The Feasibility of Coordinating International Monetary Policy Strategies in the Context of Asymmetric Demand Shocks

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Abstract: In the context of the increasing interdependence of countries due to the development of international trade, a relevant question arises as to whether it is necessary to conduct independent monetary policies for each country or whether it is advisable to coordinate these policies. This question becomes a key in the debate on optimal monetary policy strategies in open economies. The aim of this study is to analyze the impact of asymmetric aggregate demand shocks on the appropriateness of monetary policy coordination in a simple stochastic model of two interacting countries. The analysis of equilibrium states of the monetary authorities’ interaction strategies under study was carried out analytically by minimizing the loss function and solving one-period static optimization problems. The equilibrium states of macroeconomics of interacting countries under coordination of monetary policy and in cases of lack of coordination (Nash and Stackelberg equilibrium) in the presence of asymmetric, serially uncorrelated demand shocks have been analyzed. It is proven that the response of inflation to asymmetric demand shocks is smaller in the case of coordinated policy than in the case of non-cooperative policy. The loss function analysis shows that the compensation of demand shocks is found to be more costly in Nash equilibrium than in the case of monetary authority coordination policy. The analysis of the monetary authorities’ interaction strategies showed that the real exchange rate plays an important role in balancing supply and demand in the two economies.

Keywords: coordination policy; Nash equilibrium; real exchange rate; asymmetric shocks; inflation rate; aggregate demand; aggregate output; loss function

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1. Introduction

In the context of the interdependence of the world economy, and in particular international trade, the economic impact between states is only increasing. A state’s policy objectives are shaped not only by its own policy instruments but also by the impact of other countries’ instruments. In light of the increasing interdependence of countries through international trade, a significant question arises: should monetary policy be implemented independently or is it more appropriate to coordinate with other states? In other words, is there a benefit to coordinating international monetary policy? This question becomes central to the debate on the best monetary policy strategies in open economies.

The academic literature has articulated a strong conclusion in favor of a domestically oriented strategy and a commitment to a flexible exchange rate. This conclusion has been
presented both in articles under the Mundell–Fleming framework (Mundell 1961) and in subsequent studies of new open economy models (NOEM) that introduce elements of monopolistic competition as well as nominal price and wage rigidities. In these models, the utility function \( n \) of the household serves as a natural welfare indicator for optimal policy. Under the Mandell–Fleming framework, many researchers argue that the benefits of coordination are likely to be limited because a flexible exchange rate system effectively isolates the impact of external shocks on domestic employment and output (McKibbin 1997). It is also worth noting that the Mandell–Fleming model has the following limitations: stabilization policy is more difficult to implement at fixed exchange rates if short-term capital is immobile and at flexible exchange rates if capital is mobile. This dichotomy implies that no exchange rate system is universally optimal; its efficiency depends on the mobility of capital in the economy (Mundell 1961). Mandell argues that the effectiveness of flexible exchange rates for stabilization purposes depends on the extent to which currency areas correspond to regions of factor mobility. If regions within a country have different levels of factor mobility, flexible exchange rates may lead to instability rather than stabilization. Mandell cautions against the practicality of a flexible exchange rate system in some cases, suggesting that despite its theoretical validity, its implementation may face serious obstacles (Mundell 1961). These include ensuring dynamic stability, avoiding large disruptive exchange rate movements, and maintaining monetary discipline. The model suggests that a fixed exchange rate system is better suited to areas where factors (such as labor and capital) are mobile, while a flexible exchange rate system is more suited to areas between which factors are immobile (Mundell 1961). This distinction further complicates the application of a single policy model in different economic contexts.

That is, according to this concept, the benefits of monetary policy coordination are mostly characteristic of countries belonging to the single currency area. A single currency area is understood as a region in which a single currency or several currencies with a fixed exchange rate are used in relation to each other, and there is also a high degree of mobility of factors of production (Mundell 1961). Thus, it is expected that the implementation of a common monetary policy in the single currency area will make it possible to smooth out shocks of aggregate demand or symmetrical shocks that have a unidirectional impact on the economies of the member countries of the monetary union. This conclusion was empirically confirmed by the example of the countries of the European Monetary System in the work (Oudiz et al. 1984), indicating the importance of taking into account the institutional setting of macroeconomic policy. However, recent empirical studies have shown that in practice, monetary policy shocks may exert different effects in specific member countries of single currency areas (Cavallo and Ribba 2015; Shumba and Mukorera 2023); that is, the shocks are asymmetrical.

The specificity of asymmetric shocks lies in their different impact on the transmission mechanism of monetary policy compared to symmetric shocks. The relevance of studying the impact of these shocks on the economy lies in the fact that the symmetry or asymmetry of the response of inflation and output to a contractionary or stimulating change in monetary policy has important consequences for the choice of macroeconomic policy. The size of the asymmetry reflects, in particular, the effectiveness of monetary policy in regulating inflation.

It is important to note that the possibilities of smoothing out asymmetric shocks by coordinating international monetary policy have not been practically studied by scientists. Thus, the NOEM literature has shown that while the benefits of coordination are theoretically possible, they are quantitatively small (Obstfeld and Rogoff 2000; Obstfeld and Rogoff 2002; Corsetti and Pesenti 2005). Previous studies mainly focused on the impact of asymmetric monetary policy shocks on the economies of different countries (Ball and Mankiw 1994; Smets and Wouters 2007). The coordination of monetary policy in open economies has not been studied.
At the same time, a discussion about the feasibility of coordinating international monetary policy is of not only academic but also practical interest in the context of the development and implementation of macroeconomic policy programs necessary for preventing crises, increasing macroeconomic stability, and eliminating macroeconomic imbalances.

In this regard, the purpose and scientific novelty of the paper are to analyze the impact of asymmetric shocks on the feasibility of coordinating monetary policy within a simple model of two interacting countries. The objective of the study is to find the equilibrium states of the macroeconomics of interacting countries in the coordination of monetary policy and in the absence of coordination (Nash equilibrium) in the presence of asymmetric demand shocks. The practical significance of the results obtained is the development of directions to stabilize the economy by creating buffers against external shocks.

The rest of the paper is structured as follows: Section 2 presents a literature review on the feasibility of coordinating international monetary policy in the presence of shocks. Section 3 presents a simple stochastic model of two interacting countries. In Section 4, the results of the analysis of the impact of asymmetric shocks of aggregate demand on the expediency of monetary policy coordination are presented. Section 5 concludes the paper.

2. Literature Review

The impact of the consequences of the implementation of monetary policy instruments in a large open country on macroeconomic indicators of a small open economy has been studied in depth by scientists and widely tested on empirical data. It is believed that the realization of the task of achieving macroeconomic stability by the monetary authorities of large open countries leads to a weakening of small ones, and the relative size of the participating countries is a dominant factor that determines the feasibility of policy coordination (Sugandi 2020). Thus, it seems fair that “The uncoordinated pursuit of national policies, determined in political economy equilibrium, can create negative externalities for other nations, and thus can lead to a collectively inferior outcome.” (Frieden and Broz 2012, p. 83).

At the same time, there is still no single point of view in the academic literature on the coordination of international monetary policy. There are many paradoxes and a wide variety of points of view on the potential benefits and costs of cooperation schemes between countries. Many analytical results lead to contradictory conclusions. Obstfeld and Rogoff (Obstfeld and Rogoff 2000; Obstfeld and Rogoff 2002) argue that “lack of coordination in rule setting is a second-order problem compared with the overall gains from macroeconomic stabilization” (Obstfeld and Rogoff 2002, p. 503) and within the frames of the general equilibrium model under which coordinated and uncoordinated (according to Nash) monetary policy lead to the same result. This finding stands in contradiction with studies in the field such as (Canzoneri and Henderson 1992), which not only highlighted the possibility of reaping benefits from international political cooperation but also indicated that attempts to internally integrate such benefits may not be effective in a certain sequence of private sector-related actions.

Similarly, in the articles by (Sugandi 2020; Canzoneri and Henderson 1992; Canzoneri et al. 2005; Dedola et al. 2013; Caldara et al. 2024), the basic result of Obstfeld and Rogoff is not conclusive. For example, the authors of certain publications (Canzoneri and Henderson 1992; Canzoneri et al. 2005) argue that in general equilibrium, the opportunities to benefit from cooperation are enhanced compared to the Mandell–Fleming results in the traditional literature. These statements hold true for models of policy coordination that include monopolistic competition and nominal inertia when two countries interact across multiple sectors. The paper by (Sugandi 2020) proves that the outcomes of multilateral monetary policy coordination are better than those of bilateral coordination. In the work by (Caldara et al. 2024), it is demonstrated that gains and
financial spillovers from cooperation vary depending on the state of the economy and the severity of adverse shocks.

The paper by (Chari and Kehoe 1990) notes that the results of coordination largely depend on whether the central bank in the monetary union will be able to act before the national financial authorities, since this mechanism helps to prevent pressure to monetize the national deficit associated with failures of coordination of the private sector within countries and their connection with the single monetary credit policy. The paper by (Imisiker and Tas 2019) emphasizes, on an empirical level, that communication between central bank managers contributes to the coordination of international monetary policy.

The study by (Liu and Pappa 2005) presents a new argument supporting international monetary policy coordination based on aspects of structural asymmetry across countries. In an economy with two sectors—traded and non-traded—in each country, coordination can potentially increase welfare because the collective planner accounts for terms-of-trade externalities that independent central banks tend to ignore. The planner creates a terms-of-trade bias in favor of a country with a larger trading sector. The benefits can be large and increase with the degree of structural asymmetry. However, when structures between countries are symmetric, the benefits are quantitatively small.

In the paper by (Haizhen and Kaiyang 2019), asymmetric information is introduced into the open economy model of the two countries, and the impact of various information exchange and coordination strategies on the volatility of production and inflation is analyzed and compared. As a result of the study, it was concluded that a country with information advantages should share its economic forecast with the other side.

The impact of shocks on the interaction strategy of monetary authorities has been investigated in a few publications. (Corsetti et al. 2011) consider how news shocks affect global monetary policy under optimal cooperation, but do not compare this policy with optimal non-cooperative policy. That said, news shocks in the presence of private information by the policymaker about his intentions can affect cooperation outcomes, as shown in the models of (Bacchetta and Wincoop 2006; Bacchetta and Wincoop 2013).

Publications on new classical and Keynesian models study different types of shocks—technology shocks, preference shocks, and monetary policy shocks (Kydland and Prescott 1982; An and Schorfheide 2007; Sims 2002), but these types of shocks are not included in the policy coordination literature. Exceptions are the works of (Coenen et al. 2008; Benigno 2002), which compare economic performance under cooperation and under a Nash policy game for some of these sources of shocks.

Finally, another type of shock that has recently gained prominence is uncertainty shock. Uncertainty shocks can have effects very similar to aggregate demand shocks. This point has been noted for closed economies (Basu and Bundick 2012; Leduc and Liu 2015). The effects of uncertainty shocks in emerging economies have been investigated (Carriere-Swallow and Céspedes 2013), but no study has examined optimal monetary policy with or without cooperation in the presence of uncertainty shocks. It is possible that monetary policy is itself a source of uncertainty, and perhaps cooperation can reduce this uncertainty.

A review of the literature on the topic of macroeconomic policy coordination also revealed many publications emphasizing the importance of coordination between monetary and fiscal policies, as well as between trade and monetary policies. In particular, it is proven that the lack of coordination between the Ministry of Finance and the Central Bank may lead to economic imbalances and prevent the implementation of national priorities (Saleh et al. 2023; Fedajev et al. 2023; Das and Song 2022). In addition, the importance of monetary policy in managing the economic effects of tariff shocks is shown (Bergin and Corsetti 2023; Auray et al. 2024; Fornaro and Romei 2023).

The literature review indicates the absence of a unified point of view on the expediency of international monetary policy coordination, including in the presence of asymmetric shocks. Therefore, it is especially relevant to find the equilibrium states of the macroeconomics of the interacting countries in the coordination of monetary policy and
in the absence of coordination in the presence of asymmetric shocks of supply and demand.

3. Description of the Stochastic Model of Two Interacting Countries

In this article, the model of the two countries proposed in the work of (Walsh 2003) is used to analyze equilibrium conditions in the coordination of monetary policy and in the absence of coordination. This open economy model is applicable in a situation where nominal wages are fixed, which means that unexpected fluctuations in inflation affect real output, and the inflation rate is treated as a variable maintained by the monetary authorities. Its advantage is the possibility of an analytical solution to the set of problems.

Below, we describe the model in more detail. All variables in the system of Equations (1)–(5) are logarithmic deviations from the stationary state. Variables with an asterisk refer to the foreign economy.

Equations (1) and (2) are the equations of aggregate supply for the domestic and foreign economies:

\[ y_t = -b_1 \rho_t + b_2 (\pi_t - E_t \pi_t) + \epsilon_t \]  
\[ y_t^* = b_5 \rho_t + b_6 (\pi_t^* - E_t \pi_t^*) + \epsilon_t^* \]  

Equations (3) and (4) are the aggregate demand equations for these economies.

\[ y_t = a_1 \rho_t - a_2 r_t + a_3 y_t^* + u_t \]  
\[ y_t^* = -a_1 \rho_t - a_2 r_t^* + a_3 y_t + u_t^* \]  

Equation (5) characterizes the condition of uncovered interest rate parity:

\[ \rho_t = r_t^* - r_t + E_t \rho_{t+1} \]  

Variables \( y_t, y_t^* \) characterize the volume of output in the domestic and foreign economies (in fact, the variables \( y_t, y_t^* \) are, to a first approximation, the output gap, since all model variables are expressed as logarithmic deviations from the stationary state), \( \pi_t, \pi_t^* \) the level of inflation, and \( r_t, r_t^* \) the real interest rates in the studied economies of the two countries. The variable \( \rho_t \) denotes the real exchange rate, which is defined as the purchasing power of the national currency with respect to foreign goods. An increase in this variable leads to a depreciation of the national currency in real terms and a decrease in the total output of the domestic economy (according to Equation (1)), caused by an increase in the prices of imported components. At the same time, real exchange rate appreciation due to the depreciation of the domestic currency shifts consumption from foreign to domestic output (Equation (3)). The operator \( E_t \) characterizes the rational expectations of economic agents. To analyze the role of stabilization policy, serially uncorrelated supply shocks \( \epsilon_t, \epsilon_t^* \) and demand shocks \( u_t, u_t^* \) were included in the system of equations under study. In addition, the assumption of mutual correlation of shocks is also valid to be able to distinguish between common shocks affecting both economies (inclusion of a common shock in both demand equations) and asymmetric shocks to one economy. But this assumption does not lead to a change in the results of the study.

The coefficients \( b_1, a_1, a_2, a_3 \) are calibrated based on the elasticities of domestic supply and demand at the real exchange rate, real interest rate, and foreign demand. The coefficient \( b_2 \) is negative and is associated with a positive inflationary shock in production costs. This coefficient is subject to variation in this research.

It should be noted that in the paper by (Walsh 2003), the stabilization policy (coordination of monetary policy, its absence) was considered only in the presence of symmetrical supply shocks. Therefore, it is of interest to consider this policy in the presence of asymmetric shocks.

Further analysis will require expressions for the equilibrium real exchange rate and output in the economies of the two countries. The solution of the model represented by
the system of Equations (1)–(5) allows us to find an equilibrium real exchange rate (Walsh 2003). To determine the real exchange rate, we first subtract foreign domestic demand (Equation (4)) from domestic aggregate demand (Equation (3)), using Equation (5) to eliminate the difference \((r_t - r^*_t)\). We get the expression for \((y_t - y^*_t)\). Next, we subtract foreign aggregate supply (Equation (2)) from domestic supply (Equation (1)) to obtain the second expression for \((y_t - y^*_t)\). After which, we equate the two expressions for \((y_t - y^*_t)\) and obtain the equation for the equilibrium real exchange rate:

\[
\rho_t = \frac{1}{B} \left\{ b_2 (1 + a_2) \left[ (\pi_t - E_{t-1} \pi_t) - (\pi^*_t - E_{t-1} \pi^*_t) \right] + (1 + a_3) (\epsilon_t - \epsilon^*_t) - (u_t - u^*_t) + a_2 E_t \rho_{t+1} \right\}
\]

(6)

where \(B \equiv 2a_1 + a_2 + 2b_1(1 + a_3) > 0\).

The work by (Walsh 2003) proves that with serially uncorrelated shocks, the expected future real exchange rate \(E_t \rho_{t+1} = 0\) for any bubble-free solution.

Substituting (6) into the equations of aggregate supply (1) and (2), one can obtain expressions for equilibrium output volumes:

\[
y_t = b_2 A_1 (\pi_t - E_{t-1} \pi_t) + b_2 A_2 (\pi^*_t - E_{t-1} \pi^*_t) - a_2 A_3 E_t \rho_{t+1} + A_1 \epsilon_t + A_2 \epsilon^*_t + A_3 (u_t - u^*_t)
\]

(7)

\[
y^*_t = b_2 A_2 (\pi_t - E_{t-1} \pi_t) + b_2 A_1 (\pi^*_t - E_{t-1} \pi^*_t) + a_2 A_3 E_t \rho_{t+1} + A_2 \epsilon_t + A_1 \epsilon^*_t + A_3 (u_t - u^*_t)
\]

(8)

where \(A_1 = \frac{2a_1 + a_2 + b_1(1 + a_3)}{B} > 0\), \(A_2 = \frac{b_1(1 + a_3)}{B} > 0\), \(A_1 + A_2 = 1\), \(A_3 = \frac{b_1}{B} > 0\).

Note that Equations (6)–(8) are valid for symmetric and asymmetric shocks of aggregate supply and demand. It follows from Equations (7) to (8) that an asymmetric demand shock (as opposed to a symmetric one) in the foreign economy affects output in the domestic economy. The analysis of these equations is presented in detail in the publication by (Walsh 2003). In this paper, the analysis of the monetary policy coordination between the two countries and the case of its absence (Nash equilibrium) was carried out only for symmetric serially uncorrelated supply shocks while optimizing (minimizing) the loss function depending on the variation of output and inflation. The main conclusion of the author (Walsh 2003) is that the reaction of the stabilization policy of the monetary authorities to the shock of aggregate supply is weaker in the absence of coordination than in its presence. As a result, fluctuations in output become more noticeable in the absence of coordination. Since the responses of output and inflation to the symmetric shocks under consideration are symmetric in Nash equilibrium, the real exchange rate shows no response to supply shocks in the case of symmetric influences.

4. Analysis of the Impact of Asymmetric Aggregate Demand Shocks on the Feasibility of Monetary Policy Coordination

As mentioned earlier, the effectiveness of stabilization policy is assessed by minimizing the loss functions \(V_t, V^*_t\) for the domestic and foreign economies, which depend on changes in output and inflation:

\[
V_t = E_t \sum_{i=0}^{\infty} \beta^i \left( \lambda y^2_{t+i} + \pi_{t+i}^2 \right)
\]

(9)

\[
V^*_t = E_t \sum_{i=0}^{\infty} \beta^i \left[ \lambda (y^*_{t+i})^2 + (\pi^*_{t+i})^2 \right]
\]

(10)

where \(\beta\) is the discount factor parameter, \(\lambda\) is the weight given to fluctuations in output relative to fluctuations in inflation.

The basic concept in Equations (9) and (10) is that the monetary authority seeks to minimize fluctuations in output and inflation near the steady state. In contrast to the publication (Walsh 2003), this article examines the stabilization policy of monetary authorities in the case of asymmetric, serially uncorrelated demand shocks. The choice of demand shocks is caused by the fact that with these shocks, it is possible to clearly show
the difference between stabilization policy with the coordination of monetary authorities and in its absence.

4.1. Stabilization Policy under the Monetary Authority’s Coordination and Asymmetric Shocks of Aggregate Demand

With a coordinated stabilization policy, the loss functions (9) and (10) are reduced to the following sequence of single-period static optimization problems (since there are no connections between time periods):

$$
\min_{\pi_t, \pi_t^*} \left\{ \frac{1}{2} (\lambda y_t^2 + \pi_t^2) + \frac{1}{2} [\lambda (y_t^*)^2 + (\pi_t^*)^2] \right\} 
$$

under conditions (7) and (8).

First-order conditions for inflation rates $\pi_t, \pi_t^*$ are written in the following forms:

$$
\lambda b_2 A_1 y_t + \pi_t + \lambda b_2 A_2 y_t^* = 0 
$$

$$
\lambda b_2 A_1 y_t^* + \pi_t^* + \lambda b_2 A_2 y_t = 0 
$$

Substituting expressions for output volume (7) and (8) into Equations (12) and (13), we find the differential and the sum of inflation rates for the two countries:

$$
\pi_t - \pi_t^* = \frac{-2\lambda b_2 H A_2 (u_t - u_t^*)}{1 + \lambda b_2 H^2}, \quad H = A_1 - A_2 
$$

$$
\pi_t + \pi_t^* = 0 
$$

Equation (15) implies that the average inflation (mathematical expectation) of the two countries does not depend on demand shocks; it will depend on supply shocks, which are not considered in this paper. However, inflation in each country reacts differently to asymmetric demand shocks, which is a consequence of coordination policies.

It follows from Equations (14) and (15) that in cooperative equilibrium:

$$
\pi_{c,t} = \frac{-\lambda b_2 H A_3 (u_t - u_t^*)}{1 + \lambda b_2 H^2}, \quad \pi_{c,t}^* = -\pi_{c,t} 
$$

$$
\pi_{c,t} + \pi_{c,t}^* = 0 
$$

Similar calculations for output volumes in the two countries show that in a cooperative equilibrium

$$
y_{c,t} = \frac{A_3 (u_t - u_t^*)}{1 + \lambda b_2 H^2}, \quad y_{c,t}^* = -y_{c,t} 
$$

The result from Equation (16) is that the more weight $\lambda$ is assigned to output in the loss functions (9) and (10), the more inflation should respond to asymmetric demand shocks and the more stable the output should be. It is interesting to compare the results obtained with similar results at equilibrium in the absence of stabilization policy coordination in the two countries.

4.2. Stabilization Policy without Coordination of Monetary Authorities and Asymmetric Shocks of Aggregate Demand

The stabilization policy in the absence of the monetary authorities’ coordination presupposes the choice of the form of strategic interaction between the monetary authorities of the two countries. Below, the proposed paper investigates in more detail the form of interaction corresponding to the Nash equilibrium, in which monetary authorities in each country choose the rate of inflation in order to minimize losses, given a given rate of inflation in the other country. To a lesser extent, we consider the Stackelberg interaction strategy, where one country acts as a leader relative to the other.
With a strategy consistent with the Nash equilibrium, the domestic monetary authority solves the following one-period optimization problem for a given inflation rate \( \pi^*_t \):

\[
\min_{\pi_t} \left\{ \frac{1}{2} (\lambda y^2_t + \pi^2_t) \right\},
\]

under conditions (7) and (8).

Monetary authorities in a foreign country solve a parallel problem of minimization at a given rate of inflation \( \pi^*_t \):

\[
\min_{\pi_t} \left\{ \frac{1}{2} A(y^2_t) + (\pi^2_t) \right\},
\]

under conditions (7) and (8).

The conditions of the first order for the domestic monetary authorities are as follows:

\[
\lambda b_2 A_1 y_t + \pi_t = 0.
\]  \tag{20}

Accordingly, for the monetary authorities of a foreign country:

\[
\lambda b_2 A_1 y^*_t + \pi^*_t = 0
\]  \tag{21}

Taking into account (7) and (8) and finding the sum and difference of inflation rates in domestic and foreign economies, we obtain:

\[
\pi_t - \pi^*_t = -\frac{2\lambda b_2 A_1 A_3 (u_t - u^*_t)}{1 + \lambda b_2^2 A_1 H}
\]  \tag{22}

\[
\pi_t + \pi^*_t = 0
\]  \tag{23}

It follows from Equations (23) and (24) that in cooperative equilibrium:

\[
\pi_{N,t} = -\frac{2\lambda b_2 A_1 A_3 (u_t - u^*_t)}{1 + \lambda b_2^2 A_1 H}, \pi^*_{N,t} = -\pi_{N,t}.
\]  \tag{24}

Similar calculations for output volumes in the two countries show that at Nash equilibrium (in the absence of coordination):

\[
y_{N,t} = \frac{A_3 (u_t - u^*_t)}{1 + \lambda b_2^2 A_1 H}, y^*_{N,t} = -y_{N,t}
\]  \tag{25}

It should be noted that the reaction of inflation to asymmetric demand shocks is less in the case of coordinated policies than in the case of non-cooperation policies, as can be seen, for example, by comparing coefficients in equilibrium terms for \( \pi_{N,t} \) (Equation (16)) and \( \pi_{N,t} \) (Equation (24)):

\[
\frac{\lambda b_2 H A_3}{1 + \lambda b_2^2 H^2} < \frac{\lambda b_2 A_1 A_3}{1 + \lambda b_2^2 A_1 H}
\]  \tag{26}

this inequality always holds, given that \( H < A_1 \), as far as \( H = A_1 - A_2 \) and \( A_1, A_2 > 0 \).

To explain this result, it should be borne in mind that both with a coordinated policy of the monetary authorities and in its absence in the presence of asymmetric shocks (in this case, demand shocks), the real exchange rate does not remain unchanged. With a negative demand shock under both policies of the monetary authorities, the real exchange rate increases according to Equation (6) due to an increase in the rate of inflation in the domestic economy. But the difference between both policies lies in the fact that in Nash equilibrium, the inflation rate in the foreign economy is set, and in equilibrium, when coordinated, it is a variable of choice of the monetary authorities. Therefore, the monetary authorities of a foreign country, in order to stabilize demand in their economy, will increase the inflation rate and thereby smooth out fluctuations in demand in their country by reducing the real exchange rate (Equation (4)). At the same time, demand is stabilizing in the domestic economy (Equation (5)). Such a reaction by foreign authorities is absent in a policy without coordination, and therefore the reaction of inflation to asymmetric
demand shocks is less in the case of a coordinated policy than in the case of a policy of non-cooperation.

To explore the potential role of the coordination policy, it is possible to evaluate the loss function of domestic monetary authorities within the framework of two policies. Substituting the equilibrium values (16) and (17) into the one-period loss function under the coordination of monetary authorities, we obtain:

$$V_{c,t} = \frac{1}{2} \left( \frac{\lambda A^2}{1 + \lambda b^2_H} \right) \left( \sigma^2_d + \sigma^2_u \right)$$

where $\sigma^2_d, \sigma^2_u$ — the variance of demand shocks in the domestic and foreign economies, respectively.

Similarly, substituting the equilibrium values (24) and (25) into a one-period loss function in the absence of coordination (Nash equilibrium):

$$V_{N,t} = \frac{1}{2} \left( \frac{\lambda A^2 (1 + \lambda b^2 A^2)}{(1 + \lambda b^2 A^2 H)^2} \right) \left( \sigma^2_u + \sigma^2_u^* \right)$$

Comparing (27) and (28), it can be concluded that the policy of monetary authorities in the absence of coordination is more expensive than in its presence. To do this, the following inequality must be satisfied:

$$V_{N,t} > V_{c,t}$$

which is true when the following ratio is fulfilled:

$$\frac{1 + \lambda b^2 A^2}{(1 + \lambda b^2 A^2 H)^2} > \frac{1}{1 + \lambda b^2_H}$$

It is easy to verify that this inequality is respected under all the restrictions imposed on the coefficients $H, A_1$ and $A_2$ (Figure 1).

It is of interest to check how the loss functions depend on the parameter $b_2$, which characterizes the magnitude of the inflationary shock (Equations (1) and (2)). According to (Kontorovich 2001; Kudrin 2006), the values of the coefficients of the model are assumed to be equal: $b_1 = 0.2$, $a_1 = 0.35$, $a_2 = 0.77$, $a_3 = 0.5$. It is worth noting that the values of these coefficients were obtained using Russian statistical data. However, the conclusions drawn for a specific country are valid for other countries, since the equations of aggregate supply and demand (1)–(5) are valid for the economies of these countries. The described model is applicable to various countries in which nominal wages are set in advance, and therefore inflation shocks affect real output. Figure 1 shows the dependence of the loss functions on the value of the inflationary shock $b_2$, according to which, in the presence of a coordination strategy, the loss function decreases monotonously with an increase in the parameter $b_2$. With a strategy corresponding to the Nash equilibrium, this function has a parabolic form. Thus, with a decrease in inflationary costs, there is a convergence between the loss functions under the policy of the monetary authorities, the corresponding coordination ($V_{c,t}$) and its absence (Nash equilibrium $V_{N,t}$).
Let us consider what happens in the case of a positive demand shock in a domestic country ($u_t > 0$). This country will reduce the rate of inflation ($\rho_t > 0$), in order to partially offset the impact of the demand shock on domestic output. Since the monetary authorities in the domestic economy accept foreign inflation as set in Nash equilibrium, they expect that this decrease will lead to a real depreciation of the exchange rate, since according to (6), when inflation decreases, the value of $\rho_t$ reduces. Thus, the impact of inflation on domestic output is decreasing. High volatility in inflation is necessary to maintain the stability of output. Thus, compensation for demand shocks is considered more expensive. With a coordinated policy, inflation $\pi_t$ decreases, and $\pi'_t$ increases, which helps stabilize output and reduce fluctuations in inflation.

Next, let us consider the Stackelberg strategy of monetary authority interaction. In this strategy, one country behaves as a leader relative to another, given how the monetary authorities of the other country will respond to the choice of inflation rates of the leader country.

Suppose that the Stackelberg leader is the monetary authority in the domestic economy. In doing so, they take into account that the monetary authority in the other country responds to their choice of inflation rate through an inflation rate response function corresponding to a Nash equilibrium.

Substituting the equilibrium output in the foreign economy (Equation (8)) into the first-order condition for the foreign monetary authority (Equation (21)), we obtain the reaction function for the inflation rate in the foreign economy at the Nash equilibrium:

$$\pi_t^* = -\left(\frac{\lambda b_2 A_1}{1 + \lambda b_2 A_1^2}\right) \pi_t - \left(\frac{\lambda b_2 A_1 A_2}{1 + \lambda b_2 A_1^2}\right) (u_t - u'_t). \text{ (29)}$$

As a result, the first-order conditions for minimizing the loss function for the domestic economy take the form:

$$\lambda \left[ b_2 A_1 - b_2 A_2 \left(\frac{\lambda b_2 A_1 A_2}{1 + \lambda b_2 A_1^2}\right)\right] y_t + \pi_t = 0 \text{ (30)}$$

Comparing the obtained condition (30) with the similar condition for the strategy corresponding to the Nash equilibrium (20), one can notice in Equation (30) the presence of an additional term.
This summation reflects the response of inflation in the foreign economy to the choice of inflation rate in the domestic economy.

Transforming the expression in square brackets in Equation (30), we obtain:

\[
\begin{align*}
- \lambda b_2 A_2 \left( \frac{\lambda b_2^2 A_1 A_2}{1 + \lambda b_2^2 A_1^2} \right) y_t
\end{align*}
\]  

(31)

The expression on the right side is in square brackets \( \lambda b_2^2 A_1^2 < 1 \). The first-order conditions for minimizing the loss function for the domestic economy take the form:

\[
\lambda b_2 A_1 \left[ \frac{1 + \lambda b_2^2 H}{1 + \lambda b_2^2 A_1^2} \right] y_t + \pi_t = 0
\]  

(33)

Figure 2 shows the dependence of the marginal effect of PR inflation growth for the leading country in the Stackelberg strategy on parameter \( b_2 \). In this case, the values of the model parameters are the same as in Figure 1.

It follows from the figure that with a decrease in the value of parameter \( b_2 \), that is, with a decrease in inflationary costs, the marginal effect of inflation growth for the leading country decreases monotonously.

Condition (33) differs from the first-order condition at Nash equilibrium \( \lambda b_2 A_1 y_t + \pi_t = 0 \). One of the reasons for the difference is that, since \( \frac{1 + \lambda b_2^2 H}{1 + \lambda b_2^2 A_1^2} < 1 \), the marginal effect of higher inflation in the leading country is now smaller than in the Nash equilibrium. The monetary authorities in the domestic economy believe that a higher inflation rate will help to reduce the inflation rate in the foreign economy (according to (29)), causing the currency depreciation in the leading country \( \rho_t \) to rise according to (6), which compensates for the expansionary effect of a rise in domestic inflation on domestic output (Equation (1)).

The expression for the function of the reaction of inflation rates to asymmetric demand shocks under the Stackelberg strategy is not given in this paper due to its complexity and lack of information in the context of comparison with similar functions under the Nash coordination and equilibrium strategies.
5. Conclusions

In the article, according to the purpose of the publication, the influence of asymmetric shocks of aggregate demand on the expediency of coordinating monetary policy within the framework of a simple model of two interacting countries is investigated. According to the objectives of the study, the equilibrium states of the macroeconomics of interacting countries are analyzed in the coordination of monetary policy and in the absence of coordination (Nash equilibrium) in the presence of asymmetric, serially uncorrelated demand shocks. The novelty of this study is to identify that taking into account asymmetric shocks affects the results of assessments of the strategies of interaction of monetary authorities. In particular, the inflation response to asymmetric demand shocks is less in the case of coordinated policies than in the case of non-cooperation policies. This result is the opposite of the result obtained in the presence of symmetrical supply shocks. The analysis of loss functions showed that compensation for demand shocks is considered more expensive in Nash equilibrium than under the policy of coordination of monetary authorities. An analysis of the monetary authorities’ interaction strategies confirmed previous results in the literature showing that the real exchange rate plays an important role in balancing supply and demand in the two economies. It is proven that with a decrease in inflationary costs, there is a convergence between the loss functions under the policy of monetary authorities, the corresponding coordination ($V_c$) and its absence (Nash equilibrium $V_N$).

The presented research results allow us to highlight several recommendations to the monetary authorities of the interacting countries. First, since essentially all demand shocks are asymmetric and the response of inflation to asymmetric demand shocks is smaller in the case of coordinated policy than in the case of non-cooperative policy, a coordination strategy is more beneficial for monetary authorities to stabilize policy in the presence of asymmetric demand shocks. Secondly, a reduction in inflation costs, which is an inflation shock, also leads to the stabilization of monetary policy, both with and without coordination.

In further research, it is of interest to go beyond monetary policy and explore the possibility of coordination between macroprudential and monetary policies. This issue is considered in the works (Jeanne 2014; Nyati et al. 2023; Jiang et al. 2019).

The practical significance of the results obtained for the monetary authorities is to stabilize the economy by creating buffers against external shocks.

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**References**


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