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Chapter 1

INTRODUCTION

OVER THE PAST TWO DECADES, monetary economics has been among the most fruitful research areas within macroeconomics. The efforts of many researchers to understand the relationship among monetary policy, inflation, and the business cycle have led to the development of a framework—the so called New Keynesian model—that is widely used for monetary policy analysis. The present monograph offers an overview of that framework and a discussion of its policy implications.

The need for a framework that can help us understand the links between monetary policy and the aggregate performance of an economy seems self-evident. On the one hand, and in their condition as consumers, workers, or investors, citizens of modern societies have good reason to care about developments in inflation, employment, and other economy-wide variables, for those developments affect to an important degree their opportunities to maintain or improve their standard of living. On the other hand, monetary policy has an important role in shaping those macroeconomic developments, both at the national and supranational levels. Changes in interest rates have an influence on the valuation of financial assets and their expected returns, as well as on the consumption and investment decisions of households and firms. Those decisions can in turn have consequences for GDP growth, employment, and inflation. It is thus not surprising that the interest rate decisions made by the Fed, the ECB, or other prominent central banks around the world are given so much attention, not only by market analysts and the financial press, but also by the general public. It would thus seem important to understand how those interest rate decisions end up affecting the various measures of an economy's performance, both nominal and real. A key goal of monetary theory is to provide us with an account of the mechanisms through which those effects arise, that is, the transmission mechanism of monetary policy.

Central banks do not change interest rates in an arbitrary or whimsical manner. Their decisions are meant to be purposeful, that is, they seek to attain certain objectives, while taking as given the constraints posed by the workings of a market economy, in which the vast majority of economic decisions are made in a decentralized manner by a large number of individuals and firms. Understanding what should be the objectives of monetary policy and how the latter should be conducted in order to attain those objectives constitutes another important aim of modern monetary theory, in its normative dimension.

The following chapters present a framework that helps us understand both the transmission mechanism of monetary policy and the elements that come into play in the design of rules or guidelines for the conduct of monetary policy. The framework presented is, admittedly, highly stylized and should be viewed more as a pedagogical tool than a quantitative model that can be readily taken to the data. Nevertheless, and despite its simplicity, it contains the key elements (though not all the bells and whistles) found in the models being developed and used at central banks and other policy institutions.[1]

The monetary framework that constitutes the focus of the present monograph has a core structure that corresponds to a Real Business Cycle (RBC) model, on which a number of "Keynesian features" are superimposed.[2] Each of those two influences is briefly described next, in order to provide some historical background to the framework developed in subsequent chapters.

1.1 BACKGROUND: REAL BUSINESS CYCLE THEORY AND CLASSICAL MONETARY MODELS

During the years following the seminal papers of Kydland and Prescott (1982) and Prescott (1986), Real Business Cycle (RBC) theory provided the main reference framework for the analysis of economic fluctuations, and became to a large extent the core of macroeconomics. The impact of the RBC revolution had both a methodological and a conceptual dimension.

From a *methodological* point of view, RBC theory established firmly the use of dynamic stochastic general equilibrium (DSGE) models as a central tool for macroeconomic analysis. Behavioral equations describing aggregate variables were thus replaced by first order conditions of intertemporal problems facing consumers and firms. Ad hoc assumptions on the formation of expectations gave way to rational expectations. In addition, RBC economists stressed the importance of the quantitative aspects of modeling, as reflected in the central role given to the calibration, simulation, and evaluation of their models.

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[1] See, e.g., Bayoumi (2004), Christoffel, Coenen, and Warne (2008), Erceg, Guerrieri, and Gust (2006), Edge, Kiley, and Laforte (2007), Adolfson et al. (2007) for a description of some of the DSGE models used at the International Monetary Fund, the European Central Bank, and the Federal Reserve Board.

[2] That confluence of elements led some authors to label the new paradigm as the "new neoclassical synthesis." See Goodfriend and King (1997).

The most striking dimension of the RBC revolution was, however, conceptual. It rested on three basic claims:

- *The efficiency of business cycles*. Thus, the bulk of economic fluctuations observed in industrialized countries could be interpreted as an equilibrium outcome resulting from the economy's response to exogenous variations in real forces (most importantly, technology), in an environment characterized by perfect competition and frictionless markets. According to that view, cyclical fluctuations did not necessarily signal an inefficient allocation of resources (in fact, the fluctuations generated by the standard RBC model were fully optimal). That view had an important corollary: stabilization policies may not be necessary or desirable, and they could even be counterproductive. This was in contrast with the conventional interpretation, tracing back to Keynes (1936), of recessions as periods with an inefficiently low utilization of resources, which could be brought to an end by means of economic policies aimed at expanding aggregate demand.
- *The importance of technology shocks as a source of economic fluctuations*. That claim derived from the ability of the basic RBC model to generate "realistic" fluctuations in output and other macroeconomic variables, even when variations in total factor productivity—calibrated to match the properties of the Solow residual—are assumed to be the only exogenous driving force. Such an interpretation of economic fluctuations was in stark contrast with the traditional view of technological change as a source of long-term growth, unrelated to business cycles.
- *The limited role of monetary factors*. Most importantly, given the subject of the present monograph, RBC theory sought to explain economic fluctuations with *no reference to monetary factors*, even abstracting from the existence of a monetary sector.

Its strong influence among academic researchers notwithstanding, the RBC approach had a very limited impact (if any) on central banks and other policy institutions. The latter continued to rely on large-scale macroeconometric models despite the challenges to their usefulness for policy evaluation (Lucas (1976)) or the largely arbitrary identifying restrictions underlying the estimates of those models (Sims (1980)).

The attempts by Cooley and Hansen (1989) and others to introduce a monetary sector in an otherwise conventional RBC model, while sticking to the assumptions of perfect competition and fully flexible prices and wages, were not perceived as yielding a framework that was relevant for policy analysis. As discussed in chapter 2, the resulting framework, which we refer to as the *classical* monetary model, generally predicts neutrality (or near neutrality) of monetary policy with respect to real variables. That finding is at odds with the widely held belief (certainly among central bankers) in the power of that policy to influence output and employment developments, at least in the short run. That belief is underpinned by a large body of empirical work, tracing back to the narrative evidence of Friedman and Schwartz (1963), up to the more recent work using time series techniques, as described in Christiano, Eichenbaum, and Evans (1999).[3]

In addition to the empirical challenges mentioned above, the normative implications of classical monetary models have also led many economists to call into question their relevance as a framework for policy evaluation. Thus, those models generally yield as a normative implication the optimality of the Friedman rule—a policy that requires that central banks keep the short-term nominal rate constant at a zero level—even though that policy seems to bear no connection whatsoever with the monetary policies pursued (and viewed as desirable) by the vast majority of central banks. Instead, the latter are characterized by (often large) adjustments of interest rates in response to deviations of inflation and indicators of economic activity from their target levels.[4]

The conflict between theoretical predictions and evidence, and between normative implications and policy practice, can be viewed as a symptom that some elements that are important in actual economies may be missing in classical monetary models. As discussed below, those shortcomings are the main motivation behind the introduction of some Keynesian assumptions, while maintaining the RBC apparatus as an underlying structure.

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[3] An additional challenge to RBC models has been posed by the recent empirical evidence on the effects of technology shocks. Some of that evidence suggests that technology shocks generate a negative short-run comovement between output and labor input measures, thus rejecting a prediction of the RBC model that is key to its ability to generate fluctuations that resemble actual business cycles (see, e.g., Galí (1999) and Basu, Fernald, and Kimball (2006)). Other evidence suggests that the contribution of technology shocks to the business cycle has been quantitatively small (see, e.g., Christiano, Eichenbaum, and Vigfusson (2003)), though investment-specific technology shocks may have played a more important role (Fisher (2006)). See Galí and Rabanal (2004) for a survey of the empirical evidence on the effects of technology shocks.

[4] In the wake of the recent economic and financial crisis and the subsequent slow recovery, many central banks, including the Federal Reserve and the ECB, have brought down their policy rates to zero or near-zero levels. Few (if any) would interpret that policy as the result of a deliberate attempt to implement the Friedman rule. Rather, it should be viewed as an illustration of the zero lower bound on nominal interest rate becoming binding, in the face of central banks' attempt to provide further stimulus to the economy.

1.2 The New Keynesian Model: Main Elements and Features

Despite their different policy implications, there are important similarities between the RBC model and the New Keynesian monetary framework. The latter, whether in the simple versions presented below or in its more complex extensions, has at its core some version of the RBC model. This is reflected in the assumption of (i) an infinitely lived representative household, who seeks to maximize the utility from consumption and leisure, subject to an intertemporal budget constraint, and (ii) a large number of firms with access to an identical technology, subject to exogenous random shifts. Though endogenous capital accumulation, a key element of RBC theory, is absent in the basic versions of the New Keynesian model, it is easy to incorporate and is a common feature of medium-scale versions.[5] Also, as in RBC theory, an equilibrium takes the form of a stochastic process for all the economy's endogenous variables, consistent with optimal intertemporal decisions by households and firms, given their objectives and constraints, and with the clearing of all markets.

The New Keynesian modeling approach, however, combines the DSGE structure characteristic of RBC models with assumptions that depart from those found in classical monetary models. Here is a list of some of the key elements and properties of the resulting models:[6]

- *Monopolistic competition*. Prices and/or wages are set by private economic agents in order to maximize their objectives, as opposed to being determined by an anonymous Walrasian auctioneer seeking to clear all markets.
- *Nominal rigidities*. Firms are subject to some constraints on the frequency with which they can adjust the prices of the goods they sell. Alternatively, they may face some costs of adjusting those prices. The same kind of friction applies to workers—or the unions that represent them—in the presence of sticky wages.
- *Short-run non-neutrality of monetary policy*. As a consequence of the presence of nominal rigidities, changes in short-term nominal interest rates (whether chosen directly by the central bank or induced by changes in the money supply) are not matched by one-for-one changes in expected inflation, thus leading to variations in real interest rates. The latter bring about changes in consumption and investment and, as a result, on output and employment, since

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[5] See, e.g., Smets and Wouters (2003, 2007).

[6] See Galí and Gertler (2007) for an extended introduction to the New Keynesian model and a discussion of its main features.

> firms find it optimal to adjust the quantity of goods supplied to the new level of demand. The same holds true for workers in the presence of sticky wages. In the long run, however, all prices and wages adjust, and the economy reverts back to its natural equilibrium, that is, the equilibrium that would prevail in the absence of nominal rigidities.

It is important to note that the three ingredients above were already central to the New Keynesian literature that emerged in the late 1970s and 1980s, and which developed in parallel with RBC theory. The models used in that literature, however, were often static or used reduced form equilibrium conditions that were not derived from explicit dynamic optimization problems facing firms and households. The emphasis of much of that work was instead on providing microfoundations, based on the presence of small menu costs, for the stickiness of prices and the resulting monetary non-neutralities.[7] Other papers emphasized the persistent effects of monetary policy on output, and the role that staggered contracts played in generating that persistence.[8] The novelty of the new generation of monetary models has been to embed those features in a fully specified DSGE framework, thus adopting the formal modeling approach that has been the hallmark of RBC theory.

Not surprisingly, important differences with respect to RBC models emerge in the new framework. First, the economy's response to shocks is generally inefficient. Second, the non-neutrality of monetary policy resulting from the presence of nominal rigidities makes room for welfare-enhancing interventions by the monetary authority, in order to minimize the existing distortions. Furthermore, those models are arguably suited for the analysis and comparison of alternative monetary regimes without being subject to the Lucas critique.[9]

1.2.1 Evidence of Nominal Rigidities and Monetary Policy Non-Neutrality

The presence of nominal rigidities and the implied real effects of monetary policy are two distinctive ingredients of New Keynesian models. It would be hard to justify the introductions of those features in the absence of evidence in support of their relevance. Next we briefly describe some of that evidence and provide the reader with some relevant references.

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[7] See, e.g., Akerlof and Yellen (1985), Mankiw (1985), Blanchard and Kiyotaki (1987), and Ball and Romer (1990).

[8] See, e.g., Fischer (1977) and Taylor (1980).

[9] This will be the case at least to the extent that the economy is sufficiently stable so that the log-linearized equilibrium conditions remain a good approximation, and that some of the parameters that are taken as "structural" (including the degree of nominal rigidities) can be viewed as approximately constant.

1.2.1.1 EVIDENCE OF NOMINAL RIGIDITIES

Most attempts to uncover evidence on the existence and importance of price rigidities have generally relied on the analysis of micro data, that is, data on the prices of individual goods and services.[10] In an early survey of that research, Taylor (1999) concludes that there is ample evidence of price rigidities, with the average frequency of price adjustment being about one year. In addition, he points to the very limited evidence of synchronization of price adjustments, thus providing some justification for the assumption of staggered price setting commonly found in the New Keynesian model. The study of Bils and Klenow (2004), based on the analysis of the average frequencies of price changes for 350 product categories underlying the U.S. CPI, called into question that conventional wisdom by uncovering a median duration of prices between 4 and 6 months. Nevertheless, more recent evidence by Nakamura and Steinsson (2008), using data on the individual prices underlying the U.S. CPI and excluding price changes associated with sales, has led to a reconsideration of the Bils-Klenow evidence, with an upward adjustment of the estimated median duration to a range between 8 and 11 months. Evidence for the euro area, discussed in Dhyne et al. (2006), points to a similar distribution of price durations to that uncovered by Nakamura and Steinsson for the United States.[11] It is worth mentioning that, in addition to evidence of substantial price rigidities, most studies find a large amount of heterogeneity in price durations across sectors/types of goods, with services being associated with the largest degree of price rigidities, and unprocessed food and energy with the lowest.

The literature also contains several studies using micro data that provide analogous evidence of nominal rigidities for wages. Taylor (1999) contains an early survey of that literature and suggests an estimate of the average frequency of wage changes of about one year, the same as for prices. A significant branch of the literature on wage rigidities has focused on the possible existence of asymmetries that make wage cuts very rare or unlikely. Bewley's (1999) detailed study of firms' wage policies based on interviews with managers finds ample evidence of downward nominal wage rigidities. The multicountry study of Dickens et al. (2007) uncovers evidence of significant downward nominal and real wage rigidities in most of the countries in their sample. More recently, Barattieri et al. (2014) and Druant et al. (2012) use large survey-based data sets for the United States and euro area countries, respectively, and confirm the low frequency of wage adjustments, pointing to wage spells that on average last one year or longer.

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[10] See, e.g., Cecchetti (1986) and Kashyap (1995) for early papers examining the patterns of prices of individual goods.

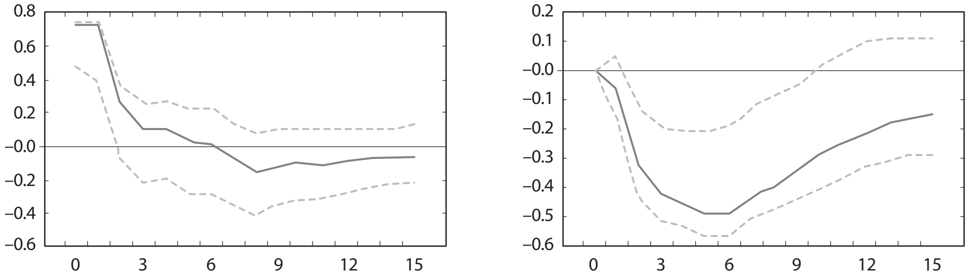
[11] In addition to studies based on the analysis of micro data, some researchers have conducted surveys of firms' pricing policies. See, e.g., Blinder et al. (1998) for the United States and Fabiani et al. (2005) for several countries in the euro area. The conclusions from the survey-based evidence tend to confirm the evidence of substantial price rigidities coming out of the micro-data analysis.

1.2.1.2 EVIDENCE OF MONETARY POLICY NON-NEUTRALITIES

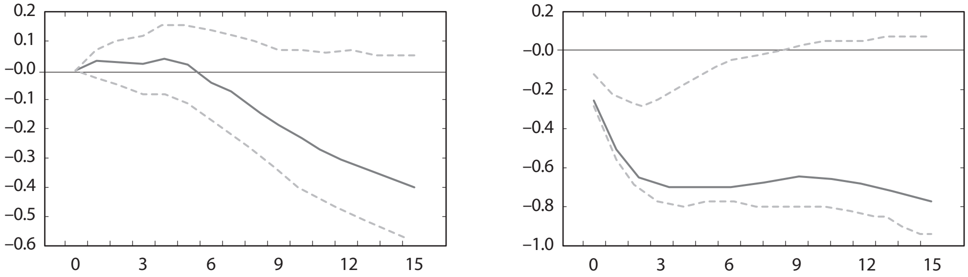
Monetary non-neutralities are, at least in theory, a natural consequence of the presence of nominal rigidities. As will be shown in chapter 3, if prices don't adjust in proportion to changes in the money supply (thus causing real balances to vary), or if expected inflation does not move one-for-one with the nominal interest rate when the latter varies (thus leading to a change in the real interest rate), the central bank will generally be able to alter the level aggregate demand and, as a result, the equilibrium levels of output and employment. Is the evidence consistent with that prediction of models with nominal rigidities? And if so, are the effects of monetary policy interventions sufficiently important quantitatively to be relevant?

Unfortunately, identifying the effects of changes in monetary policy is not an easy task. The reason for this is well understood: an important part of the movements in whatever variable we take as the instrument of monetary policy (e.g., the short-term nominal rate) are likely to be endogenous, that is, the result of a deliberate response of the monetary authority to developments in the economy. Thus, simple correlations of interest rates (or the money supply) on output or other real variables cannot be used as evidence of non-neutralities, for the direction of causality may go, fully or in part, from movements in the real variable (resulting from nonmonetary forces) to the monetary variable. Over the years, a large literature has developed seeking to answer such questions while avoiding the pitfalls of a simple analysis of comovements. The main challenge facing that literature lies in identifying changes in policy that could be interpreted as exogenous, that is, not the result of the central bank's response to movements in other variables. While alternative approaches have been pursued in order to meet that challenge, much of the recent literature has relied on time series econometrics techniques and, in particular, on structural (or identified) vector autoregressions.

The evidence displayed in figure 1.1, taken from Christiano, Eichenbaum, and Evans (1999), is representative of the findings in much of the recent literature seeking to estimate the effects of exogenous monetary



Federal funds rate **GDP**



GDP deflator **M2**

Figure 1.1. Estimated Dynamic Response to a Monetary Policy Shock
Source: Christiano, Eichenbaum, and Evans (1999).

policy shocks.[12] In the empirical model underlying figure 1.1, monetary policy shocks are identified as the residual from an estimated policy rule followed by the Federal Reserve. That policy rule determines the level of the federal funds rate (taken to be the instrument of monetary policy), as a linear function of its own lagged values, current and lagged values of GDP, the GDP deflator, and an index of commodity prices, as well as the lagged values of some monetary aggregates. Under the assumption that neither GDP nor the two price indexes can respond contemporaneously to a monetary policy shock, the coefficients of the previous policy rule can be estimated consistently with OLS, and the fitted residual can be taken as an estimate of the exogenous monetary policy shock. The response over time of any variable of interest to that shock is then given by the estimated coefficients of a regression of the current value of that variable on the current and lagged values of the fitted residual from the first stage regression.[13]

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[12] Other references include Sims (1992), Galí (1992), Bernanke and Mihov (1998), Uhlig (1995), and Romer and Romer (2004), all of them using postwar U.S. data. Peersman and Smets (2003) provide similar evidence for the euro area. An alternative approach to identification, based on a narrative analysis of contractionary policy episodes, can be found in Romer and Romer (1989).

Figure 1.1 shows the dynamic responses of the federal funds rate, (log) GDP, (log) GDP deflator, and the (log) money supply (measured by M2), to an exogenous tightening of monetary policy. The solid line represents the estimated response, with the dashed lines capturing the corresponding 95 percent confidence interval. The scale on the horizontal axis measures the number of quarters after the initial shock. Note that the path of the funds rate itself, depicted in the top-left graph, shows an initial increase of about 75 basis points, followed by a gradual return to its original level. In response to that tightening of policy, GDP declines with a characteristic hump-shaped pattern. It reaches a trough after 5 quarters at a level about 50 basis points below its original level, and then it slowly reverts back to its original level. That estimated response of GDP can be viewed as evidence of sizable persistent real effects of monetary policy shocks. On the other hand, the (log) GDP deflator displays a flat response for over a year, after which it declines. That estimated sluggish response of prices to the policy tightening is generally interpreted as evidence of substantial price rigidities.[14] Finally, note that (log) M2 displays a persistent decline in the face of the rise in the federal funds rate, suggesting that the Fed needs to reduce the amount of money in circulation in order to bring about the increase in the nominal rate. The observed negative comovement between money supply and nominal interest rates is known as the "liquidity effect." As discussed in chapter 2, it appears at odds with the predictions of a classical monetary model.

Having discussed the empirical evidence in support of the key assumptions underlying the New Keynesian framework, we end this introductory chapter with a brief description of the organization of the remaining chapters.

1.3 ORGANIZATION OF THE BOOK

The book is organized in nine chapters, including this introduction. Chapters 2 through 8 develop a unified framework, with new elements being incorporated in each chapter. Throughout the book references in the main text are kept to a minimum. The reader will find instead a section at the end of each chapter with notes on the literature, including references to some of the key papers underlying the results presented in the chapter or containing extensions not covered therein. In addition, each chapter contains a list of suggested exercises related to the material covered in the chapter. Next a brief description follows of the book's organization and the content of the different chapters.

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[13] In practice, the estimation of the impulse responses is carried out in a single step, using a linear transformation of an estimated vector autoregressive model that satisfies some identifying assumptions (typically in the form of predeterminedness and exclusion restrictions).

[14] Also, note that expected inflation hardly changes for several quarters and then declines. Combined with the path of the nominal rate, this implies a large and persistent increase in the real rate in response to the tightening of monetary policy, which provides another manifestation of the non-neutrality of monetary policy.

Chapter 2 starts by introducing the assumptions on preferences and technology that are maintained, with few variations, throughout the book. The economy's equilibrium is then analyzed under the assumptions of *perfect competition* in all markets, and fully *flexible prices and wages*. Those assumptions define what is labeled the *classical monetary economy*, whose baseline specification is characterized by neutrality of monetary policy and efficiency of the equilibrium allocation, with monetary policy's influence on equilibrium outcomes restricted to the determination of nominal variables.

In the baseline model used in the first part of chapter 2, as in the rest of the book, "money" is just the unit of account, that is, the unit in terms of which prices of goods, labor services, and financial assets are quoted. Its role as a store of value (and hence as an asset in agents' portfolios) or as a medium of exchange is ignored. As a result, one generally does not need to specify a money demand function, unless monetary policy itself is specified in terms of a monetary aggregate, in which case a simple log-linear money demand schedule is postulated in an ad hoc way. In the second part of chapter 2, however, an explicit motive to hold money is introduced by assuming that real balances are an additional argument in households' utility function, and its implications are examined under the alternative assumptions of separability and non-separability of real balances. In the latter case, in particular, the result of monetary policy neutrality is shown to break down, even in the absence of nominal rigidities. The resulting non-neutralities, however, are shown to be quantitatively small and empirically little relevant.

Chapter 3 introduces the basic New Keynesian model, by adding product differentiation, monopolistic competition, and staggered price setting to the framework developed in chapter 2. Labor markets are still assumed to be perfectly competitive and wages fully flexible. The solution to the optimal price setting problem of a firm in that environment and the resulting inflation dynamics are derived. The log-linearization of the optimality conditions of households and firms, combined with some market clearing conditions, leads to the canonical representation of the model's equilibrium, which includes the New Keynesian Phillips curve, a dynamic IS equation, and a description of monetary policy. Two variables play a central role in the equilibrium dynamics: the output gap and the natural rate of interest. The output gap is defined as the log deviation between output and the natural level of output, where the latter corresponds to the equilibrium level of output in the absence of nominal rigidities. Similarly, the natural rate of interest refers to the equilibrium, real interest rate in the absence of nominal rigidities. The presence of sticky prices is shown to make monetary policy non-neutral. This is illustrated by analyzing the economy's response to three types of shocks: an exogenous monetary policy shock, a shock to households' discount rate, and a technology shock.

Chapter 4 discusses the role of monetary policy in the basic New Keynesian model from a normative perspective. In particular, it shows that, under some assumptions, it is optimal to pursue a policy that fully stabilizes the price level ("strict inflation targeting") and discuss alternative ways in which that policy can be implemented (optimal interest rate rules). The likely practical difficulties in the implementation of the optimal policy motivate the introduction and analysis of simple monetary policy rules, that is, rules that can be implemented with little or no knowledge of the economy's structure and/or realization of shocks. A welfare-based loss function that can be used for the evaluation and comparison of those rules is then derived and applied to two simple rules: a Taylor rule and a constant money growth rule.

A common criticism of the analysis of optimal monetary policy contained in chapter 4 is the absence of a tradeoff between inflation stabilization and output gap stabilization, a property that has come to be known as "the divine coincidence." In chapter 5 that criticism is addressed by showing how a meaningful policy tradeoff emerges in the presence of variations in the gap between the natural and efficient levels of output. In that context, and following the analysis in Clarida, Galí, and Gertler (1999), the optimal monetary policy is derived under two alternative assumptions, discretion and commitment, emphasizing the key role played by the forward-looking nature of inflation as a source of the gains from commitment. The final section in the chapter discusses the challenges and tradeoffs generated by the presence of a zero lower bound on the nominal interest rate, which may become binding in the face of an adverse demand shock. The relevance of the zero lower bound has become evident in the wake of the recent economic and financial crisis, when central banks' efforts to stimulate the economy through reductions in the short-term policy rate *eventually* hit that constraint, forcing them to rely on a variety of unconventional measures.

Chapter 6 extends the basic New Keynesian framework by introducing imperfect competition and staggered nominal wage setting in labor markets, in coexistence with staggered price setting, following the work of Erceg, Henderson, and Levin (2000). The presence of sticky nominal wages, and the consequent variations in wage markups, render a policy aimed at fully stabilizing price inflation suboptimal. The reason is that fluctuations in wage inflation, in addition to variations in price inflation and the output gap, generate a resource misallocation and a consequent welfare loss. Thus, the optimal policy is one that seeks to strike the right balance between stabilization of those three variables. For a broad range of parameters, however, the optimal policy can be approximated well by a policy that stabilizes a weighted average of price and wage inflation, where the proper weights are function of the relative stickiness of prices and wages.

Chapter 7 reformulates the standard New Keynesian model with staggered price and wage setting of the previous chapter in a way that allows for the explicit introduction of unemployment in the model, defined as the gap between participation and employment. The role of unemployment in the design of monetary policy is discussed. It is shown that a simple interest rate rule that responds to inflation and the unemployment rate can approximate surprisingly well the optimal monetary policy.

In chapter 8 a small open economy version of the basic New Keynesian model is developed. The analysis of the resulting model yields several results. First, it is shown that the equilibrium conditions have a canonical representation analogous to that of the closed economy, including a New Keynesian Phillips curve, a dynamic IS equation, and an interest rate rule. In general, though, both the natural level of output and the natural real rate are a function of foreign, as well as domestic, shocks. Second, and under certain assumptions, the optimal policy consists in fully stabilizing domestic inflation, while accommodating the changes in the exchange rate (and, as a result, in CPI inflation) necessary to bring about desirable changes in the relative price of domestic goods. Thus, in general, policies that seek to stabilize the nominal exchange rate, including the limiting case of an exchange rate peg, are shown to be suboptimal.

Chapter 9 concludes by reviewing some of the general lessons that can be drawn from the previous chapters. In doing so two key insights associated with the New Keynesian framework are emphasized, namely, the key role of expectations in shaping the effects of monetary policy, and the importance of the natural levels of output and the interest rate for the design of monetary policy. The chapter ends by discussing some of the limitations of the New Keynesian framework as developed here, together with a description of extensions not covered in the present book that aim at overcoming some of those limitations.

REFERENCES

Adolfson, Malin, Stefan Laséen, Jesper Lindé, and Mattias Villani (2007): "RAMSES–A New General Equilibrium Model for Monetary Policy Analysis," *Sveriges Riksbank Economic Review* 2.

Akerlof, George, and Janet Yellen (1985): "A Near-Rational Model of the Business Cycle with Wage and Price Inertia," *Quarterly Journal of Economics* 100 (Supplement), 823–838.

Ball, Laurence, and David H. Romer (1990): "Real Rigidities and the Nonneutrality of Money," *Review of Economic Studies* 57, 183–203.

Barattieri, Alessandro, Susanto Basu, and Peter Gottschalk (2014): "Some Evidence on the Importance of Sticky Wages," *American Economic Journal: Macroeconomics* 6(1), 70–101.

Basu, Susanto, John Fernald, and Miles Kimball (2006): "Are Technology Improvements Contractionary?," *American Economic Review* 96(5), 1418–1448.

Bayoumi, Tam (2004): "GEM: A New International Macroeconomic Model," IMF Occasional Paper 239.

Bernanke, Ben S., and Ilian Mihov (1998): "Measuring Monetary Policy," *Quarterly Journal of Economics* 113(3), 869–902.

Bewley, Truman F. (1999): *Why Wages Don't Fall during a Recession?*, Harvard University Press, Cambridge, MA.

Bils, Mark, and Peter J. Klenow (2004): "Some Evidence on the Importance of Sticky Prices," *Journal of Political Economy* 112(5), 947–985.

Blanchard, Olivier J., and Nobuhiro Kiyotaki (1987): "Monopolistic Competition and the Effects of Aggregate Demand," *American Economic Review* 77, 647–666.

Blinder, Alan S., Elie R. D. Canetti, David E. Lebow, and Jeremy B. Rudd (1998): *Asking about Prices: A New Approach to Understanding Price Stickiness*, Russell Sage Foundation, New York.

Cecchetti, Stephen G. (1986): "The Frequency of Price Adjustment: A Study of Newsstand Prices of Magazines," *Journal of Econometrics* 31, 255–274.

Christiano, Lawrence J., Martin Eichenbaum, and Charles L. Evans (1999): "Monetary Policy Shocks: What Have We Learned and to What End?," in J. B. Taylor and M. Woodford, eds., *Handbook of Macroeconomics*, vol. 1A, 65–148. North Holland-Elsevier (Amsterdam)

Christiano, Lawrence, Martin Eichenbaum, and Robert Vigfusson (2003): "What Happens after a Technology Shock?," NBER working paper 9819.

Christoffel, Kai, Günter Coenen, and Anders Warne (2008): "The New Area-Wide Model of the Euro Area: A Micro-founded Open-Economy Model for Forecasting and Policy Analysis," ECB working paper 944.

Clarida, Richard, Jordi Galí, and Mark Gertler (1999): "The Science of Monetary Policy: A New Keynesian Perspective," *Journal of Economic Literature* 37, 1661–1707.

Cooley, Thomas F. (1995): *Frontiers of Business Cycle Research*, Princeton University Press. Princeton, NJ.

Cooley, Thomas F., and Gary D. Hansen (1989): "Inflation Tax in a Real Business Cycle Model," *American Economic Review* 79, 733–748.

Dhyne, Emmanuel, Luis J. Àlvarez, Hervé le Bihan, Giovanni Veronese, Daniel Dias, Johannes Hoffmann, Nicole Jonker, Patrick Lünnemann, Fabio Rumler, and Jouko Vilmunen (2006): "Price Changes in the Euro Area and the United States: Some Facts from Individual Consumer Price Data," *Journal of Economic Perspectives* 20(2), 171–192.

Dickens, William T., Lorenz Goette, Erica L. Groshen, Steinar Holden, Julian Messina, Mark E. Schweitzer, Jarkko Turunen, and Melanie E. Ward (2007): "How Wages Change: Micro Evidence from the International Wage Flexibility Project," *Journal of Economic Perspectives* 21(2), 195–214.

Druant, Martine, Silvia Fabiani, Gabor Kezdi, Ana Lamo, Fernando Martins, and Roberto Sabbatini (2012): "Firms' Price and Wage Adjustment in Europe: Evidence of Nominal Stickiness," *Labour Economics* 19, 772–782.

Edge, Rochelle M., Michael T. Kiley, and Jean-Philippe Laforte (2007): "Documentation of the Research and Statistics Division's Estimated DSGE Model of the U.S. Economy: 2006 Version," Finance and Economics Discussion Series 2007-53, Federal Reserve Board, Washington, DC.

Erceg, Christopher J., Luca Guerrieri, and Christopher Gust (2006): "SIGMA: A New Open Economy Model for Policy Analysis," *International Journal of Central Banking* 2(1), 1–50.

Erceg, Christopher J., Dale W. Henderson, and Andrew T. Levin (2000): "Optimal Monetary Policy with Staggered Wage and Price Contracts," *Journal of Monetary Economics* 46(2), 281–314.

Fabiani, Silvia, Martine Druant, Ignacio Hernando, Claudia Kwapil, Bettina Landau, Claire Loupias, Fernando Martins, Thomas Y. Matha, Roberto Sabbatini, Harald Stahl, and Ad Stokman (2005): "The Pricing Behavior of Firms in the Euro Area: New Survey Evidence," ECB working paper 535.

Fischer, Stanley (1977): "Long-Term Contracts, Rational Expectations, and the Optimal Money Supply," *Journal of Political Economy* 85(1), 191–206.

Fisher, Jonas D. M. (2006): "The Dynamic Effects of Neutral and Investment-Specific Technology Shocks," *Journal of Political Economy* 114(3), 413–451.

Friedman, Milton, and Anna J. Schwartz (1963): *A Monetary History of the United States, 1867–1960*, Princeton University Press, Princeton, NJ.

Galí, Jordi (1992): "How Well Does the IS-LM Model Fit Postwar U.S. Data?," *Quarterly Journal of Economics* 107(2), 709–738.

Galí, Jordi (1999): "Technology, Employment, and the Business Cycle: Do Technology Shocks Explain Aggregate Fluctuations?," *American Economic Review*, 89(1), 249–271.

Galí, Jordi, and Pau Rabanal (2004): "Technology Shocks and Aggregate Fluctuations: How Well Does the RBC Model Fit Postwar U.S. Data," *NBER Macroeconomics Annual* 2004, 225–288.

Galí, Jordi, and Mark Gertler (2007): "Macroeconomic Modeling for Monetary Policy Evaluation," *Journal of Economic Perspectives* 21(4), 25–45.

Goodfriend, Marvin, and Robert G. King (1997): "The New Neoclassical Synthesis and the Role of Monetary Policy," *NBER Macroeconomics Annual*, 1997, 231–282.

Kashyap, Anil K. (1995): "Sticky Prices: New Evidence from Retail Catalogues," *Quarterly Journal of Economics* 110, 245–274.

Keynes, John Maynard (1936): *The General Theory of Employment, Interest and Money*, Macmillan, London.

Kydland, Finn E., and Edward C. Prescott (1982): "Time to Build and Aggregate Fluctuations," *Econometrica* 50, 1345–1370.

Lucas, Robert E. (1976): "Econometric Policy Evaluation: A Critique," *Carnegie-Rochester Conference Series on Public Policy*, 1, 19–46.

Mankiw, Gregory (1985): "Small Menu Costs and Large Business Cycles: A Macroeconomic Model of Monopoly," *Quarterly Journal of Economy* 100(2), 529–539.

Nakamura, Emi and Jón Steinsson (2008): "Five Facts about Prices: A Reevaluation of Menu Cost Models," *Quarterly Journal of Economics* 123(4), 1415–1464.

Peersman, Gert and Frank Smets (2003): "The Monetary Transmission Mechanism in the Euro Area: More Evidence from VAR Analysis," in Angeloni et al., eds., *Monetary Policy Transmission in the Euro Area*, Cambridge University Press, Cambridge, 36–55

Prescott, Edward C. (1986): "Theory Ahead of Business Cycle Measurement," *Federal Reserve Bank of Minneapolis Quarterly Review* 10, 9–22.

Romer, Christina D., and David H. Romer (1989): "Does Monetary Policy Matter? A New Test in the Spirit of Friedman and Schwartz," *NBER Macroeconomics Annual* 4, 121–170.

Romer, Christina D., and David H. Romer (2004): "A New Measure of Monetary Shocks: Derivation and Implications," *American Economic Review* 94(4), 1055–1084.

Sims, Christopher (1980): "Macroeconomics and Reality," *Econometrica* 48(1), 1–48.

Sims, Christopher (1992): "Interpreting the Macroeconomic Time Series Facts: The Effects of Monetary Policy," *European Economic Review* 36, 975–1011.

Smets, Frank, and Raf Wouters (2003): "An Estimated Dynamic Stochastic General Equilibrium Model of the Euro Area," *Journal of the European Economic Association* 1(5), 1123–1175.

Smets, Frank, and Raf Wouters (2007): "Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach," *American Economic Review* 97(3), 586–606.

Taylor, John (1980): "Aggregate Dynamics and Staggered Contracts," *Journal of Political Economy* 88(1), 1–24.

Taylor, John B. (1999): "Staggered Price and Wage Setting in Macroeconomics," in J. B. Taylor and M. Woodford, eds., *Handbook of Macroeconomics* 1341–1397, Elsevier, New York.

Uhlig, Harald (2005): "What Are the Effects of Monetary Policy on Output? Results from an Agnostic Identification Procedure," *Journal of Monetary Economics* 52, 381–419.

Walsh, Carl E. (2003): *Monetary Theory and Policy*, 2nd ed., MIT Press, Cambridge, MA.

Woodford, Michael (2003): *Interest and Prices: Foundations of a Theory of Monetary Policy*, Princeton University Press, Princeton, NJ.

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