Appendix

The historical evolution of central banks: Narratives

Modern central banking began with the founding of the Riksbank in 1664. It was preceded by proto institutions which performed some central bank functions such as the Banco di Rialto in Venice and the Wissel bank (exchange bank) in Amsterdam (Roberds and Velde 2016)

Central banks evolved with the functions of the modern nation state. They were initially called banks of issue because their charters gave them the privilege to issue bank notes. They were established to market government debt (usually in wartime) and to serve as a temporary lender to the government to cover shortfalls between expenditures and tax receipts. Their notes often served as the basis of the payments mechanism since their notes convertible into specie would serve as the nominal anchor and some of them served as clearing houses. They later evolved into bankers" banks because of their large size and capital base.

As the specie standard evolved into the gold standard in the nineteenth century, these banks followed the rules of the game and managed the adjustment mechanism of the gold standard. The gold standard acted as the foundation for both domestic monetary and financial systems and also the international monetary and financial system (Bordo 1999).

With the growth of the international monetary system, financial innovation and financial globalization, came the financial crisis problem: banking, currency and debt crises. Central banks learned to act as lenders of last resort to deal with banking panics and currency crises following Bagehot's stricture 'to lend freely but at a penalty rate'. The learning curve however was not very steep, in part because private banks of issue would place their shareholders interest above that of the public. Following Bagehot's Responsibility Doctrine after the Overend Gurney crisis in 1866 the Bank of England finally got the plot and prevented the Baring crisis from damaging the British financial system. The CBs of other advanced countries followed suit. In the twentieth century central banks were heavily involved in financing two World Wars. In the interwar the restoration of the gold standard ultimately failed because central banks lost their prewar credibility and ran the gauntlet between internal and external stability. After WWII central banks became public institutions (with the exception of the Fed and the SNB) and lost their independence. Under Bretton woods their tasks were to use exchange market intervention to maintain their parities, as well as to maintain full employment and provide price stability. They also enforced credit, capital and exchange controls. After the breakdown of the Bretton Woods system which in part was due to the Fed following an inflationary policy it took well over a decade for the CBs to learn to operate in a managed floating environment without any external constraints. The Great Inflation was also accompanied by exchange rate volatility.

The back of inflation was broken by very tight monetary policies between 1979 and 1982 which precipitated one of the worst recessions of the postwar period. The subsequent Great Moderation period saw the return of a credible nominal anchor now based on fiat money. The quintessence of this period was the adoption of (flexible) inflation targeting by most of the countries in our sample. In this period the technologies of central banking were transmitted between countries in part through the auspices of the Bank of International Settlement (Bordo and Schenk 2016).

In this era the nature of banking crises changed drastically as the major countries adopted deposit insurance and other trappings of a financial safety net. Central banks no longer followed Bagehot's strictures but adopted the' too big to fail' doctrine. This converted fast moving banking panics into drawn out banking crises which were resolved by the fiscal authorities. A direct link between banking and fiscal crises was created (Bordo and Meissner 2016). Finally the financial crisis of 2007-2008 was in part caused by central banks keeping their policy rates too low for too long to prevent the mirage of deflation (Taylor 2007). These actions fueled a speculative asset price boom in real estate in the US, UK and other countries leading to the financial crisis and the Great Recession. Since then all of the advanced country central banks are adopting macro prudential policies to head off future asset price booms. Innovations by the Bank of England have influenced new technologies adopted by other country's CBs.

We briefly survey the history of 10 advanced countries CBs and consider how the strategies of the different countries are interdependent. As discussed in the text , in the previous two centuries leading central bank technologies have come from the leading countries –-the UK and US-- but in recent years small open countries have been at the lead.

1. *The Riksbank*

The Riksbank was founded in 1664 as a Parliament sponsored private financial intermediary to encourage private lending, as an anchor to the specie standard, and as a base of the payments system (Fregert 2016). In the eighteenth century it served as the government's financier in a number of wars, issuing its notes to cover the government's expenditures. Excessive note issue during the war with Russia in 1741-1743 led to the suspension of convertibility and high inflation. Specie payments were not restored until the beginning of the next century. In the nineteenth century the Riksbank became a bankers' bank after the establishment of chartered note issuing banks (the Enskilda banks). Once Sweden joined the gold standard in 1873 The Riksbank followed the rules of the game (Jonung 1984).

Sweden faced a number of big international banking crises in the nineteenth century (1857, 1873 and 1877). It is not clear whether the Riksbank used its discount rate and acted as a lender of last resort in the Bagehot sense. However, the crises were allayed by foreign loans arranged by the government's debt office. Sweden was part of the Scandanavian Monetary Union which involved the use of common coins between the 3 members and some coordination of central bank discount rate policy (Jonung 1996). During World War I although Sweden was not a belligerent, massive exports of war materiel to both sides fueled a gold inflow and high inflation leading Sweden to suspend convertibility and leave the SCU. The high inflation continued after the war but like the other European CBs, the Riksbank tightened monetary policy in 1920 leading to a serious recession and deflation and a banking crisis. The evidence is not clear on whether the Riksbank followed Bagehot lender of last resort (LLR) policies but several insolvent banks were rescued by the Swedish government. (Feinstein and Temin 1995). Sweden followed the UK off the gold standard in September 1931. Then, during the 1930s, the Riksbank instituted its novel price level stabilization policy (Berg and Jonung 1999).

Like in World War I Sweden remained neutral in World War II but profited by exporting to both sides. During the war Sweden imposed price, exchange and capital controls administered by the Riksbank. As in other countries the Riksbank was subordinate to the Treasury. This continued after the war as Sweden became a planned economy and the Riksbank administered an elaborate set of credit controls and allocation schemes. Sweden was also part of the Bretton Woods system and the Riksbank engaged in exchange market Intervention to maintain the krona dollar parity. Sweden like other countries followed Keynesian full employment geared aggregate demand management policies. This led to high inflation in the years after the collapse of Bretton Woods along with several large devaluations. Sweden joined the EMS in the mid-1980s and was hard hit by the EMS crisis in 1991. To defend the krona the Riksbank raised its discount rate to 500%. The policy was unsuccessful and Sweden was forced out of the EMS and turned to floating in 1993.The currency and banking crisis of 1991 rocked the economy. The Swedish authorities successfully managed and resolved the banking crisis in 1992. In the 1990s the Riksbank adopted a strategy to maintain credibility for low inflation and pioneered in the use of flexible inflation targeting.

2. The Bank of England

The Bank of England was founded in 1694. In some respects it resembled the Riksbank since it received its charter from the Crown as a private joint stock company but with a public purpose—to aid the government in managing its debt and to provide temporary finance when revenues were less than expenditures. Like the Riksbank the Bank of England had the right to issue bank notes and to engage in private banking. Like the Riksbank, the Bank of England's notes served as the base of the payments system. The Bank was required to make its notes convertible into specie at the official price of 3 pounds, six shillings and 10 pence per ounce.

The Bank had operational independence but not goal independence. Its main goal was to stay on the specie standard. It developed the use of Bank rate (discount rate) as its key policy tool. Because of its size and importance, like the Riksbank, it evolved into a bankers' bank. As a private institution with a government charter and purpose the government had oversight over it via periodic reviews of its charter.

In the nineteenth century the Bank followed the gold standard convertibility rule which was a contingent rule—in the case of a wartime emergency or a serious financial crisis it could request a letter from the Treasury to suspend convertibility and increase its note issue (Bordo and Kydland 1995). The Bank also followed the 'rules of the game 'of the classical gold standard and used Bank rate to speed up adjustment to balance of payments disequilibria. In the 1870s and 80s the Bank developed the use of open market operations and gold policy (policies to alter the gold points) as a way to make Bank rate effective (Sayers 1957). The Bank also used Bank rate to stabilize the money market (for bankers' acceptances).

The Bank evolved into its role as a lender of last resort gradually in three crises in the first half of the nineteenth century. It provided liquidity too late and too sparsely to stem the crisis. A key problem it faced was the conflict between satisfying its shareholders and the public interest. Persistent criticism by Parliamentary committees and by Walter Bagehot, editor of the Economist, led the Bank to adopt the Responsibility Doctrine –to elevate the public interest above its private interest.. After the Overend Gurney crisis of 1866 the Bank acted as a lender of last resort following Bagehot's strictures "to lend freely but at a penalty rate".

With the outbreak of World War I the gold standard was suspended (de facto) and the Bank like other belligerent central banks served as an engine of inflation by pegging short term interest rates and freely discounting Treasury bills. This policy led to high inflation. After the war the Cunliffe Report of 1918 recommended that Britain go back to the gold standard at the pre-war parity. Tight monetary policy leading to recession was sufficient to deflate prices to allow a return to convertibility in April 1925. Britain went back to the gold standard at an overvalued parity which led to persistent maladjustment through the 1920s and eventually contributed to the breakdown of the gold exchange standard.

In World War II like the previous war, the Bank became an engine of inflation. It subsumed its independence to the Treasury. After the war the Bank was nationalized. Britain joined the Bretton Woods System in 1946 and declared current account convertibility in December 1958. Under Bretton Woods the Bank had to continuously engage in exchange market intervention to maintain the dollar peg. During the next decade Britain was caught between the constraints of the Public Sector Borrowing Requirement of the fiscal authorities and maintaining convertibility of the pound. The Bank and the Treasury followed stop go policies. Like in the interwar the pound was overvalued and there was continuous deflationary pressure. When the balance of payments improved the financial authorities would “go for growth” which would lead to a payments deficit, a currency crisis and an international rescue. Sterling went through 4 crises between 1959 and 1967 until the devaluation in November 1967 (Bordo, Oliver and MacDonald 2008).

In 1959 the Radcliffe Report commissioned to evaluate the Bank’s policies concluded that the use of traditional tools like Bank rate were powerless to affect the real economy. Radcliffe made the case for credit allocation policy and the use of fiscal instead of monetary policy. Thus, similar to the Riksbank the Bank was subservient to the Treasury’s policies to control the economy.

The Bretton Woods System collapsed between 1971 and 1973 and the UK floated the pound in 1972. In the absence of an external constraint and the continued pursuit of full employment policies, considerable monetary expansion led to very high inflation (20% per year) and an exchange rate crisis in 1976 which was resolved by an IMF rescue.. Factors for the rise in inflation in the 1970s included fiscal dominance, the belief that inflation was caused by non-monetary forces such as union power and playing the Phillips Curve tradeoff. The UK Great Inflation was ended by Margaret Thatcher and her advisor Alan Walters' pursuit of a monetarist program of tight money which like the policies followed in the US by Paul Volcker, broke the back of inflation and inflationary expectations by the mid-1980s. The Bank of England began to follow inflation targeting in 1992 adopting the Reserve Bank of New Zealand's practice. The Bank was given instrument independence from the Treasury in 1998.

The Bank had learned to be a lender of last resort in the 1870s and was successful in heading off the Baring crisis in 1890 , a crisis facing the merchant banks in 1931 (Acomminotti 2015) and several small crises in the 1970s and 80s but like the Fed began following the 'too big to fail ' doctrine.

In the 1980s the UK liberalized its financial markets and opened up its capital account. This led to a renaissance of the City of London as a global financial center. This later contributed, by the turn of the twentieth century, to a debt financed asset price boom and the financial crisis of 2007-2008. The Bank of England failed to prevent a run on Northern Rock in 2007 as well as the subsequent insolvency of many of the British banks. By 2008 it followed similar expansionary monetary and credit aggregates as the US. In reaction to the crisis the Bank has been granted radical new powers over financial stability, especially macro prudential policies. It is too soon to tell whether this new approach will succeed.

3. *The Banque de France*

The Banque was established in 1800 by Napoleon to restore monetary discipline after the Assignats inflation during the French Revolution. The object was to restore specie convertibility in a bimetallic system. The original goals for the banque were: to ease financing for the state; to ease credit conditions for the private sector; and, to remove interregional disparities in credit conditions. The Banque was not modeled after the Bank of England but earlier central bank models were considered in the design of the Banque (Ramon 1932). Like the Bank of England, convertible Banque de France notes served as the basis of the French payments system although unlike Britain most payments were done in specie. The Banque also evolved as a bankers' bank discounting commercial paper to the nascent French commercial banking system (the haute banque).

The Banque was the center of the bimetallic system .Its large reserves of gold and silver kept the bimetallic mint ratio close to the market rate until France joined the gold standard in 1876 (Flandreau 1995). During this period The Banque suspended convertibility (cours force) in 1848 to 1850 and 1870 to 1873 but after each of these episodes went back to convertibility at the original parity thereby following the contingent gold standard rule (Bordo and Kydland 1995). During the classical gold standard era the Banque did not follow the' rules of the game' the way the Bank of England did. It rarely changed its discount rate and kept very large gold reserves. It engaged in credit allocation policies to stabilize the French financial system and only changed its discount rate when the Bank of England made large changes to Bank rate. (Bazot, Bordo and Monnet 2016). Despite not closely following the rules, the Banque did maintain convertibility and had high credibility.

The Banque, like the Bank of England learned to be an effective lender of last resort in the late nineteenth century. It used its policy tools to allay banking panics in 1882 and 1889. Indeed the Banque may have been the first to use lifeboat policies in the crisis of 1889, a technology that was then used in the following year by the Bank of England in successfully managing the Baring crisis (White 2016).

During World War I France left the gold standard. The Banque pegged short term interest rates and freely discounted the government's Treasury bills thus becoming an engine of inflation. France had one of the highest inflation rates of the belligerents (after Germany). After the war the large run up in the price level and a huge debt overhang prevented France from going back to the gold standard at the prewar parity. A continuous struggle between the left and the right prevented budget balance and the Banque ended up financing the fiscal deficit with the printing press. High inflation in the 1920s and a serious currency crisis eventually led to Poincare's stabilization program in 1926 which balanced the budget and restored gold convertibility at a greatly devalued rate. The stabilization was aided by outside loans by JP Morgan. The Banque continued to follow hard money policies into the 1930s and continually sterilized the gold inflows from France's persistent payments surpluses. Once Britain and then the US left the gold standard competitive pressure eventually forced France off the gold standard. The French devaluation was well managed by the Tripartite agreement of 1936, the only effective cooperation in the Great Depression (Bordo, Humpage and Schwartz 2015).

During World War II France was occupied by the Germans. The Banque´s policies produced another wartime inflation. After World War II the Banque was nationalized. It took most of the 1940s to stabilize prices and the exchange rate.in the 1950s and 1960s the Banque followed unorthodox credit allocation policies that had been developed under Vichy. According to Monnet (2015) it was very successful at keeping inflation low and growth stable.

France joined the Bretton Woods system in 1947 because of its inflation problems .The franc was devalued in 1948, 1949 and 1957. Monetary stability returned after the Currency Reform of 1960.During the Convertible Bretton Woods period France was active in trying to reform the system. Charles De Gaulle and Jacques Rueff were critical of the US 'exorbitant privilege' and pushed to return the world to the classical gold standard. They were unsuccessful. France was hard hit by a currency crisis in 1968 leading to another devaluation of the franc.

After the breakdown of Bretton Woods the Banque, like most advanced countries, followed inflationary policies and accommodated the two oil price shocks. France was part of the unsuccessful 'Snake in the Tunnel' arrangement in the 1970s but was forced out by its inflationary policies. It joined the European

Monetary system as a credibility enhancing mechanism In 1983 France adopted the 'franc fort' policy with tight money by the Banque. Subsequent disinflation restored some credibility. The EMS crisis of 1992 ended the EMS with France's exit and devaluation of the franc. France signed the Maastricht Treaty in 1992 leading to EMU. The Banque was granted independence in 1993 and became fully dedicated to price stability. For the next six years until EMU and the creation of the euro in 1999, the Banque followed a credible policy of low inflation.

4. *The Norges Bank*

The NB was established in 1816 when Norway became independent of Denmark. Its main task was to restore price and exchange rate stability after the chaos of the Napoleonic wars. It took 19 years to restore convertibility to silver (Eitrheim and Klovlund 2016). Thereafter the NB followed the convertibility rule of the silver standard until Norway joined the gold standard in 1874. The NB also acted as a commercial bank discounting paper for business and other banks. As in other countries its notes became the base of the payments system. Norway had several big financial crises in the nineteenth century as did Sweden. In 1857 and 1873 the government was able to secure rescue funds from abroad. It is not clear that the NB acted as a lender of last resort. A big real estate boom bust in Christiana (Oslo) in 1899 led to a banking panic. Then the NB acted as a LLR and saved the banking system. In the post-World War I recession, Norway like most open European economies was hard hit by a banking crisis in 1922. The NB provided liquidity support to solvent but illiquid banks and the government re-capitalized two large banks.

Norway left the gold standard in 1914 like Sweden and had high inflation. Like most other countries the NB followed a deflationary policy to restore gold convertibility. The krone restored its original gold parity in 1929. Norway was occupied during World War II and had very high inflation. After the war the NB worked towards restoring monetary stability but like Sweden it became subservient to the government's credit allocation policies. Norway joined the Bretton Woods system in 1946 and maintained the peg until

1971. Like Sweden and the UK Norway had high inflation after the breakdown of Bretton Woods but did not float and suffered periodic devaluations. Macro instability persisted into the 1980s when NB received operational independence in 1985 and began a policy dedicated to price stability in 1986 which succeeded in reducing inflation and restoring credibility for low inflation. It adopted inflation targeting in 2001 and has become a pioneer in creating a forecast based flexible inflation targeting regime. Norway, like Sweden, liberalized its financial sector in the 1980s and removed capital controls. Expansionary monetary policy helped fuel a real estate boom in the late 1980s which ended up with a bust and a banking crisis in 1991. The NB provided liquidity as a LLR (Steigum 2009) and the government arranged the fiscal resolution.

5. The Reichsbank/Bundesbank

Germany´s central bank was founded after the Franco-Prussian war and German reunification. The Reichsbank had private ownership but public management and it had operational independence. It was established to unify the currency, preserve gold convertibility, to act as a central bank using its discount rate to backstop the money market (the market for banker's acceptances) and to be a lender of last resort.

The Reichsbank was very successful in maintaining gold convertibility until World War I. It followed the rules of the game (McGouldrick (1984), Bordo and Eschweiller 1994). It was also a successful lender of last resort in the financial crises of 1901 and 1907.Germany abandoned the gold standard in World War I and like the central banks of the other belligerents it used a low interest rate peg to fund the fiscal deficit. Its independence was subordinated to the treasury. Germany had one of the highest inflation wartime rates of the belligerents.

After defeat in 1918, the Reichsbank still was an engine of inflation and was part of a fiscally dominant regime (Leeper and Walker 2011). The weak Weimar government could not solve the fiscal impasse resulting from the demands for reparations and reconstruction. This led to a major hyperinflation which ended with a currency reform in 1924 which created a new currency, the Reichsmark, and restored gold convertibility at a vastly devalued parity as well as budget balance. The Reichsbank maintained macro stability for the next five years. Germany was hard hit by the Great Depression. The Bruning government and the Reichsbank followed gold standard orthodoxy and resisted countercyclical policy while Germany imported depression from the US via the gold standard. The Austrian Credit Anstalt crisis of May 1931 spread to Germany in July leading to a banking and currency crisis. The German monetary authorities rescued most of the banks and imposed exchange controls, leaving the gold standard de facto.

Under Hitler the Reichsbank became part of the German government and helped finance rearmament and the war effort, producing high but suppressed inflation. After the war the allies established the Deutsches Lander bank. Like the Federal Reserve, it was to be a loose federation of regional banks coordinated by a Board. Its mandate was to preserve price and exchange rate stability. It was given independence from the Federal Government. The Currency Reform of 1948 ended inflation and created a new currency, the Deutschemark. The BdL based on the stability culture of postwar Germany focused on price stability though, as argued by de Haan (this volume), the primacy of the price stability objective did come into conflict from time to time with the need to maintain stable exchange rates. In general, however, price stability was an important objective for the Bundesbank. It was succeeded by the Bundesbank (DBB) in 1957. West Germany was part of the Bretton Woods system and the DBB faced an ongoing conflict between maintaining the dollar peg of the Deutsche Mark (DM) and internal price stability. Germany experienced more rapid productivity advance and growth than most of its trading partners leading to persistent balance of payments surpluses and capital inflows. This led the German authorities to impose capital controls on inflows and to revalue the DM in 1961 and 1969. After the breakdown of the BWS, the DBB focused on price stability. It was not successful in avoiding the first oil price shock in 1973 and in 1974 adopted a money growth targeting strategy. It followed the monetarist approach in targeting central bank money (like M3) and gradually reducing its targets. But it often missed. Its policies made Germany's inflation rate (along with Switzerland) the lowest among advanced countries during the Great Inflation period. The DBB followed money targeting until the early 1990s. When the euro was created in 1999 and the ECB became responsible for monetary policy in the Eurozone although the Bundesbank retained an important influence on the common currency area's central bank. The DBB's monetary strategy influenced the ECB's two pillar approach that incorporates a role for the "monetary pillar" that continues to recognize the role of money in the medium-term (e.g., see Issing 2005).

6. *The Bank of Japan* [1]

The Bank of Japan was founded in October 1882, 15 years after the Meiji restoration. Once Japan opened up to the West it quickly tried to adopt best practice institutions to create the framework for rapid economic development. In 1872 Japan adopted something similar to the National Banking System in the United States. For a number of years there were 4 banks of issue which later grew to 173 banks. High inflation induced by the expansion of bank notes in 1877 led to the search for a true central bank. The government modeled the Bank of Japan on the Belgian central bank.

The BOJ was under the supervision of the Minister of Finance. It was given the sole right to issue convertible notes. In addition to regulating the currency, like the First and Second Banks of the United States, it was also supposed to aid in the development of the financial system. Other tasks included keeping interest rates low, helping finance the Treasury and discounting bills of exchange.

The BOJ operated a discount window available to the large banks who in turn supplied the smaller banks. The financial system developed rapidly after the creation of the BOJ. There were 1457 ordinary banks, 52 specialized banks and 684 small savings banks in 1913 (Schiffer 1962).

Japan initially was on a silver standard but adopted the gold standard in 1897. Between 1871 and 1897 the system was bimetallic and the system was challenged by the global silver inflation of the 1870s and

[1] For helpful research on this section we thank Ryuichiro Izumi.

1880s, as was the case in the US. In 1897 after defeating China, Japan used its gold indemnity to create the gold reserves necessary to join the gold standard (Sussman and Yafeh). Japan adhered to gold convertibility until the outbreak of World War I and the BOJ followed the rules of the game.

World War I led to high inflation driven by foreign demand for Japanese goods and a balance of payments surplus and gold inflows were accommodated by the BOJ's note issue (Tamaki 1995) and a departure from the gold standard as in most countries. The postwar retrenchment in monetary policy led to deflation as in other countries. As in many European countries there were a series of bank failures 1920-1922 and the BOJ extended emergency lending complemented by a government sponsored rescue. The Great Kanto Earthquake of 1923 led to banking distress which was alleviated by access to the BOJ's discount window. A subsequent banking crisis in 1927 was also dealt with by BOJ lender of last resort actions. It was followed by a new Banking Act in 1928 which gave the BOJ bank supervision authority (Cargill, Hutchison and Ito 2001),

Japan returned to the gold standard in January 1930 but it only stayed on gold until shortly after the UK suspended gold convertibility in September 1931. As Japan drifted toward war in the 1930s the BOJ became an integral part of war finance. A new Bank of Japan Law in 1942 placed the BOJ officially under control of the Ministry of Finance and as with other belligerents BOJ became an engine of high inflation. Its dependent role continued in the immediate postwar period. The Finance Law in 1947 and an amendment in 1949 reduced to some extent the bank's role in accommodating the government's fiscal deficits but the Ministry of Finance was still dominant.

The Dodge Plan in 1949 led to a fiscal and monetary reform and a commitment to a pegged exchange rate, and price stability was restored by 1952. Japan pegged its rate at 360 yen to the dollar and became part of the Bretton Woods System although it did not declare current account convertibility until 1961. The decades of the 1950s and 60s were associated with rapid productivity driven real growth. Like

Germany, Japan ran successive balance of payments surpluses and the BOJ attempted to stem their inflationary consequences and like China many decades later, kept the yen at an undervalued level using various forms of exchange market intervention and capital controls. During the 1950s and 60s the BOJ developed new tools of monetary policy including window guidance (limits on commercial bank borrowing), changes in the discount rate, operations in the interbank market, changes in reserve requirements and in 1962 open market operations.

After the collapse of the Bretton Woods system in 1973 Japan adopted a (managed) floating exchange rate. During the 1970s, Japanese inflation picked up as in the rest of the world. The BOJ under the Ministry of Finance's control accommodated the first oil price shock in 1973 -74 leading to an upsurge in inflation (Ito 2013). However, in the case of the second oil price shock in 1979 the BOJ asserted its de facto independence and did not accommodate the shock. This shift to tight money decoupled Japan's inflation rate from the US and most advanced countries with the principal exception of Germany and Switzerland. Thereafter the BOJ began using monetary aggregates as their intermediate policy indicator and followed the monetarist objective of maintaining low inflation.

In the 1980s, as in many other countries the financial sector was liberalized. This set the stage for the bubble and later bust in 1990 which transformed the Japanese economy from one of high growth to one of secular stagnation. Many argue that the asset price bubble in stocks and real estate was triggered by the disastrous decision at the Plaza Accord in 1995 to have Japan follow loose monetary policies to weaken the yen against the dollar and help the US deal with the political economy of a strong dollar (Bordo and Schenk 2017). The loose monetary policy interacted with financial liberalization to produce asset price booms in stocks and real estate (Ito and Iwaisako 1995). The boom ended with tight BOJ monetary policy in 1989 to stem a buildup in inflation. The asset price collapse fed into the banking system and into the real economy. The BOJ and the MOF have been heavily criticized by Western economists for not speedily and effectively dealing with the banking crisis and the stagnation that plagued the Japanese economy for 3 decades (Krugman 1998, Bernanke 2004)).

The BOJ gained formal independence in the Bank of Japan Law of 1998 which gave the BOJ responsibility for price stability with shared responsibility with the MOF for financial stability. To deal with on again off again deflation and very sluggish growth, the BOJ began following a policy of Quantitative Easing in 2001. This policy of open market purchases of long term government securities as well as mortgage backed securities and private securities was a way of conducting expansionary monetary policy in the face of the zero

lower bound on short term securities. The policy was followed until 2006 with only moderate success.

During the Financial Crisis of 2007-2008, the BOJ followed standard LLR policies as well as non-traditional policies to support the corporate sector. The Japanese financial system was not as hard hit by the subprime mortgage crisis as were the banks of many European countries. The BOJ joined with other central banks in the dollar swap arrangements sponsored by the Federal Reserve in October 2008. Also, Japan along with other advanced countries in the G20 agreed to coordinate their expansionary monetary and fiscal policies.

Although Japan was not hit as hard by the Great Recession, the problem of sluggish growth and putative deflation remained. In 2012, the incoming Liberal Democratic Party under Prime Minister Shinzo Abe announced the “Three Arrows “stabilization package. This encompassed an explicit inflation target of 2 per cent; enhanced expansionary quantitative and qualitative easing policies by the BOJ including policies to depreciate the yen. Finally, the Japanese Government was to enact structural reforms to increase real growth (the third arrow). The strategy has so far been successful in depreciating the yen but less so in raising inflation toward the target and stimulating the real economy.

7. The Banca D’Italia

The Banca D'Italia was founded in 1893, 30 years after Italy was united. In the interim three competing banks of issue operated in different parts of the country. The Banca like other European Central banks of the era was privately owned and independent. Its mandate was to unify the currency, serve as the base of the payments system and maintain convertibility. It turned out that maintaining convertibility was problematic. Italy was initially on the bimetallic standard until 1883 and was part of the Latin Monetary Union. It then joined the gold standard but its adherence to specie was chequered, reflecting ongoing fiscal pressures coming from frequent wars. Italy was off specie 1861 to 1883, then on gold for 10 years 1881 to 1893, then off 1892 to 1902, and then it shadowed gold until World War I. In this later period the Banca kept prices stable. The Banca also acted as a lender of last resort in the global banking crisis of 1907 but was less successful in the timely provision of liquidity in the crisis of 1893. During World War I Italy suspended the gold standard and the Banca acted as an engine of inflation as did the central banks of its fellow belligerents. After the war the Banca lost its independence in 1922 with Mussolini's accession to power. The Banca followed a tight monetary policy in the 1920s and returned to the gold standard at a devalued parity after 35 years the Banca followed orthodox policies until 1935. Italy was also in the Gold Bloc and, like Belgium, was forced off gold in 1935. Italy was hit by a series of banking crises during the Great Depression and the Banca and two new State institutions (IRI and IMI) saved the major banks from collapse.

During World War II the Bank fueled high inflation with its accommodative discount policies. The fiscal dominant regime continued after the war and Italy had a significant inflationary overhang until the 1950s. Italy joined the Bretton Woods system in 1946 and declared current account convertibility in 1960. During the Bretton Woods era Italy generally followed stable monetary policies under Governor Guido Carli with the exception of a few years in the early 1960s which led to a currency crisis and IMF rescue in 1964. with the breakdown of Bretton Woods the Banca became subservient to the Treasury and fueled the highest inflation rate during the Great Inflation period (Fratianni and Spinelli 1992) leading to a serious currency crisis and IMF rescue in 1976. Italy had a chequered experience with the Snake in the Tunnel exchange rate arrangement in the 1970s because of the Banca's inflationary policies. Like France, Italy joined the EMS in 1979 as an inflationary disciplinary device (Pagano and Giavazzi 1987) but was forced out in the EMS crisis in 1992. The Banca D'Italia achieved goal independence from the Treasury in 1992 but did not become an inflation targeter. In the rest of the decade the Bank was able to keep inflation low and the fiscal authorities were able to reduce the key fiscal markers (Debt to GDP and the Fiscal deficit) to levels that allowed Italy to join EMU in 1999 and to adopt the Euro and the ECB.

8. The Swiss National Bank

The Swiss National Bank (SNB) was established in 1907. Its mandate was to adhere to the specie standard, serve as the basis of the payments system and to provide financial stability (Bordo and James 2008). Unlike earlier banks of issue it was not set up to aid the fiscal authorities. Like the Federal Reserve, founded 6 years later, the SNB adhered to the real bills doctrine and was to freely discount eligible bills of credit for the Swiss commercial banks. Switzerland left the gold standard in 1918 and had high (internationally driven) inflation. After World War I the SNB followed a deflationary policy to restore the gold standard *de facto* 1924 and de jure 1926.

Switzerland was exposed to the global depression in the 1930s and a number of banks faced stringency in 1931 to which the SNB provided liberal liquidity support.

Switzerland was part of the Gold Bloc and stayed on gold until 1936 when like France it devalued and began floating. During World War II Switzerland remained neutral. After the war, the SNB like the DBB followed the stability culture and kept inflation low throughout the post-World War II period. Switzerland did not join the gold standard but defined the franc in terms of gold. Like Germany, by keeping inflation low, ran continuous balance of payments surpluses which led to inflationary pressure. The SNB did not sterilize these inflows but rather imposed capital controls on inflows. With the collapse of the Bretton

Woods System Switzerland floated the franc in 1973 and followed a monetary targeting strategy to maintain price stability. The SNB targeted the monetary base. Its policies were generally successful and during the Great Inflation period Switzerland's inflation rate was lower than virtually all other advanced countries.

Switzerland's reputation for monetary and financial stability its efficient banking sector as well as Switzerland's bank secrecy laws led to continuous capital inflows putting upward pressure on the money supply making it difficult for the SNB to hit its monetary base target so that in 1978 it temporarily suspended its target. The SNB was generally able to hit its target until 1986, after which external shocks put upward pressure on the Swiss franc and on money and prices forcing Switzerland to abandon its base control strategy and to shift to a version of inflation targeting in 1999, namely inflation forecast targeting, while still monitoring monetary aggregates as predictors of future inflation. In the financial crisis of 2007 -2009 several big banks were hard hit by their exposure to subprime mortgage derivatives and posed a grave threat to the Swiss economy because of their sizes. An earlier crisis during the 1990s, also involving mortgage lending arguably produced even larger economic costs than in the aftermath of the GFC (e.g., see Junge and Kugler 2013). The SNB and the Swiss government arranged an effective rescue package following the latest financial crisis and have imposed strict regulations to prevent further exposure to global turmoil. More recently, Swiss monetary policy made headlines by abandoning flexible exchange rates that led to a steady appreciation of the Swiss Franc. Instead, in 2011, the SNB pegged the exchange rate to the euro to forestall further appreciation. In so doing, the SNB's balance sheet soared due to the expansion of foreign exchange reserves as a reflection of the continued upward pressure on the Franc. On the eve of QE in the Eurozone the SNB abandoned the peg in January 2015. '…to the perfect surprise of markets, …" Instead, it pivoted toward using negative interest rates to achieve its monetary policy objectives. Negative interest rates prevailed to this day.

9. The U.S. Federal Reserve

The Fed was founded in 1913 to provide financial stability and especially to act as a lender of last resort and also to maintain the U.S. adherence to the gold standard. The U.S. had not had a central bank since the demise of the Second bank of the United States in 1836. In the interim there were frequent banking panics, the worst one, the Panic of 1907 led call for monetary reform. The National Monetary Commission suggested that the US have a regional system of central banks modelled both on the clearing houses that had prevailed in the National Banking era and the German Reichsbank. The Federal Reserve System consisted of 12 autonomous (privately owned) regional banks with their own discount policy supervised hy a government appointed board in Washington DC. (Bordo and Wheelock 2010). The Reserve banks would use their discount rates to freely accommodate commercial bills and act as lenders of last resort. During World War I the US stayed on the gold standard and, until the U.S. entered the war in April 1917, it imported inflation from gold flows from the belligerents. Once the US entered the War, the Federal Reserve, like other central banks accommodated short term Treasury bills at a low pegged rate acting as an engine of inflation. Prices rose by 100% which was considerably less than the other belligerents.

In 1919 the Fed raised its discount rate to protect its gold reserves leading to a sharp recession in 1920-21. . There was no financial panic in that recession which some attribute to the presence of the Fed as a lender of last resort (Rottemberg 2014). In the 1920s the Federal Reserve System developed open market operations as its principal tool of monetary policy and began to conduct countercyclical policies to both maintain price stability and real economic stability.

The great Contraction which began in the summer of 1929 has been blamed on the Fed's pursuit of tight money in 1928-29 to stem the Wall Street stock market boom, and then its failure to act as a lender of last resort to allay a series of 4 banking panics 1930-33 9 Friedman and Schwartz 1963). This led to an over 30% decline in the money supply and a similar decline in output and the price level and a collapse of bank lending (Bernanke 1983). Recovery from the contraction began in March 1933 after the incoming President Roosevelt declared a one week banking holiday which closed one sixth of the nation's banks and took the US off the gold standard and later in 1934 devalued the dollar by 60%. These actions which greatly increased the monetary gold stock and the money supply helped reflate the economy. These actions were taken by the US Treasury and not the Federal Reserve which continued to follow a passive monetary policy. The recovery was interrupted by a sharp recession in 1936-37 precipitated in part by the Fed's doubling of reserve requirements to soak up excess reserve (and prevent a future asset price boom and inflation).

The Federal Reserve System was greatly reorganized in the Bank Act of 1935 which consolidated power in the Board of Governors in Washington. In the 1930s and 1940s the Fed lost its independence to the Treasury and followed a low interest rate peg to facilitate Treasury fiscal operations. This fueled inflation during World War II. After the war the Fed pushed to restore its independence from the Treasury and to use its policy tools to end inflation. The Fed was successful in restoring its independence after the Federal Reserve Treasury Accord of February 1951. In the 1950s the Fed under the stewardship of Chairman William McChesney Martin followed monetary orthodoxy and maintained price stability. It used its policy tools (open market operations, the discount rate and changes in reserve requirements) to conduct counter cyclical policy during several business cycles.

Beginning in 1965 under pressure from the Johnson administration to finance the Vietnam war and the Great Society the Fed began to follow accommodative expansionary monetary. This led to the Great Inflation from 1965 to 1982 when prices increased to the double digit level. In the 1970s the Fed followed Keynesian doctrine and geared its policies to maintain full employment at the expense of inflation. The Fed also accommodated the two oil price shocks of the 1970s. On several occasions under Chairman Arthur Burns the Fed tightened monetary policy to reduce inflation and inflationary expectations but as unemployment rose the Fed backed off from its tightening. This pattern led to a ratcheting up of inflationary expectations.

By 1978 high and variable inflation led to a precipitous drop in the dollar exchange rate. This crisis finally led President Carter to appoint Paul Volcker as Chairman of the Fed with a mandate to break the back of inflation and inflation expectations. Volcker pursued a monetarist policy of greatly reducing monetary aggregates and allowing short term rates to rise to 20%. This strategy led to a serious recession in 1980-82 but was successful in reducing inflation and defusing inflationary pressures. The decline in inflation to 4 % by 1985 restored the Fed's credibility. Thereafter for over 15 years the Fed followed a policy of low inflation. It followed the dual mandate but attached greater weight to inflation than unemployment on the argument that price stability would foster growth and high employment. This was in sharp contrast to the 1970s. In the 1980s the Fed returned from using monetary aggregates to short term interest rates as their policy instrument. Alan Greenspan succeeded Paul Volcker as Chairman of the Fed and continued to follow his low inflation strategy. Greenspan also followed classic Bagehot LLR doctrine during the Stock market crash of October 1987 and pumped ample liquidity into the New York money market to prevent a financial crisis.

The financial crisis of 2007 -2008 may have in part been precipitated by the Fed keeping its policy rates too low (relative to the Taylor Rule) between 2003 -2005 to prevent the economy falling into deflation after the tech bust and recession of 2001-2002. It also did not use its regulatory powers to prevent the use of subprime mortgages and a run up in leverage in the financial system. In the face of the crisis and the recession, the Fed used expansionary monetary policy in the fall of 2007 and then after the collapse of Lehman brothers in September 2008 it developed several unorthodox discount window policies. These policies combined with the Treasury's TARP plan, stress tests and an inter-central bank swap arrangement ended the crisis. By late fall 2008 the Fed's policy rate had hit the zero lower bound and the recession was still ongoing. This led the Fed to begin following Quantitative

Easing policy (QE1)- the purchase of long term Treasury securities and mortgage backed securities. This policy was followed in the next four years by three other packages in the face of an unprecedented slow recovery (Bordo and Haubrich 2016). These policies quadrupled the Fed's balance sheet and the issue still remains about how the Fed will exit from its expansionary stance and wind down its balance sheet,

10. *The Bank of Canada*

The BoC was founded in 1935 during the Great Depression. Canada had managed for 70 years without a central bank. It had no banking panics and adhered to the gold standard in peace time. The main reasons it was established were because other countries had them and to deal with the ongoing slump (Bordo and Redish 1987). The Bank's early functions were to manage monetary policy using conventional tools and to stabilize the macro economy and the exchange rate. (Nuffield 1972). The Bank was initially private but it was nationalized in 1938. During World War II it managed the government's debt and financed the fiscal deficit running a cheap money policy until the end of the 1940s. Both exchange and price controls were imposed. In the early 1950s the Bank was involved in developing a money market so that it could conduct traditional monetary policy using its discount rate. It kept its discount fate as a penalty rate floating one quarter of a per cent above the market rate. In addition to discount rate policy the Bank used moral suasion to pressure the concentrated chartered banks to follow its wishes.

Canada joined the Bretton Woods system in 1945 but had continuous difficulties in maintaining the parity because of continuous capital inflows from the US to gain access to Canada's natural resources. After two adjustments Canada pegged in 1949 but then with the advent of the Korean war and massive capital inflows Canada began floating in 1950 and kept doing so until 1961 (Bordo, Dib and Schembri 2008). Considerable evidence suggests that Canadian monetary policy operated well and the Canadian economy was well insulated from the US business cycle. Under pressure from the IMF Canada returned to the par value system from 1962 to 1970, then leaving it permanently in 1970 as the BWS collapsed.

In the 1970s, Canada ran high inflation for many of the same reasons as the US, UK and other countries. In an attempt to control inflation the Bank adopted monetary aggregate targeting and a policy of Gradualism in the 1980s. It was not very successful reflecting financial innovation and other factors which shifted the demand for money. By the end of the 1980s the Bank abandoned its monetarist strategy and began inflation targeting in 1991. It has been one of the most successful and credible central banks ever since then.

Canada mostly avoided exposure to the Financial Crisis of 2007 -2008. Its concentrated Universal banking system and single regulator were key reasons. Also it was not a global financial center (Bordo, Redish and Rockoff 2015). During the crisis in 2007 the Bank did follow LLR actions and created emergency lending facilities to allay a run on the shadow banks. Like the Fed, to deal with the global recession in 2008, the Bank was the first central bank to use forward guidance since the BoJ in the 1990s.