

Israel, Karl-Friedrich

**Article — Published Version**

## The fiat money illusion: On the cost-efficiency of modern central banking

The World Economy

**Provided in Cooperation with:**

John Wiley & Sons

*Suggested Citation:* Israel, Karl-Friedrich (2021) : The fiat money illusion: On the cost-efficiency of modern central banking, The World Economy, ISSN 1467-9701, Wiley, Hoboken, NJ, Vol. 44, Iss. 6, pp. 1701-1719,  
<https://doi.org/10.1111/twec.13028>

This Version is available at:

<https://hdl.handle.net/10419/230222>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



<http://creativecommons.org/licenses/by/4.0/>

# The fiat money illusion: On the cost-efficiency of modern central banking

Karl-Friedrich Israel 

Institute for Economic Policy, Leipzig University, Leipzig, Germany

## Funding information

Open access funding enabled and organized by Projekt DEAL

## KEYWORDS

Bank of England, Bank of Japan, central bank, Eurosystem, Federal Reserve System, fiat standard, gold standard, operating expenses

## 1 | INTRODUCTION

Monetary policy has become more and more activist since it had been entirely freed from its golden fetters in the 1970s. The end of Bretton Woods marked the beginning of a global monetary system based on unbacked fiat money. The potential and the dangers of such a system have been widely discussed in the economics literature, and they remain highly contested (Blinder, 2013; Friedman & Schwartz, 1986; Polleit, 2011).

For many economists, the exogenous political management of a flexible money stock contains an essential part of the solution to major macroeconomic problems, such as low growth, unemployment and the business cycle (Bernanke, 2013; Clarida, Galí, & Gertler, 1999; Feldstein, 2010; Galí & Gambetti, 2009). For others, it is one of the root causes of these phenomena (Calomiris & Haber, 2014; Howden & Salerno, 2014; Selgin, Lastrapes, & White, 2012). In their eyes, financial market instability, systemic risk and growing macroeconomic fluctuations are in large measure due to monetary policy interventions that would never be possible in a system based on the principle of sound money developed in classical political economy (Mises, 1953, ch. 21).

Economic history provides numerous examples of the dangers of excessive monetary intervention.<sup>1</sup> This might be the reason why for the longest time in the history of economic thought, the argu-

<sup>1</sup>By the term monetary intervention, we refer to political measures to expand the money stock. Historical examples of excessive monetary interventions include, for example, ancient Rome which experienced a hyperinflation during the third century. Similar inflationary experiences were made in China during the first century and multiple times between the 11th and 15th centuries, or in Renaissance England under the reign of Henry VIII, in France during the revolutionary period and in the United States after the war for independence (Davies 2002; He 2018).

ment for, first of all, fiduciary elements in the money supply, and then ultimately a completely unbacked fiat money, was not framed in the context of its potential for monetary policy interventions. The downside was far too obvious. Political control over a flexible money stock would sooner or later corrupt the system. Advocates of inflationary policies were thus seen as cranks. The traditional economic argument was not about economic policies at all. It was much more mundane.

Traditionally, economists have referred to the costs of production as the main reason why the money stock should be freed to some extent from its precious metal base. A substantial part of the factors of production that would be devoted to gold mining, refinement and transportation could then be used for other and more productive purposes and enrich society as a whole. As far as this argument goes, it contains of course an undeniable truth. However, it is by no means an a priori necessity that any given fiat money regime actually operates cost-efficiently. Quite to the contrary, there are good reasons to believe that public or semi-public institutions that do not only enjoy political independence, but also, in a very important sense, financial or budgetary independence, become increasingly wasteful and inefficient (Mises, 1944; Niskanen, 1971).

One of the most interesting examples in this regard is the European Central Bank (ECB) whose operating expenses have grown since its inception in 1998 at an average annual rate of more than 9%. Since 2012 alone, the average annual growth rate has been above 12% (Israel, 2019). This is partly due to the fact that the ECB is a relatively young institution and that the euro area expanded several times during that period. One could suspect that the Eurosystem as a whole is exceptionally inefficient by international comparison as all member states of the monetary union have kept their own national central banks in place. But that is not the case. In this study, we look at the operating expenses of four central banks or central bank systems: the Federal Reserve System, the Bank of England, the Bank of Japan and the Eurosystem. It is shown that the operating expenses of all four of them lie above the lower-bound benchmark for the estimated costs of a generic gold standard derived from Friedman (1960), White (1999) and Garrison (1985).

Before we enter into the empirical analysis of the operating expenses of modern central banking, the following section provides a brief historical overview of the traditional cost-saving argument from the classic writers to even some members of the Austrian school, who are known for their opposition to unbacked money, as well as modern standard economic textbooks.<sup>2</sup>

## 2 | THE COST-SAVING ARGUMENT FROM THE CLASSICS TO THE AUSTRIANS TO THE MODERN STANDARD TEXTBOOK

The roots of the cost-saving argument lead us far back into the history of economic thought. It was initially not conceived as an argument for a fully unbacked money, but merely as one for a certain share of fiduciary media in the overall money stock. In other words, it was an argument for fractional-reserve banking.

Adam Smith hinted at the advantages of paper notes over commodity money in the second chapter of the second book of the *Wealth of Nations*. The first lesson to be learned from his well-known analysis is of course that the quantity of money circulating within a community is as such not part of the community's revenue or wealth. Yet, by replacing an expensive money by a cheaper one, the community's net revenue could be increased:

The substitution of paper in the room of gold and silver money, replaces a very expensive instrument of commerce with one much less costly, and sometimes equally convenient.

---

<sup>2</sup>This overview is an extension and elaboration of the one presented in Israel (2019).



Circulation comes to be carried on by a new wheel, which it costs less both to erect and to maintain than the old one.

(Smith, 2007 [1789], p. 226)

There is thus a permanent or flow element of cost saving from replacing precious metal coins by paper notes, because the notes are cheaper to maintain and replace after wear and tear from ongoing circulation.

Moreover, a one-shot gain could be obtained. Smith argued that a much smaller quantity of precious metals than the quantity of paper notes in circulation, that is, a fractional reserve, would suffice to cover occasional demands for redemption. Hence, reserves in excess of the quantity needed, in Smith's example a fifth (20%) of the volume of paper notes, could be exchanged for goods and services from abroad. This would increase the net revenue of the community.

Indeed, Smith pointed out that it would be important that the additional revenue was invested and not merely consumed, so that 'it promotes industry; and though it increases the consumption of the society, it provides a permanent fund for supporting that consumption' (Smith, 2007 [1789], p. 228). It must again be noted that Smith did not advocate an entirely unbacked money. He merely highlighted the potential benefits from reducing the amount of precious metals held in reserve for redemption.<sup>3</sup>

The argument was later made more explicit and pushed further in the writings of David Ricardo. In his *Principles of Political Economy and Taxation*, we find the following passage:

A currency is in its most perfect state when it consists wholly of paper money, but of paper money of an equal value with the gold which it professes to represent. The use of paper instead of gold, substitutes the cheapest in place of the most expensive medium, and enables the country, without loss to any individual, to exchange all the gold which it before used for this purpose, for raw materials, utensils, and food; by the use of which, both its wealth and its enjoyments are increased.

(Ricardo, 1821, pp. 262–263)

The above reflection, however, is merely theoretical. Like Smith, Ricardo did not openly advocate the abolition of convertibility of paper notes into coin and bullion, although there is a certain tension in his writings. On the one hand, he deemed it absolutely necessary to keep redeemability of paper notes into specie in place as a check against potential abuses of the note issuing privilege. Yet, on the other hand, he would allow, within certain limits, for a fluctuating market rate at which notes could be redeemed, bringing his scheme in some sense very close to a fiat standard.<sup>4</sup>

---

<sup>3</sup>As Smith (2007 [1789], p. 227) explained:

By this operation, therefore, twenty thousand pounds in gold and silver perform all the functions which a hundred thousand could otherwise have performed. The same exchanges may be made, the same quantity of consumable goods may be circulated and distributed to their proper consumers, by means of his promissory notes, to the value of a hundred thousand pounds, as by an equal value of gold and silver money. Eighty thousand pounds of gold and silver, therefore, can, in this manner, be spared from the circulation of the country; and if different operations of the same kind should, at the same time, be carried on by many different banks and bankers, the whole circulation may thus be conducted with a fifth part only of the gold and silver which would otherwise have been requisite.

<sup>4</sup>See Ricardo (1824), where his monetary reform plan is laid out. According to this plan, new notes would usually come into circulation in exchange for either old notes or precious metals. Point 12 of his plan states that: 'The Commissioners in London shall be obliged to buy any quantity of gold of standard fineness, and exceeding one hundred ounces in weight, that may be offered them, at a price not less than £3: 17s. 6d. per oz.' (pp. 18–19). This leaves of course open the possibility for a substantially higher exchange rate and relative devaluation of paper notes.

Ricardo discussed in some detail the relative advantages of granting the legal privilege of note issue to either banks or the government. He argued that society as a whole would be as well off in one case as in the other, given that the note issue follows the dictates of prudence. Yet, if the government was to issue the notes directly, the public would be relieved of interest payments accruing from banks extending loans to finance government expenses. Banks in turn would no longer receive the respective interest payments. Ricardo saw precisely this as an argument for leaving the responsibility for issuing paper notes in the hands of government.<sup>5</sup>

This line of argumentation was followed up in more detail in Ricardo's posthumously published *Plan for Establishment of a National Bank*. The author was aware of the dangers of a legal monopoly privilege and strongly advocated what would today be referred to as 'central bank independence' with strict limitations on direct government finance:

There would, I confess, be great danger of this, if Government - that is to say, the ministers - were themselves to be entrusted with the power of issuing paper money. But I propose to place this trust in the hands of Commissioners, not removable from their official situation but by a vote of one or both Houses of Parliament. I propose also to prevent all intercourse between these Commissioners and ministers, by forbidding every species of money transaction between them. The Commissioners should never, on any pretence, lend money to Government, nor be in the slightest degree under its controul or influence. Over Commissioners so entirely independent of them, the ministers would have much less power than they now possess over the Bank Directors.

(Ricardo, 1824, pp. 11)<sup>6</sup>

The cost-saving argument for unbacked paper substitutes or fiduciary media has also found its way into the writings of economists of the 20th century. It was taken up, for example, by Ludwig von Mises. According to Mises (1953, pp. 298–299), fractional-reserve banking has historically prevented a stronger increase in the exchange value of money during the time of the classical gold standard. In the course of technological progress as well as the extension of the division of labour, money would have gained much more in value (i.e., price deflation), if it had not been for an expansion of the money stock through fractional-reserve banking. As a result, less capital and labour was directed towards the mining of gold for monetary purposes and was instead available for other productive enterprises.<sup>7</sup> In his later writings, Mises rejected the alleged benefits of fiduciary media

<sup>5</sup>He provided the following example of financing government expenditures in the two alternative ways to illustrate his point:

Suppose that a million of money should be required to fit out an expedition. If the State issued a million of paper, and displaced a million of coin, the expedition would be fitted out without any charge to the people; but if a Bank issued a million of paper, and lent it to Government at 7 per cent, thereby displacing a million of coin, the country would be charged with a continual tax of £70,000 per annum: the people would pay the tax, the Bank would receive it, and the society would in either case be as wealthy as before; the expedition would have been really fitted out by the improvement of our system, by rendering capital of the value of a million productive in the form of commodities, instead of letting it remain unproductive in the form of coin; but the advantage would always be in favour of the issuers of paper; and as the State represents the people, the people would have saved the tax, if they, and not the Bank, had issued this million. (Ricardo, 1821, p. 263)

<sup>6</sup>Indeed, here seems to be another tension in Ricardo's writings as the previously mentioned advantage of leaving the note issue in the hands of the government was the interest-free finance of government expenditures, that is, direct government finance.

<sup>7</sup>A whole debate has emerged out of these statements by Mises on whether or not he was a proponent of fractional-reserve banking. See White (2014), for an interesting back and forth between some of the contenders.



altogether, arguing that they are always causing symptoms of the business cycle, whenever issued (Mises, 1998, ch. XX).

Indeed, regardless of the question of fractional-reserve banking, Mises was no proponent of central banking. He thought a free banking system under a gold standard to be more reliable in checking abuses of excessive note issue. In that regard, he was more in line with the teachings of Smith rather than Ricardo.

Moreover, Mises was not the only adherent to the Austrian School, who took up the cost-saving argument. Both Carl Menger and Friedrich von Wieser, two eminent predecessors of Mises especially in the field of monetary economics, referred in some form or another to the cost-saving argument. Menger (1970 [1909], p. 112) pointed out, in the third edition of a largely neglected encyclopaedia entry on money, that central bank-issued paper money substitutes may free up some of the precious metal otherwise used in circulation. It could be either exported or used for other productive purposes. After Menger's death, it was Wieser who wrote the entry on money for the fourth edition of the *Handwörterbuch der Staatswissenschaften*. Wieser (1926, pp. 689–699), too, emphasised the economising effect on the monetary good that credit money and unbacked paper notes may have, while of course not failing to mention the detrimental effects of an excessive note issue. Similar considerations can be found in his *Social Economics* (Wieser, 1927, pp. 258–290).

The fact that even some adherents to the Austrian School have picked this argument up underlines its importance in the history of economic thought. After all, the Austrians are associated, more than any other branch of modern economics, with advocacy of either sound commodity money or competition in the provision of money.

In fact, today, the cost-saving argument is mentioned as a matter of course, often only in passing, when the advantages of our modern monetary system are discussed. Samuelson and Nordhaus (2009, p. 459), for example, write in the 19th edition of their celebrated textbook *Economics*: 'But metallic money has shortcomings because scarce resources are required to dig it out of the ground'.

Krugman and Wells (2015, pp. 856–857) make a direct reference to Adam Smith's famous metaphor for paper money as being a 'waggon-way through the air'. According to them, the 'big advantage of commodity-backed money over simple commodity money, like gold and silver coins, was that it tied up fewer valuable resources'. Banks would have 'to keep only enough [reserves] to satisfy demands for redemption of its notes'. And only a couple of paragraphs later they rhetorically ask: 'why make any use at all of gold and silver in the monetary system, even to back paper money?' And the answer the student gets is that we do not actually use it anymore, because an unbacked fiat money 'is even more of a 'waggon-way through the air' – creating it doesn't use up any real resources beyond the paper it's printed on'.

While this could of course be true in principle, it might not actually be the case in practice. How much more cost-efficient are fiat money-producing central banks really? In order to properly evaluate the actual cost savings from fiat money, we have to estimate the resource costs of a gold standard. Only with such an estimate would we have a suitable benchmark for comparison when we look at the actual operating expenses of modern central bank systems.

### 3 | A BENCHMARK FOR COMPARISON

Such an estimate of the costs of the gold standard as a percentage of GDP was provided by Milton Friedman who probably is the modern economist who has reinvigorated the cost-saving argument most forcefully. He has pushed it to the point of explicitly advocating a complete fiat standard

(Friedman, 1960), which implies the necessity of a central bank as the very institution that controls the quantity of fiat money.<sup>8</sup>

White (1999, pp. 42–48) concisely summarises Friedman's influential estimate of the flow resource costs of the gold standard (Friedman, 1953, ch. 7; 1960; Friedman & Schwartz, 1963). He explains that Friedman decomposed the estimation of the ratio  $\Delta G/Y$ , where  $\Delta G$  is the nominal value of the change in the gold stock from one year to the next and  $Y$  denotes annual nominal GDP, into three factors:

$$\frac{\Delta G}{Y} = \frac{\Delta G}{\Delta M} \frac{\Delta M}{M} \frac{M}{Y},$$

In the above equation,  $M$  corresponds to the money stock  $M_2$ . Each of the three ratios was then replaced by its respective empirical, or indeed normative, counterpart. Friedman assumed, somewhat surprisingly, a 100%-reserve standard on  $M_2$ , and hence,  $\Delta G/\Delta M$  would have to be equal to 1. That is to say, every increase in  $M_2$  would be fully backed by an increase in the gold stock. This of course exaggerates even the suggestions of the most ardent supporters of a full-reserve gold standard, who typically are in favour of 100% reserves on the smaller monetary aggregate  $M_1$  (Rothbard, 2011, ch. 41). Friedman's estimate is thus likely to be too high.

As suggested by Friedman (1960), the money stock would have to grow by about 4% annually to ensure price stability, and hence,  $\Delta M/M$  was set equal to 0.04.<sup>9</sup> Lastly, the ratio between the money stock  $M_2$  and nominal GDP was estimated to lie around 0.625. Hence, plugging in these values one obtains,

$$\frac{\Delta G}{Y} = 1 \times 0.04 \times 0.625 = 0.025.$$

Friedman thus estimated that a 100%-gold reserve standard on the  $M_2$  money stock with an annual expansion of the money stock that ensures price stability (zero price inflation) would lead to resource costs of 2.5% of GDP each year for acquiring, refining and transporting the necessary amount of gold. This would be the amount potentially saved each year under a well-managed fiat standard.<sup>10</sup>

<sup>8</sup>As Friedman (1953, p. 216) explained:

The introduction of fiat elements into the monetary stock immediately raises the question, who is to create the fiat currency and control its issuance? Fiat currency is practically costless, whereas commodity currency is not. Under competition there will be a tendency for each kind to be produced up to the point at which its value equals its costs. This sets definite limits to the quantity of a commodity currency; it means indefinite increase in the quantity of a fiat currency and indefinite decrease in its value. There is no stable competitive equilibrium except when the fiat currency declines so much in value that it becomes a commodity currency, the commodity being the paper and services used in producing the currency. Competition is therefore inappropriate for determining the amount of a fiat currency. The production of fiat currency is, as it were, a natural monopoly, which explains why a measure of control has typically been exercised by government, why the privilege of issuing currency has been fought for so vigorously, and why proponents of a private competitive order, like Henry Simons, have held the view - which I share - that the creation of fiat currency should be a government monopoly.

<sup>9</sup>Friedman used the dynamic version of the equation of exchange which equates the sum of the annual growth rates of money and velocity to the sum of the growth rates of the price level and real output ( $\Delta M/M + \Delta V/V = \Delta P/P + \Delta Y/Y$ ). Hence, assuming a real output growth of 3% and velocity growth of -1% (i.e., velocity slows down), the money stock has to grow at 4% to ensure price stability (i.e., zero price inflation).

<sup>10</sup>It is interesting to note that Friedman himself became more critical about the relative benefits of fiat money later in his career emphasising additional resource costs of a fiat standard that emerge, for example, from hedging against increased future price uncertainty (Friedman and Schwartz, 1986). This, however, one might argue, is not a necessary cost element of a fiat standard. It comes into play only under a poorly managed fiat standard.



White (1999, p. 46), too, argues that this ‘calculation gives a huge overestimate of the resource costs of a gold standard with an advanced banking system in the absence of legal reserve requirements’. Indeed, a central characteristic of an advanced banking system in White’s sense would be the lack of legal reserve requirements. He points out that with an actual reserve ratio of about 2% instead of 100% the estimate would turn out to be 0.05% of GDP ( $0.02 \times 0.04 \times 0.625$ ).<sup>11</sup> White further suggests a downward adjustment of the growth rate of the money stock to 2%. A lower growth rate would have sufficed to ensure price stability, since velocity had increased since Friedman’s work had been published. The estimate would thus fall further to 0.025% of GDP ( $0.02 \times 0.02 \times 0.625$ ).<sup>12</sup> Moreover, White (1999, p. 48) adds that the costs could be reduced even below 0.01% of GDP when full-bodied gold coins in circulation were to be replaced by fractionally backed token coins.<sup>13</sup>

There are of course reasons to believe that White’s estimate may be downward biased due to the extremely low reserve ratio he assumed. Yet, there is also at least one important respect in which it might still be too high an estimate. As Garrison (1985) points out, the price elasticity of the gold supply in a free-market setting would not be perfect. Hence, if we assume a market-driven production of gold money, the equilibrium price inflation rate would be negative as a result of real economic growth. The effect of technological progress and economic growth would translate partly into a quantity effect, that is an expansion of the gold stock, and partly into a price effect, that is an increase of the exchange value of gold vis-à-vis other goods, or in other words, a reduction of the general price level. Hence, in a genuinely free monetary system based on gold, there would not be zero price inflation as Friedman and White assumed. There would be benign growth deflation as was observed, for example, during the period of the classical gold standard (Bagus, 2015; Borio & Filardo, 2004; Hülsmann, 2008; Salerno, 2003). So, with an annual price inflation rate of, let us say,  $-1\%$ , the estimated resource costs of the gold standard would further decrease to 0.005% of GDP.

It seems clear that this number can only serve as a rather optimistic lower-bound estimate for the annual costs of a gold standard. Gradually increasing the reserve ratio would also increase our estimate. If we were to follow Rothbard’s (2011, ch. 41) recommendation of full reserves on  $M_1$ , the estimate would, however, still be much lower than Friedman’s original number.

Over the past 20 years,  $M_1$  has on average been about 22% of  $M_2$ . At the time of White’s estimate, it was closer to a third. Hence, taking full reserves on  $M_1$ , we would obtain a gold to  $M_2$  ratio of about 0.3 with a flow resource cost estimate of 0.1875% of GDP ( $0.3 \times 0.01 \times 0.625$ ), accordingly. Allowing for possible shifts in the money-to-GDP ratio, the real growth rate and the velocity of money, we are rounding up to 0.2% of GDP and take this value as an upper-bound benchmark for comparison.<sup>14</sup> This leaves us with an estimated range of 0.005%–0.2% of GDP.

White himself proceeded to calculate the deadweight loss of increased price inflation. Assuming that his estimated annual resource costs of 0.025% of GDP for the gold standard could be avoided

<sup>11</sup>An actual reserve ratio of close to 2%, occasionally even less, prevailed, for example, during the free banking period in Scotland in the first half of the 19th century prior to Peel’s Act of 1845 (White 1984).

<sup>12</sup>The ratio of the money stock to GDP had not changed systematically according to White.

<sup>13</sup>White (1999, pp. 46–47) invoked other empirical ratios from the United States in the 1990s, such as that coins were about 8% of currency (circulating banknotes and coins), currency about 51% of  $M_1$ , and  $M_1$  about 32% of  $M_2$ . Assuming that all coins are full-bodied gold coins, he thus showed that with a 2% reserve ratio on notes and demand deposits, as in Scotland back in the days, a total of about 2% of  $M_2$  would be backed by gold in this version of the gold standard. This ratio could be further reduced with fractional-reserve token coins.

<sup>14</sup>In fact, as pointed out in Israel (2019, fn. 6) the velocity of money has slowed down again since the time of White’s publication, which would increase the estimate. However, real economic growth has decreased, too, which has an offsetting effect. By rounding up our value, we allow for a buffer.



entirely if gold was to be replaced by a fiat money, he concludes that a 'country where fiat money is managed so as to keep inflation below 4 percent can do without a gold standard; but a high-inflation country would be better off with gold' (White, 1999, p. 49).

These estimates are arguably arbitrary and could be tweaked in either direction, but it is important to note that they implicitly assume the costs of fiat money production to remain negligible over time. In the following section, we will challenge this assumption by looking at the actual operating expenses of the Eurosystem, the Bank of England, the Bank of Japan and the Federal Reserve System. Their annual operating expenses will be compared with the above range of estimated resource costs of a generic gold standard (0.005%–0.2% of GDP).

## 4 | THE OPERATING EXPENSES OF MODERN CENTRAL BANKING

As a matter of principle, it is indisputable that fiat money could be much more cheaply produced than gold or any other commodity money. Yet, it is by no means a necessity. Sure enough, a Friedmanite *k*-per cent rule with respect to some monetary aggregate could be implemented by a powerful computer network, a printing press and some, relatively small, supervisory board. The costs of production would reduce to an annual electricity bill, expenses for ink, cotton (not actually paper) and some other materials needed for banknote and coin production and distribution, computer maintenance expenses, salaries for the board members, as well as some other minor expenses, such as maybe an annual board meeting in a pleasant and stimulating environment in order to vigilantly supervise the constant growth rate. The overall costs of production of money could be truly negligible.

Modern central bank monetary policy is, however, conducted very differently. It does not follow any simple and strict rule, but implements, especially in recent years, unconventional policy interventions and discretionary adjustments. Their effects are studied empirically and theoretically by numerous expert groups who are directly or indirectly on the payroll of central banks.<sup>15</sup> Modern monetary policy is based on relatively costly data gathering and processing and requires very close and careful supervision of various macroeconomic developments both on the domestic and the international level. The overall operating expenses ultimately turn out to be much higher than one might have expected.

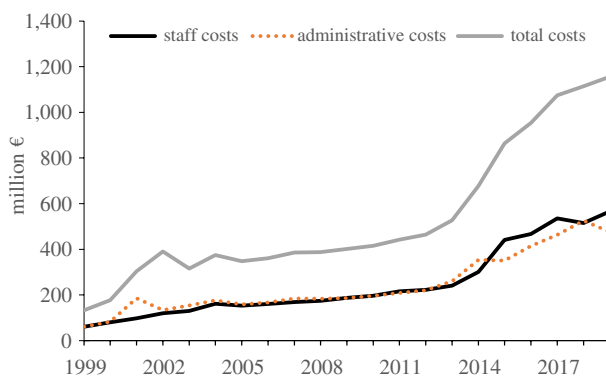
The economic theory of bureaucracy as developed by Mises (1944) and Niskanen (1971), for example, suggests that bureaucratic institutions that are not subject to strict profit and loss accounting like conventional businesses tend to become less cost-efficient over time. Primary concerns for such institutions are the maximisation of their own budgets in order to increase their power, their prestige or the career opportunities of their employees within the boundaries set by bureaucratic management.

As pointed out in the introduction to this paper, the case of the European Central Bank is of particular interest, since it is a young and still rather dynamic public policy institution, which lends itself perfectly to illustrating some central public-choice considerations (Tullock, Seldon, & Brady, 2002).

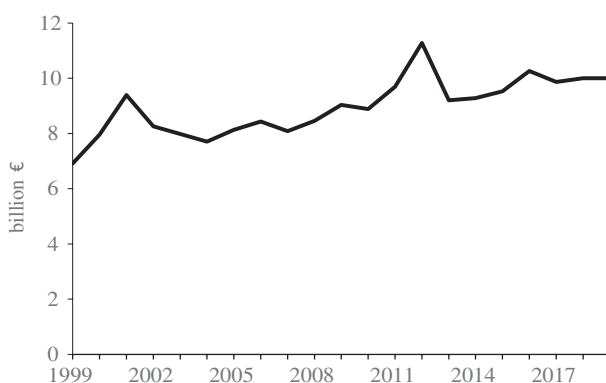
### 4.1 | The Eurosystem

Figure 1 contains the development of the total annual operating expenses as reported in the annual financial statements of the ECB since 1999. Total operating expenses have reached about €1,156

<sup>15</sup>In fact, for the United states, White (2005, p. 325) estimates that 'some 74 percent of the articles on monetary policy published by US-based economists in US-edited journals appear in Fed-published journals or are co-authored by Fed staff economists'.



**FIGURE 1** Annual operating expenses of the European Central Bank 1999–2019. Sources: Annual Reports of the ECB [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]



**FIGURE 2** Annual operating expenses of the Eurosystem 1999–2019. Sources: Annual Reports of the ECB and the respective national central banks of the Eurosystem

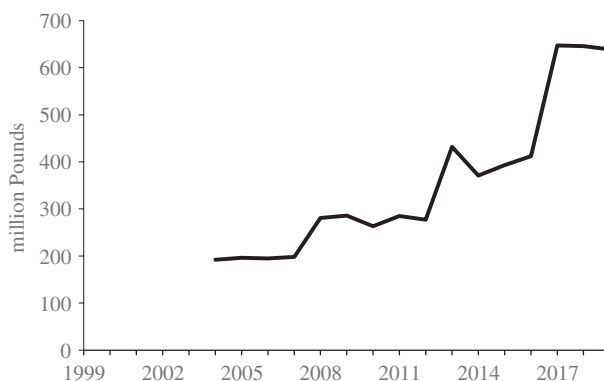
million in 2019. The figure also includes the time series for the two most important items of expenditure, namely staff costs and administrative expenses, which amounted to €566 and €476 million during the same year, respectively.<sup>16</sup> Overall the full-time staff of the ECB has increased from 732 in 1999 to 3,770 in 2019. While this is justified to some extent by the expansion of the euro area over this time period, it must also be recognised that all the national central banks of the member states are still working within the union, and they have not actually reduced their own expenses as political authority was transferred to the ECB in Frankfurt.

In order to account for the operating expenses of the entire Eurosystem, we have to look at 20 institutions: 19 national central banks and the ECB. Figure A1 in the Appendix contains their individual annual expenses.<sup>17</sup> Figure 2 shows the overall sum. The plot takes account of the changing composition of the Eurosystem over time.<sup>18</sup>

<sup>16</sup>For a more detailed discussion of all items of expenditure, see Israel (2019).

<sup>17</sup>Figure A2 in the appendix also contains their expenses relative to nominal GDP.

<sup>18</sup>The initial 12 founding members of the monetary union at the time the euro was introduced as a cash currency and became the exclusive legal tender in 2002 were Belgium, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Greece, Spain, Portugal, Austria and Finland. Slovenia entered in 2007. Cyprus and Malta followed in 2008 and Slovakia in 2009. Estonia adopted the euro in 2011, and finally, Latvia and Lithuania followed in 2014 and 2015, respectively.



**FIGURE 3** Annual operating expenses of the Bank of England 2004–2019. Sources: Annual Reports of the Bank of England from 2004 to 2018

The Eurosystem's total annual operating expenses amounted to € 10,003 million in 2019, which corresponds to 0.088% and 0.084% of the euro area's nominal GDP for that year. The actual operating expenses of the Eurosystem are thus well above our lower-bound estimate for the resource costs of a generic gold standard (0.005% of GDP).<sup>19</sup> Over the entire period, total annual expenses of the Eurosystem have corresponded to 0.099% of nominal GDP, which is about half the size of our upper-bound benchmark (0.02% of GDP). It is equal to the estimated costs of a gold standard with a 50% reserve ratio.

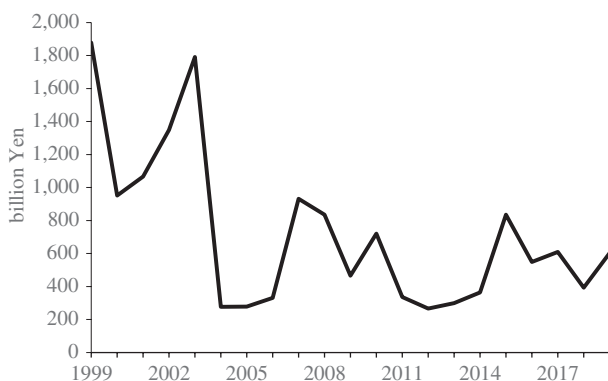
## 4.2 | The Bank of England

The next currency area we consider is the one of the British pound. The institutional structure in this case is much less complicated than for the Eurosystem, and there are good reasons to believe that it is more cost-efficient. There is only one central bank that controls the issue of the base money stock, namely the Bank of England based in London.

Figure 3 captures the development of the overall operating expenses of the Bank of England between 2004 and 2019. They amounted to £639 million in 2019, which is equal to 0.029% of the United Kingdom's nominal GDP for that year. While this is merely a third of the relative costs of the Eurosystem, it is still higher than our lower-bound benchmark. It is also higher than White's original estimate (0.025%).

Over the entire period, the annual operating expenses of the Bank of England show a strong upward trend, not unlike the trend we have seen for the ECB. In fact, they have more than tripled which corresponds to an average annual growth rate of 8.3%. This trend is undoubtedly linked to the most recent financial crisis. The first strong increase occurred between 2007 and 2008. As early as 2004, the annual operating expenses were only 0.015% of GDP, which is still three times as high as our lower-bound benchmark. The sharpest increase occurred from 2016 to 2017 after the Brexit referendum. The Bank of England expanded its operations, for example, by implementing the new firm-level survey Decision Maker Panel (Bloom et al., 2019), to cope with the potential economic disruptions and increased uncertainty the referendum has caused.

<sup>19</sup>For a more detailed discussion of the particular features that are shown in Figures A1 and A2 in the Appendix, such as the peak for the Central Bank of Greece in 2012, see again Israel (2019).

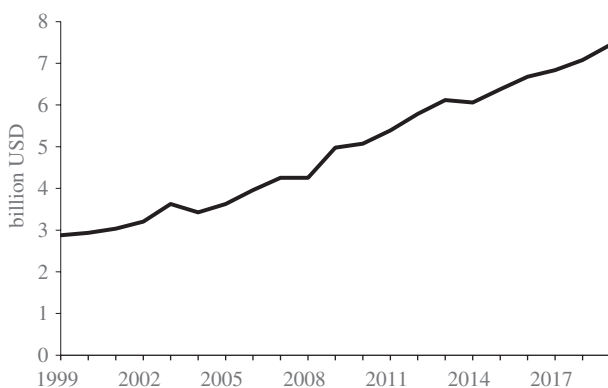


**FIGURE 4** Annual operating expenses of the Bank of Japan 1999–2019. Sources: Annual Reports of the Bank of Japan

### 4.3 | The Bank of Japan

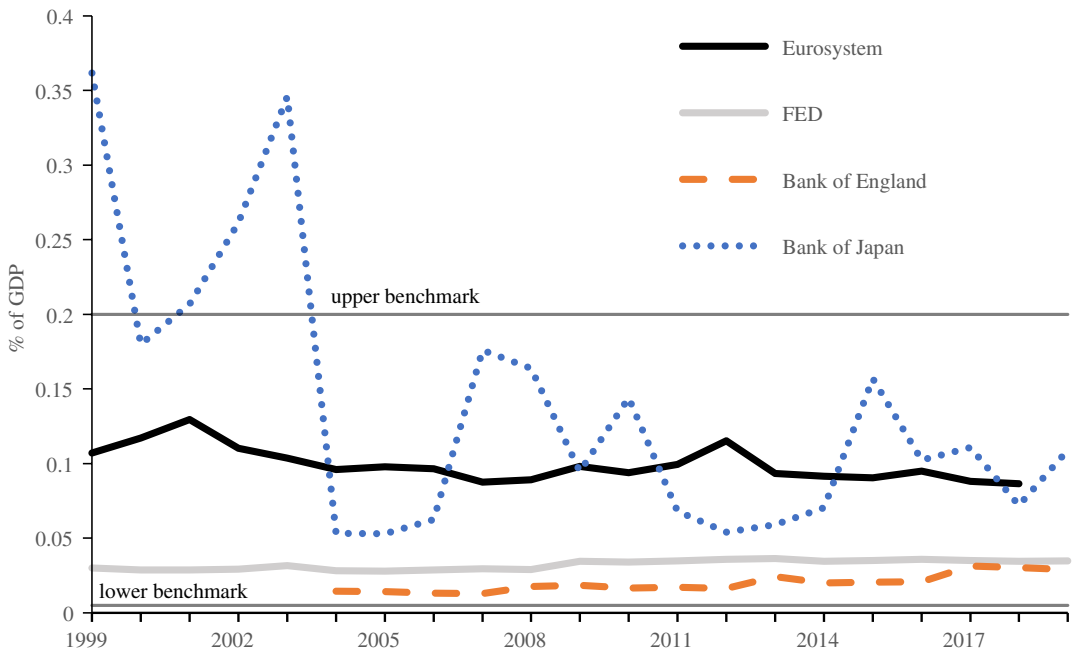
The third currency area considered in this study is Japan. Just as in the previous case, there is only one institution to consider here, the Bank of Japan. Its operating expenses are shown in Figure 4.

There is no clear trend visible in this case. What stands out are the extremely high values between 1999 and 2003. In 1999, overall expenses amounted to ¥1,877 billion, which corresponds to 0.362% of Japan's annual GDP for that year. This is even 80% higher than our upper-bound estimate for the resource costs of a gold standard (0.2% of GDP). The sharp decline after 2003 is due to a change in the accounting standards applied by the bank. After 2003, Japanese government bonds held by the bank are valued at amortised costs, whereas before the total of net losses on sale and arising from redemption of government bonds as well as losses arising from devaluation of government bonds were reported (BoJ, 2005, p. 125, fn. 5). The extremely high values coincide with the stock market downturn and economic turmoil towards the end of Japan's lost decade (Hayashi & Prescott, 2002).<sup>20</sup>



**FIGURE 5** Annual operating expenses of the Federal Reserve System 1999–2019. Sources: Consolidated Financial Statements of the Federal Reserve System

<sup>20</sup>I would like to thank my colleague Taiki Murai who helped me gather the data prior to 2003, which is not publicly available, and corresponded with employees of the Bank of Japan in order to shed light on the drop in operating expenses after 2003.



**FIGURE 6** Annual operating expenses of the Eurosystem, the Bank of England, the Bank of Japan and the Federal Reserve System as percentages of nominal GDP 1999–2019 with the lower and upper bound of the estimated costs of a generic gold standard. Sources: Annual Reports of the respective central banks; GDP data from FRED Economic Data St Louis Fed (Japan and US), Eurostat (euro area), Office for National Statistics (UK) [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

Since 2004, the operating expenses fluctuated between ¥277 billion in 2005 (minimum) and ¥931 billion in 2007 (maximum), which corresponds to values between 0.05% and 0.18% of annual GDP. These are below the upper bound, but still well in between our two benchmark estimates. Although there is only one single central bank in control of the base money supply of the Japanese yen, it is even more costly than the central bank system of the euro area in terms of its relative operating expenses.

#### 4.4 | The Federal Reserve System

Lastly, we look at the Federal Reserve System (FED), another system of multiple central banks that manages the US dollar, still the most important fiat currency in the world.

The FED consists of 12 regional banks that are located throughout the United States: Boston, New York City, Philadelphia, Cleveland, Richmond, Atlanta, Chicago, St Louis, Minneapolis, Kansas City, Dallas and San Francisco. A consolidated financial statement for all these banks is published every year, including an overall profit and loss account.

Figure 5 contains the overall annual operating expenses of the FED. In absolute terms, they are slightly more than half the operating expenses of the Eurosystem, despite the United States being larger in terms of GDP. There is an upward trend in the time series that reached \$7,436 million in 2019. For that year, the total expenses of the FED corresponded to 0.035% of GDP, which is only a tenth of the maximum value for the Bank of Japan. The lowest value for the FED occurred in 2015 with 0.022% of GDP, which is less than half the minimum value for Japan (0.053% in 2012).



The FED is more cost-efficient than the Bank of Japan or the Eurosystem. However, also in this case the annual operating expenses as a percentage of GDP do not lie below the range taken as a benchmark for comparison (0.005% and 0.2% of GDP). In fact, we could increase the lower bound by a factor of four and there would still be no observation below it in the case of the FED.

## 5 | CONCLUSION AND OUTLOOK

The central banks considered in this study all operate under relatively high costs from the perspective of conventional business accounting. The assumption that the introduction of an unbacked fiat money would lead to annual cost savings that are virtually equivalent to the annual resource costs of the alternative gold standard, which implicitly underlies both Friedman's and White's analysis, is thus illusory. It turns out that in every case considered here, the operating expenses of the fiat money issuers are actually higher than the estimated costs of a generic gold standard, if only one with a relatively low reserve ratio. According to our estimates, the expenses of the FED and the Bank of England in recent years correspond to the costs of a fractional-reserve gold standard with about 20% reserves on  $M_1$ . This incidentally corresponds exactly to the reserve ratio that Adam Smith originally had in mind in his *Wealth of Nations*. However, the cases of the Eurosystem and the Bank of Japan stand out. They are in relative (as well as absolute) terms much more expensive. On average, their operating expenses are equivalent to the estimated costs of a gold standard with more than 50% reserves on the money stock  $M_1$ .

The annual operating expenses as percentages of the respective annual GDP for all four central banks or central bank systems are plotted in Figure 6 along with the lower- and upper-bound estimates of the resource costs of a generic gold standard (0.005%–0.2% of GDP). For Japan prior to 2004, we observe the only instances when the operating expenses exceed even the upper bound. In all other instances, the observed values lie within the range of the estimated costs of a gold standard. The Bank of Japan also shows the highest fluctuations throughout the period under consideration.

The cost savings from unbacked fiat money in all these cases are thus well below expectations. In fact, these examples undermine the traditional cost-saving argument for fiat money as presented by eminent economists throughout the history of economic thought as well as contemporary authors of economics textbooks. These results show that from the vantage point of conventional business accounting, a return to gold as an anchor of the money stock is economically feasible. This conclusion does not take into account other potential benefits, such as greater economic and financial stability (Borio & Nelson, 2008; Huerta de Soto, 1995, 2006; Schnabl & Hoffmann, 2008), reduced moral hazard that would arise from ending the political control over the base money supply (Hayek, 1978; Hülsmann, 1996, 2006) and reduced inequality in terms of income and wealth as a result of more restrictive monetary policy (Duarte & Schnabl, 2019; Hülsmann, 2014; Israel, 2017; Israel & Latsos, 2020; Saiki & Frost, 2014).

The cost-saving argument is indeed further undermined by the fact that actual gold mining has not decreased since the Nixon Shock of 1971. In fact, according to the United States Geological Survey, world mine production of gold has more than doubled since the 1970s and reached its peak in 2016 with more than 3,000 metric tons. While a part of this increase might simply be due to technological progress, it suggests that also under fiat money a substantial amount of resources remains dedicated to gold production. These resources are not actually saved and freed up for other productive purposes. Central banks as well as private individuals continue to demand and hold gold as a hedge against inflation.

At the moment, political steps towards a return to gold seem very unlikely since political authorities cling to the almost inexhaustible possibilities of monetary policy under fiat money. With a gold standard, monetary policy would be severely restricted because central banks would not be able to expand the base money supply at will. However, this restriction would be desirable because it would force actors in the real economy and national governments of the countries involved to implement structural changes necessary for a return to a sustainable economic growth path, such as the reduction of public and private credit finance. At present, these structural adjustments are prevented by an ultra-loose monetary policy (Banerjee & Hofmann, 2018; Borio, Kharroubi, Upper, & Zampolli, 2016; Hoffmann & Schnabl, 2016; Giménez Roche & Janson, 2019).

It has been argued that commitment to gold has historically reduced sovereign borrowing costs (Bordo & Rockoff, 1996), although the evidence is unclear (Alquist & Chabot, 2011; Flandreau & Zumer, 2004). Modern fiat money regimes have almost certainly facilitated government finance when compared to the classical gold standard (Bordo & Schwartz, 1984; Goff & Toma, 1993), but it is not self-evident whether this constitutes an argument for or against the gold standard. It depends on ideological preferences. Another advantage of gold, however, cannot be denied. A large part of personnel and administrative costs could be reduced, as the process of monetary policy would be much less complex under a gold standard. Hence, it would potentially be more transparent for the general public. The real resources, most notably human capital in the form of PhD economists, that are currently tied up in various central banks could then be used for more urgent and productive purposes in other parts of the economy to enrich society as a whole.

## ACKNOWLEDGEMENTS

Open access funding enabled and organized by Projekt DEAL.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## ORCID

Karl-Friedrich Israel  <https://orcid.org/0000-0003-3512-7362>

## REFERENCES

- Alquist, R., & Chabot, B. (2011). Did gold-standard adherence reduce sovereign capital costs? *Journal of Monetary Economics*, 58(3), 262–272. <https://doi.org/10.1016/j.jmoneco.2011.03.006>
- Bagus, P. (2015). *Defense of deflation*. Heidelberg, Germany: Springer International Publishing Switzerland.
- Banerjee, R., & Hofmann, B. (2018). The rise of zombie firms: Causes and consequences. *BIS Quarterly Review*, 23(3), 67–78.
- Bernanke, B. S. (2013). A century of US central banking: Goals, frameworks, accountability. *Journal of Economic Perspectives*, 27(4), 3–16. <https://doi.org/10.1257/jep.27.4.3>
- Blinder, A. S. (2013). *After the music stopped: The financial crisis, the response, and the work ahead*. New York, NYPenguin Press.
- Bloom, N., Bunn, P., Chen, S., Mizen, P., Smietanka, P., Thwaites, G., ... Young, G. (2019). *Brexit and uncertainty: Insights from the decision maker panel*. (Bank of England Staff Working Paper No. 780). <https://www.bankofengland.co.uk/working-paper/2019/brexit-and-uncertainty-insights-from-the-decision-maker-panel>
- BoJ (2005). *Bank of Japan Annual Review 2005*.
- Bordo, M. D., & Rockoff, H. (1996). The gold standard as a 'Good Housekeeping Seal of Approval'. *Journal of Economic History*, 56(2), 389–428. <https://doi.org/10.1017/S0022050700016491>



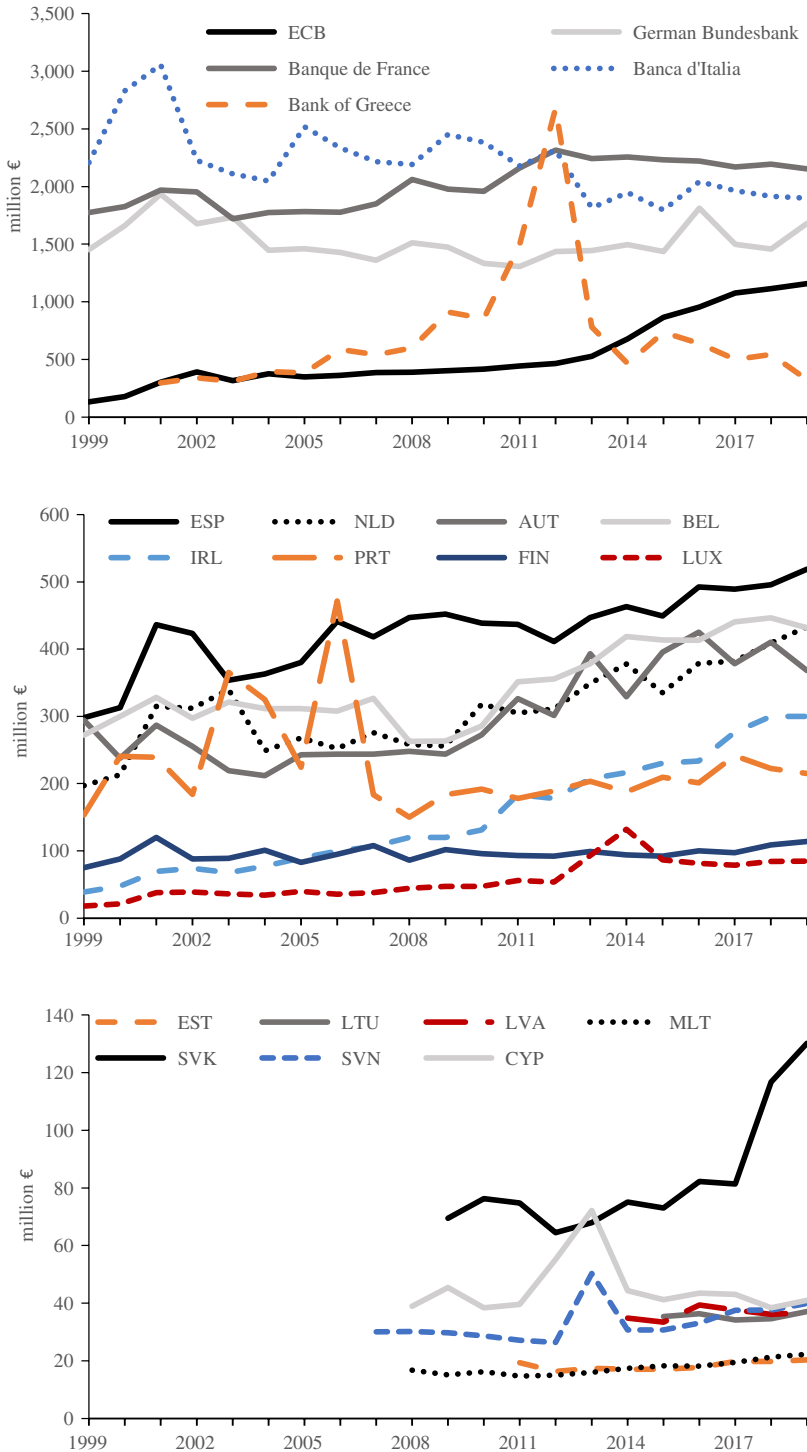
- Bordo, M. D., & Schwartz, A. J. (Eds.) (1984). *A retrospective on the classical gold standard, 1821–1931*. Chicago and London: The University of Chicago Press.
- Borio, C., & Filardo, A. J. (2004). *Back to the future? Assessing the deflation record* (BIS Working Papers No 152). <https://www.bis.org/publ/work152.pdf>
- Borio, C., Kharroubi, E., Upper, C., & Zampolli, F. (2016). *Labour reallocation and productivity dynamics: Financial causes, real consequences* (BIS Working Papers No 534). <https://www.bis.org/publ/work534.pdf>
- Borio, C., & Nelson, W. (2008). Monetary operations and the financial turmoil. *BIS Quarterly Review*, 13(1), 31–46.
- Calomiris, C. W., & Haber, S. H. (2014). *Fragile by design: The political origins of banking crises and scarce credit*. Princeton and Oxford: Princeton University Press.
- Clarida, R., Gali, J., & Gertler, M. (1999). The science of monetary policy: A new Keynesian perspective. *Journal of Economic Literature*, 37(4), 1661–1707. <https://doi.org/10.1257/jel.37.4.1661>
- Davies, G. (2002). *A history of money from ancient times to the present day*. Economic affairs. Vol. 23. Cardiff, UK: University of Wales Press.
- Duarte, P., & Schnabl, G. (2019). Monetary policy, inequality and political instability. *The World Economy*, 42(2), 614–634. <https://doi.org/10.1111/twec.12730>
- Feldstein, M. (2010). What powers for the federal reserve? *Journal of Economic Literature*, 48(1), 134–145. <https://doi.org/10.1257/jel.48.1.134>
- Flandreau, M., & Zumer, F. (2004). *The making of global finance 1880–1913*. Paris: OECD.
- Friedman, M. (1953). *Essays in positive economics*. Chicago and London: The University of Chicago Press.
- Friedman, M. (1960). *A program for monetary stability*. New York, NY: Fordham University Press.
- Friedman, M., & Schwartz, A. J. (1963). *A monetary history of the United States, 1867–1960*. Princeton, NJ: Princeton University Press.
- Friedman, M., & Schwartz, A. J. (1986). Has government any role in money? *Journal of Monetary Economics*, 17(1), 37–62. [https://doi.org/10.1016/0304-3932\(86\)90005-X](https://doi.org/10.1016/0304-3932(86)90005-X)
- Gali, J., & Gambetti, L. (2009). On the sources of the great moderation. *American Economic Journal: Macroeconomics*, 1(1), 26–57. <https://doi.org/10.1257/mac.1.1.26>
- Garrison, R. W. (1985). The costs of a gold standard. In L. H. Rockwell (Ed.), *The gold standard: An Austrian perspective* (pp. 61–79). Lexington, MA: D. C. Heath and Co.
- Giménez Roche, G., & Janson, N. (2019). From conventional to unconventional monetary policies: the failure of the market-maker of last resort. *World Economy*, 42(1), 296–317. <https://doi.org/10.1111/twec.12659>
- Goff, B. L., & Toma, M. (1993). Optimal seigniorage, the gold standard, and central bank financing. *Journal of Money, Credit and Banking*, 25(1), 79–95. <https://doi.org/10.2307/2077821>
- Hayashi, F., & Prescott, E. C. (2002). The 1990s in Japan: A lost decade. *Review of Economic Dynamics*, 5(1), 206–235.
- Hayek, F. A. (1978). *Denationalisation of money*. London, UK: Institute of Economic Affairs.
- He, L. (2018). *Hyperinflation: A world history*. London and New York: Routledge.
- Hoffmann, A., & Schnabl, G. (2016). Adverse effects of unconventional monetary policy. *Cato Journal*, 36(3), 449–484.
- Howden, D., & Salerno, J. T. (2014). *The fed at one hundred*. Heidelberg, Germany: Springer International Publishing Switzerland.
- Huerta de Soto, J. (1995). Critical analysis of central banks. *The Review of Austrian Economics*, 8(2), 25–38.
- Huerta de Soto, J. (2006). *Money, bank credit, and economic cycles*. Auburn, AL: Ludwig von Mises Institute.
- Hülsmann, J. G. (1996). *Logik Der Währungskonkurrenz. Ein Versuch Auf Der Grundlage Einer Kantischen Interpretation von Unsicherheit Und Institutionen*. Berlin, Germany: MA Akademie.
- Hülsmann, J. G. (2006). The political economy of moral hazard. *Politická Ekonomie*, 1, 35–47. <https://doi.org/10.18267/j.polek.544>
- Hülsmann, J. G. (2008). *Deflation and liberty*. Auburn, AL: Ludwig von Mises Institute.
- Hülsmann, J. G. (2014). Fiat money and the distribution of incomes and wealth. In D. Howden, & J. T. Salerno (Eds.), *The fed at one hundred* (pp. 127–138). Heidelberg, Germany: Springer International Publishing Switzerland.
- Israel, K.-F. (2017). In the long run we are all unemployed? *The Quarterly Review of Economics and Finance*, 64, 67–81. <https://doi.org/10.1016/j.qref.2016.07.003>
- Israel, K.-F. (2019). How cost efficient is the eurosysteem? *Economics Bulletin*, 39(1), 115–126.
- Israel, K.-F., & Latsos, S. (2020). The impact of (un)conventional expansionary monetary policy on income inequality – Lessons from Japan. *Applied Economics*, 52(40), 4403–4420. <https://doi.org/10.1080/00036846.2020.1735620>
- Krugman, P., & Wells, R. (2015). *Economics*. New York, NY: Worth Publishers.



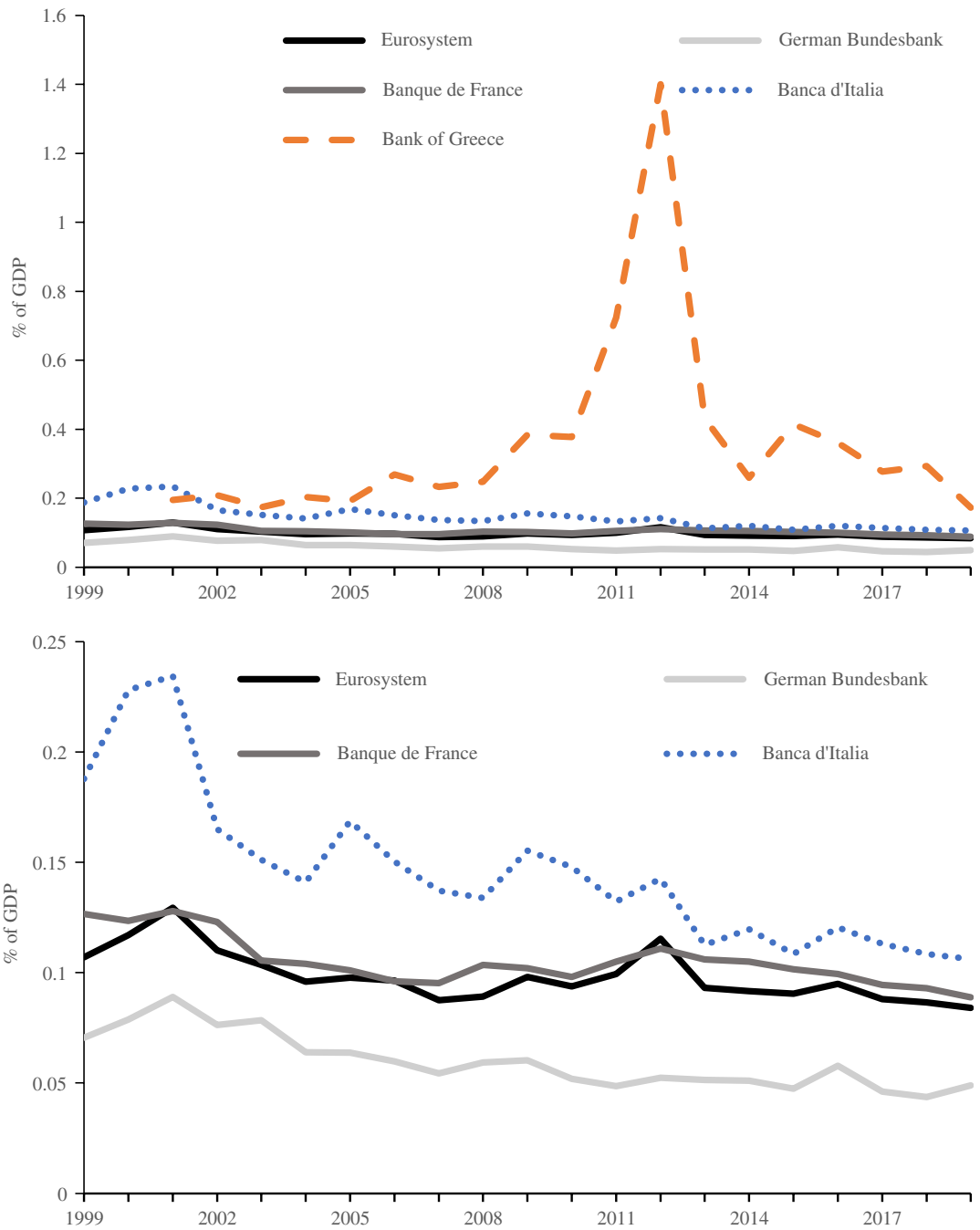
- Menger, C. (1970). Geld. In F. A. von Hayek (Ed.), *Carl menger gesammelte werke band IV: Schriften über geld und währungspolitik* (pp. 1–116). Tübingen, Germany: J. C. B. Mohr.
- Niskanen, W. A. (1971). *Bureaucracy and representative government*. New Brunswick and London: Transaction Publishers.
- Polleit, T. (2011). Fiat money and collective corruption. *The Quarterly Journal of Austrian Economics*, 14(4), 397–415.
- Ricardo, D. (1821). *On the principles of political economy and taxation*. Kitchener, Canada: Batoche Books, republished 2001.
- Ricardo, D. (1824). *Plan for the establishment of a national bank*. London: John Murray.
- Rothbard, M. N. (2011). *Economic controversies*. Auburn, AL: Ludwig von Mises Institute.
- Saiki, A., & Frost, J. (2014). Does unconventional monetary policy affect inequality? Evidence from Japan. *Applied Economics*, 46(36), 4445–4454. <https://doi.org/10.1080/00036846.2014.962229>
- Salerno, J. T. (2003). An Austrian taxonomy of deflation – with applications to the U.S. *The Quarterly Journal of Austrian Economics*, 6(4), 81–109. <https://doi.org/10.1007/s12113-003-1007-1>
- Samuelson, P. A., & Nordhaus, W. D. (2009). *Economics*, 19th ed. New York, NY: McGraw-Hill Education.
- Schnabl, G., & Hoffmann, A. (2008). Monetary policy, vagabonding liquidity and bursting bubbles in new and emerging markets: An overinvestment view. *World Economy*, 31(9), 1226–1252. <https://doi.org/10.1111/j.1467-9701.2008.01126.x>
- Selgin, G., Lastrapes, W. D., & White, L. H. (2012). Has the fed been a failure? *Journal of Macroeconomics*, 34(3), 569–596. <https://doi.org/10.1016/j.jmacro.2012.02.003>
- Smith, A. (2007). *An inquiry into the nature and the causes of the wealth of nations*. Amsterdam, the Netherlands: MetaLibri.
- Tullock, G., Seldon, A., & Brady, G. L. (2002). *Government failure: A primer in public choice*. Washington, D. C.: Cato Institute.
- von Mises, L. (1944). *Bureaucracy*. New Haven, CT: Yale University Press.
- von Mises, L. (1953). *The theory of money and credit*. New Haven, CT: Yale University Press.
- von Mises, L. (1998). *Human action: A treatise on economics*. Auburn, AL: Ludwig von Mises Institute.
- von Wieser, F. (1926). Geld (Theorie Des Geldes). *Handwörterbuch Der Staatswissenschaften*, 4, 681–717.
- von Wieser, F. (1927). *Social economics*. New York, NY: Selphi Company.
- White, L. H. (1984). *Free banking in Britain*. New York, NY: Cambridge University Press.
- White, L. H. (1999). *The theory of monetary institutions*. Massachusetts and Oxford: Blackwell Publishing Ltd.
- White, L. H. (2005). The Federal Reserve System's influence on research in monetary economics. *Econ Journal Watch*, 2(2), 325–354.
- White, L. H. (Ed.) (2014). *Liberty matters: Ludwig von Mises's the theory of money and credit at 101*. Indianapolis, IN: Liberty Fund.

**How to cite this article:** Israel K-F. The fiat money illusion: On the cost-efficiency of modern central banking. *World Econ.* 2021;44:1701–1719. <https://doi.org/10.1111/twec.13028>

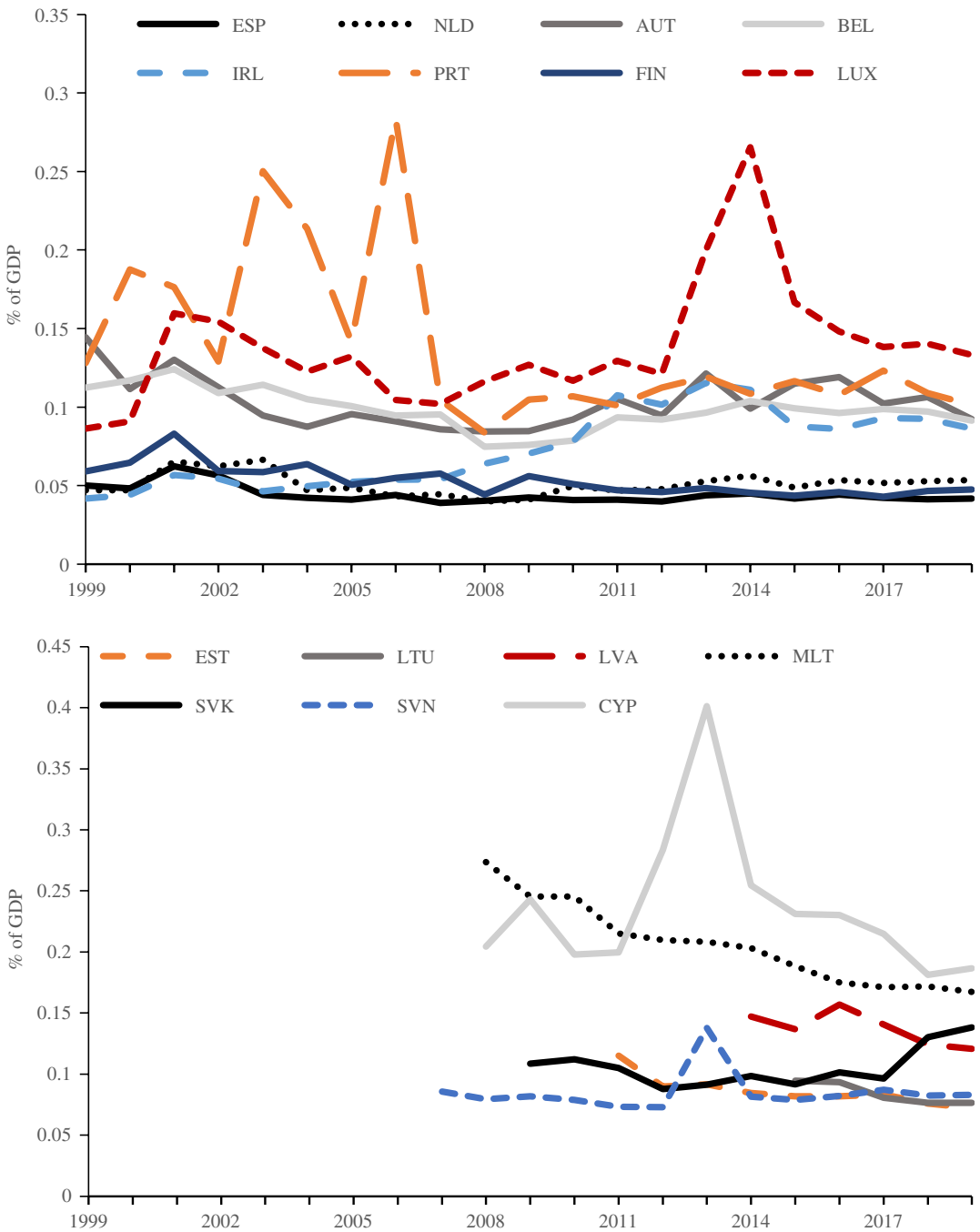
APPENDIX



**FIGURE A1** Annual operating expenses of the ECB and the national central banks of the Eurosystem 1999–2019. AUT, Austria; BEL, Belgium; CYP, Cyprus; ESP, Spain; EST, Estonia; FIN, Finland; IRL, Ireland; LTU, Lithuania; LUX, Luxembourg; LVA, Latvia; MLT, Malta; NLD, Netherlands; PRT, Portugal; SVK, Slovakia; SVN, Slovenia [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]



**FIGURE A2** Annual operating expenses of big member banks of the Eurosystem as a percentage of GDP 1999–2019 [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]



**FIGURE A3** Annual operating expenses of small member banks of the Eurosystem as a percentage of GDP 1999–2019. AUT, Austria; BEL, Belgium; CYP, Cyprus; ESP, Spain; EST, Estonia; FIN, Finland; IRL, Ireland; LTU, Lithuania; LUX, Luxembourg; LVA, Latvia; MLT, Malta; NLD, Netherlands; PRT, Portugal; SVK, Slovakia; SVN, Slovenia [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]