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DOI: 10.15290/oes.2023.03.113.05

MONETARY POLICY WITHOUT A FROZEN AGGREGATE SUPPLY CURVE. A LITERATURE REVIEW[1]

Summary

Purpose – The article reviews the literature on the interactions between aggregate demand and aggregate supply. It discusses the relevance of the presented mechanisms for the current economic situation, especially due to the ongoing monetary tightening in major economies.

Research method – The article is based on a review of the literature on the linkages between aggregate demand and aggregate supply shocks.

Results – According to the presented models, heightened corporate debt makes firms more vulnerable to financial shocks, including an unexpected increase in interest rates. As a result, tight credit conditions (due to monetary tightening) may reduce aggregate demand and aggregate supply, with ambiguous effects on general price level and inflation rate.

Originality/value/implications/recommendations – The review summarises the broad but overlooked literature on the links between aggregate demand disturbances and shocks to aggregate supply. The paper's originality lies in its attempt to present the literature in relation to ongoing increases in the policy of interest rates around the world.

Keywords: aggregate demand, aggregate supply, monetary policy, corporate debt.

JEL classification: E2, E4, E5

1. Introduction

The biggest economic challenge that policymakers worldwide face is the worldwide spike in inflation rates. Focusing on the period from January 2022,

[1] Article received on 5.12.2022, accepted on 5.09.2023.

the rates in Germany, Italy, and the United Kingdom peaked at 8.8%, 11.8%, and 11.1%, respectively (all in October 2022), levels not seen since January 1952, March 1984, and January 1982, respectively. The record in the USA (9.1%) was reached in June, the highest it had been since November 1981.[2] To foster disinflation, major central banks (including the FED, the European Central Bank, and the Bank of England) have engaged in monetary tightening.

There are, however, two problems with the strategy adopted by monetary authorities. The first is that it is unclear whether the increased inflation is the result of increased demand only. Agarwal and Kimball [2022] enumerated several causes of the current inflation surge. The demand side includes the post-Covid-19 shift towards durable (postponable) goods, as well as the aggregate stimulus (including both fiscal and monetary measures), combined with economic recovery. The supply side includes supply chain bottlenecks, labour shortages, and shocks to the supply of energy and food due to the Russian invasion of Ukraine. If higher inflation rates are the result of disturbances to both aggregate demand and aggregate supply, the advocated steep increases in interest rates may not be the best policy response (especially when supply-sided effects dominate demand-sided adjustments), as the focus on aggregate demand means that nothing would be done to relax supply constraints.

This article relates to the second type of critique. Regardless of the roots of rampant inflation, tight credit conditions may affect both aggregate demand and aggregate supply. Due to the applied confinement measures and heightened uncertainty during the Covid-19 shock, firms are now much more financially vulnerable. Under such circumstances, increased interest rates may act as a cost-push factor, countervailing the disinflationary effects of the depressed aggregate demand. In other words, tight credit conditions may result in another supply shock, even if the accelerated inflation is driven by aggregate demand. However, reference to such consequences of monetary tightening is rare in policy and popular discussions. What is common is the treatment of monetary policy as influencing aggregate demand only, leaving no impact on supply.

The aggregate supply curve may move for other inflation-related reasons, such as changes in inflation expectations, policy credibility, macroeconomic stability, or wage-price spiral. This article focuses on monetary tightening only, leaving other forces out of the review. However, monetary policy may be said to reinforce these factors; hence the implications of the reviewed models go beyond monetary policy. For instance, if raised policy interest rates contribute to even higher inflation rates due to cost-push effects, a tight monetary policy may boost inflation expectations,

[2] The data are taken from the Bank for International Settlements database [www 1].

undermine the credibility of the monetary authorities and macroeconomic stability, and create a wage-price spiral.

The importance of tight credit conditions for aggregate supply may remain high since firms are still affected by the Covid-19 shock, which caused enormous liquidity problems. For instance, according to the estimates of the European Bank for Reconstruction and Development, around 20%–25% of firms in the emerging Europe are financially vulnerable. The Covid-19 shock provided striking proof of the notion of firm-size bias regarding access to credit. Although outstanding commercial and industrial loans rose substantially in the first quarter of 2020, it was almost entirely caused by higher drawdowns of pre-existing credit lines by large firms. That pattern was also observed by Greenwald, Krainer, and Paul [2020]. The intensity of drawdowns was also studied by Acharya and Steffen [2020], who documented the run on bank credit lines for different types of firms.

After the "dash-for-cash" period, when stabilisation policies were implemented, the highest-rated firms switched more to the capital market. It may reflect the presence of broader liquidity constraints around the Covid-19 shock, as smaller firms with lower financial scores not only face more unfavourable credit conditions, but also find it difficult to issue bonds and raise equity. The importance of credit constraints for different types of firms was also investigated by Chodorow-Reich, Darmouni, Luck, and Plosser [2022]. Using US supervisory loan-level data, they documented several size-related facts. Compared to large firms, small enterprises obtain credit lines with shorter maturity, have less active maturity management, post more collateral, have higher utilisation rates, and pay higher spreads (even conditional on other firm characteristics). All these findings suggest the coexistence of lenders' commitment to large firms and discretion to small firms. Such a pattern also indicates the difficulties small enterprises may encounter when applying for credit, especially in times of financial distress that may stem from increased leverage.

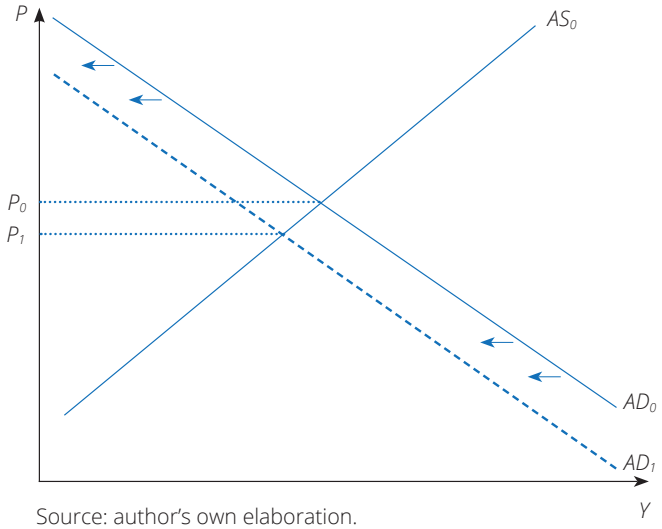
With all these findings, one may question whether the assumption that aggregate demand and aggregate supply shocks are independent is true. This paper presents a literature review of the issue, focusing on monetary policy shocks. It starts with the "textbook treatment" of the policy (Section 2), a view held in many macroeconomic textbooks, including those at the graduate level (such as Romer [2018]). Section 3 analyses the simultaneous impact on both aggregate demand and aggregate supply. Section 4 deals with the possibility that only demand is directly influenced by monetary policy shocks, but aggregate supply is still affected (although indirectly). Section 5 presents the models with the demand-supply loop. Section 6 concludes.

2. Textbook treatment of the effects of monetary policy

The textbook treatment of the effects of monetary policy predicts that an increase in the policy interest rate (or the decline in money supply) reduces the general price level. The standard AD-AS model[3] shows that contractionary monetary policy brings the leftward movement of the aggregate demand (AD) curve (from AD_0 to AD_1 in Figure 1), reducing the price level (from P_0 to P_1). This reasoning is present in Romer [2018], for instance. In Chapter 11 ("Inflation and monetary policy"), the main premise is stated as follows: *inflation is almost always the result of rapid growth of the money supply*. Consequently, monetary tightening lowers (ceteris paribus) the rate of inflation. In an alternative exposition, Bernanke [1995] presented such a view in the form of the following sequence: The monetary authorities initiate open market sales; hence banks reduce their reserves in exchange for bonds. Then, the reduction in money supply raises interest rates. Lastly, higher interest rates raise the cost of funds, depressing the aggregate demand.

FIGURE 1

The effects of monetary tightening (textbook scenario)



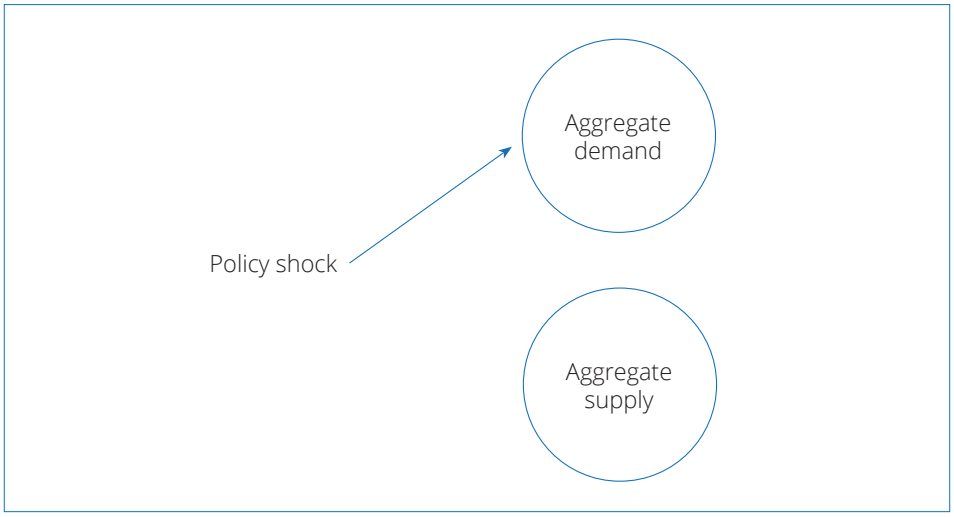
Source: author's own elaboration.

[3] The AD-AS model is used here for illustrative purposes only. It can be argued that it is only a short-run framework and does not apply to long-run analyses. Yet, as the article in the article, many papers challenge the classical dichotomy, suggesting that demand fluctuations may drive long-run output trajectories (e.g., Blanchard, Cerutti, and Summers [2015], Benigno and Fornaro [2018], Furlanetto, Robstad, Ulvedal and Lepetit [2021], and Aikman, Drehmann, Juselius and Xing [2022]). A brief overview of these studies is present in the main text.

In such a scenario, there is no room for any movement of the aggregate supply curve. We may think of it as a case of a frozen curve since it does not change its position. Any impact of a monetary policy shock on prices and economic activity goes through aggregate demand only. It is illustrated in Figure 2 by the arrow that links a policy shock with the demand side of the economy, without any impact on the aggregate supply.

FIGURE 2

The impact of monetary policy shock on the aggregate demand and supply (textbook case)



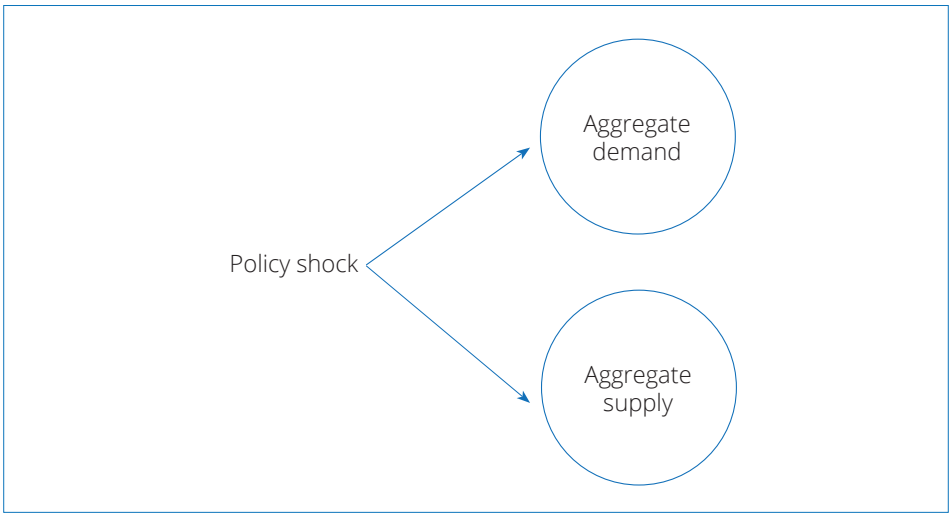
Source: author's own elaboration.

3. When monetary shocks affect aggregate demand and aggregate supply simultaneously

Although recent editions of Romer's textbook make it clear that monetary shocks affect only aggregate demand, the first edition from 1996 includes a more nuanced remark. Chapter 9 (which resembled Chapter 11 from subsequent editions) states: *many shocks affect both curves.* (…) *The overall effect of any shock on the price level depends on how it affects both curves* [Romer, 1996, p. 390]. The simultaneous impact of a policy shock on both aggregate demand and aggregate supply is shown in Figure 3. Using the AD-AS framework (see Figure 4), it is easy to verify that when both curves move leftwards, the price level may remain unchanged (upper panel), fall (middle panel), or even increase (bottom panel).

FIGURE 3

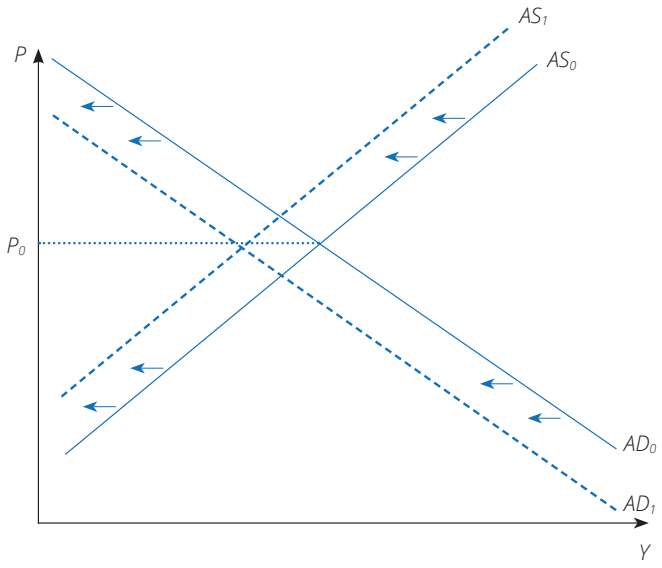
The simultaneous impact of monetary policy shock on the aggregate demand and aggregate supply

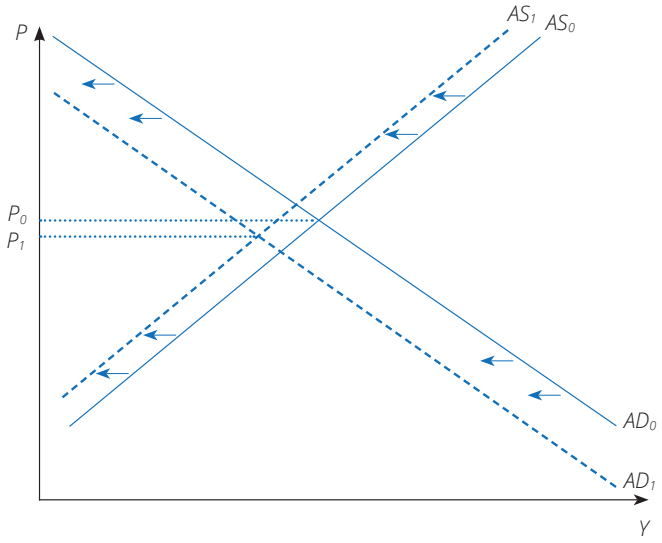


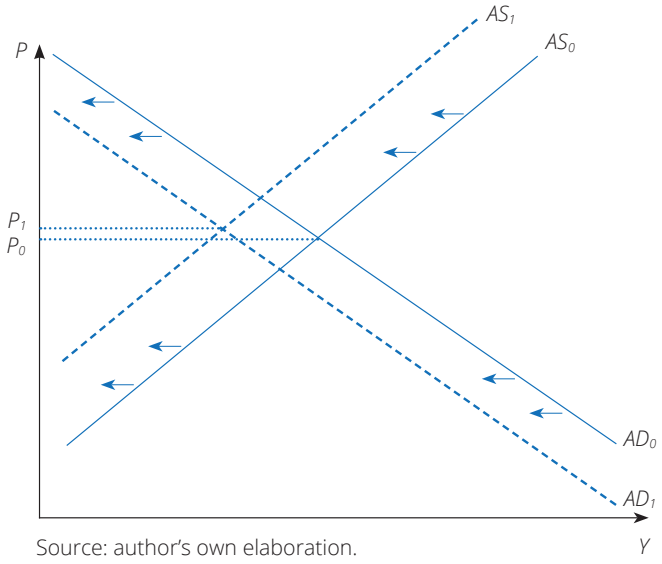
Source: author's own elaboration.

FIGURE 4

The effects of monetary tightening – the simultaneous movement of both curves







Source: author's own elaboration.

Regardless of the exact scenario, the simultaneous movements of both curves mean that the inflation-reducing effect is at least dampened (relative to the conventional scenario with the movement of the AD curve only). While it is ex-ante ambiguous what the price-related consequences of a tight monetary policy

may be, it is unambiguous that the movement of the AS curve exacerbates the output-depressing effects of such policy decisions (compared to the traditional reasoning with only the AD curve being relocated).

The co-movement of both curves may be explained within the "credit view". According to Bernanke [1995], it incorporates two channels. The bank lending channel operates as follows: The monetary authorities reduce banks' reserves through open market transactions. Then, having depleted their reserves, banks lower the supply of loans to firms. Eventually, firms that are credit-dependent decrease planned spending. The second channel (the balance sheet channel) is based on the assumption of information asymmetry, with borrowers having better information than lenders. Consequently, to compensate for the risk, lenders charge a premium, which varies inversely with the firm's net worth.

With such a framework, the channel's sequence may be presented as follows: In the first step, the monetary authorities initiate open market operations, leading to reduced money supply and higher interest rates. Then, with the negative correlation of asset prices and interest rates, firms' net worth is reduced. Next, lower net worth is translated into less collateral for loans, which results in higher lenders' premiums. In the last stage, firms reduce planned spending. Both channels reinforce each other, explaining why monetary tightening may reduce firms' investment expenditures, leading to the leftward movement of the AS curve. The credit view corresponds with the two strands in the literature on financial frictions, as presented by Brzoza-Brzezina and Makarski [2011] and Brzoza-Brzezina, Kolasa, and Makarski [2013]. They divided the literature into models with collateral constraints and external financial premiums. These models emphasise the quantity and prices of loans, respectively.

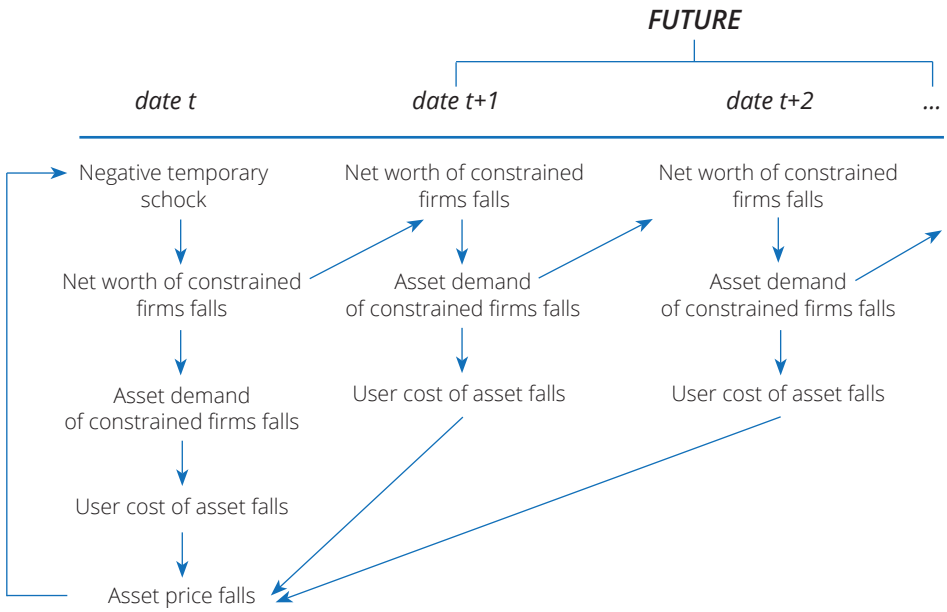
Kiyotaki and Moore [1997] analysed the importance of collateral. They assumed that durable assets, such as land, may serve as both collateral and production input. Credit-constrained (highly leveraged) firms respond to adverse productivity shocks, which reduce their net worth, by cutting back on their investment expenditure. This response includes reducing investment in land, meaning that in the next period, such firms suffer from lower revenue and net worth, exacerbating the problem of credit constraint through the fall in collateral they own. Figure 5 presents the structure and timing of the model.

The bank lending channel may be seen through the lens of credit rationing. One of the most notable models was built by Blinder [1987]. He showed that when monetary policy becomes stricter, credit rationing makes it impossible for constrained firms to meet their desired supply since they cannot finance working

capital, inventories, or fixed capital with bank credit. That drought in investment lowers both the aggregate supply and the aggregate demand, and the relative strength of these effects determines the direction of changes in the general price level. If contraction in supply dominates, then the tight monetary policy becomes inflationary.

FIGURE 5

The Kiyotaki-Moore model



Source: Kiyotaki and Moore [1997, p. 213].

While firms are either financially constrained or unconstrained in most macroeconomic models, in reality, both types of firms may populate a given economy. Such is a premise of the model built by Manea [2020]. Monetary tightening affects constrained firms through various mechanisms. The balance-sheet channel is linked to the reduction in collateral values and increase in the real value of nominal debt. The input price channel leads to lower input prices secured by collateral. At the same time, there are spillover effects since the consequences of monetary tightening for constrained firms also affect unconstrained enterprises through input and output markets (enhancing or dampening the impact of monetary policy).

Regarding the price level, monetary policy may lead to unorthodox consequences, when the reaction of aggregate supply to policy tightening is stronger than the reaction of aggregate demand. Contractionary monetary policy acts through the balance-sheet channel and input-price channel. The former pushes the constrained firm's output and prices downwards and upwards, respectively. The latter has the opposite effect. Unconstrained firms are also affected – through the impact of monetary tightening on consumer spending (direct effect of monetary policy) and the pricing decisions of constrained firms (indirect effect). Ultimately, theory cannot predict a priori what the consequences of contractionary policy may be. For a high enough share of constrained firms, a price puzzle may occur.

Barth and Ramey [2002] provided evidence of the cost channel of monetary transmission. Using data for the US economy from January 1959 to March 2000, they observed that negative monetary shocks act more like technology shocks than demand shocks. For instance, they found that all these disturbances led to a fall in private output, but the trajectory of the price level varied across shocks. While a negative demand shock did not cause any significant price change, monetary and technological disturbances caused an increase (temporary and persistent, respectively). Thus, monetary tightening may be inefficient regarding its power to provide disinflation in a relatively short time horizon. In the short-to-medium run, there was a non-textbook response of prices to monetary tightening (price puzzle). Additional empirical research found that an unanticipated increase in the federal funds rate by 25 basis points increased the general price level. Although the exact results depend on the specification, type of data, and subperiod, no proof of disinflation was found.

4. When monetary shocks affect aggregate supply through aggregate demand

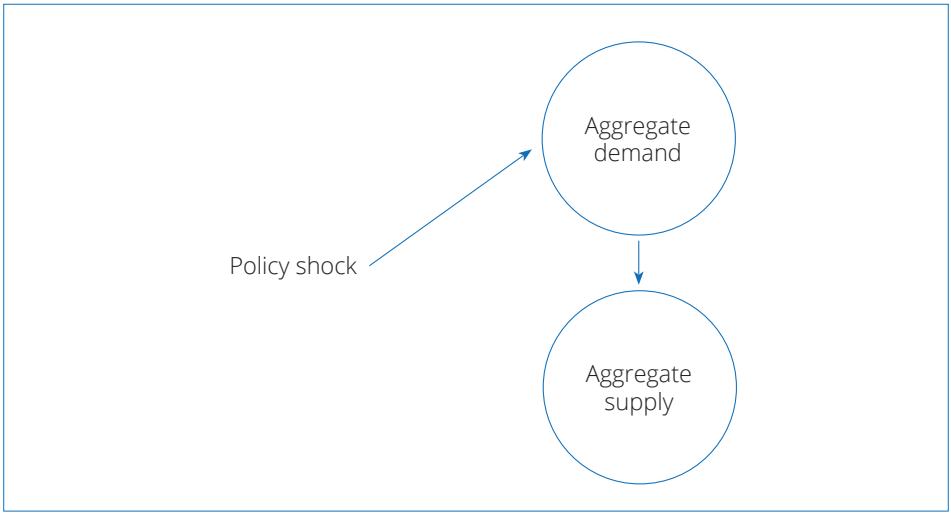
Even if monetary shocks directly affect only aggregate demand, without any direct impact on the supply, it is still possible that changes in demand lead to the movement of the aggregate supply curve. In other words, policy changes could still indirectly impact the economy's production possibilities. It is illustrated in Figure 6 as a chain formed by arrows, going from the shock, through aggregate demand, to the aggregate supply.

The textbook treatment of monetary policy shocks implies that such disturbances are relatively short-lived. Blanchard and Quah [1989] established that in the USA, the shocks to aggregate demand peak after two to four quarters and

completely vanish after three to five years. By contrast, the effects of supply shocks are long-lasting, as their peak is reached after eight quarters; the effect then slightly declines and plateaus. The implication for monetary policy is straightforward – the demand-sided effects of monetary policy should not translate to the supply side of the economy.

FIGURE 6

The indirect impact of monetary policy on the aggregate supply through aggregate demand



Source: author's own elaboration.

However, other studies cast doubt on Blanchard and Quah's [1989] findings. For instance, Furlanetto, Robstad, Ulvedal, and Lepetit [2021] observed that a substantial fraction of long-run GDP fluctuations in the USA is the result of permanent demand shocks: about 50% of the variance in GDP can be attributed to demand disturbances. Importantly, these long-lived effects of demand shocks are concentrated mostly in three recessions (1990–1991, 2001, and 2007–2009). These results are consistent with Blanchard, Cerutti, and Summers [2015], who analysed the consequences of 122 recessions in 23 countries, starting from 1960. According to their estimates, for only 29%-33% of cases were recessions not followed by a sustained gap. In other words, the long-run effects of a recession were obtained for 67%-71% of the cases. Additionally, many of the recessions (31%-34%) were actually characterised by a growing gap (with the gap based on comparing pre- and post-recession trajectories of real GDP growth).

Similarly, Aikman, Drehmann, Juselius, and Xing [2022] analysed the roots and consequences of economic contractions for 24 advanced economies starting from 1970. They found that the most severe recessions created enormous economic costs even ten years later. They were able to classify 198 recessions based on their causes. Importantly, monetary policy shocks were the second culprit, causing 51 recessions, beaten only by banking crises with 100. Regarding the severity of contractions caused by various shocks, no significant differences were detected, as monetary policy tightening led to long-run consequences of similar orders of magnitude as banking crises and oil shocks.

One of the main roots of the long-run importance of demand shocks may be hysteresis, which itself may be caused by several mechanisms. They include the impact on net capital formation (resulting in changes in the productive capacity of a given economy), an effective labour supply (e.g., through an insider-outsider mechanism or skill depreciation), and productivity (e.g., through incentivising R&D efforts or technological upgrading, learning-by-doing considerations, or intersectoral spillover effects). Referring to monetary policy shocks, Kienzler and Schmid [2013] found that monetary tightening may have profound, long-lasting consequences for both the real economy and inflation. These consequences are the function of the degree of hysteresis (defined as the parameter that governs the transmission of the lagged actual output on the present potential output). Monetary tightening leads to a long-run decline in (log) actual and potential output, and the persistence of that effect is more visible for higher degrees of hysteresis.

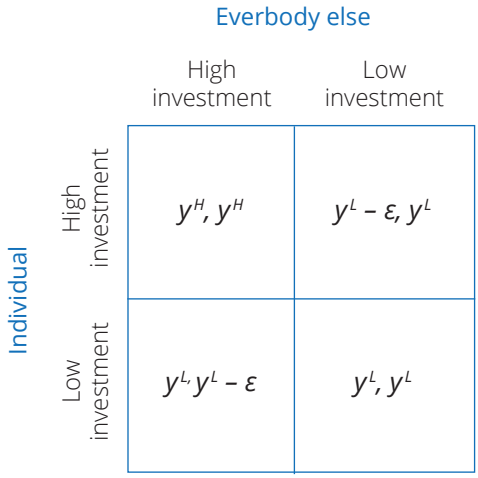
According to the model simulations, the inflation rate initially drops significantly, but then increases, even above the initial level, due to the hysteretic decline of output. This pattern is consistent with the chain logic observed in Figure 6. Since the impact of monetary policy on aggregate supply is indirect, it occurs with a lag, meaning that after some time, the non-textbook behaviour of the inflation rate emerges in response to an increase in the policy interest rate.

Another channel is coordination failure. Murphy, Shleifer, and Vishny [1989] and Acemoglu [2009, Section 21.5] showed that in the presence of aggregate demand externalities, one firm's investment may encourage other firms to invest. As a result, multiple equilibria arise since agents' investment decisions are based on the expected decision of others. A coordinated low investment constrains an economy's productive capacity, while a coordinated high investment does the opposite. Applying this logic to monetary policy, it may be argued that monetary tightening lowers aggregate demand. It may thus adversely affect some firms' investment expenditures, leading to similar decisions from other firms, eventually causing the entire economy to get stuck in a "bad equilibrium" with a slower pace of long-run growth.

This reasoning may be illustrated with the game theory example taken from Acemoglu [2009, Section 4.3.1]. Suppose that two agents (a given individual and the other, whom we can collectively label "everybody else") are engaged in a game with the payoff matrix, as in Figure 7. Each agent can choose between high and low investment outlays. Suppose that high investment is more profitable, hence $y^H > y^L$. Also assume that $\varepsilon > 0$ (ε is a parameter introduced to ensure the existence of two equilibria and can be seen as a reflection of the cost of overinvestment by a single agent in the environment featured by low aggregate demand). This construction of the payoff matrix implies that low investment is more profitable when others also decide to spend less on investment, for instance, due to technological complementarities or demand externalities.

FIGURE 7

The multiple equilibria example



Source: Acemoglu [2009, p. 115].

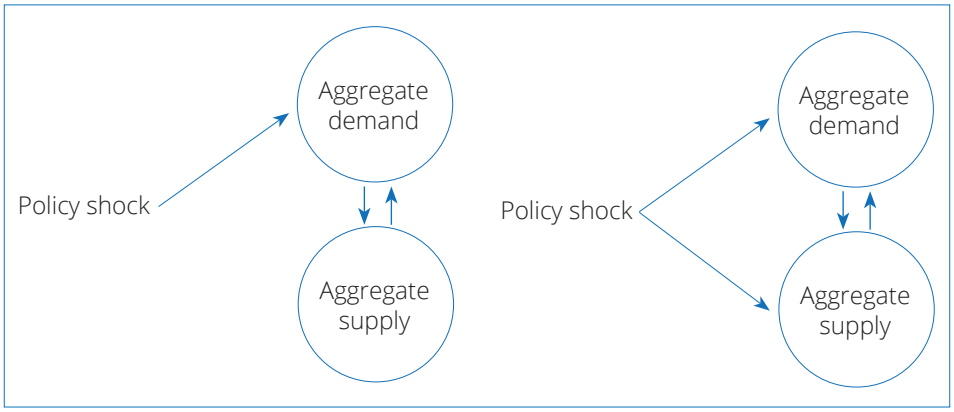
5. When monetary shocks affect aggregate demand and aggregate supply, with the loop

Compared to the models from the previous section, an even more elaborate analysis includes loops. Suppose that a monetary policy shock affects aggregate demand. For now, it does not matter whether there is also simultaneously an aggregate supply (the right panel in Figure 8) or not (left panel). Then, through some channels, like those from the previous section, changes in aggregate demand

lead to an adjustment in the aggregate supply. Next, due to other mechanisms, changes in the supply side of the economy feed back to the aggregate demand, eventually constituting a demand-supply loop.

FIGURE 8

The impact of monetary policy on the aggregate demand and aggregate supply with the demand-supply loop

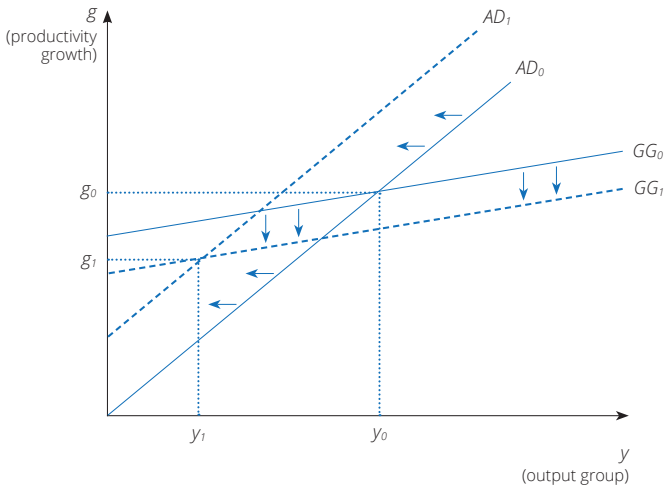


Source: author's own elaboration.

If the strength of demand determines firms' decisions to invest and innovate, no liquidity constraints are needed to explain why firms may cut back on expenditures. This logic can be illustrated using the framework developed by Benigno and Fornaro [2018] and later adjusted to the Covid-19 shock by Fornaro and Wolf [2020]. Figure 9 presents the model. The aggregate demand (AD) curve links demand with productivity through expectations of future income. At the same time, strong aggregate demand enhances innovation and investment; thus, it increases productivity growth, as depicted by the GG curve. The initial equilibrium is determined by the intersection of the AD_0 and GG_0 curves (with the output gap and productivity growth equal to y_0 and g_0, respectively). If the monetary authorities decide to raise the policy interest rate, it shifts the AD curve leftwards (from AD_0 to AD_1). The resulting decline in the output gap the expectations about future income downwards, discouraging investment. Consequently, the GG curve moves from GG_0 to GG_1. The new equilibrium state is achieved, as indicated by point (y_1, g_1). The price effect of such a monetary tightening is ambiguous. On the one hand, a lower output gap relaxes the upward pressure on prices. On the other hand, lower productivity growth pushes inflation up. The net effect depends on the parameter of the Phillips curve.

FIGURE 9

The effects of tight credit in the Benigno-Fornaro model



Source: author's own elaboration based on: Benigno, Fornaro [2018].

It is also possible to consider that the demand-supply loop is caused by mechanisms similar to those described in the previous sections, with an additional link going from the supply side of the economy to aggregate demand. Guerrieri, Lorenzoni, Straub, and Werning [2022] presented a model which predicts that negative supply shocks may affect aggregate demand. They considered a multi-sector economy, where some sectors are affected by a negative disturbance to supply. In the case of complete markets, workers in the affected sectors are perfectly insured, and the contraction in demand occurs only due to complementarity between sectors. Then, workers reallocate their spending towards unaffected sectors, but the reallocation is incomplete, and there is a decline in demand in unaffected sectors. When markets are incomplete, the demand shortage in unaffected sectors is even amplified.

Although the model was built to analyse policy issues linked to the Covid-19 shock, it can be considered a tool for analysing the impact of supply disruptions on aggregate demand. An unexpected increase in the policy interest rates can adversely affect production in some sectors leading to demand shortage in other sectors due to consumption complementarities. Under this scenario, a decrease in aggregate demand may counterbalance the inflationary pressure that stems from supply shortages. The net effect is thus hard to predict a priori.

6. Conclusions

The models and mechanisms presented in the article demonstrate that the assumption of aggregate demand and supply shocks being orthogonal may not be valid. The links between demand and supply may arise mainly through firms' investment decisions. Enterprises heavily exposed to deep or prolonged demand contractions may cut their investment expenditure, with adverse effects on the production capacity of the entire economy. As a result, the co-movement of both aggregate demand and aggregate supply curves makes it hard to predict the consequences for the general price level and inflation rates.

The literature calls for caution when monetary policy decisions are to be made. Monetary tightening may indeed lower aggregate demand, causing disinflation. At the same time, it may increase firm debt, undermining investment decisions or the purchases of inventories, eventually reducing aggregate supply. It may also negatively affect overall supply due to demand-supply interactions. In other words, under serious liquidity constraints of firms and technological or consumption externalities, monetary authorities may engineer stagflation instead of preventing it, as Berthold and Gründler [2013] and Drechsler, Savov, and Schnabl [2023] found.

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