

Response to Referee 1's Report on "The E-monetary Theory" for *Economics: The Open-Access, Open-Assessment E-Journal*

I thank the referee for reading my work and providing thoughtful and fair comments on it. Below I will outline how I would respond to the referees' suggestions:

Referee (Major comments):

1. Exposition of the paper

Bullet Point 1: "My understanding is that the main contribution of the paper is the modeling part. The author should stress this contribution and, at the same time, the author should provide extensive details on the algorithms used to solve the model with 5 occasionally binding constraints (OBCs): Matlab, Fortran, Dynare, etc. Appendix C should be much more detailed. Let me stress again that such a model is far from being standard in the literature."

My Response: I am happy to do this in my revised version. In the introduction, I will emphasize the main contribution, which is to model an economy with electronic payment system where banks play a vital role. This model allows us to understand the unconventional monetary policy.

On the algorithm of numerical method, I am happy to document the whole procedure in detail. I will upload all computational files (code and instruction) on the main journal's website with my revised version. My files were written in C++ with the help of IPOPT to solve a perfect-foresight transition path. After getting the numerical results, I use Matlab to draw impulse response functions from these numerical results.

After transforming the 5 occasionally binding constraints into the equality constraints, I will insert a new subsection in the Appendix C to list the transformed system of equations that I bring into computer.

Bullet Point 2 "The paper should provide the economic intuition on why two types of electronic money are useful for the research question of the paper. What are they capturing in terms of the effects of UMP?"

My Response: I will create a new section "Discussion" before the "Conclusion" to discuss this important point. I model two types of electronic money to capture the effect of money supply (quantity theory of money) in the UMP. If the central bank adjusts the interbank rates by changing the level of reserves, the interest rate alone will capture all information of monetary policy. However, if the main tool is interest on reserves, the effect of monetary policy depends on both money supply and interest rate. Therefore, we need "money" in our model, especially money

created by banks. Besides that, I cannot avoid modeling banking reserves when the interest on reserves becomes the main tool of the central bank.

Bullet Point 3 “The list of main results in the introduction (page 3 and 4) is too long and unclear.”

My response: I will change my writing to emphasize what is similar to the literature and what is not. The list of the main results will be cut shorter, including only the differences between my paper and the literature.

Bullet Point 4 “The paragraph on related literature covers different strands of research: money supply side, money demand side, New-Keynesian models, the contribution by Brunnermeier and Sannikov (2016, NBER WP). These approaches rely on very different techniques for solving/simulating models. The author should clarify which is the main strand of literature and what the paper adds to this.”

My response: I am happy to follow your advice. I will have some adjustments to the literature review to make it more logical. My framework still shares many similarities with the New Keynesian literature, so I will start from there in the revised version. Then I will mention what I add to it.

Bullet Point 5 “The Conclusion refers to the stance of monetary policy. Generally speaking people refer to the stance of monetary policy when discussing whether it is loose or tight. This paper does not deal with the stance of monetary policy.”

My response: I will clarify this statement in the conclusion. Economists often refer to a loose (tight) monetary policy when the central bank cuts (raises) interest rate. I show that it is not complete true in the unconventional monetary policy. A raise on nominal interest rate (by raising IOR) is not a tight monetary policy if the central bank couples it with an increase in the money supply (my main message). A cut on nominal interest rate is not a loose monetary policy if the central bank simultaneously sells a huge amount of agency MBS or government bonds back to market. As I do not use the term “loose” or “tight” monetary policy in the whole paper, it makes my conclusion difficult to comprehend. I will definitely fix it.

Referee’s Other Comments:

2. “I am also wondering how the different algorithms used to solve the OBCs interact. I am pretty sure that determinacy in the paper is not always guaranteed. The model might display some regions of indeterminacy depending on some parameter values. This is also

evident from the shape of some IRFs in Figures 4 and 5. The paper should deal with this issue.”

My Response: I will definitely put the problem of determinacy in the new “Discussion” section because it is an important issue. As my model is non-linear in nature with inequality constraints, it requires the global determinacy rather than local determinacy. My model guarantees the uniqueness of the steady state under some conditions. By numerical methods, I also show that there exists a transition path converging to the unique steady state that shares many salient features with reality. However, the limitation of my model is that it does not have a theoretical proof to show the uniqueness of this transition path. I will clearly state this limitation in the discussion and hope that future research can address this issue.

3. “Monetary policy. In the model section, equations (31) and (32) explain monetary policy. First of all, it is not clear to me why in the baseline model the central bank follows a rule that fixes the interest rate to a constant level. Why not using a "standard" interest-rate rule where the policy rate respond to inflation (in deviation from the target) and to the output gap? Second, additional monetary policy tools are examined throughout the paper. From a reader perspective it is better to list all of them in the model section. It would be much clearer which instrument is used in the policy exercises conducted later in the paper.”

My Response: In the baseline model, the central bank follows a Taylor Rule (equation 32) when adjusting the interbank rate. Hence, it is standard in the literature. Equation (31) is the rule for interest on reserves (IOR), which is kept constant near 0. In the regime of no excess reserves, IOR is not a tool for central bank. In fact, the Fed only started using IOR since Oct 2008. My baseline model just wants to replicate the monetary policy before the Great Recession. Equations (31) and (32) still imply that the policy rate responds to inflation.

I am happy to follow your advice to list all the potential monetary policy tools at the baseline model: helicopter money, asset purchasing from the non-bank private sector and interest on reserves.

4. “Calibration. The explanation of the parameter choice is not precise. For some parameters the paper does not provide an explanation, such as the monitoring costs, loan amortization, the relative weight of labor, cost of changing price, the central bank parameters. I am pretty sure that the calibration of some bankers parameters, such as the monitoring cost, is not innocuous. The paper should either provide a justification or conduct robustness exercises for alternative

parameterizations.”

My Response: I am happy to put more explanations and justifications on my calibration, especially for the non-standard bankers’ parameters. The monitoring cost is to calibrate to match with the real borrowing cost about 4.5% before the Great Recession.

5. “Impulse response functions. First, the interest rate shock is calibrated quite persistent, while in the figure it seems very short-lived. Why? Second, as far as I understood, the number of quarters in Figure 3 varies from 10 (for investment and labor) to 300 (for inflation). This generates confusion in the reader. In addition, this is a business cycle model. I really do not approve the choice of plotting the response of a variable up to 75 years after the shock. Same rationale or Figures 4-6.”

My Response: The interest shock is calibrated quite persistent but the response seems short-lived. This happens because the loans in my model are long-term loans. In DSGE models with one-period loans, they allow the 100% pass through from the short-term rate to the loan rate. In my model, even with the federal funds rate (short-term rate) is persistent, the loan rate is not dropping much, leading to short-lived response.

In Figure 3, I will change the number of quarters to 300 for every figure. The reason I plot 10 quarters for investment and labor as they already near the steady state after 10 quarters. Hence, I want to enlarge this picture.

I also choose 300 periods for my model due to the fact that this non-linear model needs these long periods to go back the steady state. The common impulse response functions are drawn with a very small shock on a log-linearized model. The level of shock is only 1%-5% of its steady state level, so it takes only 20 periods for the system coming back to the initial level. The level of banking reserves in my model, with large scale asset purchasing, could go up to 700% of its steady state level. Therefore, it takes a long-time to go back the steady state. In fact, this phenomenon matches with the US economy. The Fed started unwinding quantitative easing, but even with next 20 years (30 years since 2008), it is unlikely that the banking reserves back to the level in 2007.

6. “It is not clear to me why page 6 and page 12 report the same utility function (with a different index). The author could report the utility function of bankers and households once in Section 3.”

My Response: I am happy to fix the notations here. I will write both utilities from period 0 to make them consistent.

7. “The paper refers to forward guidance in Section 6.5.1. I think that this reference is too stretched. Strictly speaking, this paper is not modeling forward guidance.”

My Response: I understand your concerns, as the forward guidance in my model is a little bit different from the standard way. That comes from the complicated interaction between interbank rate, IOR and reserve level. However, the agents in my model are perfect-foresight; and the central bank follows a committed monetary policy with keeping the interbank rate near 0 for 20, 40, 80 quarters. Hence, the central bank guides the agents to know the interest rate path in the future. Moreover, I find the same result with the common literature that this type of forward guidance increases inflation in the short run.

8. “The borrowing constraint (equation 19 page 15) simply states that households face an exogenous borrowing constraint. An important amplification channel is then missing. This channel would be very relevant also to investigate the effects of UMP. My guess is that results would be even amplified. I understand that the author has chosen to simplify this part of the model. However, the explanation reported in the paper does not sound convincing. The author could better justify this choice or run a robustness exercise with a proper collateral borrowing constraint in the spirit of Iacoviello (2005, AER).”

My Response: I completely agree with you that an amplification channel is missing because I do not model the collateral borrowing constraint. Still, this channel is well understood in the literature with many seminal papers. I just want to focus on the capital constraint channel of commercial banks so I do not include it.

9. “The authors should update the references since a paper has been published.”

My Response: I fixed the references for Abel (1985) and Keister and McAndrews (2009)