THE MONETARY TRANSMISSION MECHANISM: IS IT RELEVANT FOR POLICY?

Bernardino Adão
Banco de Portugal
Isabel Correia
Banco de Portugal
Universidade Católica Portuguesa,
and CEPR

Pedro Teles
Federal Reserve Bank of Chicago,
Banco de Portugal,
Universidade Católica Portuguesa,
and CEPR

Abstract
We study environments with sticky prices, wages, or portfolios where it is feasible and optimal to use monetary policy to replicate the allocation under full flexibility. In these environments the optimal policy does not depend on the scope of the frictions. In this sense, the strength of the monetary transmission mechanism is irrelevant for the conduct of monetary policy. So, asymmetries in the strength of the transmission mechanisms do not impose a cost on a common policy. (JEL: E31, E41, E58, E62)

1. Introduction

How should monetary policy be conducted in response to shocks in the economy? How relevant is the transmission mechanism of monetary policy, for the conduct of this optimal policy? How costly can a single monetary policy be when countries don’t share a single monetary transmission mechanism? In this paper we analyze a commonly used economic environment where it is possible to obtain answers to these policy questions.

Our model economy is a standard dynamic general equilibrium model where the government must finance exogenous expenditures with distortionary taxation. We consider three types of restrictions on the agents choices that correspond to three types of transmission mechanisms. Agents may be restricted in the setting of prices, wages, or in the choice of portfolio composition. The severity of these restrictions determines the strength of the transmission mechanism.

One example of a transmission mechanism is when monopolistic competitive firms are restricted to set the prices before observing the shocks. With this

Acknowledgments: We thank Chuck Carlstrom, Tim Fuerst, Jordi Galí, and Marvin Goodfriend, for helpful discussions, as well as participants at seminars where this work was presented.
E-mail address: mihcarvalho@bportugal.pt
price stickiness, an unanticipated monetary injection can raise production, lowering the markups and thus inducing a more efficient scale of production. This increase in economic activity is more pronounced the higher is the fraction of firms that set the prices in advance, that is, the more potent is the monetary transmission. If, instead, prices are perfectly flexible but portfolio choices are not, a different source of nonneutrality of money arises. This is identified in the literature as limited participation or market segmentation models, as in Fuerst (1992). The households choose their portfolios before observing the shocks, which gives rise to the liquidity effects of monetary policy. As the share of households that are unable to adjust the portfolios increases, the impact of the monetary policy is larger.

Even though monetary policy can have beneficial effects, because of the inefficient scale of production with monopolistic competition, it is not possible to use this policy systematically to take advantage of these effects. However, there is still a role for stabilization policy. Policy can be used in response to technological or other shocks so that the negative welfare effects of the nominal rigidities, together with the other distortions in the economy, are minimized.

Optimal policy in environments like these has been extensively studied in recent literature. In this paper we directly apply the results of Correia, Nicolini, and Teles (2002) and Adao, Correia, and Teles (2001) on optimal fiscal and monetary policy in economies with nominal rigidities on the setting of prices or choice of portfolios. They obtain that it is optimal to use policy to replicate the optimal allocations under full flexibility.

At first sight one could think that economies with different degrees of monetary transmission should also follow different monetary policy rules. This is the conventional wisdom, that there is a cost for economies with different transmission mechanisms of following a common monetary policy. This is not necessarily the case. Monetary shocks have larger effects, the larger is the extent of the frictions. However, the impact of other types of shocks is also affected by the extent of the frictions. It turns out that optimal monetary policy is the same in response to common shocks, irrespective of the strength of the transmission mechanism. The strength of the monetary transmission mechanism is, thus, irrelevant for the conduct of the optimal monetary policy. This is the main result of the paper.

The paper proceeds as follows: In Section 2 we analyze an economy where prices and wages are perfectly flexible and there are no portfolio restrictions. We show that there are policies such that one of the nominal variables, prices, wages, or money holdings do not change with the history of shocks. Thus, with adequate fiscal and monetary policy it is possible to replicate the behavior of the full flexible economy, when, instead there is either price, wage or portfolio stickiness. In Section 3 we explain that the optimal fiscal and monetary policy is independent of the degree of one type of stickiness. Section 4 contains concluding remarks.
2. An Economy with Flexible Prices, Wages, and Portfolio Choices

Our model economy is very similar to the one in Christiano, Eichenbaum, and Evans (1997). The economy consists of a large number of identical households, a continuum of firms, each producing a distinct good indexed by \( i \in [0, 1] \), financial intermediaries, and a government. The period \( t \) vector of productivity and government expenditure shocks is denoted by \( s_t = [A_t, G_t] \in S_t \), and the history of these shocks up to period \( t \) (or state at \( t \)), \((s_0, s_1, \ldots, s_t)\), is denoted by \( s^t \subseteq S^t \). The initial realization \( s_0 \) is given. To simplify the exposition, we assume that the history of shocks has a discrete distribution. The conditional probability of shocks \( s_t \) given the history \( s^{t-1} \) is denoted by \( \Pr(s_t | s^{t-1}) \).

2.1. The Households

The preferences are described by the utility function:

\[
U = E \left\{ \sum_{t=0}^{\infty} \beta^t u(C_t, L_t) \right\}, \quad \beta < 1
\]

where \( \beta \) is a discount factor, \( L_t = 1 - N_t \), where \( N_t \) is the level of labor and the composite consumption \( C_t \) is \( C_t = \left[ \int_0^1 c_i(t)^{(\theta-1)/\theta} di \right]^\theta/(\theta-1), \theta > 1 \). Households start period \( t \) with wealth \( \mathbb{W}_t \). At the start of period \( t \), households decide to hold money balances, \( M^h_t \), decide to make deposits at the financial intermediaries, \( B^h_t \), that pay \( R_t B^h_t \) at the beginning of period \( t + 1 \), and decide to buy \( Z^h_{t+1} \) units of state contingent nominal securities, that cost \( z^h_{t+1} \Pr(s_{t+1} | s^t) \) and pay one unit of money at the beginning of period \( t + 1 \) in a particular state. Thus, in the beginning of period \( t \) they face the budget constraint

\[
M^h_t + B^h_t + E_t Z^h_{t+1} z^h_{t+1} \leq \mathbb{W}_t.
\]

Labor is paid in the beginning of the period in the form of money, \( W_t N_t \), where \( W_t \) is the net nominal wage rate. The purchases of consumption goods have to be made with money, so

\[
\int_0^1 P_t c_i(t) di \leq M^h_t + W_t N_t
\]

where \( P_i(t) \) is the price of final good \( i \). At the end of the period, the households receive the profits net of taxes, \( (1 - \tau^\pi_i) \Pi_t \). Thus, the nominal wealth households bring to period \( t + 1 \) is

\[
\mathbb{W}_{t+1} = M^h_t + R_t B^h_t + Z^h_{t+1} - \int_0^1 P_t c_i(t) di + W_t N_t + (1 - \tau^\pi_i) \int_0^1 \Pi_t di,
\]
The households choose \( \{ c_{it}, N_t, M^h_t, B^g_t, Z^g_{t+1} \}_{t=0}^\infty \), for a given sequence \( \{ P_{it}, W_t, \tau^m_t, \Pi_{it}, R_t, z_{t+1} \Pr(s_{t+1}|s^t) \}_{t=0}^\infty \) that maximize (1) satisfying (2), (3), and (4) together with a no-Ponzi games condition.

Let \( P_t = \left[ \int P_{it}^{1-\theta} \, dl \right]^{1/(1-\theta)} \). The households choose consumption of good \( i \) according to \( c_{it}/C_t = (P_{it}/P_t)^{-\theta} \). In addition, the following first-order conditions must be satisfied

\[
\frac{u_L(t)}{u_C(t)} = \frac{W_i}{P_i}, \\
\frac{u_C(t)}{P_t} = R_t E_t \left[ \frac{\beta u_c(t + 1)}{P_{t+1}} \right].
\]

2.2. Government

The government must finance an exogenous path of purchases \( \{ G_t \}_{t=0}^\infty \), such that \( G_t = \left[ \int_0^1 g_{it}^{(\theta-1)/(\theta+1)} \, dl \right]^{\theta/(\theta-1)} \), \( \theta > 1 \), where \( g_{it} \) is the government consumption of good \( i \). Given the prices on each good, \( P_{it} \), the government decides according to \( g_{it}/G_t = (P_{it}/P_t)^{-\theta} \). A government policy is a sequence of money supplies \( \{ M^s_t \}_{t=0}^\infty \), a sequence of interest rates \( \{ R_t \}_{t=0}^\infty \), a sequence of contingent debt \( \{ Z^g_t \}_{t=0}^\infty \), a sequence of noncontingent debt \( \{ B^g_t \}_{t=0}^\infty \) and a tax policy \( \{ \tau^m_t \}_{t=0}^\infty \) satisfying

\[
E_t z_{t+1} Z^g_{t+1} + B^g_t + M^s_t + \frac{\tau^m_t W_t}{1 - \tau^m_t} N_t + \tau^m_t \int_0^1 \Pi_{it} \, dl \\ \geq Z^g_t + R_{t-1} B^g_{t-1} + M^s_{t-1} + P_t G_t,
\]

and

\[
\lim_{T \to \infty} E_T Q_T [M^s_T + B^g_T + E_{T+1} z_{T+1} Z^g_{T+1}] \leq 0, \quad \text{where } Q_T = \Pi_{k=1}^T z_k.
\]

2.3. Financial Intermediary

The households, at the beginning of the period \( t \), deposit \( B^h_t \) with the financial intermediary. The gross interest rate on these deposits is \( R_t \), received at the beginning of period \( t + 1 \). The financial intermediary lends \( B^h_{it} \) to the firms. The return on these loans is also \( R_t \), since the intermediary behaves competitively and makes zero profits. In addition the intermediary buys state contingent assets \( E_t Z^g_{t+1} z_{t+1} \) and holds government debt \( B^g_t \).

2.4. Firms

The technology used by firms is linear in labor, the only production input. The firms need to borrow the net wage bill from the financial intermediaries as they
must pay wages at the beginning of the period. At the beginning of period $t$, firm $i$ gets loans $B_{it}^f$ from the intermediary and decides to hold $M_{it}^f$ of cash balances.

The problem of firm $i$ is to choose $\{P_{it}, n_{it}, y_{it}, B_{it}^f, M_{it}^f\}_{i=0}^{\infty}$, taking as given the sequence $\{Y_t, P_t, W_t, \tau^n_t, R_t, A_t\}_{i=0}^{\infty}$, that solves:

$$\max P_{it} y_{it} - \frac{W_t}{1 - \tau^n_t} n_{it} - (R_t - 1) B_{it}^f,$$

subject to the demand function, $y_{it}/Y_t = (P_{it}/P_t)^{-\theta}$, obtained from the households problem, the production function, $y_{it} \leq A_t n_{it}$, the cash-in-advance restriction, $W_t n_{it} \leq M_{it}^f$, and $M_{it}^f \leq B_{it}^f$.

The firms set the common price equal to a constant markup over marginal cost,

$$P_{it} = P_t = \frac{\theta}{(\theta - 1)} \frac{W_t[(1 - \tau^n_t)^{-1} + (R_t - 1)]}{A_t}. \ (9)$$

### 2.5. Market Clearing

Market clearing requires: $B_{it}^f + B_{it}^g = B_t^h$, where $B_{it}^f = \int_0^1 B_{it}^f di$, $c_{it} + g_{it} = y_{it}$, $N_t = \int_0^1 n_{it} di$, $Z_t^g = Z_t^h + Z_t^b$, and $M_t^g = M_t^f + M_t^h$, where $M_t^f = \int_0^1 M_{it}^f di$.

### 2.6. Equilibrium Allocations

An equilibrium in this environment is an allocation, prices, and a government policy such that: Given the prices and the government policy, the allocation solves the problems of the households, firms and financial intermediary; and the allocation satisfies the market clearing conditions.

The government chooses the policy associated with the equilibrium allocation that gives the highest value of welfare, that is, solves the standard Ramsey problem. Let $\mathbb{W}_0 = 0$. Then, the Ramsey problem can be simplified to the choice of $\{C_t, N_t\}_{i=0}^{\infty}$ and $\{\tau^n_t\}_{i=0}^{\infty}$ that maximizes utility (1) subject to the feasibility condition,

$$C_t \leq A_t N_t - G_t, \quad (10)$$

and an implementability condition that summarizes all the competitive equilibrium conditions. The optimal policy is such that $\tau^n_t = 1$, since the tax on profits is a lump-sum tax.

Let $\{C_t^*, N_t^*\}_{i=0}^{\infty}$ be the Ramsey allocation. Then we obtain the optimal distortion $\gamma_t^*$ in each period from condition

$$\frac{u_L(t)}{u_C(t)} = \gamma_t A_t, \quad \text{where} \quad \gamma_t = \frac{\theta - 1}{\theta} \frac{(1 - \tau^n_t)}{1 + (R_t - 1)(1 - \tau^n_t)}, \quad (11)$$
which combines the intratemporal condition (5) and the pricing condition (9). The sequences of interest rates and taxes rates \( \{ R_n, \tau^* \}_{n=0}^{\infty} \) are not uniquely determined.

The nominal variables, \( P_t, W_t, \) and \( M_t^h \), are also not uniquely determined. The relevant equilibrium conditions to determine these variables are:

\[
\frac{W_t}{P_t} = \frac{\theta - 1}{\theta} A_t \gamma_t^*, \quad (12)
\]

\[
\frac{u^*(C_{t-1}^*, 1 - N_{t-1}^*)}{P_{t-1}} = R_{t-1} E_{t-1} \left[ \frac{\beta u^*(C_t^*, 1 - N_t^*)}{P_t} \right], \quad t \geq 1, \quad (13)
\]

and

\[
M_t^h + W_t N_t^* = P_t C_t^*. \quad (14)
\]

Let there be one state at date 0 and \( \Phi_t \) states at date \( t \geq 1 \). Consider a given sequence for \( \{ R_t \}_{t=0}^{\infty} \). At \( t = 0 \), there is one equation (12) and one equation (14) to determine the three variables \( P_0, W_0, \) and \( M_0^h \). At \( t \geq 1 \) there are \( \Phi_t \) equations (12), \( \Phi_t \) equations (14), and \( \Phi_{t-1} \) equations (13) to determine \( 3 \Phi_t \) variables. There are, thus, \( \Phi_t - \Phi_{t-1} \) degrees of freedom in the determination of the nominal variables \( P_t, W_t, \) and \( M_t^h, t \geq 0, \) with \( \Phi_{-1} = 0 \). This result is stated in the following proposition.

**Proposition 1.** Given a sequence \( \{ \gamma_t^*, R_t \}_{t=0}^{\infty} \) the optimal equilibrium allocation is determined but there is nominal indeterminacy. There are multiple sequences for the households’ money holdings, the price level and the nominal wage, \( \{ P_t, W_t, M_t^h \}_{t=0}^{\infty} \), associated with that real allocation. The degrees of freedom are \( \Phi_t - \Phi_{t-1} \) for each \( t \geq 0 \).

This indeterminacy result is related to the one in Sargent and Wallace (1975), where it is shown that prices are indeterminate when the monetary authority picks the interest rates.

The result in Proposition 2 implies that there are monetary policies such that one of the three nominal variables does not depend on the contemporaneous shocks. A related point was made by Carlstrom and Fuerst (1998) in an environment where prices are set in advance by a fraction of firms.

Since in this environment the government can freely choose the path of interest rates provided that the labor income tax is adjusted to satisfy \( \gamma_t = \gamma_t^* \), there are \( \Phi_{t-1} \) additional degrees of freedom in the joint determination of \( \{ R_t, P_t, W_t, M_t^h \}_{t=0}^{\infty} \), using equations (12), (13), and (14). The total degrees of freedom are \( \Phi_t \) for each period \( t \geq 0 \). This means that there is a unique monetary and fiscal policy, \( \{ R_t, M_t^h, \tau_t^* \}_{t=0}^{\infty} \) such that one of the three nominal variables, prices, wages or households money holdings, does not depend on the state. It is also straightforward to show that, in general, the policy that achieves state
independence of each one of the nominal variables is a different one. This means that, in general, it is not possible to achieve state independence of more than one of the nominal variables. These results are stated in the following proposition.

**Proposition 2.** The policy instruments \( \{\pi_t^n, R_t, M_t^S\}_{t=0}^\infty \) can be chosen in such a way that one and only one of the three nominal variables, prices, wages, or households money holdings, \( \{P_t, W_t, M_t^h\}_{t=0}^\infty \) does not depend on the state and implements the optimal real allocation \( \{C^*_t, N^*_t\}_{t=0}^\infty \).

### 3. Transmission Mechanisms

We have analyzed so far an economy without frictions. As will become clear, the results in the flexible economy can be directly applied to establish the main point of this paper, that the strength of the transmission mechanism is irrelevant for the conduct of optimal policy. We proceed in the following way: We consider three types of frictions, on the decision of prices, wages, and portfolios. Each of these frictions is associated with a transmission mechanism. The strength of a particular monetary transmission mechanism depends on the extent of the friction, measured by the fraction of agents that are able to choose either prices, wages or portfolios contemporaneously. We use the results in the literature on optimal fiscal and monetary policy in economies with sticky prices and sticky portfolios, according to which, when fiscal and monetary policy is conducted jointly it is feasible and optimal to replicate the optimal allocation in the flexible environment. Finally, we apply the results in the previous section to show that the policies that replicate the allocations in the flexible economy are the same independently of the extent of the friction.

The literature has studied the second best optimal government policy when there is one of the three types of frictions, on prices, wages, or portfolios. Adao, Correia, and Teles (2003) characterize optimal monetary policy in an economy with prices set in advance and show that in general it is not optimal to replicate the allocation under flexible prices. Instead, when both fiscal and monetary policy are chosen jointly the result is overturned and it is always optimal to replicate the flexible price allocation. This is shown in Correia, Nicolini, and Teles (2002). It is straightforward to extend those results to an environment with sticky wages. The result is confirmed in an environment where portfolios are set in advance by Adao, Correia, and Teles (2001). The following proposition states these results.

**Proposition 3.** In the presence of only one rigidity, in prices, wages, or portfolios, it is optimal to replicate the Ramsey solution of the flexible economy.

Now we show the main result of the paper, that the strength of the transmission mechanism is irrelevant for the conduct of optimal policy. We use
the result in Proposition 3, that the Ramsey solution of the flexible economy should be replicated and Proposition 2, stating that this allocation can be achieved with a policy such that the path for one of the nominal variables, price, wages or portfolios, is independent of the state.

Consider an economy where only a fraction $\alpha < 1$ of the firms can set the prices contemporaneously. The remaining firms are restricted as they cannot revise the price they charge. If the policy is the one stated in Proposition 2, the firms that can revise the price would choose not to do it. The restriction would not be binding. As prices are identical for every firm, that particular policy would decentralize the optimal flexible price allocation. This is true for any $\alpha$, which implies that the optimal policy is independent of the size of the $\alpha$. The same reasoning applies to the other types of frictions. While the degree of rigidity is irrelevant, the type of rigidity matters, as implied by Proposition 2. The following proposition states these results.

**Proposition 4.** The optimal policy $\{M_t^g, R_t, \tau^g_t\}_{t=0}^{\infty}$ depends on the type of friction, but is independent of the extent of the friction measured by $\alpha$.

We have not been completely explicit about the particular restrictions on the setting of prices, wages or the decisions on portfolios. The results stated above hold for many specifications of these restrictions. In particular, if, for example, prices are set in the Calvo staggered manner, in order to replicate the allocation under flexible prices the prices will have to be constant over time. This is a particular case of state independence of the price sequence that can be achieved with the policies described in the last section. The nominal interest rate will move with the real rate and taxes on labor income will adjust to guarantee the optimal state dependent intratemporal distortion. The price setting restrictions could be more complex and still the optimal monetary policy would be the same. For instance, firms could be heterogeneous in that a fraction would be setting prices one period in advance, another fraction would be flexible and the remaining fraction would be setting prices according to Calvo.

We have simplified the analysis by assuming that the nominal interest rate does not generate an additional distortion, as in a model with cash and credit goods or a transactions technology. In those models, the movements in the nominal interest rate would be distortionary and therefore under our assumptions on the fiscal instruments it would not be optimal to replicate the flexible price allocation. Assuming consumption taxes, however, allows to recover the results, as shown in Correia, Nicolini, and Teles (2002).

The policy conclusion of this paper is that economies with different $\alpha$s, that is, with differing strengths of the monetary transmission mechanism, but with the same type of friction, share the same optimal policy in response to aggregate shocks. This result can be explained using the concept of a gap, defined in the following way: Consider an economy with flexible prices and a given fiscal and
monetary policy. The same policy in an economy with nominal rigidities will require lump sum taxes to finance the budget. The gap is the difference between the allocations in the two economies. In response to a technological or government expenditure shock, the gap is larger the larger is the extent of the stickiness. However the effect of the policy reaction to those shocks, aiming at closing the gap, is also larger the larger the extent of the stickiness. We show in this paper that the response of monetary policy is the same for all levels of stickiness. Monetary policy is the most effective when it is most necessary.

An empirical implication of the results above is that if policy is conducted optimally, it is not possible to identify the degree of stickiness from the comovements of aggregate variables. The time series generated by economies with very different levels of nominal rigidities are the same. Thus, the real business cycles paradigm would be useful to describe the behavior of macroeconomic aggregates, but not to assess the effects of a monetary policy shock. This may also justify why the quantitative contribution of the monetary shocks for the explanation of business cycles is relatively insignificant, even with microeconomic evidence on price or wage stickiness.

4. Concluding Remarks

The existence of different transmission mechanisms has influenced the discussion on the costs of a common monetary policy across countries. The first step to understand these costs is to identify whether economies with different transmission mechanisms should follow different monetary policy rules. We conclude in this paper that this may not be the case. Asymmetries in the monetary transmission mechanisms do not necessarily impose a cost on a common policy.

In economies with frictions, policy shocks will have very different effects depending on the type and strength of the monetary transmission mechanism. The strength of the transmission mechanism is determined here by the fraction of agents that are prevented from making choices, on either prices, wages or portfolios, in response to shocks. However, if policy is conducted optimally, so that the allocation under full flexibility is replicated, the response to common shocks is the same independently of the strength of the transmission mechanism. A monetary shock will have a big impact, when a big impact is necessary.

It may not be feasible to replicate the allocation under full flexibility. Since, monetary policy cannot undo the effects of more than one source of frictions. In this case the monetary transmission mechanism is relevant for policy. But is it really the case that there is such a vast menu of transmission mechanisms as we commonly see in the policy oriented surveys on this issue?

Other cases in which it is not feasible to replicate the full flexibility allocation is when shocks are idiosyncratic, for example when the rigidity is on
prices and the technological shocks are idiosyncratic across firms. To replicate flexible prices, the relative prices would have to move with the shocks, and monetary policy is unable to accomplish this.

When monetary and fiscal policies are not jointly determined, under general conditions it is not optimal to replicate the flexible allocation. Also in this case the transmission mechanism would be relevant in the determination of the optimal policy.

References