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MAGYAR NEMZETI BANK

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1 Introduction

This Handbook focuses on general issues and theories in connection with the monetary policy transmission of the traditional interest rate instrument, and the related empirical evidence. Monetary policy transmission captures the process through which monetary policy influences the economy. The Handbook shows how traditional monetary tightening, i.e. raising the central bank base rate, influences key economic variables, such as output (real GDP) and inflation. The two approaches to analysing transmission, i.e. the so-called reduced-form evidence and the structural model evidence, are reviewed, and then the channels of monetary transmission are detailed using the latter approach.

The Handbook concentrates solely on traditional monetary policy decisions, i.e. on changes to the central bank base rate.[1] This means that the unconventional monetary policy instruments widely used in the wake of the 2008 crisis, such as liquidity measures, direct credit market interventions or central bank securities purchase programmes (Krekó et al. 2012), are not discussed. Nevertheless, the approach used here is modern in the sense that the operational target of monetary policy is regarded to be the money market interest rate rather than a monetary aggregate (e.g. the monetary base).

The three main sources used for this study were Bofinger (2001), Mishkin (2004) and Walsh (2010). The main transmission channels (interest rate, asset price and expectations channel) are presented along the lines of these textbooks, but using a unique classification. The main channels are supplemented with two further channels, the risk-taking and cost channels, but these are only briefly discussed. The empirical results include general conclusions on the impact of base rate shocks on output and prices, and the relative strength of the individual transmission channels compared to each other. The structure of the Handbook is as follows: Chapter 2 contains the definition of monetary policy transmission and the general issues

[1] The transmission of unconventional instruments will be presented in detail in an upcoming Handbook.

surrounding it, then in Chapter 3 the traditional monetary transmission channels are discussed. In Chapter 4, the empirical evidence from the literature is presented, and finally in Chapter 5 the main conclusions are drawn.

2 Monetary policy transmission

2.1 Monetary policy stance, monetary conditions and monetary policy transmission[2]

In this Handbook, *monetary policy stance* is understood to mean the combined application of certain elements of monetary policy and the definition of their characteristic features, which allow monetary policy to contribute to economic, financial and monetary developments. In the case of modern central banks, the stance is primarily determined by the central bank base rate (a relatively high interest rate indicates tighter monetary policy, while a relatively low interest rate indicates looser monetary policy). At the same time, if the set of monetary policy instruments consists of several elements, the monetary policy stance is determined by all of these collectively.[3]

***Monetary conditions* are financial variables that are affected by monetary policy and that influence the target variables of monetary policy, i.e. inflation and output.** Such financial variables include interbank and government securities market yields and the exchange rate. Since macroeconomic performance is mainly influenced by real variables, the development of real interest rates (the real interest rate is the value of the nominal interest rate adjusted for inflation; $real\ interest\ rate = \frac{1+nominal\ interest\ rate}{1+inflation\ rate} - 1$) and the real exchange rate (the number of domestic goods that need to be sold for one unit of foreign goods) is crucial in this respect. The linear combination of the real interest rate and the real exchange rate is referred to as the monetary conditions index (Bofinger 2001, p. 416). Lower real interest rates or a weaker (higher) real exchange rate point to looser monetary conditions.

[2] This subchapter is principally based on Csávás–Kollarik (2016).

[3] Monetary policy stance has no generally accepted definition. For example, if a higher base rate reflects higher expected inflation, monetary policy cannot necessarily be considered tighter (Bernanke 2003). The definition presented here and centred on the base rate applies mostly under normal conditions (and not, for example, during hyperinflation or deflation).

Monetary policy transmission **bridges the gap between the monetary policy stance and monetary conditions on the one hand, and the target variables of monetary policy on the other hand.** The transmission mechanism captures the transition between the monetary policy stance and monetary conditions on the one hand, and the final goal of the central bank on the other hand. Transmission is deemed efficient when monetary conditions and the final goal adjust to the stance. Transmission is efficient when a higher base rate (tighter stance) is coupled with higher interbank interest rates, while inflation (with a sufficient lag) is also subdued.[4] Transmission takes place in several steps: first, the stance generally triggers a response from the financial markets; second, prices and other conditions set by financial intermediaries for their clients respond; and finally, macroeconomic variables react to monetary policy.

2.2 Impact of a monetary policy shock in the standard New Keynesian model

In the widely used New Keynesian model, monetary policy influences output and inflation in the short run, but only affects the price level in the long run (Walsh 2010, pp. 344–347). The New Keynesian model (used for a closed economy) consists of three equations: IS curve, Phillips curve (aggregate supply) and a monetary policy rule (the so-called IS-MR-PC model framework,[5] Carlin–Soskice 2005). Figure 1 shows how real GDP, inflation and the real interest rate respond to a positive monetary policy shock (base rate increase), assuming rational expectations. After the shock, the output gap[6] and inflation drop immediately, while the real interest rate climbs. As inflation falls, the real interest rate increases more than the nominal interest

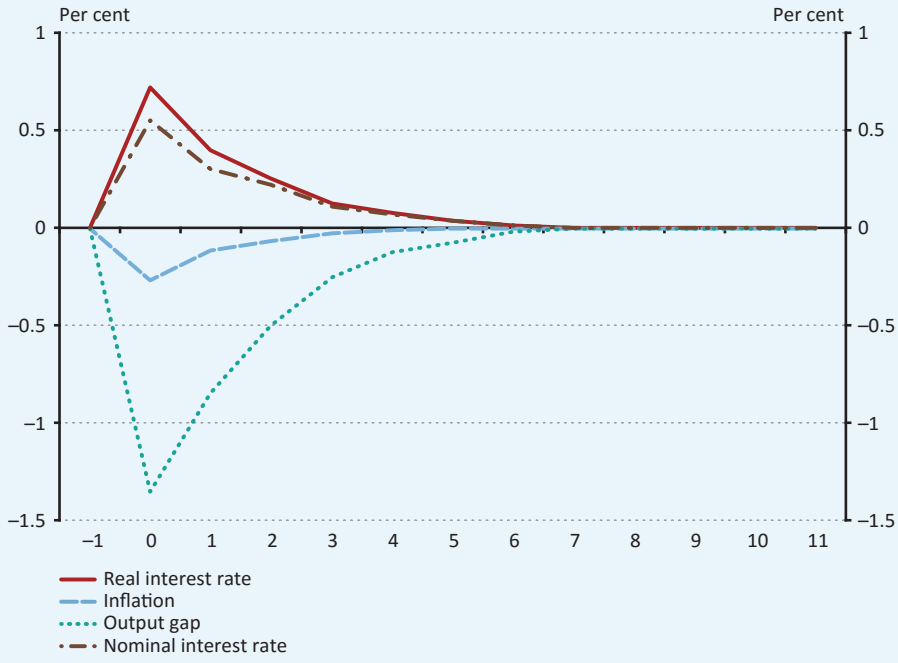
[4] The efficiency of transmission cannot always be defined accurately. For example, it is unclear how medium-term government securities yields should respond to a base rate hike. Ideally, monetary tightening results in a rise in the medium-term real interest rate and lower inflation expectations. However, the combined effect of these remains obscure. See the expectations channel in subchapter 3.3.

[5] IS: investment = saving, MR: monetary rule, PC: Phillips curve.

[6] The output gap is the difference between actual output and potential output, i.e. it is a measure of the overheating (positive gap) and overcooling (negative gap) of the economy. Therefore, the output gap is often used in monetary policy to examine inflation developments. It should be noted that the output gap is a non-observable variable: its value can only be estimated, but in practice there are numerous difficulties and shortcomings in connection with this. In Figure 1, the response by the output gap and real GDP are the same, since constant potential output is assumed.

rate. The rise in the real interest rate dampens aggregate demand (IS curve), and this leads to lower real GDP and inflation (Phillips curve). However, in the long run, both the monetary policy shock and its impact taper off. This also means that in the long run, monetary policy exerts an effect on the price level alone (this is because potential output is exogenous, i.e. an external given, in the model, and it is the shock to *inflation* that tapers off rather than the shock to the *price level*). Accordingly, the nominal and real variables are independent from each other over the long term; this view is referred to as the *neutrality of money* or *classical dichotomy*.

Figure 1
Response of output, inflation and the real interest rate to a monetary policy shock in the New Keynesian model



Source: Walsh (2010, p. 345).

However, the concept of *hysteresis* also appears in the literature, and according to that potential output (aggregate supply) is not independent of actual output (aggregate demand), and therefore monetary policy

may have a long-term effect on the real economy. The *discouraged worker* hypothesis was first formulated by Long (1953) (Altavilla–Ciccarelli 2007). According to the theory, the potential workforce is discouraged as a result of persistent unemployment, workers do not make any more sacrifice to market their labour supply, and therefore they enter the inactive group. The concept of hysteresis was first used by Blanchard and Summers (1986), also in the context of the labour market. They cite obsolete professional knowledge and the erosion of social capital as the factors contributing to a decline in employability, which ultimately also guide the long-term unemployed towards the inactive group. However, later it was suggested that factors other than labour market developments may also have a lasting impact on the real economy. For example, during economic crises, investments may be postponed, and the quality of productive capacities may deteriorate due to underutilisation. As a result, crises may have a much larger impact on long-term growth trends than previously believed (Lehmann–Szalai–H. Váradi, 2017). Beenstock and Ilek (2005) refute the long-term neutrality of money hypothesis using labour market hysteresis. The authors point out that employment diminishes as monetary policy is tightened, and due to hysteresis, this, i.e. the real economy impact of monetary policy, is persistent.

2.3 Reduced-form evidence and structural model evidence

Mishkin (2004, pp. 603–631) differentiates between two methods for examining monetary policy transmission: *reduced-form evidence* and *structural model evidence*.

Reduced-form evidence means a black box approach. This method was initially characteristic of monetarists. It directly analyses the relationship between the instrument variable (stance) and target variable of monetary policy. Let us assume that the stance is captured by the central bank base rate, while the target variable is captured using inflation. In this case, the reduced-form evidence examines the direct relationship between the base rate and inflation. This is usually done using three basic methods: examining timing, correlation and past episodes.

- *Timing* follows the "post hoc, ergo propter hoc" principle. According to this, earlier events cause subsequent ones.
- In the case of the *correlation method*, the question is whether the correlation coefficient between the two variables differs significantly from a given value, or what the sign of the coefficient is.
- *Examining past episodes* is an approach based on the history of money. The outstanding literature on this is the book by Friedman and Schwartz (1963) on the monetary history of the United States.

By contrast, the structural model evidence examines the relationship between the stance and the target variable by creating a model of the economy, and defining the individual channels through which the relationship is forged between the variables. This method was initially characteristic of Keynesian thinkers. To use the above-mentioned example, retaining the base rate as the instrument variable and inflation as the target variable, one of the potential channels for the structural model evidence may be the interest rate channel in the IS-MR-PC model framework (see subchapter 3.1.). Accordingly, a higher base rate increases the real interest rate, and this curbs aggregate demand due to the negative slope of the IS curve. On account of the Phillips curve (aggregate supply) with a positive slope, inflation (and output) ultimately decline.

Both the reduced-form evidence and the structural model evidence have advantages over each other. One benefit of the reduced-form evidence is that it is more likely to capture the full impact of monetary policy. However, one of its drawbacks is that it does not address the causal relationship between the monetary policy stance and the target variable. Even if some kind of a correlation (e.g. negative) is observed between the instrument variable of monetary policy (base rate) and its target variable (inflation), that does not necessarily indicate a causal link between the two variables. This means that the lower inflation is not necessarily caused by a higher base rate. Although lower inflation may be observed in the context of a higher base rate, actually the causality may be the opposite between

the two variables,[7] and they can be shaped by external factors as well.[8] By contrast, the advantage of the structural model evidence is that it reveals the causal link between the base rate and inflation, but one disadvantage is that if it is not well-specified (and it leaves out certain transmission channels), it may underestimate the effect of monetary policy.

The two different approaches chart two different paths for researching monetary policy transmission. Monetarists were able to create more sophisticated reduced-form models using the method of *reduced-form evidence*. The most famous was the so-called St. Louis model (Andersen–Jordan 1968), which consisted of only one regression equation, with the left-hand variable being the change in nominal GNP, and the right-hand variables containing, inter alia, the change in the money supply. The St. Louis equation showed a strong positive correlation between money supply and the gross national product, although the equation is misspecified if money supply is an endogenous variable (Walsh 2010, p. 14). The *structural model evidence* method was used to develop structural models in order to better understand the operation of the channels through which monetary policy influences aggregate demand. These are called *transmission channels* or *transmission mechanisms*. Using the structural model approach in Chapter 3 of the Handbook, the main traditional transmission channels are presented.

[7] For example, lower inflation, i.e. a growing change in the purchasing power of money, means an increase in the change to the value of money. This may be interpreted by economic actors as an increase in the time value of money, i.e. a rise in the nominal interest rate on the market. If the central bank adjusts to the interest rate developments on the market through the base rate, it raises the base rate.

[8] One common cause may be a negative cost shock affecting firms. On the one hand, this may lead to a drop in inflation, and on the other hand falling costs improve the profitability of firms, which may lead to growing credit demand on their side, thereby lifting nominal interest rates on the market. Once again, if the central bank adjusts to the interest rate developments on the market through the base rate, it raises the base rate.

3 Traditional monetary transmission channels

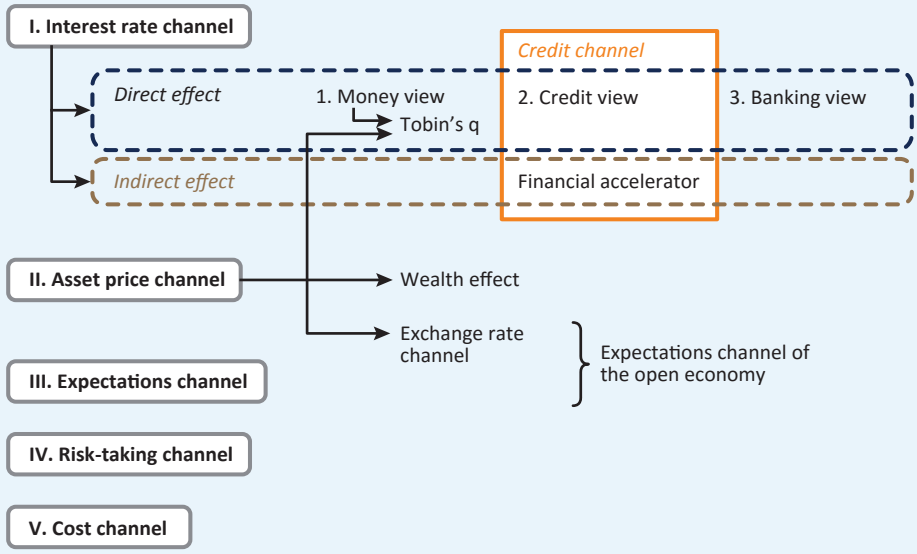
According to Bofinger (2001, p. 73), our knowledge of monetary policy transmission is limited. This is due partly to model uncertainty, and partly to the long and variable lags of monetary policy impulses. Model uncertainty means that there is no consensus among economists regarding the appropriate model or econometric method. Monetary policy lags consist of three stages:

- *inside lag*: the central bank responds with a lag to the shock sustained by the economy;
- *intermediate lag*: the banking system and financial markets respond with a lag to the central bank measure;
- *outside lag*: real economy actors respond with a lag with their investment and consumption decisions to the change in financial conditions.

The lags are long and variable (Friedman 1961), which renders pursuing monetary policy difficult. Moreover, the transmission channels also depend on the institutional environment and the objectives of the central bank. For example, the model describing the economy differs in the case of an exchange rate-targeting and an inflation-targeting central bank, which also influences the impact mechanism of monetary policy.

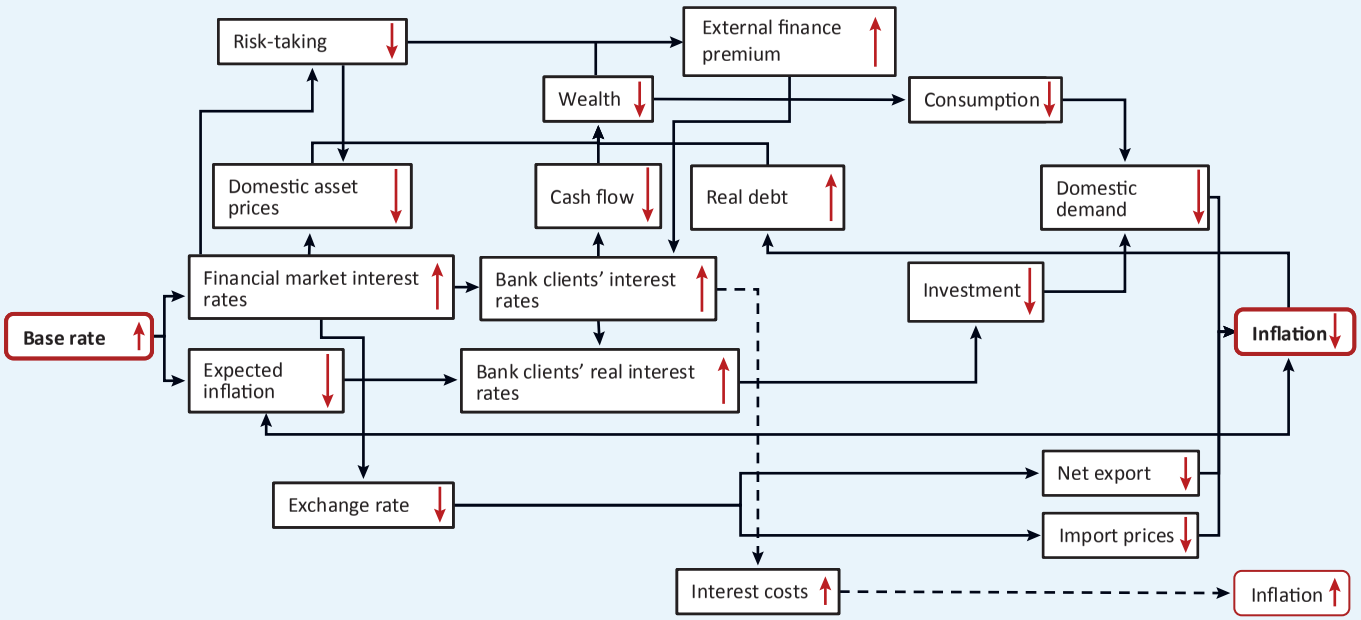
Due to model uncertainty and the different set-up of the different economies, there is no consensus in the literature on the structure of transmission channels. Different authors (central banks) have developed different models for transmission mechanisms, see, for example, ECB (2000), BoE (2005), MNB (2006; 2012), NBP (2013) or CNB (2013). This Handbook contains two figures about the channels (Figures 2 and 3) created by the authors, and the transmission mechanism will now be presented along the lines of these. Nevertheless, the empirical results are presented in Chapter 4 with a different structure, adopting the categorisation in the literature, and due to the quantifiable results, authors typically use a simpler classification in model estimates than the one in this paper.

Figure 2
Schematic illustration of the traditional monetary policy transmission channels



Source: Authors' work.

Figure 3
Impact mechanism of monetary tightening



Source: Authors' work.

3.1 Interest rate channel

The interest rate channel is the most basic channel of monetary policy transmission. In this study, in line with Bofinger (2001, pp. 80–95), the interest rate channel is interpreted broadly, usually as transmission explained by interest rate changes (Figure 4). The alternative name for this mechanism is the aggregate demand channel. In addition to the traditional interest rate channel, this includes the credit channel as well, since that also captures the direct or indirect effect of interest rate changes on spending.

3.1.1 Direct effect

The direct interest rate channel captures the direct impact of the interest rate on interest rate-sensitive spending. The essence of the channel is that spending (mainly investments) are in a negative correlation with the (real) interest rate. This means that the slope of the IS curve capturing the equilibrium of the commodities market is negative (Hicks 1937).[9] The negative slope of the investment function is due to the following: if the rate of return on investment projects follows a specific distribution, then a higher interest rate, as the cost of capital, renders fewer projects profitable, and therefore fewer projects will be realised.[10] Three approaches to the direct interest rate channel are distinguished in the literature, depending on whether the IS-LM model is accepted, and if not, how it is modified (Bofinger 2001, pp. 82–90).

3.1.1.1 Money view

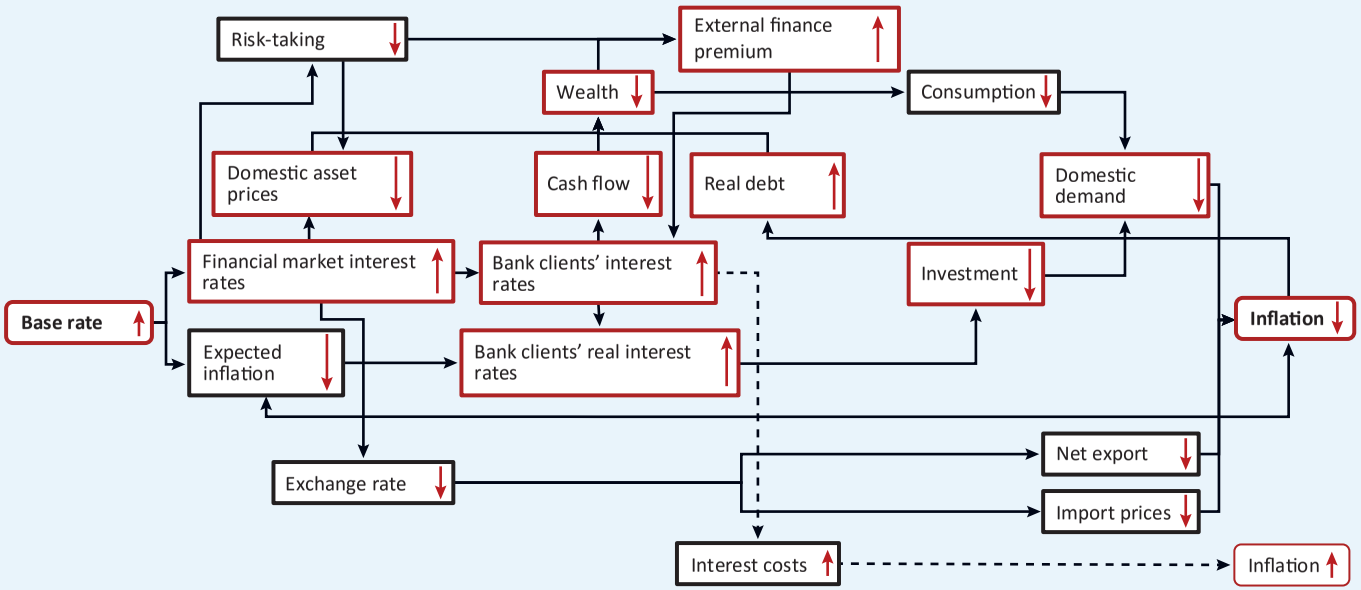
The traditional money view uses the IS-LM[11] model. It assumes sticky prices, thus equalling the real interest rate with the nominal interest rate. The model contains three different financial assets: money, bonds (representing either private or public debt) and the central bank reserves of commercial banks, i.e. bank loans are not included in the model. The money supply is exogenous: the central bank has complete control over the monetary base

[9] The other condition for the negative slope of the IS curve is that the marginal propensity to consume be less than 1. The marginal propensity to consume is understood to be the derivative of consumption with respect to real income.

[10] This is our own interpretation.

[11] IS: see Footnote 5, LM: liquidity preference (or demand for money) = money supply.

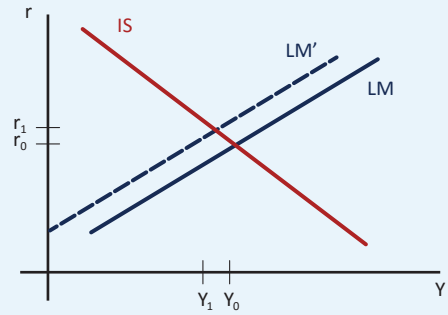
Figure 4
Impact of monetary tightening through the interest rate channel



Source: Authors' work.

as well as the money multiplier. Therefore, the LM curve capturing money market equilibrium has a positive slope, i.e. a higher interest rate is consistent with higher real income (Figure 5).[12]

Figure 5
The IS-LM model



Note: r denotes the real interest rate, Y denotes real output. The dashed LM' shows a tighter monetary policy stance (more limited money supply). Monetary tightening lifts r and reduces Y.

Source: Authors' work based on Mankiw (2009, pp. 287–310).

The negative slope of the IS curve is the result of not only the above, but also the so-called Tobin's q effect (Tobin 1969). In Tobin's model, there are two types of capital goods: old (existing) and new (investment). The prices of the different forms of capital are in direct proportion to each other, and the constant of proportionality is *q*: the price of new capital is *p* (which equals the price of consumption goods), while the price of old capital is *q*p*. Another assumption of the model is that both types of capital ensure the same *C* constant real cash flow in perpetuity. Nevertheless, the expected return on the two types of capital may differ: the real discount rate of new capital is *R*, while that of old capital is r_K. Therefore, the following two equations hold true:[13]

$$p = \frac{C}{R}, \tag{1}$$

$$qp = \frac{C}{r_k}. \tag{2}$$

[12] Except for the liquidity trap when the LM curve becomes horizontal.

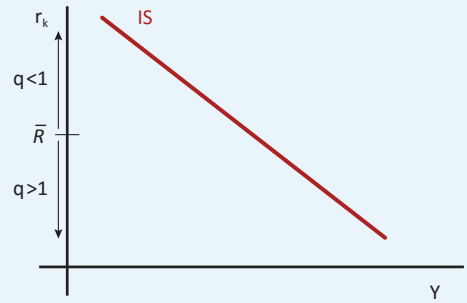
[13] A horizontal yield curve and positive discount rates are assumed here. In such a case, the present value of an infinite constant cash flow series equals the quotient of the cash flow and the discount rate.

The relationship below follows from the two equations:

$$r_K = \frac{R}{q}. \tag{3}$$

This means that the returns are also directly proportional to each other, but the constant of proportionality is the reciprocal of q. It is worth investing precisely when the return on the new capital exceeds that on the old capital ($R > r_K$), i.e. if $q > 1$. In the context of a given $\bar{R}$, the greater r_K, the smaller is q and thus the fewer are investments. This is how the slope of the IS curve (in the domain of r_K) becomes negative (Figure 6). Alternatively, when considering the price of the different forms of capital, it can be said that if $q > 1$, old capital is more expensive than new capital, and therefore investors choose the cheaper, the new one, i.e. they invest (see the asset price channel in subchapter 3.2.). If monetary policy is able to determine r_K (with a given $\bar{R}$), then monetary tightening (raising r_K) leads to a reduction in q and investments.[14]

Figure 6
Tobin's IS curve



Note: r_K denotes the real discount rate of the existing capital, $\bar{R}$ is the (given) real discount rate of new capital, q is the price of the existing capital relative to new capital, while Y is real output.

Source: Authors' work based on Tobin (1969)

The money view provides a moderately realistic picture of the operation of modern economies.

- **First, assuming exogenous money supply is not realistic.** The operational target of most modern central banks is the short-term interbank rate rather

[14] This is our own interpretation.

than the monetary base. Therefore, the monetary base is determined endogenously, based on the demand of private actors for central bank money (Komáromi 2008). Furthermore, even if a central bank targets the monetary base, it cannot determine the entire money supply, since that also depends on the money multiplier. And the money multiplier is not determined by the central bank alone (through the required reserve ratio), as it is influenced by the decisions of private actors, too (through the ratio of free reserves and the cash ratio). All in all, the central bank can only cap money supply, it cannot set a floor to it.[15] "You could lead a horse to water but you could not make him drink" (Friedman 1968, p. 1).

- **Second, the model is based on the capital market rather than the banking system.** This feature may capture the financing structure of the United States well, but in the case of the euro area, for example, it is not realistic (ECB 2000).

3.1.1.2 Credit view (bank lending channel)

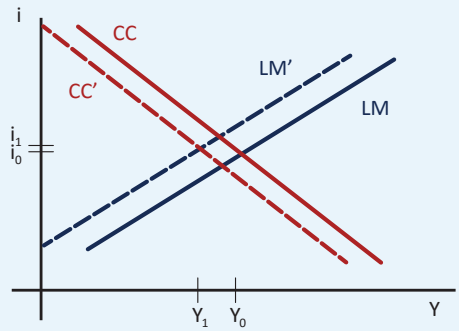
The credit view or the bank lending channel incorporates bank loans into the IS-LM model. In the model of Bernanke and Blinder (1988), the central bank's money supply is still exogenous (the central bank targets the monetary base), but the loans extended by commercial banks appear as new elements. The IS curve is substituted for the so-called CC curve,[16] which, similar to the former, is in the interest rate–output plane, and it has a negative slope. The difference is that the CC curve includes not only the commodities market equilibrium but also the credit market equilibrium. If the central bank determines a tighter stance, i.e. the monetary base is reduced, then both the LM curve and the CC curve shift to the left (Figure 7). In this case, output declines more than in the traditional model, and the interest rate of bonds may even drop (since falling output considerably reduces the demand for money). Bernanke (1993, p. 56) argues that "in addition to affecting short-

[15] The maximum money supply = monetary base divided by the required reserve ratio. This happens when banks do not hold free reserves, and currency in circulation is also zero. However, the minimum money supply is zero. This is possible when the whole monetary base consists of the central bank reserves of commercial banks, which do not create deposit money, and therefore neither cash nor deposits will be held by the actors outside the banking system. The actual money supply can be anywhere between the minimum and the maximum money supply.

[16] Commodities and credit.

term interest rates, monetary policy affects aggregate demand by affecting the availability or terms of new bank loans".

Figure 7
The CC-LM model



Note: i denotes the interest rate of bonds, Y denotes real output. The dashed CC' and LM' show a tighter monetary policy stance (more limited central bank money supply). Monetary tightening substantially reduces Y, while its impact on i remains questionable.

Source: Authors' work based on Bernanke and Blinder (1988)

Bernanke (2007) and Disyatat (2010) approach the bank lending channel differently than described above. Both authors deduce the channel from banks' so-called external finance premium. Monetary policy influences banks' balance sheet and risk perception, and thus also their external finance premium.[17] Tighter monetary policy increases banks' external finance premium, which is then passed on to customers. It should be noted that Disyatat (2010) does not apply the loanable funds model (Kohn 1998, pp. 46–54), but instead uses the endogenous money supply theory. According to this, the level of bank deposits does not constrain bank lending; on the contrary, loans create deposits (Bain–Howells 2009, pp. 31–53 and 95–119).

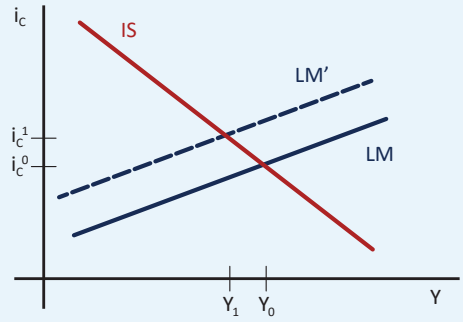
3.1.1.3 Banking view

Bofinger (2001, pp. 53–90) constructs an IS-LM model in which bank financing plays a crucial role, and he calls it the "banking view". In the model, the money supply is endogenous, and the central bank decides on the base rate. Credit supply (= money supply) by banks rises as a function

[17] For more on the external finance premium, see the financial accelerator in subchapter 3.1.2.

of the lending rate. Similar to the traditional model, the LM curve has a positive slope here as well, but it is flatter than if the central bank targeted the monetary base. Monetary tightening shifts the bank credit supply curve to the left, thereby raising the lending rate and curbing lending. The rising lending rate shifts the LM curve to the left as well, while leaving the IS curve intact (Figure 8). This leads to a decline in aggregate demand. The main claim of Bofinger is that the separation of the effects of monetary policy with respect to the credit view is wrong (according to which the impact of the rise in the short-term interest rate is *coupled* with an effect on the availability or terms of new bank loans). Bofinger believes that there is only one impact. This has an empirical result as well, since there is no use looking for effects in addition to the rise in the base rate.

Figure 8
Bofinger's IS-LM model



Note: i_C denotes the bank lending rate, Y denotes real output. Since the central bank targets the interbank interest rate rather than the monetary base, the LM curve is flatter than the traditional one. As a result of monetary tightening (the rise in the base rate), the LM curve shifts to the left, and therefore the lending rate increases, while output drops.

Source: Authors' work based on Bofinger (2001 p. 89)

3.1.2 Indirect effect (financial accelerator, balance sheet channel)

3.1.2.1 The financial accelerator in general

During monetary policy transmission, the impact of the policy rate on economic activity through the interest rate channel can be exerted not only directly. The indirect impact of the interest rate on spending is called the financial accelerator (Bernanke–Gertler–Gilchrist 1994). This name comes from the fact that even a small change in the interest rate influences spending

(investments) substantially. In the literature, the financial accelerator is also referred as the balance sheet channel, since the indirect effect of the interest rate channel takes hold through the balance sheet of real economic actors. Monetary policy exerts a strong indirect impact on investments and labour demand by influencing firms' and households' balance sheet (cash flow and profits).

The financial accelerator and the bank lending channel, which has already been reviewed, comprise the credit channel. The operation of financial markets is determined not only by demand from the real economy but also the strategy of the actors offering credit instruments as well as their adjustment to the real economic environment, which can actively influence real economic activity (Bernanke 1983; Bernanke–Gertler 1989; Coric 2011). In the analysis of the transmission mechanism, the effects based on the credit supply strategy take hold through the *credit channel*. The functioning of the credit channel can be divided into two subchannels: the *financial accelerator* and the *bank lending channel*.

- The financial accelerator is based on the lending strategy of the lender (bank) resting on its information about the borrower (company, household), regarding the latter's creditworthiness, in line with which it makes a decision with respect to the price and availability of the credit instrument. The perception of creditworthiness depends on the capital position of the borrower. In the literature, this effect is often identified as the *balance sheet channel* concept (Bernanke 2007).

- However, the credit supply strategy is influenced not only by the perception of the borrower's creditworthiness in the eyes of the lender, but also the opportunities of the lending bank for obtaining funds. The effects of monetary policy on credit supply take hold by influencing banks' opportunities to obtain funds (bank lending channel). In this case, the bank appears as the actor obtaining funds, and the lending party makes a decision regarding funding.

The basis of the financial accelerator is information asymmetry between the lender and the borrower. Usually borrowers have more information than the economic actor extending the loan. At the time of the

decision on disbursing the loan, the lender faces a so-called *ex ante* (prior) information asymmetry, since it does not have access to all the information on the quality and risks of the borrower's project to be financed or the objective of borrowing. After the disbursement, the lending party cannot observe the activities of the borrower, the return on the investment or the utilisation of the funds provided. This time, the lending party faces an *ex post* (subsequent) information asymmetry (Coric 2011). Accordingly, if the borrower is a company, while the lender is a commercial bank, the latter takes a risk with the lending decision, and this risk can only be mitigated by raising financing costs.

The gearing[18] of the borrowing company is positively correlated with the level of incentives for increasing information asymmetry. In the context of an adverse capital position, the company's external financing need increases. Yet the less the borrower can participate in the financing of the envisaged project by covering the risks with its equity, the more its incentives for increasing the information asymmetry rise. It becomes interested in using external funds to have a project financed that has a borrowing requirement beyond its capital position, and that is riskier and more expensive, because in this scenario it incurs lower losses if the project fails. By contrast, the bank runs a risk when extending the loan. The conflict of interest between the lender and the borrower diminishes if the borrower becomes interested in the success of the project to be financed, for example if the loaned funds are only disbursed if an appropriate amount of equity is available. If the company assumes a portion of the risks related to lending, the risk borne by the bank decreases, which calls for less compensation during lending.

Depending on the opportunities of the lender for assessing risks, it can influence credit supply through the price and availability of the credit instruments. If it is assumed that the lender can partly or completely manage the information asymmetry, it will place a great emphasis on the comprehensive assessment of the creditworthiness of the credit applicant and the monitoring of the project in order to mitigate the risks. In the case of a bank lender, the bank can set the price of the credit instrument tailored to

[18] Gearing is understood to mean the ratio of the balance sheet total to equity.

the customer to a certain extent, after assessing the extent of the risk arising from the capital position of the credit applicant. In this case, credit supply is influenced through pricing. By contrast, if it is assumed that the bank is unable to efficiently assess the riskiness of its customers, it can prescribe general collateralisation requirements, and if they are not met, the customer cannot obtain the loan or only under restrictive conditions. In this case, the bank influences credit supply through the amount of loans extended, i.e. the availability of credit (*credit rationing*). In such a case, as a result of the negative perception of the given capital position of the company, the credit applicant's project to be financed, which has an otherwise positive net present value, may not get off the ground in the absence of the disbursement. Then the failure of the project entails social costs as well.

When the financial accelerator takes hold, the lender also becomes a source of moral hazard from a macroeconomic perspective. In line with the financial accelerator effect, during a recession banks use the skim-off principle, aiming to reach customers with a good credit rating, and excluding actors with a weaker capital position or constraining their borrowing, thereby increasing the inequalities and exacerbating the downturn.

3.1.2.2 The operation of the financial accelerator and its subchannels

The external finance premium is the difference between the cost of external financing and the opportunity cost of equity financing. This premium is (usually) increased by the company's gearing. If the company's assets are denoted by A, equity by E and debt by D, and the return on assets (weighted average cost of capital)[19] is i_A, the return on equity is i_E and the return on debt is i_D, the following correlation holds true:

$$A = E + D, \tag{4}$$

$$i_A = \frac{E}{A} i_E + \left(1 - \frac{E}{A}\right) i_D. \tag{5}$$

[19] WACC.

Let EFP denote the external finance premium. Then, based on (5):

$$EFP = i_D - i_E = \frac{A}{E}(i_D - i_A). \tag{6}$$

Let i_D depend on gearing ($\frac{A}{E}$). Let c denote the derivative of the cost of borrowing with respect to gearing, which is positive:

$$c = \frac{\partial i_D}{\partial \frac{A}{E}} > 0. \tag{7}$$

Therefore, the derivative of the external finance premium with respect to gearing can be determined:

$$\frac{\partial EFP}{\partial \frac{A}{E}} = \left(i_D\left(\frac{A}{E}\right) - i_A \right) + \frac{A}{E}c.^{20} \tag{8}$$

The second term on the right-hand side of Equation (8) is positive, and presumably so is the first term, at least in the case of higher gearing.[21] Therefore the sum is also likely to be positive, i.e. gearing increases the external finance premium.

Box 1
Example for calculating the external finance premium

1) A company wishes to obtain a loan from a commercial bank for financing its investments. The assets of the company are valued at HUF 1 million, and its equity is HUF 500,000. The average yield of its assets on the balance sheet is 5 per cent. The interest payable on its debt is in a linear correlation with the company's gearing, it can be calculated by multiplying the latter by *c*, which has a constant value of 0.03. How much is the external finance premium set by the bank for the loan requested by the company?

$$A = 1\,000\,000\ HUF;\ E = 500\,000\ HUF;\ i_A = 0.05;\ c = 0.03$$

The company's gearing $\frac{A}{E}$ can be calculated from the known information, just like the interest payable on the existing debt, i_D:

$$\frac{A}{E} = 2;\ i_D = 2 \cdot 0.03 = 0.06.$$

[20] In the calculation it was assumed that the first Modigliani–Miller theorem holds true, i.e. that WACC is independent from the capital structure (Modigliani–Miller 1958).

[21] For example, if there is a linear relationship between i_D and gearing $\left(i_D = c\frac{A}{E}\right)$, it is easy to see that gearing increases the external finance premium precisely if $\frac{A}{E} > \frac{i_A}{2c}$. When $i_A < 2c$, this correlation holds true in all cases.

Substituting this in Equation (4), the debt on the company's balance sheet can be calculated as follows: *D = 500 000 HUF*.

Equation (5) shows the weighted average cost of capital (WACC) of the company, i_A which is already known. The only element not yet known is the return on equity i_E, which can be expressed as follows:

$$i_E = \frac{A}{E}\left[i_A - \left(1 - \frac{E}{A} \right) i_D \right] \tag{8b}$$

$$i_E = 2 \cdot (0.05 - 0.5 \cdot 0.06) = 0.04$$

The external finance premium can be derived from Equation (6):

$$\text{EFP} = 0.06 - 0.04 = 0.02.$$

The external finance premium is 2 percentage points, which covers the credit risk faced by the lending bank.

2) If the value of Equation (8) is positive, a rising gearing entails an increase in the external finance premium. In line with Footnote 21, if $2c > i_A$, the assertion regarding the increasing external finance premium in gearing will hold true for all gearings (that are greater than or equal to 1). The values of c and i_A from Example 1) satisfy this condition ($2 \cdot 0.03 > 0.05$), therefore when substituting them to Equation (8), the positive correlation between gearing and the external finance premium (where $\frac{A}{E} \geq 1$ and $i_D\left(\frac{A}{E}\right) = c \cdot \frac{A}{E}$) can be deduced.

$$\frac{\partial EFP}{\partial \frac{A}{E}} = \left(0.03 \times \frac{A}{E} - 0.05 \right) + 0.03 \times \frac{A}{E} > 0$$

With equivalent changes: $\frac{A}{E} > \frac{5}{6}$.

It can be seen that when choosing the two exogenous variables, c and i_A, in line with the conditions, the rise in gearing leads to an increase in the external finance premium charged for new borrowing in the case of all gearings (that are greater than or equal to 1).

When examining the external finance premium at the aggregate level, it can be observed that it is countercyclical with regard to its relationship to the business cycle;[22] **therefore, the financial accelerator makes the effects of real economy shocks affecting the capital and financial position stronger and more persistent.** If the economy is hit by a negative shock that also affects the capital position of the sector representing borrowers, the external finance premium can play a more central role in shaping lending rates. For example, as a result of a base rate increase by the central bank, in addition to the change in the risk-free component of the lending rates, the distribution effect depending on the capital position is also strengthened, in parallel with the general rise in the external finance premium. The financial accelerator impacts the real economy through the effect of the real economy shock on credit supply, making the shock greater and more persistent.

The equity of the borrower can be calculated as the sum of the value of its liquid assets and the illiquid assets used as collateral less the value of debt:

net worth (equity) = liquid assets + illiquid assets – debt.

Monetary policy can influence all three components determining the equity of the company, thereby affecting the company's creditworthiness (Coric 2011). Accordingly, Mishkin (2004, pp. 621–626) identifies three subchannels, through which monetary policy can influence banks' credit supply decisions by shaping the development of net worth.

3.1.2.2.1 The impact of the financial accelerator on companies' illiquid assets[23]

When the interest rate is increased, the value of the collateral provided for the bank loan by the borrower declines, therefore as companies and households can obtain no loans or only a limited amount, their losses rise as a result of the skim-off strategy (Mishkin 2004). When analysing the transmission effect exerted on companies' illiquid assets, Coric points

[22] The external finance premium ***rises*** in the ***downward*** phase of the business cycle.

[23] Mishkin identifies the effects on the borrower's illiquid assets as the balance sheet channel rather than as its subchannel, which is inconsistent with the conceptual framework of the present paper and the other sources used. One possible solution may be the term 'collateral channel', however, this is already used with a slightly different interpretation, see Benmelech–Bergman (2011).

out that an interest rate increase entails a drop in the value of the collateral, simply because of the higher discount rate (Coric 2011). As a result of the increase in the external finance premium, the external funding of investment in the economy and thus also investment activity declines.

3.1.2.2.2 Cash flow channel

Monetary policy also influences the liquidity of the credit applicant. When interest rates increase, due to a slump in aggregate demand and especially the demand for a company's products, the borrower's liquidity position deteriorates, and therefore the lending bank can reduce its credit supply through the pricing or the availability of the credit instrument (Coric 2011). Ultimately, the adjustment of credit supply to the reduction in corporate or household cash flow contributes to a slowdown in economic activity. The cash flow of a given household or company can be influenced by the nominal interest rate, while investment decisions are shaped by real interest rates (Mishkin 2004). Mishkin underlines that short-term nominal interest rates are pivotal in the transmission mechanism, because the interest paid on short-term debt has the strongest impact on household and corporate cash flows (Mishkin 2004).

3.1.2.2.3 Unexpected price level channel

The policy rate exerts an impact on companies' external funds through the unexpected price level channel. Assuming that corporate debt is stipulated in a contract, an unexpected interest rate increase leads to falling price levels. This adds to the debt of the applicant company in real terms, while the real value of the assets remains unchanged, thereby reducing real equity (Mishkin 2004). This means poorer creditworthiness, and a higher external finance premium should be expected, just like constraints in lending. When analysing companies' existing debt, Coric points out another mechanism, in which an interest rate increase raises the component of external funds depending on variable interest rates, thereby raising companies' indebtedness and reducing equity (Coric 2011).

3.1.2.3 The balance sheet channel in the household sector

3.1.2.3.1 Households as borrowers

According to certain authors, the financial accelerator can also be interpreted for households as borrowers. The external financing of households depends more on banks than in the case of companies, but the loans extended to households are usually substantially smaller than the loans financing firms' investments. The financial accelerator can influence households' demand for consumer durables with respect to aggregate effects (Coric 2011). The authors analysing the financial accelerator interpreted for households conclude that the financing of households' investment largely means transactions secured by real estate, and therefore the development of house prices may be a relevant factor when determining the creditworthiness of a particular household (Bernanke 2007; Coric 2011). Accordingly, the external finance premium is priced depending on the change in the value of households' illiquid assets. Therefore, when interest rates increase, house prices drop as a result of a slowdown in economic activity, and thus, due to a fall in the value of the illiquid assets, households' net worth declines as well; therefore, the given household faces constraints on the amount or price of the loans that can be obtained, which is ultimately reflected in sluggish demand for credit-driven goods (e.g. consumer durables) (Coric 2011).

3.1.2.3.2 Household liquidity effects

Based on household liquidity effects, as the probability of a future financial downturn increases, households may become motivated to raise the share of liquid financial assets on their balance sheets relative to illiquid assets (Mishkin 2004). In this case, the mechanism is not based on the shaping of the credit supply, but on the expense decisions of households aimed at balance sheet restructuring. Households' illiquid assets usually include consumer durables and real estate. After a negative income shock, for example an interest rate increase, households may strive to improve their liquidity position by selling their assets. However, consumers may suffer huge losses when selling their illiquid assets, as during a financial downturn, the asset cannot generate its full monetary value when sold on account of its illiquid nature (Mishkin 2004). By contrast, holding liquid, money market instruments ensures an easier and more stable selling opportunity

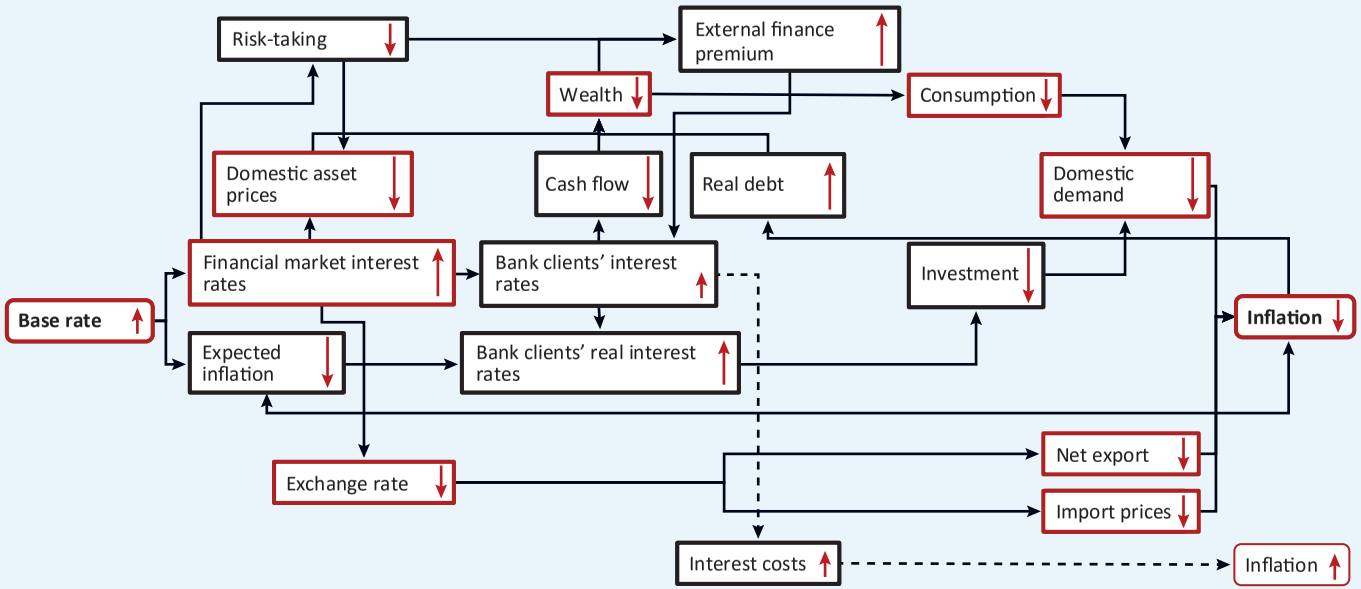
to households, providing the necessary liquidity. In view of this, when consumers believe that the probability of a future financial downturn has increased, for example the policy rate is expected to rise, they are less likely to invest in illiquid assets, real estate or consumer durables, and they increase their liquid asset holdings within their portfolio. This contributes to the slump in the demand for big-ticket durable goods, and thus also indirectly to flagging aggregate demand. Within household liquidity effects, the impact on consumers' expectations becomes key, which is close to the concept of the expectations channel.

3.2 Asset price channel

The second large channel of the monetary transmission mechanism is the asset price channel. This channel also plays a central role in transmission, since interest rate moves influence the prices of real and financial assets, which in turn affect consumption and investment decisions (Figure 9). The traditionally Keynesian IS-LM model takes into account the price of only one asset (bond yields) (Hicks 1937). Therefore, monetarists criticised the model because they believe that monetary policy exerts an effect on the economy through other relative asset prices and real wealth as well. Later, Keynesians revised their macroeconomic models to incorporate such considerations. These economists included Franco Modigliani, who also regarded these other asset price effects as critical from the perspective of the monetary transmission mechanism.

In Frederic S. Mishkin's classification, three different effects on the asset price can be distinguished in the case of the transmission mechanism of the asset price channel (Mishkin 2001). These include the exchange rate, stock and housing prices, which are analysed in more detail later. The logic behind the asset price channel can be extended to the prices of other financial or investment assets as well, for example to government bonds, but in this Handbook, the transmission mechanism of the asset price channel is analysed based on the classification of Mishkin and Modigliani. Analysis of the asset price channel starts with the definition of its three subchannels that facilitate the understanding and separation of the transmission of interest rate decisions, and that control the flow of the effects of monetary policy decisions towards economic variables. Based on the works of Bofinger

Figure 9
Impact of monetary tightening through the asset price channel



Source: Authors' work.

(2001) and Mishkin (1996), the following subchannels can be highlighted which contribute to asset price changes:

- *Tobin's q*;
- *Wealth effect*;
  - General view;
  - Wealth distribution across countries;
- *Exchange rate channel*.

The first such channel operates in line with the Tobin's q theory, while the second focuses on how the change in wealth, due to the actions of the monetary policy decision-makers, impacts the economy through a change in asset prices. The third subchannel, which is regarded as a separate channel in several papers in the literature, is the exchange rate channel, which shows how the exchange rate, which reaches a new equilibrium when new information is disclosed, influences the decisions of economic actors. This chapter presents these subchannels in more depth.

3.2.1 Tobin's q

The Tobin's q effect can also be defined as the subchannel of the asset price channel. It may be beneficial for investments if Tobin's q is greater than 1, because then old capital is more expensive than new capital, and therefore investors pick the cheaper new alternative, i.e. they invest (see the description in subchapter 3.1. on the interest rate channel).

3.2.2 Wealth effect

3.2.2.1 General approach

The second subchannel of the asset price channel is the wealth effect, which can be further divided into two parts. First, the focus will be on the general approach to the wealth effect, which is closely linked to the MPS model developed by Modigliani.[24] The life-cycle hypothesis (Modigliani

[24] The MPS model was developed in the 1960s by economists Franco Modigliani, Albert Ando and Frank de Leeuw. The model based on the paradigm of the IS-LM curve and the Phillips curve was used by the decision-making body of the Federal Reserve between 1970 and 1995 for forecasts and analysis (Brayton et al. 1997).

1971), i.e. the impact of wealth on consumption mostly exhibits monetarist characteristics. The model is based on the assumption that the level of consumer spending is determined by consumers' resources. Human capital, real capital and financial wealth can all be interpreted as resources. Changes to the monetary base or, implicitly, changes in interest rates, affect the value of consumers' available resources, making companies and households richer or poorer. Monetary policy tightening, i.e. a base rate increase, entails a drop in the value of real and financial capital through the rise in market rates. Higher short-term interest rates boost the expected return from investment instruments, which leads to a fall in their prices through selling pressure. As a result of lower asset prices, the wealth of economic actors shrinks, which leads to less consumption, and thus more subdued aggregate demand. This mechanism can influence not only consumption but also investments. Reduced wealth makes economic actors curb their investments, which in turn hampers aggregate demand. The general approach to the wealth effect can be applied to various assets, including stocks, foreign currencies and real estates.

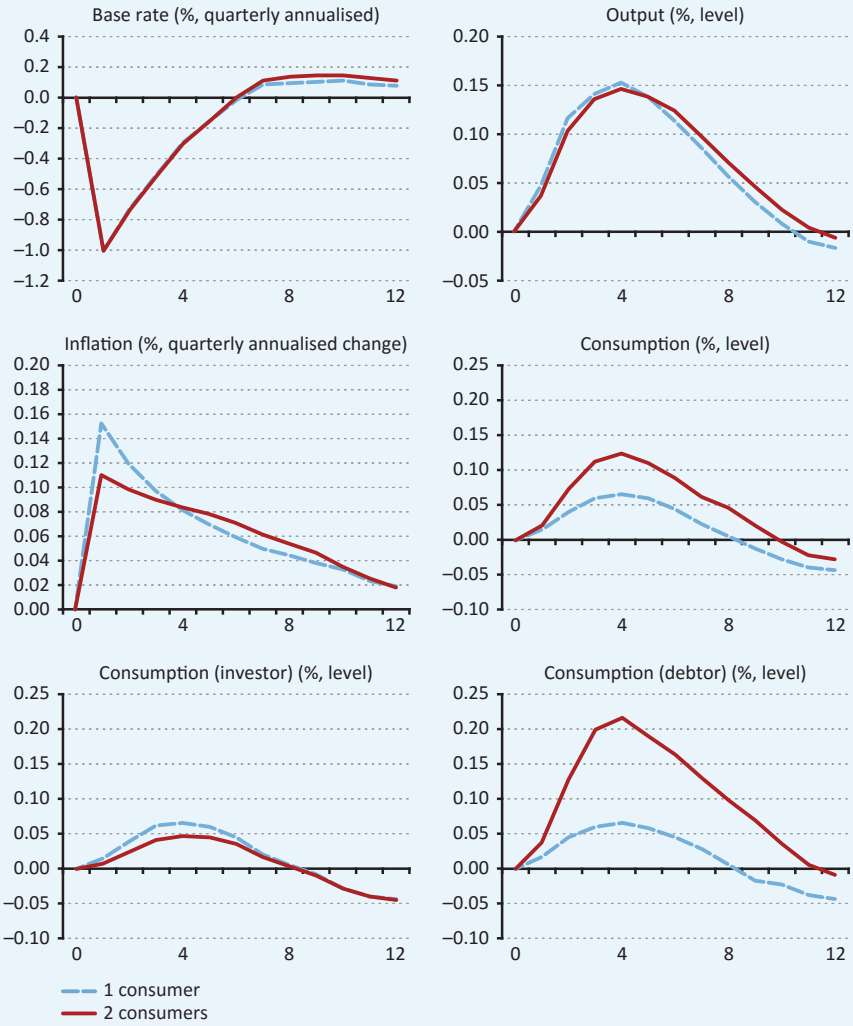
Box 2
Wealth distribution in heterogeneous households

In the academic responses to the lessons from the 2007–2008 financial and macroeconomic crisis, the development of macroeconomic forecasting models, one of the main features of which is the incorporation of heterogeneous households, emerged as a necessity. In most DSGE models,[25] aggregate consumption demand is derived from the behaviour of a representative household. The drawback of the homogeneous households approach is that it fails to take into account the impact of households' wealth differences on consumption. In their studies, Eggertson and Krugman (2012), and Eggertson and Mehrotra (2014) addressed the major macroeconomic consequences of households' different wealth and indebtedness. Assuming heterogeneous actors, two types of households were distinguished: indebted households and those with financial wealth. Since the wealth position of the actors varies, households respond to monetary policy measures differently. The MNB's economists (Békési et al. 2016) also looked at this problem, using a monetary policy

[25] Dynamic stochastic general equilibrium models.

shock to illustrate how the introduction of the two types of households affects various real economic variables (Figure 10).

Figure 10
Impact of wealth heterogeneity in an easing monetary policy shock



Source: Békési et al. (2016, p. 27).

In the case of heterogeneous households, the response of consumption to a monetary policy shock is significantly greater than with homogeneous households. It can be seen in Figure 10 how the response of consumption and real GDP to an easing monetary policy shock changes when indebted households are replaced by ones with positive net wealth, i.e. when wealth heterogeneity is eliminated. When taking into account heterogeneity, the maximum response of consumption is almost double that of the homogeneous wealth distribution scenario. Furthermore, the difference in inflation is also noteworthy, at around 5 basis points.

3.2.2.2 Wealth distribution across countries

According to the traditional theories on the macroeconomics of open economies, monetary policy influences real variables only in the short run, while over the long term, adjustment occurs in nominal variables. Several studies (Gale–Sabelhaus 1999; Kiley 2000) address the issue of comparing the marginal propensity to consume to aggregate wealth, and its extension across countries. In this Handbook, the topic of wealth distribution across countries is detailed based on Walsh (2010, pp. 395–451), with a focus on open economies. In the standard approach, monetary policy exerts no perceptible long-term effect on the real economy, as it influences only the nominal variables. Over time, prices and wages adjust, and at the same time output, the real interest rate and the real exchange rate return to the equilibrium, and these are independent from monetary policy. The traditional models examining open economies are developed for exploring short-term effects. In the short run, the impact of interest rate moves is significant. In response to monetary policy measures, real GDP and the real exchange rate shift, fluctuating around their long-run equilibrium path.

In contrast to the traditional approach, the two-country model of Obstfeld and Rogoff (1995; 1996) also includes the long-term real economy impact of monetary policy. One typical feature of open economies is that they are not independent from other economies, and the economic policy decision taken by foreign actors may influence the operation of the domestic economy. *Spillover effects* take hold when the economic policy of one country is considerably influenced by monetary policy measures introduced by other countries. The huge advantage of the two-country model is that it captures

the most important links between economies, describing them in a simple manner. The Obstfeld–Rogoff model rests on four main pillars:

• There is only consumption, no investments;

• The trade balance facilitates the intertemporal decisions of individuals;

• Monopolistic competition;[26]

• Sticky prices.

Shocks to the economy influence countries' wealth position, exerting long-term effects on the real economy. Positive, temporary productivity shocks, which increase current output more than future output, encourage individuals to boost their current and future consumption as well, thereby smoothing their consumption path. Accordingly, current output increases more than consumption, and therefore the economy's net exports grow as well, i.e. foreign receivables emerge. There may be a long-term effect, because that makes the future high consumption sustainable even in the case of a temporary productivity shock. Therefore, in this approach, the trade balance plays an important role in the intertemporal organisation of goods. Changes in net exports affect countries' current account as well; this is how indebted and wealthy countries emerge.

This means that monetary policy can have a long-term impact on the real economy through the wealth effect, since it can influence output and the distribution of wealth across economies with its interest rate measures. When prices are predetermined, monetary policy shocks permanently change the level of real consumption and welfare. These effects arise because monetary policy surprises change the current account balances of the individual countries, thereby influencing their relative asset positions. For example, monetary policy tightening in the home country leads to appreciation of the exchange rate and a drop in the price level (see below: exchange rate channel). This process generates a temporary decline in output in the home country –

[26] The theory is based on the blending of free competition and monopoly. Sellers offer products of varying quality at different prices (product differentiation), therefore all market participants enjoy a monopoly in their own product or service, but they also compete with each other for market share and consumers.

a larger fall than the contraction in consumption, which is characterised by intertemporal consumption smoothing – and therefore the domestic economy will run a trade deficit, and products need to be imported. As a result of higher imports, liabilities arise against foreign, exporting countries. Thus, domestic consumption will fall over the longer term, even if the slump in output could only be observed in one period.

3.2.3 Exchange rate channel

In line with Mishkin, the exchange rate channel is interpreted here as a subchannel of the asset price channel. It has already been mentioned that the exchange rate is central in open economies, and therefore this channel should be analysed more closely. Most studies in the literature (e.g. ECB 2000; BoE 2005) interpret and treat the exchange rate channel as a separate channel, but in Mishkin's classification it can be regarded as a special branch of the asset price channel. Of course, this does not mean that in this categorisation the exchange rate channel has a more muted impact or plays a smaller role in the transmission mechanism.

Raising the central bank base rate causes short-term strengthening of the exchange rate. This process can be explained using the uncovered interest parity theory. In contrast to the *covered interest parity* (CIP), the *uncovered interest parity* (UIP) is based on the expected future exchange rate rather than the arbitrage-free pricing and the forward rate.[27] Assuming a risk-free world, the interest from a domestic and a foreign investment with a similar term differs by the amount that is compensated by the expected shift in the exchange rate of the domestic currency. According to the theory, when the risks are taken into account, the nominal interest spread can be expressed as the sum of the expected exchange rate depreciation and the risk premium. Accordingly, in the wake of the interest rate increase the interest spread increases, and so do the expected exchange rate fluctuations (with a given risk premium). If the exchange rate is assumed to be constant in the future, this process immediately leads to exchange rate appreciation. The exchange rate effect can be felt only in the short run, as over time the

[27] For more information on the exchange rate theories, see MNB Handbook No. 7 (Kálmán–Makay–Tóth 2016).

exchange rate weakens to its originally anticipated level. It should be noted that the empirical results do not always confirm this exchange rate response (*delayed overshooting puzzle*). Nevertheless, Scholl and Uhlig (2005) argue that appropriate identification can mitigate the delayed overshooting puzzle.

Besides the models based on the covered and uncovered interest parity, the best-known model among partial equilibrium models is the purchasing power parity. In this exchange rate theory, absolute and relative purchasing power parity are distinguished. According to the *absolute purchasing power parity* (PPP) model, exchange rate levels adjust to the proportion of the purchasing power of currencies. The *relative purchasing power parity* theory differs from this in that the change in exchange rates is caused by the relative change in price levels, in other words the currency of countries characterised by low inflation appreciates. It can be stated that the extent of the appreciation and depreciation equals the inflation differential between the two countries. However, empirically these do not necessarily work. Measuring absolute PPP is difficult, and its operation has not been confirmed, while relative PPP sometimes works, but mostly only in the long run (Pippenger 1993).

The shift in the exchange rate influences inflation and output. Indirectly, it affects aggregate demand through the difference between exports and imports, and it has a direct impact on consumer prices through fluctuations in the prices of imported goods. Due to the appreciation of the domestic currency, domestic goods become relatively more expensive than foreign goods, which reduces demand for domestic products. This entails a drop in exports. Similarly, imports rise because demand for foreign goods increases. Falling net exports result in a slump in output. Net exports can be expressed as the difference between exports and imports multiplied by the real exchange rate ($NX = EX - IM^*q$, where q is the real exchange rate). The impact of the real exchange rate on net exports is not straightforward because the "quantity effect" (the real exchange rate increases exports, while it decreases imports) and the "cost effect" (the adjustment of imports for the real exchange rate) point in opposite directions. These two effects should be examined more thoroughly to determine the direction of the shift in net exports. Net exports grow on account of the real exchange rate if the Marshall–

Lerner condition[28] is met. However, empirically this condition is usually not met in the short run, but the theory can be confirmed over the long term (Hooper et al. 2000). The change in the base rate also affects the supply side due to the change in the price of imported goods and certain production factors expressed in the domestic currency. This effect can be explained by the fact that a portion of the goods in the consumer basket are imported, and their prices respond directly to the development of the exchange rate.

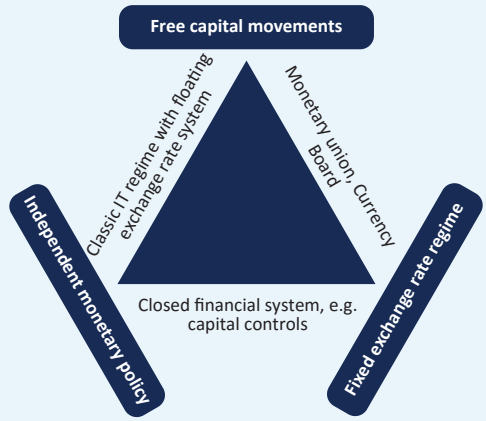
Interesting conclusions can be drawn from the above-mentioned interest parity theory with respect to the various exchange rate regimes. The uncovered interest parity theory can be used to distinguish transmission in the countries using a fixed exchange rate from those employing a floating-rate regime. Different economic effects and monetary policy responses can be observed in the different regimes if the risk premium suffers a positive shock,[29] and if it is assumed that this will not influence the future expected exchange rate. In the case of a fixed exchange rate regime, the new information only affects the forward rate, and the shock does not materialise in the spot rate. The nominal interest spread increases by as much as the risk premium. Therefore, the central bank must respond to the rising premium by raising the base rate in order to maintain the fixed exchange rate regime. By contrast, in a floating exchange rate regime the spot exchange rate weakens on account of a risk premium shock, by as much as the risk premium has risen (with unchanged interest rates). From a monetary policy perspective, it can be stated that in the case of a positive shock, raising the base rate tightens monetary conditions in a fixed exchange rate regime, while in the case of a floating exchange rate there is no interest rate response, and the conditions are eased due to the short-term depreciation of the exchange rate.

[28] The Marshall–Lerner condition (Marshall 1923; Lerner 1944) points out that if the current account was in equilibrium at the outset, the real depreciation causes a positive balance if, and only if, the sum of the absolute value of elasticities of the demand for exports and imports with respect to the real exchange rate is greater than 1, i.e. the export and import functions respond flexibly enough to the variation in the real exchange rate. (If the current account is not in equilibrium at the outset, the condition becomes fundamentally more complex.) According to the calculations of Artus–Knight (1984), in most countries the value of the immediate elasticity indicators is so small that their sum cannot be greater than 1. Therefore, based on the estimated values of the immediate elasticities, the Marshall–Lerner condition is met in almost none of the national economies, while in the short run most countries fulfil the condition, and in the long run almost all countries do so.

[29] The risk premium shock is examined instead of a monetary policy shock because the latter influences different financial instruments in the two exchange rate regimes (the exchange rate in a fixed-rate regime and the interest rate in a floating-rate regime).

The assertions of the well-known trilemma, i.e. the "impossible trinity", follow from the theories discussed above. According to the Mundell–Fleming trilemma (Mundell 1963; Fleming 1962), there is a fundamental incompatibility between a fixed exchange rate, the international mobility of capital and an independent monetary policy, and if a government/central bank picks any two of them, it becomes impossible to achieve the third (Figure 11). Familiarity with the trilemma is also important from the perspective of the monetary policy transmission mechanism, since, as it can be seen above, different short-term economic effects can be observed in the case of the different exchange rate regimes. Nonetheless, according to several later studies (Bofinger–Wollmershauser 2003; Bofinger–Mayer–Wollmershauser 2006), the trilemma can be potentially resolved. In order to successfully achieve an independent monetary policy, a managed exchange rate and the free flow of capital, the central bank can introduce a crawling peg.[30] In this case, the UIP links the interest rate policy to the exchange rate policy: a higher base rate is consistent with a faster pace of pre-announced devaluation.

Figure 11
The Mundell–Fleming trilemma



Note: IT = Inflation targeting. Inflation targeting is a monetary policy strategy where the central bank seeks to provide price stability through the achievement of a publicly announced inflation target, without having an intermediate target. Currency board = a credibly fixed exchange rate regime in which the central bank has at least as much foreign exchange reserves as the monetary base.

Source: Authors' work based on Mundell (1963)

[30] With a crawling peg, the central bank declares the extent of the exchange rate movements in advance, changing the exchange rate constantly at this declared pace. Thus, the exchange rate changes (crawls) constantly over time, and this is where the name of this policy comes from.

3.3 Expectations channel

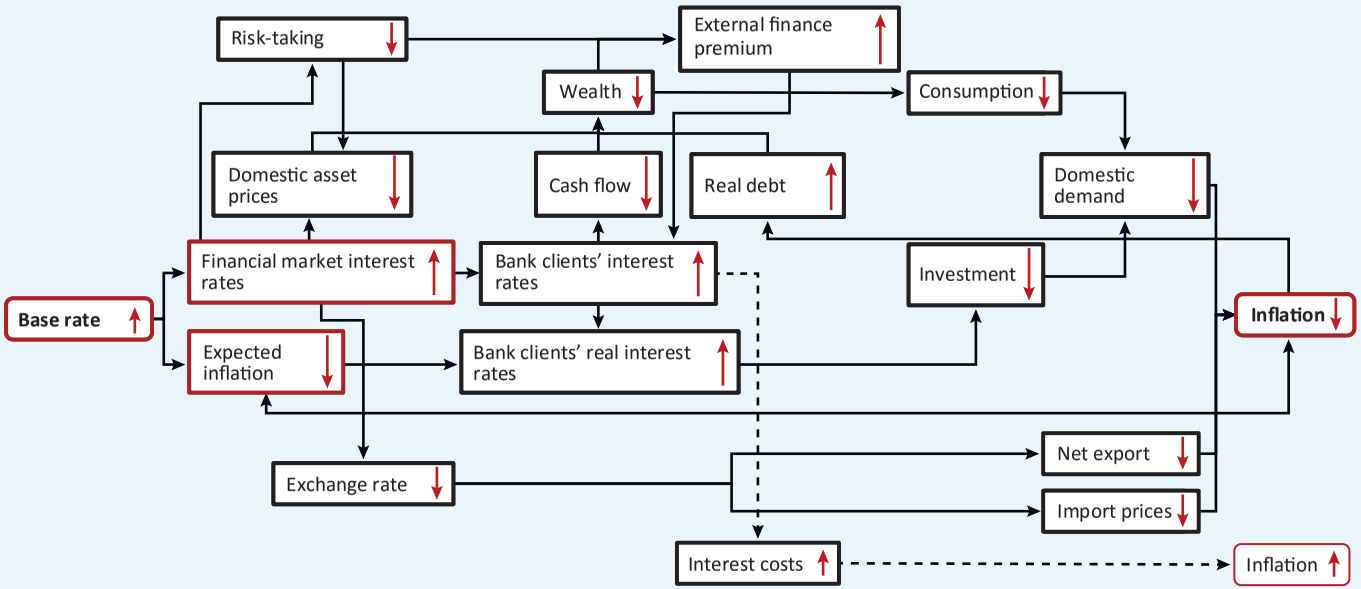
3.3.1 The expectations channel in general

The primary objective of a central bank pursuing an inflation targeting policy is price stability, which means the achievement of a predetermined, medium-term inflation target by anchoring the inflation expectations of economic actors. If expectations are successfully anchored, economic actors expect the low and stable pace of price level increase determined by the central bank over the *monetary policy horizon* and make their current medium-term and long-term economic decisions in line with that. In the context of an adequately credible central bank policy, the economic decisions taken in the light of the anchored expectations can facilitate the achievement of the inflation target in themselves. Accordingly, one of the priorities of the central bank is to be familiar with the structure of the expectations characteristic of economic actors, and to efficiently influence expectations based on that. This chapter focuses on the expectations channel of monetary policy transmission.

Economic actors have expectations regarding the effects of the future interest rate policy, which is reflected in the interest rate, inflation and exchange rate expectations. Therefore, the expectations channel of monetary policy transmission plays a role on the money markets and in companies' pricing and wage policies (Figure 12).

Depending on its objectives, the central bank may use a predictable, transparent monetary policy with a medium-term horizon, thereby strengthening its credibility, or it can make an impact in the short run with shock-like, unexpected, activist measures if it is ready to sacrifice its credibility (Bofinger 2001, p. 95). In a mechanism where institutional credibility is key from the perspective of the effectiveness of the policy, predictability and transparency become more prominent. In the context of a predictable monetary policy, economic actors feel that they can make plans for the future, which makes them more likely to make longer-term economic decisions that consistently support rising aggregate demand. In the case of an inflation targeting central bank, monetary policy goes hand in hand with a medium-term orientation and transparency. Nevertheless, if the central

Figure 12
Impact of monetary tightening through the expectations channel



Source: Authors' work.

bank has other objectives, for example concerning the real economy, it may have an incentive to make unexpected decisions, relying on the element of surprise and responding to a momentary shock, and it can actively influence a given real economy variable, for example the unemployment rate or the output gap. If economic actors trust the central bank, an unexpected step can trigger a powerful real economy effect over the short term, as the actors do not have time to prepare for it, nor do they have enough information to bring their decisions in line with the next central bank measure. Although the short-term effect is ensured, the actors will trust the central bank's policy less over the medium and long term, and thus the transmission that takes hold by anchoring expectations is less able to guarantee the achievement of price stability over the monetary policy horizon.

3.3.2 Transmission through the expectations channel

The shaping of inflation expectations affects companies' pricing decisions, and interest rate expectations shape future money market yields, while the effect exerted by monetary policy over exchange rate expectations becomes relevant in open economies. When the interest rate is increased, companies expect prices to decline in the future. They can start reducing their prices in the present, thereby contributing to the negative inflationary effect with their own activities. On financial markets, monetary policy has an effect over the different sections of the yield curve via various mechanisms. While over the short term the effects of expectations about the key interest rates take hold, long-term yields are also affected by inflation expectations and the assessments regarding the future performance of the economy. Due to the beliefs surrounding the central bank's information base, when interest rates are increased, short-term yields rise but the development of medium-term yields is uncertain (in the case of a transparent central bank), or they may rise (assuming a substantial information asymmetry between the economic actors and the central bank). In a small, open economy with a fixed exchange rate, the factors that determine the regime's sustainability and the anchoring of inflation expectations are the exchange rate and inflation expectations and the credibility of the central bank with respect to its commitment to the exchange rate.

3.3.3 Impact of the expectations channel on pricing and wage decisions

3.3.3.1 Reasons behind price and wage rigidity

Price and wage rigidity is a central factor in the expectations channel of monetary policy. The main reason behind price and wage rigidity in the economy is that changing pricing and renegotiating wages entails costs for companies, even if the changes are warranted by the variation in aggregate demand. In a changing economic environment, constant prices and wages entail welfare losses, as they constrain firms' resilience to shocks (Juhász 2008). Activist central bank measures based on the element of surprise can exert an impact on the real economy, because pricing policies and wage negotiations are often based on long-term contracts and considerations (*intertemporal price-setting* – see Bofinger 2001, p. 96). Therefore, over the short term, an unexpected monetary policy measure also affects the value of goods and production factors in real terms. In the case of a transparent and credible central bank, the short-term real economic effect of transmission takes hold on account of price and wage rigidity as well, while in the case of a communicated and expected decision, companies may base their pricing and wage decisions on the expected measure even before the decision is taken by the central bank, reducing the intensity and time profile of the effects of the future monetary policy step in the present. Another reason behind price and wage rigidity may be that businesses do not have enough information on whether the change in demand is temporary or permanent, and therefore they have fewer incentives to adjust prices and wages (Bofinger 2001, pp. 95–97).

Current inflation depends on the current expected inflation and current output. Assuming that certain companies use a flexible wage policy, while others use a rigid one, in the case of an adequately credible central bank a reduction in expected inflation may trigger adjustment steps in the present at the companies using rigid pricing (even leading to a greater price reduction than warranted). This prods other firms to introduce price cuts as well, and therefore the price level declines (Mankiw 2009, pp. 381–383). Yet there is also a demand-side effect: if output diminishes on account of the interest rate increase, aggregate demand also drops. Businesses using flexible pricing respond by reducing their prices, which leads to a general decline in prices. From this perspective, the effect of output on prices also

depends on the share of the companies employing flexible pricing (Mankiw 2009, pp. 381–383).

3.3.3.2 Development of the Phillips curve concept

Price and wage rigidity as the basis of the operation of the expectations channel calls for an explanation of the development of prices and wages. *Alban Phillips* provided a solution for this in 1958, by empirically identifying a negative correlation between the current, nominal wage inflation and the unemployment rate in the previous period even over the long term (this is the original Phillips curve – see Bofinger 2001, pp. 97–105).

Later *Samuelson and Solow* modified the original *Phillips curve* concept to allow the correlation to explain the current inflation rate as well. According to them, wage inflation can be expressed as the sum of the productivity growth rate and the inflation rate if the company uses *markup pricing*.[31] Assuming that the pace of productivity growth is constant, there is also a negative correlation between the unemployment rate and the inflation rate for the given period.

The increasing inflation in the 1960s raised the necessity of distinguishing between nominal and real value. *Friedman and Phelps* then supplemented the concept with inflation expectations, while drawing on Phillips's results and assuming that wage negotiations are conducted for raising real wages rather than nominal wages.

This is how the *expectations-augmented modified Phillips curve* theory arose, in which, when productivity growth is constant, the inflation rate is determined by the unemployment rate from the previous period and inflation expectations.

Further theories can be found in the literature, for example Friedman's where expected inflation cannot influence unemployment over the long term, and therefore the *long-term Phillips curve* is derived as a vertical line, while the short-run variety exhibits a negative slope.

Nevertheless, the role of expectations has become truly relevant in the latest approaches. The new perspectives on the Phillips curve are based on the so-called *Taylor model*, according to which current inflation is determined by

[31] The price of a particular product is the average cost of production plus a fixed percentage.

the expected inflation in the next period and the output gap in the present period. Since this method uses the output gap instead of the unemployment rate, this is also referred to as the *new Phillips curve*. However, these models still do not take into account the fact of price and wage rigidity.

This shortcoming was sought to be addressed by *Fuhrer and Moore*, with a model where inflation in the given period can be expressed as the sum of the average of the inflation in the previous period and that expected for the next period, a term depending on the output gap and an error term. The Fuhrer–Moore formula assumes the presence of both price and wage rigidity. On the other hand, *Walsh* assumes that while wage rigidity is characteristic of the economy, price rigidity is not. Despite the two contrasting assumptions, both models lead to the same numerical results.

If it is also assumed that wages are determined in the given period only for the next one, and that inflation in the given period is unknown at the time of the wage negotiations, in the context of price and wage rigidity, wage inflation can be expressed as the sum of the expected inflation and a term depending on economic activity. If it is assumed that wage inflation equals price inflation, the inflation for the given period can be expressed as the sum of the expected inflation for the given period and a term depending on economic activity. This concept is the same as the previously mentioned expectations-augmented Phillips curve approach, using the output gap instead of the unemployment rate (therefore this might be called the *traditional expectations-augmented new Phillips curve*). In view of the fact that the new Phillips curve approaches lead us back to the expectations-augmented Phillips curve, this method has recently become the most widespread:

$$\pi_t = \pi_t^e + \alpha y_t, \tag{9}$$

where π_t denotes inflation in the tth period, π_t^e is the expected inflation for t, y_t denotes the output gap, and α is a positive coefficient.

3.3.3.3 Theories for inflation expectations

Several theories seek to explain how companies' inflation expectations are formed. Since expectations play a crucial role in the Phillips curve concepts,

the conceptual framework used for describing them in the literature should be analysed.

Based on *extrapolative expectations*, the inflation expected for the next period is the same as the inflation rate in the previous period. According to a modified version of the theory, expected inflation can be derived as the weighted average of the inflation values in the previous *n* periods (Bofinger 2001, pp. 105–108).

When *adaptive expectations* are used, economic actors determine the expected inflation depending on the inflation expected for the previous period and the difference between that expectation and the actual data. Accordingly, this approach includes a term that represents the expectation error in the previous period. Since the current expectation can be used to derive the earlier inflation rates recursively, this form of expectations is similar to a modified version of the extrapolative expectations.

According to the *rational expectations* theory developed by Muth (1961) and Lucas (1976), economic actors do not determine their expectations regarding current inflation based on past inflation data, but on an economic model using all the information available at the time of the forecast. In this view, the available information is more important from the perspective of inflation expectations than the shaping and accuracy of earlier expectations. One strong assumption of this approach is that there is an optimal model that is the same for all actors, and that the same information base leads to the same inflation expectations for everyone.

The *bounded rationality* theory incorporates the limited nature of projections from a cognitive and computing perspective, and therefore a retrospective and adaptive approach is preferred. Nevertheless, economic actors also use the complex information base available at the time of greater shocks to the economy for shaping their expectations, in line with rational expectations.

According to empirical results, the traditional, expectations-augmented Phillips curve (current inflation depends on the currently expected inflation and the output gap) seems to be confirmed, in which expectations are highly adaptive (the results of Rudebusch [2000] show that the inflation rate may follow an AR(2) process).

3.3.4 Expectations channel of an open economy

In a small, open economy, expectations concerning exchange rates play a relevant role in shaping inflation expectations (Bofinger 2001, p. 409). In the case of a fixed exchange rate, if the commitment proves to be credible, the exchange rate anchor may be an important starting point in wage negotiations. Accordingly, the direct inflationary impact of a fixed exchange rate is strengthened by the indirect effects of wages and costs. Bofinger found that the goal of the fixed exchange rate policies in the 1980s and 1990s was to stabilise inflation expectations, on account of the positive experiences with inflation in credible exchange rate regimes. However, if economic actors do not believe that the central bank can maintain the fixed exchange rates, their inflation expectations will remain high even after the regime is introduced, since they expect the exchange rate to depreciate in the future, and wage agreements are negotiated in the light of this. When the exchange rate is fixed, this may lead to appreciation in real terms, which, due to the reduction in competitiveness, ultimately puts the central bank under pressure to devalue the currency. All in all, the commitment to the exchange rate is abandoned due to the erosion of the belief in the central bank's credibility, which permanently impairs the central bank's credibility. It can be seen that in a fixed exchange rate regime and a small, open economy, inflation expectations are pivotal. In line with the principle of purchasing power parity, the monetary policy of the anchor currency's country will dominate from the perspective of monetary policy transmission, while imported inflation effects take hold.

3.3.5 Expectations channel on money markets

The yield curve provides information on the expectations of economic actors regarding the future development of nominal interest rates and inflation. According to the expectations hypothesis of the yield curve, the yield corresponding to a given longer maturity equals the average of the *expected* yields of the subsequent short-term securities purchases in this period, weighted by maturity. The expectations about the short-term section of the yield curve are determined by the expected development of the key interest rates. In the middle section of the yield curve, the beliefs regarding expected inflation and the central bank's stance dominate, while the yields of long-term assets are

mostly affected by inflation expectations and structural factors, such as central bank credibility or the longer-term prospects of the economy.

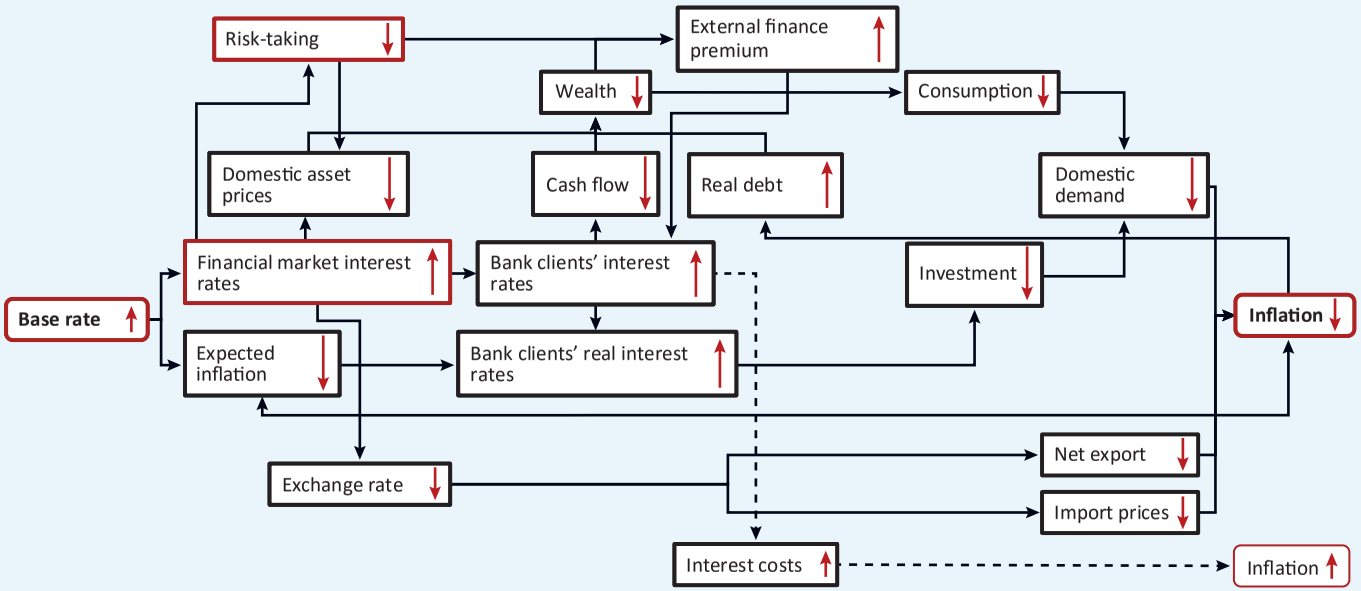
Depending on the perception of the central bank's transparency, the policy rate may impact the shape of the yield curve differently (Thorbecke–Zhang 2008). An interest rate increase by the central bank entails a rise in the short-term section of the yield curve, while assuming that inflation expectations are anchored in the long run, in theory conventional central bank interest rate policy cannot affect the long end of the yield curve. Since monetary policy can exert its impact over the medium term (2–5 years), a monetary policy tightening ideally leads to a *drop* in inflation expected over the medium term. At the same time, the tightening lifts the medium-term real interest rate, and the result of these two effects is uncertain. This process occurs if economic actors assume that the central bank has made the decision on the interest rate increase based on the information that is also available to them. However, if economic actors assume that the central bank has an information advantage over them, an interest rate increase may be perceived as a preliminary step to fend off the effects of an expected inflationary shock. As a result, when the policy rate is increased, the medium-term expectations of economic actors *increase*, since they start to expect the inflationary shock. When real interest rates are constant, this entails higher nominal interest rates. Therefore, if the short end and middle section of the yield curve change in the same direction in the wake of an interest rate increase, this may suggest limited central bank transparency.

3.4 Risk-taking channel

3.4.1 The risk-taking channel in general

The basis of the risk-taking channel is the change in the risk appetite of investors or lenders as a result of a shift in the policy rate. According to the traditional approach to the risk-taking channel, the direction of the central bank's interest rate move is contrary to the extent of investors' risk appetite. Borio and Zhu (2008) introduced the concept of this channel and defined it as the effect of the interest rate policy on risk perception and risk-tolerance, which ultimately takes hold in the risk of investor portfolios, asset prices and the qualitative and quantitative features of lending (Figure 13). In this sense,

Figure 13
Impact of monetary tightening through the risk-taking channel



Source: Authors' work.

the risk-taking channel is linked to the operation of the asset price and balance sheet channel, contributing to their real economy impact.

When the central bank raises the interest rate, reduced risk-taking can be expected, which can take hold in two different ways: through the shaping of investor portfolios and the search for yield of financial institutions providing a fixed yield. In the so-called traditional portfolio allocation approach, higher risk-free yields indicate to investors that the yield on safer assets has increased; therefore, they reduce the share of their riskier assets and increase the weight of safer ones, thereby transforming the risk structure of their portfolios (Dell'Ariccia–Laeven–Suarez 2016). The negative impact of the policy rate on risk-taking is strengthened by incentives of certain financial institutions for the search for yield. Guaranteeing fixed yields to investors by dynamically shaping the maturity and risk structure of their portfolios is a widespread practice among investment and pension funds. In the context of monetary policy easing,[32] risk-free yields contract, and therefore fixed yields can only be guaranteed when taking greater risk, i.e. increasing the proportion of riskier assets.

3.4.2 Banks' risk-taking channel

Interest rate policy influences not only the quantity but also the quality of credit (Dell'Ariccia–Laeven–Suarez 2016). Dell'Ariccia et al. examined the features of the risk-taking channel in 2016, focusing on the banking sector, depending on the capitalisation of banks and other financial institutions. While in the case of the balance sheet channel of the credit channel, commercial banks determine the external finance premium based on the assumed risk appetite of borrowing companies, the essence of banks' risk-taking channel of monetary policy transmission is the change in the risk-taking of the bank or the financial institution extending the loan on account of a shift in the central bank's interest rate policy. While in the case of the balance sheet channel the external finance premium set by the bank depends only on the riskiness of the credit applicant, in the case of the risk-taking channel, the risk appetite of the bank as the lending party is also taken into consideration, and the latter is also indicative of the risk-tolerance that depends on the prevailing monetary

[32] In contrast to the practice used in the study so far, for purposes of clarity, the risk-taking characteristics arising from the search for yield are presented through the reduction of the policy rate.

conditions. Banks' risk-taking channel differs from the bank lending channel of the credit channel in that in the latter the commercial bank acquires funds, i.e. it acts as a borrower, therefore the channel is dominated by the risk taken by the borrower, while in the case of the risk-taking channel, banks as lenders decide on extending the loan, based on their own risk-taking attitude.

In the case of a bank with weak capitalisation, an interest rate increase by the central bank may also trigger a rise in risk-taking through another effect. Dell'Ariccia et al. found that the traditional portfolio restructuring effect applies to banks irrespective of their capitalisation, while the search for yield mostly affects banks and other financial institutions with poorer capitalisation. They also identified a so-called *risk-shifting* effect, in which, in contrast to the two processes presented above, the extent of risk-taking is in a positive relationship with the policy rate. Financial institutions with a poor capital position face an increase in their funding costs when interest rates are raised, which influences their lending activities as well. It could be seen in the case of the balance sheet channel that the capital position of companies deteriorates when interest rates are raised, therefore firms have an incentive to greater risk-taking and increasing the information asymmetry. In the balance sheet channel concept, banks respond to this by raising the external finance premium irrespective of their own capital position, thereby skimming off the less risky customers. Nevertheless, the risk-shifting effect that takes hold through banks' risk-taking channel paints a more nuanced picture. Banks with poorer capital position seek to improve their profitability in the wake of an interest rate increase, taking on excess risk when lending, as their main motivation is to stabilise their capital position rather than to reduce risk-taking. As a result, an interest rate increase leads to greater risk appetite in the case of banks with a weaker capital position.

The strength of the risk-taking channel depends on how much the given bank can pass on the change in the risk-free interest rate to lending rates, and on the extent of the change that can be implemented in the capital structure in the wake of the change (Dell'Ariccia–Laeven–Suarez 2016). Based on the results presented above, well-capitalised banks and other financial institutions are characterised by the traditional portfolio allocation model; therefore, the negative correlation between risk-taking and the direction of the interest rate move is straightforward in their case. The impact

is less pronounced in the case of institutions with a weaker capital position, as according to the results of Dell'Ariccia et al., they may be characterised by either being subject to the traditional portfolio allocation effect (negative correlation), by risk-taking (positive correlation) or by the search for yield (negative correlation). Based on the empirical results of the authors, in the case of well-capitalised banks in the USA, the negative correlation between the direction of the interest rate move and risk appetite is stronger.[33]

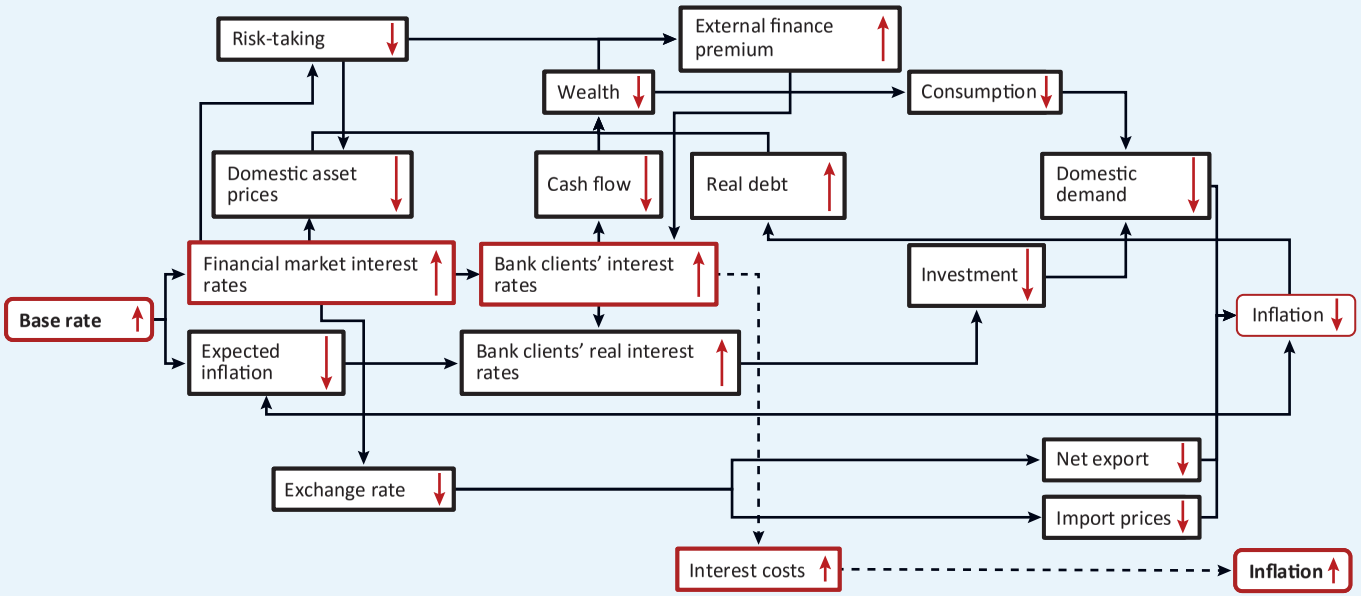
3.5 Cost channel

If the marginal cost of a company depends directly on nominal interest rates, an interest rate increase by the central bank may induce a rise in the company's prices (Ravenna–Walsh 2006). A change in the policy rate primarily affects short-term interest rates. If a company can ensure the short-term production capacities (current assets, wages) by borrowing short-term loans, the interest rate increase lifts the utilisation costs of production factors, which may encourage the company to raise its prices (Figure 14). For the first time, empirical evidence for this phenomenon was provided by Barth and Ramey (Barth–Ramey 2001). The effect of passing through the cost channel exerts its impact on prices through the company's marginal cost, and therefore the cost channel is equivalent to a supply-side channel. If the existence of the cost channel can be proved, the result of monetary policy on inflation is determined by the relative strength of the effects taking hold through the change in aggregate demand and the cost channel.

If the existence of the cost channel can be proved, it can force the central bank to make a trade-off between stabilising inflation and output in the case of *all* types of shocks (Ravenna–Walsh 2006; Gaiotti–Secchi 2006). If this is the case, the optimal monetary strategy is a more cautious interest rate policy, since achievement of the inflation target and stabilisation of output would require measures that point in opposite directions in response to the given shock.

[33] The authors contrast two opposing views with respect to the risk-taking channel. They refer to the scenario when the traditional portfolio allocation and the risk-shifting effect take hold together as the traditional risk-taking channel, while in the case of the search for yield, they highlight the maturity mismatch between the assets and liabilities held in the portfolio as the driver behind the channel. Based on their empirical results, the traditional risk-taking channel takes hold in the US banking system.

Figure 14
Impact of monetary tightening through the cost channel



Source: Authors' work.

In the short run, the cost channel may dominate the demand-side inflation effects of monetary policy (Barth–Ramey 2001; Gaiotti–Secchi 2006). The cost channel affects companies' marginal cost through the interest rate on short-term credit instruments. Accordingly, the theory and the empirical results by Barth and Ramey point towards the short-term effect of the cost channel, which may explain the so-called *price puzzle* phenomenon. This refers to the fact that after an interest rate increase, the inflation rate soars for a short time before it starts declining in line with intuitions.

The existence of the cost channel can explain three empirical phenomena that contradict the theory (Barth–Ramey 2001; Gaiotti–Secchi 2006):

1. According to empirical results, the real economy effect of monetary policy shocks is stronger and more persistent than suggested by the *classical dichotomy* principle.

2. Price puzzle: the price level jumps in the short run in the wake of monetary tightening.

3. In the short run, the impact of a monetary shock on the major macroeconomic variables is much more similar to the effects of technological shocks than demand-side shocks.

The empirical results related to the existence of the cost channel and the explanation of the price puzzle phenomenon are uncertain. In 2001, Barth and Ramey provided empirical evidence for the existence of the cost channel in the industrial sector. Based on their results, Ravenna and Walsh concluded that the hypothesis about the existence of the cost channel cannot be refuted, which tallies with the results of Castelnuovo (2007). In a study examining 2,000 Italian companies, Gaiotti and Secchi pointed out that companies' interest rate exposure exerts a significant effect on their pricing, but they were unable to refute the hypothesis that this takes hold through companies' current assets during the production process. Rabanal (2003) has found that the cost channel takes hold only weakly, but a stronger effect can be identified in the USA than in the euro area.

4 Empirical results

4.1 General results

In the literature, so-called structural vector autoregressive (SVAR) models are used for measuring the effects of monetary policy on price level and output. These are multivariate models (simultaneous equations) in which the relationships between the variables are subject to constraints reflecting correlations from macroeconomics (Ábel–Kóbor 2010). Separate equations are stated for the different variables of the VAR model, and the equations of all variables contain the lagged values of their own variables and those of the other variables. The impact mechanism of monetary policy shocks on all the variables of the VAR model can be examined in this framework (so-called impulse response functions).[34]

According to a common observation, the impulse response of output to a monetary tightening shock is hump-shaped, while prices do not always respond in line with the theory (Walsh 2010, pp. 21–32). Output declines after a restrictive shock, and the effect reaches its minimum (absolute maximum) in a couple of months and then gradually tapers off. This hump-shaped impulse response may be due to the lag of the economy's adjustment on the one hand, and the fact that monetary policy also responds to monetary policy shocks on the other hand (i.e. the shock influences monetary policy on a sustained basis). By contrast, the price puzzle emerges in several cases with respect to the impulse response of the price level:[35] i.e. a tightening monetary policy shock is followed by a rise in prices. In the literature, the price puzzle is sought to be managed by including commodity prices in the VAR as well, as a variable reflecting the central bank's additional information capturing expected inflation. However, this approach is also not always successful.

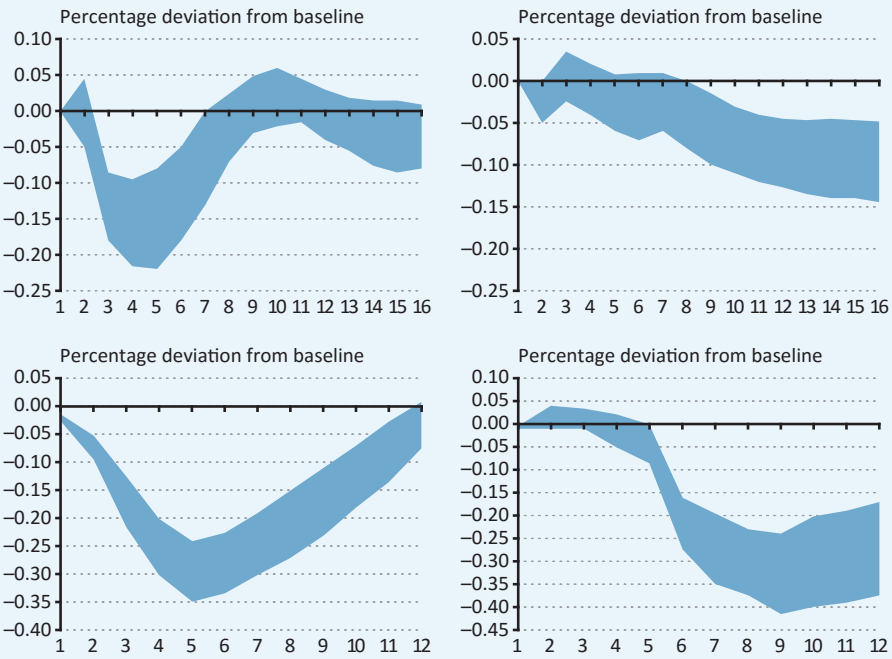
The pre-crisis estimate of the European Central Bank and the Bank of England shows that the negative effect of monetary tightening on output

[34] For more details on VAR models, see Hamilton (1994, pp. 257–350).

[35] See subchapter 3.5. on the cost channel for the price puzzle.

is temporary, while prices permanently drop in the euro area and the United Kingdom (ECB 2000 and BoE 2005). The impulse response of real GDP reaches its minimum (absolute maximum) over a 1–1.5-year horizon, while the price level (ECB) or inflation (BoE) remain below the initial value over the whole forecast horizon (i.e. even 3–4 years after the shock, Figure 15). In addition, it can be observed that prices adjust to the shock slower than output.

Figure 15
Responses to a temporary interest rate shock



Note: the upper row shows the results of the ECB, while the lower shows the results of the BoE. The left-hand panels indicate real GDP response, while the right-hand ones indicate that of prices. The temporary interest rate shock amounts to 25 basis points in the case of the ECB and 100 basis points in the case of the BoE. The time axis shows quarters.

Source: ECB (2000), BoE (2005).

4.2 The relative strength of the individual transmission channels – Advanced economies

Prior to the crisis, both the Bank for International Settlements and the ECB conducted a study in which they examined the impact of monetary

policy shocks in advanced economies. The decomposition of the effects of the shock for the individual transmission channels can be found in Smets (1995), McAdam–Morgan (2001) and Van Els et al. (2001). The BIS ran a central bank model comparison project in 1995, and similar work was conducted at the ECB in 2001 based on the earlier project of the BIS. Both working groups analysed the effect of a 100-basis point base rate increase over 2 years. The BIS study focused on the most advanced countries (G7), while the ECB's study was limited to the euro area. Various central bank models and comprehensive, multi-country models were used in the simulations.

The BIS and the ECB distinguished different transmission channels than this study in Chapter 3, but the systems do overlap in some respects.

- The BIS determined the *income/cash flow channel*, which captures the transmission through the net interest payments of various sectors. The rise in yields increases the income of net lenders, while lowering that of net debtors, especially if financial assets are short-term or floating-rate.
- The *wealth channel* was understood to be the effect of interest rates on asset prices, which influences households' wealth and thus also consumption.
- The *substitution effect* and the *cost of capital channel* were distinguished. The former is the direct interest rate channel of consumption, while the latter is that of investments.
- The *exchange rate channel* was understood to mean the same as in the present study.

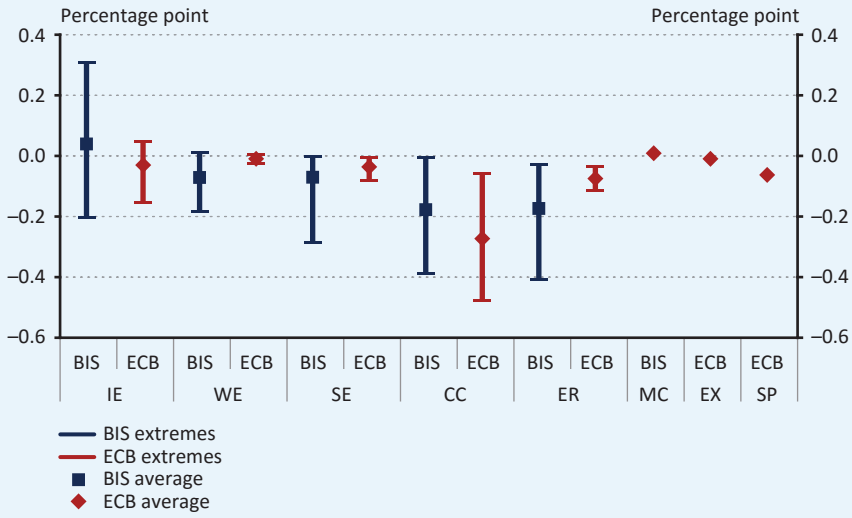
In addition to the above, the ECB identified three further channels:

- The *monetary channel* captures the impact of interest rates on inflation through the so-called *price gap*. The price gap means the difference between the current price level and the equilibrium level. In this view, the rise in interest rates reduces the M3 monetary aggregate and the equilibrium price level, thereby lowering prices.
- The *expectations channel* means the direct impact of base rate changes on inflation expectations.

• Finally, the *spillover effect* distinguishes the impact of the changes in external demand.

Different estimates have reached similar results with respect to the relative strength of the individual transmission mechanisms. In both the BIS and the ECB simulations, the strongest effect on both real GDP and the price level was exerted by the cost of capital channel and the exchange rate channel (Figures 16 and 17). However, it should be noted that the response of output is much more pronounced than that of prices. One interesting aspect of the BIS results is that the income effect on output is positive on average, i.e. an interest rate increase boosts GDP through this channel. This is due to the fact that in most of the countries under review, the net investment position of the private sector is positive, i.e. the value of financial assets is greater than that of liabilities. Therefore, investment income

Figure 16
Impact of monetary tightening on real output in advanced economies – Decomposition

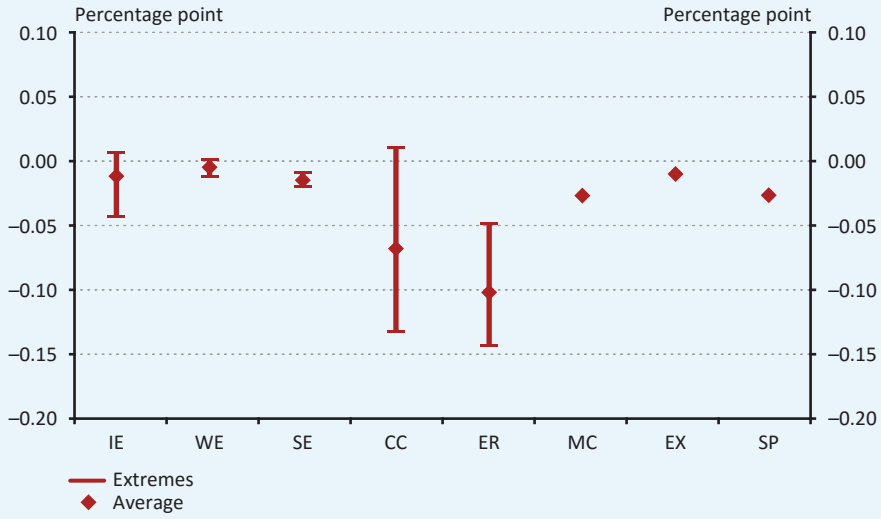


Note: the average contribution of the individual channels to the divergence of output from the baseline scenario in the three years following the shock. IE = income effect, WE = wealth effect, SE = substitution effect, CC = cost of capital, ER = exchange rate channel, MC = monetary channel, EX = expectations, SP = spillover. The vertical dispersion of the values is due to the different results of the different countries and models. The averages are ordinary arithmetic means.

Source: Authors' work based on Smets (1995), McAdam–Morgan (2001) and Van Els et al. (2001)

is lifted by an interest rate increase. However, in the case of price level, the average income effect is negative, albeit its value is near zero.

Figure 17
Impact of monetary tightening on price level in the euro area – Decomposition



Note: the average contribution of the individual channels to the divergence of the price level from the baseline scenario in the three years following the shock. IE = income effect, WE = wealth effect, SE = substitution effect, CC = cost of capital, ER = exchange rate channel, MC = monetary channel, EX = expectations, SP = spillover. The vertical dispersion of the values is due to the different results of the different models. The averages are ordinary arithmetic means.

Source: Authors' work based on McAdam–Morgan (2001) and Van Els et al. (2001).

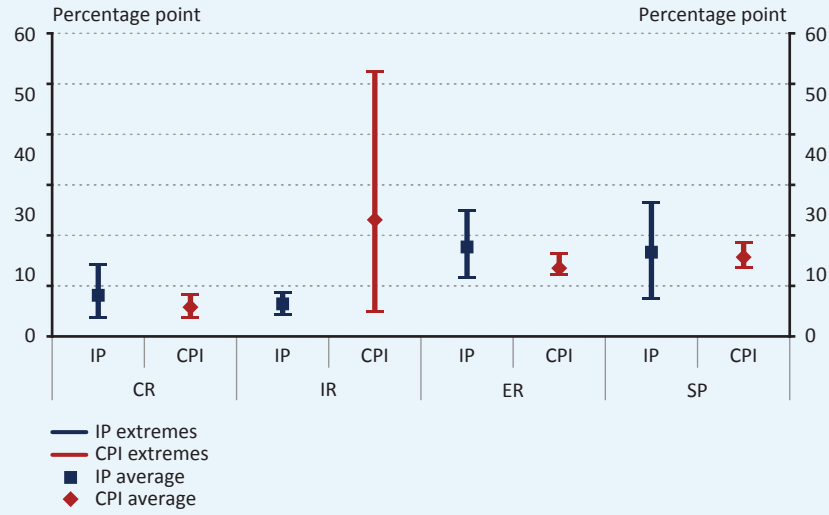
4.3 The relative strength of the individual transmission channels – Emerging economies

Tahir (2012) provides an overview of the relative strength of transmission channels with respect to emerging economies. His analysis focuses on the relative importance of the transmission mechanisms of Brazil, Chile and South Korea. He identifies and examines four channels: *credit channel, interest rate channel, exchange rate channel* and *share price channel*. The interest rate channel is interpreted in the money view; the credit channel and the exchange rate channel are understood to mean the same as in the present study; and the share price channel is an alternative approach to the Tobin's q effect. With respect to its methodology, Tahir's analysis differs from the technique used

by the BIS and the ECB. The study builds a SVAR model, but it presents the forecast error variance decomposition of various shocks instead of the impulse response of monetary policy shocks. The four types of shocks correspond to the four types of transmission channels.

According to Tahir's results, the exchange rate channel and the share price channel usually dominate in the emerging countries under review. This is because the largest portion of the forecast error variance of industrial production (as the approximation of output) is explained by these two channels (Figure 18). The author reached a similar conclusion in the case of consumer prices, except for Chile, where the interest rate channel dominates.

Figure 18
Decomposition of transmission channels in emerging economies



Note: IP = industrial production, CPI = consumer price index. Forecast error variance decomposition of the two indicators for four types of shocks (contributions at the end of the third year). CR = credit channel, IR = interest rate channel, ER = exchange rate channel, SP = share price channel. The vertical dispersion of the values is due to the different results of the different countries. The averages are ordinary arithmetic means. Higher values mean stronger channels.

Source: Authors' work based on Tahir (2012).

5 Conclusion

After the overview of the traditional *theories* of monetary policy transmission, it can be concluded that monetary tightening affects both nominal and real variables in the short run, but that the long-term effect on the real economy is not straightforward. According to the standard New Keynesian model for both closed and open economies, monetary policy shocks exert an effect on the real economy only in the short run, affecting only the nominal variables over the long term. As a result of a tighter monetary policy, real GDP temporarily falls (providing a hump-shaped impulse response), and then it returns to its long-run equilibrium value. Inflation gives a similar response, but this also means that monetary tightening has a sustained negative effect on price levels. Nevertheless, not all models reflect these results. For example, in the case of open economies, in the Obstfeld–Rogoff model monetary policy influences real GDP even in the long run, through the international wealth distribution effect. In addition, monetary policy exerts a long-term effect on the real economy in the hysteresis theory as well. The theory contains further uncertain aspects. One example is the issue of the direct interest rate channel. According to the credit view that revised the traditional money view, *besides* influencing short-term interest rates, monetary policy *also* has an effect on aggregate demand by influencing the availability or terms of new bank loans. By contrast, in line with the banking view, the impact of monetary policy on interbank rates cannot be separated from the effect on credit supply, since they emerge together, and there is no point in talking about a bank lending channel.

In *practice*, a consensus seems to be emerging that the effect of monetary tightening on real GDP is hump-shaped, and that the two strongest transmission mechanisms are the interest rate and the exchange rate channel. For example, the analysis of both the ECB and the BoE also found that tighter monetary policy reduces output and prices. The restriction affects real GDP faster, but for a shorter time than prices. This means that prices fall slower but more steadily. Nevertheless, the price puzzle phenomenon is also present in the literature, and according to it raising the base rate does not

reduce but increases prices, and this anomaly cannot always be resolved. In this sense, it can be argued that there is also no full consensus regarding empirical results. It calls for caution in connection with the relative strength of the transmission channels that this survey was conducted in the 1990s and the early 2000s in advanced economies, and the transmission mechanism may have changed since then, and that in the case of emerging economies the available sample included merely three countries. Taking these constraints into account, it can be stated that the cost of capital channel (a subchannel of the interest rate channel) and the exchange rate channel have proven to be the strongest in advanced economies from the perspective of both real GDP and prices. In the three emerging countries under review, the so-called share price channel (a special version of Tobin's q, which in this sense can also be classified under the interest rate channel) dominated in addition to the exchange rate channel. Therefore, all in all it can be concluded that in the economies and periods under review, transmission was dominated by the interest rate channel and the exchange rate channel.

6 References

Altavilla, C.–Ciccarelli, M. (2007): Inflation Forecasts, Monetary Policy and Unemployment Dynamics, Evidence from the US and the Euro Area. European Central Bank, Working Paper Series No 725 – February 2007.

Andersen, L.–Jordan, J. (1968): Monetary and Fiscal Actions: A Test of Their Relative Importance in Economic Stabilization. Federal Reserve Bank of St. Louis Review 50 (Nov.): 11–24.

Artus, J. R.–Knight, M. (1984): Assessment of the Exchange Rates of Industrial Countries, Occasional Paper 29, Washington, D.C.: International Monetary Fund, Table 4.

Ábel, I.–Kóbor, Á. (2010): A monetáris restrikció hatása strukturális VAR keretben (The effect of monetary restriction in a vector autoregression framework). Economic Review, Volume LVII, May 2010, pp. 412–430.

Bain, K.–Howells, P. (2009): Monetary Economics: Policy and Its Theoretical Basis. Second edition. Palgrave Macmillan, Hampshire, England.

Barth, J. M.–Ramey, V.A. (2001): The Cost Channel of Monetary Transmission. NBER Macroeconomics Annual 2001, Volume 16.

Beenstock, M.–Ilek, A. (2005): Wicksell's Classical Dichotomy: Is the Natural Rate of Interest Independent of the Money Rate of Interest? Bank of Israel, Monetary Department, Monetary Studies, Discussion Papers – December 2005.

Benmelech, E.–Bergman, N.K. (2011): Bankruptcy and the Collateral Channel. The Journal of Finance, Vol. LXVI, No. 2. April 2011, pp. 337–378.

Bernanke, B. S. (1983): Non-Monetary Effects of the Financial Crisis in the Propagation of the Great Depression. American Economic Review, vol. 73 (June), pp. 257–76.

Bernanke, B. S. (1993): Credit in the Macroeconomy. FRBNY Quarterly Review. Spring 1992/93.

Bernanke, B. S. (2003): Remarks by Governor Ben S. Bernanke At the Federal Reserve Bank of Dallas Conference on the Legacy of Milton and Rose Friedman's Free to Choose. Dallas, Texas, October 24, 2003.

Bernanke, B. S. (2007): The Financial Accelerator and the Credit Channel. Speech at The Credit Channel of Monetary Policy in the Twenty-first Century Conference, Federal Reserve Bank of Atlanta, Atlanta, Georgia. June 15, 2007.

Bernanke, B. S.–Blinder, A. S. (1988): Credit, Money, and Aggregate Demand. American Economic Review, May 1988, 435–39.

Bernanke, B. S.–Gertler, M. (1989): Agency Costs, Net Worth and Business Fluctuations. American Economic Review, vol. 79 (March), pp. 14–31.

Bernanke, B. S.–Gertler, M.–Gilchrist, S. (1994): The Financial Accelerator and The Flight to Quality. NBER Working Paper No. 4789.

Békési, L.–Köber, Cs.–Kucsera, H.–Várnai, T.–Világi, B. (2016): Az MNB makrogazdasági előrejelző modellje (The macroeconomic forecasting model of the MNB), MNB Working Papers 2016/4.

Blanchard, O. J.–Summers, L. H. (1986): Hysteresis and the European unemployment problem. NBER Macroeconomics Annual 1986, Vol. 1, MIT Press.

Bank of England (BoE) (2005): The transmission mechanism of monetary policy. The Monetary Policy Committee, Bank of England.

Bofinger, P. (2001): Monetary Policy: Goals, Institutions, Strategies, and Instruments. Oxford University Press

Bofinger, P.–Wollmershauser, T. (2003): Managed floating as a monetary policy strategy. Economics of Planning, 36(2), 81–109.

Bofinger, P.–Mayer, E.–Wollmershauser, T. (2006): The BMW model: A new framework for teaching monetary economics. The Journal of Economic Education, 37(1), 98–117.

Borio, C.–Zhu, H. (2008): Capital regulation, risk-taking and monetary policy: A missing link in the transmission mechanism? BIS, Working paper No 268.

Brayton, F.–Levin, A.–Tryon, R.–Williams, J. C. (1997): The Evolution of Macro Models at the Federal Reserve Board; Washington, D.C. 20551

Carlin, W.–Soskice, D. (2005): The 3-Equation New Keynesian Model – A Graphical Exposition. In: Contributions to Macroeconomics. Vol. 5, Issue 1, Article 13.

Castelnuovo, E. (2007): Cost Channel and the Price Puzzle: The Role of Interest Rate Smoothing. University of Padua. November 2007.

Czech National Bank (CNB) (2013): What We Know About Monetary Policy Transmission in the Czech Republic: Collection of Empirical Results. Research and Policy Notes 1/2013.

Coric, B. (2011): The financial accelerator effect: concept and challenges. Financial Theory and Practice, Institute of Public Finance, Vol. 35(2), pp. 171–196.

Csávás, Cs.–Kollarik, A. (2016): Effect of the Self-financing Programme on monetary conditions. In: Hoffmann, M.–Kolozsi, P. P. (eds.): The first two years of the Self-financing Programme. Volume of studies. pp. 67–93.

Dell'Ariccia, G.–Laeven, L.–Suarez, G. (2016): Bank leverage and monetary policy's risk-taking channel. VOX, CEPR's Policy Portal, 2 August 2016.

Disyatat, P. (2010): The bank lending channel revisited. BIS Working Papers No 297.

Eggertsson, G. B–Krugman, P. R. (2012): Debt, Deleveraging and the Liquidity Trap: a Fisher-Minsky-Koo Approach, Quarterly Journal of Economics, 127(3), 1469–1513.

Eggertsson, G. B.–Mehrotra, N. R. (2014): A Model of Secular Stagnation, NBER Working Paper, 20574.

European Central Bank (ECB) (2000): Monetary policy transmission in the euro area. ECB Monthly Bulletin, July 2000.

Fleming, J. M. (1962): Domestic financial policies under fixed and under floating exchange rates. IMF Staff Papers, 9 (November), 369–379.

Friedman, M. (1961): The Lag in Effect of Monetary Policy. In: The Journal of Political Economy, Vol. 69, No. 5, pp. 447–466.

Friedman, M. (1968): The Role of Monetary Policy. The American Economic Review, Vol. 58, No. 1. (Mar., 1968), pp. 1–17.

Friedman, M.–Schwartz, A. (1963): A Monetary History of the United States, 1867–1960. Princeton, N.J.: Princeton University Press.

Gaiotti, E.–Secchi, A. (2006): Is There a Cost Channel of Monetary Policy Transmission? An Investigation into the Pricing Behavior of 2,000 Firms. Journal of Money, Credit and Banking, Vol. 38, No. 8 (Dec., 2006), pp. 2013–2037.

Gale, W.–Sabelhaus, J. (1999): Perspectives on the household savings rate. Brookings Papers on Economic Activity, Vol. 1999, No. 1, pp. 181–224

Hamilton, J. D. (1994): Time Series Analysis. Princeton University Press. Princeton, New Jersey.

Hicks, J. R. (1937): Mr. Keynes and the "Classics"; A Suggested Interpretation; Econometrica, Vol. 5, No. 2 (Apr., 1937), pp. 147–159.

Hooper, P.–Johnson, K.–Marquez, J. (2000): Trade elasticities for the G7 countries. Princeton University: Princeton Studies in International Economics, No. 87, Department of Economics.

Juhász, R. (2008): The optimal rate of inflation and the inflation target: international experience and the Hungarian perspective. MNB Bulletin, September 2008, pp. 30–37.

Kálmán, P.–Makay, E.–Tóth, D. (2016): Foreign Exchange Market. MNB Handbooks, No. 7.

Kiley, M. (2000): Identifying the effect of stock market wealth on consumption: pitfalls and new evidence. Board of Governors of the Federal Reserve System.

Kohn, M. (1998): Bank- és pénzügyek, pénzügyi piacok (Money, Banking and Financial Markets). Osiris Kiadó – Nemzetközi Bankárképző. Budapest.

Komáromi, A. (2008): A monetáris aggregátumok szerepe a monetáris politikában (The role of monetary aggregates in monetary policy). MNB Occasional Papers 71.

Krekó, J.–Balogh, Cs.–Lehmann, K.–Mátrai, R.–Pulai, Gy.–Vonnák, B. (2012): International experiences and domestic opportunities of applying unconventional monetary policy tools. MNB Occasional Papers 100.

Lehmann, K.–Szalai, Z,–Váradi, B. H. (2017): Új szelek a gazdaságpolitikában (A new era in economic policy). MNB Professional articles, 24 February 2017.

Lerner, A. P. (1944): The Economics of Control, New York, Macmillan.

Long, C. (1953): Impact of effective demand on the labour supply. American Economic Review, Papers and Proceedings, Vol. 43, 458–467.

Lucas, R. E. (1976): Econometric Policy Evaluation: A Critique. in: The Phillips Curve and Labor Markets. Carnegie-Rochester Conference Series on Public Policy, Vol. 1: 19–46.

Mankiw, N. G. (2009): Macroeconomics. Seventh Edition. Harvard University. Worth Publishers.

Marshall, A. (1923): Money, Credit and Commerce, London, Macmillan and Co.

McAdam, P.–Morgan, J. (2001): The Monetary Transmission Mechanism at the Euro-Area Level: Issues and Results Using Structural Macroeconomic Models. ECB Working Paper No. 93.

Mishkin, F. S. (1996): The Channels of Monetary Transmission: Lessons for Monetary Policy. NBER Working Paper 5464.

Mishkin, F. S. (2001): The Transmission Mechanism and the Role of Asset Prices in Monetary Policy. NBER Working Paper No. 8617.

Mishkin, F. S. (2004): The Economics of Money, Banking, and Financial Markets. Seventh edition. The Addison-Wesley series in economics.

Magyar Nemzeti Bank (MNB) (2006): Monetáris politika Magyarországon (Monetary policy in Hungary). Third edition. Ed.: Ágnes Horváth. August 2006.

Magyar Nemzeti Bank (MNB) (2012): Monetáris politika Magyarországon (Monetary policy in Hungary). January 2012.

Modigliani, F. (1971): Monetary Policy and Consumption: Linkages via Interest Rate and Wealth Effects in the FMP Model.

Modigliani, F.–Miller, M. H. (1958): The Cost of Capital, Corporation Finance and the Theory of Investment. The American Economic Review, Vol. 48, No. 3 (Jun., 1958), pp. 261–297.

Muth, J. (1961): Rational Expectations and the Theory of Price Movements. Econometrica, 29: 315–335.

Mundell, R. A. (1963): Capital mobility and stabilization policy under fixed and flexible exchange rates. Canadian Journal of Economics and Political Sciences, 29(4), 475–485.

National Bank of Poland (NBP) (2013): Monetary policy transmission mechanism in Poland – What do we know in 2013? NBP Working Paper No. 180.

Obstfeld, M.–Rogoff, K. (1995): Exchange Rate Dynamics Redux, Journal of Political Economy 103(3): 624–660.

Obstfeld, M.–Rogoff, K. (1996): Foundations of International Macroeconomics, Cambridge, Mass.: MIT Press.

Pippenger, M. (1993): Cointegration tests of purchasing power parity: the case of Swiss exchange rates. Journal of International Money and Finance, Vol. 12, pp. 46–61.

Rabanal, P. (2003): The Cost Channel of Monetary Policy: Further Evidence for the United States and the Euro Area. IMF Working Paper WP/03/149, Monetary and Financial Systems Department, July, 2003.

Ravenna, F.–Walsh, C. E. (2006): Optimal Monetary Policy with the Cost Channel. Journal of Monetary Economics 53. (2006) 199–216.

Rudebusch, G. D. (2000): Assessing Nominal Income Rules for Monetary Policy with Model and Data Uncertainty. ECB Working Paper No. 14, Frankfurt.

Scholl, A.–Uhlig, H. (2005): New Evidence on the Puzzles. Results from Agnostic Identification on Monetary Policy and Exchange Rates, SFB 649 Discussion Paper 2005-037; Berlin: Humboldt University.

Smets, F. (1995): Central bank macroeconometric models and the monetary policy transmission mechanism. Bank for International Settlements.

Tahir, M. N. (2012): Relative Importance of Monetary Transmission Channels: A Structural Investigation; Case of Brazil, Chile and Korea. Université de Lyon.

Thorbecke, W.–Zhang, H. (2008): Monetary Policy Surprises and Interest Rates: Choosing between the Inflation-Revelation and Excess Sensitivity Hypotheses. RIETI Discussion Paper Series 08-E-031.

Tobin, J. (1969): A General Equilibrium Approach to Monetary Theory. Journal of Money, Credit and Banking, Vol. 1, No. 1 (Feb., 1969), pp. 15–29.

Van Els, P.–Locarno, A.–Morgan, J.–Villetelle, J.P. (2001): Monetary Policy Transmission in the Euro Area: What Do Aggregate and National Structural Models Tell Us? ECB Working Paper No. 94.

Walsh, C. E. (2010): Monetary Theory and Policy. Third edition. The MIT Press, Cambridge, Massachusetts.

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