The Coevolution of Money Markets and Monetary Policy, 1815-2008

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Abstract:
Money market structures shape monetary policy design, but the way central banks perform their operations also has an impact on the evolution of money markets. This is important, because microeconomic differences in the way the same macroeconomic policy is implemented may be non-neutral. In this paper, we take a panel approach in order to investigate both directions of causality. Thanks to three newly-collected datasets covering nine countries over two centuries, we ask (1) where, (2) how, and (3) with what results interaction between money markets and central banks has taken place. Our findings allow establishing a periodization singling out phases of convergence and divergence. They also suggest that exogenous factors – by changing both money market structures and monetary policy targets – may impact coevolution from both directions. This makes sensible theoretical treatment of the issue a particularly complex endeavor.

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"That in their activities and operations, the Federal Reserve banks influence and are influenced by developments in the money market is but the statement of a truism. Central banks must adapt their policies to the particular credit economy in which they operate, and these policies, in turn, influence and shape money market trends" (Beckhart 1932, p.3).

1. Motivation

Nowadays, central banks in developed countries not only pursue a similar macroeconomic policy – viz., slightly different versions of inflation targeting. They also implement this policy in a broadly similar way and by relying on one main instrument: a short-term uncollateralized interbank market rate, which is kept close to the target value by liquidity-providing or liquidity-absorbing repo operations. These operations – often labelled open market operations – are done against safe assets, most often sovereign debt, and on the central bank's own initiative. The standing facility or discount window, available at the discretion of commercial banks, on the other hand is more or less stigmatized and reserved for use in cases of emergency.

But implementation frameworks also differ in some important respects. This became suddenly evident when the financial crisis hit in 2007/2008. Beforehand, the Federal Reserve had operated exclusively with a handful of dealers in the market for Treasury debt, while the European Central Bank traditionally auctioned liquidity to hundreds of large and small universal banks and against a much broader set of collateral. Few people cared about these differences as long as financial markets redistributed central bank liquidity smoothly within the banking system. When the wholesale market froze, however, the Fed had to introduce a number of new lending programs, while (at least in the initial phase of the crisis) the E.C.B. managed to cope with the shock without changing its existing framework. Since then, changes in market functioning and new regulation (in particular, liquidity requirements under Basel III) have raised concerns that in the medium term, the pre-crisis operational frameworks might no longer work as before and would thus need to be adjusted.

This suggests that the microeconomic aspects of monetary policymaking – which macroeconomics and economic policy have long neglected as a merely technical issue – are worth much more attention than they are usually paid. If implementation frameworks differ significantly across countries today, a look back in time uncovers even more important dissimilarities. This raises the question of understanding why implementation frameworks actually look the way they do.

Unfortunately, not much is known about the characteristics of such frameworks in different geographical and chronological contexts. Clearly there is some interaction between the structure of money markets and the practice of monetary policy, but the question has been hardly investigated in a comprehensive manner so far. In order to address it, this paper takes a panel approach. The idea is to systematize our dispersed knowledge on the evolution of money markets and monetary policymaking, to identify regularities, and to propose hypotheses about the relation between the two.

To our knowledge, this research is innovative in at least two respects. On the one hand, we are the first ones to perform a comparative analysis (based on several newly-collected datasets) of the microeconomic aspects of monetary policymaking for a relatively large number of countries over a period of nearly two centuries. As our survey starts with the early 19th century, we are able to cover the entire history of still existing central banks for all of the countries included in our sample except for the Bank of England, which has a longer history still. On the other hand, we are the first ones to explicitly organize information in a framework of coevolution. Our idea is that there are mutually enforcing processes in the way money markets and monetary policymaking evolve over time: the way

the former work not only shapes, but is also shaped by the way the latter work. In our survey of historical evidence, we systematically collect information on both directions of causality.

Our work is at the crossroad of two independent strands of the economic and financial literature. On the one hand, there is the literature on the workings of money markets: it features a wealth of case studies focusing on specific markets in some given periods, but no panel analysis actually exists. On the other hand, there is the literature on monetary policy implementation: it features a number of interesting comparative analyses, but they either provide an only loosely connected collection of individual country portraits (e.g. Holbik 1973; Bank for International Settlements 1997), cover a short period of time (e.g. Kneeshaw and Van den Bergh 1989; Borio 1997) or a very limited number of countries (e.g. Goodhart *et al.* 1994; Bindseil 2004). As far as we know, works attempting to bring these two dimensions together are exceedingly scarce – one exception being Forssbæck and Oxelheim (2007), who cover a number of small European countries from 1980 to 2000. Our paper breaks new ground not only because it provides a panel analysis of a larger number of developed countries over a very long period, but also because it links these two strands of the literature in a systematic way throughout the analysis.

The remainder is organized as follows. Section 2 sketches a conceptual framework for approaching the question of the coevolution of money markets and monetary policy design. Section 3 constructs quantitative indicators to capture long-term trends and patterns, and presents three newly-collected historical datasets. Section 4 concludes.

2. The Coevolution of Money Markets and Monetary Policy: A Conceptual Framework

Coevolution is defined as the influence of closely associated objects on each other in their evolution: changes in A will trigger changes in B, which in turn will trigger changes in A – and so on and so forth, in a continuous loop. The medium- to long-run evolution of money market structures and monetary policy design is a clear case of such reciprocal influence. In what follows, we focus on the channels through which causality works in both directions. First, we ask how the way money markets are structured may impact the design of monetary policymaking. Then, we ask how the way monetary policy is designed may impact the structure of money markets. Finally, we present our approach with respect to this question.

2.1 From Money Markets to Central Banks

A central bank is generally defined as a banking institution whose liabilities (banknotes and deposits) play the role of ultimate medium of exchange (high-powered money) in a given geographical area. This privileged situation is granted to the central bank by its sitting at the center of a payments system. Such a privilege typically does not come without strings attached, as a central bank is often required to be the ultimate banker to the government. In view of this, a central bank's final objectives may be manifold. They may include: preventing disruptions in the payments system (by keeping an efficient financial infrastructure or implementing lending of last resort), protecting the real value of its liabilities (by maintaining convertibility, a foreign exchange target, or price stability), supporting government finance (by lending directly to the Treasury or keeping orderly conditions in the sovereign debt market), supporting some particular institutions or sectors considered as strategically important (by providing subsidized loans or preferential credit conditions), and ensuring profitability to shareholders (by farming seigniorage and other operating revenues).

In order to pursue these aims, a central bank typically interacts with the rest of the financial system through the interface of money markets. A money market is generally defined as the locus in which credit assets of short maturity (e.g. up to one year) are exchanged. Because of the particularly

short average maturity of a central bank's liabilities, money markets tend to be its preferred domain of operation. Yet many different money markets often coexist, and the central bank will not necessarily be active in all of them. The choice to participate or not in a particular market may depend on different orders of factors. First, it may be dictated by the nature of the central bank's final objectives (e.g. entering the sovereign debt market if political requirements imply so, or the foreign exchange market if a foreign exchange target is set). Second, it may be influenced by the fundamental properties of the underlying asset – viz., its *ex ante* liquidity (the existence of a sufficiently strong supply and demand) and inherent credit risk (the characteristics of debtors, the opportunity to create supervisory structures, the easiness to seize collateral). Third (and most important), it will be urged by the actual possibility for the central bank to produce significant and durable effects on the financial system – viz., the bank's capacity to effectively influence market prices and the market's ability to transmit impulses to the wider system and thus serve the bank so as to achieve its ultimate objectives.

Once the central bank has selected the money markets in which it will participate, it can proceed to organize its operations. The design of monetary operations depends on market characteristics at a twofold level. On the one hand, the bank may take either a passive or an active stance: it may leave initiative to provide (or withdraw) liquidity to its counterparties (as is the case with standing facilities) or, alternatively, take initiative on its own (as is the case with open market operations). On the other hand, according to the identity and features of market participants, the bank decides on the counterparties it wants to interact with. This selection may be relatively neutral (including all or most market participants) or alternatively non-neutral (possibly creating privileged positions for a small group of counterparties, selected according to some particular criteria). The way monetary policy is designed will, in turn, have an impact on the market characteristics on the basis of which it had been formulated.

2.2 From Central Banks to Money Markets

Once a central bank has chosen to enter a given money market, the latter will no longer look the same. Because of the monetary authority's involvement, in fact, crucial changes are bound to take place in the microstructure of the market and, consequently, in the behavior of prices.

In view of its faculty to create high-powered money out of nothing (albeit subject to some constraints), the central bank is not an actor in the money market as any other. In fact, the central bank's participation in a market inevitably enhances the liquidity of the market *ex post* – not only because it establishes a direct channel through which financial assets can be converted into cash, but also because it encourages further participation via network effects. Moreover, a central bank often has the firepower to become the market-maker of the money markets it participates in – thus modifying their microstructure very radically. The presence of a market-maker impeding complete dry-ups of demand (i.e. a lender of last resort) may provide a money market with a competitive advantage with respect to others; such "subsidization" can be so extreme as to allow for the creation of previously inexistent markets. Thanks to its power, a central bank may be able to impose modifications on the characteristics of market participants (e.g. by refusing to operate with some kinds of counterparties) as well as on the characteristics of the exchanged assets (e.g. by requiring standardization or quality enhancement).

By construction, changes in the microstructure of money markets have a direct impact on price behavior. The market-maker's willingness to buy unlimited amounts at a given bid price (i.e. the existence of a purchase or lending facility) sets a ceiling to market prices, while its willingness to sell unlimited amounts at a given ask price (i.e. the existence of a selling facility) sets a floor. Prices can also be impacted indirectly by a central bank's spot and forward buying and selling operations, and – even in the absence of transactions – by the simple creation of expectations. All of this will decrease

the volatility of prices, thus potentially reducing the amount of market risk associated with the given monetary asset.

The relationship between central bank intervention and market success is far from being univocal, though. The complexity of this relationship emerges when money markets with an active central bank are compared to markets without. On the one hand, it is possible that non-participated markets suffer from a relative decline in liquidity and popularity in front of participated ones because of the above-mentioned reasons. On the other hand, however, the central bank's market power over participated markets may open scope for some sort of "regulatory" arbitrage: in fact, it is also possible that non-participated markets become an ideal outlet for those unable or unwilling to abide with the central bank's requirements, as well as for those looking at price volatility as a positive thing (i.e., generating profit opportunities). As a result, central banks' endeavor to impact money market structure may backfire, as it may not necessarily translate into an increase in the efficacy of monetary policy itself.

2.3 Conceptual Issues: Sum-Up

The evolution of money markets and that of monetary policymaking are determined by both exogenous and endogenous factors. Money markets may evolve because of changes originating outside the financial system (e.g. increasing or decreasing demand or supply of a given asset as industrial or commercial practices develop). Some of these changes might be country-specific while others international. But money markets may also evolve because of modifications in the operational and regulatory policies adopted by central banks. In turn, monetary policymaking may evolve because of changes originating outside the financial system (e.g. increasing or decreasing importance attached to certain asset classes as political conditions develop), but also because of modifications in the characteristics of money markets. Assessing precisely the relative weight of exogenous and endogenous factors in triggering evolutionary trends is still an impossible task given the current state of our knowledge. In the light of this, we opt for a descriptive rather than an explanatory approach as a first step into this largely under-researched subject. In what follows, we try to mobilize as much as possible historical information. With the aim of identifying from hard data broad trends and empirical regularities, section 3 mainly presents quantitative evidence, complemented by qualitative information available from different types of sources. Our goal is to provide an as much as possible inclusive review of the coevolutionary trends that have emerged over the last two hundred years.

3. Quantitative Evidence

To develop a sense of how much the interaction between money markets and monetary policymaking has changed over time and to identify relevant criteria and indicators, it is convenient to start from an obvious but telling example: a basic comparison of the monetary practices of the world's most important central bank today (viz. the Federal Reserve) with those of the world's most important central bank around one hundred years before (viz. the Bank of England).

Nowadays' Federal Reserve can be sketchily (albeit, under some respects, rather imperfectly) described as a central bank mainly operating *(a)* in the sovereign bond market *(b)* by implementing repos *(c)* on its own initiative *(d)* with a relatively small number of counterparties *(e)* while offering a more or less stigmatized standing facility exclusively as an emergency tool, and this *(f)* with the aim of targeting the uncollateralized interbank market interest rate *(g)* in order for the latter to basically coincide with the main policy rate – i.e., *(h)* much lower than the standing facility rate. One century ago, instead, the Bank of England could have been sketchily (but again, quite imperfectly) described as a central bank mainly operating *(a)* in the acceptance market *(b)* by discounting assets *(c)* on the

initiative of counterparties, through a standing facility *(d)* potentially open to a very large number of counterparties (including non-banks) and *(e)* not stigmatized, *(f)* with the aim of targeting the acceptance market interest rate *(g)* in order for the latter to fluctuate freely *(h)* below or close to the standing facility rate.

This rough "bird's eye" comparison suggests that the design of monetary policy implementation frameworks has been subjected to major changes over the decades. It also allows singling out three main dimensions along which interaction between money markets and central banks can be described: **(1)** The **location** of the interaction, i.e. what is the money market in which the central bank mainly intervene (sovereign debt market vs. acceptance market) *(a; f)*; **(2)** The **form** of the interaction, i.e. what is the type of financial operation the central bank mainly adopts for intervention (collateralized vs. uncollateralized, repos vs. discounts) *(a; b)*; and **(3)** The **substance** of the interaction, which has several aspects – what are the counterparties to the central bank *(d)*, who takes the initiative in monetary policy operations *(c)*, what are the limits to operations (quantitative restrictions or stigma) *(e)* – which altogether determine the relative position of official bank rates and market rates *(g; h)*. The three dimensions concern both directions of causation in coevolutionary patterns: what they all tell about is always the "reduced-form" outcome of the interaction between central bank preferences and choices, market structures and functioning, and fundamental factors affecting both. This does not in itself allow deducing the underlying supply and demand factors. Still, combined with assumptions and additional information on exogenous factors impacting market development and central bank preferences, it allows getting an idea on causation within the coevolution framework.

All three dimensions lend themselves to quantitative characterization. In order to be useful, quantitative indicators should not only be representative of coevolutionary trends and patterns. They should abstract from institutional details, yet reflect the economic logic underlying monetary intervention and market functioning – thus allowing for reasonable comparisons over time and space. Fortunately, available data allow constructing indicators abiding by these criteria: **(1)** Monetary authorities' main domain of intervention can be assessed by looking at the relative share of each money market instrument within their holdings – i.e., through an analysis of the composition of the asset side of central banks' balance sheets (a *stock variable*); **(2)** The forms of the relationship between markets and banks can be assessed by looking at the type of instruments most often used by the central bank – i.e., through an analysis of the turnover in central banks' operations (a *flow variable*); **(3)** The most substantial aspect of the relationship between markets and banks is price formation, which can be captured by comparing interest rates in the private market with official central bank rates – i.e., though an analysis of the spreads between interbank rates and standing facility rates (a *price variable*). In the end, the three indicators have to be interpreted together to yield a comprehensive picture of the bank-market relationship.

The next three subsections will address these three questions through a panel analysis of each indicator across time and space. The sample includes a number of big and small countries, situated either at the core of international monetary system or at its periphery. Although we make an effort to provide a reasonably representative overview, our selection criterion is inevitably heuristic. Reflecting long-lasting world financial equilibria, the countries in our sample are mostly located in North-Western Europe (Austria, Belgium, Britain, France, Germany, the Netherlands, Norway, and Switzerland), but we also include the United States. Besides the central banks still existing to date (Oesterreichische Nationalbank, Banque Nationale de Belgique, Bank of England, Banque de France, Deutsche Bundesbank, De Nederlandsche Bank, Norges Bank, Schweizerische Nationalbank, and the Federal Reserve), we also cover institutions that provided central banking functions in earlier times – such as the Second Bank of the United States, Belgium's Société Générale, and Germany's Königlich Hauptbank, Preußische Bank, Reichsbank, and Bank deutscher Länder.

3.1 The Location of Interaction: The Central Bank Balance Sheet

The balance sheet of the central bank reflects all its transactions and operations: the issuance of banknotes, purchase and sale of precious metals and foreign exchange, investments, as well as monetary policy operations proper. The composition of the central bank's assets is determined by its ultimate and intermediate objectives that can include stable exchange rates or the convertibility of its liabilities into some foreign asset, a particular level of short-term interest rates, the quantity of some central bank liability or wider monetary aggregates, support to the government, profitability (notably in the case of privately owned central banks), or the support to some selected sectors or institutions. The central bank will choose its investment assets and the type of operations in order to achieve its objectives. Key characteristics of the assets are risk, maturity, and liquidity; key characteristics of the markets and operations are the possibility to influence or set prices, as well as the importance of the selected asset/market for the broader financial and economic structure – so that policy impulses are transmitted predictably to other asset prices and the real economy in accordance with the objectives of the central bank.

An eternal concern for central banks is the liquidity of their investments. While such a concern might seem odd for the sole institution that can create liquidity at its will, the reasons relate to the way it has to pursue its monetary policy objectives. As long as central banks aimed to ensure the convertibility of their liquid liabilities (banknotes and deposits) into foreign assets (gold, silver, or foreign exchange) on demand, the bank's portfolio had to be sufficiently liquid to allow a quick reduction of the amount of outstanding liabilities to reduce the pressure on reserves whenever there was a drain on foreign assets. In the case of inconvertible fiat currencies there is no threat of a run on foreign reserves, yet the central bank has to be able to adjust the level of its liabilities in order to adjust liquidity conditions in line with its operational target (be it a short term interest rate, an exchange rate, or monetary aggregates). In this setting, the asset portfolio has again to be sufficiently liquid to allow a precise and timely adjustment of the liquidity position of the banking sector.

The use of balance sheet data for assessing central bankers' main domain of intervention does come with a number of caveats. Definitions are not uniform, as they reflect different realities: central bank balance sheets have always been drawn up in the absence of international standards and with accounting rules that vary substantially between countries and over time (Käppeli 1930; Bindseil 2004). Moreover, a high share of a particular instrument in the central bank's portfolio might not necessarily imply that this instrument is particularly important in money market management, but reflect other considerations such as the earning of returns, the subsidization of particular agents, or the transfer of resources to the government. A further complication is due to the fact that central bank reports typically distinguish according to operations, not underlying instruments – i.e. advances are not necessarily on securities but can be granted on the security of commercial bills, while discounts can apply to treasury bills and thus be completely unrelated to commercial bills based on private economic transactions. These constraints should be kept in mind when interpreting the following evidence. Despite these caveats, it is nonetheless fair to say that balance sheet data provide an illustrative representation of the broad lines along which interaction between money markets and central banks takes place.

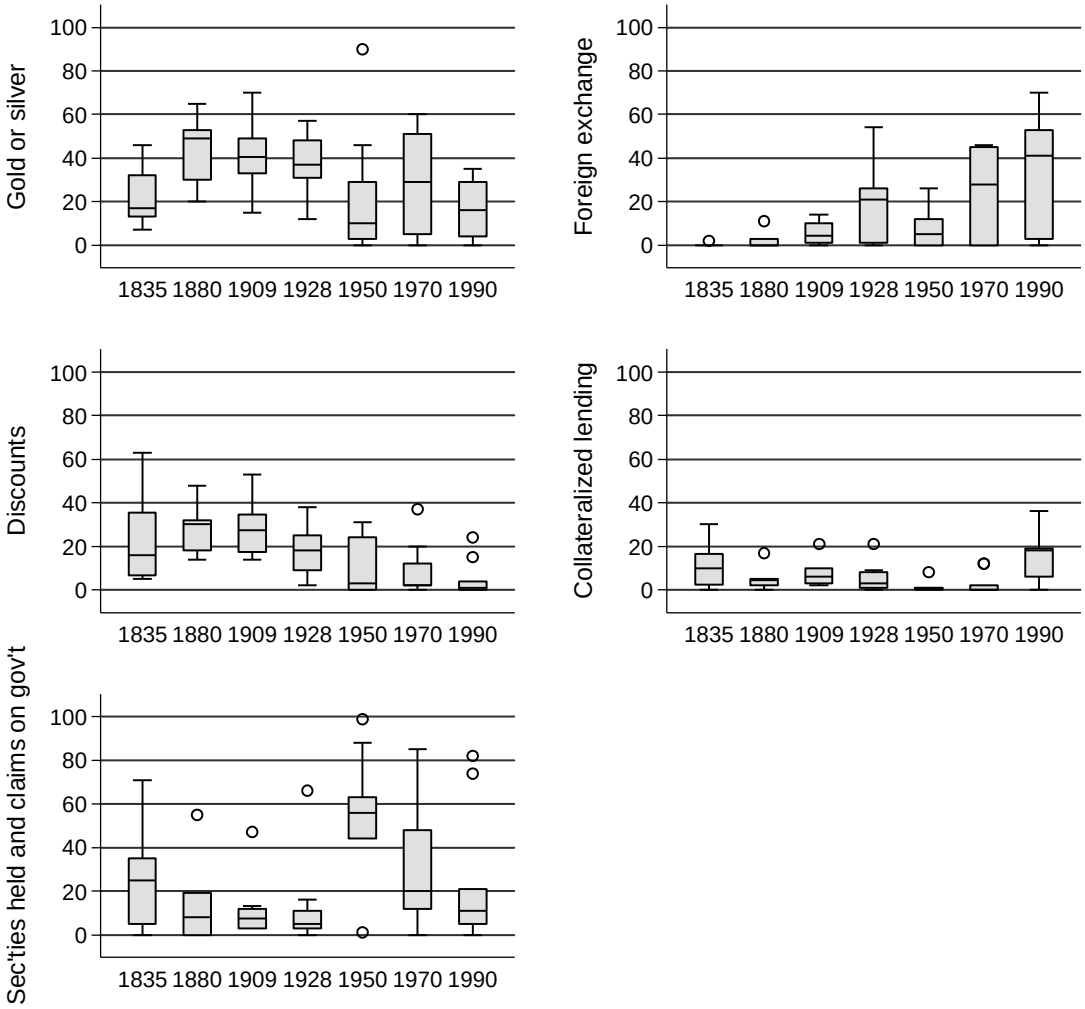
Table 1 gives the composition of the balance sheets of the central banks of the nine central banks in the sample for seven benchmark years (1835, 1880, 1909, 1928, 1950, 1970, and 1990). The benchmark dates were selected according to three criteria: i) being representative of the period; ii) being as much as possible unbiased by cyclical factors (i.e., avoiding boom and bust periods); and iii) being compatible with data availability. Assets are grouped into the following broad categories: foreign assets, which can be decomposed into precious metals (gold, silver) and other foreign assets (bills of exchange, deposits abroad, securities denominated in foreign currencies); monetary policy

operations as discounts, advances, and open market operations; and claims on the government, either as direct loans and overdrafts or holdings of government securities. In addition to these components, which are the most important from a monetary policy point of view, balance sheets also include other lending to the private sector (outside monetary policy operations) like mortgage loans, long-term lending to specific financial institutions, unspecified securities, and other assets including real estate, stakeholdings, etc.

Figure 1 summarizes the changes in the composition of central bank assets. The following trends emerge. In the 1830s, **foreign assets** consist exclusively of bullion. From a long perspective, all countries report in these years relatively low shares of reserves in total assets. As money market integration improves in the following decades, the share of foreign assets increases everywhere. At the beginning of the 20th century, foreign bills start to appear in all balance sheets except those of the Bank of England. While holdings are small in absolute terms, they represent an element that is more and more actively used for active exchange rate policy in Austria (Jobst 2009), Belgium (Ugolini 2012), France (Flandreau and Gallice 2005), and Germany (Bopp 1953). This reflects internationally integrated money markets that require central banks to manage the impact of short-term capital flows on domestic liquidity. In this context, foreign exchange markets are more liquid and have lower transaction costs than operations in precious metals. In the interwar years the share of foreign exchange increased further to the detriment of gold as foreign exchange serves more and more as reserve asset in addition to its role as intervention instrument (Eichengreen and Flandreau 2009): the only two exceptions are the anchors of the gold-exchange standard, the Fed and the Bank of England, which hold reserves in gold rather than foreign exchange. Total foreign reserves remain relatively high everywhere until the 1970s, when an increasing divergence becomes visible. Some of the divergence is due to different accounting practices (historical costs vs. market value) that began to matter with the end of Bretton Woods, yet today reserve holdings appear to be much more a function of country size and exchange rate regime, and thus of the need for regular operations in the foreign exchange market (Borio *et al*. 2008).

Domestic monetary operations (as opposed to operations in foreign assets) are long dominated by discounts and advances. The principal difference between the two is that discounting is unsecured, i.e. the central bank depends solely on the ability of the issuer to pay, while advances are secured, i.e. in addition to the borrower's ability to pay the central bank also disposes of a pledge that can be sold if the counterparty fails to do so (see section 3.2). In the first half of the 19th century advances can rival with discounts, but rapidly lose importance afterwards. Advances gain again in importance before World War One and during the Interwar years. After World War Two patterns appear more idiosyncratic. Open market operations, which in the graph are included alongside advances, only start to appear in the 1920s, the exception being the Bank of England that operated in exchequer bills and East India Company securities to adjust overall liquidity conditions as early as the 1830s (Wood 1939) and then in the 1890s to absorb liquidity (Sayers 1936). The classification here follows official statements given by central banks. In practice, the distinction between advances, open market operations and security holdings becomes blurry after the 1950s and would require a closer reading of national documentation: in the case of the Fed and the Bank of England, for instance, open market operations appear under the heading "lending to the government" as well as under "other securities". What appears already, however, is that the extensive use of open market operations depended very much on the size and liquidity of underlying markets and thus only appears when financial markets are liberalized and earlier in larger countries, while smaller countries stick longer with traditional discount and/or advance operations (Borio 1997; Kneeshaw and Van den Bergh 1989).

Figure 1: Composition of central bank assets (selected dates)



Source: Authors' database. For the countries included at the various dates, see table 1.

Note: Each central bank is one observation. For individual country data see table 1. Boxes cover observations between the first and third quartile (inside line being the median), whiskers cover the remaining observations except outside values. Outside values (smaller/larger than the first/third quartile less/plus 1.5 times the interquartile range) are plotted individually.

Claims on the government appear mainly driven by geopolitical factors. Central banks came out of Napoleonic Wars with significant holdings of government debt, which were very slowly reduced over the whole 19th century. Remarkably, no major impact of World War One is visible in 1928 (except for Britain), as very large holdings accumulated during the conflict had already been inflated away by then (especially in Austria and Germany). By contrast, the impact of World War Two appears much more persistent everywhere. Today, the central banks with relatively large government debt portfolios are those holding relatively few foreign assets (Federal Reserve, Bank of England). It should be noted that this category covers a wide range of operations with very different implications for money markets and monetary policy. On the one hand, central banks have often been obliged to hold government debt as compensation for the note-issuing privilege. Typically these loans were remunerated below market interest rate in order to transfer seigniorage revenue to the Treasury before the introduction of explicit profit sharing arrangements. This was the case e.g. in Austria, Britain, and France. As these loans were long-term, they did not imply any particular involvement of the central

bank in sovereign debt markets. On the other hand, though, sovereign debt has also typically served as collateral or investment asset in monetary policy operations. In this case, the main focus is on changing liquidity conditions in the money market, not on influencing the interest expenses of the government in particular. As a result, large holdings after wars might reflect not only past monetization of government deficits, but also the increased breadth and liquidity of the government debt market. Additionally, holdings of government debt can also serve to satisfy the structural demand for banknotes and central bank deposits. Purchases of long-term government debt have the advantage to be low-risk and avoid the costs of lending operations (which have to be frequently renewed). For instance, before 2007 the Federal Reserve provided about two-thirds of required liquidity against long-term Treasury bonds. In the Euro area much of the structural liquidity demand is catered for through the investment portfolios of the national central banks, again reducing the need for regular liquidity-providing repos. The same is probably true of the securities held by the Bank of England for most of its history (Wood 1939). A positive impact on government finance will however result indirectly from the ensuing increased liquidity of government debt. Nowadays central banks typically try to isolate these structural operations from monetary policy and calibrate purchases so that they do not change asset prices or the yield curve (Board of Governors 2005). Lastly, central banks can operate in the sovereign debt market to influence interest rates more broadly. This is the logic behind the Fed's post-2009 Large Scale Asset Purchase (LSAP) programs, that aimed for a general reduction of longer-term market rates rather the interest rate on sovereign debt alone (Borio and Disyatat 2010). **Other items** are most of the time small and patterns not systematic.

To sum up, our analysis of balance sheet data allows singling out a number of trends in the evolution of the channels through which interaction between money markets and central banks takes place. (i) Foreign exchange markets initially played a relatively small role everywhere, but their importance increased substantially as long as international market integration developed – country size being a fundamental determinant of central bank involvement into this market. As far as domestic markets are concerned, (ii) sovereign debt markets played a varying role across time and space which was mainly driven by the impact of geopolitical factors on market size, while private debt markets experienced a secular decline: (iii) the discount market peaked in the second half of the 19th century and then contracted throughout all of the 20th century to almost disappear, while (iv) the collateralized loan market contracted during the 19th century, partially revived in the first half of the 20th century, almost disappeared after World War Two, and made some comeback in recent decades only. Interestingly, the central banks of large countries appear to have resorted to domestic collateralized lending earlier and more often than those of smaller ones, while the opposite is true for foreign reserves – probably reflecting an international specialization of money markets.

3.2 The Form of Interaction: Uncollateralized vs. Collateralized Lending

Section 3.1 has brought to light a changing importance of uncollateralized vs. collateralized lending by monetary authorities. The two techniques of intervention can be associated to two different conceptions of liquidity, corresponding respectively to today's definitions of *liability-side (funding) liquidity* and *asset-side (market) liquidity* (Holmström and Tirole 2010). In some scholars' view, these two conceptions of liquidity are but the two sides of the same coin (see e.g. Brunnermeier and Pedersen 2009): but this applies if liability-side liquidity can only be obtained through collateralized loans, access to which is proportional to capital. This is not necessarily always the case, though: when uncollateralized transactions are easily available, funding and market liquidity are not bound to behave accordingly. The reason is that the role of capital as a transmission channel between the two (Brunnermeier and Pedersen 2009) may not be at work: as a matter of fact, access to uncollateralized operations may not be proportional to capital but involve other kinds of (moral) guarantee (Ghatak and

Guinnane 1999). This suggests that the two conceptions do not perfectly coincide, and that the fact that central banks chiefly provide the one or the other type of liquidity may have important consequences on the overall behavior of the financial system.

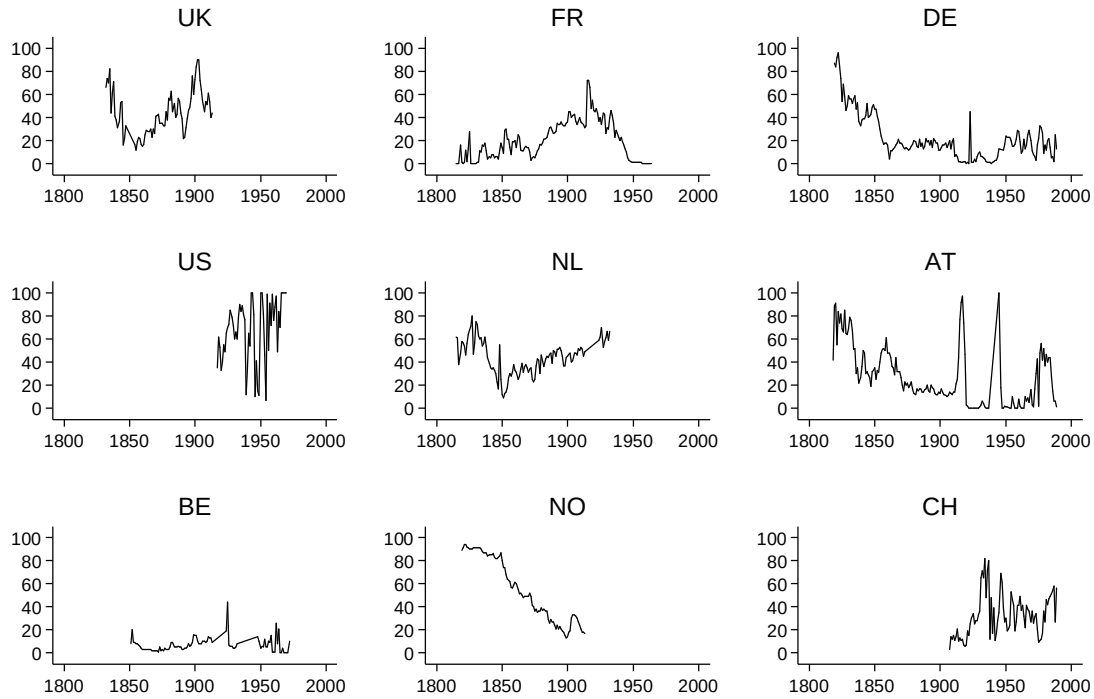
Resort to the one or the other form of intervention may be dictated to central bankers by market characteristics. As stated above (sections 2.1 and 3.1), central banks have to keep liquid assets, and *ex-ante* liquidity is a determinant of the choice of the money market in which they intervene. Yet each money market only features one possible operation: by definition, only uncollateralized lending is possible on the discount market, while only collateralized lending is possible on the repo market. As a result, the forms assumed by the market-bank interaction may depend on preexisting structural factors.

However, the extent to which central bankers embark into the one or the other technique of intervention may also be dictated by their own preferences. The latter appear to have changed considerably over time according to evolving institutional environments. Commentators unanimously report that discounting of uncollateralized (but jointly-guaranteed) bills of exchange was clearly preferred in the 19th century. For instance, Niebuhr (1854) argues that bills of exchange were always paid on time, while advances on securities and goods were most difficult to diminish in critical times as borrowers faced declining prices of their collateral assets. In a variation of this argument, Wagner (1873) maintains that continuous backflows from bills falling due could facilitate the granting of new loans to new counterparties, which was useful whenever money markets were not working perfectly. Mecenseffý (1896) and Reichsbank (1910) similarly argue that the central bank might have been forced to prolong advances or face difficulties selling the collateral in the very moment when the liquidity of its portfolio becomes more important due to a crisis. Bills were considered to be "self-liquidating", a widespread notion in 19th century banking (Plumptre 1947). The same concern about liquidity can also explain the preference of many central banks for real bills over finance bills, as finance bills with their need to be rolled over at maturity rather resemble advances on securities in moments of financial stress. An additional argument in favor of discounting was the possibility for the central bank to derive information on economic activity from the bills submitted to discount (Reichsbank 1910; Roulleau 1914). Central banks were in fact big players in the market. As a consequence, the argument of liquidity primed over concerns about credit risk, which in principle should be lower for a secured than an unsecured loan all else being equal. Additional evidence for a preference for bills is also provided by the active policies by some central banks to increase the pool of eligible bills by opening branch offices, lowering the minimum nominal amount of eligible bills as well as by reducing the number of signatures required on a bill (most central banks changed from three to two signatures over the course of the 19th century).

Central bankers' attitude seems to have changed following World War One. This prompted a rethinking of the concept of liquidity, which became closer to the modern one – according to which asset- and liability-side liquidity are but the two sides of the same coin (Plumptre 1947; Brunnermeier and Pedersen 2009). Consequently, most central banks started to care less about the relative weight of discounts vs. advances. The long-running opposition of outright purchases vs. secured lending focuses today not on the maturity of outright holdings (i.e., their being "self-liquidating") but the possibility to sell them in the market if need be (i.e., their "shiftability"): the *ex-ante* liquidity of the markets for those assets potentially used in monetary policy operations is thus a crucial input for the design of open market operations (Borio 1997). While some central banks (notably, the Fed) keep lending operations to a minimum and operate mostly through outright purchases, others (like the Eurosystem) rely mainly on secured lending. Outright purchases expose the central bank fully to credit risk, thus severely limiting the spectrum of assets that qualify for eligibility. The main argument in favor of secured loans is that they can be done on a much broader set of assets without requiring the central bank to analyze credit risk, as the prime responsibility for repayment remains with the counterparty

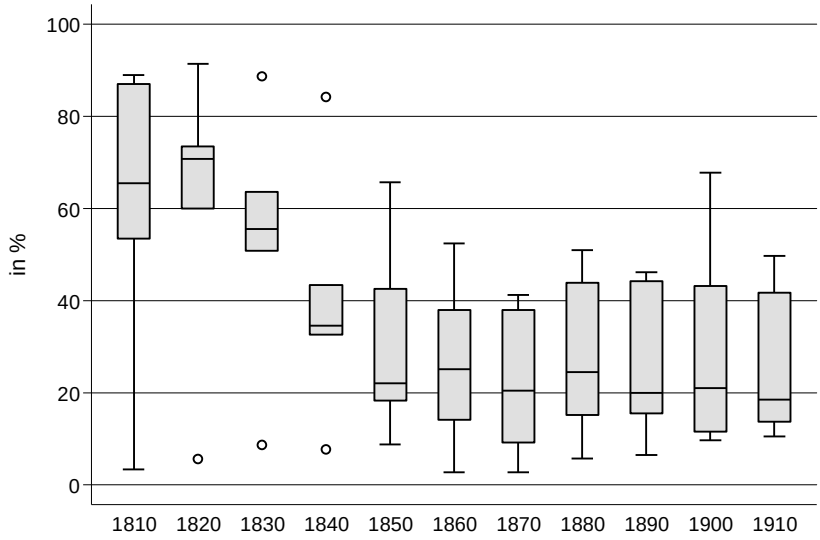
and risk control measures can be limited to keeping a sufficient margin on the collateral. Outright purchases, on the other hand, can be more long-term. This is an advantage insofar as the central bank can reduce the size of operations, reducing operational costs and risks. An additional argument is that long-term outright purchases allow the central bank to earn a term premium. In the end, the relative preferences of central banks seem again related to the structure of the financial system they are operating in. Outright operations in a narrow range of assets require the existence of a sufficient amount of eligible assets, as well as of developed and integrated money markets that can smoothly redistribute central bank liquidity within the banking system and financial markets more broadly. Secured lending operations, on the other hand, give potentially more counterparts direct access to the central bank using a potentially broader and diverse set of assets as collateral (Bindseil and Papadia 2009). This might be more necessary in less well integrated financial systems or if a deep and sufficiently large market in potential assets for outright holdings is lacking.

Figure 2: Share of advances in domestic lending



Source: Authors' database.

Figure 3: Share of advances in domestic lending, averages per decade



Source: Authors' database.

Note: For individual country data, see table 2.

Figure 2 gives continuous series for the share of advances in total domestic lending between 1815 and 1914. Numbers refer to average or end-of-year holdings. As unlike outright holdings of securities, discounts and advances were however by statutory rules short-term, with a maturity of typically three months or lower, the levels give an approximation of turnover and thus the importance of the two instruments in policy operations. Figure 3 synthesizes available information on all countries by providing averages per decade. This we do only until World War One, as data availability becomes exceedingly scarce for the following period.

Unlike what was to be expected from contemporary preferences, the discounting of bills does not always dominate. Instead, two patterns stand out: First, with the exception of the Banque de France, advances dominated domestic lending in all central banks at the beginning of the 19th century. Discounts then increased everywhere at the expense of advances until the 1850s. For the second half of the 19th century two groups of countries can be distinguished. In the Netherlands and Britain the share of advances recovers gradually, if not to the levels seen at the beginning of the 19th century. In France advances increase notably after the 1880s. In Belgium, Germany, and Austria on the other hand advances remain stable at low levels between 10% and 20% of total lending. If the preference for bills was in fact constant over the 19th century, the increase in bill holdings must have reflected a better availability of bills towards the mid of the century. Ziegler (1993) makes this argument for Prussia, where the integration of the Prussian market and the growing importance of trade increased the availability of eligible bills. While the Königliche Hauptbank relied to a large extent on holdings of long-term securities and advances, the statutes of the Preußische Bank (which succeeded the Königliche Hauptbank in 1847) could in a first step limit the share of advances in the cover of the fiduciary note issue to one sixth, and exclude them after 1856 altogether (Ziegler 1993). From the late 1850s onwards the share of advances in domestic lending of the Preußische Bank, later the Reichsbank, fluctuated between a low 10 and 20%. After 1880 the Reichsbank, concerned about what they considered a misuse of advances around stock-exchange settlement dates, actively discouraged resort to them by increasing the minimum maturity of loans, thus increasing the effective interest rate on very short term loans (Reichsbank 1910). A similar desire to reduce advances in the lending portfolio was voiced by representatives of the Oesterreichische Nationalbank (Mecenseffý 1896). In other countries like Britain, France, and the Netherlands advances kept a more important role in

monetary policy implementation. Bank of England directors seem to have had fewer concerns about liquidity, frequently fixing the rate for temporary advances below discount rate in the 1830s and 1840s (Wood 1939). In the Netherlands the spread between the interest rate on advances and discounts was most of the time zero after the 1860s (De Jong 1967). The opposite was the case in France, where this spread apparently increased in the 1860s (Bopp 1952). The difference between Germany and Austria on the one hand, and notably Britain and the Netherlands on the other, might reflect differences in the liquidity of security markets. However, Berlin also hosted a highly developed market for stock exchange loans that was well integrated with the unsecured money market (Prion 1907), thereby limiting the differences between discounts and advances from the point of view of the central bank. A further factor driving the differences between the resort to the discount and advance facilities could be preferences by the counterparties. In addition to the availability of eligible assets for individual counterparties (in particular non-banks probably have more bills available than securities), the main difference between discounts and advances from the point of view of the counterparties is the maturity of the loan. In the case of discounts the maturity is determined by the residual maturity of the bill submitted for rediscount, in the case of advances maturity can be set flexibly. This is an advantage, in particular in well-defined periods of temporarily high liquidity demand e.g. at the end of year or quarter (De Kock 1954). A higher share of advances might thus also have reflected differences in the structural liquidity deficit and differences in the amplitudes in liquidity demand.

Faced with temporary needs for accommodation during World War One, central banks adjusted operational procedures that tended to stay in place after the war – notably the eligibility of Treasury bills to rediscount operations. Commercial banks adopted Treasury bills as secondary reserves and consequently advances against government securities and rediscounts of Treasury bills became more attractive compared to the classical rediscount of bills of exchange (De Kock 1954). As a result, the traditional link between discounting and the bill market on the one hand, and advances and the market for long-term securities on the other hand, became more blurry – which actually complicates the interpretation of reported figures. Most central banks started to care less about the relative weight of discounts vs. advances. If restrictions persisted on advances in some countries (Germany and Austria), these can be linked to restrictions over indirect budgetary financing through advances on government debt rather than to the liquidity of the instrument and are thus unrelated to the money market. The newly created Fed applied the same rate for advances and rediscounts. The trend towards indifference between advances and discounts got even stronger after World War Two, when some central banks started to report advances and discounts lumped together – as the Bank of England had always done since 1844.

The share of discounts and advances varied widely after World War Two. These differences appeared now due less to a preference of the central bank but rather the availability of bills in the different countries. Where banking systems relied more on trade bills (notably Belgium, France, and Germany), discounts feature more prominently in the central bank balance sheet, while their role is negligible in the Netherlands and Britain. As bills related to specific transactions, they lent themselves also easier to credit allocation. Preferential rates for discounts of certain classes of bills in Belgium, France, and Germany can be read in this context (C.E.E. 1962). By 1990, discounts had disappeared from central bank balance sheets in all countries (see above, figure 1).

To sum up, our analysis of central banks' lending operations allowed identifying trends in the evolution of the forms assumed by the bank-market interaction. Not surprisingly, patterns mostly coincide with developments observed through the study of central bank balance sheets (section 3.1). Collateralized lending was most prominent in the first half of the 19th century, when discounting was relatively weak and holdings of government debt important: the two phenomena were linked, as government bonds used to be the most common collateral for secured lending operations. Collateralized lending started to increase again before World War One, and became predominant

along the 20th century. In the meantime, the nature of central banks' collateralized loans changed, as it shifted from secured standing facility lending (advances) to secured open market operations (repos). However, significant deviations from this general trend can be recorded. For instance, unlike in all other countries, in France and Belgium collateralized lending played a marginal role for much of the 19th century. Such deviations may have been the outcome of political factors (Ramon 1929; Ugolini 2012).

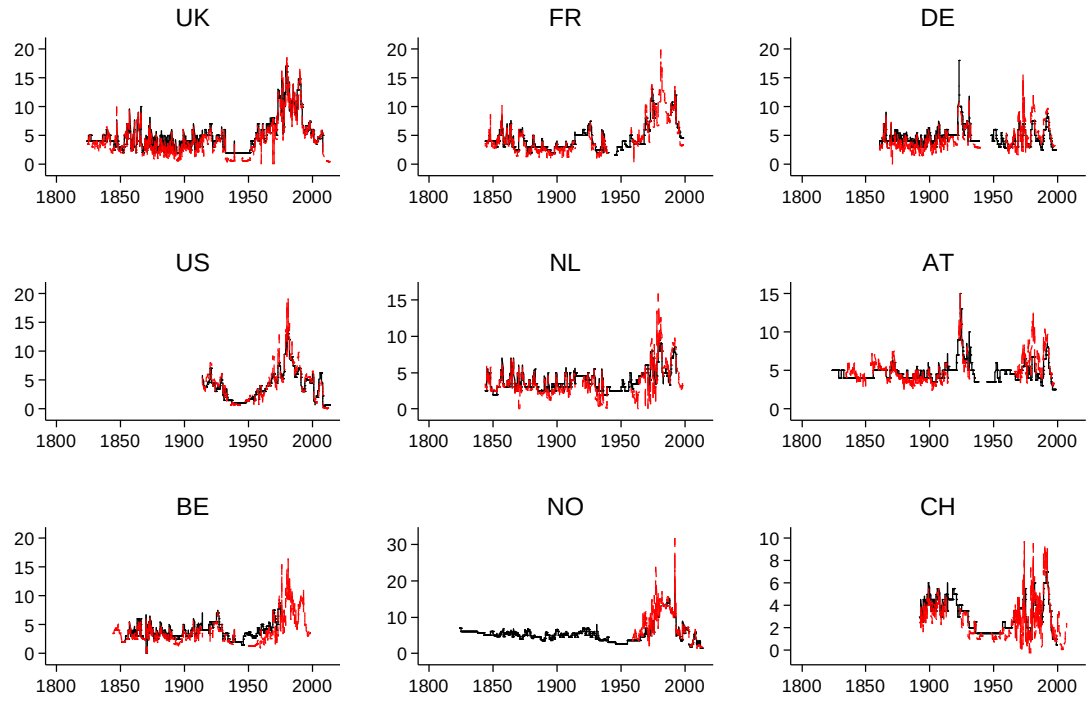
3.3 The Substance of Interaction: Market vs. Bank Interest Rates

As seen in section 3.2, discounting and the provision of loans on collateral were the oldest types of monetary policy operations. Both were most often organized as a standing facility, meaning that eligible counterparts of the central bank could use them at their own discretion at any time, while the central bank fixed the general conditions for use. One of the most important parameters to be set by the central bank is the price of liquidity, either expressed as a discount rate (in the case of the purchase of short-term securities) or an interest rate (in the case of collateralized loans). For long periods central banks used to publicly quote a discount rate or "bank rate" that also served as the main indicator for the stance of monetary policy. In most countries this rate applied to the discount of eligible paper. Following its loss of importance in the late 20th century, some central banks (e.g. Deutsche Bundesbank and Schweizerische Nationalbank) abolished the discount rate in the 1990s. In other countries, the type of the underlying operation changed (in particular after World War Two) even if the old name survived: this was the case e.g. for the discount rate of the Federal Reserve, which had since the inception of the Fed been applied to discount and collateralized lending operations alike, and applies exclusively to secured loans since 2002.

A standing facility has a potentially significant impact on market interest rates. Its power derives from the fact that it provides an unlimited amount of liquidity at set conditions. It should be noted that this principal role is independent of whether the rate applies to discounting or advances. *De facto*, however, central banks set more or less restrictive conditions as to the use of the discount facility. These conditions concerned the definition of eligible paper, limits per counterpart, 'moral' restrictions in the sense that counterparts were advised to use the discount facility only to some limited extent, as well as administrative procedures that would add costs to the use of the facility. In addition, most central banks made clear that they could, in principle, always refuse to discount or provide advances without giving reasons (Bindseil 2004). The effective role of standing facilities and thus of the published discount or bank rate crucially depends on these rules and procedures. Changes in the rules repeatedly altered the relationship between official rate and market rates. A proper understanding of bank rate would thus require detailed knowledge about practices and how they evolved. An alternative approach is to look at the outcome – i.e., the observed relationship between the official discount rate and market interest rates as well the extent to which the facility was used in order to infer the rules and procedures applied. Market interest rates above the official discount rate are indicators for effective restrictions on the use of the facility. Evidence on the recourse gives indications as to whether the facility was used to satisfy structural or only occasional liquidity demand.

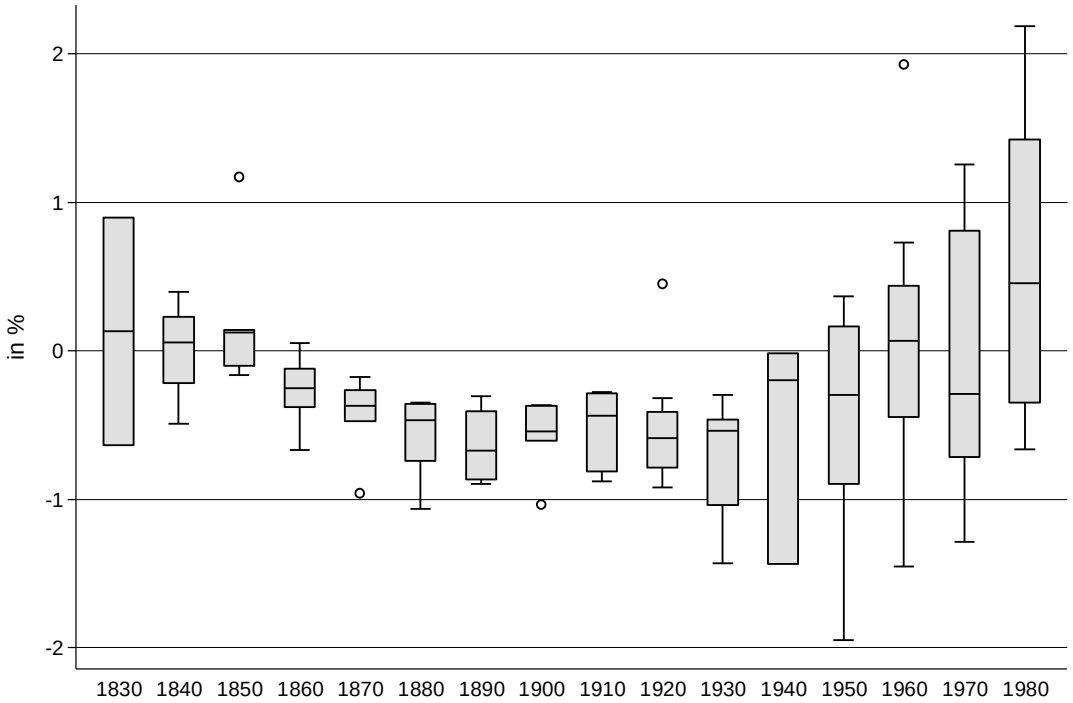
Figure 4 plots the official discount rates along with a representative market rate for the nine countries in our sample. Despite significant idiosyncrasies in the design of the standing facilities in the various countries, distinct periods stand out, as becomes evident when looking at average spreads between official and market rates (figure 5) and the number of instances when market rates rose above standing facility rates (figure 6).

Figure 4: Market (in red) and standing facility interest rates (in black)



Source: Authors' database.

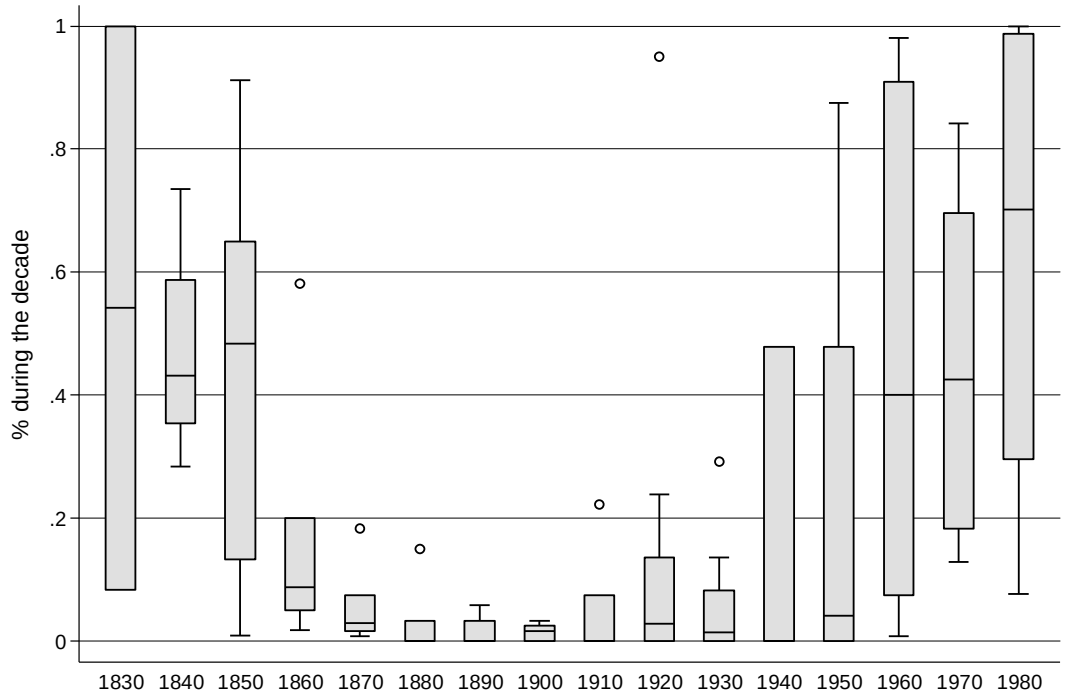
Figure 5: Spread between market and standing facility rate: averages per decade



Source: Authors' database.

Note: For individual country data, see table 3. War and immediate post-war periods (1914-1919 and 1939-1945) are excluded from the calculation.

Figure 6: Share of months with average market rate above average standing facility rate



Source: Authors' database.

Note: For individual country data, see table 4. War and immediate post-war periods (1914-1919 and 1939-1945) are excluded from the calculation.

In the **first half of the 19th century** official rates moved very little and mostly lie between four and five percent. Often no market rates are available before the 1850s, which might be due either to a hesitancy of traders to report rates given that usury laws made higher rates illegal or to the structure of the market itself which might have lacked standardization (Flandreau *et al.* 2009). The key feature of this period is that in all countries market rates quote time and again above official rates meaning that the standing facility was closed and that the central bank did not always serve as liquidity provider of last resort. In other respects, country experiences vary. With the exception of the three years between 1844 and 1847, the Bank of England in principle aimed at a discount rate above market rate in order to keep the provision of liquidity at the standing facility to a minimum and rather adjusted the liquidity position of the market through other channels like open market operations in Indian debt (Wood 1939) or special advances to smooth the end of quarters (King 1936). When demand for discounts increased significantly, however, demand was not satisfied fully. As the Bank did not (or could not) raise the rate it instead imposed quantity restrictions (Bignon *et al.* 2012). In Austria market rates quoted above official rates for extended periods of time while at the same time the standing facilities were used consistently. This setting suggests that access to the standing facilities was limited to a select group that enjoyed preferential access below market interest rates. From the point of view of the central bank such policy might be optimal as a means to filter out less risky counterparties, as was argued for Austria (Lanier 1998). This was also the case in France (Bopp 1952; Bignon *et al.* 2012). In the Netherlands access to the discount and advances facilities was hampered by a combination of high costs and fussiness (Jonker 1996), which might explain why market rates moved above official rates occasionally until the 1850s. In Prussia, the Königliche Hauptbank managed its (limited) discount operations restrictively, limiting access and increasing rates whenever liquidity conditions were tight (Niebuhr 1854). As a result and as can be seen in figure 5, market interest rates (where available) tended to fluctuate around the official interest rate.

Patterns change in the **second half of the 19th century**. Also thanks to the repeal of usury laws everywhere, official rates now moved much more frequently, and by the 1860s official rates are the *de facto* upper limit of market rates in all countries covered here, as can be seen in figure 6 from the sharp decline in the number of instances with market rates above official rates between the 1850s and the 1860s. Apparently central banks had eased restrictions on the access to standing facilities sufficiently so that all peaks in demand for central bank money would effectively be accommodated at the standing facility rate. The standing facility rate became the upper bound to the market rate. In Britain the change concerned policy during crises only, as during normal periods market rates had already quoted below the official rate before. By 1857 Bank of England directors acknowledged that demand for central bank deposits was (in the short run) highly inelastic and quantitative restrictions thus useless at best, and would cause panic at worst. Demand should be satisfied in full, while a high bank rate would encourage borrowers to look for alternative sources of liquidity (Wood 1939). In the crises of 1857 and 1866 the Bank of England acted accordingly, and the new doctrine of the lender of last resort was formulated in Bagehot (1873). In France, the evolution in central bankers' attitude followed the very same pattern and timing as in Britain (Bignon *et al.* 2012). Similar changes can be observed on the continent at about the same time. While the Preußische Bank had restricted access to refinancing during the 1847 and 1857 crisis, it acted as a reliable source of refinancing in the crises of 1866, 1870, and 1873 (Tilly 1966; Ziegler 1993). The same is true for its successor, the Reichsbank (Bopp 1953; Prion 1907). Austria is a comparative late-comer. Here the market rate quoted above the official rate quite frequently until as late as the mid-1870s. The stock exchange crisis of 1882 marked the last instance of the market rate surpassing the official rate; in later years the official rate became the effective cap on market rates. In the Netherlands, this was true at least by the early 1870s. Before, the money market was apparently flexible enough to weather the crises of 1857 and 1866 without much support of Nederlandsche Bank, but the Bank's leverage over the market increased with the rise of commercial banking (Jonker 1996).

While the lender-of-last-resort function of the standing facility thus became general, the behavior of market rates below the official rate continued to differ between national markets, even though a considerable convergence can be observed between 1860 and 1900, as evident in the ten-year averages in figure 5. Short-run patterns looked of course much more different. The importance of the standing facility rate depends on the need of the market to access the facility on a daily basis and thus on the aggregate liquidity position of the banking system. The aggregate liquidity position in turn depends on alternative sources of liquidity. These can be foreign exchange inflows (that in a fixed exchange rate system as the 19th century metallic standards will be automatically converted into domestic money) or operations on the initiative of the central bank like investments or explicit open market operations. In some instances high liquidity resulted from the monetization of government debt. If after taking these alternative liquidity sources into account the system as a whole still suffered from a shortage of liquidity it is forced to access the standing facility and market rate should quote at the official rate. Often this occurred when the demand for liquidity peaked at the end of the month, quarter or year (e.g. in Britain: Goodhart 1986). Conversely, a market rate below the official rate implies that there is no aggregate need for liquidity and thus the standing facility would not be used. In fact, however, even though the extent of usage differed, recourse to the standing facility was always positive at all central banks in this period (see sections 3.1 and 3.2). Such recourse, that could be labeled individual recourse as opposite to aggregate recourse, must reflect some transaction costs that prevent banks to access the liquidity available in the market at the lower market interest rate (Bindseil 2004). In the case of the Bank of England, this was due to special long-standing client relationships (Ziegler 1990). On the Continent, central banks entertained business relations with a wider set of clients that would often not qualify for the discount market, typically restricted to first class banking houses. The maintenance of large branch networks further increased the number of central bank

counterparts that had no alternative access to the money market. The importance of individual recourse is well evident in the constantly high use of the discount facility in the face of high spreads between market and official rates, notably in Germany (table 3). An indication for the different motivation for accessing the standing facility is provided by the typically much longer maturities of discounts at branch offices (source of structural liquidity) than at the main offices (cover peak demand).

In modern parlance, the changes happening after the 1850s can be resumed as the establishment of a one sided interest rate corridor that in some countries was combined with additional liquidity providing or absorbing operations below the standing facility rate. In principle, this framework remained in place during the **Interwar.** In all countries the discount rate continued to cap market interest rates, even though discount operations lost in importance relative to open market operations. The Bank of England started to keep market rates considerably below its discount rate through open market operations (Sayers 1976). The same role as upper limit to market rates can be observed for France, Austria, and the Netherlands. The newcomer to the central bank world, the Federal Reserve, was an outlier. At its foundation, the Fed conceptualized discount rates as penalty rates along the lines of the Bank of England, but soon market rates quoted above discount rates and continued to do so until 1932. The U.S. discount window was from the beginning set up in a much more complicated fashion than discount facilities in Europe. The Fed distinguished several types of recourse with different access criteria and administrative procedures (Meltzer 2003). Conditions and rates were set autonomously by the individual Federal Reserve banks, making coordination with open market purchases as at the Bank of England very difficult (Meulendyke 1989; Meltzer 2003). During the banking crises of the 1930s, the discount window became increasingly stigmatized. Access to the facility was interpreted as a sign of problems at the individual bank and not of aggregate need for liquidity, a pattern that persisted in the U.S. at least until the early 2000s. As a result, the discount window was barely used despite costs below the level of market interest rates.

After 1945, in many countries the traditional ordering of money market and official rates reversed and market rates started to quote above the discount rate. Data are no longer easy to interpret, as the number of relevant official interest rates multiplies in many countries. While in some countries preferential rates had been available for specific kind of paper (e.g. government securities in collateralized lending) or counterparties (e.g. agricultural cooperatives) before, the framework was in principle oriented around one interest rate – or, in some cases, two (discount and advances). Now central banks started to operate with four, five standing facilities upwards, each with its own interest rate. The reason for this dramatic change of approach was the introduction of restrictions on the use of the facility within the context of pervasive credit controls during and after the War, and often the introduction of specific rates for different classes of credit. This was the case most notably in France and Belgium, whose central banks operated with a multitude of different rates. Credit controls played a significant role also in the case of Britain (Tucker 2004) as well as in France, the Netherlands, and Belgium (C.E.E. 1962). Individual country experiences were rather idiosyncratic. The German central bank assigned the discount facility a key role after 1948 and until the 1980s. However, already in the 1950s the Bank set individual discount limits calculated as a function of selected liabilities of the banks, thereby changing the discount facility to a much more administrative procedure. In the beginning, foreign exchange inflows limited the need for liquidity from the standing facility, so that the discount rate served as an effective ceiling for market rates. From the mid-1970s onwards, recourse became systematic such that the discount rate became the floor rather than the ceiling for market rates, as banks would typically reduce discount loans to zero before market rates could fall below the discount rate. The role of the marginal borrowing facility was taken over by the advances facility, priced above the discount rate and access to which was most of the time unlimited. The rates thus formed a sort of corridor for the short-term interest rate (Bindseil 2004).

New consensus: corridor. The liberalization of financial markets in the 1980s and the return to market rather than administrative pricing reduced the variety of instruments adopted across countries. The major reforms of the money market in England in the mid-1990s (Tucker 2004), the introduction of the primary credit facility in the United States in 2002 (Bindseil 2004), and the start of the Eurosystem in 1999 (Galvenius and Mercier 2011) marked the convergence of the major central banks towards a new consensus (Borio 1997). Within this consensus the role of the standing facilities, in most cases a borrowing and a lending facility forming a corridor, is to prevent sharp increases or decreases of the market rate due to unforeseen changes in liquidity demand. According to current practice, the borrowing facility is available against a sufficiently wide range of collateral and not subject to administrative procedures and so, as a successor to the old discount facility, provides again an upper limit to market rates. In normal situations, open market operations by the central bank should keep market rates close to the target rate within the corridor and thus well below the borrowing facility rate, however. Recourse to the facility is accordingly small and not systematic. The main difference to the framework exemplified by the Bank of England before 1914 is thus that nowadays central banks effectively neutralize any liquidity shocks through open market operations and reserve averaging, thereby keeping market rates close to target rate, and never forcing (or even letting) the market "into the bank". Yet this very refined system is not without downsides. As banks should be able to obtain all required liquidity at the market rate, use of the borrowing facility implies that the borrowing bank had for some reason no market access. This might be related to timing – if e.g. an unexpected large payment occurs after the interbank market has closed – but could also signal more fundamental liquidity troubles. Consequently, use of the borrowing facility has a tendency to become stigmatized – a problem most notably discussed for the case of the Fed (Armantier *et al.* 2011). When recourse to central bank borrowing is stigmatized, the standing facility rate no longer serves as the upper bound to market rates. If not *de jure, de facto* this is bound to recreate a situation similar to the early-19th-century one, in which the lending-of-last-resort function was not properly provided by central banks. As the 2008 crisis seems to suggest, such dysfunctionalities in the design of the standing facility may engender very costly effects on the overall financial system and require central banks to create new quasi standing facilities – as exemplified by the full-allotment policies of the Fed and E.C.B. during the crisis, that might yet suffer from stigma as well.

To sum up, thanks to our analysis of market vs. bank interest rates we are now able to draw a general sketch of the changes in the substance of the market-bank interaction which have taken place over time and space. Positive market-bank spreads frequently occurred in the first half of the 19th century, when central banks often rationed credit to a number of counterparties. They basically disappeared around the mid of the century, as soon as usury ceilings were dropped and central bank started to behave as neutral lenders of last resort. They forcefully reappeared after World War Two, when a number of preferential conditions for access to central bank liquidity started to be granted to different classes of counterparties. Spreads returned to drop after the 1980s, as central banks generally went back to a more neutral stance with respect to money market participants. Recent attempts at neutrality, however, may have been partly compromised by the sentiment of stigma informally instilled around the discount window. Together with the increasing paucity of the number of counterparties, the creeping stigmatization of standing facility borrowing is a major difference between today's implementation framework and that prevailing in the late 19th century.

3.4 Quantitative Evidence: Sum-Up

The results of our quantitative survey suggest that during the last two centuries there were at least four major breaking points, when the interaction between money markets and central banks underwent some substantial transformations. *(1)* In the mid-19th century, the earlier importance of

government debt and collateralized loan markets faltered, as the discount market became the predominant channel of interaction between central banks and their counterparts: at around this time, credit rationing disappeared and the official discount rate became the effective upper bound to market rates. *(2)* World War One was a natural watershed, accelerating the rise of foreign exchange markets and the come-back of government debt markets. *(3)* World War Two exacerbated such transformations by making wartime credit controls durable: insulation allowed for significant divergences in country experiences and for the creation of a number of privileged positions in the access to central bank liquidity. *(4)* The financial liberalizations of the 1980s and 1990s finally fostered a new convergence of monetary practices around the world, with a general disappearance of discount markets, a relative decline of government debt markets, and a relative rise of foreign exchange and repo markets: like in the late 19th century, market rates returned to stay lower than standing facility rates, but – unlike in the late 19th century – stigma also came to be attached to the discount window.

The fundamental drivers of the breaks we observed appear to have been exogenous factors: changes in the availability of financial assets (e.g. increasing provision of trade acceptances or government debt), changes in the level of international financial integration (e.g. the late-19th-century globalization or the early-20th-century deglobalization), as well as changes in the structural characteristics of the country (e.g. its position within the international monetary system or its level of indebtedness). Driven by these exogenous inputs, money market structures and monetary practices did evolve together.

4. Conclusions

In this paper, we have surveyed historical information concerning the interplay between money market structures and monetary policy design in Western countries over roughly two hundred years. We have found that the very foundations of the relationship between markets and central banks evolved considerably over time. The money markets that central banks participated in were not always the same; the operational techniques implemented by monetary authorities did vary; and the operational targets of monetary policy also changed. On the one hand, the characteristics of money markets (*ex-ante* liquidity, credit risk, market participation, quality of transmission channels) played a role in determining central bankers' choice of their preferred fields of intervention (the acceptance market, the sovereign debt market, etc.), of their preferred techniques of intervention (uncollateralized or collateralized operations), and of their preferred stance (neutrality or not). On the other hand, though, the way monetary policy was designed also played a role in determining the relative importance of money markets (the supremacy of the acceptance market, of the sovereign debt market, etc.), their mode of functioning (origination of the one or the other collateral), and their attitude towards monetary authorities (reliance on the lender of last resort, or not). Both directions of causation contributed to determining what monetary policy implementation frameworks looked like over time and space. In the cross-sectional dimension we have seen that, although international trends play a crucial role, significant differences persist between countries even in periods of convergence. This means that the big, important central banks, that typically dominate policy debates and academic research, are often outliers rather than representative for central banking practices at their time. This is in particular true concerning the role of foreign exchange, the relative importance of government and non-government domestic assets, as well as the reliance on market mechanisms (vs. standing facilities) in the conduct of monetary policy operations.

Our survey suggests that although implementation frameworks may evolve endogenously, the factors leading to more drastic transformations may be rather exogenous in nature. This implies that assessing the actual efficiency of each framework may be much more complicated than it might

appear at first sight. On the one hand, exogenous shocks on money market structures (e.g. commercial openness as a driver of the development of the acceptance market, or government indebtedness as a driver of the development of sovereign bond market) are bound to impact the degree of optimality of a given monetary policy design. On the other hand, though, also exogenous shocks on central bank's policymaking (e.g. political pressure to keep a standing facility for acceptances, or political need to subsidize the sovereign bond market) are bound to impact the degree of optimality of a given money market structure. Approaching these phenomena theoretically in a sensible way appears to be an extremely complex issue. This is even more complicated by the fact that apparently exogenous shocks may not be mutually exogenous. Just to give an obvious example, the economic push leading to the emergence of the sovereign debt market and the political push leading to the emergence of the central bank's management of this market hardly look independent of each other. In order to get a fuller understanding of these important dynamics, a lot of additional research might well be required.

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Balance sheets

Bank	Dates	Source
Britain		
Bank of England	1835	Parliamentary Report on Banks of Issue (1840), App. 16
	1880	BoE archives
	1909	Lévy (1911) complemented by BoE archives
	1928	Käppeli (1930)
	1950, 1970, 1990	Annual reports, BoE
Germany		
Königliche Hauptbank	1835	Niebuhr (1854)
Reichsbank	1880	Reichsbank (1910)
	1909	Lévy (1911)
	1928	Kerschagl (1929)
Bank deutscher Länder	1950	Deutsches Geld- und Bankenwesen in Zahlen 1876-1975
Deutsche Bundesbank	1970	Deutsches Geld- und Bankenwesen in Zahlen 1876-1975
	1990	50 Jahre Deutsche Mark: monetäre Statistiken 1948-1997
France		
Banque de France	1835, 1880	Annual report, BdF
	1909	Lévy (1911)
	1928	Käppeli (1930)
	1950, 1970, 1990	Annual report, BdF
United States		
Second Bank of the United States	1831	Catterall (1903)
Federal Reserve System	1928	Kerschagl (1929)
	1950, 1970, 1990	Annual reports, Federal Reserve System
Belgium		
Société Générale de Belgique	1835	Malou (1863)
Banque Nationale de Belgique	1880 - 1990	Annual reports, NBB
Netherlands		
De Nederlandsche Bank	1835, 1880	De Jong (1967)
	1909	Lévy (1911)
	1928	Mitteilungen der OeNB
	1950, 1970, 1990	Annual reports, DNB
Austria		
Oesterreichische Nationalbank	1835	OeNB archives
Oesterreichisch-ungarische Bank	1880, 1909	Annual reports, complemented by OeNB archives
Oesterreichische Nationalbank	1928, 1950, 1970, 1990	Annual reports, OeNB
Switzerland		
Schweizerische Nationalbank	1909 - 1990	Historical time series, SNB
Norway		
Norges Bank	1835 - 1928	Hvidsten (2013)
	1950, 1970, 1990	Historical monetary statistics, NB

Uncollateralized and collateralized domestic loans

Bank	Period	Source	Type of data
Britain			
Bank of England	1832 - 1840	Parliamentary Report on Banks of Issue (1840), App. 12	End of year
	1841 - 1847	Parliamentary Report on Commercial Distress, 2nd Report (1847), App. 8	End of year
	1848 - 1913	BoE archives	Yearly total
Germany			
Königliche Hauptbank	1817 - 1846	Niebuhr (1854)	End of year
Preußische Bank	1847 - 1875	Poschinger (1879)	Yearly average
Reichsbank	1876 - 1945	Reichsbank (1910), Deutsches Geld- und Bankenwesen in Zahlen 1876-1975	End of year
Bank deutscher Länder	1948 - 1957	Deutsches Geld- und Bankenwesen in Zahlen 1876-1975	End of year
Deutsche Bundesbank	1958 - 1989	Deutsches Geld- und Bankenwesen in Zahlen 1876-1975, Bundesbank	End of year
France			
Banque de France	1807 - 1964	Annuaire statistique de la France: résumé rétrospectif (1966)	Yearly total
United States			
Federal Reserve System	1917 - 1942	Monetary and Banking Statistics (1943)	End of year
	1943 - 1970	Monetary and Banking Statistics (1976)	End of year
Belgium			
Banque Nationale de Belgique	1851 - 1913	Annual report 1950, NBB	End of year
	1924 - 1973	Mitteilungen der OeNB	End of year
Netherlands			
De Nederlandsche Bank	1814 - 1913	De Jong (1967)	Yearly average
	1924 - 1932	Mitteilungen der OeNB	End of year
Austria			
Oesterreichische Nationalbank	1818 - 1860	Lucam (1861)	End of year
	1861 - 1866	Lucam (1876)	End of year
Oesterreichische Nationalbank	1867 - 1877	Annual reports, OeNB	End of year
Oesterreichisch-ungarische Bank	1878 - 1918	Annual reports, OeNB	End of year
Oesterreichische Nationalbank	1919 - 1993	Annual reports, OeNB	End of year
Switzerland			
Sweizerische Nationalbank	1907 - 1997	Historical times series, SNB	End of year
Norway			
Norges Bank	1819 - 1913	Historical monetary statistics, NB	End of year

Monthly interest rates

Instrument	Period	Source	Frequency of underlying data
Britain			
Bank rate	1824 - 1835	Clapham (1944)	End of month
Bank rate	1836 - 1939	NBER MacroHist	Daily
Bank rate	1940 - 2008	BoE	Daily
Open market rate of discount	1824 - 1939	NBER MacroHist	Weekly
Prime bank bill rate	1939 - 1958	Capie and Webber (1985)	End of month
3M bank bills	1958 - 1962	Mitteilungen der OeNB	
3M T-bills from	1963 - 1974	Mitteilungen der OeNB	
UK Interbank overnight - middle rate	1975 - 2013	Thomson Reuters	Daily
Germany			
Discount rate Prussian Bank	1861 - 1875	The Economist	Weekly
Discount rate Reichsbank	1876 - 1938	NBER MacroHist	Daily
Discount rate Bundesbank	1948 - 1999	Bundesbank BBK01.SU0112	End of month
Open market rate Berlin	1861 - 1875	The Economist	Weekly
Private discount rate, prime banker's acceptances	1876 - 1939	NBER MacroHist	Daily
Tagesgeld Frankfurt	1959 - 1999	Bundesbank BBK01.SU0101	Daily
France			
Banque de France discount rate	1844 - 1852	Ugolini (2010)	Weekly
Banque de France discount rate	1852 - 1940	NBER MacroHist	Daily
Banque de France discount rate	1945 - 1977	BIS	End of month
Banque de France policy rate	1989 - 1998	BdF	Daily
Open market, Paris	1844 - 1861	Ugolini (2010)	Weekly
Open market, Paris	1861 - 1863	The Economist	Weekly
Open market, Paris	1863 - 1940	NBER MacroHist	Weekly
Paris daily rate on private paper	1958 - 1972	Mitteilungen der OeNB	
Rate for day-to-day loans against private bills	1973 - 1998	Eurostat	Daily
United States			
Discount rate New York Fed (average für commercial, agricultural and livestock paper)	1914 - 1969	NBER MacroHist	Daily
Discount rate New York Fed (average on loans to member banks)	1969 - 2003	Fed H.15m	Daily
Discount rate primary credit	2003 - 2013	Fed H.15m	Daily
U.S. Commercial Paper Rates, New York City	1857 - 1953	NBER MacroHist	Daily
Effective Fed funds rate	1954 - 2013	Fed H.15m	Daily
Belgium			
NBB discount rate	1851 - 1914	Annual report 1950, NBB	Weekly
NBB discount rate	1919 - 1998	NBB	End of month

Antwerp open market	1844 - 1861	SCOB database	Weekly
Brussels open market	1861 - 1914	The Economist	Weekly
Discount rates at Brussels on first class commercial paper	1920 - 1936	International Abstract of Economic Statistics	No indication in source
Private discount rate	1937 - 1939	Fed International Financial Statistics	No indication in source
Argent au jour le jour	1945 - 1969	NBB	Daily
Rate on banks' deposits of their daily cash surpluses	1970 - 1998	Eurostat	Daily
Netherlands			
DNB discount rate	1844 - 1861	Ugolini (2010)	Weekly
DNB discount rate	1861 - 1913	The Economist	Weekly
DNB discount rate	1914 - 1998	DNB	Daily
DNB discount rate	1914 - 1998	DNB	Daily
Amsterdam open market	1844 - 1861	Ugolini (2010)	Weekly
Amsterdam open market	1861 - 1913	The Economist	Weekly
Private discount rate	1920 - 1936	International Abstract of Economic Statistics	No indication in source
Private discount rate	1937 - 1939	Fed International Financial Statistics	No indication in source
3M T-bills	1958 - 1972	Mitteilung der OeNB	
Representative rate on the money market for loans between banks	1973 - 1981	Eurostat	Daily
Call money guilder market	1982 - 1998	DNB	Daily
Austria			
OeNB discount rate	1824 - 1999	OeNB	Daily
Shadow interest rate Trieste	1835 - 1859	Journal des österreichischen Lloyds, Osservatore Triestino, Oesterreichischer Volkswirth, Austria	Weekly
3 month prime bills Vienna	1860 - 1870	Coursblatt des Gremiums der Börse-Sensale	Weekly
3 month prime bills Vienna	1871 - 1914	Denkschrift zur Währungsfrage, after 1874 Wiener Zeitung	End of month
3 month prime bills Vienna	1923 - 1931	Mitteilungen der OeNB	Weekly
Taggeld	1968 - 1999	OeNB	
Switzerland			
Bank rate Geneva	1892 - 1907	The Economist	Weekly
SNB discount rate	1907 - 1999	Historical times series SNB	Daily
SNB lombard rate/liqudity shortage financing facility	1907 - 2007	Historical times series SNB	Daily
Market rate Geneva	1892 - 1914	The Economist	Weekly
Private discount rate	1924 - 1941	Fed International Financial Statistics	not given in source
Call money	1948 - 1972	Historical times series SNB	Weekly
Tomorrow next	1972 - 2007	Historical times series SNB	Daily
Norway			
Norges Bank discount rate	1818 - 1965	Historical monetary statistics NB	End of month
Norges Bank marginal rate (various instruments)	1965 - 2014	Historical monetary statistics NB	End of month
Market rate Christiania	1894 - 1914	The Economist	Weekly
Euro Krone 3M	1959 - 1986	NB	End of month
NIBOR tomorrow next	1987 - 2011	NB	Daily
NIBOR 1W	2011 - 2013	NB	Daily

Tables

Table 1: Composition of central bank assets

Britain	*1835*	*1880*	*1909*	*1928*	*1950*	*1970*	*1990*
Gold, Silver	12	30	36	31	0	0	0
Other foreign assets	0	0	0	0	0	0	0
Discounts	30	14*	16*	2*	1*	2*	3*
Advances	15						
Open market repos	5	0	0	0	0	12	8
Other lending to private sector	0	0	0	0	0	0	0
Gov't securities/ claims on gov't	30	38	31	60	97	79	56
Securities not specified	4	17	16	6	2	6	26
Other assets	4	0	2	1	0	2	7

** After 1844 discounts and advances reported together.*

Germany	*1835*	*1880*	*1909*	*1928*	*1950*	*1970*	*1990*
Gold, Silver	14	53	30	47	6	60	30
Other foreign assets	0	0	4	1	0	0	0
Discounts	9	32	37	38	24	20	24
Advances	13	5	10	2	8	2	2
Open market operations	0	0	0	0	0	0	34
Other lending to private sector	11	0	0	0	2	0	0
Gov't securities/ claims on gov't	34	4	2	1	55	14	4
Securities not specified	0	1	11	2	2	1	0
Other assets	18	5	7	9	3	3	6

France	*1835*	*1880*	*1909*	*1928*	*1950*	*1970*	*1990*
Gold, Silver	29	53	70	37	10	5	29
Other foreign assets	0	0	0	41	17	27	26
Discounts	41	30	14	5	24	37	0
Advances	12	5	9	3	1	0	0
Open market operations	0	0	0	0	0	0	19
Other lending to private sector	0	0	0	0	0	0	0
Gov't securities/ claims on gov't	16	8	6	4	36	7	8
Securities not specified	0	0	0	7	8	17	3
Other assets	3	4	1	3	3	7	14

United States	*1831*	*1880*	*1909*	*1928*	*1950*	*1970*	*1990*
Gold, Silver	16	-	-	51	46	12	4
Other foreign assets	2	-	-	0	0	0	3
Discounts	63	-	-	20	0	0	0
Advances	0	-	-	0	0	0	0
Open market operations	0	-	-	9	0	0	6
Other lending to private sector	0	-	-	0	0	0	0
Gov't securities/ claims on gov't	10	-	-	4	44	70	74
Securities not specified	0	-	-	0	0	0	0
Other assets	9	-	-	16	10	17	14

Austria	*1835*	*1880*	*1909*	*1928*	*1950*	*1970*	*1990*
Gold, Silver	18	31	54	12	1	32	16
Other foreign assets	0	3	2	54	5	43	41
Discounts	5	25	23	15	31	12	15
Advances	5	4	3	0	0	0	0
Open market operations	0	0	0	0	0	0	18
Other lending to private sector	0	17	10	0	0	0	0
Gov't securities/ claims on gov't	69	14	2	8	63	9	0
Securities not specified	2	5	1	0	0	3	7
Other assets	1	2	6	11	0	1	3

Netherlands	*1835*	*1880*	*1909*	*1928*	*1950*	*1970*	*1990*
Gold, Silver	46	65	44	57	17	55	35
Other foreign assets	0	0	5	26	26	28	43
Discounts	23	18	19	9	0	2	0
Advances	30	17	21	8	1	0	14
Open market operations	0	0	0	0	0	12	4
Other lending to private sector	0	0	8	0	0	0	0
Gov't securities/ claims on gov't	0	0	0	0	56	0	0
Securities not specified	0	0	3	0	0	0	0
Other assets	0	0	1	0	0	3	5

Belgium	*1835*	*1880*	*1909*	*1928*	*1950*	*1970*	*1990*
Gold, Silver	7	20	15	35	29	29	8
Other foreign assets	0	11	14	21	12	46	62
Discounts	6	48	53	25	11	3	4
Advances	8	2	6	1	1	0	0
Open market operations	0	0	0	0	0	0	0
Other lending to private sector	9	0	0	0	0	0	0
Gov't securities/ claims on gov't	34	10	9	16	46	20	21
Securities not specified	2	0	0	0	0	0	0
Other assets	35	9	4	2	2	3	5

Switzerland	*1835*	*1880*	*1909*	*1928*	*1950*	*1970*	*1990*
Gold, Silver	-	-	39	48	90	51	22
Other foreign assets	-	-	14	22	4	45	70
Discounts	-	-	32	18	3	2	1
Advances	-	-	4	7	1	1	0
Open market operations	-	-	0	0	0	0	0
Other lending to private sector	-	-	0	0	0	0	0
Gov't securities/ claims on gov't	-	-	0	0	0	0	0
Securities not specified	-	-	3	2	1	1	5
Other assets	-	-	8	3	1	0	1

Norway	*1835*	*1880*	*1909*	*1928*	*1950*	*1970*	*1990*
Gold, Silver	35	49	42	31	3	1	0
Other foreign assets	0	0	6	9	8	46	53
Discounts	7	30	32	26	0	0	0
Advances	0	0	1	21	0	0	31
Open market operations	0	0	1	0	0	0	0
Other lending to private sector	56	21	2	0	0	1	0
Gov't securities/ claims on gov't	0	0	0	0	87	39	13
Securities not specified	0	0	11	5	1	9	0
Other assets	1	0	5	8	1	4	2

Table 2: Share of advances in domestic lending (advances + discounts)

	AT	*BE*	*CH*	*DE*	*FR*	*NL*	*NO*	*UK*
1820	74			71	6	60	91	
1830	51			51	9	60	89	64
1840	34			43	8	33	84	36
1850	43	9		30	18	22	66	18
1860	38	3		14	16	33	52	25
1870	21	3		15	9	33	41	38
1880	15	6		17	25	44	32	51
1890	16	7		18	33	46	20	44
1900	13	10	10	16	40	47	26	68
1910	19	12	15	11	34	50	19	50

Note: For Norway, mortgage lending is included in domestic lending. War and immediate post-war periods (1914-1919 and 1939-1945) are excluded from the calculation.

Table 3: Average spreads between market and standing facility rates in basis points

	AT	*BE*	*CH*	*DE*	*FR*	*NL*	*NO*	*UK*	*US*
1830	90							-63	
1840	40				6	5		-49	
1850	117	-10			12	14		-16	
1860	5	-38		-67	-35	-12		-15	
1870	-18	-34		-96	-48	-26		-40	
1880	-54	-36		-106	-39	-35		-74	
1890	-31	-71	-67	-89	-41	-55		-87	
1900	-37	-54	-55	-103	-60	-37		-48	
1910	-34	-81	-28	-88	-44	-29		-45	
1920	-32	-66	-62	-92	-92	-51		-56	45
1930	-93	-50	-48	-57	-45	-143		-115	-30
1940			-20					-144	-2
1950		-195	-52	-8	29	-96	37	-83	4
1960	44	-145	-36	7	73	-97	193	-44	18
1970	81	-129	-121	126	-42	-29	118	-72	65
1980	219		-35	151	-35	104	-12	-66	133

Note: War and immediate post-war periods (1914-1919 and 1939-1945) are excluded from the calculation.

Table 4: Percentage of months with average market rates above average standing facility rates

	AT	*BE*	*CH*	*DE*	*FR*	*NL*	*NO*	*UK*	*US*
1830	100							8	
1840	74				42	44		28	
1850	91	1			65	48		13	
1860	58	5		2	12	6		20	
1870	18	2		1	2	4		8	
1880	3	0		0	15	0		0	
1890	6	0		0	1	0		3	
1900	2	0		0	3	2		3	
1910	7	0	22	0	0	0		5	
1920	24	3	0	3	0	3		0	95
1930	0	3	2	1	14	0		0	29
1940			0					0	48
1950		0	5	0	63	0	88	3	33
1960	95	1	33	53	91	7	98	8	40
1970	70	18	18	84	30	43	70	13	68
1980	100		43	100	8	98	45	17	95

Note: War and immediate post-war periods (1914-1919 and 1939-1945) are excluded from the calculation.