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Supermultiplier Models, Demand Stagnation, and Monetary Policy: Inevitable March to the Lower Bound for Interest Rates?

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ABSTRACT

This article integrates monetary policy into a very simple dynamic supermultiplier model with an accommodating supply side. Results show that monetary policy guided by a conventional Taylor rule may stabilize an economy around the steady-state path of demand-led growth following temporary demand shocks. However, monetary policy is ineffective in offsetting permanent negative demand shocks even if the lower bound for interest rates is not binding. This outcome contrasts with the prevailing view among policymakers that monetary policy can usually assure full utilization of an economy's resources in the long run. The ineffectiveness of monetary policy is particularly acute if autonomous demand grows more slowly than necessary to generate full employment. In this case, if policymakers recognize the under-utilization of resources, monetary policy leads to interest rates trending necessarily to their lower bound. The analysis also shows how monetary policy may lead to counter-productive responses to supply shocks. The article concludes with observations about how the theoretical results correspond with the history of US monetary policy in recent decades.

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Supermultiplier Models, Demand Stagnation, and Monetary Policy: Inevitable March to the Lower Bound for Interest Rates?*

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This article integrates monetary policy into a very simple dynamic supermultiplier model with an accommodating supply side. Results show that monetary policy guided by a conventional Taylor rule may stabilize an economy around the steady-state path of demand-led growth following temporary demand shocks. However, monetary policy is ineffective in offsetting permanent negative demand shocks even if the lower bound for interest rates is not binding. This outcome contrasts with the prevailing view among policymakers that monetary policy can usually assure full utilization of an economy's resources in the long run. The ineffectiveness of monetary policy is particularly acute if autonomous demand grows more slowly than necessary to generate full employment. In this case, if policymakers recognize the under-utilization of resources, monetary policy leads to interest rates trending necessarily to their lower bound. The analysis also shows how monetary policy may lead to counter-productive responses to supply shocks. The article concludes with observations about how the theoretical results correspond with the history of US monetary policy in recent decades.

Keywords
Supermultiplier, Monetary Policy, Demand-Led Growth, Keynesian Macroeconomics

JEL Codes: E12, E52

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1. Introduction

This paper takes a first step to integrate two important strands of research. First, there has been an explosion of interest in supermultiplier models of demand-led growth pioneered by Serrano (1995). Recent work explores a wide variety of model extensions and policy issues in the supermultiplier framework. However, prior to this symposium, there has been little attention in supermultiplier models to the second research strand considered here, the effects of monetary policy. There is a wide range of post-Keynesian research and perspectives on monetary policy employing other modeling frameworks (see Lavoie, 2014, chapter 4 and Docherty, 2021 for example), but consideration of monetary policy has been minimal in supermultiplier research.

More specifically, I consider the implications of mainstream "Taylor rule" monetary policy in a simple, stylized model of demand-led growth with accommodating supply. The baseline model is a simplified version of Fazzari, Ferri, and Variato (2020), as presented in Fazzari and González (2023), with the addition of interest elasticity of aggregate demand. The demand side of this model generates familiar supermultiplier results. Also, it integrates the supply side to show there is no long-run path of potential output or equilibrium rate of unemployment that is independent of the path of demand. Indeed, growth in both actual and potential output is driven by the dynamics of autonomous demand.[1] While resources can constrain the economy from growing arbitrarily fast, there is neither a unique supply-determined path of potential output nor a unique supply-determined equilibrium rate of unemployment.

In contrast, most mainstream "new consensus" or "new Keynesian" models are based on a view of the economy in which the supply side of tastes, technology, and resources uniquely determines the long-run path of the economy independent of the dynamics of aggregate demand, as discussed by Palley (2007) and Hein and Stockhammer (2010). In this framework the job of monetary policy is to offset effects of demand shocks that affect real output and employment because of nominal rigidities. The objective is to return the output to its supply-driven "potential" path and the labor market to its "natural" rate of unemployment. The maintained

[1] While they do not use the supermultiplier framework explicitly, Setterfield (2011), Palley (2012), and Mason and Jayadev also present models of demand-led growth with accommodating supply induced by endogenous productivity and labor supply. The implications for monetary policy developed here apply in these alternative models. Also see Hein and Stockhammer (2010), along with the extensive references they provide, for post-Keynesian critiques of the "natural" or "NAIRU" rate of unemployment assumptions that are central to the mainstream monetary policy approach.

assumption in these mainstream models is that monetary policy is sufficient to accomplish this goal, unless a negative demand shock is so large that a lower bound on interest rates is binding, a situation usually considered abnormal. The key question is: what can mainstream Taylor rule monetary policy accomplish if the economy is, in fact, driven by demand beyond a short-run horizon defined by nominal rigidity?

Following the presentation of the model (section 2) and the integration of monetary policy and interest rates (section 3), the paper presents four key results. First, I consider how the model predicts that Taylor rule monetary policy can stabilize output and employment around an equilibrium unemployment rate and steady-state growth path following temporary demand shocks (section 4). But that unemployment rate is not "natural;" it depends on the growth rate of autonomous demand. While activist monetary policy can mitigate output loss following a temporary negative demand shock, monetary stabilization that targets an equilibrium unemployment rate may sacrifice output after a temporary positive demand shock.

Second, I consider permanent negative shocks to the *level* of autonomous demand (section 5). Following a permanent negative shock, monetary policy that targets the equilibrium unemployment rate reduces output loss along the transition path that follows the shock. But if monetary policy follows a Taylor rule it will not prevent the long-run output loss resulting from a permanent downward shift of demand. This result arises even if the interest rate is above its lower bound, and therefore strongly contrasts with the mainstream view that monetary policy can always offset demand shocks (temporary or permanent) if the lower bound is not binding. Symmetrically, restrictive monetary policy following a permanent positive demand shock will slow the transition to a higher long-run output path.

Third, and perhaps most interesting, I analyze the effect of mainstream monetary policy following a permanent negative shock to the *growth* rate of autonomous demand (section 6). This shock, other things equal, raises the equilibrium unemployment rate (equivalent in this model to the output gap). Monetary policy will not be able to restore the unemployment rate that prevailed prior to the shock. I propose two possible scenarios for the policy response to this situation. First policymakers guided by a mainstream view of the long run according to which the supply side necessarily drives the output path, will conclude that the "natural" rate of unemployment has risen and accept an economy that grows more slowly that would be feasible with faster demand growth. Second, if policymakers understand that economic growth is unacceptably low due to weak aggregate demand, they may abandon the rigid Taylor rule and keep cutting interest rates. But this policy will cause an inevitable march of the interest rate to its lower bound.

Fourth, although the focus of this paper is on the interaction between monetary policy and the dynamics of aggregate demand, I exploit the integration of the supply side into the simple model and consider how monetary policy affects the response of the economy to supply shocks (section 7). The analysis shows that Taylor-rule monetary policy can lead to economic damage following negative shocks to labor productivity, especially following permanent shocks to productivity growth. Furthermore, a positive shock to productivity growth will likely lead the interest rate to its lower bound.

Although the model is very simple, section 8 considers of how the results can be used to interpret important features of the interaction of monetary policy and the path of output over the past several decades. During this period, the US and other countries experienced a persistent downward trend in interest rates, eventually hitting the lower bound for an extended period prior to the pandemic. This history fits broad aspects of the theoretical results here and provides motivation for more detailed research on the theoretical and empirical effects of monetary policy when growth is led by demand beyond the short run as discussed briefly in the concluding section 9.

2. A Simple Model of Demand-Led Growth

This section presents a simple supermultiplier model of demand-led growth. The model is designed to explore basic results and build intuition in the most transparent way possible. As such it abstracts away from features of modern economies that must ultimately be incorporated to address critical issues related to the empirical effectiveness of monetary policy. In this sense, the simple model here follows how Summa, et al. (2022) describe much of the supermultiplier research as intended to investigate "general analytical properties" of the model.[2] That said, the results are sufficiently general that they will very likely apply in more realistic models designed for quantitative and empirical research.

[2] Serrano et al. (2023) provide an insightful discussion of the supermultiplier model that identifies and addresses a variety of criticisms of the associated research.

The model is based on the simple version of the demand-led growth model for a closed economy designed to develop intuition in Fazzari and González (2023, section 2).[3] It includes just two components of demand: private consumption based on income (C_t) and autonomous demand (Z_t). Autonomous demand can be thought of as a bond-financed government transfer that is fully consumed or government spending on public goods and services, but the specific definition of autonomous demand for the purposes of this paper does not matter. For simplicity, there is no capital or fixed investment in the model, although all results could be easily generalized to include investment and fixed capital in the version of the extended empirical model from Fazzari and González (2023).

Total output (Y_t) is determined by aggregate demand

$$Y_t = C_t + Z_t.$$

subject to the constraint that output cannot exceed supply (Y_t^s) that will be discussed below. The consumption function is

$$C_t = (1 - s)Y_t$$

with the saving propensity (s) between zero and one. Autonomous demand grows at a constant rate g_Z. It is immediately obvious that

$$Y_t = \frac{Z_t}{s} \tag{1}$$

and output grows at rate g_z for a given value of s.[4]

To analyze some basic implications of monetary policy on the economy's capacity to produce and its equilibrium unemployment rate, the supply side must be modeled explicitly. Supply is a linear (Leontief) function of employment (l_t)

$$Y_t^s = A_t l_t.$$

Labor productivity (A_t) evolves over time. Assume total labor supply is fixed and normalized to one. Then, employment and unemployment (u_t) can be interpret as rates that sum to unit labor supply

$$1 = u_t + l_t.$$

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[3] The assumption of a closed economy, while useful given the simple objective of this analysis, excludes effects of monetary policy on exchange rates working through balance-of-payments constraints. See Serrano and Summa (2022) and Dvoskin and Landau (2023) for discussion of monetary policy in an open economy.

[4] In the absence of capital, the supermultiplier becomes the most basic textbook Keynesian multiplier $1/s$. For example, see Pariboni (2016, equation 11).

A simplified version of the productivity growth (g_A) specification from Fazzari, et al. (2020) is

$$g_A = \phi_0 - \phi_1 u_{t-1}. \quad (2)$$

The intuition is that productivity will grow faster in a stronger economy in which there is greater incentive to economize on labor and engage in productivity-enhancing R&D. The strength of the economy is proxied by the unemployment rate which creates a key connection between the demand and supply sides of the economy.[5]

In this very simple framework, equation 1 shows the economy will grow at the rate of growth of autonomous demand, g_Z.[6] The supply-side productivity relationship in equation 2 gives the steady-state unemployment rate as

$$u^* = \frac{\phi_0 - g_z}{\phi_1} \quad (\phi_1 > 0). \quad (3)$$

Equation 3 shows a central result of this research program that is critical to understanding its implications for monetary policy: *there is no "natural" rate of unemployment* defined independently of the economy's demand dynamics. The basic intuition for this result is clear. Suppose the economy starts in steady state in period zero and then g_z rises in period one. Higher demand induces greater output which requires more labor input and reduces the unemployment rate in period one which stimulates faster productivity growth in the period two (equation 2). If the higher rate of productivity growth in period two is not large enough to accommodate the faster growth of autonomous demand, the unemployment rate in period two falls again, causing even faster growth of productivity in period three.[7] The process continues until the unemployment rate converges to u^* such that productivity grows at a rate consistent with the new higher level of g_z. This result is the central message of Fazzari, et al. (2020), that is, the

[5] This relationship is explained in more detail in Fazzari et al. (2020) with extensive references. The connection between the *level* of economic activity and the *growth* of productivity, somewhat different from the more common Kaldor-Verdoorn effect relating output growth to productivity growth, is critical to the results of the model, as recognized explicitly prior to our work by Setterfield (2011) and Palley (2012) and further developed in Fazzari and González (2023).

[6] In Fazzari, et al. (2020) we have a broader set of structural features and dynamics, including capital accumulation and expectation formation. In this environment, as in all other supermultiplier modeling with stable dynamics, it is the steady-state rate of growth that converges to the rate of growth of autonomous demand. Deviations from the steady-state path can be significant and persistent, as discussed in detail by Gallo (2023).

[7] For high values of ϕ_1, it is possible for productivity growth in period one to exceed the level necessary to accommodate faster demand growth. In this case the unemployment rate falls below u^* in period one and the convergence to equilibrium is cyclical. This case does not change the main implications of this paper. However, estimates of ϕ_1 from Fazzari and González (2023) imply the case described in the text is much more likely.

dynamic path of the supply side *accommodates* the demand-determined dynamics, or, more simply: demand leads supply.

This result has two caveats. First, equation 2 has a meaningful solution for the steady-state unemployment rate only if $\phi_1 > 0$, that is, there must be some structural channel in the economy that induces faster supply side *growth* when the *level* of economic activity rises. Fazzari and González (2023) provide estimates of the effect of the unemployment rate on both productivity and labor supply growth that strongly support this requirement. Second, the demand-determined equilibrium unemployment rate implied by equation 2 must be above a minimum unemployment rate determined by the work force. That is, there must be some slack in the economy. Therefore, demand growth cannot be accommodated by supply at an arbitrarily high level. We shall proceed with the assumption, however, that in normal times labor supply constraints are not binding.

3. Integrating Interest Rates and Monetary Policy

The results presented in the previous section differ fundamentally from the "new consensus" or "new Keynesian" theoretical framework that typically guides mainstream policy recommendation. In that world, long-run growth is governed exclusively by the supply side, independent of dynamic path of demand. From the mainstream perspective, the objective of monetary policy becomes to simply stabilize deviations from the supply-determined path that arise from the combination of demand "shocks" and nominal rigidity assumed to disappear in the long run. Sim (2022, page 1), following Blanchard (2017), calls this the "independence hypothesis" and writes that it "has been at the center of monetary economics and the majority of Keynesian economics have accepted the concept" as an "unquestionable axiom." Goodfriend (2007, page 58) describes part of the mainstream consensus as "there is a natural rate of unemployment (where output equals its potential) at which wage and price setters perpetuate the going rate of inflation."

The objective of this paper is to explore what happens if a mainstream monetary policy rule premised on the "independence hypothesis" is used in an economy that actually behaves as predicted by a demand-led growth. To generalize the model presented in section 2 for this purpose there must be a channel for the interest rate controlled by monetary policy to affect demand. In a closed economy, the most realistic channel is likely through residential construction, the most interest-sensitive component of aggregate demand. The interest sensitivity of business investment is more questionable, but that channel may also matter for monetary policy. However, the objective here is to illustrate some basic results in the most straightforward way. Therefore, instead of modeling different components of demand separately, assume that the saving rate is time-varying and depends on the interest rate (r_t)[8]:

$$s_t = \eta_0 + \eta_1 r_t. \tag{4}$$

This specification, while simplistic, is more general than it may appear. One can interpret "consumption" in this model more broadly as "induced" demand, that is, demand that depends on the level of output. This demand could include residential construction and even business investment through a simple accelerator relationship. The interest sensitivity of the saving rate, therefore, can be interpreted as related to the cost of credit for various categories of demand. This specification is also qualitatively consistent with a model in which higher interest costs raise debt service and reduce spending for indebted consumers, although this simple approach does not capture the rich dynamics of interest rates and debt as in Barbieri Góes (2021) and Avritzer and Brochier (2022). Again, the objective here is not to model the details of the varied channels through which interest rates affect aggregate demand. Rather, this approach identifies some basic conceptual effects of conventional monetary policy when growth is demand led beyond the short run.

Imposing a zero lower bound on the policy rate and the possibility of interest rate smoothing, specify monetary policy through a Taylor-like rule:[9]

$$r_t^{targ} = \max\left[0, \gamma_0 - \gamma_1\left(u_{t-1} - u_t^{targ}\right)\right] \tag{5}$$

$$r_t = \lambda_r r_{t-1} + (1 - \lambda_r) r_t^{targ}.$$

[8] Other post-Keynesian analysis of monetary policy explores the link between the interest rate, income distribution, and aggregate demand. See Serrano and Summa (2020) and Docherty (2021) and references there. Usually this approach leads to a propensity to save averaged across workers and capitalists / rentiers. To the extent that lower interest rates stimulate demand through distribution, equation 4 can represent a reduced form of this channel. Another channel for interest rate effects on demand could arise through interest rate elasticity of autonomous demand, for example, residential investment and debt-financed consumption. It is worthwhile to explore this channel in more complex models (see Barbieri Góes, 2021, for example). However, to the extent that the level of Z_t (and not its growth rate) depends on the level of the interest rate, the main conclusions of the following analysis will remain largely unchanged.

[9] Lima et al. (2023) generalize the concept of a zero lower bound to an "effective lower bound."

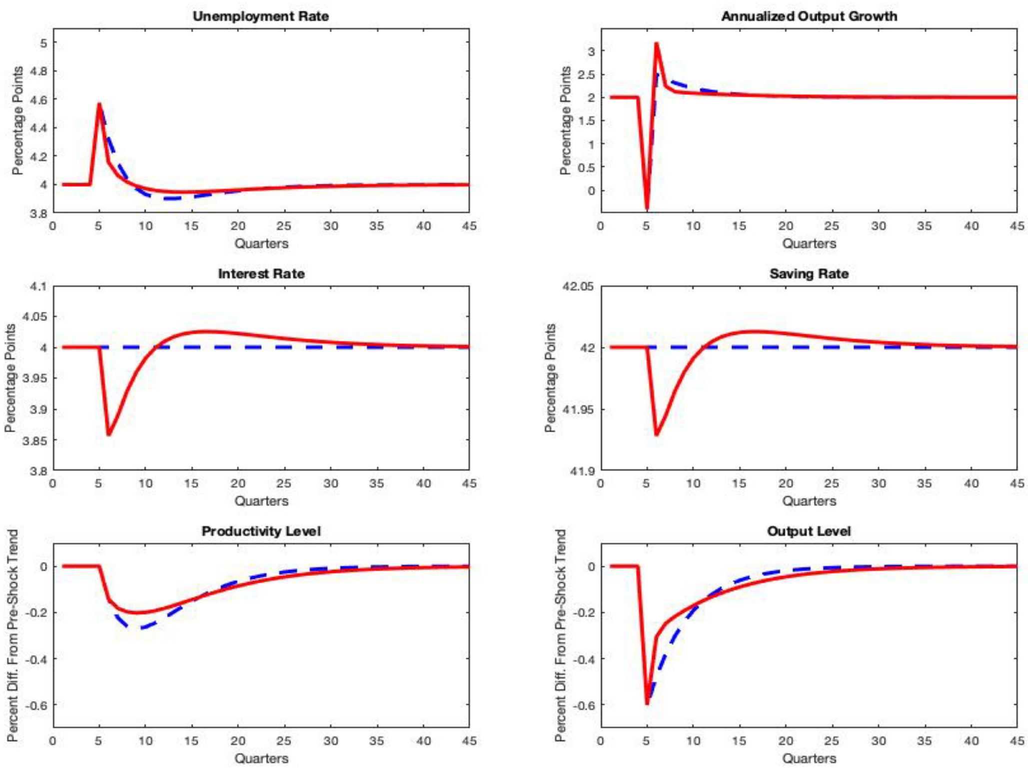
Goodfriend (2007, page 59) states the Taylor rule "became the most common way to model monetary policy." Rochon and Setterfield (2008) identify mainstream monetary policy with the Taylor rule. For simplicity, this specification suppresses the inflation component of the Taylor rule. But this simplification is easily modified to include a linear inflation effect on the target interest rate along with a linear Phillips Curve. As the appendix shows, adding these features to the model just changes the γ_0 and γ_1 coefficients in the interest rate equation. In particular, the total response of the target interest rate to changes in unemployment will be larger if the policy also targets inflation and there is a negative correlation between inflation and unemployment.

4. Short-Run Demand Shocks and Monetary Stabilization

Mainstream conventional wisdom about monetary policy is that interest rate adjustments should stabilize demand relative to a supply-determined output path. As the discussion above demonstrates, the steady-state output path in this model is demand-led with supply following as long as slack labor resources exist. However, the model can reproduce some aspects of mainstream conventional wisdom assuming a constant growth rate of autonomous demand (g_z) with a target unemployment rate equal to the steady-state unemployment rate (u^*) from equation 3 that equates supply growth to g_z. If g_z is constant, the economy will follow a steady growth path over time, with what will be interpreted through the lens of the mainstream perspective as a "natural" or "neutral" unemployment rate at which supply and demand growth are balanced.

Following a temporary shock to the level of autonomous demand, the simple demand-led growth model delivers mainstream results. A temporary demand shock does not change the steady-state path of the economy. Therefore, the demand-led growth model largely mimics the behavior of a mainstream model in which the long-run path of the economy is independent of demand. To illustrate this result, consider a simulation of simple model. Details of the simulation and parameter choices appear in the appendix, but the main qualitative results hold for any sensible parameter choices. Figure 1 presents impulse-response functions from the simulation following a negative shock in quarter 5 to autonomous demand (Z_t). The shock is initially equal to one quarter percent of output and then decays with a quarterly autoregressive parameter of 0.80 each quarter. The blue dotted line shows a baseline case in which there is no monetary policy response, that is, with a constant interest rate. The red line is the counter-factual case when an increase in the unemployment rate leads to a policy-induced decline in the interest rate.[10]

Figure 1: Temporary Negative Shock to Autonomous Demand



Note: Simulation results following a temporary negative demand shock as described in the text and the simulation appendix. Blue dotted lines are the benchmark scenario with no monetary policy response. Red lines represent results with Taylor rule monetary policy.

Initially, the impulse-response functions correspond to basic mainstream predictions as well as what Rochon and Setterfield (2008, page 13), similar to Palley (2007), identify as the "activist" post-Keynesian view of monetary policy. The negative demand shock raises the unemployment rate immediately on impact. Higher unemployment lowers productivity (see equation 2). After the shock, demand growth returns to its initial value, the temporary drop in demand decays, and the unemployment rate falls back toward its initial value in both scenarios. However, with activist monetary policy, interest rate cuts initially push down the saving rate compared with the baseline case. A lower saving rate boosts aggregate demand causing the unemployment rate to decline more quickly, output to recover more quickly, and productivity

[10] Docherty (2001, figure 3) presents similar results from a model in which monetary policy affects demand through a distributional channel.

growth to rebound more quickly for a few quarters. Due to the discrete time simulation, the unemployment rate falls slightly below its steady-state value, leading the interest rate and the saving rate to temporarily rise slightly above its initial value because of the mechanical Taylor rule. But the short-run effects of activist monetary policy are stabilizing.

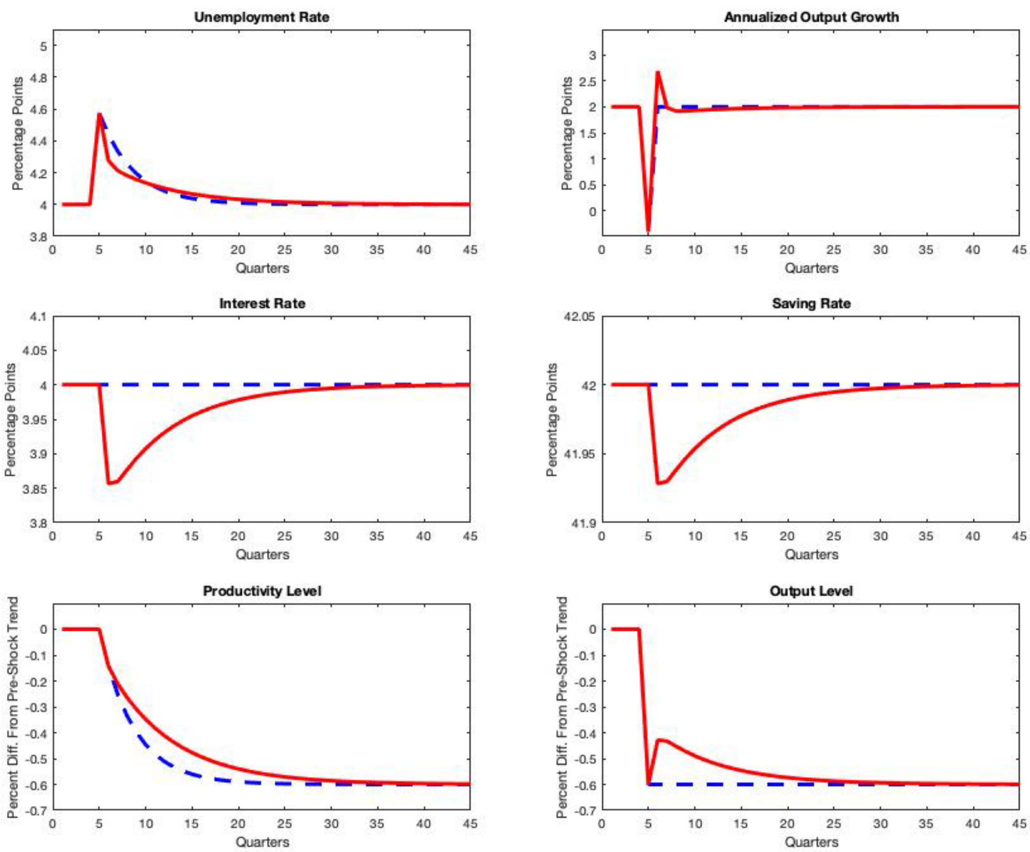
The effects are symmetric. A positive demand shock will have the standard effect of reducing unemployment. Assuming no change in the long-run growth path of autonomous demand, this effect will be temporary. But it could be beneficial if the initial equilibrium unemployment rate is above the minimum level imposed by labor supply. A rigid monetary policy rule that targets an unemployment rate higher than the rate consistent with true full employment reduces the Keynesian benefits of positive demand shocks. This result also implies an asymmetric monetary policy rule. with a stronger response to higher unemployment than lower unemployment, may improve economic performance compared with the standard Taylor rule.

5. Permanent Shocks to the Level of Demand

Consider the effect following a negative shock to autonomous demand that leads to a permanently lower level of autonomous demand, but, following the shock, demand growth returns to the previous rate of g_z. Again, lower demand causes the unemployment rate to rise, inducing slower productivity growth such that supply adjusts to the permanently lower level of demand. The steady-state unemployment rate does not change (because neither the long-run growth rate nor the productivity growth parameters have change, see equation 3), but potential output falls.

This result has important implications for monetary policy. Figure 2 shows the effect of a negative permanent level shock to autonomous demand equal to a quarter percent of GDP holding the long-run growth rate of autonomous demand constant. Again, the blue dotted lines show a base case with a constant interest rate while the red lines simulate the results when monetary responds to the unemployment rate. The initial impact of the shock is the same as it is following a temporary shock as shown in figure 1. However, because the shock does not decay, unemployment is more persistent. The monetary policy rule reduces the interest rate by more than in the case of the temporary shock and keeps it lower over for a longer time. Again, activist monetary policy mitigates the effects of the demand shock on output, unemployment, and productivity.

Figure 2: Permanent Negative Shock to Autonomous Demand



Note: Simulation results following a permanent negative demand shock as described in the text and the simulation appendix. Blue dotted lines are the benchmark scenario with no monetary policy response. Red lines represent results with Taylor rule monetary policy.

The lower right panel of figure 2 shows that the output path following a permanent demand shock is not just quantitatively different from the effect of a temporary shock, it is qualitatively different. And this difference is fundamentally inconsistent with mainstream conventional wisdom. Note that the blue line shows there is no return to the initial output path following the shock. With no monetary accommodation, output remains 0.6 percent below the pre-shock trend. In the first few quarters following the shock, a lower interest rate offsets part of this output loss. But monetary policy does not generate convergence back to the pre-shock trend. Indeed, the output path with activist monetary policy converges to the baseline case, permanently below the earlier trend even though the interest rate never comes close to its lower bound.

The reason for this result is demand-driven path dependence of supply. The higher unemployment and weaker economy induced by lower demand reduces productivity growth temporarily during the transition path between the initial and final equilibria. This effect permanently lowers the level of productivity. The unemployment rate converges back to its original steady-state value given by equation 3. Conventional monetary policy would conclude its job is done: the unemployment rate has returned to its initial equilibrium level, what the mainstream would interpret as the "natural" or "neutral" rate. Targeting the output gap would lead to the same result because, in this model, the output gap and the unemployment rate are identical.[11] According to the mainstream model in which the long-run path of the economy is independent of demand. Therefore, this outcome would be interpreted, incorrectly, as a negative "supply shock," assumed unrelated to the demand shock, that cannot, and should not, be offset by monetary policy. Policymakers guided by a standard Taylor rule would believe they have successfully restored full employment. They will ratchet down their estimate of potential output. But they would be mistaken. The economy could be restored to its previous higher output path with policies to stimulate autonomous demand.

6. Permanent Shocks to Demand Growth

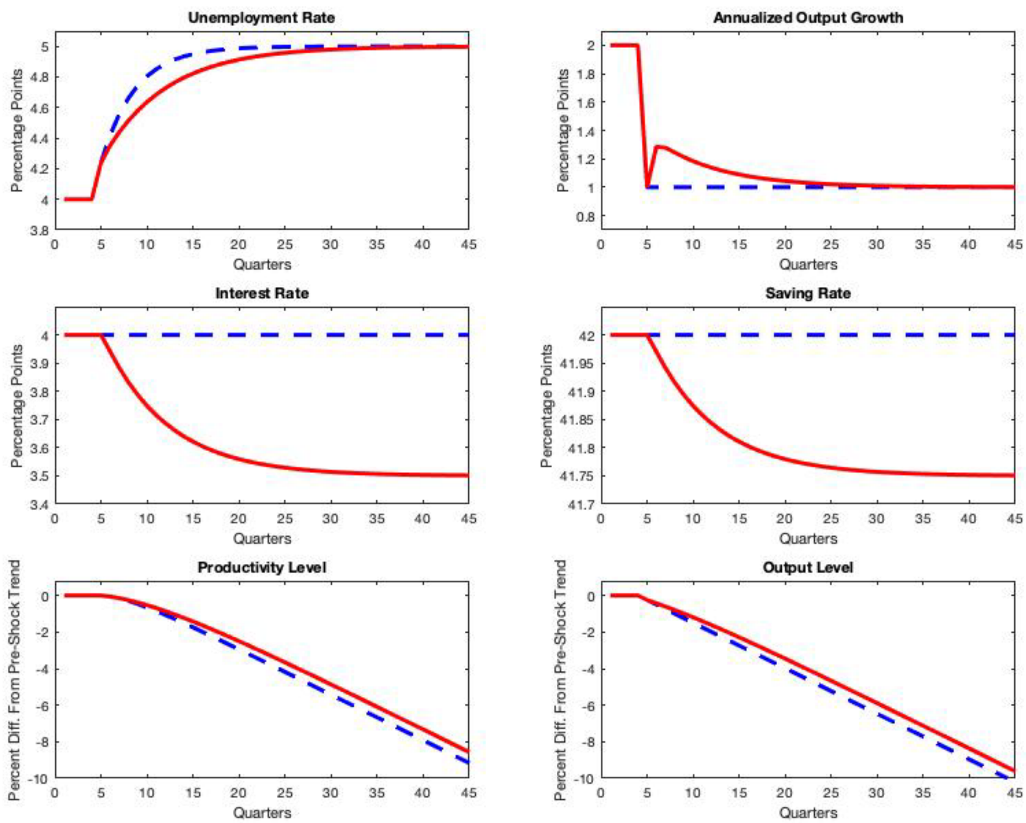
This section analyzes an even greater inconsistency between the operation of Taylor rule monetary policy and the predictions of the demand-led growth model. Consider a permanent reduction in the growth rate of the demand generating process. In the simple model presented here, as well as in the more developed models in Fazzari, et al. (2020) and Fazzari and González (2023), a permanent reduction in the growth rate of autonomous demand (g_z) causes a permanent reduction in output growth and supply growth along with a permanent increase in the equilibrium level of the unemployment rate (see equation 3).

Figure 3 shows these effects for a one percentage point decline in the annual growth rate of autonomous demand. In the model without a monetary policy response, output growth falls by one percentage point immediately and growth remains one percentage point lower indefinitely. The unemployment rate also rises, but over time the rate of change in the unemployment rate

[11] This statement would not be strictly true if the minimum unemployment rate is above zero. Then, the output gap would be lower than the unemployment rate by the amount of the minimum unemployment rate. All the results presented here go through, however, with the unemployment rate normalized to zero when all labor resources are fully employed.

from quarter to quarter declines. Why? A higher unemployment rate reduces productivity growth (equation 2). Therefore, the unemployment rate changes by less each period as time passes, ultimately converging to the new higher equilibrium unemployment rate. At this higher rate, demand and supply converge in both levels and growth rates.

Figure 3: Permanent Negative Shock to Autonomous Demand Growth



Note: Simulation results following a permanent negative shock to autonomous demand growth as described in the text and the simulation appendix. Blue dotted lines are the benchmark scenario with no monetary policy response. Red lines represent results with Taylor rule monetary policy.

How does mainstream monetary policy affect these dynamics? The higher unemployment rate leads monetary policy to cut interest rates raising the level of demand. This policy offsets some of the output loss along the weaker demand growth path, but the effect on output *growth* is only temporary. In the Taylor rule equation, the long-run level of the interest rate depends linearly on the gap between the current unemployment rate and the target unemployment rate. If the target rate does not change after the permanent reduction in demand growth, the gap does not disappear, but it converges to a constant and monetary policy that follows the Taylor rule no longer cuts the interest rate. This result follows in a straightforward way from equations 3 and 5. In steady state, assuming the zero lower bound is not binding the interest rate converges to

$$r^* = \gamma_0 - \gamma_1\left(u^* - u_t^{targ}\right) = \gamma_0 - \gamma_1\left(\frac{\phi_0 - g_z}{\phi_1} - u_t^{targ}\right)$$

If u_t^{targ} is set at the equilibrium unemployment rate for a high level of g_z and then g_z falls, the equilibrium interest rate will decline, but it will converge to a constant level despite the fact that the output and employment paths are permanently lower due to slower demand growth. Figure 3 illustrates these effects. Because the interest rate is permanently lower, the saving rate falls permanently. This effect implies both output and productivity levels are somewhat higher with monetary policy that follows the Taylor rule compared with no monetary policy response. But monetary policy has no effect on long-run output growth or the long-run unemployment rate. *Mechanical Taylor rule policy cannot prevent stagnation induced by a permanently lower demand growth rate.*

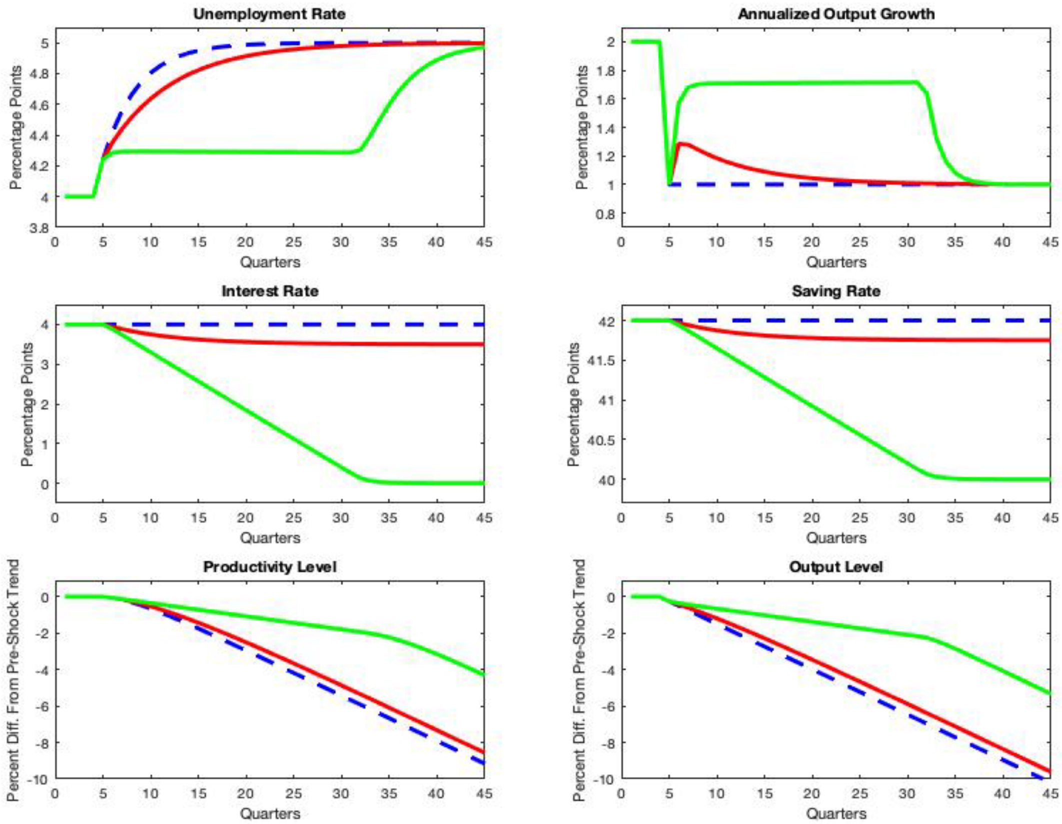
One can imagine two policy responses to this situation. First, and perhaps most likely for monetary policy guided by mainstream thinking, policymakers would infer that the economy was hit by some kind of negative supply shock that permanently raised the unemployment rate and slowed productivity growth. Even though the assumed "supply shock" would coincide with slower demand growth, mainstream models would interpret the supply effect as independent from the demand side of the economy. Indeed, because supply converges to demand, supply would indeed be lower. But the weaker path for the economy is not the result of exogenous changes in technology, worker preferences, etc. Instead, it is due in this model to the long-run effect of a lower demand path on productivity.

In this case, the monetary authority might raise its unemployment target to the new higher equilibrium rate. The effect of raising the target unemployment rate in the Taylor rule would imply that what previously was perceived as output below potential now becomes defined as the "new normal" with a zero-output gap. Other things equal, this change could imply raising the interest rate back to the initial level, offsetting any benefit of monetary policy in the face of lower demand. However, as the economy converges to the lower-growth equilibrium, there would be no persistent excess demand, as mainstream perspective would predict following a negative supply shock, despite the higher equilibrium unemployment rate because there really was no negative supply shock. There would be no reason for inflation to rise; indeed inflation may fall. Therefore, monetary policymakers could conclude that the "natural" interest rate had fallen and simply leave the lower rate in place, as is the case in the simulation presented in figure 3. This policy would imply a one-time change in the Taylor rule intercept, γ_0 in equation 5.

However, a second more enlightened and practical approach to monetary policy might be followed. Policymakers might recognize that the stagnant economy and the stubbornly higher unemployment rate signal an under-performing economy. Because the deeper problem is in fact slower demand growth, there would be no reason to expect higher inflation in this scenario and the stagnation might be interpreted, correctly, as the result of weak demand. Through the mainstream lens, this situation implies that the current "natural" rate of interest is lower than the current policy rate, inducing policymakers to reduce the intercept of the Taylor rule continuously over time in an attempt to find the "natural" rate of interest they assume exists. *But there is no "natural" interest rate that can restore the economy's initial growth path* (also see Lavoie, 2014 section 4.2.2 and Cesaratto and Pariboni, 2022, along with further references in those sources on this point).

Figure 4 shows the result of a policy that attempts to find a natural rate of interest when autonomous demand growth falls. There are now three policy scenarios in the figure: the blue line shows results with no monetary policy response and the red line depicts a mechanical Taylor rule policy that simply accepts the higher unemployment rate caused by the demand growth shock as the new normal (as in figure 3). The green line shows what happens if monetary policy abandons strict rule-based policy and embarks on a mission to find a new "natural" interest rate that restores the former growth path by continuously reducing the intercept of the Taylor rule equation. This dynamic induces a rising multiplier, another source of growth to demand for a while, keeping the unemployment rate below the equilibrium level implied by slower growth of autonomous demand. However, eventually the interest rate hits the zero lower bound. The permanently lower interest rate influences the level of saving and demand, so output is somewhat higher with the interest rate at zero rather than a positive level dictated by a mechanical Taylor rule. But after the interest rate hits its lower bound, growth converges to the same lower level that obtains without activist monetary policy, unemployment converges to the new, higher equilibrium level, and the level of output falls continuously away from the initial trend.

Figure 4: Negative Demand Growth Shock and March to the Zero Lower Bound



Note: Simulation results following a permanent negative shock to autonomous demand growth as described in the text and the simulation appendix. Blue dotted lines are the benchmark scenario with no monetary policy response. Red lines represent results with Taylor rule monetary policy. Green lines depict results if monetary policy cuts interest rates as long as the unemployment rate remains above the original level, unless constrained by the lower bound.

The problem with the mainstream view that monetary policy can usually solve problems of insufficient demand is that monetary policy affects the level rather than the growth rate of demand.[12] Mainstream, so-called New Keynesian, models do not recognize this problem because

[12] A possible criticism of the idea that an interest rate set by monetary policy affects just the level, rather than the growth rate, of demand could arise from the neo-Kaleckian growth model if interest rates affect the investment-capital ratio. Among other channels, a lower interest rate could raise the profit share of indebted firms and therefore raise growth as in Hein and Stockhammer (2010, equation 17). However, their full analysis does not recommend that monetary policy target growth. Palley (2007) also specifies growth as a positive function of profits. Paraboni (2016) section 1 surveys several models in which interest payments by workers affect capacity utilization and therefore partially determine the investment-capital ratio and growth in the neo-Kaleckian models. However Pariboni (2016, p. 217) concludes these models do "not provide a fully satisfactory tool." In a supermultiplier model, Pariboni (2016) finds, consistent with the results here, that the interest rate affects the long-run level but not the growth rate of output. The debate between the neo-Kaleckian and supermultiplier approaches to demand-led growth is beyond the scope of this paper. In the supermultiplier model presented here, adding effects of the interest rate on either the functional distribution of income or the capital-output ratio would not change the main results.

demand is assumed to converge back to an equilibrium supply-determined path in the long run when wages and prices fully adjust to neoclassical general equilibrium. Monetary policy is mostly a tool to speed that convergence. Therefore, absent a demand shock so large that the zero-lower bound binds, adjusting the level of the interest rate to its "natural" target seems like it should be sufficient. But the supermultiplier model with accommodating supply recognizes that demand growth can be permanently lower than a level that induces full utilization of resources. Weak demand pulls supply down with it. Any attempt to address persistent slow demand growth with monetary policy alone results in an inevitable march to the zero lower bound.

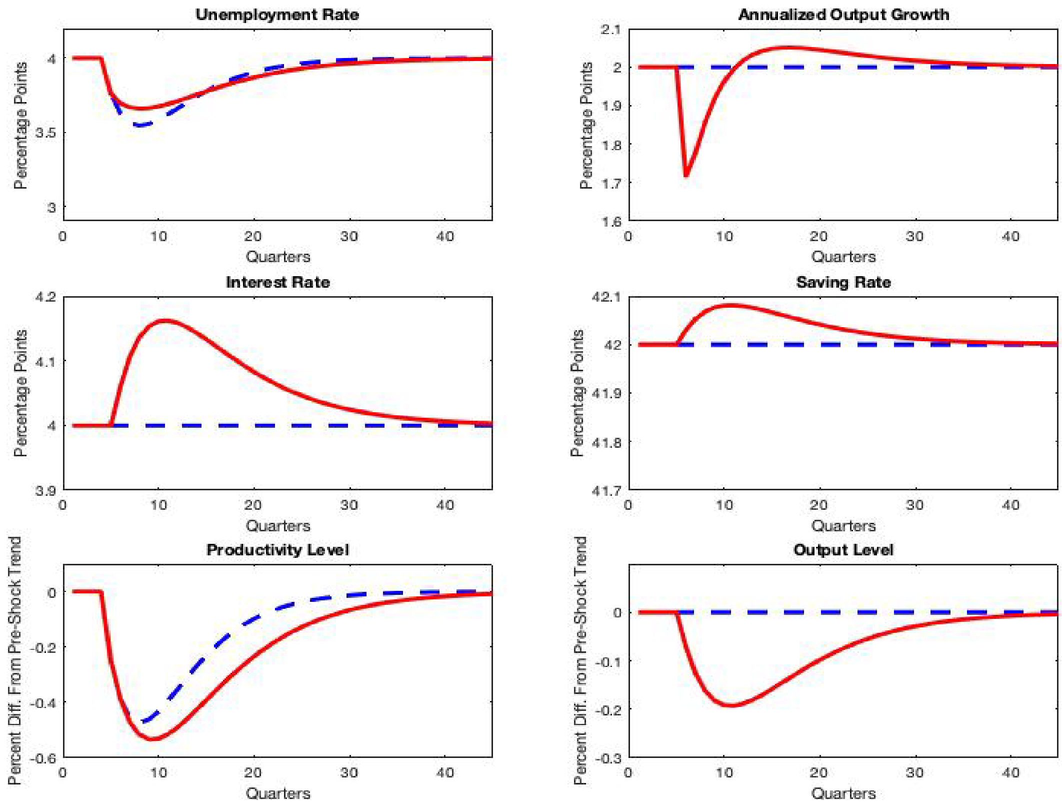
7. Supply Shocks and Monetary Policy

Although the main theme of this article is to explore the basic implications of monetary policy on the demand dynamics of supermultiplier models, the simple model here has a supply side and we can consider how Taylor rule monetary policy affects the economic implications of changes in supply, modeled by shocks to labor productivity (ϕ_0 in equation 2).

A negative productivity shock reduces the unemployment rate in the supermultiplier model because output and employment are driven by demand. If labor is less productive but the demand path does not decline, the unemployment rate falls. Assuming monetary policymakers do not have knowledge about the productivity shock, a falling unemployment rate leads to a higher interest rate which reduces demand. This policy response most likely arises from the fear, or reality, that a lower unemployment rate will raise inflation.

Figure 5 shows the effect of a temporary supply shock initially equal to a quarter percentage point of output that decays with a 0.8 autoregressive coefficient each quarter. Assuming the economy was not initially facing hard supply constraints, there is no need for output to fall, as the blue dotted lines show, because the path of demand has not been affected. But if monetary policy raises the interest rate, aggregate demand and output fall. In addition, a higher interest rate increases unemployment and reduces productivity (red solid lines). Productivity is lower due to the dependence of supply on the path of demand. In the long run, everything comes back to its initial path. But Taylor rule monetary policy, which in this case is probably best interpreted as fighting the threat of inflation following a negative supply shock, slows recovery.

Figure 5: Temporary Negative Supply Shock

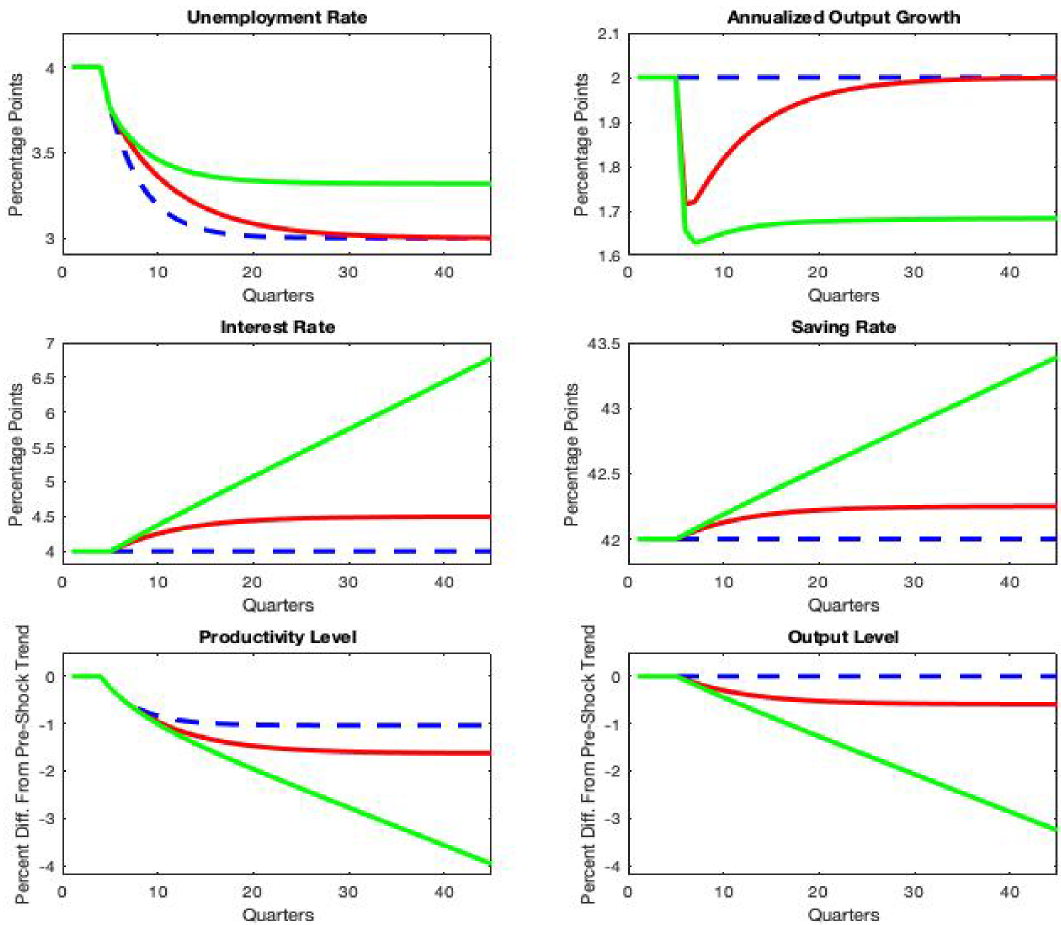


Note: Simulation results following a temporay negative supply shock as described in the text and the simulation appendix. Blue dotted lines are the benchmark scenario with no monetary policy response. Red lines represent results with Taylor rule monetary policy.

Now consider a permanent negative shock to productivity growth. The first thing to recognize is that if autonomous demand growth (g_z) remains constant, the equilibrium unemployment rate will fall. This outcome follows from equation 3 because a permanent reduction in productivity growth reduces ϕ_0. Again, the economic intuition is that the path of demand, initially, has not changed so unemployment falls if labor becomes less productive. Without monetary policy intervention, this initial situation prevails in the long run, that is, the demand and output paths are not affected by the productivity shock as long is the new equilibrium unemployment rate does not fall below a minimum level imposed by labor supply.

The outcome without policy intervention is depicted by the blue dotted lines in figure 6. The red solid lines show the result of the mechanical Taylor rule response if monetary policy continues to target the initial higher unemployment rate, reducing demand and output. In the long run, the unemployment gap in equation 5 converges to a constant and the interest rate ultimately stabilizes. The level of output falls in the long run, but output growth returns to its initial value.

Figure 6: Permanent Negative Supply Shock, Two Monetary Policy Responses



Note: Simulation results following a permanent negative supply shock as described in the text and the simulation appendix. Blue dotted lines are the benchmark scenario with no monetary policy response. Red lines represent results with Taylor rule monetary policy. Green lines depict results if monetary policy raises interest rates as long as the unemployment rate remains below the original level.

But now suppose monetary policy insists on trying to restore the initial, higher unemployment rate despite the fact that the unemployment gap stabilizes because policy is based on the idea that the non-existent "natural" unemployment rate has not declined. Policy strives to find a non-existent "natural" interest rate by continuously raising the policy rate. The outcome is illustrated by the green lines in figure 6. The attempt to raise the unemployment rate is frustrated. Effectively, the continuous rise in the interest rate continuously reduces the multiplier. Aggregate demand growth falls below g_z and the economy converges to a steady-state path with lower output growth, lower productivity growth, and higher unemployment than if monetary policy had not responded to the supply shock. One would suppose that, eventually, the continuous march to higher interest rates would stop despite the inability of monetary policy to return the unemployment rate to its initial level. But this kind of monetary policy could inflict significant economic damage.

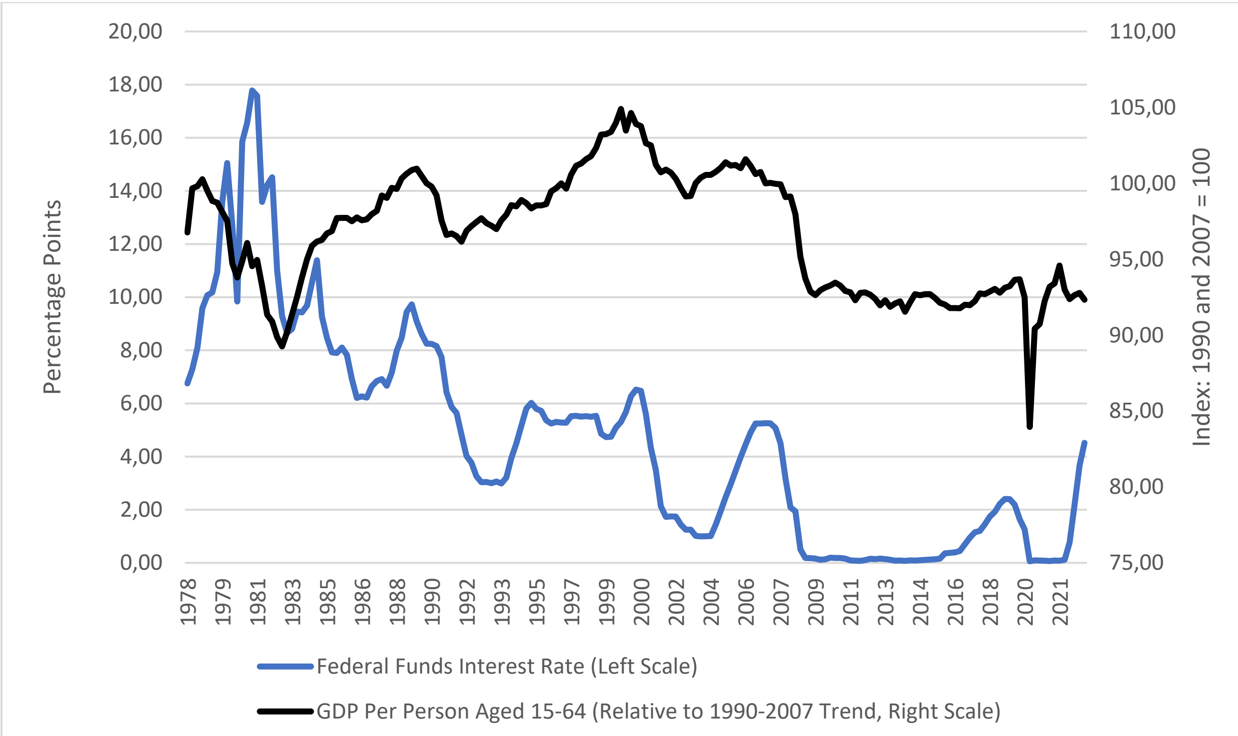
Finally, consider how monetary policy operates when there is a permanent *positive* shock to productivity growth. Any growth theory implies faster productivity growth creates the opportunity for higher standards of living and enhanced absolute economic mobility. In the mainstream view, the economy will "naturally" adjust to a higher growth path in the long run, perhaps with a little help from monetary policy to speed adjustment. According to supermultiplier theory, however, there must be some independent stimulus to demand growth if the economy is to exploit the growth opportunity created by the productivity shock. There is no endogenous process that changes the path of demand so that higher productivity simply leads to higher unemployment. Monetary policy can fight higher unemployment with lower interest rates which may stimulate demand for a while. But, as in the case discussed previously of a negative demand growth shock, the attempt to restore unemployment to its pre-shock level will lead to an inevitable march to the lower bound for the interest rate because the model requires a continuous decline in the interest rate to raise the growth rate of demand.

8. Monetary Policy, Demand-Led Growth, and Recent US Macro History

This section briefly explores how one can interpret recent monetary policy and macro outcomes using the very simple model developed in this paper. Again, the model is much too stylized for a detailed quantitative analysis, but even in this simple form, it provides useful insights.

Figure 7 presents the US effective federal funds interest rate since 1978. This rate is the key policy variable assumed by mainstream conventional wisdom to keep the economy on an entirely supply-determined, full employment path in the long run, at least in the absence of a binding lower bound on the policy rate. The figure also shows an index of US real GDP divided by the working age population (aged 15 to 64). The GDP index is scaled to equal 100 in both 1990 and 2007 and can be interpreted as GDP per potential worker relative to the 1990 to 2007 trend. Two major features are evident in the figure. First, as implied by the mechanical Taylor rule used here to model conventional monetary policy, interest rates are cut aggressively in recessions, at least beginning in the early 1990s.[13] Second, the Federal Funds rate has been on a long-run downward trend, at least until the pandemic (discussed below).

Figure 7: Federal Funds Rate and GDP per Potential Worker Relative to Trend



One can argue that the mainstream approach to understanding short-run monetary policy worked reasonably well in the 1990s. The early 1990s recession was shallow. By the late 1990s, the US economy was booming, perhaps the only true "boom" since the 1960s. It would be reasonable to claim that the US operated close to full employment by 1999. But a good case can also be made that this outcome was not much due to monetary policy. Instead, the strength of the late 1990s US economy can be attributed the enormous business investment boom associated with what came to be known as the technology bubble, which would be interpreted in the supermultiplier model as a positive shock to autonomous demand. While lower interest rates may have helped pull the economy out of the early 1990s slump, interest rates *rose* in the middle 1990s, well prior to the emergence of the late-decade boom.

[13] The interpretation of policy in the 1980s is less clear. The Volcker Fed tried to fight inflation, beginning in 1979, by targeting money supply growth leading to volatile financial conditions and a very deep recession. In the third quarter of 1982, the Fed relented and allowed interest rates to fall, approximately in line with Taylor rule logic. Perhaps the 1980s can be viewed as a transition to a policy regime by the 1990s in which recessions induced substantial cuts in the policy rate.

Following the recession caused by bursting of the tech bubble, monetary policy was again aggressive in an attempt to restore trend growth and low unemployment. But output and employment under-performed during a period often labeled a “jobless recovery.” Even with the policy rate pushed down to an unprecedented low by postwar standards of one percentage point, recovery was sluggish. Although the unemployment rate was reasonably low by 2006, this was not a booming economy. The low interest rates helped fuel a housing bubble that surely strengthened the economy through early 2006, but Fed policy did not seem particularly effective. And the low interest rates contributed to the financial fragility that would soon bring the economy to its knees. Through the lens of the demand-led growth model presented here, even the aggressive monetary policy response to the tech collapse of the early 2000s was not strong enough to restore the booming economy of the late 1990s.

The experience of monetary policy in the Great Recession and its aftermath corresponds most closely with the theoretical perspective presented here. Early in the recession, policymakers believed they could keep the downturn modest with monetary policy.[14] By late 2008, it became clear this was not the case as the policy rate collapsed to zero and the U.S. economy contracted at an alarming rate (-8.5 percent in the fourth quarter of 2008 and -4.6 percent in the first quarter of 2009, annualized rates). However, several quarters of zero interest rates do not necessarily contradict conventional wisdom. A very large demand shock might cause the lower bound on interest rates to bind even though the economy will return to a supply-determined growth path, independent of the path of demand, in the long run. But figure 7 shows the policy rate remained at zero for *seven years* (December 2008 through December 2015). In addition, even though the Fed began to raise its rate target in early 2016, figure 7 also shows that the economy had not recovered anything close to its pre-2007 trend by that time. Consistent with responses to a permanent negative demand shock discussed above, it seems as if the Fed decided that since interest rates had been so low for so long, the economy must have been close to full employment in 2016 and some (unknown) supply shock had pushed the “natural” trend of the economy well below its path prior to the Great Recession. Annualized labor productivity growth fell from 2.6

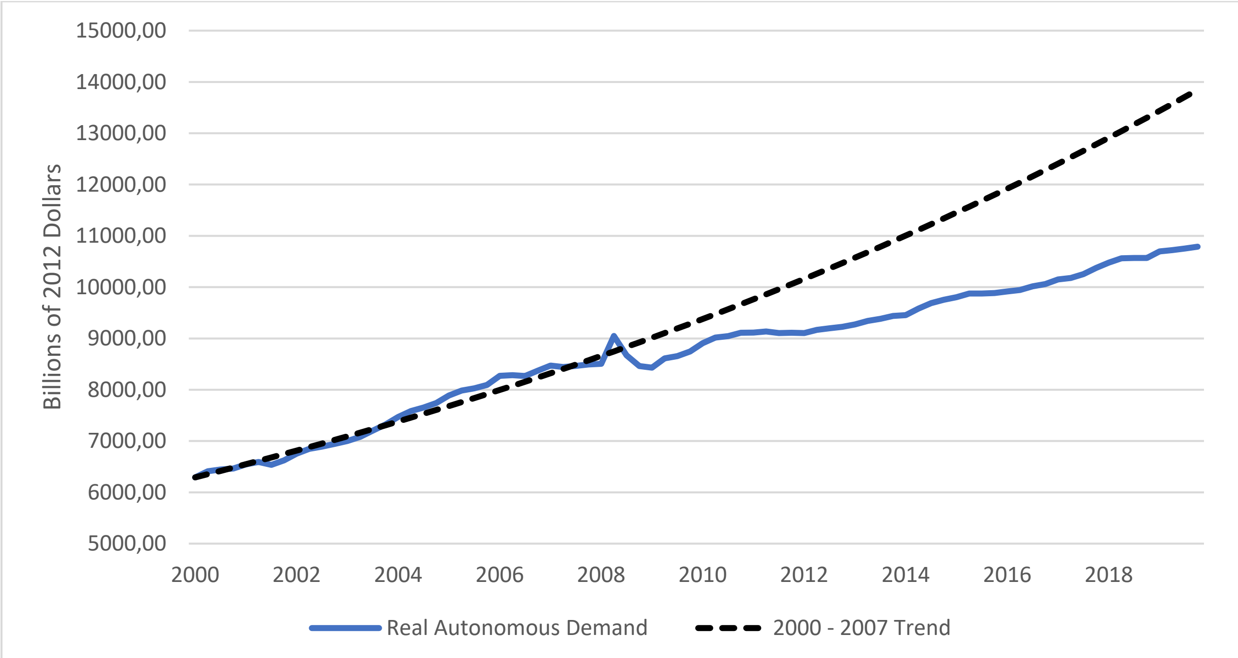
[14] Representative of this view is a statement from Ben Bernanke in the spring 2008 that “monetary and fiscal policies are in train that should support a return to growth in the second half of this year and next year” (testimony to the Joint Economic Committee of the US Congress, April 10, 2008). At that time, fiscal responses to the weakening economy were trivial, Bernanke’s view, consistent with new consensus thinking, had to be that monetary policy would do the job. In reality, the second half of 2008 and early 2009 were disastrous.

percent (fourth quarter of 2000 to fourth quarter of 2007) to 1.4 percent (fourth quarter of 2007 to fourth quarter of 2019).

The interpretation of this history is very different using the simple demand-led growth model presented here. The financial crisis that caused the Great Recession led to a permanent negative shock to demand. Figure 8 shows the dramatic drop in a broad measure of real autonomous demand relative to its trend prior to the Great Recession (from Fazzari and González, 2023; also see a related autonomous demand definition in Summa, et al., 2022). The growth rate of this measure of autonomous demand from 2000 to 2007 was 3.7 percent at an annual rate; from 2007 to 2019 it was just 2.0 percent. A narrow definition of autonomous demand growth that includes just real government spending (including government-financed medical care) fell from 4.3 percent to 1.7 percent over the same periods. With such a massive decline in autonomous demand growth, the simple model predicts conventional monetary policy will push the policy rate to the zero lower bound and keep it there, which happened from 2009 to 2016. There was no need to begin raising interest rates in 2016; there was certainly no sign of accelerating inflation. It seems the Fed simply decided the economy must be at full employment even though GDP was well below the pre-2008 trend.[15]

[15] The headline unemployment rate in 2016 was close to its level prior to the Great Recession. However, broader measures of unemployment and the employment-population ratio showed persistent slack in the labor market.

Figure 8: Autonomous Demand Relative to pre-2007 Trend



Note: Autonomous demand as defined in Fazzari and González (2023) including government consumption and investment (minus some cyclical components such as unemployment insurance), autonomous social spending (primarily government-financed health care), exports, and residential investment.

Finally, briefly consider the monetary policy response to the dramatic economic disruption caused by the covid-19 pandemic. The early stages of the pandemic surely caused enormous contractions in both demand and effective supply. A few months before the pandemic hit, the Fed had already backed off the tentative interest rate increases started in late 2016. It seems there was a recognition that demand was weak even before the pandemic. When the pandemic hit, monetary policy responds quickly. By late spring of 2020, the federal funds rate was again effectively zero where it would remain for almost two years. While this policy likely was implemented with an eye toward stabilizing demand, perhaps the greater motivation, especially in 2020, was to contain financial instability and prop up asset prices. Clearly, unprecedented fiscal stimulus played a much bigger role in containing a demand collapse due to the pandemic, putting the economy on a surprisingly quick path to recovery (although still not to anything approaching the pre-Great Recession trend). In 2022, monetary policy turned aggressively contractionary because of accelerating inflation. That such an aggressive policy has, as of this writing in mid 2023, not caused much of an economic slowdown raises questions about the effectiveness of monetary policy to affect the demand path, an important issue that lies outside the scope of this article but merits further attention in research.

Although the pandemic macro shocks are complicated, these events bear some resemblance to the negative supply shock analysis in the previous section. If one discounts the severe, but very brief, lockdown contraction in the late spring of 2020, the demand path seems largely maintained, no doubt due to massive fiscal stimulus to counteract what otherwise likely would have been a catastrophic reduction in demand. Therefore, output growth relative to trend remains approximately constant over several years. Labor productivity swung wildly early in the pandemic, but since the third quarter of 2020, labor productivity has fallen. The supply shock model predicts a fall in the unemployment rate, other things equal. The headline unemployment rate is about the same as prior to the pandemic. A broader measure of unemployment (U-6) is a bit lower than pre-pandemic. The model here provides reasonable support for the view that the Fed's aggressive interest rate policy since the spring of 2022 is unnecessarily fighting the effects of a supply shock.

The more relevant question is how monetary policy will evolve going forward as the unusually disruptive pandemic and Ukraine war effects fade. The mediocre growth trend from the economic peak in 2007 to the pre-pandemic peak, seems likely to return since there is no clear reason to expect a long-run change in autonomous demand generation. Considering the recent inflation experience, the monetary policy stance in the face of what could still be a "secular stagnation" economy is likely to be interest rates above the zero lower bound. But, as the analysis here shows, this outcome does not mean the economy is fully utilizing its potential. Furthermore, if demand falters, a march back toward the zero lower bound is likely.

8. Conclusion

This paper uses a simple demand-led "supermultiplier" growth model to show that monetary policy that follows a mainstream Taylor rule will be ineffective in addressing permanent negative shocks to the level or, especially, the growth rate of autonomous demand. The basic problem arises from implementing policy guided by a flawed economic model according to which the long-run output path is independent of demand. In a supermultiplier model with accommodating supply, permanent negative shifts in demand permanently lower the output path, but they do not necessarily raise the equilibrium unemployment rate or create long-run "output gaps." Therefore, mainstream monetary policy will not identify the need for demand stimulus, even though resources are wasted.

Furthermore, if demand *growth* declines, monetary policy could drive the interest rate to the zero lower bound even if the stagnation is correctly identified as a weakness in demand. In this case, the problem is that interest rate management can affect the level of demand rather than its growth rate. Therefore, if growth is persistently below a target level that maximizes production and employment, interest rates must fall continuously if monetary policy is the only tool available offset suboptimal growth in autonomous demand. The interest rate will eventually hit its lower bound.

These results raise important doubts about the effectiveness of monetary policy as the first line of defense against insufficient demand. This article makes these points with a very simple, stylized model that does not account for many important details through which monetary policy operates through different components of aggregate demand. A much more developed model is required to assess quantitatively how monetary policy affects an economy led by demand, Barbieri Góes (2023) is an important step in this direction. But adding complexity such as explicit models of interest-sensitive sectors is unlikely to change the basic conceptual results presented here as long as the model retains the feature that demand leads supply and monetary policy affects the level, but not the long-run growth rate, of aggregate demand.

The results here reinforce what I believe is the most important policy message of the burgeoning supermultiplier research program. We cannot assume that long-run growth can be understood by looking at the supply side in isolation. To create a strong economy that operates at or near full employment requires structural features to assure adequate aggregate demand growth. Nominal adjustment is not effective, which seems partially recognized in the mainstream by now as new consensus models propose monetary policy as the primary mechanism to close output and unemployment gaps. But the logical results here, along with even a cursory look at recent history, imply monetary policy cannot do the job. It is possible that discretionary monetary policy can help to offset some undesirable effects of negative, temporary demand shocks. But monetary policy is not well suited to address insufficient demand beyond the short run. Good macroeconomic performance in the 21st century requires attention to policies that ensure strong and sustainable growth of autonomous demand over time horizons extending beyond a few quarters.

This goal requires putting the long-run demand growth implications of fiscal and distributional measures front and center in policy analysis and implementation. Lima et al. (2023) proposes fiscal policy as effective explicitly when monetary policy can no longer do the job. It also implies that monetary policy may be more productively directed to objectives of financial stability and income distribution (see Lavoie, 2014, pages 234-238 and further references there).

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Appendix

Inflation in the Taylor rule

Suppose the policy interest rate depends on both an unemployment gap and an inflation (π) gap, abstracting from the zero lower bound:

$$r_t^{targ} = \gamma_0 - \gamma_1(u_{t-1} - u^*) + \gamma_2(\pi_{t-1} - \pi^*)$$

Add a simple Phillips Curve equation to determine the inflation rate:

$$\pi_t = \beta_0 - \beta_1 u_{t-1}.$$

In principle, the intercept β_0 could include a measure of inflation expectations given exogenously. Plug the Phillips Curve into the interest rate rule:

$$\begin{aligned} r_t^{targ} &= \gamma_0 - \gamma_1(u_{t-1} - u^*) + \gamma_2[\beta_0 - \beta_1 u_{t-1} - \pi^*] \\ &= [\gamma_0 + \gamma_2\beta_0 + \gamma_1 u^* - \gamma_2\pi^*] - (\gamma_1 + \gamma_2)u_{t-1}. \end{aligned}$$

Therefore, the specification in the text according to which the target interest rate responds just to the unemployment gap can capture an inflation effect on interest rates as well that magnifies the effective response of interest rates to unemployment. Intuitively, if the economy is hit by a negative demand shock, unemployment tends to rise and inflation tends to fall. Therefore, if the policy rate responds to both unemployment and inflation the response will be larger than if monetary policy targets unemployment only.

A direct of application of this simple inflation model implies that inflation is independent of monetary policy in the long run because the long-run equilibrium unemployment rate is independent of monetary policy. Such a conclusion, however, would need to be explored in a more developed model that better analyzes both the sources of inflation and the dynamics of inflation expectations.

Simulation Details

The simulations presented in the paper begin with the model in steady state with the growth of autonomous demand set at 2 percent at an annual rate (0.5 percent quarterly). The initial interest rate and unemployment rate are both set at 4 percent. The simulation parameter values are:

Parameter	**Symbol**	**Value**
Monetary rule intercept	γ_0	0.04
Monetary rule effect of interest rate	γ_1	0.50
Interest rate smoothing parameter	λ_r	0.50
Effect of unemployment rate on quarterly productivity growth	ϕ_1	0.25
Saving rate intercept	η_0	0.40
Effect of interest rate on saving rate	η_1	0.50

The intercept of the productivity equation is set to equate initial productivity growth with the initial growth rate of autonomous demand when the unemployment rate is 4 percent. The equilibrium value of the saving rate and the effect of unemployment on productivity are approximately the same as those estimated in an expanded model by Fazzari and González (2023). The implied semi-elasticity of output with respect to a one percentage point change in the interest rate is 1.3 percent, similar to the level estimated from Barbieri Goés (2023) by integrating the impulse-response function for output following a one percentage point shock to the federal funds interest rate.

Shocks are equal to one quarter of one percent of GDP in the fifth simulation quarter. The temporary shock (figure 1) is assumed autoregressive and decays by 20 percent per quarter. The permanent level shock (figure 2) reduces autonomous demand by one quarter percent of GDP indefinitely. The permanent growth rate shock (figures 3 and 4) reduces quarterly g_z by one quarter percent so that annualized growth in autonomous demand falls by one percentage point.

Although the simulation parameters are chosen to reflect plausible values for the US economy, the objective of the simulations is not to provide calibrated quantitative results, but simply to illustrate the broad theoretical predictions from the simple, stylized model. These results are unaffected by parameter choices.

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