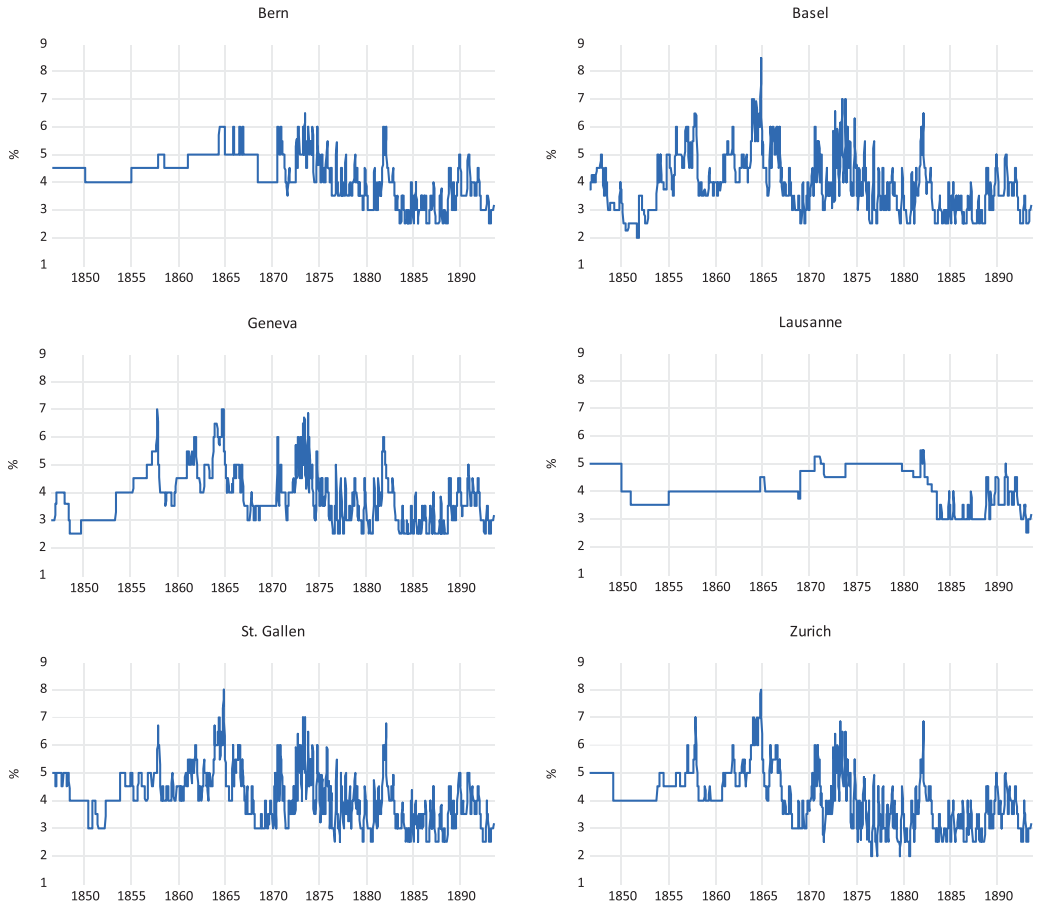

FIGURE 1 Weekly discount rates in six Swiss cities, 1846–93. *Note*: Weekly data calculated as average of daily observations. *Source*: Online appendix B.

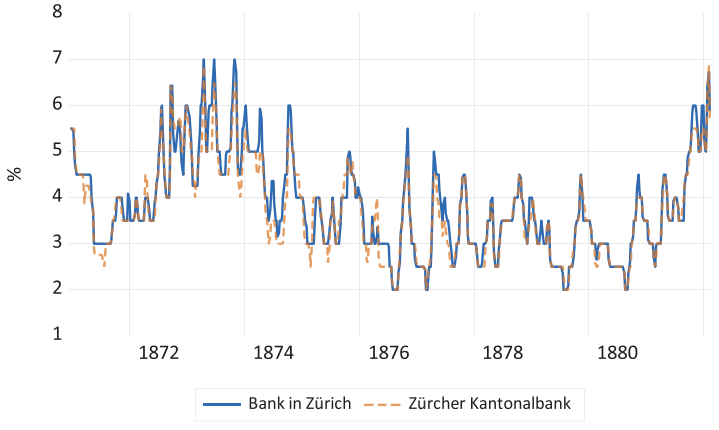

FIGURE 2 Discount rates of Zürcher Kantonalbank and Bank in Zürich, December 1870 and February 1882. *Note*: Weekly data calculated as average of daily observations. *Source*: Online appendix B.

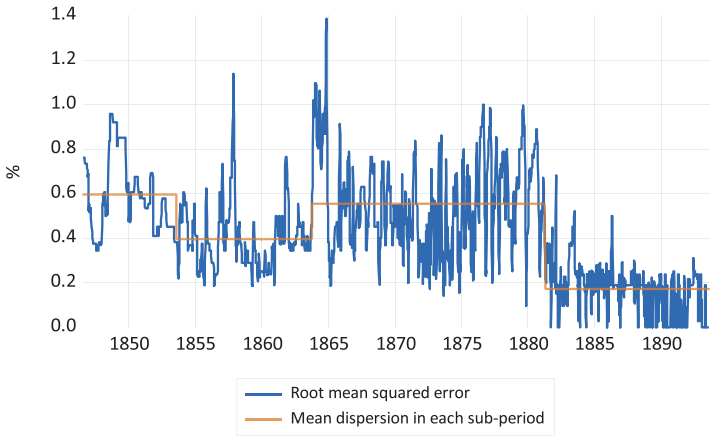

FIGURE 3 Weekly discount rate dispersion, 1846–1893. *Note*: Weekly data calculated as average of daily observations. Sub-periods determined using Bai–Perron test for a break at an unknown time (see app. E for a discussion of the methodology). *Source*: Authors' calculations.

not seem to be the case that cantonal banks as a rule set discount rates differently from private banks: instead the lower frequency of rate changes in Bern and Lausanne appears to be a feature of the local market, and as we argue below, reflects the large degree of autonomy in discount rate setting due to market segmentation.

We use the dispersion of interest rates as a measure of the integration of the financial system. Our preferred measure of dispersion is the root mean squared deviation (RMSD)[56] of the six discount rates. The RMSD is calculated as follows:

$$RMSD_t = \sqrt{\frac{\sum_{i=1}^{N}\left(r_{i,t} - \overline{r_t}\right)^2}{N}}$$

where $r_{i,t}$ is the discount rate in city i in month t, and $\overline{r_t}$ is the average of the six discount rates in month t. Since there are six Swiss cities, $N = 6$. Whilst the choice of dispersion measure is arbitrary, we show in appendix D that six alternative measures of dispersion lead to almost identical conclusions. The RMSD of the discount rates is presented in figure 3. A decrease in the RMSD of discount rates is interpreted as an increase in integration.

Eyeballing figure 3, it is evident that the process of integration occurred in steps. In particular, following a decline in dispersion around the time of the introduction of Swiss franc coins, there is no discernible decrease in the RMSD over the following 30 years. As we discuss below, this suggests that gradual improvements in transport and communication networks were not factors driving integration. However, there is a clear break and decline in the RMSD in the early 1880s, suggesting that a single event drove integration.

More formally, we conduct Bai–Perron breakpoint tests for a break in the mean of the RMSD (see appendix E for details of the breakpoint test procedure). We find breaks in late 1853, late 1863, and early 1881. The mean levels of dispersion in each sub-period are included in figure 3. Unsurprisingly, the first break, which roughly coincides with the Swiss franc replacing the

[56] This is equivalent to the population cross-sectional standard deviation of the series. The sample cross-sectional standard deviation would divide by $(N - 1)$ instead of N.

pre-existing plethora of coins, results in a decline in dispersion. This suggests that the introduction of a common metallic currency also contributed to money market integration.[57] The break in 1863, during the 30 years of unfettered free banking, results in an increase in dispersion, implying that the integration actually declined during the period. However, the break in 1881 leads to a decisive decline in the dispersion of discount rates and coincides very closely with the passing of the Banknote Act.[58]

Given that, as already noted, there were attempts at regulating note issuance in the preceding years, one might expect an 'anticipation effect' where the break happens in advance of the Banknote Act. However, such anticipation effects should be limited because the passing of the Banknote Act was not perfectly predictable due to direct democratic instruments.[59] Indeed, when we conduct a robustness (see appendix F) where we drop one city in turn and search for breaks in the RMSDs for the remaining five cities, any variation we find in the break date (as we do when we drop the discount rate in Lausanne) results in the break occurring somewhat earlier (late 1879), which is reassuring for our hypothesis that the regulation of free banking was a key event in this period.

Overall, it seems that private regulation did not lead to an integrated market but that public regulation did. Why that was is considered in the next section.

IV | WHY WAS THERE NO INTEGRATION BEFORE 1881?

In this section we first rule out transport and transaction costs as drivers of the pattern of integration that we observe in the Swiss market, before presenting our two preferred explanations: an end to banknote cartels (or 'networks') and a diminution and convergence in so-called conversion risk.

In the literature, a lack of integration in other countries' financial markets is often attributed to information or transportation barriers.[60] However, the step-change pattern of integration observed in our data suggests that is not the case here. For instance, with the establishment of the Confederation, the postal services and telegraph infrastructure were also centralized. In 1850, there were already 1500 postal offices operated by the newly founded *Eidgenössische Post*.[61] The first telegraph line came into operation in July 1852 and by 1853, the telegraph network already included 70 locations.[62] The first railways in Switzerland started to operate before 1850, connecting

[57] This period was also characterized by rapidly improving communication and transportation systems.

[58] Specifically, the break occurs at the week beginning 14 April 1881. The Banknote Act was passed less than a month before, on 15 March 1881 (see Landmann, *The Swiss Banking Law*) although it took effect only in 1882 (see table in app. A). This points to an anticipation effect or may reflect estimation uncertainty inherent in the breakpoint tests.

[59] The Banknote Act's passing was not perfectly predictable because it was potentially subject to a popular referendum. Indeed, its predecessor had been – surprisingly – rejected by the public in 1876.

[60] Mitchener and Ohnuki, *Institutions, Competition, and Capital Market Integration*, Nogues-Marco et al., *The Making of a National Currency*, Klovland and Øksendal, *The decentralized central bank*.

[61] Kronig, *Post*. More generally, most internal barriers to trade were abolished when the Confederation was founded (before, there were about 180 customs stations between cantons; Polli-Schönborn, *Zölle*). Thereafter, there was little further economic integration during our sample period as measured by dispersion in gross domestic product (GDP) per capita (from Stohr, *Multiple Core Regions*) of the six cantons that we study.

[62] Buschauer, *Telegraf*. Moreover, a reduction of information lags is unlikely to explain changes in persistent differences in discount rate dispersion. Specifically, we find very similar results with monthly data, we therefore argue that improved communication is not the main driver of the decline in discount rate dispersion.

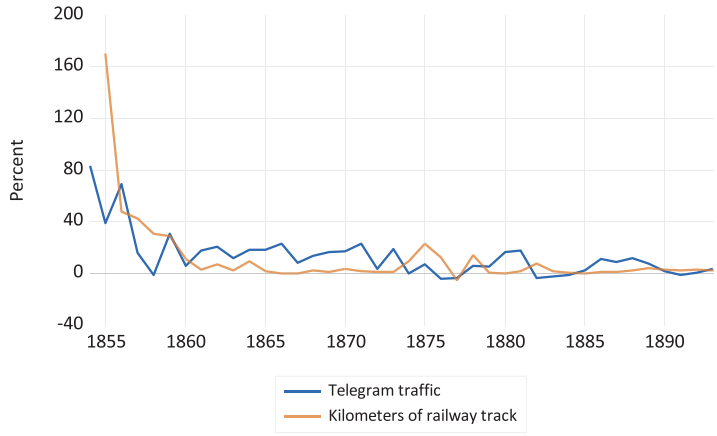

FIGURE 4 Annual growth rates in the kilometres of railway track and in telegram traffic, 1854–1893. *Source*: Historical Statistics Switzerland online database (https://hsso.ch/en), Tables N.04 (railway track) and N.2.1b (telegram traffic).

Basel and Strasbourg (1844) and Zurich and Baden (1847).[63] The railway boom started in earnest in 1855, and the railway network expanded from 38 km in 1854 to 210 km in 1855 and 1052 km in 1860.[64] However, there is no decline in dispersion during this 5-year period, suggesting that transportation costs, at least for shipping banknotes, were already low.[65]

To consider this in more detail, we use data on the growth rates in the number of kilometres of railway track and in telegram traffic on an annual frequency in Switzerland beginning in 1854 and 1855, respectively. As is evident from figure 4, there is no major change in either of these series that could explain the step change in discount rate dispersion in 1881. Indeed, the parameters in a regression of the dispersion of discount rates on the growth rates of these variables are insignificant.[66]

Since transport and information barriers do not explain the step-change that we observe in integration at the time of the Banknote Act, we must turn to other mechanisms. The first relates to the nature of competition in the market for paper money. Note-issuing banks had a strong incentive to create their own banknote brand, as this was a profitable activity, but also, to ward off competitors by refusing to convert their banknotes at par to protect their market share. We can think of this in the framework of Xu and Yang, who establish the concept of networks and competition in relation to US free banking in the 1880s.[67] They differentiate between notes circulating within a network and those outside. The network is the bank or set of banks that have agreed to accept each other's notes. Within the network, notes circulate freely. However, there is strong competition between

[63] See Bärtschi and Dubler, *Historisches Lexikon der Schweiz*.

[64] HSSO, *Tab. N4*.

[65] Indeed, Switzerland is a small country. The straight-line distance between Geneva and St. Gallen is 281 km. For instance, to travel about half that distance – from Bern to Geneva – took about 20 h using a *Diligence*, a carriage transporting nine people drawn by four or five horses.

[66] Specifically, the *p*-values on the coefficients are 0.36 (growth rate in telegram traffic) and 0.28 (growth rate in kilometers of railroad track).

[67] Xu and Yang, *Real Effects of Supplying Safe Private Money*.

networks, and banks seek to protect their network from outside competition to maintain their market. Having a lot of separate networks enables discount rate dispersion.

Selgin and White expect the banks to ultimately accept one another's notes at par (if transaction and transportation costs are low enough), because each bank has an incentive to accept the notes from other banks in an effort to increase the circulation of its own notes.[68] Essentially, they are arguing that all banks will eventually choose to be on the same network to increase their own circulation.[69]

However, although we see agreements between banks in Switzerland involving the formation of accords or cartels to accept notes at par, they never extended over the entire Swiss market. The cartels resemble the networks Xu and Yang emphasize in the sense that notes circulated freely within the cartel, but the cartels also introduced important barriers to entry.[70] The table in appendix A provides a list of the most important accords from the perspective of the six banks in our sample, but also from banks in smaller cities (*Nebenplätze*). With almost 70 different accords listed, the table illustrates the complicated and sketchy web of accords that existed during the period, which would have been difficult for customers to keep track of.[71] Moreover, although the fees to convert notes tended to decline towards the end of the 1850s for several accords, we do not know of an accord between two major banks that converted their banknotes at par until the 1860s. A further problem of such accords was that they were limited to a subset of banks that did not necessarily meet the needs of consumers. Another problem was that there was no legally binding enforcement: if one bank got into trouble, others could simply suspend their accords with it. These accords therefore included an inherent uncertainty which may have rendered them unstable, and therefore they had a limited impact on market integration. For example, in the wake of the Franco-Prussian war, the *Bank in Zürich* publicly retained the right to refuse banknote conversion despite existing agreements.

Overall, as a result of incumbents' ability to protect their local networks, banknotes were illiquid and did not circulate widely. This is evidenced by how little time notes were in circulation: for instance, Mangold[72] states that notes of the *Bank in Basel* spent on average only 36 days in circulation in 1855.[73] Thus, it seems that these small accords were ill suited to overcoming the network effect and reducing discount rate dispersion.

There were, however, two broader accords, the *Alte Konkordat* and a second agreement between the *Konkordatsbanken*, that must also be considered. We believe that these, too, were unlikely on their own to lead to an integrated market. To understand why, we need to discuss the origins of both.

First, the *Alte Konkordat* has its origins in the foundation of the *Eidgenössische Bank*, which was a private bank established at the end of 1863. One aim of the *Eidgenössische Bank* was that its

[68] Selgin and White, *The Evolution of a Free Banking System*, p. 446.

[69] Indeed, early on, contemporaries hoped that with the introduction of the Swiss franc coins, mutual agreements between all banks in Switzerland to accept notes at par would lead to more financial market integration (BEKB, *Bericht über die Verhandlungen der Kantonalbank von Bern*, p. 5). However, in practice, we see little evidence of this happening.

[70] Xu and Yang, *Real Effects of Supplying Safe Private Money*.

[71] Indeed, we have found several newspaper examples in the 1870s in which readers are reminded of which banks are involved in accords. This particularly relates to the *Konkordatsbanken* discussed below.

[72] Mangold, *Die Bank in Basel*, referred to in Weber, *Free banking in Switzerland*, p. 193.

[73] Indeed, Landmann, *The Swiss Banking Law*, p. 11, reports that 'outside their home Canton they [banknotes] could either not be given in payment at all or only at a certain discount'.

notes circulated all over Switzerland and replaced notes of other institutes as much as possible.[74] That threatened the local monopolies and cartels of the existing banks, which sought to ward off the competition by establishing a multilateral agreement on banknote conversion. The *Bank in St. Gallen* contacted two other banks, arguing that a *Konkordat*, or cartel agreement, would enlarge circulation in the interest of all three banks, but also: 'counter the encroachments of the *Eidgenössische Bank* in Bern into the territory of the three designated banks as far as possible'.[75] The private banks in Basel, St. Gallen, and Zurich agreed on 19 September 1864 to convert their banknotes at par value (see table in appendix A). This cartel agreement became known as the *Alte Konkordat*, the old accord.

The main aim of the banks in the cartel was clearly to ward off competition: in addition to establishing the *Konkordat*, the banks made a concerted effort to undermine the credibility of the *Eidgenössische Bank* with the public.[76] Moreover, when smaller banks asked in December 1864 to join the agreement, or alternatively to dissolve the cartel,[77] the *Alte Konkordat* banks dismissed their demands. As a result of the existing banks' efforts, the public did not fully trust the *Eidgenössische Bank*, and its banknotes in circulation remained relatively modest.[78]

Thus, although *Alte Konkordat* appears to be an improvement on the earlier bilateral accords since it involved several banks, precisely because the purpose of this accord was to defend local networks, it cannot be expected that it would eventually have led to widespread banknote acceptance and money market integration.

The second multilateral accord was formed in 1876 between 20 (later 28) banks (*Konkordatsbanken*) who agreed to convert each other's notes at par. However, the driving factor behind this accord was again defensive: in the wake of the failure of the constitutional referendum to unify banknotes in 1876, the commercial banks formed the accord to try to pre-empt any further attempts at regulation.[79] As a result, it seems unlikely such an accord would have been agreed upon without the threat of public regulatory initiatives.

Overall, there is little evidence that, left to their own devices, Swiss banks would eventually have accepted each other's notes at par as Selgin and White suggest.[80] Thus, despite the lack of information and transport barriers, the ability of incumbents to protect their local networks meant that there were limited means to take advantage of arbitrage opportunities arising from discount

[74] Nyborg, *Wie Banknoten Bargeld wurden*, p. 126–7.

[75] Cited in Bleuler, *Die Bank in Zürich*, p. 271.

[76] See Ritzmann, *Die Schweizer Banken*, p. 69 and Gygax, *Bank in St. Gallen*, p. 216 ff. The board of the *Bank in St. Gallen* organized a conference with the *kaufmännische Direktorium*, an important and powerful chamber of commerce in St. Gallen, and another credit bank to discuss measures. They decided to boycott the 'foreign' or 'wild' banknotes of the *Eidgenössische Bank*. In addition, the *Bank in St. Gallen* tried to convince the *kaufmännische Direktorium* to help publicly denounce the *Eidgenössische Bank* (see Gygax, ibid; p. 217, author translation): 'It would be appreciated if all money institutes would draw the public's attention to the danger of accepting banknotes that are not covered according to recognized principles, and that they would set a good example and declare that they will stop accepting these notes at their cash desks altogether'.

[77] Nyborg, *Wie Banknoten Bargeld wurden*, p. 158.

[78] Although there is some evidence that *Eidgenössische Bank* was indeed not particularly well run (Nyborg, *Wie Banknoten Bargeld wurden*, p. 127, suggests that the bank's Zurich branch was subject to a run after it misappropriated funds), the actions of the other banks were surely motivated by self-preservation and profit motives on the part of the incumbent banks, rather than an altruistic desire to protect the wider public.

[79] Baltensperger and Kugler, *Swiss Monetary History*, p. 36, and Ritzmann, *Die Schweizer Banken*, p. 94.

[80] Selgin and White, *The Evolution of a Free Banking System*.

rate dispersion. By requiring banks to accept all notes of banks of issue at par, the Banknote Act destroyed local networks and caused a step-change in market integration.

The second mechanism that we identify is conversion risk. Miron defines this as the risk that there is a run on the bank,[81] such that the bank must convert large quantities of notes to specie. Herger, based on Miron's work, shows theoretically that higher conversion risk leads to higher discount rates: that is, when banks perceive the risk of a run has increased, they increase discount rates to increase the ratio of reserves to notes in circulation.[82] If there is variation of (perceived) conversion risk between banks, which seems quite likely since banks were not uniformly regulated and since conversion risk depends also on public perceptions of their financial soundness, this will lead to discount rate dispersion.[83]

Conversion risk is difficult to measure. Although we know today that banks almost always converted their own notes, the mere perceived ex ante risk that this may not be the case for some banks suffices to lead to discount rate dispersion. For our argument to hold, it suffices that the risk materializes only rarely. One such example was the *Geldcrisis* during the Franco-Prussian War (see section III). Another example was the *Banque Général Suisse*, which experienced a run in which 75 per cent of banknotes were converted in only 24 hours.[84] As a consequence, this bank stopped issuing banknotes.

In addition, we require that conversion risk varied between banks. We collected data to compute the cover ratio for the banks in our sample in 5-year intervals. This is, of course, an imperfect measure for conversion risk: a high cover ratio may reassure the public conversion risk is low, but also, it may reflect that the bank cannot issue many banknotes because the public perceives the conversion risk to be high. However, we interpret differences in the cover ratio as evidence that there were differences in conversion risk, whether actual or perceived. We find relevant differences across different banks and episodes. In 1880, before the Banknote Act, the cover ratio ranged from 36 per cent to 109 per cent. The differences were even more pronounced before that.[85] With the introduction of the Banknote Act, the cover ratios converged to between 45 per cent and 65 per cent in 1885 and remained in this range until 1895 (see figure C2 in appendix C). Although we cannot empirically disentangle the relative importance of capital, liquidity, and transparency legislation, it is likely that financial stability regulation was at least partly responsible to make the financial system safer, and therefore, reduce the (perceived) differences in conversion risk and cover ratios.

A second type of conversion risk was also relevant. Even though some banks made official accords, they rarely agreed to convert notes of a wide range of banks at par and there are examples of outright refusal of conversion of banknotes from other banks (see appendix A). The *Bank in St. Gallen* refused to convert notes of the *Eidgenössische Bank* in August 1865, and generally of 'foreign' and 'wild' notes in 1873.[86] The *Bank in Zürich* suspended its accords with other banks in July 1870. The *Eidgenössische Bank* suspended convertibility of notes of other banks in Febru-

[81] Miron, *Financial Panics*.

[82] Herger, *Unregulated and regulated free banking*.

[83] Similarly, Xu and Yang, *Real Effects of Supplying Safe Private Money*, argue that default risk of privately issued money, creating transaction frictions, hampered economic development during the US free-banking era.

[84] See Ritzmann, *Die Schweizer Banken*, p. 62.

[85] Basel had a higher cover ratio than most other banks. The Bank in Zürich increased its cover ratio to 173% during the Franco-Prussian War, whilst it stayed at 79% in St. Gallen, for example. Before the Banknote Act, the BEKB and BCV had a lower cover ratio than the Bank in Basel and Bank in Zürich, perhaps reflecting the fact that they were cantonal banks.

[86] Those were notes emitted by smaller institutes from other cantons, in particular, of the *Eidgenössische Bank*.

ary 1870. As a result, even in periods where there was no threat to the stability of one or more banks, there was always the risk that a 'foreign' note was not convertible at a specific bank and the market was naturally segmented and lacking in integration. This problem was well known to contemporaries. After the rejection of the first draft of the Banknote Act in 1876, a commentary in the NZZ[87] reads (author translation):

Of more than a dozen banks, whose soundness is difficult to assess from afar, and who are completely unknown to the public, a wide variety of notes circulate. Those notes, that can be obtained for example in Fribourg, can be used in St. Gallen only with difficulty or not at all. This leads to a situation resembling the former imbroglio of the cantonal coinage systems [before the introduction of the Swiss franc], and the important properties of the banknote, creditworthiness and ability to circulate, suffer.

The Banknote Act reduced differences in both types of conversion risk through three channels. The first is the same channel through which it increased the risk of over-issuance of banknotes: by requiring all banks to accept notes at par, the Act spread some of the risk of instability in a single bank across the entire banking system. Customers then had less incentive to monitor banks' balance sheets since they knew they could redeem their notes at any bank should the need arise. Thus, there was less risk that there will be a run on an individual bank, as there was less risk that a customer would be unable to convert a note issued by an individual bank.

The second channel is related to the first: by making all bank notes essentially the same, even in periods without financial stress, noteholders could use the notes of any bank to avail of arbitrage opportunities anywhere in the system.

The third channel was through the imposition of uniform financial stability regulation on the banks. This reduced conversion risk directly by reducing uncertainty about the stability of individual banks.[88] The overall effect of the Banknote Act should therefore be to reduce and equalize conversion risk across banks, reducing discount rate dispersion.[89]

V | HOW IMPORTANT WERE LOCAL MONOPOLIES AND CONVERSION RISK?

Quantifying the importance of local monopolies and conversion risk in discount rate dispersion is difficult. To get some sense of the effect, we searched for another country that could act as a counterfactual. Specifically, we need a country that:

a. Unlike Switzerland, did not experience banknote competition,
b. Unlike Switzerland, did not experience heterogeneous conversion risk,
c. Like Switzerland, did have non-centralized discount rate setting.

[87] 'Das neue Banknotengesetz' in *NZZ*, 12 April 1876.

[88] Specifically, note-issuing banks were required to back 40% of their notes issued by precious metal, to hold equity capital equal to at least 50% of the notes they issued, and regular (weekly, monthly) reporting duties were imposed on the banks (Baltensperger and Kugler, *Swiss Monetary History*).

[89] Indirectly, this is evidenced in fig. C2 in app. C, showing not only that cover ratios became more similar after the Banknote Act, but also, fell on average. One interpretation of this evolution is that higher trust in the banking system overall required a smaller cover ratio to issue a certain amount of banknotes.

Having (a) and (b) allows us to get a sense of the effect of these factors on discount rate dispersion in Switzerland compared with the other country in the period before 1881. Controlling for point (c) is crucial, as countries with centralized interest rate setting do not display any discount rate dispersion by definition and are therefore simply not comparable.

On the basis of these criteria, we believe that Norway is a good counterfactual. As noted by Klovland and Øksendal, Norway was unique at this time in having a note-issuing monopoly and a high degree of autonomy granted to branches.[90] During the period, branches of the Norwegian central bank, Norges Bank, were located across the country. They had discretion in setting discount rates but distributed identical notes in every location.[91] As a result, there was little to no conversion risk in Norway. Moreover, there was no incentive to protect local networks since note issuers were all branches of the Norges Bank. Indeed, Klovland and Øksendal suggest that discount rate dispersion in Norway can be traced back mostly to limits to arbitrage, that is, differences in riskless interest rates arising from transportation and information costs. Thus, Norway meets all three criteria.

Of course, in a perfect world, we would also like the broader economic and monetary arrangements in Norway and Switzerland to be identical. Whilst that is not possible, both were small, open economies where various regions were active in quite different economic sectors and export industries.[92] Their monetary systems were similar in the sense that Norway adopted a silver standard in 1842 (Switzerland in 1852, soon to be turned to a bimetallic standard) and turned to the gold standard in 1874 (Switzerland – de facto, although never officially during the 1870s – similar to France and other members of the Latin Monetary Union). At the same time, the political centralization in the two countries is different: Swiss cantons had a high degree of autonomy which was not matched by Norwegian fylker. Nonetheless, we believe that the two countries are similar enough to provide some useful insights.

Comparing discount rate dispersion between our six Swiss cities and the six most important branches of the Norges Bank, it is evident that the dispersion in Norway was on average lower before 1881 (see figure 5).[93] The difference was especially large before the introduction of the Swiss franc in 1852, suggesting that the common Swiss currency contributed to financial integration as well, but it subsequently gradually declined. Nonetheless, with a few temporary exceptions, the difference remained positive until the early 1880s. It then declined sharply around the time

[90] Klovland and Øksendal, *The decentralized central bank*. Indeed, we ruled out several other countries, primarily because they did not meet (c), the requirement to have decentralized discount rate setting. For instance, whilst having branch networks, the Banque de France, Bank of England, Bank of Japan, and Austrian-Hungarian Bank set rates directly or maintained control to varying extents over their branch networks. In Sweden, the Enskilda banks – private note-issuers – were required to hold reserves at the Riksbank ensuring that they were responsive to changes in the official rate. See Klovland and Øksendal, *The decentralized central bank*, for a discussion of how independent branches were in these countries. In Belgium, a fellow member of the Latin Monetary Union and perhaps a natural comparator for Switzerland, discount rates at branches or agencies of the National Bank of Belgium (NBB) were set centrally by the NBB's general council (see Conant, *The National Bank of Belgium*, p. 116 for a discussion).

[91] Klovland and Øksendal, *The decentralized central bank*.

[92] See, for instance, Saul, *The Economic Development of Small Nations*, for a discussion of Norway, Switzerland, and other small European nations in the 19th century.

[93] Since the Norwegian data are end-month values, we also use end-month data for Switzerland. The six Norwegian cities that we use are: Bergen, Christiania, Christianssand, Drammen, Skien, and Trondhjem. Data for all of these cities are available from 1846 to the end of 1892.

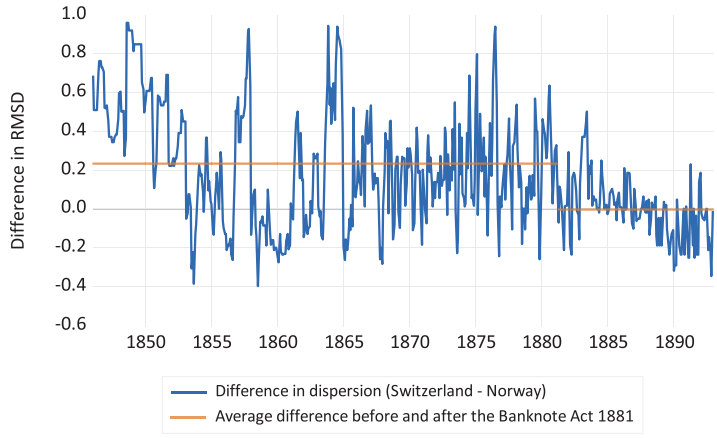

FIGURE 5 Difference in monthly discount rate dispersion, as measured by RMSDs, Switzerland and Norway, 1846–93. *Notes*: Calculated as the RMSD for Switzerland minus the RMSD for Norway. End-of-month values for both countries. Following Klovland and Øksendal (2017), for Norway we exclude small branches. *Source*: Norwegian data from Eitrheim and Klovland (2007). Swiss data as per app. B.

the Banknote Act was introduced in the early 1880s. Afterward, the difference was low, or even negative, until the end of our sample.[94]

Overall, the Norwegian counterfactual provides suggestive evidence that the combination of conversion risk and local monopolies in Switzerland added markedly to the dispersion of discount rates in the period of unfettered free banking. By the 1880s, Norway still experienced segmented markets due to transport and information costs whilst the Banknote Act reduced or removed dispersion arising from differences in conversion risk and local monopolies in Switzerland. As a result, it seems reasonable that the dispersion is lower (and integration higher) in Switzerland than in Norway by the end of the sample.

VI | CONCLUSIONS

In this article we considered the role of payments infrastructure in developing money market integration in Switzerland during the era of free banking. In particular, we asked whether private markets alone could create the infrastructure necessary for money markets to integrate, or whether public intervention was needed to drive the necessary changes.

Using newly collected daily discount rate data for six Swiss cities to measure the integration of the Swiss market, we find that integration was not a gradual process but occurred as a step-change when the Banknote Act was passed in 1881. We attribute the failure to integrate during the unfettered free banking period to two structural issues which the private sector was not well placed to address. First, we argue that banks protected their local monopolies and formed cartels to ensure their banknote networks were protected. Second, free banking brought with it a relevant conversion risk, either within a given network or between different networks, which was heterogeneous across regions at any point in time. These factors were reflected in regional dis-

[94] Indeed, a Chow test rejects the null of no break in the average of the difference in dispersion in April 1881 (p-value = 0.00) (see Chow, *Tests of Equality* for test details).

count rate dispersion. The Banknote Act eliminated both problems, causing a rapid integration of the market.[95]

Overall, we find little evidence that, left to its own devices, the private sector alone would have generated an integrated money market. In light of the increasing popularity of new forms of private money, particularly stable coins, we believe that this is an important finding that can inform the debate about the need (or lack thereof) to regulate these new forms of private money.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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[95] It remains an open question whether financial stability regulation, even without forcing banks to accept each other's banknotes at par, would have been sufficient to reduce discount rate dispersion. Unfortunately, we do not see a possibility to disentangle the two effects in our setup, as both measures were introduced at the same time.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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