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Trust and monetary policy

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Abstract

We analyze how trust affects the transmission of negative demand and supply shocks using a behavioral macroeconomic model. We define trust to have two dimensions: trust in the central bank's inflation target and trust in the central bank's capacity to stabilize the business cycle. We find, first, that when large negative shocks occur, the subsequent trajectories taken by output gap and inflation typically coalesce around a good and a bad trajectory. Second, these good and bad trajectories are correlated with movements in trust. In the bad trajectories, trust collapses, and in the good trajectories, it is not affected. This feature is stronger when a negative supply shock occurs than in the case of a negative demand shock. Third, initial conditions, in particular the initial state of inflation and output expectations, matter. Unfavorable initial expectations drive the economy into a bad trajectory, and favorable initial expectations produce good trajectories. Fourth, we analyze the sensitivity of our results with respect to the size of the shocks. Fifth, we derive implications of our results for our capacity of making forecasts about the effects of large demand and supply shocks.

KEYWORDS

behavioral macroeconomics, monetary policy, trust

1 | INTRODUCTION

The importance of trust in economic life is pervasive. Trust in the quality of institutions, trust in the executive and judiciary, and trust in a stable environment governed by the rule of law, they all affect the behavior of economic agents and make them more willing to engage in contractual arrangements, to plan, and to invest. There is now a large literature documenting how trust matters for economic development and growth.[1]

Trust also plays a role in standard macroeconomic models. These now typically incorporate a central bank that announces an inflation target. The credibility of this inflation target and reputation of the central bank usually play an important role in the effectiveness of monetary policies and in the transmission of shocks (Barro & Gordon, 1983; Bursian & Fürth, 2015; Bursian & Faia, 2018; Christelis et al., 2020). As a way of illustrating how trust may affect the effectiveness of monetary policies, consider the Eurobarometer survey shown in Figure 1. According to this survey, the European Central Bank (ECB) enjoyed a relatively high public trust record prior to 2008. This high level of trust was associated with a rate of inflation close to the 2% target rate (see Figure 2). As will be shown in this paper, trust in the central bank's ability to maintain price stability matters for the way monetary policies and exogenous shocks are transmitted into the economy. This is the first dimension of trust we will consider.

Trust in the central bank has a second dimension. This is related to the capacity of the central bank to minimize the intensity of business cycle fluctuations. Or put differently, it has to do with the capacity to maintain macroeconomic stability. From Figure 1 we also observe that after the global financial crisis and the deep economic recession that followed it (see Figure 2), public trust in the ECB significantly declined in the Eurozone. Note also from Figure 2 that the inflation rate during the same period became more variable despite its low level. This suggests that trust in the central bank can also be undermined when it is perceived to fail in maintaining macroeconomic stability (see more studies such as Wälti, 2012; Ehrmann et al. 2013; Roth et al. 2014). One of the major objectives of this paper is to investigate how the nature of the shocks (supply and demand) and the size of these shocks affects the trust in the central bank in its two dimensions.

We will use a behavioral macroeconomic model (see De Grauwe, 2012; De Grauwe & Ji, 2019) to analyze trust. This is a model which assumes that agents have cognitive limitations. They do not know the underlying structure of the model nor do they know the distribution of the shocks that affect the economy. It will be seen that in such models with imperfect information trust is of great importance to understand how shocks are transmitted and how monetary policies affect the economy.

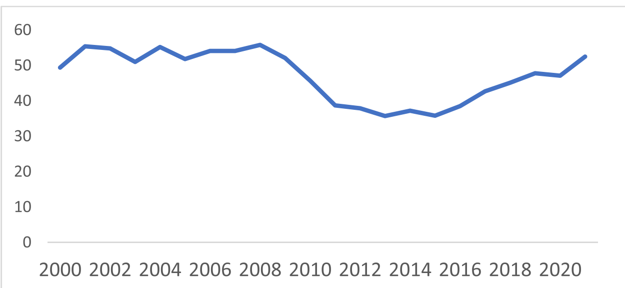

FIGURE 1 Trust in ECB 2000–2021 (%). Source: Eurobarometer. Note: Trust is defined as the percentage of EU citizens declaring that they have trust in the ECB. ECB, European Central Bank.

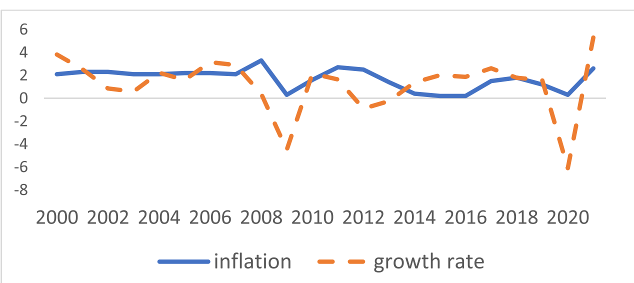

FIGURE 2 Eurozone inflation (%) and growth rate (%) annual data, 2000–2021. Source: Eurostat.

The behavioral macroeconomic model we will use generates an endogenous dynamics of trust and business cycle. The fundamental reason of the emergence of such a dynamics is the fact that individuals have cognitive limitations preventing them from having rational expectations, that is, preventing them from understanding the complexity of the underlying model. This lack of understanding provides the basis of a mechanism in which individuals find it rational to use simple rules of behavior, check ex post how well these rules have worked, and are willing to experiment with other rules when they observe that these work better. It also turns out that the shifting in the rules of behavior at the individual level generates a collective process of herding based on the fact that successful rules will be adopted by others. It is this collective process that is at the core driving the business cycle movements and influencing the trust in the central bank.

In this paper, we will analyze how demand and supply shocks are propagated. We will focus on large shocks (to be defined appropriately). It will be shown that when the size of the shocks is large enough, the transmission path after the shock will tend to coalesce around two possible trajectories, a good one and a bad one, as if there are two attractors around which the transmission dynamics is organized. It will be shown that the good trajectory coincides with a state of trust, whereas the bad trajectory distrust prevails. This feature will also allow us to focus on the importance of initial conditions (such as initial state of trust) in guiding the economy towards the good or the bad trajectories. In other words, we will show that history matters.

The rest of the paper is structured as follows. Section 2 presents the behavioral macroeconomic model. Section 3 presents the impulse responses of large demand and supply shocks and shows how the trajectories taken by these impulse responses are associated with trust. Section 4 analyzes the power of initial conditions in predicting the subsequent trajectories of output gap, inflation, and interest rate. Section 5 performs a robustness analysis allowing us to trace the transition from small to large shocks. This section also contains a Monte Carlo simulation aimed at checking the robustness of our results by allowing a wide selection of parameters. Section 6 discusses policy issues, in particular it focuses on the policy implications arising from the fact that the distribution of the impulse responses is non-Gaussian, it discusses the power of output stabilization and how it affects trust in response to supply shocks, and it provides for a short historical analysis of large shocks during the 1970s and during the pandemic. Section 7 concludes.

2 | THE MODEL

2.1 | Basic equations

The basic behavioral model consists of an aggregate demand equation, an aggregate supply equation, and a Taylor rule as described by De Grauwe (2012) and De Grauwe and Ji (2019, 2020). The aggregate demand and supply equations can be derived from expected utility maximization of consumers and expected profit maximization of firms (Hommes, 2019; De Grauwe & Ji, 2019). In De Grauwe and Ji (2019), we provide a microfoundation.

The aggregate demand equation obtained from this microfoundation can be expressed in the following way:

$$y_t = a_1\tilde{\mathrm{E}}_t y_{t+1} + (1-a_1)y_{t-1} + a_2\left(r_t - \tilde{\mathrm{E}}_t\pi_{t+1}\right) + v_t \tag{1}$$

where y_t is the output gap in period t, r_t is the nominal interest rate, π_t is the rate of inflation and two forward looking components, $\tilde{\mathrm{E}}_t\pi_{t+1}$ and $\tilde{\mathrm{E}}_t y_{t+1}$. The tilde above E refers to the fact that expectations are not formed rationally. How exactly these expectations are formed will be specified in Section 2.2.

The aggregate supply equation is represented in Equation (2). This New Keynesian Philips curve includes a forward looking component, $\tilde{\mathrm{E}}_t\pi_{t+1}$, and a lagged inflation variable. Inflation π_t is sensitive to the output gap y_t. The parameter b_2 measures the extent to which inflation adjusts to changes in the output gap.

$$\pi_t = b_1\tilde{\mathrm{E}}_t\pi_{t+1} + (1-b_1)\pi_{t-1} + b_2 y_t + \eta_t \tag{2}$$

The Taylor rule describes the central bank's behavior in setting the interest rate. This behavior can be described as follows:

$$r_t = (1-c_3)\left[c_1(\pi_t - \pi^*) + c_2 y_t\right] + c_3 r_{t-1} + u_t \tag{3}$$

where r_t is the interest rate in period t, π_t is the inflation rate, π^* is the target rate of inflation, and y_t is the output gap.

This Taylor rule (Taylor, 1993) tells us that the central bank increases (reduces) the interest rate when currently observed inflation exceeds (falls short of) the target and when the currently observed output gap is positive (negative). We assume that the central bank wants to smoothen interest rate changes (see Levin et al., 1999; Woodford, 1999, 2003).

There are error terms in each of Equations (1)–(3), which describe the nature of the different shocks that can hit the economy. They include demand shocks, v_t, supply shocks, η_t, and interest rate shocks, u_t. These shocks are assumed to be normally distributed with mean zero and a constant standard deviation.

2.2 | Expectations formation

We analyze how the forecast of output gap $\tilde{\mathrm{E}}_t y_{t+1}$ and inflation $\tilde{\mathrm{E}}_t\pi_{t+1}$ are formed in the model. The rational expectations hypothesis requires agents to understand the complexities of the underlying model and to know the frequency distributions of the shocks that will hit the economy. We take it that agents have cognitive limitations that prevent them from understanding and processing this kind of information. These cognitive limitations have been confirmed by laboratory experiments and survey data (see Branch, 2004; Hommes, 2011, 2021; Assenza et al., 2014; Pfajfar & Zakelj, 2014).

2.2.1 | Forecasting the output gap

We assume two types of rules agents follow to forecast the output gap. A first rule is called a "fundamentalist" one. Agents use the steady state value of the output gap (which is normalized at 0) to forecast the future output gap. A second forecasting rule is a "naïve" extrapolative one. Following this rule, agents extrapolate the previous observed output gap into forecasting the future. The fundamentalist and extrapolator rules for output gap are specified as follows:

$$\tilde{\mathrm{E}}_t^f y_{t+1} = 0 \tag{4}$$

$$\tilde{\mathrm{E}}_t^e y_{t+1} = y_{t-1} \tag{5}$$

This kind of simple heuristic has often been used in the behavioral macroeconomics and finance literature where agents are assumed to use fundamentalist and chartist rules (see Brock & Hommes, 1997; Branch and& Evans, 2006; Brazier et al., 2008).

The market forecast can be obtained as a weighted average of these two forecasts, that is

$$\tilde{\mathrm{E}}_t y_{t+1} = \alpha_{f,t}\tilde{\mathrm{E}}_t^f y_{t+1} + \alpha_{e,t}\tilde{\mathrm{E}}_t^e y_{t+1} \tag{6}$$

$$\alpha_{f,t} + \alpha_{e,t} = 1 \tag{7}$$

where $\alpha_{f,t}$ and $\alpha_{e,t}$are the probabilities that agents use the fundamentalist and the naïve rules, respectively.

We specify a switching mechanism of how agents adopt specific rule. Using discrete choice theory (see Anderson et al., 1992; Brock & Hommes, 1997) to work out the probability of choosing a particular rule (see De Grauwe & Ji, 2019) for more detail, we obtain

$$\alpha_{f,t} = \frac{\exp(\gamma U_{f,t})}{\exp(\gamma U_{f,t}) + \exp(\gamma U_{e,t})} \tag{8}$$

$$\alpha_{e,t} = \frac{\exp(\gamma U_{e,t})}{\exp(\gamma U_{f,t}) + \exp(\gamma U_{e,t})} \tag{9}$$

where $U_{f,t}$ and $U_{e,t}$ are the past forecast performance (utility) of using the fundamentalist and the naïve rules (measured as minus the root mean squared errors of past forecasts. The parameter γ measures the "intensity of choice." It can also be interpreted as expressing a willingness to learn from past performance. When $\gamma = 0$, this willingness is zero; it increases with the size of γ.

2.2.2 | Forecasting inflation

Agents also forecast inflation using a similar heuristic, with one rule that could be called a fundamentalist rule and the other a naïve extrapolative rule (see Brazier et al. [2008] for a similar setup). In an institutional setup, the central bank announces an explicit inflation target. The fundamentalist rule will be called an "inflation targeting" rule described in Equation (10); that is, agents who have confidence in the credibility of the central bank use the announced inflation target to forecast inflation.

$$\tilde{E}_t^f \pi_{t+1} = \pi^* \tag{10}$$

where the inflation target is π^*. Agents who do not trust the announced inflation target use the naïve rule, which consists in extrapolating inflation from the past into the future. The "naive" rule is defined by

$$\tilde{E}_t^e \pi_{t+1} = \pi_{t-1} \tag{11}$$

The market forecast is a weighted average of these two forecasts, that is,

$$\tilde{E}_t \pi_{t+1} = \beta_{f,t} \tilde{E}_t^f \pi_{t+1} + \beta_{e,t} \tilde{E}_t^e \pi_{t+1} \tag{12}$$

$$\beta_{f,t} + \beta_{e,t} = 1 \tag{13}$$

where $\beta_{f,t}$ and $\beta_{e,t}$ are the probabilities that agents use the fundamentalist and the extrapolative rules, respectively. The same selection mechanism is used as in the case of output forecasting to determine the probabilities of agents trusting the inflation target and those who do not trust it and revert to extrapolation of past inflation. This inflation forecasting heuristics can be interpreted as a procedure of agents to find out how credible the central bank's inflation targeting is. If, on the one hand, this is credible, using the announced inflation target will produce good forecasts, and as a result, the probability, $\beta_{f,t}$, that agents will rely on the inflation target will be high. If, on the other hand, the inflation target does not produce good forecasts (compared to a simple extrapolation rule), the probability that agents will use it will be small. Using the switching mechanism similar to the one specified in Equations (8) and (9), we can compute the probability of choosing a particular rule.

$$\beta_{f,t} = \frac{\exp\left(\gamma U'_{f,t}\right)}{\exp\left(\gamma U'_{f,t}\right) + \exp\left(\gamma U'_{e,t}\right)} \tag{14}$$

$$\beta_{e,t} = \frac{\exp\left(\gamma U'_{e,t}\right)}{\exp\left(\gamma U'_{f,t}\right) + \exp\left(\gamma U'_{e,t}\right)} \tag{15}$$

The probability, $\beta_{f,t}$, that agents will rely on the inflation target to make inflation forecasts can also be interpreted as the fraction of agents who trust the central bank's inflation target.

2.3 | Defining trust

The output and inflation expectation formation discussed in Section 2.2 allows us to give a precise definition of trust. As mentioned earlier, we assume it has two dimensions. Let us start with the first dimension which is the trust that the central bank can keep inflation close to the announced target. We will define this trust as the market's expectation of inflation, $\tilde{E}_t \pi_{t+1}$, in Equation (12). As we normalize the inflation target, π^*, to be equal to 0, a deviation of $\tilde{E}_t \pi_{t+1}$ from 0 (positive or negative) amounts to a lack of trust. This can be seen as follows. The higher this deviation is, the more agents believe that the central bank will be unable to keep inflation close to the target; in other words, the lower is their trust in the central bank's capacity (willingness) to keep inflation close to the target.

Using Equations (10) and (11) and setting $\pi^* = 0$, Equation (12) can be rewritten as follows:

$$\tilde{E}_t \pi_{t+1} = \beta_{e,t} \pi_{t-1}$$

This shows that deviation of the market's expectations of inflation from 0 will tend to increase when the fraction of agents using the extrapolative rule $\beta_{e,t}$ is high, or put differently, when the fraction of agents using fundamentalist rule, $\beta_{f,t}$, is low. Thus, trust will be low when $\beta_{f,t}$ is low; that is, few agents use the inflation target as their forecasting rule. In the limit when $\beta_{e,t} = 1$ and$\beta_{f,t=}0$, trust will be at its lowest level. We will come back to this interpretation when we present the results of the model.

The second dimension is trust in the capacity of the central bank to maintain macroeconomic stability. We will measure this by $\tilde{E}_t y_{t+1}$ in Equation (6). Because the steady state output gap is 0, $\tilde{E}_t y_{t+1}$ measures the market's expected deviation of the output gap from the steady state. The larger is this deviation (positive or negative), the lower is the trust agents have in the capacity of the central bank to stabilize output (the business cycle) around its steady state value. Using Equations (4) and (5), Equation (6) can be written as

$$\tilde{E}_t y_{t+1} = \alpha_{e,t} \mathrm{y}_{t-1}$$

Thus, the deviation of the market's expectations of the output gap from 0 will tend to increase when the fraction of agents using the extrapolative rule is high or put differently when the fraction of agents using the fundamentalist rule, $\alpha_{f,t}$, is low. This is because fewer agents believe that the output gap will converge to the steady state and trust in the capacity of the central bank to stabilize output will be correspondingly low.

2.4 | Calibration

As our model has strong nonlinear features, we use numerical methods to analyze the dynamics created by the model. In order to do so, we have to calibrate the model, that is, to select numerical values for the parameters of the model. The model was calibrated in such a way that the time units can be considered to be quarters. In Table 1, we show these numerical values with the references from the literature. Note that these numerical values for the parameters are very similar to the ones estimated by Kukacka et al. (2022) based on the US data (see also Grazzini et al., 2017). The three shocks (demand, supply, and interest rate shocks) are independently and identically distributed (i.i.d.) with standard deviations of 0.5%. These shocks produce standard deviations of the output gap and inflation that mimic the standard deviations found in the empirical data using quarterly observations for the United States and the Eurozone. The way we did this is described in more detail in De Grauwe and Ji (2020). It should also be mentioned that the parameter values in Table 1 ensure local stability of the steady state. Finally, we will perform a Monte Carlo experiment varying the numerical values of different parameters to check the robustness of our results.

3 | THE RESULTS OF THE MODEL

In this section, we present impulse responses of demand and supply shocks. One important feature of impulse responses in a (nonlinear) behavioral model is that these responses are sensitive to initial conditions. Thus, the transmission of, say, a supply shock will be influenced by the values of output, inflation, interest rate, and the expectations of these variables at the moment the shock occurs. In particular, the initial state of trust (measured by the initial inflation and output expectations) will be shown to matter a great deal for the subsequent trajectories of the endogenous variables of the model after a

TABLE 1 Parameter values of the calibrated model.

$a1 = 0.5$	Coefficient of expected output in output equation (Smets & Wouters, 2003)
$a2 = -0.2$	Interest elasticity of output demand (Smets & Wouters, 2003).
$b1 = 0.5$	Coefficient of expected inflation in inflation equation (Smets & Wouters, 2003)
$b2 = 0.05$	Coefficient of output in inflation equation
$\pi^* = 0$	Inflation target level
$c1 = 1.5$	Coefficient of inflation in Taylor equation (Blattner & Margaritov, 2010)
$c2 = 0.5$	Coefficient of output in Taylor equation assuming a dual Mandate Central Bank (Blattner and Margaritov [2010])
$c3 = 0.5$	Interest smoothing parameter in Taylor equation (Blattner and Margaritov [2010])
$\gamma = 2$	Intensity of choice parameter, see Kukacka et al. (2022)
$\sigma_\nu = 0.5$	Standard deviation shocks output
$\sigma_\eta = 0.5$	Standard deviation shocks inflation
$\sigma_u = 0.5$	Standard deviation shocks Taylor
$\rho = 0.5$	Memory parameter (see Appendix for an analysis of the memory parameter)

supply and demand shock. All this will be made clear in this section.

The way we computed the impulse responses to a particular shock was the following. We first run a base simulation using a particular realization of all the stochastic variables (the error terms in the demand, supply, and Taylor rule equations). We then rerun the model with exactly the same realizations of these stochastic variables except for the fact that at period $t = 100$, a shock is introduced in the demand or in the supply equation. We then compute the differences between the output gap in the series with the shock and the series obtained in the base simulation. We also expressed these differences as "multipliers"; that is, we divided them by the size of the shock. This yielded one particular impulse response for a given set of realizations of the stochastic variables. We repeated this 1000 times, each time with another realization of the stochastic variables in the model. This then yielded 1000 different impulse responses to the same shock, but with different initial conditions of the endogenous variables of the model.

This procedure also implies that at the moment the shock occurs, the system is out of equilibrium. Thus, each of the 1000 impulse responses will have, as a starting point, a different disequilibrium. Put differently, the initial states of trust (measured by the initial inflation and output expectations) each reflect different initial disequilibria. We will show that this has important implications for the subsequent trajectories the impulse responses take.

3.1 | Impulse response to supply shocks

We first discuss the impulse responses to a negative supply shock. We will consider a large shock which we define as a 10 standard deviation shock. This is a truly large shock, but it corresponds to the size of the shock observed in early 2020 when GDP dropped by 10% to 20% in many countries as a result of the worldwide shutdown of production. The shock produced by the financial crisis of 2007–2008 was of a similar order of magnitude. In Section 5, we produce a sensitivity analysis with respect to the size of the shocks. There, we establish that shocks with standard deviations of 3 or more broadly reproduce the results reported in this section.

We present the 1000 impulse responses to a negative supply shock in Figure 3. A first thing to note is the large differences in the trajectories of the endogenous variables after the supply shock. Over time, these impulse responses tend to converge, but it takes a long time for convergence to be reached. We observe the existence of two trajectories. The first one, a "good" trajectory (green), implies a relatively small decline of the output gap and a relatively quick return to the steady state value; the second trajectory, a "bad" one (black), follows a very deep decline in output and a slower recovery. A similar good and bad trajectory is detected in the impulse responses of inflation with a good trajectory of rapid declines in inflation and a bad trajectory characterized by a slower decline in inflation. These two trajectories seem to be related to the interest rate trajectory where we observe a bifurcation immediately after the shock into a (good) trajectory of quickly declining interest rate and a (bad) trajectory where the interest rate continues on an increasing path to start a decline only after four periods. We also note a wider variation of the individual impulse responses in the good trajectories as compared to the bad trajectories.

It should be stressed that the two colors we give to the trajectories are not determined ex post in an arbitrary way. They are determined ex-ante, by the nature of the initial inflation expectations. In particular, we color the trajectories green when the initial inflation expectations, which is our measure of trust, are below the central banks' inflation target, and black when they are above that target. A negative supply shock directly increases inflation pressure. Hence, it tends to increase the trust in central bank when the initial inflation expectation is below target, whereas it tends to reduce the trust in central bank when the initial inflation expectation is already above zero.

We show the frequency distribution of the initial inflation expectations in Figure 4 (where we have normalized the inflation target at 0). Thus, approximately half of the initial inflation expectations are "benign" (below the inflation target). All these benign initial conditions determine a subsequent good trajectory; the "bad" initial conditions (above the inflation target) determine a subsequent bad trajectory. We discuss the importance of initial conditions more rigorously using econometric analysis in Section 4.

The existence of two distinct trajectories can also be illustrated by presenting the distribution of the responses of the output gap in period 12 after the shock. This is obtained by taking a cross-section of the impulse responses of the output gap from Figure 3 at a particular period. Here we select period 112 (which corresponds to 12 quarters after the shock). We then plot the frequency distribution of the 1000 impulse responses. We show the results in Figure 5.

We observe a clearly bimodal distribution with peaks around −1.1 and −0.1 in the case of the output gap. We do the same for inflation and interest rates. For inflation, the peaks are around −0.05 and 0.5. This bimodal structure is associated with a bimodal structure of the interest rate with one peak at −0.3 and another at 0.6. We will

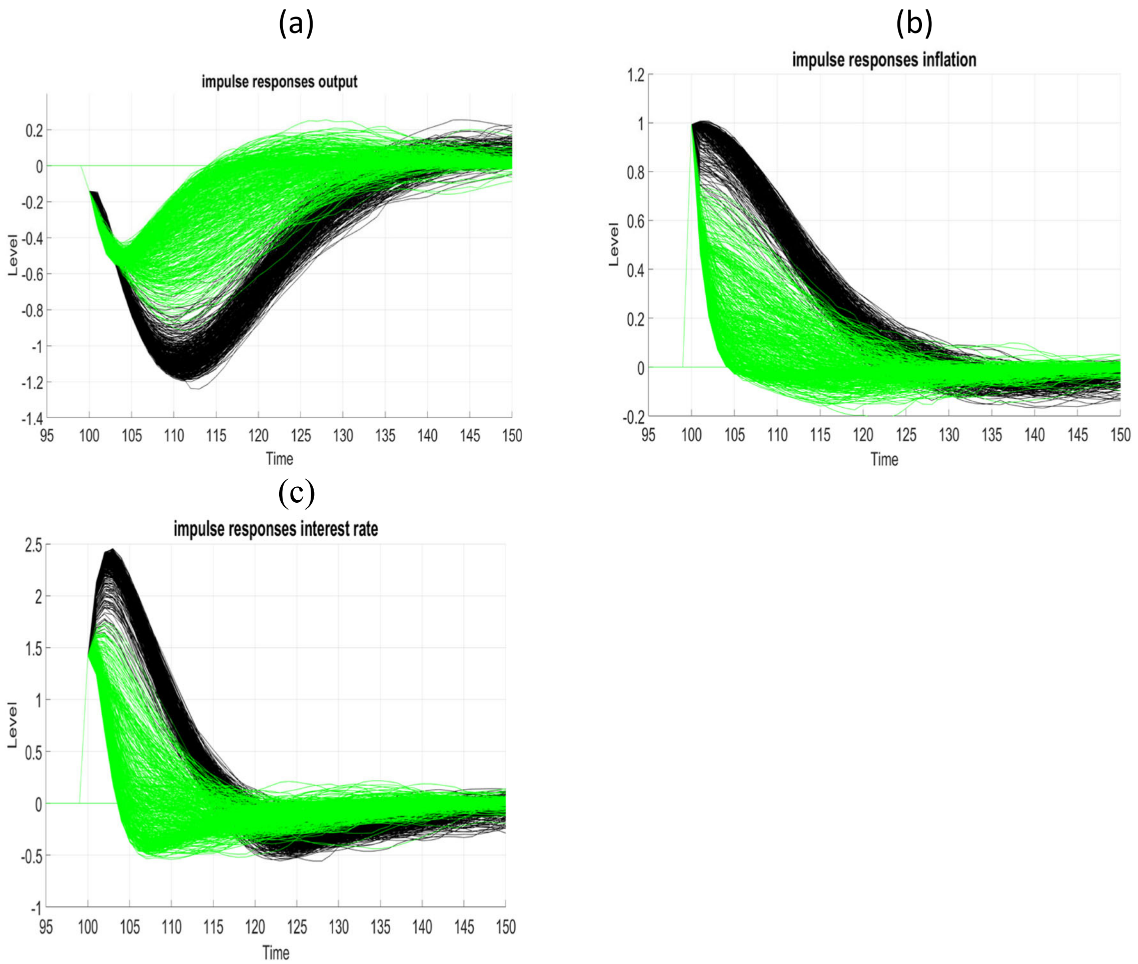

FIGURE 3 Impulse responses to a large negative supply shock (10 SD).

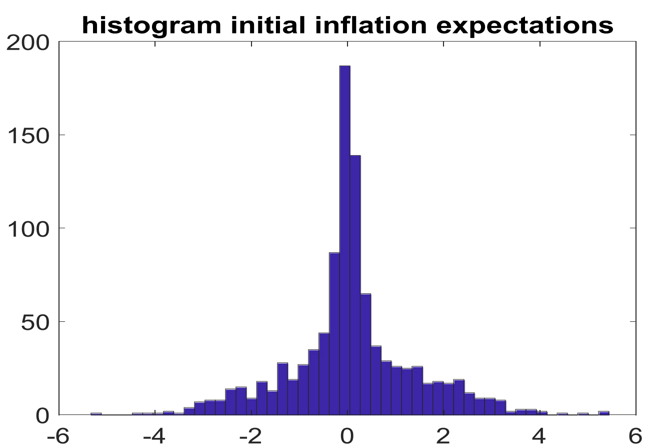

FIGURE 4 Frequency distribution of initial inflation expectations.

come back to give an interpretation for the existence of bimodal structure of the distribution of the impulse responses. We will then also discuss the importance of initial conditions.

How are these trajectories connected to our measures of trust? We answer this question in two ways. We first show the impulse responses of our indicators of trust, that is, inflation and output expectations in Figure 6. We find that in the bad trajectories (black) trust in the capacity of the central bank to stabilize output declines much more than in the good trajectories. Something similar happens with trust in the central bank's capacity to keep inflation close to the target: in the good trajectories, this trust is less affected than in the bad trajectories. Thus, we find that bad trajectories are associated with a more intense drop in trust in the central bank than good trajectories.

The second way we analyze trust is to focus on $\alpha_{f,t}$ and $\beta_{f,t}$. As will be remembered, these are the fractions of agents that use the fundamentalist rules. We argued that when these are low, this is a sign that agents do not trust the central bank's capacity to stabilize output around the steady state and to keep inflation close to its target. In Figure 7, we present $\alpha_{f,t}$ and $\beta_{f,t}$ before and after the supply shock in period 100. Because we run the model 1000 times, we obtain 1000 trajectories for these two variables.

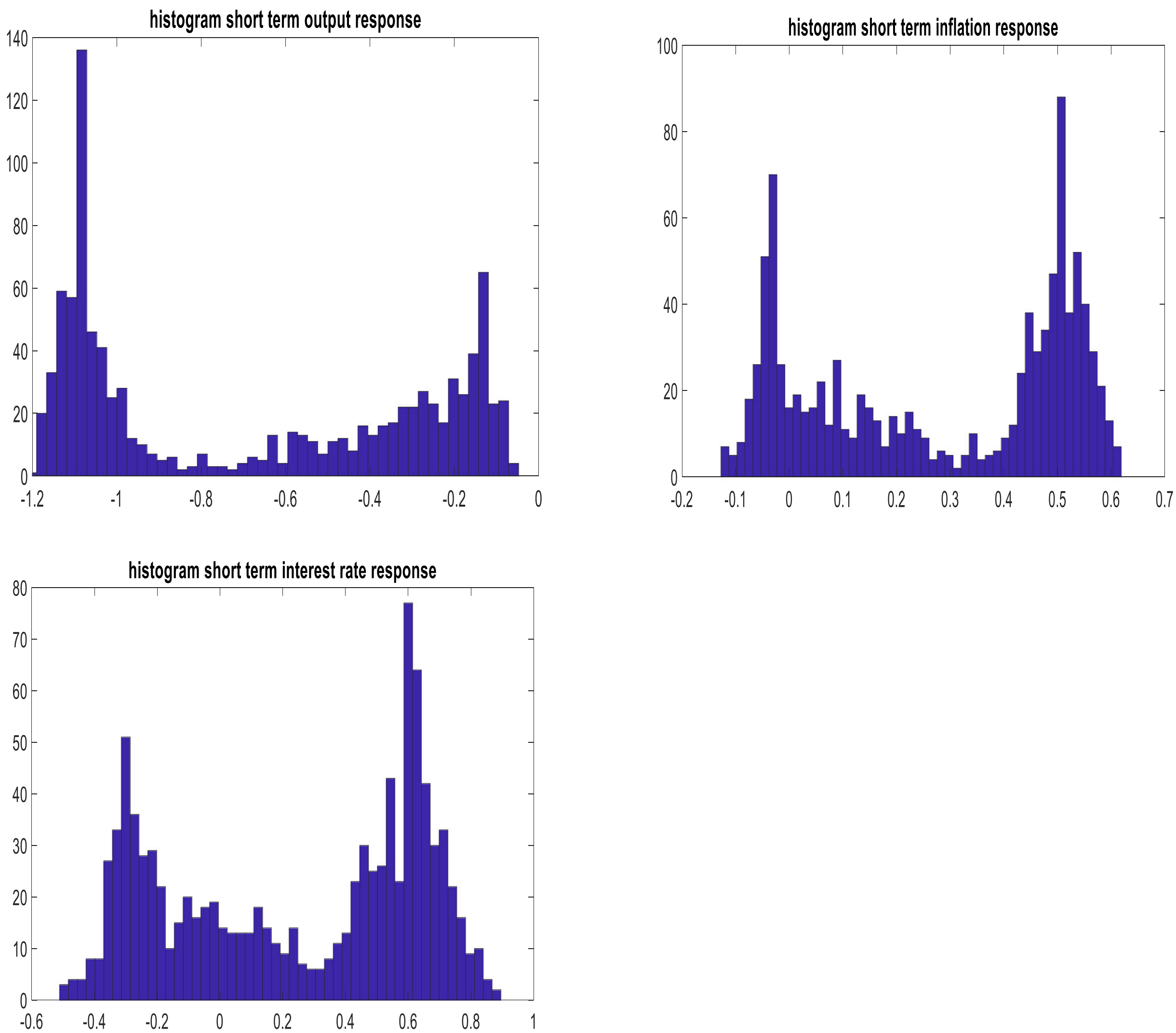

FIGURE 5 Frequency distribution of impulse responses (12 periods after shock).

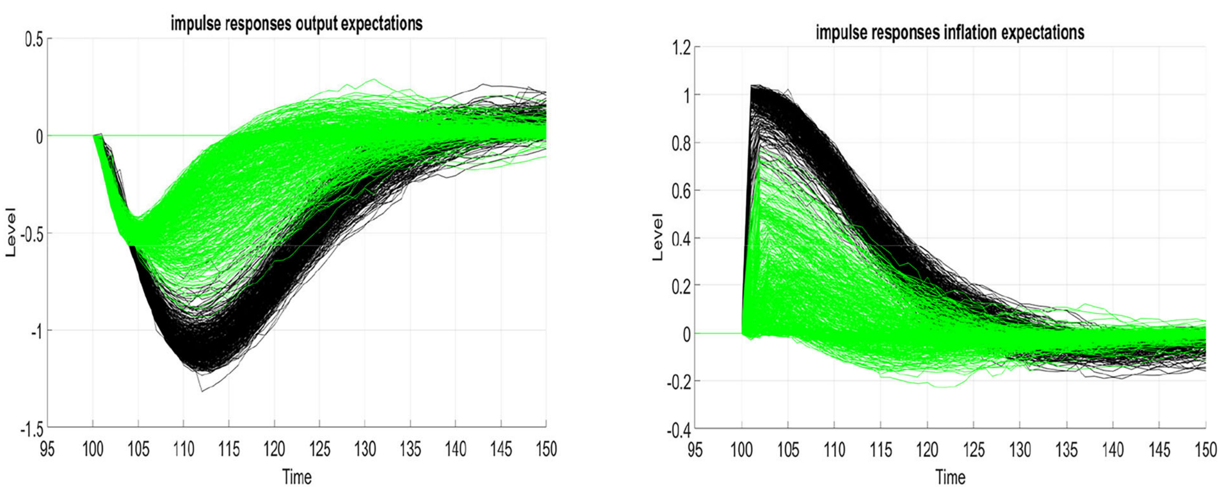

FIGURE 6 Impulse responses of trust indicators.

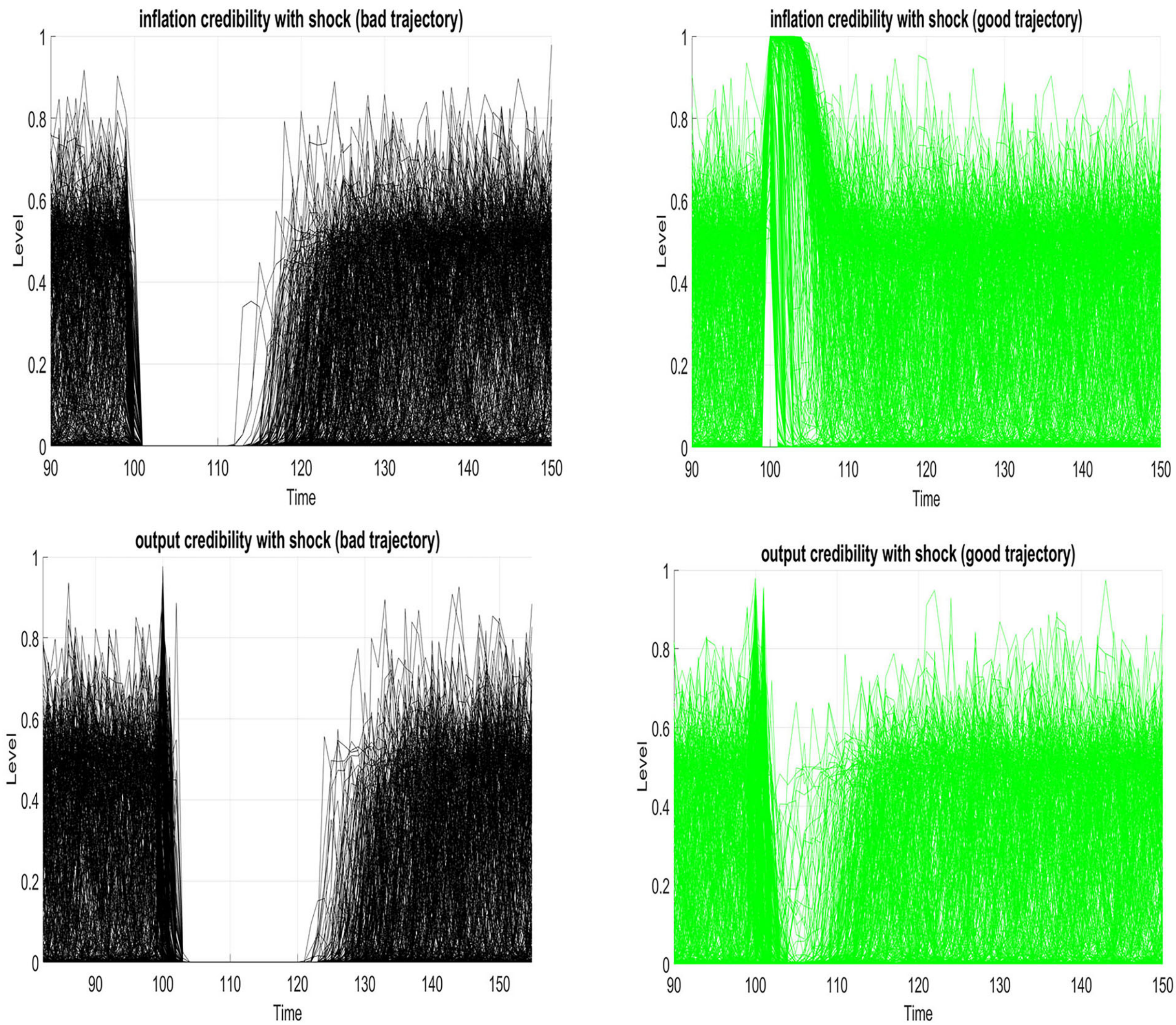

FIGURE 7 Trust: inflation credibility and output credibility with large supply shock.

We have split these trajectories into two: one corresponding to the bad trajectories and one from the good trajectories obtained in Figure 3. They are presented side by side for both $\alpha_{f,t}$ and $\beta_{f,t}$. We call the first one output credibility, as it measures the fraction of agents who expect output to go back to equilibrium. We call the second one inflation credibility as it measures the fraction of agents who use the inflation target as their forecasting rule.

Let us concentrate first on the inflation credibility. We observe something remarkable, very soon after the supply shock inflation credibility drops to zero in all the bad trajectories. Thus, when the economy is in a bad trajectory, this coincides with a collapse of credibility of the central bank. No single agent trusts the central bank anymore: the fraction of agents that use the inflation target as their forecasting rule drops to zero, and they all use the extrapolative rule to make inflation forecasts. This feature is absent in the good trajectories. In fact, we observe the opposite: immediately after the shock inflation credibility shoots up. This is because of the fact that the initial conditions of the good trajectories are characterized by inflation expectations below the target. The supply shock tends to raise inflation and brings it closer to the target (at least for a while), thereby improving credibility.

The results with output credibility are shown in the bottom half of Figure 7. When the economy is pushed into a bad trajectory output credibility drops to 0; that is, no agents trust that the central bank can bring output back to equilibrium. In the good trajectory, we also observe some deterioration of output credibility, but this is much less extreme and much shorter.

The question that arises now is why the bifurcations occur. This is the question we want to analyze here. From Figure 7, we observe the following. When the supply shock is large, the bad trajectory is characterized by the fact that immediately after the shock we obtain a limit solution; that is, the inflation and output credibilities ($\alpha_{f,t}$ and $\beta_{f,t}$) drop to zero. This means that the mean reverting processes in the expectations formations are switched off and only the extrapolating dynamics is left over. This creates a destabilizing dynamics that keeps the output gap low and the inflation high. For example, when inflation credibility is zero, there are no agents anymore who expect the inflation to return to the target set by the central bank. As a result, the inflation dynamics is driven by extrapolative behavior. The same holds for the output gap.

There is also the role played by initial expectations. In Section 4, we analyze this role more rigorously. Anticipating on this analysis, we can describe the role of initial expectations as follows. In order to get stuck into this bad trajectory, the initial expectations must be "bad," that is, high inflation expectations (relative to the target). These bad initial conditions make it possible for the large negative supply shock (which raises inflation further away from target) to push the system towards the limits of zero inflation and output credibility. This is reinforced by the fact that the central bank is pushed into a dilemma situation. In order to contain inflation, it has to raise the interest rate, thereby reducing output leading to a loss of trust that central bank can stabilize output. In contrast, when the initial conditions are favorable (low inflation expectations), the same negative supply shock does not push inflation and output credibilities against their limits. In fact, initially, these are pushed away from their limits as inflation credibility initially improves. Mean reverting processes continue to do their work of softening the impact of the supply shock and one ends up in a good trajectory. Thus, favorable initial inflation expectations work as a buffer preventing large shocks from hitting the boundaries and preventing a collapse of trust.

Another way to interpret these results is as follows. Large shocks that arise under unfavorable initial conditions lead to a loss of trust, both a loss of trust in the central bank's capacity to keep inflation on target and to stabilize output. In fact, as Figure 7 shows one can conclude that a large shock can lead to a complete breakdown of trust. This intense loss of trust amplifies the negative effects of the supply shock. Thus, trust is the key in smoothly returning the economy to equilibrium. Trust allows mean reverting dynamics to do its work to bring the economy back to equilibrium. Conversely, the absence of trust makes the economy less resilient to absorb large exogenous shocks. When trust is absent, the economy is adrift lacking an anchor that is needed to stabilize the economy after a shock.

3.2 | Impulse responses to demand shocks

We now turn to the impulse responses to a large negative demand shock. We show the results in Figures 8. Comparing this with Figure 3, we find the following results. The large demand shock leads to a similar but less pronounced bifurcation of the output trajectories into a good (green) and a bad one (black). In the good trajectory, output returns relatively quickly to the steady state; in the bad trajectory, the recovery after the shock is slower. This seems to be related to a similar bifurcation of the interest rate trajectories.

It should be stressed again that the two colors we give to the trajectories are determined ex-ante by the nature of the initial output expectations. In particular, we color the trajectories green when the initial output expectations, which is the other measure of trust, are above the central banks' output target, and black when they are below that target. The reason we use initial output expectation instead of inflation expectation is related to the fact that a negative demand shock leads to recessionary pressures. Hence, when the initial output expectation is below zero, the negative demand shock reduces the trust in the central bank to maintain macroeconomic stability; when the initial output expectation is above zero, the same negative demand shock will initially tend to increase the trust in the capacity of the central bank to maintain macroeconomic stability.

One difference with the supply shock is that the output gap tends to return to the steady state much quicker after the demand shock than after the supply shock. This is related to the fact that in contrast to a supply shock, a demand shock does not put the central bank in a dilemma situation. Both output and inflation reductions therefore give an unequivocal signal to the central bank that the interest rate should decline. This contrasts with a supply shock that produces and increase in inflation and a decline in output (stagflation). This creates a mixed signal for the central bank: the increase in inflation signals a required interest increase, and the decline in output a required interest rate decline.

We also show the distribution of the responses of the output gap, inflation, and interest rate in period 4 after the demand shock (Figure 9). We chose four quarters because after the demand shock the output gap is much quicker to return to its long-term equilibrium than after the supply shock. One way to put this difference is that the short term is much shorter after a demand shock than after a supply shock.

We observe a bimodal distribution of the impulse responses of output and interest rate four quarters after the shock. This is less evident for inflation responses. In addition, the bimodal structure is less pronounced than after the supply shocks. Again, the interpretation is that the demand shock does not push the central bank in a dilemma situation, allowing it to pursue an unequivocal policy of interest rate reduction.

What happens with our measures of trust after the demand shock? We show the answer in Figures 10 and

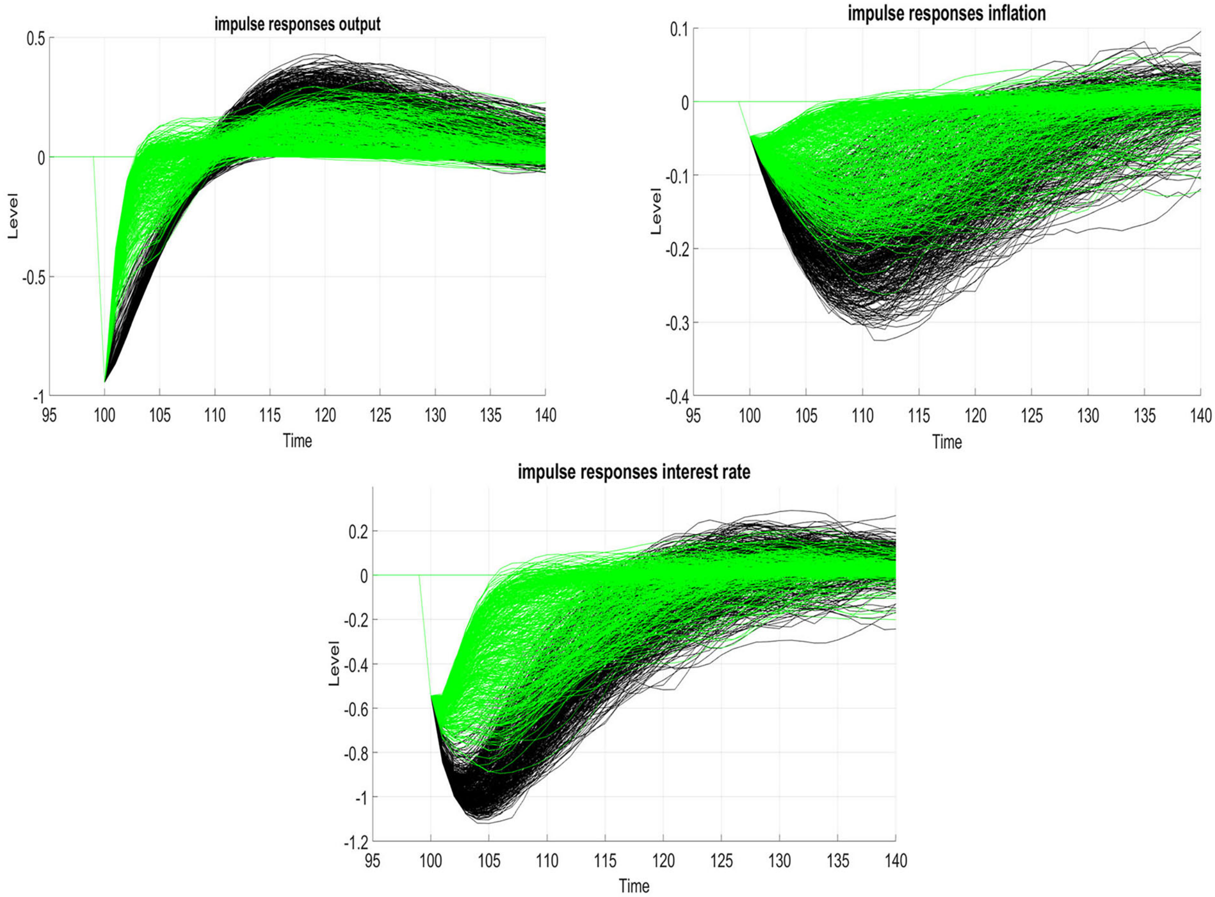

FIGURE 8 Impulse responses to a large demand shock (10 SD).

11. Figure 10 presents the impulse responses of our measures of trust, that is, output and inflation expectations. We observe, as in the case of a supply shock, that trust is deteriorating more in the bad trajectories than in the good ones, although the difference is less pronounced. This is especially so with the impulse responses of inflation credibility where we see that the good and bad trajectories largely overlap.

The second way to look at trust is again to focus on $\alpha_{f,t}$ and $\beta_{f,t}$. We show the plots of these fractions in Figure 11 where we separate these fractions according to whether they correspond to good or bad trajectories. We observe that following the negative shock in demand trust in the central bank's capacity to meet its inflation target is very little affected in the bad trajectory and not at all in the good trajectory. Bad and good trajectories in this demand shock scenario are associated mainly with negative developments in the central bank's capacity to stabilize the output gap. We observe that in the bad trajectories, there is a strong decline in the fraction of agents $\alpha_{f,t}$ forecasting a return of the output gap to its equilibrium value. We observe the contrary in the good trajectories: the $\alpha_{f,t}$ actually increase. This suggests that after the negative demand shock agents believe that the central bank's capacity to stabilize output increases. This may seem surprising but it is not. The good trajectories follow initial conditions where agents expect a positive deviation of output from the equilibrium. This implies that initially they had limited trust in the central bank's capacity to stabilize output. The negative demand shock turns this around. As output moves towards its equilibrium value, trust in the central bank's capacity to stabilize output increases.

We conclude that after a negative demand shock, the central bank does not suffer much from a loss of trust in its capacity to control inflation. This is related to the fact that after the demand shock, the central bank is not pushed into a dilemma situation that prevents it from pursuing a clear interest rate policy aimed at boosting the economy and bringing the inflation rate closer to its target. The loss of trust concerns the future output. When initial conditions are unfavorable, that is, when there is initially a lot of pessimism (an expectation of future output decline), the demand shock will push this pessimism to its extremes, thereby intensifying the pessimism further because everybody extrapolates this pessimism into

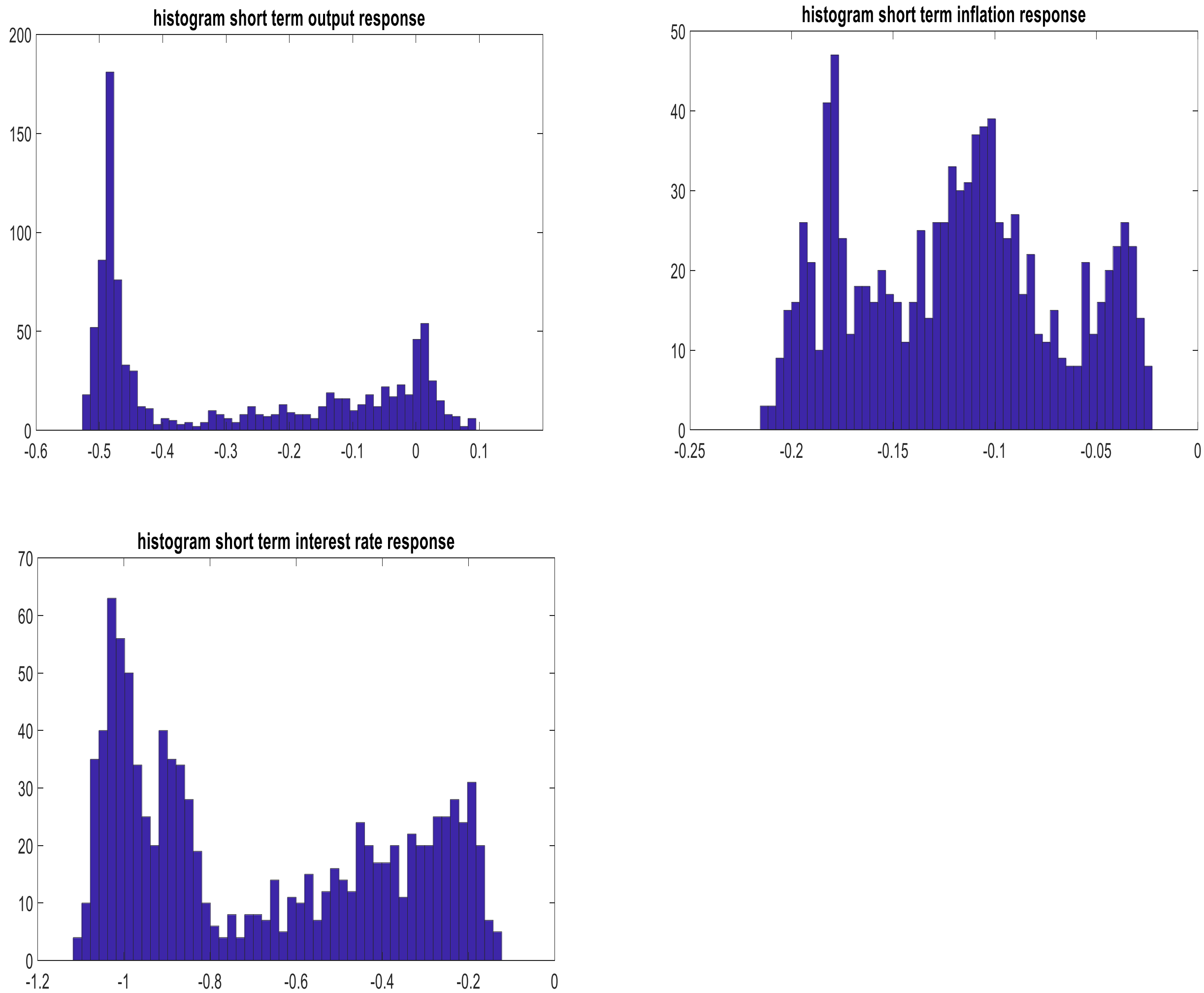

FIGURE 9 Frequency distribution of impulse responses (four periods after shock).

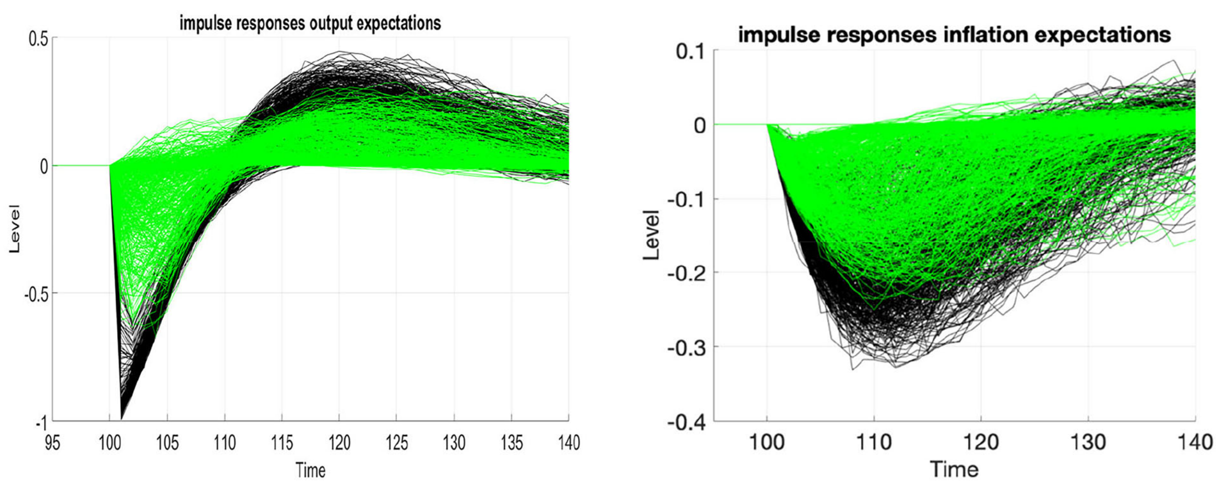

FIGURE 10 Impulse responses of output and inflation credibilities.

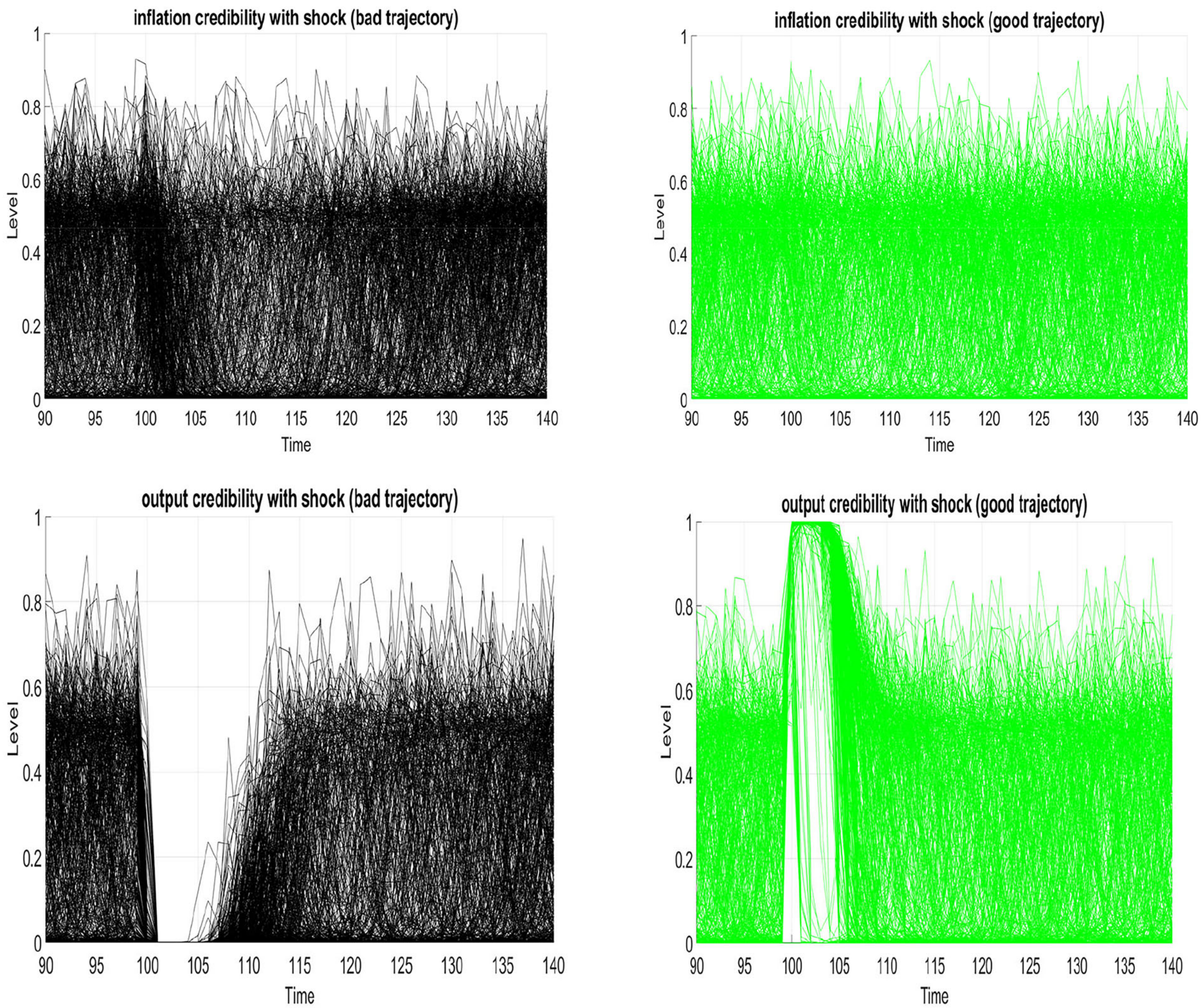

FIGURE 11 Inflation and output credibility with large negative demand shock.

the future. When initial conditions are favorable (i.e., positive outlook about the future output), this deflationary mechanism is dampened.

4 | THE POWER OF INITIAL EXPECTATIONS

How do the initial conditions affect the output and inflation trajectories following the demand and the supply shocks? In previous sections, we have highlighted the importance of initial expectations. Here using the data that we collect from our simulations, we analyze this question more formally. First, we illustrate the relationship between initial expectations and the output gap and inflation with the help of a few figures. Second, we will use an econometric analysis to establish the power of initial expectations to predict in which cluster the output gap will be pushed 12 periods after the supply shock and 4 periods after the demand shock.

We start with the supply shock. In Figure 12, we present the initial inflation expectations prevailing just before the shock, on the horizontal axes, and the output gap and inflation 12 periods after the supply shock on the vertical axes. We find that after a large supply shock, the initial expectations of inflation appear to be a very good predictor of the subsequent trajectories of the output gap and inflation. More specifically, when initially inflationary expectations exceeded the central bank's inflation target (normalized at 0), the output gap multiplier after 12 periods settles around −1.1. In other words, the subsequent output trajectory is almost always the bad one. In contrast, when initially the inflation expectations are below the central bank's inflation target, the output gap multiplier after 12 periods settles close to −0.3 (but with a relatively large variance). Thus, in this case, the subsequent trajectory is always a good one.

The initial expectations of inflation have an equally strong predictive power for subsequent inflation. Favorable initial inflation expectations (negative numbers) lead

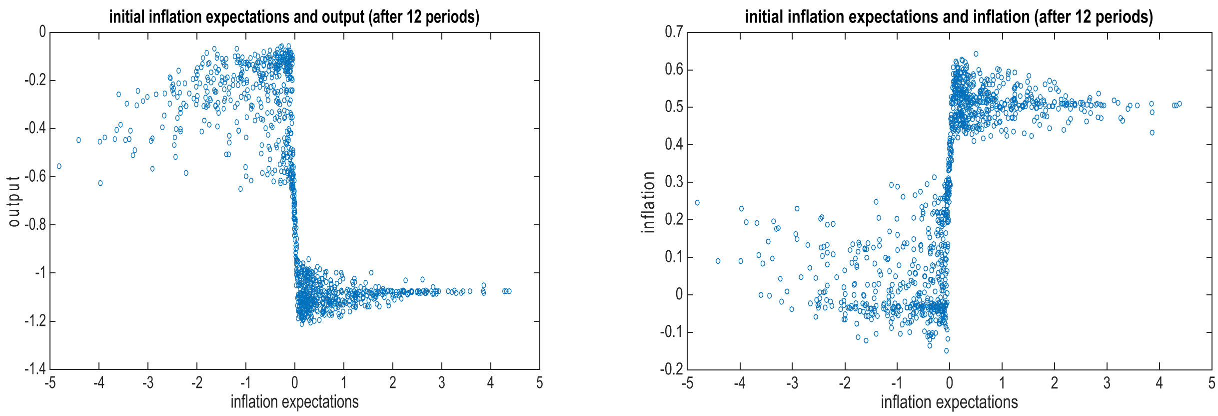

FIGURE 12 Initial inflation expectations, and output gap and inflation 12 periods after shock.

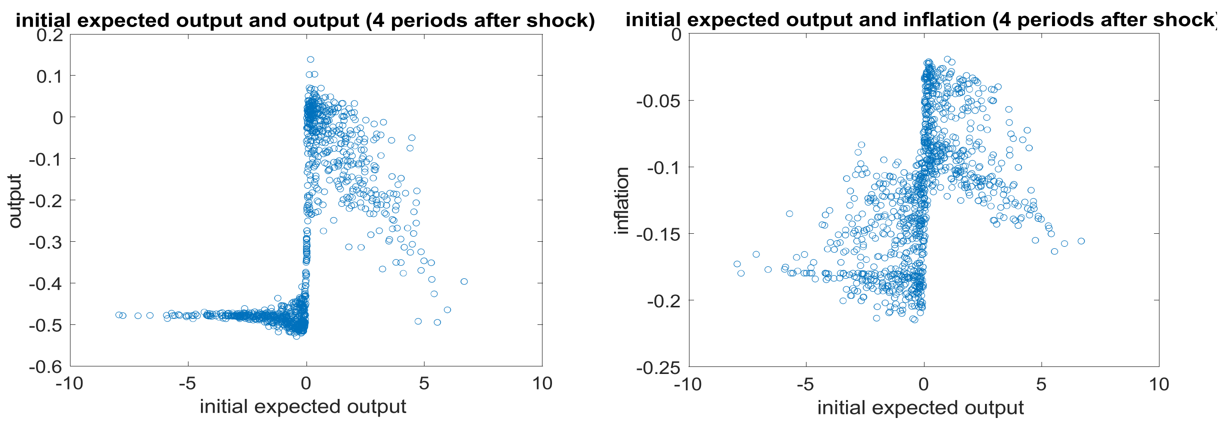

FIGURE 13 Initial inflation and output expectations, and output gap four periods after demand shock.

to the trajectory of low inflation 12 periods later. With unfavorable inflation expectations, the economy is forced onto the high inflation trajectory.

What is the underlying mechanism that explains the strong power of the initial inflation expectations to predict the subsequent trajectory of the output gap and inflation when the supply shock is large? To answer this question, we have to analyze the reactions of the central bank to the supply shock. To do so, it is useful to turn to Figure 3 again.

We note the following. There is a quick bifurcation in the interest rate path after the shock. One path goes up; the other goes down. The upward interest rate path corresponds to the high expected inflation initial condition. This unfavorable initial condition has the effect of keeping the inflation rate at a high level after the supply shock. As a result, the central bank that attaches a relatively high weight on inflation in the Taylor rule is obliged to raise the interest rate. This in turn pushes the output gap further down. The economy is pushed into a bad trajectory because the unfavorable inflation expectations that existed prior to the shock force the central bank to tighten up after the shock, thereby enhancing the downturn in output.

In contrast, when the inflationary expectations are initially favorable (below the inflation target), the upward movement of the inflation immediately after the shock remains subdued. As a result, the central bank observing a relatively favorable inflation outcome reacts by reducing the interest rate to deal with the negative effect of the supply shock on output. This mitigates the negative output effect of the supply shock and pushes the economy onto the good trajectory with a quick return of the output gap to its equilibrium level. Here again the initial favorable inflation expectations tend to reduce the inflation effect of the supply shock "freeing the hands" of the central bank to fight the decline in output by a reduction of the interest rate.

We now represent the power of initial output expectation to forecast output and inflation after a negative demand shock. We show this in Figure 13. On the horizontal axis, we set out the initial output expectation; on the vertical axis output, respectively, inflation four periods after the demand shock. In contrast with the

TABLE 2 Impact of initial conditions on the probability of being in a bad cluster (finite mixture Probit model).

	Supply shock 10	Demand shock 10
Output gap expectation	−0.09	**−68.99*** **
	(0.94)	**(13.68)**
Inflation expectation	**134.27*** **	0.14
	(32.25)	(1.03)
Initial output gap	−0.53	−0.52
	(1.13)	(0.76)
Initial inflation	0.07	0.81
	(1.14)	(1.14)
Initial interest rate	0.48	0.56
	(0.63)	(0.50)
Good cluster (mean)	−0.32***	0.01***
	(0.01)	(0.00)
Bad cluster (mean)	−1.07***	−0.45***
	(0.00)	(0.00)
Probability of bad cluster	0.51	0.52
Probability of good luster	0.49	0.48
Observations	1000	1000

***$p < 0.01$.

supply shock, we now find that it is the initial output expectation that has the strongest predictive power. More precisely, when initially agents are optimistic about future output, the output gap four periods later clusters around 0%. In other words, initial optimism about the future business cycle forces the economy along the good trajectory after the demand shock. In contrast, when output forecasts are negative, the output gap four periods later settles around −0.5. Thus, pessimism about the future business cycle pushes the economy along the bad trajectory after the negative demand shock.

Next, we show the power of initial expectations based on an econometric analysis. To identify the bimodal distribution as suggested earlier, we use Finite Mixture Models (FMM) to estimate both the parameters for the separate distributions and the probabilities of component membership (see McLachlan & Peel, 2000). In each specific shock, we first fit the data using a finite model assuming two distributions as suggested by our theoretical analysis and then we fit the data using a similar model assuming one distribution. Both the Akaike information criterion (AIC) and the Bayesian information criterion (BIC) favor the two-class model; that is, the output gap generated in our simulation has a bimodal distribution. We proceed with the two-class model in analyzing how expectations and other initial conditions are associated with future output gap. The estimates results are shown in Tables 2 and 3.

In Table 2, we find that in the case of a large supply shock, there is a bad cluster with a mean of −1.07 and a good cluster with a mean of −0.32. It is estimated that about 51% of the observations is in the bad cluster whereas about 49% is in the good cluster. Initial inflation expectation is found to be a very powerful predictor of the future output gap. This significant and positive coefficient of 134.27 means that an increase in the initial inflation expectation leads to an increase in the probability of being in a bad cluster. By contrast, none of the other initial conditions exhibit any significant and sizable effect. The coefficient of 134.27 also informs us that, for example, a 0.05 increase in the initial inflation expectation from the steady state zero will lead to a bad cluster with the probability of 1[4].

In the case of a large demand shock, there is a bad cluster with a mean of −0.45 and a good cluster with a mean of 0.01. It is estimated that about 52% of the observations is in the bad cluster whereas about 48% is in the good cluster. We find that initial inflation expectation does not have a predictive power. Instead, the output expectation is a very powerful predictor of the future output: the higher the initial output expectations, the lower the probability of being in a bad cluster. The coefficient is −68.99, indicating that, for example, a 0.05 increase in the initial inflation expectation from the steady state zero will lead to a bad cluster with the probability of close to 1[5].

TABLE 3 Impact of initial conditions on output gap in good/bad cluster (finite mixture model).

	Supply shock 10	Demand shock 10
Good cluster		
Output gap expectation	−0.08***	0.01
	(0.03)	(0.01)
Inflation expectation	−0.03*	−0.01
	(0.02)	(0.00)
Initial output gap	0.01	−0.05***
	(0.02)	(0.00)
Initial inflation	0.03	0.02**
	(0.03)	(0.01)
Initial interest rate	0.01	0.00
	(0.01)	(0.00)
Bad cluster		
Output gap expectation	0.03***	0.00
	(0.01)	(0.00)
Inflation expectation	0.00	−0.01**
	(0.01)	(0.01)
Initial output gap	−0.00	0.02***
	(0.01)	(0.00)
Initial inflation	−0.02***	−0.01
	(0.01)	(0.01)
Initial interest rate	−0.01*	0.00
	(0.00)	(0.00)

*$p < 0.1$.**$p < 0.5$.***$p < 0.01$.

Table 3 presents the predictive power of the initial conditions conditional on being in the good, respectively the bad cluster. We find significance of the initial output and initial output expectation in the case of a demand shock. Similarly, we find significance of initial inflation and inflation forecasts in the case of a supply shock. Thus, initial conditions continue to matter once the economy is traveling along one of these two trajectories.

We have performed similar econometric exercises to analyze the distributions of the impulse response of inflation and interest rate after a large supply shock and a large demand shock. The results we obtain are very similar to those obtained for the output gap, that is, the existence of two separate clusters, a good and bad one; the power of initial expected inflation to forecast in which cluster the impulse responses of inflation and interest rate will be after a supply shock; and the power of the initial expected output to forecast in which cluster the impulse responses of inflation and interest rate will be after a demand shock.

5 | ROBUSTNESS ANALYSIS

In this section, we apply some robustness tests to find out how sensitive our results are to the parameter choices we made in the previous sections. We first perform a Monte Carlo study introducing random changes in the parameters of the model. Second, we study the question of the sensitivity of our results to the size of the socks.

5.1 | Monte Carlo study

The results discussed up to now use the point estimates of the parameters of the model as given in Table 1. It will be interesting to know how sensitive these results are to the choice of these numerical values. To do so, we perform a Monte Carlo experiment in which all the structural parameters (i.e., a1, a2, b1, b2, γ, and ρ) in Table 1 vary within a certain range. We set this range as + and −50% of the point estimates and assume a uniform distribution (For example: a_1 varies uniformly between 0.25 and 0.75). We then computed 1000 impulse responses following a negative supply shock, where for each impulse response we choose the parameter values randomly within that range. We show the impulse responses obtained from this exercise in Figure 14.

We observe the same bifurcations of the impulse responses into good and bad trajectories. This can be observed from both the results in the time domain and the frequency domain. Similarly, trust appears to be disappearing suddenly in the bad trajectory in the same way as we documented earlier. We have performed similar Monte Carlo experiments showing that our results are equally robust after a demand shock. These robust results justify that we may continue to use the parameters in Table 1 in our other analyses.

In the Appendix, we focus on the memory parameter to check for the sensitivity of our results with respect to variations in this parameter. The results appear to be robust.

5.2 | Sensitivity to the size of the shocks

In this section, we establish the size of the shocks that will trigger a bifurcation in the trajectories. We do this with a sensitivity analysis in which we allow the size of the shocks to vary. We start with a one standard deviation shock, and we gradually increase its size. We first present the results graphically. Second, we perform an econometric analysis to find out how large the shocks have to be to create a significant bifurcation in the impulse responses.

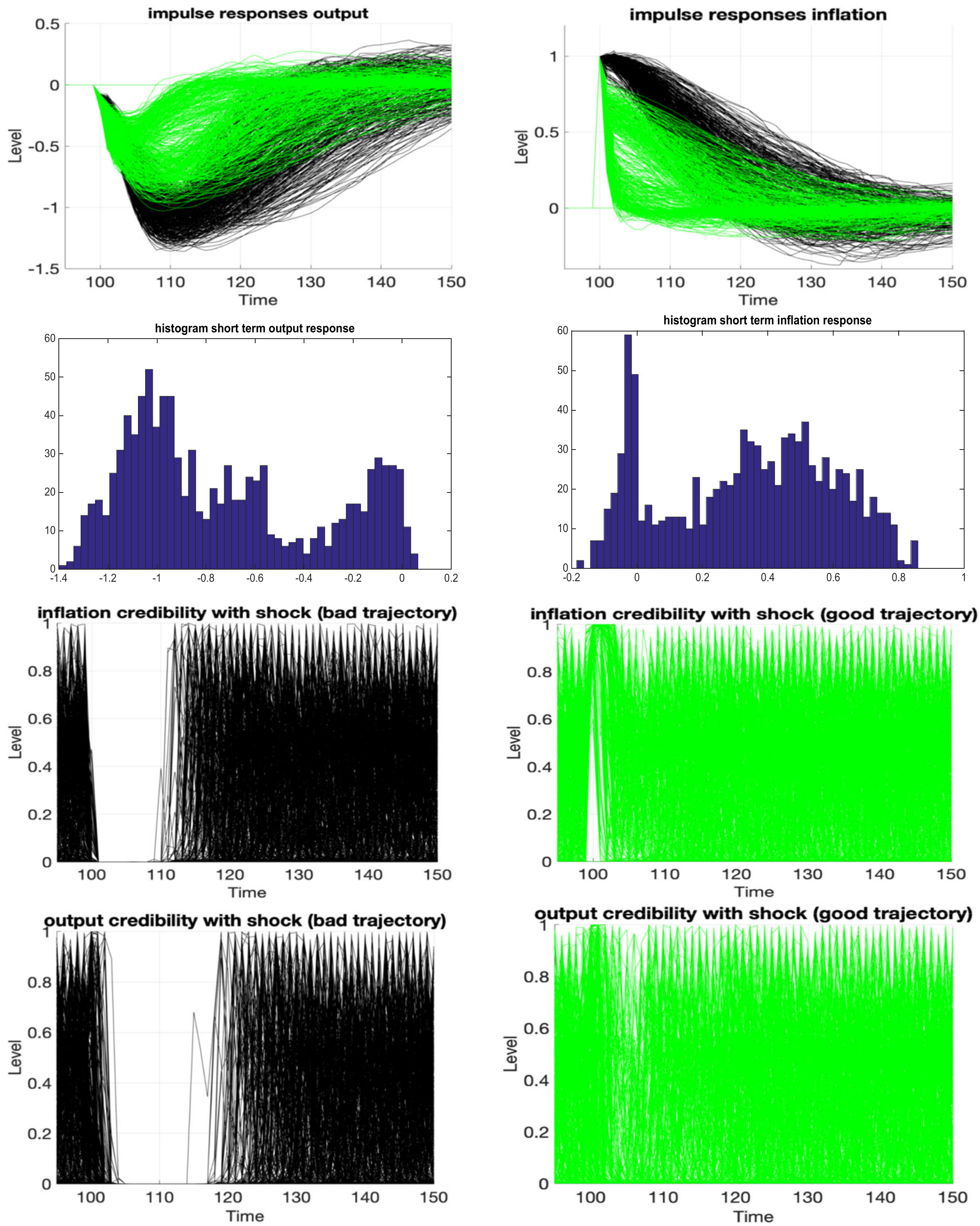

FIGURE 14 Large negative supply shock – Monte Carlo experiment.

We show the graphical results in Figure 15. Concentrating first on the impulse responses, (a) we find that as the size of the supply shock is increased, the bifurcation in the trajectories start to become visible with a shock of 3 standard deviations. This is also made clear from the (b) column in Figure 15. This shows the frequency distribution of the output response after 12 periods. We observe that from a supply shock equal to 3, the distribution starts to become bimodal, indicating that the impulse responses tend to bifurcate. Finally, the evidence in column (c) confirms this. With a supply shock of 3, we achieve some measure of predictability of the subsequent output responses by the initial inflationary expectations.

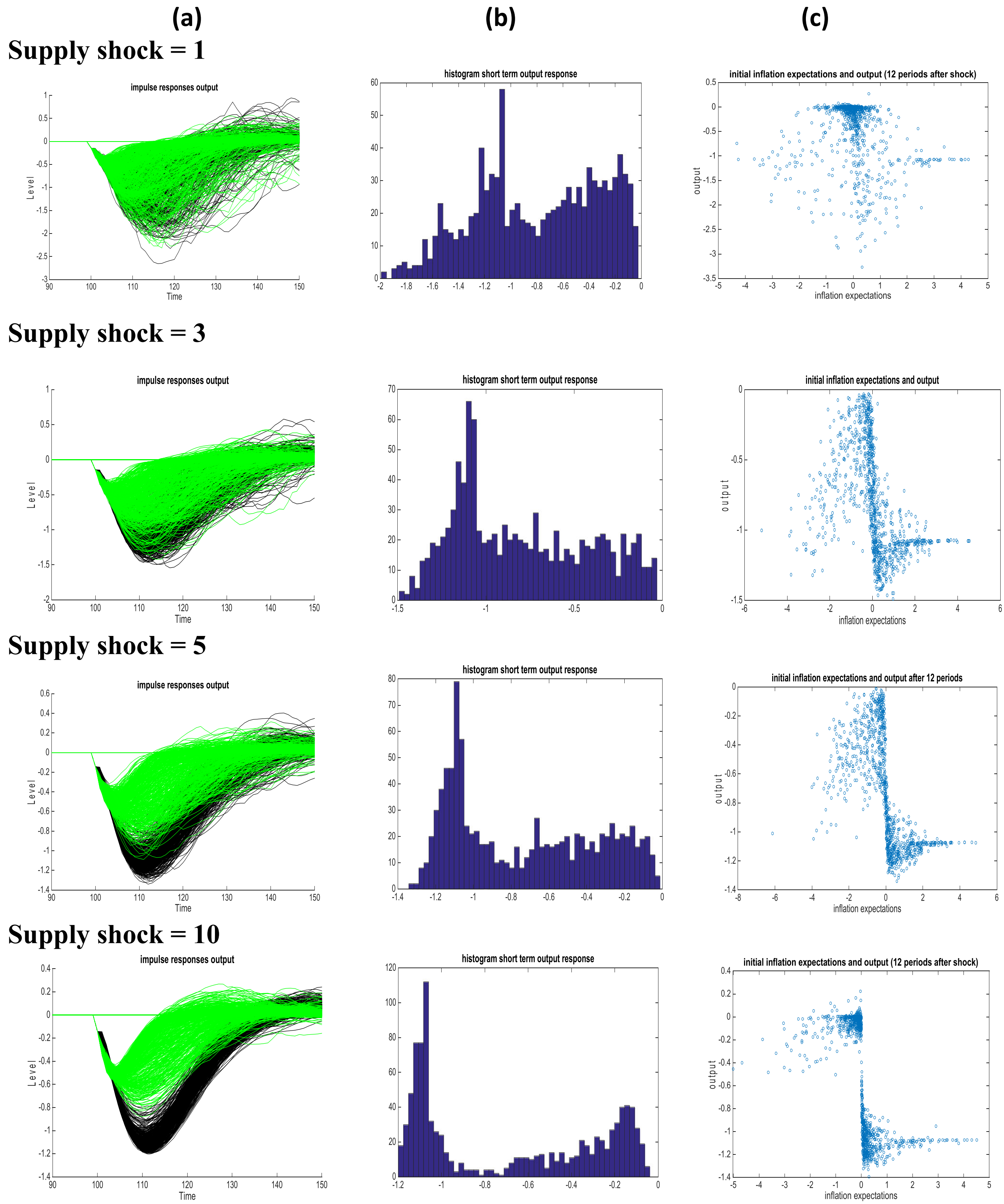

FIGURE 15 Increasing the size of the supply shock.

Next, we perform an econometric analysis similar to the one performed in Section 4. We show the results for the supply shock in Table 4 and for the demand shock in Table 5. We find that for all sizes of the shock, two different clusters (good and bad) exist with significantly different means. For example, in the case of a 1 standard deviation supply shock, we find a good cluster with mean −0.49 and a bad cluster with mean −1.3. These means

TABLE 4 Impact of initial conditions on the probability of being in a bad cluster after a negative supply shock (finite mixture model).

Initial conditions	Supply shock 1 SD	Supply shock 3 SD	Supply shock 5 SD	Supply shock 10 SD
Output gap expectation	0.04	0.61	−3.77	−0.09
	(0.42)	(1.10)	(2.65)	(0.94)
Inflation expectation	**2.40****	**26.51****	**150.06****	**134.27*****
	(0.94)	**(11.57)**	**(73.10)**	**(32.25)**
Output gap	−0.08	0.39	1.89	−0.53
	(0.39)	(0.78)	(1.73)	(1.13)
Inflation	2.90***	4.52***	0.64	0.07
	(0.63)	(1.26)	(2.24)	(1.14)
Interest rate	0.21	−0.79	2.33	0.48
	(0.30)	(0.63)	(1.72)	(0.63)
Good cluster (mean)	−0.49*** (0.02)	−0.40*** (0.02)	−0.39*** (0.16)	−0.32*** (0.01)
Bad cluster (mean)	−1.30 *** (0.05)	−1.09*** (0.02)	−1.06*** (0.01)	−1.07*** (0.00)
Observations	1000	1000	1000	1000

Note: Standard errors in parentheses. SD, standard deviation.
*$p < 0.1$, **$p < 0.5$, and ***$p < 0.01$.

TABLE 5 Impact of initial conditions on the probability of being in a bad cluster after a negative demand shock (finite mixture model).

Initial conditions	Demand shock 1	Demand shock 3	Demand shock 5	Demand shock 10
Output gap expectation	**−1.96*****	**−11.93*****	**−81.50*****	**−68.99*****
	(0.57)	**(1.80)**	**(25.02)**	**(13.68)**
Inflation expectation	−0.06	−0.24	−2.44	0.14
	(0.60)	(0.82)	(1.72)	(1.03)
Output gap	−4.37***	−3.48***	−4.77***	−0.52
	(0.66)	(0.65)	(1.75)	(0.76)
Inflation	0.59	0.00	3.65*	0.81
	(0.63)	(0.76)	(1.89)	(1.14)
Interest rate	0.81**	0.63	0.00	0.56
	(0.33)	(0.45)	(0.86)	(0.50)
Good cluster (mean)	−0.28*** (0.01)	−0.19*** (0.01)	−0.11*** (0.01)	0.01*** (0.00)
Bad cluster (mean)	−0.60 *** (0.01)	−0.52*** (0.00)	−0.49*** (0.00)	−0.45*** (0.00)
Observations	1000	1000	1000	1000

Note: Standard errors in parentheses.
*$p < 0.1$, **$p < 0.05$, and ***$p < 0.01$.

are statistically significantly different. However, in this case of low supply shock, the initial inflation expectations have little predictive power. The coefficient of the initial inflation expectation is only about 2.40. Although statistically significant, it is too low to provide for much predictive power of the initial inflation expectations. The predictive power of this variable becomes sizable when the supply shock exceeds 3 standard deviations. The same conclusion holds for demand shocks, that is, the existence of two clusters, a good and bad one, and the low predictive power of initial expected output gap when the shock is smaller than 3 standard deviations (Table 5).

How can one interpret the low predictive power of initial conditions (initial inflation expectations) when the

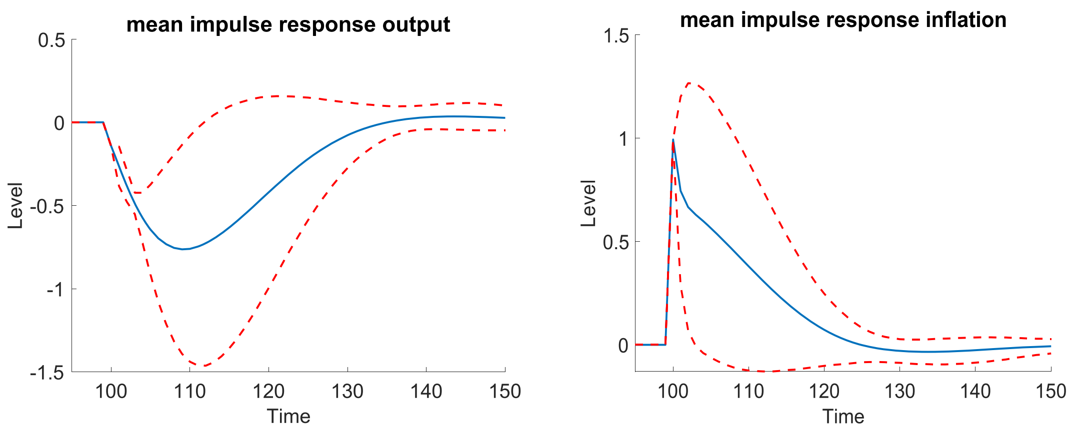

FIGURE 16 Mean impulse responses output and inflation after large supply shock.

supply shock is small? Here is the answer. A supply shock equal to 1 standard deviation of the stochastic shocks hitting the economy is of the similar order of magnitude as the existing stochastic shocks. As a result, the initial inflation expectations create departures from the equilibrium that have the similar order of magnitude as the supply shock. These initial departures from equilibrium can steer the economy in a different direction than the supply shock does. It can also be that the initial conditions and the supply shock reinforce each other. Because the forces of the initial conditions (the noise) and of the supply shock (the signal) are of a similar magnitude, it becomes near impossible to separate them out by computing impulse responses. All this produces a low predictability of the initial inflation expectations on the output trajectory after the shock. This problem of unpredictability does not occur when the supply shock is large relative to the size of the stochastic shocks, or put differently, when the signal to noise ratio is large. We obtain similar results for demand shocks.

6 | POLICY ISSUES

In this section, we discuss several policy issues. First, we analyze the implications of the non-Gaussian nature of the impulse responses for policy analysis and for policymakers. Second, we focus on the power of stabilization. We ask the question of how the central bank can affect the transmission of large shocks by more or less output stabilization. Third, we present a short case study studying the recent history of large shocks and how our model can shed some light on the choices made by policymakers.

6.1 | On the nature of uncertainty

The frequency distributions of impulse responses that we analyzed in the previous sections show strong departures from Gaussian distribution. As a result, the mean response and the standard deviations of these responses are not informative about the true underlying distribution. We illustrate this problem as follows. We use the impulse responses of output and inflation from Figure 3 and compute the mean and the two standard deviations below and above the mean. We show the results in Figure 16. Comparing these with Figure 3, it is clear that the mean and the standard deviations are not only uninformative but also misleading about the true underlying distribution because Figure 16 gives the impression of the existence of a central tendency, the mean, that is representative of the impulse responses. In fact, there are almost no observations close to the mean as the impulse responses are clustered away from the mean. In addition, the representation in Figure 16 gives the wrong impression that, as one moves away from the mean, observations become less likely. In fact, the opposite is true.

This leads to the following problem. A standard assumption made in mainstream DSGE models is that agents know the distribution of the shocks, typically assumed to be Gaussian. The impulse responses derived from such an analysis typically have a representation as in Figure 16. This only makes sense if the distribution of these responses is Gaussian. If they are not, as is the case in our model, these representations are generally misleading.

The main business of macroeconomists is to produce conditional forecasts, that is, producing mean effects of some shock and a band of uncertainty around the mean. This could be a policy shock, a demand and supply shock, and many others. In a non-Gaussian world, these conditional forecasts cannot be trusted. This leads to the idea that when making conditional forecasts, one has to think in terms of scenarios. There are good scenarios and bad scenarios. In our model, the probability of each of these scenarios is 50%. We can, however, make more precise forecasts if we know the initial conditions when the shock occurred as we showed in Section 4.

In this connection, it is useful to introduce notion of *ambiguity*. There is strong ambiguity about the effects of shocks because the same shock can lead us into different universes of adjustment. In other words, without the knowledge of initial conditions, the distribution of the impulse responses is ambiguous. This ambiguity is at the core of the recent failures of central banks to forecasts inflation after the supply shock. They could not easily know in real time which scenario the economy would end up in. They assumed it could be a good scenario. Under a good scenario, there was no need to raise interest rates aggressively. With the benefit of hindsight, one can now say that they made a wrong bet.

6.2 | Output stabilization and large supply shocks

We study how the intensity with which the central bank stabilizes the output gap affects the transmission of large shocks. The intensity of output stabilization is measured by the c2 parameter in the Taylor rule equations. We have set c2 routinely equal to 0.5 in the previously reported results. Here we ask the question of how a stronger stabilization effort affects the transmission of a large supply shock. The results are shown in Figure 17. We distinguish two output stabilization intensities, a strong one ($c2 = 2$) and a normal one ($c2 = 0.5$). (Note that the results reported in the "normal stabilization" column are the same reported supra). The results lend themselves to the following interpretation.

First, by increasing the intensity of output stabilization, the central bank ensures that the bad trajectory becomes significantly less bad. This can be seen from the impulse responses of output. Under normal stabilization, there is a deep negative trajectory. This downward movement of the bad trajectory is significantly reduced under strong stabilization. The good trajectory is pretty much unchanged when stabilization is strong. Another way to see this is provided by the histograms of the output gap. Under strong stabilization, we observe that the peaks of the bimodal distribution are closer to each other, and that this is achieved by a movement of the "bad peak" to the right and closer to the "good peak." Thus, stronger stabilization achieves a less severe downturn in the bad trajectory.

All this comes at a price, though. When output stabilization is strong, we observe that the bad and the good inflation trajectories produce an inflation trajectory that is more protracted. In other words, stronger output stabilization leads to inflation that lasts longer after a supply shock.

We have seen in previous sections that large shocks endanger the trust of economic agents in the central bank. We also found that a breakdown of trust is more likely when large supply shocks hit the economy, and less so when large demand shocks occur. How can the central bank affect trust after large supply shocks?

We answer this question by analyzing how the degree of output stabilization (measured by the Taylor parameter, c2) affects trust. We focus on a large negative supply shock and compare the case of "normal" output stabilization and "strong" output stabilization. As in the previous section, in the first case, we set $c2 = 0.5$, in the second case, we set $c2 = 2$. We show the results in Figure 18. Instead of showing all the 1000 trajectories of the inflation and output credibility indicators (as we did in Figures 7, 11, and 14), we take the mean of these trajectories. We also concentrate on the bad trajectories (black) because, as we have shown, it is in these bad trajectories that credibility is most affected. In addition, while the mean of the good and bad trajectories together is not very meaningful because of the bimodal distribution (see Section 6.1 where we elaborated on this), the mean of the bad trajectories is a meaningful representation of what happens in these bad trajectories. We observe from Figure 18 that when the central bank increases its ambition to stabilize output (c2 increases from 0.5 to 2), inflation and output credibilities decline significantly after the supply shock. We see this from the fact that after the supply shock inflation and output credibilities drop to 0, they remain stuck at zero longer when output stabilization is strong. Thus, when large negative supply shocks occur, a central bank that aggressively pursues output stabilization will suffer a loss of trust longer than a central bank that pursues output stabilization more cautiously.

6.3 | Supply shocks: some historical perspective

Our results have some relevance to understand the experience of the 1970s with the supply shocks and the recent covid supply shock. Preceding the supply shocks of the 1970s, there had been a buildup of inflation and inflationary expectations. See Figure 19 showing the US inflationary experiences during 1975–1990 and Figure 20 during 2014–21. We observe from Figure 19 that prior to the oil shock of 1979, which doubled the oil prices, inflation and inflation expectations were very high, the latter exceeding 5%. Our model predicts that with these initial conditions, the recovery would take a long time. This is also what happened. We observe from the same figure that the output gap started a long decline that reached −8% in 1982. The recovery also took a long time. The output gap reached 0% only in 1988. Thus, the decline in

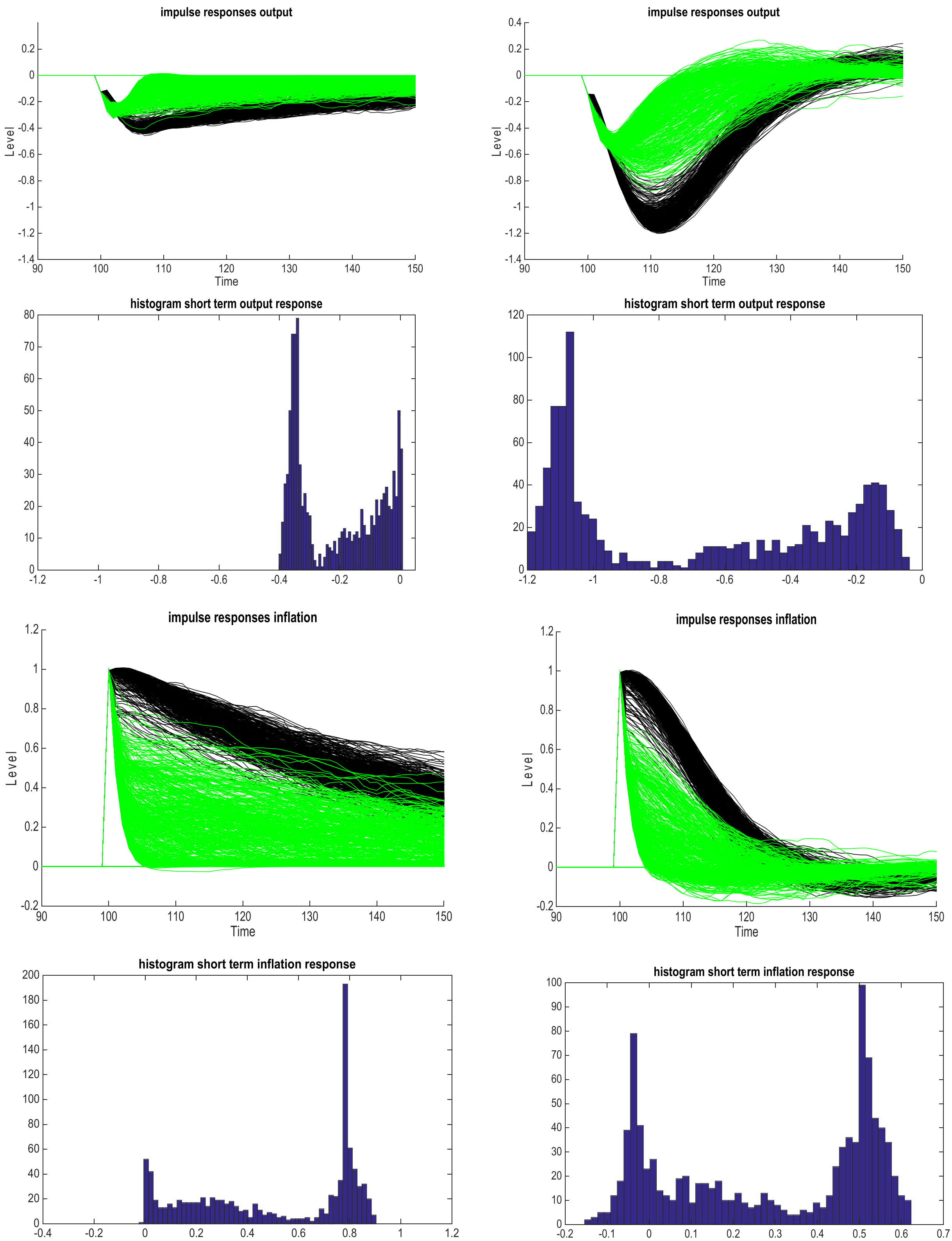

FIGURE 17 Transmission of large supply shock under strong and normal stabilization.

economic activity after the 1979 oil shock was long and protracted and lasted almost 10 years. This is also what happened for many countries with a prior history of significant inflation, after the second oil shock of 1979. According to the World Bank (2021), the world GDP growth rate took 5 years to return to its pre-1979 level of 4.2%. This growth rate was only reached in 1984 again. The trajectory of this protracted recovery also followed

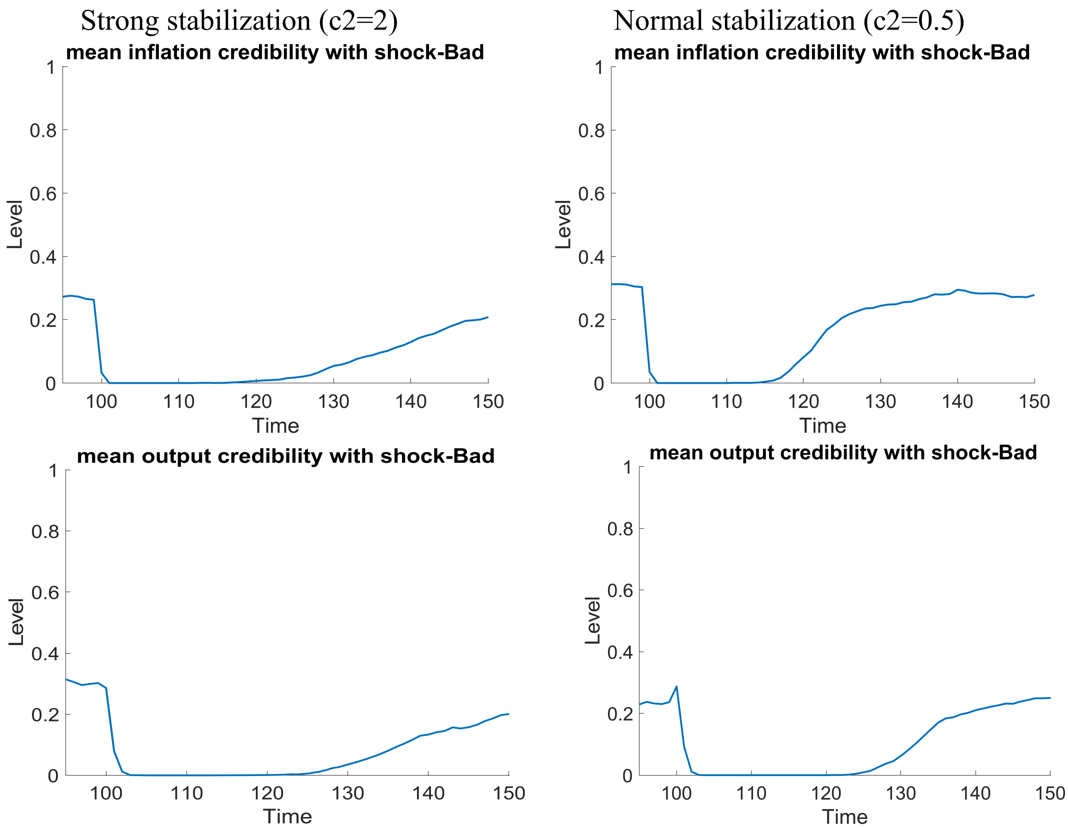

FIGURE 18 Trust under strong and normal stabilization (large supply shock).

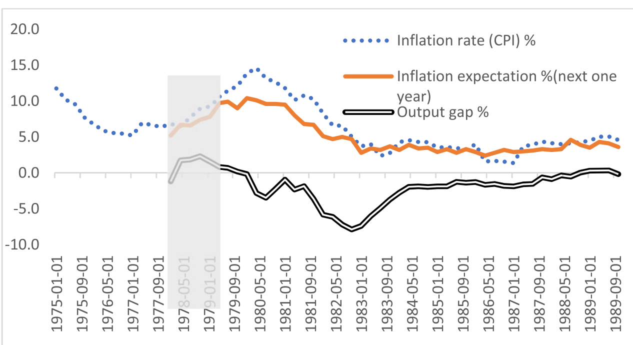

FIGURE 19 US inflation expectation, inflation, and output gap (%): quarterly data 1975–1989.

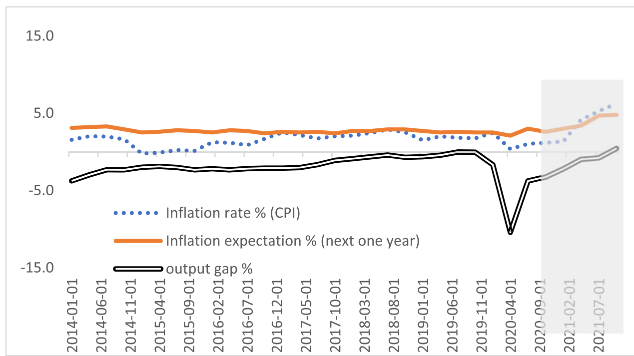

FIGURE 20 US inflation expectation, inflation, and output gap (%): quarterly data 2014–2021. Source: Federal Reserve Bank of St Louis.

the prediction of our model: given the inflationary environment, the supply shock of 1979 "forced" many central banks, in particular the US Federal Reserve under Paul Volcker, to raise the interest rates, thereby intensifying the economic downturn. See also Bernanke et al. (1997) who find that the negative output effects of the supply shock (oil shock) of the 1970s were the result of the restrictive monetary policies that the supply shock triggered.

The Covid supply shock of 2020 was preceded by a period of low inflation and low inflationary expectations in most industrialized countries. In Figure 20, we show the US experience. Our model predicts that this should make a quick recovery possible, mainly because the central banks did not worry about the inflationary consequences and therefore could actually follow expansionary monetary policies. It appears today that a relatively quick recovery occurred in the United States. Something

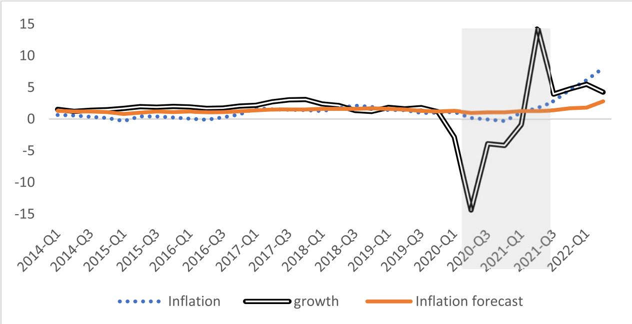

FIGURE 21 Eurozone inflation forecast, inflation, and GDP growth(%): quarterly data 2014–2021. Source: Eurostat inflation forecast (ECB), GDP growth, and inflation (Eurostat/OECD). Note: We use the growth rate of GDP because a Eurozone-wide output gap is not available. Inflation forecasts are obtained from the ECB Survey of Professional Forecasters (SPF). Eurozone-wide forecasts by households prior to 2020 are not available, in contrast to the United States.

similar happened in the Eurozone. We show this in Figure 21 which presents the real growth rates of GDP in the Eurozone together with inflation and inflationary expectations. We observe like in the United States that inflation and inflationary expectations were very low prior to the Covid-shock and that the recovery in 2021 was spectacular. It is also useful to look at Figure 1 (in Section 1) showing a measure of trust in the ECB. This is the percentage of EU citizens that respond they have confidence in the European Central Bank. We observe that from 2014 on, there was a steady increase in trust in the ECB. As a result, when the pandemic shock occurred, the hands of the ECB were freed to pursue a highly stimulatory monetary policy. This, together with expansionary fiscal policies, made it possible for the economic recovery to be very fast until in 2022 a new shock, the Ukraine war occurred, which led to a negative supply shock.

The previous discussion implies that history matters. A history of high inflation and expectations of inflation condition the impact of a supply shock and is likely to produce bad outcomes of this shock. In contrast, a history of price stability makes it possible for the economy to follow a more benign trajectory after the same supply shock.[6]

7 | CONCLUSION

In this paper, we have analyzed the importance of trust in the transmission of demand and supply shocks in the economy. We have focused on two dimensions of trust. The first one relates to the credibility of the inflation target announced by the central bank. The second one is trust in the capacity of the central bank to stabilize the business cycle (output gap).

In order to analyze the importance of trust, we used a behavioral macroeconomic model that is characterized by the fact that individuals lack the cognitive ability to understand the underlying model and to know the distribution of the shocks that hit the economy. In such a world, it is rational for these individuals to use simple forecasting rules (heuristics) and to subject these rules to a regular fitness test. As a result, these agents frequently switch to the best performing rule. This allows us to give a quantitative content to our two measures of trust.

Our main results can be summarized as follows. Focusing on negative supply shocks we find, first, that when the negative supply shock is sufficiently large (3 standard deviations or more), there exist two trajectories of output. The first one, a “good” trajectory, implies a relatively small decline of the output gap and a relatively quick return to the steady state value; the second trajectory, a “bad” one, follows a deep decline in output and a slower recovery. A similar bifurcation between good and bad trajectories is detected in the impulse responses of inflation generating a good trajectory of rapid declines in inflation and a bad trajectory characterized by a slower decline in inflation.

Second, trust follows similar good and bad trajectories. We find that (after a large supply shock) in all the bad trajectories of output and inflation, the credibility of the central bank to maintain price stability drops dramatically. Agents do not trust the central bank anymore: the fraction of agents that use the inflation target as their forecasting rule drops to zero, and they all use the extrapolative rule to make inflation forecasts. At the same time, trust in the capacity of the central bank to stabilize output also drops to its minimum value. These features are absent in the good trajectories.

Third, we find that initial conditions matter a great deal in determining which trajectory will be chosen. In order to get stuck into a bad trajectory, the initial conditions must be bad; that is, there must be high inflation expectations. These bad initial conditions make it possible for the large negative supply shock to push the system towards the limits of zero credibility. As a result, the mean reverting processes (negative feedback rule) in the forecasting behavior of agents are switched off, and forecasting is purely extrapolative (positive feedback rule). This means that along this bad trajectory, the forces that push towards a return to equilibrium are weak.

In contrast, when the initial conditions are favorable (low inflation expectations), the same negative supply shock does not push credibility against its limits. In that case, mean reverting processes in the forecasting behavior continue to do their work of softening the impact of the supply shock and one ends up in a good trajectory. Thus, favorable initial conditions work as a buffer preventing large shocks from hitting the boundaries and preventing a collapse of trust.

Summarizing these three results, one can conclude that large negative supply shocks that arise under unfavorable initial conditions lead to a loss of trust in the central bank's capacity to stabilize inflation and output. This intense loss of trust amplifies the negative effects of the supply shock. Thus, trust is the key in smoothly returning the economy to equilibrium. Trust allows mean reverting dynamics to do its work to bring the economy back to equilibrium. Conversely, absence of trust makes the economy less resilient to absorb large exogenous shocks. When trust is absent, the economy is adrift lacking an anchor that is needed to stabilize the economy after a shock.

The results obtained for large negative demand shocks are similar to the ones obtained for large supply shocks, that is, emergence of good and bad trajectories, correlation with trust, and importance of initial conditions in determining the nature of the subsequent trajectories. There is a difference though. In general, the loss of trust in the central bank is much less pronounced when a negative demand shock occurs. This has to do with the fact that after a negative demand shock, the central bank is not put into a dilemma situation (as it is after a negative supply shock). As a result, the central bank can keep inflation closer to its target more effectively and maintains much of its credibility.

Finally, we analyzed two policy issues. First, we found that in a world were impulse responses to shocks have a non-Gaussian distribution, the standard practice of representing these impulse responses in a mean–variance framework is misleading. The main business of macroeconomists is to produce conditional forecasts, that is, producing mean effects of some shock and a band of uncertainty around the mean. This could be a policy shock, a demand and supply shock, and many others. In a non-Gaussian world, these conditional forecasts cannot be trusted. We introduced the notion of *ambiguity*. There is strong ambiguity about the effects of shocks because the same shock can lead us into different universes of adjustment.

Second, we found that output stabilization by the central bank matters. Negative supply shocks create important threats to trust in the central bank and in the economy, all the more so when central banks pursue aggressive policies of output stabilization. Trying harder to stabilize output after a supply shock only makes matters worse.

Our results have some relevance to understand the experience of the 1970s with the large supply shocks and the recent covid supply shock. Preceding the supply shocks of the 1970s, there had been a buildup of inflation and inflationary expectations. Our model predicts that with these initial conditions, the recovery would take a long time. This is also what happened for many countries with a prior history of significant inflation.

The Covid supply shock of 2020 was preceded by a period of low inflation and low inflationary expectations. Our model predicts that this should make a quick recovery possible, mainly because the central banks did not worry about the inflationary consequences and therefore could actually follow expansionary monetary policies. It appears today that a relatively quick recovery occurred during 2021, until unfortunately a new large shock occurred, the Ukraine war.

Our analysis implies that history matters. A history of high inflation and expectations of inflation condition the impact of a supply shock and is likely to produce bad outcomes of this shock. In contrast a history of price stability makes it possible for the economy to follow a more benign trajectory after the same supply shock.

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We are grateful to Jean-Philippe Bouchaud, Geert Dhaene, and Eddie Gerba for their very useful comments and suggestions. We also profited from many comments and useful suggestions made during seminars at the London School of Economics, the Collège de France, University of Munich, University College London, the University of Amsterdam, the University of Bamberg, Jaume University, the University of Strasbourg, the University of Murcia, the Bank of England, the Danish National Bank, the Czech National Bank, and the European Central Bank.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were generated or analyzed during the current study.

ENDNOTES

[1] The literature on how trust affects economic behavior and ultimately economic growth and development is substantial. It is not the place here to present an exhaustive survey. Here are a few representative references: Arrow (1972), Putnam (1993, 2000), Fukuyama (1995), Knack and Keefer (1997), La Porta, et al. (1997), Guiso et al. (2000), Glaeser et al. (2000), Acemoglu et al. (2003), Beugelsdijk et al. (2004), Akçomak and ter Weel (2008), Dasgupta (2010), Tabellini (2010), Algan and Cahuc (2010, 2013), and Bjørnskov (2018).

[2] Note: $U_{f,t} = -\sum_{k=0}^{\infty} \omega_k \left[y_{t-k-1} - \tilde{\mathrm{E}}_{f,t-k-2} y_{t-k-1}\right]^2$ and $U_{e,t} = -\sum_{k=0}^{\infty} \omega_k \left[y_{t-k-1} - \tilde{\mathrm{E}}_{e,t-k-2} y_{t-k-1}\right]^2$.

[3] Note: $U'_{f,t} = -\sum_{k=0}^{\infty} \omega_k \left[\pi_{t-k-1} - \tilde{\mathrm{E}}_{f,t-k-2} \pi_{t-k-1}\right]^2$ and $U'_{e,t} = -\sum_{k=0}^{\infty} \omega_k \left[\pi_{t-k-1} - \tilde{\mathrm{E}}_{e,t-k-2} \pi_{t-k-1}\right]^2$.

[4] We obtain this probability based on the coefficient of inflation expectation in Table 2, column 1. To obtain the marginal effect at the steady state, we use cumulative distribution function of the standard normal distribution, $\Phi\,(132.27*0.05) = 1$.

[5] We obtain this probability based on the coefficient of output gap expectation in Table 2, column 2. To obtain the marginal effect at the steady state, we use cumulative distribution function of the standard normal distribution $\Phi(68.99*0.05) \approx 1$.

[6] This conclusion is also confirmed indirectly by Bobeica et al. (2020, 2021). These authors find that the wage price spiral tends to be more intense after a supply shock when initially high inflation expectations prevailed in the Eurozone and the United States.

REFERENCES

Acemoglu, D., Johnson, S., Robinson, J., & Thaicharoen, Y. (pub year2003). Institutional causes, macroeconomic symptoms: Volatility, crises and growth. *Journal of Monetary Economics*, *50*, 49–123. https://doi.org/10.1016/S0304-3932(02)00208-8

Akçomak, S. & ter Weel, B., (2008). Social Capital, Innovation and Growth: Evidence from Europe, IZA Discussion Paper, 3341.

Algan, Y., & Cahuc, P. (2010). Inherited trust and growth. *American Economic Review*, *100*(5), 2060–2092. https://doi.org/10.1257/aer.100.5.2060

Algan, Y., & Cahuc, P. (2013). Trust and growth. *Annual Review of Economics*, *5*, 521–549. https://doi.org/10.1146/annurev-economics-081412-102108

Anderson, S., de Palma, A., & Thisse, J.-F. (1992). *Discrete choice theory of product differentiation*. MIT Press.

Arrow, K. (1972). Gifts and exchanges. *Philosophy and Public Affairs*, *1*, 343–362.

Assenza, T., Bao, T., Hommes, C., & Massaro, D. (2014). Experiments on expectations in macroeconomics and finance. *Experiments in Macroeconomics*, *17*, 11–70. https://doi.org/10.1108/S0193-230620140000017002

Barro, R. J., & Gordon, D. B. (1983). Rules, discretion and reputation in a model of monetary policy. *Journal of Monetary Economics*, *12*(1), 101–121. https://doi.org/10.1016/0304-3932(83)90051-X

Bernanke, B., Gertler, M., & Watson, M. (1997). *Systematic monetary policy and the effects of oil price shocks*. Brookings Papers on Economic Activity.

Beugelsdijk, S., deGroot, H., & van Schaik, A. (2004). Trust and economic growth, a robustness analysis. *Oxford Economic Papers*, *56*, 1–134. https://doi.org/10.1093/oep/56.1.118

Bjørnskov, C. (2018). Social trust and economic growth. In E. Uslaner (Ed.), *Oxford handbook of social and political trust*. Oxford University Press.

Blattner, T.S. & Margaritov, E. (2010). Towards a robust monetary policy rule for the euro area.

Bobeica, E., Ciccarelli, M., & Vansteenkiste, I. (2020). The link between labor cost inflation and price inflation in the Euro area. In G. Castex, J. Gal, & D. Saravia (Eds.), *Changing inflation dynamics, evolving monetary policy*. Volume 27 of Central Banking, Analysis, and Economic Policies Book Series No 27. Central Bank of Chile. https://doi.org/10.2139/ssrn.3329196

Bobeica, E., Ciccarelli, M., & Vansteenkiste, I. (2021). *The changing link between labor cost and price inflation in the United States*. Working Paper Series 2583. European Central Bank. https://doi.org/10.2139/ssrn.3902304

Branch, W., & Evans, G. (2006). Intrinsic heterogeneity in expectation formation. *Journal of Economic Theory*, *127*, 264–295. https://doi.org/10.1016/j.jet.2004.11.005

Branch, W. A. (2004). The theory of rationally heterogeneous expectations: Evidence from survey data on inflation expectations. *Economic Journal*, *114*(497), 592–621. https://doi.org/10.1111/j.1468-0297.2004.00233.x

Brazier, A., Harrison, R., King, M., & Yates, T. (2008). The danger of inflation expectations on macroeconomic stability: Heuristic switching in an overlapping generations monetary model. *International Journal of Central Banking*, *32*, 2428–2452.

Brock, W., & Hommes, C. (1997). A rational route to randomness. *Econometrica*, *65*, 1059–1095. https://doi.org/10.2307/2171879

Bursian, D., & Faia, E. (2018). Trust in the monetary authority. *Journal of Monetary Economics*, *98*, 66–79. https://doi.org/10.1016/j.jmoneco.2018.04.009

Bursian, D., & Fürth, S. (2015). Trust me! I am a European central banker. *Journal of Money, Credit and Banking*, *47*(8), 1503–1530. https://doi.org/10.1111/jmcb.12282

Christelis, D., Georgarakos, D., Jappelli, T., & van Rooij, M. (2020). Trust in the central bank and inflation expectations. *ECB Working Paper*, *2375*. https://doi.org/10.2139/ssrn.3540974

Dasgupta, P. (2010). A Matter of Trust: Social Capital and Economic Development, Manchester School. Working Paper, no. 1.

De Grauwe, P. (2012). *Lectures on behavioral macroeconomics*. Princeton University Press. https://doi.org/10.2307/j.ctvcmxp1g

De Grauwe, P., & Ji, Y. (2019). *Behavioural macroeconomics. Theory and policy*. Oxford University Press.

De Grauwe, P., & Ji, Y. (2020). Structural reforms, animal spirits, and monetary policies. *European Economic Review*, *124*, 103395. https://doi.org/10.1016/j.euroecorev.2020.103395

Ehrmann, M., Soudan, M., & Stracca, L. (2013). Explaining European Union citizens' trust in the European Central Bank in normal and crisis times. *The Scandinavian Journal of Economics*, *115*(3), 781–807. https://doi.org/10.1111/sjoe.12020

Fukuyama, F. (1995). *Trust: The social virtues and the creation of prosperity*. Free Press.

Glaeser, E., Laibson, D., Scheinkman, J., & Soutter, C. (2000). Measuring trust. *Quarterly Journal of Economics*, *95*, 811–846. https://doi.org/10.1162/003355300554926

Grazzini, J., Richiardi, M. G., & Tsionas, M. (2017). Bayesian estimation of agent-based models. *Journal of Economic Dynamics and Control*, *77*, 26–47. https://doi.org/10.1016/j.jedc.2017.01.014

Guiso, L., Sapienza, P., & Zingales, L. (2000). The role of social capital in financial development. *American Economic Review*, *94*(3), 526–556.

Hommes, C. (2011). The heterogeneous expectations hypothesis: Some evidence from the lab. *Journal of Economic Dynamics and Control, Elsevier*, *35*(1), 1–24. https://doi.org/10.1016/j.jedc.2010.10.003

Hommes, C. H., & Lustenhouwer, J. (2019). Inflation targeting and liquidity traps under endogenous credibility. *Journal of Monetary Economics*, *107*, 48–62. https://doi.org/10.1016/j.jmoneco.2019.01.027

Hommes, C. H. (2021). Behavioral & experimental macroeconomics and policy analysis: A complex systems approach. *Journal of*

Economic Literature, *59*(1), 149–219. https://doi.org/10.1257/jel.20191434

Knack, S., & Keefer, P. (1997). Does social capital have a economic payoff, a cross-country comparison, *quarterly*. *Economic Journal*, *112*, 1251–1288. https://doi.org/10.1162/003355300555475

Kukacka, J., Jang, T. S., & Sacht, S. (2022). Estimation of heuristic switching in behavioral macroeconomic models. *Journal of Economic Dynamics and Control*, *146*, 104585. https://doi.org/10.1016/j.jedc.2022.104585

Levin, A. T., Wieland, V., & Williams, J. C. (1999). Robustness of simple monetary policy rules under model uncertainty. In J. B. Taylor (Ed.) *Monetary policy rules* (pp. 263–299). Chicago, IL: Chicago University Press.

McLachlan, G. J., & Peel, D. (2000). *Finite mixture models*. Wiley. ISBN 978-0-471-00626-8. https://doi.org/10.1002/0471721182

Pfajfar, D., & Zakelj, B. (2014). Experimental evidence on inflation expectation formation. *Journal of Economic Dynamics and Control*, *44*, 147–168. https://doi.org/10.1016/j.jedc.2014.04.012

Putnam, R. (1993). *Making democracy work*. Princeton University Press.

Putnam, R. (2000). *Bowling alone: The collapse and revival of American community*. Simon & Schuster.

Roth, F., Gros, D., & Nowak-Lehmann, D. F. (2014). Crisis and citizens' trust in the European Central Bank—Panel data evidence for the euro area, 1999–2012. *Journal of European Integration*, *36*(3), 303–320. https://doi.org/10.1080/07036337.2014.886400

Smets, F., & Wouters, R. (2003). An estimated dynamic stochastic general equilibrium model. *Journal of the European Economic Association*, *1*, 1123–1175. https://doi.org/10.1162/154247603770383415

Tabellini, G. (2010). Culture and institutions: Economic development in the regions of Europe. *Journal of the European Economic Association*, *8*(4), 677–716. https://doi.org/10.1111/j.1542-4774.2010.tb00537.x

Taylor, J. B. (1993). Discretion versus policy rules in practice. *Carnegie-Rochester Conference Series on Public Policy*, *39*, 195–214. https://doi.org/10.1016/0167-2231(93)90009-L

Wälti, S. (2012). Trust no more? The impact of the crisis on citizens' trust in central banks. *Journal of International Money and Finance*, *31*(3), 593–605. https://doi.org/10.1016/j.jimonfin.2011.11.012

Woodford, M. (1999). Optimal monetary policy inertia. *The Manchester School*, *67*, 1–35 Supplement. https://doi.org/10.1111/1467-9957.67.s1.1

Woodford, M. (2003). *Interest and prices*. Princeton University Press.

World Bank. (2021). https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG

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APPENDIX A

The importance of memory

Memory appears in the model when agents evaluate the performance of their forecasting rule. They do this by computing the forecast errors they made in the past. We used a parameter, ρ, that guides the exponentially declining weights given to the past. In the simulations reported in the previous sections, we set $\rho = 0.5$, which implies that they give a 50% weight to the last observation and 50% to the preceding history. We want to know how the results are affected when agents have different memories. We distinguish between short memory and long memory. In the short memory scenario, we set $\rho = 0.1$, which implies a weight of 90% to the last observation and 10% to the preceding history. In the long memory scenario, we set $\rho = 0.9$, implying that the last observation gets a weight of 10% and the preceding history 90%.

We show the results in Figure A1 where we compare the short and long memories with "normal" memory obtained when $\rho = 0.5$ (which is the assumption used in the results reported previously). We find that a short memory tends to create a clearer separation between good and bad trajectories when compared to a long memory. The interpretation is that when agents have short memories, the initial conditions get a higher weight. Agents remember mostly what happened just prior to the shock. Thus, when the initial conditions are bad, this will reverberate stronger when agents do not remember the past history well. Conversely, when memory is long, the events farther in the past get a higher weight so that the initial conditions do not play the same strong role in pushing the economy into a good or bad trajectory.

The bottom charts in Figure A1 show the evolution of the mean inflation credibility after the supply shock. Instead of showing all the 1000 trajectories of the inflation credibility indicators (as we did in Figure 7), we take the mean of these trajectories. We also concentrate on the bad trajectories (black) because, as we have shown, it is in these bad trajectories that credibility is most affected. In addition, while the mean of the good and bad trajectories together is not very meaningful because of the bimodal distribution (see Section 7 where we elaborate on this), the mean of the bad trajectories is a meaningful representation of what happens in these trajectories. We find, not surprisingly, that credibility of the central bank is restored quicker when agents have short memories, whereas it takes much longer for credibility to be restored when memory is long. In the latter case, once credibility is lost, this loss tends to propagate longer into the future. (We find similar results for output credibility).

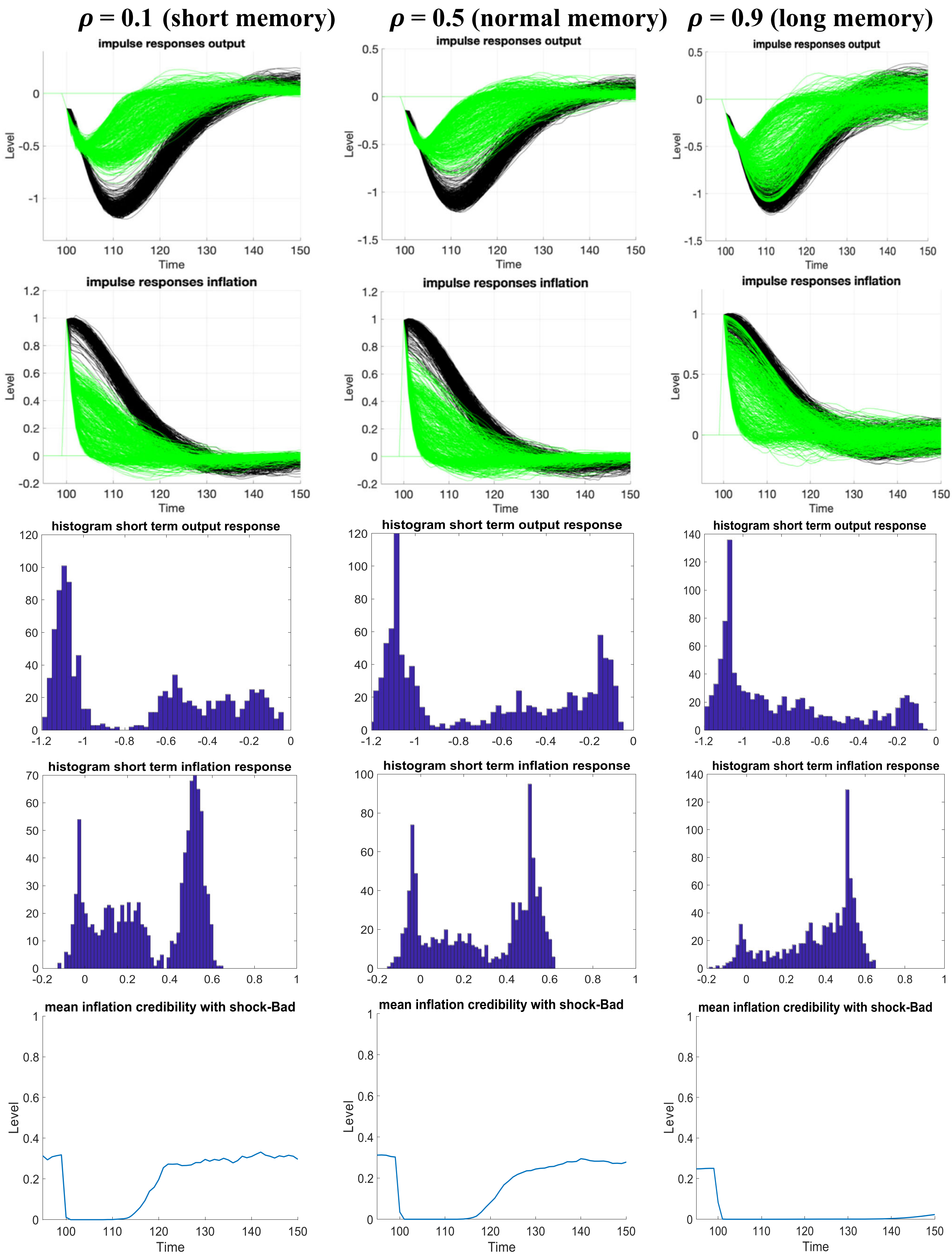

FIGURE A1 The importance of memory.