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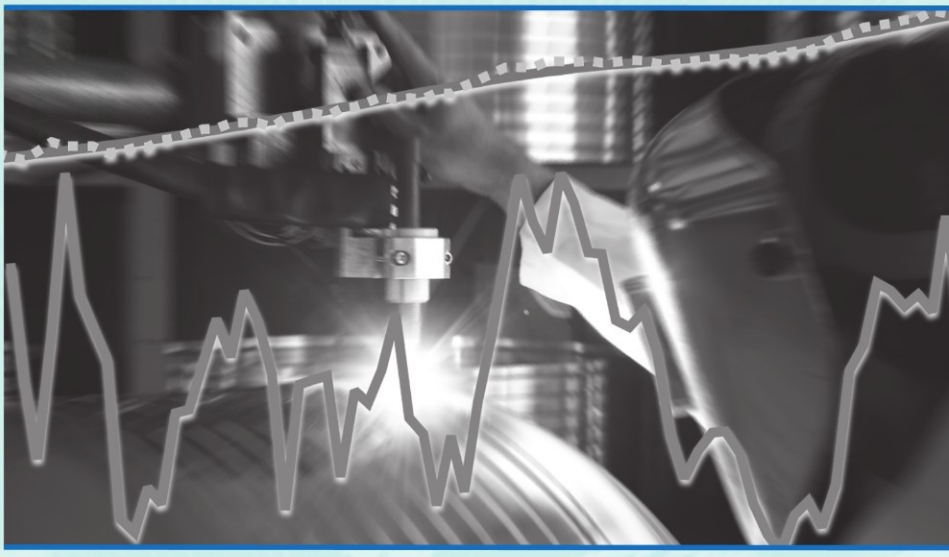
Projecting Potential Output



Methods and Problems

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1 Introduction

The concept of potential output has played an important role in economic analysis and policy debate at least since the 1960s. Usually defined as the productive capacity that would be feasible under full utilisation of all factors of production, it is a central reference variable in economic theories and provides the starting point for analysing the current status of the economy. Potential output is also a key reference variable in empirical economic research and is regularly employed by national and international economic research institutes and economic advisory boards to analyse the business cycle. Potential output is of importance in economic policy for disentangling structural problems and business cycle phenomena, in medium-term budget planning and especially for providing an orientation variable for monetary policy. The potential growth concept also plays a pivotal role at the European level in the context of the Lisbon Agenda and, at the German level, in the definition of necessary reforms and reform priorities.

In spite of the widespread use of the concept of potential output in economic theory and empirical applications as well as in economic policy debates, the historical background and the assumptions inherent to the concept of potential output regarding economic relationships as well as concerning epistemological perspectives are rarely made transparent, let alone critically questioned. Apparently well-defined and unequivocal potential figures are quoted and used in empirical practice and economic policy debates as a matter of course and with a confidence that cannot be taken for granted given the assumptions and limitations of conventional methods. It is doubtful, for example, whether some of the fundamentally retrospective empirical procedures often used to determine potential output, such as univariate filter-based methods for example, can be appropriately applied in the context of a genuinely forward-looking concept (i.e. the future growth perspectives of an economy measured in terms of potential output). It is also doubtful whether labour input in production function-based methods can be reliably projected into the future given that such volumes are influenced in their turn by changes in labour market structures, technological trends or macroeconomic developments.

Against this background this study sets out to determine the extent to which the concept of potential output rests on clearly defined theoretical foundations and how far prevailing empirical quantification methods really provide truly reliable insights into potential growth of an economy. With this aim in mind the study aims at making the concept of potential output and its underlying explicit and implicit economic and system-theoretical assumptions transparent. The theoretical assumptions, the data requirements as well as the methodological strengths and

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weaknesses of prevailing methods of determining potential output and growth are subjected to critical analysis. The study also aims at analysing how conceivable it would be to extend the current spectrum of methods by drawing on procedures that exploit the information provided by the yield curve in relation to anticipated future economic growth.

The study consists of two main parts. The theoretical part of the book examines the origins and historical background of the concept of potential output and discusses its epistemological foundations. Chapter 2 begins by tracing the way different historical economic schools of thought have developed over time that are relevant to the potential output concept. This historical outline is followed in chapter 3 by an analysis of the determinability of key aspects of potential output (the concept of an aggregate production function, the dichotomy between growth and the business cycle, the concept of non-inflationary unemployment and the role of monetary policy). The theoretical part of the book epistemologically concludes with a consideration of aspects relating to system theory (chapter 4).

The second part of the study focuses on empirical methods and begins in chapter 5 with a review of the most important univariate and multivariate methods of identifying potential output and a quantitative appraisal of the empirical distinctiveness and forecast precision of these methods. Chapter 6 briefly deals with the causes of weak growth in Germany as identified in the literature. Chapter 7 then focuses on the strengths and weaknesses of yield curve procedures that might appropriately supplement conventional methods of precisely estimating potential output since they exploit anticipations regarding future economic growth. Chapter 8 ends with conclusions for economic policy and empirical macroeconomics.

THEORETICAL PART

2 The Concept of Potential Output: A History of Origins

2.1 Introduction

This chapter outlines the economic conditions and theoretical ideas prevailing at the times of origin of the concept of potential output. In general, Okun (1962) is considered as the starting point for the development of methods for calculating potential output and output gaps (Section 2.2). However, the standard methods have been heavily criticised by proponents of the New Neoclassical Synthesis who in turn refer to Wicksell's theory of interest rate gaps, which dates back as early as 1898 (Section 2.3). Accordingly, this chapter outlines the extensive history of potential output concepts before Okun (1962), especially with respect to the development of Wicksellian and Keynesian "gap theories" since the late 1920s (Section 2.4). Since controversies about the existence of a trade-off between full employment and price-level stability are of central importance for the discussion of potential output, the different stages of the Phillips curve debates are described in Section 2.5. The development of systems of national accounting, which began in the 1930s and culminated after World War II, did also play an important role. Based on national accounting, numerous methods of calculation have been developed since the 1960s for purposes of political advisory. At the end of this chapter, it is discussed to what extent connections can be made between concepts of potential outputs and the macroeconomic framework conditions prevailing at their respective times of origin (Section 2.6). When gap theories were developed around 1930, circumstances were, after all, very different compared to the heyday of potential output concepts in the 1960s and 1970s. The corresponding macroeconomic framework conditions are captured in terms of growth regimes that give priority to the relationship between real growth rates and real interest rates – two key determinants of investment.

The various strands of evolution presented in chapter 2 amount to a chronological survey. Against this background, chapter 3 analyses key positions and controversies revolving around concepts of aggregation, the notion of non-inflationary unemployment, the interaction of growth trends and business cycles and the neutrality of monetary policy. It should be noted that in both chapters the history of economic thought is employed as a map that helps to determine the present state of theory. On the basis of earlier positions and controversies, crossroads in the

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evolution of economic thinking are identified. Not all turn-offs that have been abandoned by *mainstream* economics have been convincingly proven to be dead-ends or detours. Some alternative routes that have been discovered but only partially explored in the past may still contribute to further advancements in the determination of potential output. The current reconsiderations of Wicksellian gap theories indicate that investigating theoretical developments of the past need neither be an end in itself nor worship of ancestors, but may prove to harbour valuable analytical potential.

2.2 Okun's Contribution

It is commonly held that the concept of potential output was born at the annual conference of the American Statistical Association in 1962, when Arthur Okun, the US President's chief economic adviser, spoke on the significance and measurement of potential GNP.[1] Okun defined potential output as the level of macroeconomic output attainable without triggering inflation. He, thus, linked the idea of maximum potential output with the criterion of an unemployment rate consistent with zero inflation quite a number of years before the term NAIRU became popular.[2] In the same essay, Okun devised the well-known "Okun's law", assuming a linear negative relationship between the GNP growth rate and the change of the unemployment rate as an empirical regularity. When economic growth recedes, unemployment increases and vice versa (Okun, 1962, 1983: 148f).[3]

Okun's law was actually a by-product of Okun's key proposition concerning the relationship between current output and potential output: If current output diverges from potential output, output gaps emerge from over- or underutilisation of productive capacities. Potential output becomes the pivotal factor of orientation for stabilisation policy because the existence of gaps implies macroeconomic inefficiency. As today's current output affects tomorrow's potential output, the dynamics of the inefficiencies require special attention. In the case of negative gaps (underutilisation), entrepreneurial profits and household incomes, and with them long-term oriented investments in production facilities, instalment, research and development, fall short of the level attainable in a situation of full utilisation. In the case of positive gaps (overutilisation), replacement investment for extra wear-out of personnel and material reduce the scope for net investment. Consequently, an effective stabilisation policy not only mitigates cyclical fluctuations in the utili-

[1] See Okun (1962); with respect to Okun's work in the Council of Economic Advisers and the application of the concept of potential output during the early stages see Prachowny (2000, ch. 2).

[2] The term NAIRU is the abbreviation for "Non-Accelerating Inflation Rate of Unemployment".

[3] Okun's law, amongst other things, allows the determination of so-called employment thresholds, i.e. GNP growth rates that need to be transcended before an increase in employment can occur.

sation of the current output potential but also furthers economic growth (Okun, 1962, 1983: 147).

Okun's 1962 essay drew up a double-track approach for assessing potential output. On the one hand, Okun's characterisation of output gaps as cyclical deviations from the growth trend fostered the application of statistical methods for trend adjustments, for instance, by applying so-called filters. On the other hand, his benchmark of an unemployment rate that is consistent with stable inflation formed the basis for estimating production functions or Phillips curve equations. Both types of methods are criticised as inappropriate by proponents of the "New Neoclassical Synthesis", the current mainstream of macroeconomic theory.

2.3 The New Neoclassical Synthesis

The critique of common practices for calculating potential output is best illustrated by taking recourse to Michael Woodford's "Interest and Prices" (2003) – a standard reference on monetary theory that has advanced to the position of a "bible for central bank economists" (Green, 2005: 121). The core model of this book is a special version of the New Neoclassical Synthesis' three-equations system. In comparison with the traditional synthesis as represented by the IS-LM model, its major differences are considered to be the micro-theoretical foundations of macroeconomic relationships as well as the endogenisation of aggregate supply and of monetary policy. The core model of the new synthesis can be labelled as an IS-AS-MR model describing the dynamics of short-term fluctuations of production, inflation and interest rates:[4]

- The *IS equation* describes a negative relationship between the output gap and real interest rates, resulting from the intertemporal optimisation of the representative household. It is assumed that the household has rational expectations concerning the development of future income and inflation levels. If income is expected to rise, current demand for goods also increases. By contrast, rising real interest rates (nominal interest rates net of expected inflation rate) induce increased saving and a reduction of current aggregate demand.
- The *AS equation* establishes the interaction of aggregate supply and inflation in terms of a New Keynesian Phillips curve. Current inflation is determined by expected inflation and the current output gap. The latter results from profit maximisation of price-setting enterprises under monopolistic competition. If energy prices or nominal interest rates unexpectedly rise or if other shocks occur, a number of firms will prefer to reduce supply rather than increasing prices.
- The *MR equation* describes the reaction function of monetary policy makers in terms of a Taylor rule: Short-term nominal interest rates are set by the central

[4] See Woodford (2003: ch. 4). For a less demanding and more graphically oriented description, see the textbook by Carlin and Soskice (2006). An introduction to a similar kind of modelling in German language is given by Spahn (2006: ch. 4).

bank in such a way that they positively fluctuate (with specific weights) with the deviations of inflation and the output gap from their target value. If current inflation exceeds the target value, nominal interest rates are raised, according to the Taylor principle even overproportionally, in order to reduce inflation.

Combining intertemporal optimisation, monopolistic competition and price rigidities, the IS-AS-MR model embodies a synthesis of New Classical and New Keynesian approaches. Woodford's approach, however, refers further back in history labelling his version of the IS-AS-MR models as "Neo-Wicksellian". It refers to Knut Wicksell's (1898) work on interest and prices, which can, for good reasons, be considered as a stepping stone in the development of both Neoclassical and Keynesian macroeconomics. Woodford's output-gap concept in the IS equation refers to a "natural rate of output" that corresponds to the "natural rate of interest" – a term coined by Wicksell (1898). Furthermore, Woodford's "welfare-analytical foundation" of monetary policy (2003: ch. 6-8) refers to Wicksell's simple rule of interest: According to that rule, changes in the price level of goods need to be answered only with parallel changes of money interest rates until the changes in the price level come to a standstill since the money rate of interest coincides with the natural rate (which is not directly observable).

Woodford's benchmark variable in terms of natural output is the notional output level in an environment of monopolistic competition and perfectly flexible prices. In this case there would be welfare losses due to monopolistic price-setting that, compared to perfect competition on the supply side, reduce demand. However, there would be no additional welfare losses resulting from price rigidities that reduce supply and distort the price structure. Since it should not be expected that prices are perfectly flexible under monopolistic competition, output gaps are best reduced by ensuring that the price level remains largely stable and price rigidities cannot take effect. As a typical "second best" solution to the welfare theoretical problem of optimisation (as opposed to the utopia of perfect competition), the Taylor rule, thus, forms a modern version of Wicksell's rule for monetary policy.

Woodford's approach and further developments of the New Neoclassical Synthesis lead to criticism concerning the two standard methods for calculating potential output, namely trend-filtering and estimations of production functions (e.g. Andrés, López-Salido, & Nelson, 2005). Statistical methods that extrapolate potential output as a growth trend based on past output developments generate results that coincide with analytically determined values by accident at best. Trend-oriented methods project past developments without considering the influence of future expectations on potential output. On the other hand, methods solely based on production functions or Phillips curve equations and embedded NAIRU estimations bring about logical short-circuits as potential output is identified on the basis of the unemployment rate that is consistent with stable inflation. According to the logic of the New Keynesian Phillips curve (the above-mentioned AS equation), however, low inflation can, in the case of nominal rigidities, be associated with inefficiently high unemployment rates due to output adjustments. Secondly, stable inflation is achieved only as a result of monetary policy, which in turn requires that potential output is determined independently. Within the framework of New

Neoclassical Synthesis, the conclusion that minimising inflation by means of monetary policy keeps current output close to potential output strictly holds only if purely nominal rigidities exist. As Woodford (2003) and Blanchard and Galí (2005) show for the case of real rigidities (when prices and nominal wages are both inflexible or shift at the same rate), supply shocks (e.g., rising energy prices) can revive the classical Phillips curve trade-off. In this case, strict inflation control is bound to generate output gaps and involuntary unemployment in the sense of Keynes (1936), at least in the short run. If the model is extended to include investment (Woodford, 2003: ch. 5.3), potential output might even be permanently reduced. The framework of the New Neoclassical Synthesis, thus, opens avenues to the explanation of long-term real effects of monetary policy.

One need not agree with all of the current criticism concerning the standard methods of estimating potential output. The new synthesis itself creates problems by defining the benchmark variable as output in an environment of monopolistic competition and perfectly flexible prices. This does not only carry the usual problems of dealing with unobservable quantities. It is also theoretically dubious: If enterprises are able to set prices and, faced with the choice of either adjusting prices or quantities, opt for the latter, one cannot assume that price adjustments would "actually" be the optimal solution. At least it cannot be claimed that this version of macroeconomic theory has micro-foundations superior to traditional IS/LM analysis. The discrepancy between individually and macroeconomically optimal behaviour is explained *ad hoc* by introducing specific assumptions concerning sticky prices rather than deriving it from the model. The new synthesis has, nevertheless, made progress over the old with respect to its dynamic analysis of inflation, output gaps and interest rate policy. Exactly in these features, however, the new synthesis refers to approaches that shaped macroeconomic theory before Okun's (1962) contribution and are associated with Knut Wicksell and John Maynard Keynes.[5] The following section outlines those early Wicksell and Keynes connections of modern macroeconomics.

[5] There are, however, fundamental differences between the new synthesis and Keynes' and Wicksell's theories, especially with respect to coordination failures of the interest rate mechanism. In the new synthesis coordination failures are disregarded due to the assumption implicit in the *IS equation* that investment invariably equals the intertemporal optimum of the representative consumer. For differences between Wicksell and current approaches, see Boianovsky and Trautwein (2006a) and the response by Woodford (2006); concerning Keynes, see van der Ploeg (2005).

2.4 Wicksell and Keynes Connections

2.4.1 Interest Rate Gaps and Inflation

Wicksell (1898) developed a theory of inflation based on the gap between the money rate of interest and the "natural rate of interest". The natural rate of interest is the rate of return on capital that equalises savings supply and planned entrepreneurial investments – irrespectively of influences stemming from the loan supply of commercial banks and the monetary policy of the central bank. The most important forces affecting this equilibrium rate include technical progress and demographic change but also institutional changes, natural disasters and war. Because of these various and continuously varying influences on aggregate saving and investment, the "natural interest rate" is highly variable. By contrast, the money rate of interest that commercial banks demand from their customers – and that Wicksell defined as the representative market rate of interest – is sticky in the short run and adjusts only laggingly to changes in the market conditions. The main reasons for this lack of flexibility are contract obligations, conventions and other aspects of tending to customer relationships. If the profit expectations of entrepreneurs suddenly improve substantially, for instance, due to the opening-up of new markets by way of innovations or reforms, the natural rate of interest rises to exceed the market rate. The demand for loans increases and is normally met by commercial banks, owing to their own interests in increasing revenues.[6] As a consequence of the credit expansion, aggregate demand begins, sooner or later, to exceed available output. Excess demand leads to a rise in the general price level, which continues in a cumulative inflationary process for as long as the gap between the natural rate of interest and the money rate prevails.[7]

In Wicksell's view, market forces cause the money rate of interest sooner or later to adjust to the natural interest, thus, restoring the original equilibrium state of the economy.[8] While the interest rate structure is stable in this sense, there are no market forces that would automatically return the price level to its original position. The price level is meta-stable, i.e. its index value at the end of the cumulative process differs from the initial value. The interaction of stable and meta-stable movements in a system of interdependent markets is the trademark of all macroeconomic theories that developed from Wicksell's monetary theory: The failure of

[6] It is presupposed that sufficient collateral is provided. However, the value of the collateralised assets is itself indirectly dependent on the level and growth of the aggregate loan supply.

[7] In Wicksell (1898), the same logic applies to the process of disinflation that starts whenever the natural rate of interest falls short of the money rate.

[8] However, Wicksell's hypothesis that the money rate adjusts to the natural rate of interest cannot be conclusively deduced in a modern credit economy that is not restricted by a gold standard, an assumption that Wicksell himself made in terms of the "pure credit economy" in his theory of cumulative processes; see Trautwein (1996).

the interest rate mechanism to coordinate savings and investments in the capital market forces prices – and sometimes also quantities – in other markets (in this case, the goods market) to adjust as well. Temporary coordination failures of the interest rate mechanism can, thus, induce permanent changes of prices (and quantities) in other markets.

Wicksell considered inflation to be a social grievance, as it gives rise to distributional conflicts and particularly puts recipients of nominally fixed incomes, who have little bargaining power, at a disadvantage. This way it undermines social peace. However, inflation can be avoided quite easily, if the central bank reacts quickly to price-level increases by raising interest rates until price-level stability is regained.[9]

Wicksell's interest-rate gap theory of inflation contains the core of a theory of potential output and output gaps. Wicksell himself, however, was merely looking for an explanation of inflation. He proceeded on the assumption that the economy is in a state of full employment and full utilisation of capacities at all times. Although he conceded at times the possibility that inflation and disinflation, through distributional effects, may cause investment and output capacities to change (e.g., 1898), he dismissed these effects as non-cumulative and hence insignificant. It was not until the 1920s and 1930s that Wicksell's interest gap theory was systematically extended by economists in various places who endeavoured to develop business cycle theories and models of macroeconomic dynamics. Particularly noteworthy are the contributions by Cambridge economists Dennis Robertson (1926) and John Maynard Keynes (1930), by Friedrich August von Hayek, Vienna/London (1929, 1931), and by the Stockholm School, led by Erik Lindahl (1930) and Gunnar Myrdal (1931). The contributions by Johan Åkerman, Lund (1928) and Ragnar Frisch, Oslo (1933), who were both inspired by Wicksell's (separate) theory of the business cycle, are also of relevance with regard to the relationship between growth trends and cyclical fluctuations. In the following, the focus is set on approaches that formed the base for subsequent discussions on potential output and, at the same time, provided valuable insights nowadays neglected.[10]

2.4.2 Impulse Propagation Mechanisms

As noted above, Wicksell considered his interest-rate gap model to be a theory of inflation rather than an explanation of business cycles. In his view cyclical fluctuations are caused solely by changes in the natural rate of interest, not by deviations of the market rate.[11] He explained the variability of the natural rate of interest

[9] Wicksell's simple rule of interest in the combat of inflation constitutes the core of the Taylor rule in the MR-equation described in Section 2.3.

[10] We present only a rough outline of a selection of evolutionary strands. Some of these contributions are addressed in more detail in chapter 3.

[11] In Wickell's view, interest rate gaps are at best a reinforcing element in the progression of prices, and while they might aggravate speculative hyperboles and crisis, they cannot

as a result of asynchronous changes in the economy's set of fundamental data: While labour supply and the demand for consumption goods grow more or less steadily, technical progress in the form of new products and production processes occurs irregularly and by leaps and bounds. The corresponding increases in productivity raise the returns on investment projects and, thereby, the equilibrium rate of interest because saving does not adjust immediately, given that income and the demand for consumption goods change more slowly. Once the peak in investment activity that was caused by the leap in technology has been passed, output falls until the investment goods acquired at those peak times need to be replaced. Output oscillates until the systems returns to its equilibrium state or further technological progress occurs. Wicksell (1918) compared the business cycle mechanism to a rocking horse that pushed by means of a stick, starts to sway strongly. If the horse is built solidly, it will gradually return from vigorous rocking to a state of rest unless it is pushed again. The push is the external impulse that sets the horse off, but the horse's movements are independent of the shape and further movement of the stick. They are solely determined by the strength of the impulse and the shape of the horse.

Wicksell's rocking horse metaphor gave rise to the famous dichotomy of impulse propagation mechanisms that characterises macroeconomic and econometric thought in various areas.[12] Fluctuations of real economic activity and other processes are, thus, defined as adjustments of the system in question to changes in exogenous variables. Like waves, external impulses diffuse across the system according to its laws of motion. The dissemination of this idea was promoted especially by Åkerman (1928) and Frisch (1933).

Åkerman (1928) attempted to reconcile the observation of seemingly irregular fluctuations in crude steel production and other business cycle indicators with general equilibrium theory by developing a method for empirical analysis of the cycle.[13] He proceeded from Fourier's theorem, which states that any curve, no matter how irregular its appearance, can be decomposed into a specific number of mutually overlapping sinus curves. Accordingly, Åkerman developed a hydrodynamic model of the economy based on the idea of a normal output capacity in the hypothetical equilibrium state. The normal capacity forms the motionless water surface at "sea level". Changes in productivity, due to technical progress and population growth, occur sometimes more and sometimes less intensively and give rise to "long waves", causing the normal capacity to fluctuate over decades. The interaction between long-term, short-term and very short-term waves induced by techni-

generate business cycles. Concerning Wicksell's distinction between business cycles, crises and cumulative processes, see Boianovsky (1995) and Boianovsky and Trautwein (2001).

[12] Changes in GDP growth, inflation rates and other variables are routinely analysed as sequences of "shocks" in terms of comparative statics as well as dynamics. The effects of policy measures and other "shocks" are frequently represented using impulse response functions in structural vector autoregressive models (SVAR); see also section 2.6.2.

[13] Consistent time series of changes in national income were not available at the time; see section 2.6.1.

cal innovation cycles as well as by psychological and seasonal fluctuations in the degree of utilisation creates regular economic cycles lasting three and a half to six years depending on their position within the long wave. By treating business cycle impulses as the result of overlapping effects of various exogenous but more or less regularly occurring factors, Åkerman attempted to endogenise the timing of the occurrence of impulses and to render it accessible for business cycle forecasting.

Frisch (1933) developed Wicksell's rocking horse metaphor into models of impulse propagation mechanisms, drafting a system of difference and differential equations that describe the aggregate production of capital and consumption goods. By means of modelling a mechanism of acceleration (overproportional reactions of investment in response to changes in consumption) that works in the presence of liquidity constraints for consumption, Frisch was able to explicitly describe and consistently quantify the dynamics of investment and consumption activities as well as to make rigorous distinctions between competing business cycle theories on the basis of differences in their functional design and parameter magnitudes. Unlike Åkerman's spectral analytical approach, however, in Frisch's model impulses do not lead to permanent fluctuations, owing to their irregular nature. After a time, their effects peter out because the system's fluctuations are dampened by frictions (mainly inelasticities of demand and supply). In the absence of impulses (in modern terms: "shocks"), no difference between potential and current production exists.

2.4.3 Monetary Policy and the Formation of Expectations and Capital

All over Europe the early 1920s were marked by discussions on whether and under what circumstances the gold standard prevailing before World War I could be revived. When, in 1925 and after, the gold convertibility of most currencies was re-established but shortly afterwards called into question by the onslaught of the Great Depression (1929-33), the issue of manipulating aggregate output by means of interest rate policy came to the fore. During this period, it seemed consequent to extend Wicksell's interest rate gap theory of inflation to construct monetary theories of the business cycle and macroeconomic theories of economic policy. With regard to systematic investigations of the relationship between potential output and monetary policy, the approaches developed by the Stockholm School are particularly noteworthy. Path-breaking contributions were made by Lindahl (1930) and Myrdal (1931).

Lindahl (1930) as well as Myrdal (1931) subjected Wicksell's concept of the natural rate of interest to critical examination. Both of them demonstrated that in a modern monetary economy with a multitude of products no equilibrium interest rate can be conceptualised independently of the money rate of interest and monetary policy (see also Trautwein, 2005; Boianovsky & Trautwein, 2006b). They redefined the equilibrium rate of interest as the expected rate of return on real investment (purchases of durable means of production) that equals the planned savings of households and enterprises. For these definitions of the "real interest rate", expectations concerning the future development of the value of investment

goods are of crucial importance. Similar to modern rentability concepts that proceed from the present value of an investment project, Lindahl (1930: 248) and Myrdal (1931: 32) considered the real interest rate to be the "relation between the expected future value of output (net of fair risk-premium)" and "current invested values". These current invested values depend on investment demand, which in turn is affected by lending rates and, hence, in the end, by the central bank's monetary policy.

Lindahl (1930: 167 and 249) and Myrdal (1931: 164), thus, concluded that the real interest rate tends to adapt to the current money rate rather than the reverse. Lindahl (1930: ch. II) substantiated this conclusion by constructing various scenarios of cumulative processes that emerge in response to a cut of nominal interest rates by the central bank. For this he varied certain assumptions in the basic model, such as the degrees of capacity utilisation and employment, the intersectoral mobility of capital goods and labour, as well as incomplete foresight with regard to changes in the price level. He showed that, in an environment of underutilisation and unemployment, the decrease in the central money rate of interest (in those days: the discount rate) brings about an expansion of output until potential output is completely utilised. However, under certain conditions the decrease in interest rates may serve to expand potential output itself: if, due to interest rate cuts, aggregate demand exceeds supply while the emerging inflation is not perfectly anticipated by lenders and jobholders, enterprises earn so-called "windfall profits". They gain returns that result solely from the redistribution of purchasing power away from consumers with comparatively fixed incomes. Since the entrepreneurial propensity to reinvest retained earnings is normally higher than the households' propensity to save, it is safe to assume that the extra profits caused by inflation enhance entrepreneurial investment activity. With the extension of productive capacities potential output grows, and, open competition provided, inflation decreases as supply adapts to demand.

In this scenario as well as in the multitude of other designs of cumulative processes that abound in the key works of the Stockholm School (especially Lindahl, 1930; Myrdal, 1931, & Lundberg, 1937), disequilibria of aggregate supply and demand that give rise to inflation or disinflation are explained by deficiencies in the coordination of planned investments and planned savings by way of the interest rate mechanism. When discussing these kinds of coordination failures, the Swedish tradition particularly emphasised the formation of expectations in an environment of imperfect foresight. *Ex ante* disequilibria in the sense of incompatible plans bring about adjustments of prices and quantities that result, *ex post,* in equilibrium states of investments and savings, which differ from the original full-employment equilibrium.[14] In the above-mentioned scenario of inflation-driven growth aggregate saving deviates from the level that was originally planned, adjusting to entrepreneurial investments. Eventually, the real interest rate coincides with the decreased money rate since the formation of extra capital tends to in-

[14] The famous distinction between *ex ante* and *ex post* values in macroeconomics originates in Myrdal (1933).

crease productivity and thereby lower prices such that aggregate real income may increase.

Lindahl (1930 and 1961) was nevertheless quite sceptical with respect to efforts of fostering economic growth by means of reducing interest rates (under conditions of full employment). He assumed that, sooner or later, inflation expectations adapt to actual inflation and eventually accelerate the inflationary process by inducing interest rate-price and wage-price spirals. In the course of these processes, the income rigidities that produce windfall profits are dissolved. Furthermore, social conflicts may develop as well as a decline in saving. For both reasons, the central bank may be forced to increase interest rates in order to dampen inflation without enterprises, lenders, and jobholders being prepared for this. In any case, not only a decrease in current output but also a decline of capital stocks and, thus, potential output is imminent. Like Wicksell, Lindahl, therefore, advocated a rule-bound interest rate policy. He argued that, by stabilising expectations on inflation, the central bank should be able and obliged to stabilise capital formation as well.[15]

Lindahl and Myrdal were aware of the fundamental problem associated with a consistent definition of the equilibrium "real" interest rate – and, therewith, implicitly of the "normal" capital stock and potential output. To serve as a benchmark for evaluating measures of monetary policy, the equilibrium interest rate has to be determined independently of the impact of monetary policy. The only solution to this problem is to define the equilibrium interest rate as a path-dependent variable: Past influences of monetary policy are co-determinants of the current equilibrium interest rate.

2.4.4 The Term Structure of Interest Rates and the Business Cycle

It is considered a "stylised fact" that the central bank's monetary policy is capable of directly influencing the short-term interest rate in the money market. However, entrepreneurial investment activity – and thus the formation of capital that is decisive for potential output – primarily depends on the long-term interest rate in the capital market. How are short-term and long-term interest rates connected? Is the central bank in a position to influence the term structure of interest rates? Is it possible to extrapolate from the term structure to future potential output?

The first building blocks for answering these questions were provided by US economists Irving Fisher (1896) and Wesley Mitchell (1913). Mitchell promoted the concept of the yield curve as a representation of interest rate term structures. He observed that the yield curve is normally sloped upwards, the long-term interest rates being higher than the short-term interest rates. By contrast, in the case of

[15] Lindahl went even further and in a separate book on the rules of monetary policy (Lindahl, 1929) advocated the rule of targeting a nominally constant national product, i.e. the price level should be allowed to decline if labour productivity rises and vice versa. Given the relative rigidity of nominal wages, risks for profits and employment are evenly distributed evenly between employers and employees. For Lindahl's views on various rules for monetary policy, see Boianovsky and Trautwein (2006b).