The influence of the central bank's assets on the exchange rate and the price level: essays and empirical analyses

Inaugural-Dissertation
zur Erlangung des Doktorgrades
des Fachbereichs Wirtschaftswissenschaften am Fachbereich Wirtschaftswissenschaften
der Johann Wolfgang Goethe-Universität
Frankfurt am Main

Ingo Johannes Benjamin Sauer
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Summary

Motivation

I was very concerned when the so-called Target (or TARGET2) claims and liabilities in the Eurosystem were brought to light with the first working paper on the topic by Hans-Werner Sinn and Timo Wollmershäuser in June 2011.[1] I realized that the risks of central bank losses and/or central bank insolvencies could not be discussed adequately given the prevailing monetary theory. Most economists believe that the concept of solvency is not applicable to central banks and that the assets of the central bank are, therefore, not related to the exchange rate and the price level. Even enormous central bank losses – as would be experienced by the Bundesbank in the case of a breakup of the Eurosystem – would not affect the stability of the currency or the price level since the money supply remains constant in such a scenario.

The motivation for this thesis was simply my conviction that the importance of possible central bank losses in the Eurosystem could not be debated properly with the prevailing theoretical framework. The fundamental underlying problem in monetary theory is that the insolvency of central banks represents something like a black hole in the huge body of acknowledged economic literature. One cannot find any recognized economic textbook in a library that explains the consequences – or provides a detailed analysis – of a central bank's insolvency. The simple fact that a central bank without payment obligations in a foreign currency can *technically* never become insolvent led to the belief that the *concept of solvency* is also not applicable to central banks and that the value of the bank's financial assets (its financial strength) does not matter for the stability of the exchange rate and the price level. On the contrary, I was convinced that the *concept of solvency* is very applicable to central banks. Especially after working on this thesis, it seemed that the value of the bank's assets is *the* fundamental requirement for a relatively stable internal and external value of the currency and that an immediate recapitalization of the Bundesbank would be necessary in the mentioned scenario of enormous losses.

[1] Sinn, Hans-Werner, and Timo Wollmershäuser (2011): "Target-Kredite, Leistungsbilanzsalden und Kapitalverkehr: Der Rettungsschirm der EZB." ifo Working Paper No. 105; url: `http://www.cesifo-group.de/DocDL/IfoWorkingPaper-105.pdf`.

Accordingly, two weeks after the publication of Sinn's and Wollermershäuser's working paper, I wrote a 10-page-long letter (via email) to Sinn. Referring (e.g.) to classical scholars like Tomas Tooke and James Steuart I wanted to convince him that central banks are, first and foremost, banks to which the concept of solvency is applicable and that a stable value of the central banks' assets (i.e. the backing of the money supply) in the Eurosystem is a *necessary requirement* for the stability of the currency.

I was pleasantly surprised that Sinn, the director of the Ifo Institute at the time, wrote me that I was "completely right" and suggested to publish this backing argument (which I applied to the crisis of the Eurosystem and the Bundesbank's Target claims) in the first compilation about the Target imbalances, a CESifo Special Issue, together with countrywide famous economists.[2] In this paper, I strongly emphasized the imperative asset backing of the money supply to guarantee a stable currency. I argued, as I did in the letter to Sinn, that the focus on the mere quantity of money or notes in circulation – portrayed by the quantity theory – is completely misleading since the more important backing (the assets) behind those notes are neglected. At that time, I was optimistic that more scholars would soon realize that the assets (or the solvency) of the central bank represent the fundamental requirement to guarantee a stable currency and therewith a stable price level.

However, I learned only a year later when Sinn debated with other well-known economists[3] that even Sinn agreed – arguing with the mere quantity of money – that the Bundesbank could lose all of its assets without harming the value of the currency. In his later books, Sinn also accepted and followed the arguments from other "monetarists" who calculated – with the underlying assumption that central banks *do not need any assets* – the non-inflationary loss capacity of the Eurosystem to be around 3.4 trillion euros. This kind of statement, repeated by journalists and widely accepted by the public, were exactly what I had feared when I wrote the letter to Sinn. Accepting the quantity theory – i.e. focusing on the mere quantity – of money leads to a completely inadequate discussion about the accumulated risks in the euro area central banks' balance-sheets.

These years, including when I wrote the letter to Sinn, I worked at a consultancy in Frankfurt and as a lecturer in economics and statistics. However, in 2014 I was offered a full position as a research assistant at Goethe University, enabling me to start working on my dissertation. My aim was – and the purpose of this dissertation is – to convince other economists to abstain from the misleading view of the quantity theory of money (which disguises the importance of the central banks' assets) so that the risks accumulated in the central banks' balance-sheets could be debated more adequately. After, speaking to (well-known) economists at conferences and elsewhere, however, I realized that this would be a

[2]See Sauer (2011); see also Sauer (2012) for the English version of this paper.

[3]See paper 3 for a detailed description of the debates.

very difficult task since the vast majority assumes and believes in a general accuracy of the quantity theory.

To tackle the root cause of the problem (the belief that only the quantity of money but not the central bank's assets matter for the currency's internal and external value), I had to find out were this conviction came from. That was a relatively easy task since everything points to the *quantity* theory of money. The popularity of the quantity theory of money, in turn, is simply due to its presentation in the economic literature. Probably all of us remember those common textbook graphs for hyperinflations that convinced us about the general validity of the quantity theory of money: the money supply is plotted next to the price level index (e.g.) for the four famous hyperinflations after World War I in Austria, Hungary, Poland, and Germany. As the two curves increase more or less simultaneously in a logarithmic scale, Friedman's unforgotten phrase that "[i]nflation is always and everywhere a monetary phenomenon"[4] settled gently in our minds.

Any critique of the quantity theory of money should include these four famous hyperinflations after World War I since they essentially represent the "empirical pillar" which proves the quantity theory. Consequently, I researched about these hyperinflations and was very surpized when I found a recurrently used data source for these common textbooks graphs – for example, in Mankiw (2015, p. 643) – is a study from the Nobel laureate Thomas Sargent (1982) where *he argued exactly with the same backing arguments* which I tried to explain to Sinn. In his analysis about the four famous hyperinflations Sargent does not argue with the mere quantity of money but with the positions on the other side (the asset side) of the central bank's balance-sheets. The mere money supply (on its own) does not explain anything according to Sargent as it increased largely – (tripled or even sextupled) in all countries *after* the exchange rate and the price level had been stabilized. In the introduction and in the conclusion, Sargent emphasizes over and over again that the mere change in the money supply can neither explain the inflations nor the stabilizations thereafter; the only logical conclusion from the data is the different quality and nature of assets the central banks received for their issued notes before and after the stabilizations. While the central banks received only relatively *worthless assets* during the time of hyperinflation, the same central banks demanded and received a *valuable asset* for each note given into circulation after the stabilizations – when the money supply still increased strongly. I think it is paradoxical that Sargent was interpreted so erroneously (by Friedman, for example, as explained in paper 2), yet his data for the money supply and the price level is used in standard textbooks to demonstrate the validity of the quantity theory of money.

[4]The complete quote reads: "Inflation is always and everywhere a monetary phenomenon in the sense that it is and can be produced only by a more rapid increase in the quantity of money than in output" (Friedman, 1970).

Due to Sargent's and his paper's popularity and because these four hyperinflations represent something like the empirical cornerstone for the validity of the quantity theory of money, my dissertation *had to be about these hyperinflations* to make an impact and to test the quantity theory for the very events which still convince students and professional economists of its general validity. Furthermore, it had to be a test of Sargent's verbally explained backing argument with modern econometric techniques. Hence, my aim was to test if Sargent's argument is correct (i.e. the backing of notes was the causal factor for the famous hyperinflations and stabilizations) or not (i.e. the money supply was the causal factor). In my opinion, an empirically fastidious analysis was imperative to prove – and, even more so, to convince other economists of – the validity of that backing argument.

To commit myself to these events from the 1920s and to the associated collection of historical data was, however, the worst decision of my life. At times, it seemed impossible to gather all the necessary data for such an analysis. With a few missing time series (e.g. for a single important balance-sheet item which, for some reason, was not reported for several years) the whole project was at risk. I spent hundreds of nights not only gathering tens of thousands of data points (almost always copied by hand) but, more importantly, searching the literature and financial newspapers from the 1920s with the hope of finding out that the missing data were reported or at least mentioned. Gathering large amounts of data is always tiring, but generally one can see some kind of a (linear) progress. On the contrary, to search for data, not knowing if it exists, was draining as I experienced weeks and months without any progress. Nevertheless, at the end I was able to gather all the necessary data to econometrically test Sargent's backing argument for the four famous hyperinflations after World War I. This analysis represents the heart of my dissertation which I decided to write separately from the rest of the thesis in a single paper.

The division into three papers

The empirical analysis of the four famous hyperinflations after World War I represents the main object of investigation of this doctoral thesis. In order to place it prominently, the analysis is presented in a separate paper (paper 2). However, I also wanted to analyze the hyperinflations more qualitatively, which I did for the German hyperinflation in paper 3. I focused on historical documents from that time period where actual policymakers in action expressed their thoughts. These reports provide *much* more reliable information than the various studies and books written in retrospect, where some author rather interprets than states the facts of these historical events.

However, for a complete assessment of the quantity theory, a much broader analysis of its theoretical justification and an overview of the empirical results are required. I provide

such a general assessment also in paper 3. Furthermore, I will explain in paper 3 why the quantity theory of money (i.e. the theoretical neglection of the central bank's assets) led to a neglection of these assets in practice which made the unrestrained growth of the Target imbalances possible. Last but not least I will show the centrifugal forces of these Target imbalances for the Eurosystem and point out the involved risks for the Bundesbank and the German taxpayer.

My supervisor, Professor Bertram Schefold, is a dedicated expert in the history of economic thought and, therefore, the thesis should include at least one paper about that history. Unfortunately, the evolution of the quantity theory with its important milestones such as the Banking-Currency School debate and the well known formalizations from Fisher and Brown (1911) and from Pigou (1917) are already explored in detail. Similar stories in many different versions have been told and I would not want to add a "new" *variant*. A much less explored or discovered turning point in the history of economic thought is the *resurrection* of the quantity theory of money after the Keynesian revolution in the 1960s and 1970s. I chose to tell this story for the first paper which will explain why the quantity theory of money is an eminently natural view for economists and how it was able to reestablish after the Keynesian revolution. I expanded this paper, however, to the external sector building block of the quantity theory (the monetary model of exchange rate determination) which is commonly applied to the very hyperinflations that I analyze in paper 2.

Summary and results of paper 1

Money - Prices - Exchange: The Resurrection of a Natural View for Economists in the Wake of an Emerging Belief in Markets

As the the title reveals, this paper is largely about the relationship between money and prices and the effect from the former on the latter, hence the quantity theory of money. This paper is also about the external sector, namely the monetary model of exchange rate determination (or monetary model for short), which is an extension of the quantity theory for the external sector. Taken together, these theories represent an eminently natural view for economists. The money supply should determine the price level and, given two domestic price levels, the exchange should adjust in line with the law of one price to these domestically determined price levels. In the paper, I present various reasons why this causal chain from money via prices to the international rate of exchange is a very natural view for economists.

However, the quantity theory of money was noticeably outmoded in the 1950s and most of the 1960s, it even "seemed to be disproved once and for all until *M. Friedman*"[5] tried

[5]Original in German: „[...] schien die Quantitätstheorie ein für allemal widerlegt zu sein, bis *M. Fried-*

to reestablish it. Paper 1 explains how this (counter) revolution occurred and why it was possible.

The change of macroeconomic models: from one extreme to the other and a reconciliation

The history of economics – including its revolutions – follows the same pattern like history in general, i.e. a path of continuity and change. A disruptive change, such as a revolution, also represents a type of continuation since it evolves for a reason and the past always explains the present. Therefore, to understand the resurrection of the quantity theory of money, we have to consider the time before its re-adoption in economics. I identified an important cause for this re-adoption in the prevailing macroeconomic model of the 1950s and 1960s, namely in the IS-LM model. The IS-LM model includes the reversal of *Say's Law* and implies that "demand creates its own supply." This implicit assumption, not trivial to realize but strongly reflected in the model's outcomes, served as a theoretical justification for government interventionist policies and was strongly refused by a new generation of "liberal" economists. It led to an immense shift in macroeconomic theory from demand-side determined output (inherent in the IS-LM model) to supply-side determined output (inherent in the price adjustments of the new short- and long-run AS curve). What I identified at the heart of Keynesian economics and what bothered the new generation of "liberal" economists (the effectiveness of expansionary fiscal and monetary policies) could be overcome or shrunk down to a small effect of a few years in a very elegant manner by *adding* two more curves in a new AS-AD diagram (i.e. without "touching IS-LM").

Then, in the 1980s with the attempted reconciliation of the different schools, the debates revolved around the steepness of the AS curve. The point is that the very same economists (most notably Friedman) who argued for a very steep AS curve and who introduced the (later) widely-accepted concept of the natural rate of unemployment and potential output also argued that "the AD curve is affected only by money-supply shifts,"[6] or, equivalently, that the income velocity of money is constant. With the acceptance of the monetarist proposition of a constant income velocity of money in standard textbooks, the pure classical quantity theory mechanics for aggregate demand and aggregate supply was reintroduced to economics: any change in the money supply translates into a proportional change in aggregate demand and, given a (relatively) stable real output, a proportional price level adjustment.

man" (Issing, 1998, p. 146).

[6]See Samuelson and Nordhaus (1985, p. 326).

A critical side effect: the excavation of a highly questionable assumption

I would like to emphasize that, in my perception, the resurrection of the quantity theory of money, together with its concept of a constant income velocity of money, could only happen in the wake of that immense shift from demand-side determined output to supply-side determined output. The force of this counterrevolution led to the uncritical adoption of one of the most questionable assumptions in economic theory: the constant income velocity of money.

In summary, everything started with a disbelief in the effectiveness of government interventionist fiscal and monetary policies to increase real output or employment because markets – and the market economy – were considered to function efficiently. The presumed ineffectiveness of government policies calls for an adjustment of prices whenever they are utilized. From there, it is a small step to claim that expansionary monetary policy ($M \uparrow$) will *always* lead to inflation ($P \uparrow$) and that the adjustment is even faster when the expansionary monetary policy is anticipated (rational expectations). During that time with the focus on "an increasing money supply corresponds to an increasing price level ($M \uparrow \Rightarrow P \uparrow$)," the monetarist proposition of a stable relationship between the two (i.e. the constant income velocity of money) seems very plausible. Additionally, the stagflations of the 1970s – which, according to Friedman, were very important for the quantity theory to gain acceptance – fostered the view that increasing the money supply (above a gradual increase of potential output) will *always* cause inflation.

The expansion of the paradigm shift to the external sector

Like a mirror image, the developments of macroeconomics for the domestic sector also occurred in the theory for the external sector. The prevailing model for the exchange rate, the Mundell-Flemming model (an extension of the IS-LM model), was replaced by the monetary model. In the Mundell-Fleming model, output is determined by demand while prices are fixed. In the monetary model, output is at its natural level and prices are flexible and adjust instantly in response to excess demand. In conclusion, equivalently to the domestic sector, also in the external sector we are back to a classical view. The money supply, together with the money demand, determine the price level in each country and the exchange rate adjusts to these price levels. The more natural view for economists, i.e. from money to prices and from prices to the exchange rate – which, in 1936 (i.e. the publication year of the *General Theory*), Robinson already called the "traditional view"[7] – had reestablished itself

[7] "The traditional view that the exchange value of a country's currency in any given situation depends upon the amount of it in existence is thus seen to be justified, provided that sufficient allowance is made for changes in the internal demand for money" (Robinson, 1936, p. 229).

in economic theory.

Summary and results of paper 2

The Ends of Four Big Inflations with the Printing Press: A Rediscovery of the Dark Side of the Central Bank's Balance-Sheet

An unbelievable erroneous interpretation of a classical study

As mentioned before, one of the most curious instances in economic literature is that in standard economic textbooks (see, for example, Mankiw (2015, p. 643)) the graphical illustrations of hyperinflations used to show the validity of the quantity theory of money are based on a study from Thomas Sargent (1982) that postulates a completely opposing argument for the hyperinflations themselves and the following stabilizations. The money supply is plotted next to the price level index (e.g.) for the four famous hyperinflations after World War I in Austria, Hungary, Poland, and Germany. As the two curves increase more or less simultaneously in a logarithmic scale, and as most of us did not notice (due to the logarithmic scale) that the money supply increased heavily after the price level and the exchange rate had been stabilized, these very graphs convinced us of the general validity of the quantity theory. However, Sargent does not argue with the mere quantity of money but with the positions on the other side (the asset side) of the central bank's balance-sheets. The money supply (on the liability side) on its own does not explain anything as it increased greatly (threefold or even sixfold) in all countries *after* the exchange rate and the price level had been stabilized.

Sargent (1982) observed three concurrent patterns for all four famous hyperinflations after World War I:

- The exchange rate and the price level abruptly stabilized in each country and the introductions of a new currency ("the currency reform") played no role for these stabilizations as they occurred several months or years after the stabilizations.
- The money supply in each country increased greatly (threefold or sixfold) *after* the stabilization of the exchange rate and the price level.
- The crucial difference between the time before and after the stabilization is that the central banks issued *unbacked* money before the stabilization (i.e. they received worthless claims against broken governments for their issued notes) and *backed* money after the stabilization (i.e. they received valuable claims against the private sector, gold, or foreign stable currencies for the issued notes). The mere quantity of money (or notes)

issued *were not important*, according to Sargent. Instead, what was important was *the different nature of assets* the central banks received for the issued notes before and after the stabilizations.

Sargent demonstrates the impressive change in the composition of the assets with simple tables for the balance-sheet of each respective central bank. Unfortunately, Sargent's only source of data, an inquiry about European currency and finance for the United States Senate from John Parke Young (1925), was rather incomplete, ended too early, and did not include many important balance-sheet items. The completion of these balance-sheets was very laborious.

An econometrical test of Sargent's backing argument

To bring more light to the "dark side" of the balance-sheet, I constructed a measure condensing Sargent's backing argument in a time series that reflects all available information contained in the balance-sheet for the solvency of the central bank. This measure, the solvency exchange rate, works by deflating the asset side of the balance-sheet to its market value. I deflated "relatively worthless" claims against the government to their market value by using the market information given in bond price quotations. When the central bank (e.g.) issues more unbacked money (in Sargent's words) by granting credit to its broken government, the solvency of the central bank deteriorates because its liabilities increase while the market value of its assets does not change. If, however, the central bank issues money against valuable private sector claims, then the balance sheet expands but the solvency of the central bank does not deteriorate at all because, for each note given into circulation (a liability), the bank receives a valuable asset in exchange. In conclusion, the quantity theory of money only takes the mere quantity of issued notes into account. The measure that I constructed also takes into account how (or what for) the notes are issued. This measure allows me to empirically test Sargent's argument explicitly against the quantity theory of money.

The results: the hyperinflations and their ends are better explained by taking the asset side into account

In my analysis, I could confirm that the constructed time series, the solvency exchange rate, forms a long-run equilibrium relationship with the exchange rate. Furthermore, my analysis shows that the exchange rate forms a long-run equilibrium relationship with the price level. In conclusion, the data strongly indicates that it was the (deteriorating and stabilizing) solvency of the central bank that determined the exchange rate. The exchange rate, in turn,

determined the price level. In contrast, the money supply on its own can neither explain the exchange rate nor the price level. My empirical analysis, using modern econometric techniques that allow for a proper treatment of time series with unit roots and breaks in their trends, strongly support Sargent's verbal analysis.

This result implies that economists erroneously considered the (more visible) quantity of money to be a causal factor while, in reality, the (less visible) solvency of the central bank was the causal factor for both the devaluation of the exchange rate (combined with inflation) and the stabilization of the exchange rate (combined with a stabilizing price level) for all four hyperinflations. The central banks in each country stabilized the exchange rate *in order to* stabilize the price level and they could do so – despite a heavily increasing money supply – because they received valuable assets at the time of (and after) the stabilization. I showed that, initially, the central banks were recapitalized and, since the simple rules of sound banking were reintroduced, the respective exchange rates could be stabilized in spite of a heavily increasing money supply.

To sum up, I tested whether the real causal factor behind the hyperinflations and the following stabilizations was the quantity of notes in circulation (the money supply) or the backing of these notes (i.e. the nature of assets the central banks received for their issued notes). As Sargent's backing argument is supported by modern econometric tests, we have to consider that *the* empirical pillar for the quantity theory of money (the correlation between money and prices during hyperinflations) is no more than a misunderstanding between the more visual *quantity* of notes and the less visual *assets* behind those notes that matter for the external and internal value of money. Since these assets – hidden in the shadow or on "the dark side" of the central banks balance-sheets – turned out to be the real causal factor behind the hyperinflations and stabilizations, the quantity theory of money loses its justification even for the "clearest" events taken until now for granted.

The "dark side" of the central bank's balance-sheet as a hidden variable problem

I want to describe this "invisibility" or hidden variable problem even more metaphorically. Imagine one of those images we have all seen where bundles of mark notes were carried with wheelbarrows. Economists concluded from these pictures with the wheelbarrows – like from the graphs with the "exploding" money supply curves – that the quantity or abundance of notes must be the obvious reason for their low value. They did not see, however, that the real reason for these notes being relatively worthless was that they were only backed by "thin air" (i.e. worthless claims against bankrupt governments). Indeed, the massive increase in the money supply before the stabilization was only possible because the rules for sound central banking (i.e. the central bank demands a *valuable and secure asset for each note issued*) were

abolished. The moment when these rules were again put into force, the money supply further increased greatly, threefold, sixfold, or even fifteenfold (as I show for Germany in paper 3), without harming the value of these notes. Therefore, if you still imagine the image with the wheelbarrows of notes, you have to imagine now three, six, or (for the German case) fifteen wheelbarrows for each one you had in mind before.[8] Accordingly, the underlying reason cannot be the quantity or abundance of the notes because their quantity increased manifold *after* their external and internal value was stabilized. This massive increase in the note circulation *after* the stabilization of the exchange rate and the price level led Sargent (1982) to conclude that the reason for the hyperinflations and the following stabilizations cannot be the quantity of notes but that they were issued against valueless assets before – and for valuable assets after – the stabilizations. It was, therefore, the deteriorating solvency of the respective central bank that caused the hyperinflation and the solvency of the respective central bank that stabilized the exchange rate and therewith the price level.

Summary and results of paper 3

The Case Against the Quantity Theory of Money: King's Evidence from Hyperinflations, a Dangerous Narrative, and Hollowing Out the Euro

Why theory matters: an unasked question

The year 2011 marks the beginning of a new debate in the economic profession. With the discovery that some central banks of the Eurosystem held enormous claims against that system as an eminently important share of their assets (almost half of the assets from the Bundesbank consisted of such Target claims already at the end of 2010), a simple question was raised: what would happen if the euro falls apart, these Target claims are not settled, and some central banks become (technically) bankrupt? The insolvency of central banks represent, however, a black hole in the huge body of acknowledged economic literature. One cannot find any recognized economic textbook in a library that explains the consequences of an insolvency from a central bank. As I show for the debate between Sinn and his antagonists, the reason for this lack of literature is simply the prevailing theory. According to the quantity theory of money and the associated concept of a fiat money system, the assets of the central bank do not fulfill any function which implies that there can be no consequences if they are lost.

[8] Obviously, in the course of hyperinflations, higher and higher denominations of notes were issued. But these new notes are only higher *denominations* in the same currency.

The prevailing theory: a questionable assumption and its empirical justification

Before discussing the consequences of the quantity theory of money which led to this view that the assets of the central bank are irrelevant (and, thus, are not related to other variables like the exchange rate or the price level) I provided an overview for the theoretical and empirical validity of the quantity theory. I showed that the functional form of the quantity theory boils down to the questionable assumption that "money has to chase goods." Exactly the same is true for the external sector building block of the quantity theory of money, namely the monetary model of exchange rate determination (or the monetary model for short).

Furthermore, a review of the empirical results for the quantity theory of money and the monetary model in section 3.4 clearly uncovers that both theories seem to work only for high-inflation countries and especially for hyperinflations. Accordingly, I analyzed the most famous hyperinflation, i.e. the German hyperinflation, which represents the main subject of investigation in the literature for the quantity theory of money and the monetary model.

The unbelievable misinterpretation of causal effects for the German hyperinflation

The German hyperinflation, believed to represent the principal witness to confirm the quantity theory, instead overturns and gives king's evidence ("key witnesses evidence") for a complete falsification of the quantity theory. With the help of concrete historical documents and new (or differently presented) data, I show for the entire time period that the quantity of money was only a misconceived *concomitant or accompanying symptom*. The quantity of money was never a causal factor for inflation since the increase in the money supply exclusively worked via the deterioration of the Reichsbank's solvency and an accompanying devaluation of the exchange rate. Hence, it was the issuance of *unbacked* money that deteriorated the solvency of the Reichsbank and thereby the exchange rate. The devaluation of the exchange rate, in turn, pulled the price level with it. There is simply not a singe time period where the data or the historical documents support the quantity theory hypothesis, namely, that the increased money supply caused inflation via an increased demand on goods markets. On the contrary, the price level always reacted *to the exchange rate*.

Between the end of the war in November 1918 and June 1922, the mark lost approximately *98%* of its external value in dollars (temporarily appreciated in between) and the price level increased by similar numbers (also temporarily decreased in between during the time of an appreciating mark). In every phase, the price level followed suit behind the devaluation or appreciation of the mark; in contrast, *the money supply does not show any of these dynamics* as it only increased relatively slowly during the entire period. Furthermore, for the same time

period, I ruled out expected inflation, an (ad hoc) assumption or argument that is commonly used in the literature to explain the *enormous discrepancy* between the "exploding" price level and the slowly increasing money supply.

An even more striking time period was later, from February to April 1923, during a phase of severe hyperinflation when the Reichsbank stabilized the exchange rate *in order to* stabilize prices. The Reichsbank stabilized the exchange rate in February 1923 and even slightly appreciated it in March. The fascinating fact is that the price level followed suit; it also abruptly stabilized in February and decreased in March about the same percentage. In April, the exchange rate and the price level increased, but only a few percentage points. The price level reacted *approximately 1:1* to the exchange rate; on the contrary, the money supply (independently) increased heavily during these months.

All these data and events only make sense if we accept that the exchange rate, and not the money supply, determines the price level during hyperinflations. Then, knowing that the crucial factor is almost exclusively the exchange rate, the legislation during hyperinflations becomes clear and comprehensible. The accompanying legislation during phases of monetary financing can be characterized as a "hopeless fight to stabilize the exchange rate." The government tries to prevent the pressure on the exchange rate by making the exchange to – or the use of – foreign currencies illegal. However, these controls of foreign exchange dealings generally do not work and black markets for the exchange into major stable foreign currencies spring up at every street corner. Similarly, all type of internal price controls are bound to fail. I showed in historical documents that even the politicians who implemented price controls knew about their ineffectiveness. They understood very well that, if the mark devalues, suppliers will simply demand more devalued domestic currency and no law can stop prices from rising. Since it turns out to be simply impossible to hinder the exchange rate or prices from rising through legislation, central banks often intervene to financially stabilize the exchange rate.

The Reichsbank did financially intervene to stabilize the exchange rate between February and April 1923 since this seemed to be the only option to stabilize the price level, at least temporarily. As I already mentioned, the price level abruptly stabilized after the Reichsbank stabilized the exchange rate, but everybody knew that the bank could not afford this artificial rate for extended periods. Havenstein, the president of the Reichsbank during the time of stabilization, even described this temporary stabilization as a "contradiction in terms" since the monetary financing continued and further deteriorated the bank's solvency. As we can learn from this failed intermediate stabilization, it is a general pattern for hyperinflation countries that the respective central bank is forced by the market to lower or accept the rate of exchange to a level that can be defended (depending on the solvency of the bank).

The hyperinflation could, therefore, only be stopped by making the Reichsbank solvent

enough to permanently defend the exchange rate. This is precisely what occurred on the 15th of November 1923 with a recapitalization of the Reichsbank and the implementation of sound banking principles. The Reichsbank stabalized the exchange rate and thereby the price level between the 15th and the 20th of November 1923. The money supply approximately increased fifteenfold thereafter until the end of June 1924 but without harming the external and the internal value of the mark. The Reichsbank, which was recapitalized, stayed solvent enough to defend the exchange rate since the assets it received for its issued notes also changed dramatically. While the Reichsbank before the 15th of November received mostly worthless government bills for its issued notes, the bank from there on applied the principles of sound banking: for each note issued the bank demanded and received either advances on collateral or commercial bills which are both very short-term and secure claims. This means that any note given into circulation was automatically sterilized a few weeks or months later. The re-establishment of the bank's solvency and the permanent redemption of notes guaranteed that the bank was not vulnerable anymore and that any intended speculation against the mark had to fail. This is precisely what occurred and, as Schacht, the president of the Reichsbank in December 1923, reports, the speculation already came to an end around December 10, 1923.

The economic profession did not take notice of these mechanics behind the German hyper-inflation even though it was clearly pointed out by Sargent (1982). Instead they interpreted it as evidence for the quantity theory of money and the monetary model. This misleading evidence is the most important reason for the erroneous belief that only the quantity of money matters and that the assets behind the money supply are irrelevant.

From the wrong theory to a dangerous practice: the hollowing of the euro

Neglecting the assets of the central bank in economic theory led to their neglection in practice. When the Eurosystem was designed, no settlement mechanism for claims and liabilities that can build up between national central banks was implemented. From the perspective of a technocrat or accountant, it is probably the same scenario if a national central bank holds a claim against the system or if it is paid (e.g.) once a year with marketable assets. From an economic perspective, however, it is not the same as these uncollateralized claims (Target) are at risk if the system ceases to exist. Any economist involved in the construction of the Eurosystem (from a possible Target surplus country) should have been insisting for a regular settlement of the Target balances, similar to the settlement mechanism for the twelve Federal Reserve Banks that form the Federal Reserve System. However, the economists involved in the construction of the Eurosystem apparently focused on another issue, namely the pure quantity of money. The two-pillar approach from the ECB, which implies a regular

observance of the monetary aggregate $M3$, vividly shows the influence the quantity theory of money had on the construction of the Eurosystem.

Furthermore, the failure of the scientific community to even note the build-up of the immense Target imbalances from 2007/08 until February 2011 also shows that the assets of the central banks were broadly neglected by the profession. The Target imbalances were "hidden" in the nationals central banks' balance-sheets for a very simple reason: economists did not observe or monitor the assets of central banks.

Sticking to the wrong theory: the hollowing of the euro (cont.)

The quantity theory of money and the accompanying concept of a fiat money system are still problematic for anybody who wants to argue that risky positions in a central bank's balance-sheet matter. Economists like Hans-Werner Sinn, who permanently warn about, and alert the public to, the huge risk involved in the Target claims from the Bundesbank, face a serious dilemma. Given the generally accepted theory of fiat money, the assets of the central bank do *not* matter for the stability of the currency and the price level. When Sinn was criticized by other economists who argued that the assets of the central bank are not relevant, he agreed that the Bundesbank can lose all of its assets without any consequences for the value of the currency. He even argues in his (recent) books that the non-inflationary loss capacity of the Eurosystem is about 3.4 trillion euros – a number calculated by Buiter and Rahbari (2012) who assume a fiat money system where the central bank does not need any assets.

The acceptance of the fiat money approach by a scientist like Sinn, who spend all his energy to warn the taxpayer about the immense risks involved in the assets of the central bank, vividly shows the problem caused by the narrative (or paradigm) formed by the concept of fiat money and the quantity theory. In each of his books, Sinn emphasizes that a possible loss of the Bundesbank after a breakup of the euro signifies a loss for the taxpayer. However, to really alert the public of the risks involved in the Bundesbank's assets, he would have to add that a central bank really needs these assets to function and to guarantee a stable currency.

Nevertheless, Sinn has to be praised for bringing up the topic of risky central bank assets to the mind of economists and the public and critically accompanying the policy of the ECB (for example the OMT program) with an incredible amount of valuable and groundbreaking publications. He fought restlessly to make the German taxpayer aware of the numbers and the immense risk behind the word Target. I only wanted to show that even the very scientist who argues with the riskiness of the assets from the central bank (here, the Bundesbank) more than anybody else, is – apparently – not immune to the narrative or paradigm of a fiat

money system where only the quantity of circulating notes matter.

The obscured risk for the tax-payer and the missing public debate

The main obstacle in bringing the risk from the Target imbalances into the public debate is not their complexity but that they are presented too much in the abstract by the very opponents of the imbalances. Loosely speaking, without declaring the assets of the central bank necessary for the stability of the currency, one cannot conclude convincingly that losing those assets is of any relevance. In contrast to the conventional wisdom that the risk of Target claim losses for the Bundesbank is a complicated issue, I showed in this paper, liberated from the false narrative of the quantity theory and a fiat money system, a clearer picture. If one thinks about these possible losses in terms of real numbers that have to be covered *immediately* by the respective government (i.e. the taxpayers) in order to guarantee a stable currency, the consequences become clear and precise.

If the euro area breaks apart, Germany, Luxembourg, the Netherlands, and Finland will face enormous difficulties to recapitalize their central banks. I analyzed the consequences for Germany for that case and explained the centrifugal forces in the Eurosystem which can provoke such a break up. The tragedy for the taxpayers is that they were not informed about these tremendous financial burdens. Nobody clearly explained to them that they would have to either finance the immediate recapitalization of their central banks or their savings (in euro notes and bank accounts) have to devalue. This clear explanation was, and is, impossible as long as the consequences of the insolvency from a central bank are obscured and disguised by the misleading narrative of a fiat money system and the view that the quantity of notes (not the backing behind the notes) is the decisive factor for their value. If the euro breaks apart, economists will likely wake up and notice that only they lived in a fiat money system while central banks have always been banks that need assets, like all other banks, to guarantee the acceptance of their liabilities.

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