Financial Markets and the Macroeconomy

A Keynesian perspective

Carl Chiarella, **Peter Flaschel**,
Reiner Franke, and
Willi Semmler

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Financial Markets and the Macroeconomy

The “nancial instability and its spillover to the real sector have become a great challenge to macro-economic theory. The book takes a Keynesian theoretical perspective, representing an attempt to revive what Keynes stressed in his *General Theory*, namely the role of the “nancial market in macroeconomic outcomes. Although this book is inspired and motivated by the Asian currency and “nancial crises in the years 1997…8and the experiences of the currently evolving US “nancial disruptions, it also focuses on reviving a modeling tradition that provides a theoretical framework that throws light on recent “nancial market episodes and disturbances and their macroeconomic effects.

It brings to the forefront, as Keynes has suggested, the role of “nancial market stability for growth and macroeconomics. It criticizes theories that see economic disruptions and shocks rooted solely in the real side of the economy. It stresses the “nancial real interaction as the major source for macroeconomic instability and disruptions.

This important new book from a group of Keynesian but nonetheless technically oriented economists would be of most interest to specialists and graduate students in macroeconomics and “nancial economics, especially those with an interest in US and European “nancial markets, emerging market analysis, and dynamic economic modeling.

Carl Chiarella is a Professor at the University of Technology, Sydney, Australia. He is author of *Commerce, Complexity and Evolution,* 2000. **Peter Flaschel** is Professor Emeritus at Bielefeld University, Germany. He is co-author, with Carl Chiarella, of *Dynamics of Keynesian Monetary Growth*, 2001. **Reiner Franke** is a Lecturer at the University of Kiel, Germany. **Willi Semmler** is a Professor at the New School University, New York City, USA. He is the editor of *Monetary Policy and Unemployment*, published by Routledge in 2005.

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Foreword

This book builds to some degree on research papers written jointly with further co-authors pursuing similar lines of research. We here have to thank in particular Toichiro Asada from Chuo University, Pu Chen from the University of Melbourne, Gang Gong from Tsinghua University, Göran Kauermann, Florian Hartmann and Christian Proaño-Acosta from Bielefeld University, Ryuzo Kuroki from Rykio University, Stefan Mittnik from the University of Munich, Andreas Roethig from Darmstadt University of Technology, as well as many colleagues from our own universities for the stimulating discussions we have had with them on many occasions in the recent and more distant past. We also want to thank Miriam Rehm and Gabi Windhorst who undertook very competent and professional editing work for the “nal version of the manuscript. They have very much helped the book to become a better product.

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Introduction

This book emphasizes the role of the “nancial market in macroeconomics. Its theoretical perspective is of a Keynesian nature, representing an attempt to revive what Keynes (1936) has stressed in his •General TheoryŽ, namely the role of the “nancial market in the determination of output and employment.

The macroeconomic research perspective here is different from recent mainstream literature that uses the Dynamic Stochastic General Equilibrium (DSGE) approach as the basic modeling device. The main features of the latter are the assumptions of intertemporally optimizing agents, rational expectations, competitive markets and price-mediated market clearing through suf“ciently ”exible prices and wages. The New Keynesian approach to macroeconomics has, in the last decade or so, to a large extent, also adopted the DSGE framework, building on intertemporally optimizing agents and market clearing, but favoring more the concept of monopolistic competition, sticky wages and prices, and nominal as well as real rigidities. A path-breaking work of this type is the recent book by Woodford (2003).

In the DSGE tradition, a short-cut macromodel (that is in fact a linear quadratic (LQ) version of the DSGE model), relevant for policy making, shows a simpli“ed interaction model of the main three markets: the product market captured by an IS equation with forward-looking output and interest rates, the labor market represented by a Phillips curve with a forward-looking price, and the monetary sector with a Taylor rule for in”ation targeting. The latter represents the modern central bank policy approach where the interest rate is supposed to respond to an in”ation and output gap, both possibly also encompassing forward-looking variables. Both the nonlinear and the linearized version of the DSGE model have recently been in widespread use in central banks. With a welfare function as the central banks• objective function, those new models give the impression that the modern central bank can undertake some “ne tuning of the welfare performance of the economy by engineering interest rate changes in some direction and so steering the economy toward some steady employment, or •natural rate of unemploymentŽ, with a low in”ation rate.

Yet, from early on in the development of the DSGE paradigm, some academic economists expressed the concern that there was something important missing in this monetary macro model: namely a more detailed treatment of the “nancial market. The fact that the “nancial market, and its potential instability and disruption, were missing in those models has suddenly become clear for academics and policy makers after the US subprime and credit crises that started in the middle of 2007. As the “nancial market disruption and credit crisis evolved, this event became a great challenge to the central banks• new monetary policy concept. Central banks were suddenly forced to intervene heavily in the “nancial markets. In particular the Fed and the ECB have moved away from the in”ation targeting concept in an attempt to prevent disruption to the “nancial system. With the outbreak of the credit crisis, triggered by the subprime sector, and the threat of a “nancial meltdown, central banks focused very much on intervention in the credit sector. The central banks, in particular the Fed in the US, the European Central Bank, and the Central Bank of Japan undertook drastic action „ and also coordinated world-wide action „ to prevent the credit crisis from spreading. In the US the Fed carried out this action not only by a policy of interest rate reduction and massive liquidity provision, but also by extensive purchase of •badŽ private assets.

For the interested observer, this change in direction of monetary policy from in”ation targeting to heavy intervention in the “nancial market did not come as a surprise. Ben Bernanke, now the Fed Chair, had already written a few years ago academic papers that advocated a strong intervention by the central bank in case of a “nancial market meltdown. Already, in his earlier papers, Bernanke and his co-authors had put forward the view that the central bank should buy private assets if its interest rate policy was no longer effective. This not only would prevent a further fall in asset prices but in particular would keep down the long-term interest rate. In those papers, which were originally written with an eye to the Japanese long period of stagnation starting in the 1990s, when the zero in”ation rate and almost zero interest rates did not leave any room for monetary policy, Bernanke and co-authors hint already at a possible US application. Recently, Bernanke and Mishkin have reiterated the dangers of “nancial market disruptions and their effect on the macroeconomy. They and other academic economists have strongly advocated the view that economists need macromodels that more explicitly include “nancial markets and a richer array of “nancial assets in order to understand the modern macroeconomy and the policy challenges posed (Bernanke et al., 2004). The current book makes an attempt to address this challenge.

The preliminary work on this book had already started after the Asian crisis in the years 1997…8¸it thus contains references and material on the Asian currency and “nancial crises. Although this book is also inspired and motivated by the experiences of the currently evolving U.S. “nancial crisis, we do not explicitly model or empirically treat the recent “nancial crisis. It is too early to judge where it is going and whether the current policy reactions will suf“ce to prevent a pratracted period of unemployment. Rather, we here want to focus on reviving a theoretical modeling tradition which provides a theoretical framework that could help to throw some light on “nancial market episodes and their macro effects, which have become a major issue since “nancial markets have again been extensively liberalized since the 1980s and 1990s.

We would like to argue that the equilibrium intertemporal approaches of smoothly optimizing agents and fast adjustments (which are needed to establish temporal or intertemporal marginal conditions in the product, labor and capital markets) have not been very successful in integrating “nancial markets, with their potentials for instability, into a macro dynamic framework. The DSGE types of model have the feature that they do not yet include macroeconomic feedback effects, with their stabilizing or destabilizing impact on the macroeconomy. While one might not want to contest the view that forward-looking behavior and (the attempt at) intertemporal optimization by the economic agents might be relevant for the dynamics of the economy, in our view the exclusive focus on these issues in the present academic literature has left aside too many interesting, important and relevant issues, speci“cally pertaining to the “nancial market. For a detailed study of how, for example, asset price and credit market shocks can accelerate a downturn on the real side, see Stiglitz and Greenwald (2003).

In particular, in the interaction of all three markets there may be nonlinear feedback mechanisms at work that do not necessarily give rise to market clearing, nor necessarily to convergence to a (unique) steady-state growth path through a jump of the relevant variables to the stable path, as the DSGE class of models assumes. In our models, we will consider the working of forces of path convergence and divergence in modern macroeconomics with an extensive “nancial sector. Numerous feedback mechanisms, relevant for the interaction of labor, product and “nancial markets, have been theoretically and empirically explored since the 1930s. We want to pursue this alternative route of model building. The emphasis of the work in this book thus lies on the study of the relative strength and interaction of these feedback mechanisms as well as the transmission channels with respect to all three markets. We place an extensive emphasis on the “nancial market as a possible source and magni“er of macroeconomic instability. We will do this, in particular, in the context of a fully developed dynamic system approach.

Another important methodological perspective of our work is that, as recent research has shown, there is much heterogeneity of agents and beliefs present in modern economies as well as a large variety of informational and structural frictions present in the real world. Thus, with regard to the treatment of the “nancial market in macroeconomics, the feedback mechanisms in macroeconomics, as well the issue of heterogeneity of agents• behaviors and beliefs, we believe that the currently dominant DSGE model leaves too many open questions so that the true understanding of the economy needs to be advanced and pursued through a variety of frameworks.

We also hope that the macroeconomic constructions and empirical evidence provided in this book will show the reader alternative approaches, demonstrating that there are indeed different (and also valid) technical tools and possibilities to specify and analyze the dynamics of a “nancially sophisticated macroeconomy in a different way from the current standard theory. We study the “nancial markets and macroeconomies where the stability properties (and their analysis) are based on the relative strength of the interacting macroeconomic feedback channels. Such a type of stability analysis, despite its importance for the understanding of the dynamics of an economy, seems not to be taken into consideration by the DSGE literature. As the ongoing occurrence of herding behavior, contagion effects, and •boom-bustŽ scenarios in the “nancial markets across the world, as well as the large macroeconomic imbalances present nowadays in the global economy show, divergent paths can indeed take place and impact on growth and employment, thus setting new challenges for policy makers.

The book is organized as follows. Part I introduces our basic framework. After an introduction to the wage…price dynamics in a macroeconomic context, we “rst deal with the equity market and its potential for macroeconomic instability. We start here with the in”uential macromodel of the stock market, interest rate and output, advanced by Blanchard in 1981, which allows us to take into account a richer array of “nancial assets than the usual IS…LM or AS…AD models. This will be the work horse for further extensions in subsequent parts of the book. Next, we introduce the bond market and its interaction with the macroeconomy. as originally designed by Blanchard and Fischer (1989). A treatment of the foreign exchange market and exchange rates, as introduced by Dornbusch in the late 1970s, follows. Finally, in the context of a two-country model of the Mundell…Fleming tradition, the interactions of exchange rates, equity and bond markets are studied and their potential for macroeconomic instability explored. We critically examine and consequently avoid using the common jump variable technique (resulting from the rational expectations assumption) that usually leads to unique stable paths. The dynamics of our models are explored through the use of local linearization techniques and the analysis of high dimensional Jacobians, employing some techniques suggested by Turnovsky in the late 1980s.

Part II then introduces some extensions in our “nancial…real interaction models. Our basic “nancial…real interaction model of Part I of the book is extended by introducing further nonlinearities and allowing for state-dependent reactions by the economic agents. This can give rise to more intricate interaction patterns between the “nancial and real sectors. After introducing capital accumulation into our basic “nancial macro model and considering ”ow and stock interactions, we extend our basic model with the stock market by allowing for heterogeneous agents in the “nancial market who exhibit boundedly rational behavior. Here again local stability analysis is undertaken by the use of higher order Jacobians, and global stability analysis is pursued by way of simulations. In order to address the issue of higher order stability analysis in more general terms a high-dimensional model of the “nancial…real interaction is studied. Finally, in this part of the book, the basic variant of our “nancial…real interaction model is estimated and contrasted with calibrated DSGE models that include asset markets.

Part III broadens the framework further and extends and applies our analysis to open economy issues that have been brought into the academic discussion through the Asian currency and “nancial crisis. We analytically and empirically study the interaction of exchange rate shocks, capital ”ows and currency and “nancial crises. Here, by and large, we work with a stock and portfolio approach of the macro dynamics of an open economy. After the introduction of a stock-”ow account for an open economy, and dealing with the twin de“cit problem of the government budget and current account in the context of a Mundell„Fleming… Tobin model, we add chapters on the theoretical and empirical study of the Asian currency and “nancial crises, a type of analysis that was mainly triggered by a series of Krugman papers at the end of the 1990s. In this context, we here also add a study of the medium-run wage price dynamics and the role of hedging strategies to counter currency shocks. We try to answer the question, to what extent such currency and “nancial crises could be avoided by currency hedging strategies. Finally, we give an outlook and some suggestions of how ”ows and stocks should be properly treated in an open economy framework in the context of “nancial…real interaction models.

Overall, we revive models and tools that have been developed since the 1980s in a large body of literature. We hope that the modeling approaches presented here may be of some use in helping to understand and analyze the “nancial… real interaction as well as the “nancial instabilities and disruptions that affect the performance of macroeconomies and pose great challenges for macro policies in the current period.

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Notation

Steady-state or trend values are indicated by a superscript •o• (or sometimes superscript $*$ …in the case of closed economies) and foreign country variables are indicated by a superscript $*$ (or F in the case of foreign bonds). When no confusion arises, letters F, G, H may also de“ne certain functional expressions in a speci“c context. A dot over a variable $x = x(t)$ denotes the time derivative, a caret its growth rate: $\dot{x} = dx/dt$, $\hat{x} = \dot{x}/x$. In the numerical simulations, ”ow variables are measured at annual rates.

As far as possible, the notation tries to follow the logic of using capital letters for level variables and lower-case letters for variables in intensive form, propensities to save or for constant (steady-state) ratios. Greek letters are most often constant coef“cients in behavioral equations (with, however, the notable exceptions being π and ω, the in”ation rate and the real wage, and σ the real exchange rate. Furthermore:

B	outstanding government “xed-price bonds (priced at $p_b = 1$)
C	real private consumption (demand is generally realized)
E	number of equities
F	foreign “x-price bonds or foreign bonds in Part II of the book
G	real government expenditure (demand is always realized)
I	real net investment of “xed capital (demand is always realized)
J	Jacobian matrix in the mathematical analysis
K	stock of “xed capital
L^d	employment, i.e., total working hours per year (labor demand is always realized)
L	labor supply, i.e., supply of total working hours per year
M	stock of money supply
S	total real saving; $S = S_h + S_f + S_g$
s_x	savings propensities (households, “rms, ...): s_f, s_g, s_h
s	nominal exchange rate (σ is the real exchange rate))
T	total real tax collections
T^c, T^w	real taxes of asset holders, workers
W	real wealth of private households

Y	real output
Y^d	real aggregate demand
$\bar{Y}$	output at normal use of capacity
e	employment rate (w.r.t. hours: u_w)
s, σ	exchange rate (nominal or real: sp^*/p)
f_x	partial derivative
n_z	growth rate of trend labor productivity; $n_z = \hat{z}$
i	nominal rate of interest on government bonds;
ℓ	labor intensity (in ef“ciency units)
m	real balances relative to the capital stock; $m = M/pK$
p	price level
p_e	price of equities
r	rate of return on “xed capital, speci“ed as $r = (pY - wL - \delta pK)/pK$
s_c	propensity to save out of capital income on the part of asset owners
s_h	households• propensity to save out of total income
u	rate of capacity utilization; $u = Y/Y^p = y/y^p$
v	wage share (in gross product); $v = wL/pY$
w	nominal wage rate per hour
y	output…capitalratio; $y = Y/K$;
y^d	ratio of aggregate demand to capital stock; $y^d = Y^d/K$
y^p	potential output…capitalratio (a constant)
z	labor productivity, i.e., output per working hour; $z = Y/L^d$
α_{ii}	coef“cient measuring interest rate smoothing in the Taylor rule
α_{ip}	coef“cient on in”ation gap in the Taylor rule
α_{iu}	coef“cient on output gap in the Taylor rule
β_x	generically, reaction coef“cient in an equation determining x, $\dot{x}$ or $\hat{x}$
β_{π^c}	general adjustment speed in revisions of the in”ation climate π^c
β_{xy}	generically, reaction coef“cient related to the determination of variable x, $\dot{x}$ or $\hat{x}$ with respect to changes in the exogenous variable y
β_{pu}	reaction coef“cient of u in price Phillips curve
β_{pv}	reaction coef“cient of $(1+\mu)v - 1$ in price Phillips curve
β_{we}	reaction coef“cient of e in wage Phillips curve
β_{wv}	reaction coef“cient of $(v - v^o)/v^o$ in wage Phillips curve
γ	G/K (a constant)
δ	rate of depreciation of “xed capital (a constant)
$\eta_{m,i}$	interest elasticity of money demand (expressed as a positive number)
κ	coef“cient in reduced-form wage…priceequations; $\kappa = 1/(1 - \kappa_p \kappa_w)$
κ_p	parameter weighting $\hat{w}$ vs. π in price Phillips curve
κ_w	parameter weighting $\hat{p}$ vs. π in wage Phillips curve
π^c	general in”ation climate
θ	tax parameter (net of interest)
τ_w	tax rate on wages
ω	real wage rate

Part I

Real–financial market interaction

Baseline approaches

1 Price dynamics and the macroeconomy

1.1 Introduction

This book stresses the inclusion of the “nancial market into a macroeconomic framework. We mainly focus on the AD side of the AD…ASframework to macromodeling and leave out a more elaborate treatment of the Phillips curve. The price and wage dynamics are generally kept simple, yet a brief outline of how price dynamics can be treated in the context of the different variants of macromodels we are presenting will be provided.

New Keynesian macroeconomics is usually based on forward-looking rational expectations behavior, at least in its baseline version. It has a new type of IS curve, a new type of Phillips curve, and it uses Taylor-type interest rate rules in place of LM curves. In its baseline deterministic core with only forward-looking behavior the economy is considered in equilibrium, see Gali (2008). The dynamics are only of interest when stochastic terms are added to the model. Some of the authors of this book have investigated the merits and pitfalls of this approach elsewhere.[1]

In this book we go signi“cantly beyond the standard structure of New Keynesian macromodels, regarding not only “nancial assets but also stock-”ow dynamics which is rarely discussed in the New Keynesian literature. In this “rst chapter of the book we want to give a simple introduction to the nominal…realnteraction as we see it.

1.2 Keynesian AD–AS analysis

A Keynesian model of aggregate demand ”uctuations should allow for under- (or over-) utilization of labor as well as of capital in order to be general enough from the descriptive point of view. As Barro (1994), for example, observes, IS…LMis (or should be) based on imperfectly ”exible wages *and* prices and thus on the consideration of wage as well as price Phillips curves.

1 See Chiarella et al. (2005) and subsequent work. This analysis will thus not be repeated here. For a wavelet approach to treat forward looking variables, see Ramsey et al. (2009).

This is precisely what we will do, in an introductory manner, in the following analysis. We use the observation that medium-run aspects count in both wage and price adjustment as well as in investment behavior, here still expressed in simple terms using the concept of an in”ation as well as an investment climate. These climate terms are based on past observation, whereas we have model-consistent expectations with respect to short-run wage and price in”ation. Thus the modi“cation of the traditional AS…ADmodel that we shall introduce treats expectations in a hybrid way. There is myopic perfect foresight on the current rates of wage and price in”ation on the one hand and, on the other hand, an adaptive updating of economic climate expressions with an exponential weighting scheme.

In light of the foregoing discussion, we therefore assume here two Phillips curves (PCs) in the place of only one. In this way we provide wage and price dynamics separately, both based on measures of demand pressure $e-\bar{e}, u-\bar{u}$, in the market for labor and for goods, respectively. We denote by e the rate of employment on the labor market and by $\bar{e}$ the NAIRU level of this rate, and similarly by u the rate of capacity utilization of the capital stock and by $\bar{u}$ the normal rate of capacity utilization of “rms. Demand pressure in”uences wage and price dynamics, that is, the formation of wage and price in”ation, $\hat{w}\hat{p}$. They are both augmented by a weighted average of cost-pressure terms based on forward-looking, perfectly foreseen price and wage in”ation rates, respectively, and a backward-looking measure of the prevailing in”ationary climate, symbolized by π^c. Cost pressure perceived by workers is thus a weighted average of the currently evolving price in”ation rate $\hat{p}$ and some longer-run concept of price in”ation, π^c, based on past observations. Similarly, cost pressure perceived by “rms is given by a weighted average of the currently evolving (perfectly foreseen) wage in”ation rate $\hat{w}$ and again the measure of the in”ationary climate in which the economy is operating. We thus arrive at the following two Phillips curves for wage and price in”ation, here formulated in a fairly symmetric way.

Structural form of the wage–price dynamics:

$$\hat{w} = \beta_w(e-\bar{e}) + \kappa_w\hat{p} + (1-\kappa_w)\pi^c, \tag{1.1}$$

$$\hat{p} = \beta_p(u-\bar{u}) + \kappa_p\hat{w} + (1-\kappa_p)\pi^c. \tag{1.2}$$

In”ationary expectations over the medium run, π^c, i.e., the *inflationary climate* in which current wage and price in”ation is operating, may be adaptively following the actual rate of in”ation (by use of some exponential weighting scheme), may be based on a rolling sample (with hump-shaped weighting schemes), or on other possibilities for updating expectations. For simplicity of exposition we shall here make use of the conventional adaptive expectations mechanism. Besides demand pressure we thus use (as cost pressure expressions) in the two PCs weighted averages of this economic climate and the (foreseen) relevant cost pressure term for wage setting and price setting. In this way we get two PCs with very analogous building blocks, which despite their traditional outlook turn out to have interesting and novel implications.[2]

As for the real side, note that for our current version, the in”ationary climate variable does not matter for the *evolution of the real wage* $\omega = w/p$, the law of motion of which is given by:

$$\hat{\omega} = \kappa[(1-\kappa_p)\beta_w(e-\bar{e}) - (1-\kappa_w)\beta_p(u-\bar{u})], \quad \kappa = 1/(1-\kappa_w\kappa_p).$$

This follows easily from the obviously equivalent representation of the above two PCs:

$$\hat{w} - \pi^c = \beta_w(e-\bar{e}) + \kappa_w(\hat{p}-\pi^c),$$
$$\hat{p} - \pi^c = \beta_p(u-\bar{u}) + \kappa_p(\hat{w}-\pi^c),$$

by solving for the variables $\hat{w} - \pi^c$ and $\hat{p} - \pi^c$. It also implies that the two cross-markets or *reduced form PCs* are given by:

$$\hat{w} = \kappa[\beta_w(e-\bar{e}) + \kappa_w\beta_p(u-\bar{u})] + \pi^c, \tag{1.3}$$
$$\hat{p} = \kappa[\beta_p(u-\bar{u}) + \kappa_p\beta_w(e-\bar{e})] + \pi^c, \tag{1.4}$$

which represent *a considerable generalization* of the conventional view of a single-market price PC with only one measure of demand pressure, the one in the labor market. This traditional expectations-augmented PC formally resembles the above reduced-form $\hat{p}$-equation if Okun•s law holds in the sense of a strict positive correlation between $u-\bar{u},\ u = Y/Y^p$ and $e-\bar{e},\ e = L^d/L$, our measures of demand pressures on the market for goods and for labor. Yet the coef‘cient in front of the traditional PC would even in this situation be a mixture of all of the βs and κs of our PCs and thus represents a synthesis of goods and labor market characteristics.

With respect to the investment climate, we proceed similarly and assume that this climate is adaptively following the current risk premium $\epsilon(= r - (i - \hat{p}))$, the excess of the actual pro‘t rate over the actual real rate of interest (which is perfectly foreseen). This gives[3]

$$\dot{\epsilon}^m = \beta_{\epsilon^m}(\epsilon - \epsilon^m), \quad \epsilon = r + \hat{p} - i,$$

2 These two Phillips curves have been estimated for the US economy in various ways in Flaschel and Krolzig (2006), Asada et al. (2006) and Chen and Flaschel (2005) and were found to represent a signi‘cant improvement over single reduced-form price Phillips curves, with wage ”exibility being greater than price ”exibility with respect to demand pressure in the market for goods and for labor, respectively. Such a ‘nding is not possible in the conventional framework of a single reduced-form Phillips curve.

3 Chiarella et al. (2003), in response to Velupillai (2003), have used a slightly different expression for the updating of the investment climate.

which is directly comparable to

$$\dot{\pi}^c = \beta_{\pi^c}(\pi - \pi^c), \quad \pi = \hat{p}.$$

We believe that it is very natural to assume that economic climate expressions evolve sluggishly towards their observed short-run counterparts. It is, however, easily possible to introduce also forward-looking components into the updating of the climate expressions, for example based on the p^* concept of central banks and related potential output calculations. The investment function of the model of this section is given simply by $i_1(\epsilon^m)$ in place of $i_1(\epsilon)$.

Our model so far incorporates sluggish price adjustment as well as sluggish wage adjustment and makes use of certain delays in the cost pressure terms of its wage and price PC and in its investment function.[4]

Next we need to discuss our concept of the rate of capacity utilization that we will be using in the presence of neoclassical smooth factor substitution, but with Keynesian over- or under-employment of the capital stock. Actual use of productive capacity is of course de“ned in reference to actual output Y. As a measure of potential output Y^p, we associate with actual output Y the pro“t-maximizing output with respect to currently given wages and prices. Capacity utilization u is therefore measured relative to the pro“t-maximizing output level and is thus given by[5]

$$u = Y/Y^p \quad \text{with} \quad Y^p = F(K, L^p), \quad \omega = F_L(K, L^p),$$

where Y is determined from the IS…LM equilibrium block in the usual way. In the price PC, we assumed as a normal rate of capacity utilization one that is less than one and thus assume in general that demand pressure leads to price in”ation before potential output has been reached. This is symmetric to what is assumed in the wage PC and demand pressure on the labor market. The idea behind this assumption is that there is imperfect competition in the market for goods, so that “rms raise prices before pro“ts become zero at the margin.

There is complementary reasoning of the imperfect price level adjustment we are assuming. For reasons of simplicity, we here consider the case of a Cobb…Douglas production function, given by $Y = K^\alpha L^{1-\alpha}$. According to the above we have

$$p = w/F_L(K, L^p) = w/[(1-\alpha)K^\alpha (L^p)^{-\alpha}]$$

4 In the Sargent (1987) approach to Keynesian dynamics, the β_{ϵ^m}, β_{π^c}, β_p are all set equal to in“nity and $\bar{U}_c$ is set equal to one, which implies that only the current in”ation rate and excess pro“tabilities matter for the evolution of the economy and that prices are perfectly ”exible, so that full capacity utilization, not only normal capacity utilization, is always achieved. This limit case has, however, little in common with the properties of the model of this section.

5 In intensive-form expressions the following gives rise to $u = y/y^p$ with $y^p = f((f')^{-1}(\omega))$.

which, for given wages and prices, de“nes potential employment. Similarly, we de“ne competitive prices as the level of prices p_c such that

$$p_c = w/F_L(K, L^d) = w/[(1-\alpha)K^\alpha (L^d)^{-\alpha}].$$

From these de“nitions we get the relationship

$$\frac{p}{p_c} = \frac{(1-\alpha)K^\alpha (L^d)^{-\alpha}}{(1-\alpha)K^\alpha (L^p)^{-\alpha}} = (L^p/L^d)^\alpha.$$

We thus obtain from the de“nitions of L^d, L^p and their implication $Y/Y^p = (L^d/L^p)^{1-\alpha}$ an expression that relates the above price ratio to the rate of capacity utilization as de“ned in this section:

$$\frac{p}{p_c} = \left(\frac{Y}{Y^p}\right)^{\frac{-\alpha}{1-\alpha}} \quad \text{or} \quad \frac{p_c}{p} = \left(\frac{Y}{Y^p}\right)^{\frac{\alpha}{1-\alpha}} = (u)^{\frac{\alpha}{1-\alpha}}.$$

We thus get that (for $\bar{u} = 1$) upward adjustment of the rate of capacity utilization to full capacity utilization is positively correlated with downward adjustment of actual prices to their competitive value, and vice versa. In particular, in the special case $\alpha = 0.5$ we would get as reformulated price dynamics (see equation 1.4 with $\bar{u}$ being replaced by $(p_c/p)_o$):

$$\hat{p} = \beta_p(p_c/p - (p_c/p)_o) + \kappa_p \hat{w} + (1-\kappa_p)\pi^c,$$

which resembles the New Phillips curve of the New Keynesian approach as far as the re”ection of demand pressure forces by means of real marginal wage costs is concerned. For the new Keynesian Philips curve with forward looking variables, see Gali 2008.

Price in”ation is thus increasing when competitive prices (and thus nominal marginal wage costs) are above the actual ones and decreasing otherwise (neglecting the cost-push terms for the moment). This shows that our understanding of the rate of capacity utilization in the framework of neoclassical smooth-factor substitution is related to demand pressure terms as used in New Keynesian approaches,[6] thus further motivating its adoption. Actual prices will fall if they are above marginal wage costs to a suf“cient degree. However, our approach suggests that actual prices start rising before marginal wage costs are in fact established; i.e., in particular, we have that actual prices are always higher than the competitive ones in the steady state.

6 See also Powell and Murphy (1997) for a closely related approach, there applied to an empirical study of the Australian economy. We would like to stress here that this property of our model represents an important further similarity with the New Keynesian approach, yet here in a form that gives substitution (with moderate elasticity of substitution) no major role to play in the overall dynamics.

We have arrived at a model type that is much more complex, but also much more convincing, than the labor market dynamics of the traditional AS…ADdynamics. We now have “ve in the place of only three laws of motion, which incorporate myopic perfect foresight without any signi“cant impact on the resulting Keynesian dynamics. We can handle factor utilization problems for both labor and capital without necessarily assuming a “xed proportions technology; i.e., we can treat AS…ADgrowth with neoclassical smooth-factor substitution. We have sluggish wage as well as price adjustment processes with cost pressure terms that are both forward and backward looking, and that allow for the distinction between temporary and permanent in”ationary shocks. We have a unique interior steady-state solution of (one must stress) supply side type, generally surrounded by business ”uctuations of Keynesian short-run as well as medium-run type. Our modi“ed AS…ADgrowth dynamics therefore exhibits a variety of features that are much more in line with a Keynesian understanding of the features of the trade cycle than is the case for the conventional modelling of AS…AD growth dynamics.

Taken together, our model consists of the following “ve laws of motion for real wages, real balances, the investment climate, labor intensity and the in”ationary climate:

$$\hat{\omega} = \kappa[(1-\kappa_p)\beta_w(\ell^d/\ell - \bar{e}) - (1-\kappa_w)\beta_p(y/y^p - \bar{u})], \tag{1.5}$$

$$\hat{m} = -\hat{p} - i\epsilon^m, \tag{1.6}$$

$$\dot{\epsilon}^m = \beta_{\epsilon^m}(r + \hat{p} - i - \epsilon^m), \tag{1.7}$$

$$\hat{\ell} = -i_1\epsilon^m, \tag{1.8}$$

$$\dot{\pi}^c = \beta_{\pi^c}(\hat{p} - \pi^c), \tag{1.9}$$

with $\hat{p} = \kappa[\beta_p(y/y^p(\omega) - \bar{u}) + \kappa_p\beta_w(\ell^d/\ell - \bar{e})] + \pi^c$.

Here we already employ reduced-form expressions throughout and consider the dynamics of the real wage, ω, real balances per unit of capital, m, the investment climate ϵ^m, labor intensity, ℓ, and the in”ationary climate, π^c, on the basis of the simplifying assumptions that natural growth n determines the trend growth term in the investment function as well as money supply growth. The above dynamical system is to be supplemented by the following static relationships for output, potential output and employment (all per unit of capital) and the rate of interest and the rate of pro“t:

$$y = \frac{1}{1-c}[i_1\epsilon^m + n + g - t] + \delta + t, \tag{1.10}$$

$$y^p = f((f')^{-1}(\omega)), \quad F(1, L^p/K) = f(\ell^p) = y^p, F_L(1, L^p/K)) = f'(\ell^p) = \omega, \tag{1.11}$$

$$\ell^d = f^{-1}(y), \tag{1.12}$$

$$i = i_o + (h_1 y - m)/h_2, \tag{1.13}$$

$$r = y - \delta - \omega \ell^d, \tag{1.14}$$

which have to be inserted into the right-hand sides in order to obtain an autonomous system of “ve differential equations that is nonlinear in a natural or intrinsic way. We note however that there are many items that reappear in various equations, or are similar to each other, implying that stability analysis can exploit a variety of linear dependencies in the calculation of the conditions for local asymptotic stability. This dynamical system is investigated in Asada et al. (2006) in somewhat informal terms and, with slight modi“cations, in a rigorous way.

As the model is now formulated it exhibits “rstly the well-known real rate of interest channel, giving rise to destabilizing Mundell effects that are traditionally tamed by the application of the jump variable technique. And secondly, there is another real feedback channel (see Figure 1.1), which we have called the Rose real wage effect (based on the work of Rose (1967)) in Chiarella and Flaschel (2000). Channels like this are absent from the New Keynesian approach, see Gali (2008). The Rose effect only gives rise to a clearly distinguishable and signi“cant feedback channel, however, if wage and price ”exibilities are both “nite and if aggregate demand depends on the income distribution between wages and pro“ts. In the traditional AS…ADmodel it only gives rise to a directly stabilizing dependence of the growth rate of real wages on their level, while in our mature form of this AS…ADanalysis it works through the interaction of the law of motion (1.5) for real wages, the investment climate and the IS curve we derived on this basis. In addition, the real marginal costs effect of the New Keynesian approach is present here in the denominator of the expression we are using for the rate of capacity utilization, $u = y/y^p$. It contributes to some extent to stability should the Rose effect by itself be destabilizing. Next, we want to give an intuition of the working of the nominal and real interaction.

There are two feedback channels interacting in our extended AS…ADdynamics which, in speci“c ways, exhibit stabilizing as well as destabilizing features (Keynes vs. Mundell effects and normal vs. adverse Rose effects). A variety of further feedback channels of Keynesian macrodynamics is investigated in Chiarella et al. (2000). The careful analysis of these channels and the partial insights that can be related to them form the basis of a high stability analysis dimensional, to be undertaken in Chapter 9.

In Figure 1.1 we summarize the basic feedback channels of our approach to AS…ADdynamics. Top left we have the textbook Keynes effect or stabilizing nominal rate of interest rate channel and the therewith interacting destabilizing Mundell or in”ationary expectations effect which, together with the Keynes effect, works through the (expected) real rate of interest channel. In addition we have Rose (1967) effects working though the real wage channel. Figure 1.1 indicates the two conditions under which the real wage channel will be stabilizing: if investment reacts more strongly than consumption to real wage changes (which is the case in our model type, since consumption does not depend at all on the

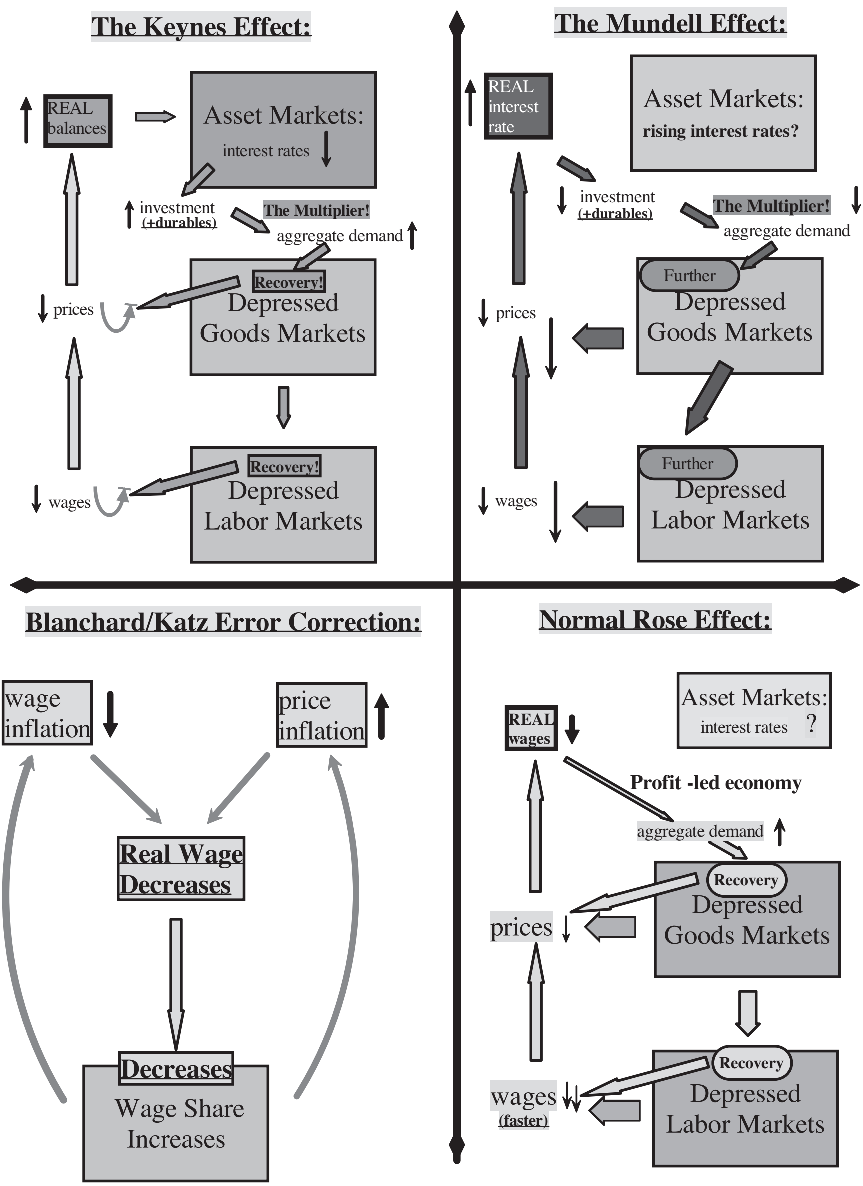

Figure 1.1 The feedback channels of matured Keynesian macrodynamics

real wage); and if this is coupled with wages being more ”exible than prices. Equation (1.5) then establishes a positive link between economic activity and induced real wage changes. However, if this latter relationship does not hold, due either to a suf“cient degree of price level ”exibility or to higher wage rigidities, this will destabilize the economy. Shrinking economic activity caused by real wage increases will then induce further real wage increases, since the price level will be falling faster than the wage level in this state of depressed markets for goods and for labor (representing an adverse type of Rose effect). Bear in mind that the degree of forward-looking behavior in both the wage and the price level dynamics is also important, since these weights enter the crucial equation (1.5) that describes the dynamics of real wages for any changing states of economic activity. Figure 1.1 “nally shows the Blanchard and Katz wage share correction mechanism (bottom left), which is discussed in detail in Asada et al. (2006).

Overall, as we have stressed above, a properly formulated Keynesian growth dynamics should ..besides allowing for under- or over-employed labor ..also allow for under or over- employment of the capital stock, at least in certain episodes. Thus the price level, like the wage level, should be assumed to adjust sluggishly.[7]

1.3 Conclusions

In closing this discussion of our proposed Keynesian disequilibrium AS…AD dynamics we state that the neoclassical case heavily depends on the neoclassical production function, while our general Keynesian model does not at all depend on it. Assuming “xed proportions in production simply implies that y^p, i.e., potential output per unit of capital, is a given magnitude and not dependent on the real wage as in the Neoclassical case which, however, is a difference of minor importance in the general framework.[8] The general conclusion is that real processes should be treated by gradual adjustments in a disequilibrium framework if considered in detail, or by just an advanced form of the IS-equation if “nancial factors are to be included. The question then remains whether “nancial markets can be treated in a similar way ..a central topic to be discussed next.

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7 See also Barro (1994) in this regard.

8 See Chiarella and Flaschel (2000, Ch. 5) for details.

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2 Stock market and the macroeconomy

2.1 Introduction

Next we consider an in”uential model advanced by Blanchard (1981), in which he extended Keynesian IS…LM analysis by taking account of a richer array of “nancial assets. Besides money and short-term bonds, he also included long-term bonds and equities. The signi“cance of this generalization derives from the corresponding treatment of the real sector. Here it is assumed that investment demand I (or likewise consumption demand) varies with Tobin•s average q, instead of the real rate of interest. Consequently the share price dynamics feeds back on the real sector. The short-term interest rate plays a more indirect role, as it is involved in the determination of Tobin•s q on the “nancial markets via an arbitrage condition. Since, for simplicity, the model abstracts from in”ation, the nominal rate of interest coincides with the real rate and it is determined by a textbook LM schedule of money market equilibrium. Through this channel real output Y impacts on the “nancial sector. Economic activity, in turn, is in”uenced by the level of investment through a Keynesian (dynamic) multiplier channel that describes gradual output adjustment towards Keynesian aggregate demand. For a given price level the real…“nancial interaction to be studied may thus be concisely summarized by the feedback loop $Y \rightarrow i \rightarrow q \rightarrow I \rightarrow Y$.

Blanchard assumes perfect substitutability between short-term bonds and “nancial assets and works with the hypothesis of rational expectations, as a special solution for model-consistent expectations. He applies the jump variable technique to the resulting (deterministic) dynamic system, according to which the steady state turns out to be a saddle point. The relevant price variable, Tobin•s q, instantaneously jumps back onto the stable manifold of saddlepoint dynamics if the economy (or the equilibrium itself) is perturbed by an exogenous shock. Though being “rmly rooted in today•s mainstream economics, this treatment is not without conceptual problems.[1] We will therefore discard the rational expectations hypothesis and explore the dynamic outcomes of a different methodological approach.

1 See in particular Burmeister (1980) on this matter.

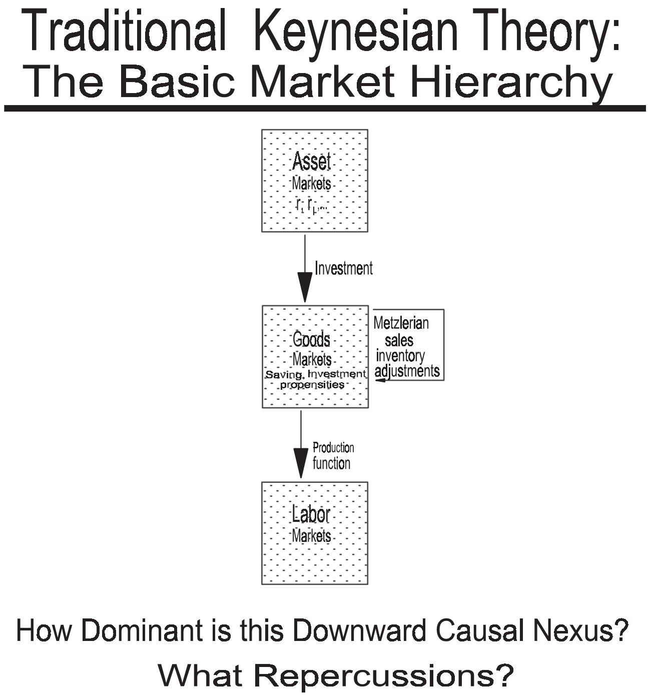

Figure 2.1 The causal nexus of Chapter 18 of Keynes•s General Theory.

The alternative model we put forward maintains the notion of fast adjustments of the expectational variable, but they are no longer in“nitely fast. This goes along with abandoning the other assumption of perfect substitutability, mentioned above. Nevertheless, the equilibrium still exhibits saddle point instability. The explosive tendencies can then be tamed by introducing a natural nonlinearity into the excess demand function for equities. This is based on the idea that agents become more cautious when, in the presence of larger differentials in the rates of return, they expect a change in the market regime. In this way persistent but bounded ”uctuations are generated, even if no shock occurs. Typically, the endogenous oscillations converge to a limit cycle, while in the limit case of myopic perfect foresight so-called relaxation oscillations come about.

Before turning to formal analysis, we may brie”y discuss some elementary feedback mechanisms at an informal level. Beginning with Chapter 18 of Keynes•s (1936) *General Theory*, consider the hierarchical relationship between the “nancial and the real sector sketched in Figure 2.1.[2] From this point of view,

2 The indicated Metzlerian quantity dynamics is simpli“ed in this chapter towards a simple dynamic multiplier story, in order to have only one law of motion in the real part of the model.

“nancial markets are at the top of the market hierarchy. Together with the other rates of return on “nancial assets, they determine the rate of interest. Compared to a rate of pro“t, or taken in conjunction with some general state of con“dence, this outcome in”uences “xed investment in the real sector (and possibly also durable consumption). The latter, in turn, determines aggregate output through a multiplier process that may work instantaneously or with some delay. The level of production, “nally, determines the volume of employment and thus the rate of unemployment on the labor market.

Starting from a situation of high unemployment (and depressed goods markets as well), in the subsequent Chapter 19 it was already recognized by Keynes (1936) himself that there may also exist a fundamental feedback from the real markets to the “nancial markets. On the whole, a feedback loop comes into being that may lead to a recovery of the economy by lowering interest rates and thus improving the investment climate (and consumption demand). This favorable effect for economic stability and a return to a position of full employment has been termed the Keynes effect in the literature. (It is often combined with the so-called Pigou real balances or wealth effect, which works in the same direction.)

The argument of the Keynes effect is summarized in Figure 2.2. The diagram points out that depressed labor and goods markets diminish wages and the price level. Falling prices are tantamount to rising real money balances, which exert a downward pressure on interest rates. The direct effect is on the short-term rate of interest, but the long-term rate may be similarly affected, so that in the end demand for goods and labor is revitalized. The signi“cance of this line of reasoning lies in the perspective on labor market problems, which are seen to arise from the interdependence of real and “nancial markets. Hence, unemployment might not be suf“ciently cured by real wage movements (which is another debatable topic), but a recovery may (also) be initiated, or reinforced, by improving this interdependent situation through an appropriate “scal or monetary policy. Hicks (1937) formulated on this basis the now traditional IS…LM model of the interaction of goods and “nancial markets, which, within a temporary equilibrium setting, concentrates on the links between output and the rate of interest.

For simplicity, in Blanchard•s (1981) analysis wage and price variations in the real sector are still left aside. On the other hand, Blanchard includes a dynamic multiplier story, which says that if demand exceeds supply, production is increased until the gap is “lled. Likewise, output decreases in the case of excess supply. Hence, taken on its own, the real sector is characterized by a stabilizing feedback loop (since, on the demand side, the marginal propensity to spend is less than unity).

The achievement of Blanchard•s contribution lies in enriching the IS…LM framework by markets for equities and long-term bonds. Regarding the stock market, Figure 2.3[3] indicates an elementary destabilizing mechanism,

3 Blanchard•s (1981) paper and this chapter also consider the market for long-term bonds, yet still without any real…“nancial interaction. This market is characterized by a “gure similar to Figure 2.3, and will be brie”y considered in the conclusions to this chapter.

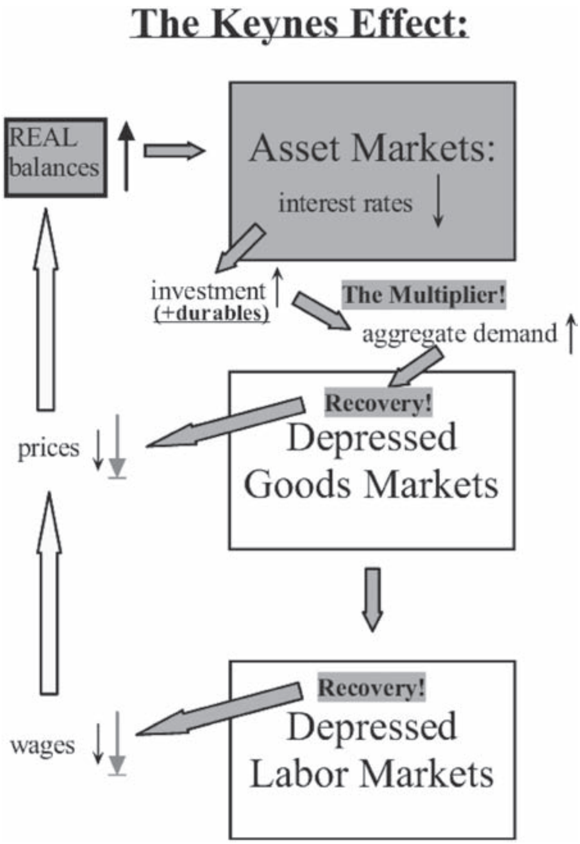

Figure 2.2 The Keynes effect as the basic stabilizing feedback from the real markets.

which explicitly involves expectations. An increasing expected rate of return on equities raises demand and so drives up the price on this market. As the rise in capital gains is expected to continue, expected capital gains are rising, too, and so does the expected rate of return. On the whole, a positive feedback loop is obtained. In Blanchard•s treatment of the "nancial sector, this mechanism is not so clearly visible because he assumes perfect substitutability of all non-money assets as well as myopic perfect foresight of capital gains. As a consequence, there is no distinction between actual and expected capital gains, and the reaction mechanism disappears after some manipulation in a mathematical formula. Our approach, by contrast, relaxes Blanchard•s assumptions in such a way that the single links of the feedback chain are recovered in Figure 2.3.

The situation in the market for long-term bonds is analogous and thus need not be discussed any further. Also, following Blanchard, real investment and

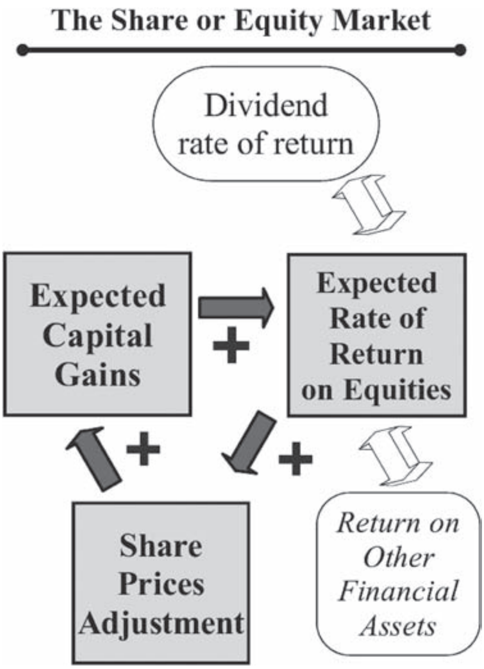

Figure 2.3 Centrifugal stock market dynamics.

consumption are supposed to be independent of the long-term rate of interest, so that this rate does not feed back on the real sector.

To sum up, both in Blanchard•s and in our model version a basically unstable “nancial sector is coupled with a stable real sector. As mentioned above, in Blanchard•s approach this interplay gives rise to saddlepoint dynamics, and the instability problem is solved by applying the jump variable technique. In our framework local stability of the equilibrium becomes possible, though instability may still be considered the normal case. So we have to turn to the global dynamics. We propose an economically meaningful concept of nonlinear price reactions on the stock market that prevent the system from exploding. It is intuitively clear that when the stabilizing forces are ruling in the outer regions of the state space, while in the vicinity of the equilibrium the destabilizing forces remain dominant, the trajectories will undergo persistent and bounded ”uctuations. Whereas their main source lies in the “nancial sector, a complete discussion has to take the interplay of the real and “nancial sector into account.

The remainder of the chapter is organized as follows. We begin with a recapitulation of Blanchard•s model. Section 2.2 presents the modeling equations, Section 2.3 investigates the model by means of geometric and analytical methods. This extensive discussion provides a “rm background for our own approach, which is put forward in Section 2.4. The same section provides a local stability analysis.

Section 2.5 is concerned with the system•s global behavior that arises if the equilibrium is unstable. It introduces the nonlinearity just alluded to and explores the resulting oscillations. Section 2.6 concludes the chapter.

2.2 The Blanchard model

All assets are treated as being given in “xed amounts; in particular, the money supply, M, the number of equities, E, and the stock of real capital, K. The latter is normalized at $K = 1$. Neglecting in”ation of goods prices, the price level is also normalized at unity, $p = 1$. a_z, b_z, c_z are parameters involved in process z ($a_z, b_z > 0$, c_z may have either sign), while β_z denotes a speed of adjustment in this context. The following variables are subject to changes over time in this or the subsequent sections:

Y	total output
Y^d	aggregate demand
d	differential in rates of return
p_b	price of long-term bonds
p_e	price of equities
q	Tobin•s (average) q; $q = p_e E/pK$, $E = K = p = 1$ in this chapter
i	short-term rate of interest
u	reciprocal of Tobin•s q; $u = 1/q$
v	auxiliary variable; $v = -\pi_e$
π_e	expected growth rate of equity price
r	rate of return on real capital

The symbol $\dot{x}$ stands for the time derivative of a dynamic variable x, $\hat{x} = \dot{x}/x$ for its growth rate. The steady-state value of x is denoted by x^o, the expected value by x^e.

Considering what is determined within the (in“nitesimally) short period, we have “rst aggregate demand on the goods market, Y^d, which depends positively on output as well as Tobin•s (average) q,

$$Y^d = a_y Y + b_y q + c_y \,, \qquad 0 < a_y < 1, \; c_y > 0 \tag{2.1}$$

The in”uence of q can be based on investment behavior (the valuation of “rms on the stock market) or on consumption demand (a wealth effect).

The money market is the counterpart (the complement, so to speak) of the market for short-term bonds. Accordingly, temporary equilibrium is brought about by the short-term rate of interest, i, where it is assumed that the underlying decisions of the asset owners are not affected by the outcome on the other “nancial assets. In other words, money market equilibrium is represented by a textbook-like LM equation. It is furthermore linear, such that it can be solved for the interest rate as

$$i = i(Y) := a_m Y - b_m \ln M + c_m \,, \qquad c_m = 0 \tag{2.2}$$

Given $p = 1$, the term c_m is zero in Blanchard (1981, eq. (2.2), p. 133), though it might reasonably be expected to be positive. (This issue is elaborated upon in an appendix to this chapter.) We will nevertheless follow Blanchard•s speci“cation in order to reproduce his results.

Because the real sector is reduced to a minimum, real pro“ts vary only with capacity utilization, i.e., the level of production. Recalling the normalization of p and K, the rate of return on “xed capital, r (with denominator $pK = 1$), can be written as[4]

$$r = r(Y) := a_r Y + c_r \tag{2.3}$$

Where long-term bonds and equities are concerned, capital gains have to be taken into account. Under Blanchard•s assumption of myopic perfect foresight, the (instantaneous) time rates of change of p_b (long-term bonds) and p_e (equities) are always correctly foreseen, so that there is no distinction between $\hat{p}_b^e$ and $\hat{p}_b$ or between $\hat{p}_e^e$ and $\hat{p}_e$. The yield terms of bonds and equities have to be respectively augmented by these growth rates.

The long-term bonds are consols paying one dollar per unit of time. Relating them to the corresponding “nancial investment, p_b, we get $1/p_b + \hat{p}_b$ as the rate of return of long-term bonds under myopic perfect foresight. On the other hand, as for equities, it is assumed that all pro“ts, rpK, of “rms are distributed to the shareholders. With $rpK/p_eE = r/q$, the rate of return of equities is $r/q + \hat{p}_e$.

The second hypothesis invoked by Blanchard is perfect substitutability of equities, long-term bonds, and short-term bonds. Arbitrage between these assets implies that the three rates of return are equal. Since there is no in”ation in the model, we need not bother about real and “nancial rates of return.[5] Thus, the arbitrage conditions read

$$\hat{p}_b + 1/p_b = \frac{B + \dot{p}_b B}{p_b B} = i \tag{2.4}$$

$$\hat{p}_e + r/q = \frac{rK + \dot{p}_e E}{p_e E} = i \tag{2.5}$$

Equations (2.2)…(2.5) show a certain hierarchy of “nancial markets: the market for short-term bonds comes “rst and provides an anchor for the rates of return of long-term bonds and of equities. Note also that the short rate is determined in a static relationship, whereas the price formation for long-term bonds and equities involves dynamic relationships.

4 Since the rate of pro“t equals the pro“t share times the output…capital ratio, minus the rate of capital depreciation, the constant term c_r will be negative in equation (2.3); see the Appendix to this chapter.

5 According to Blanchard (1981, pp. 133f), $1/p_b + \hat{p}_b$ is a nominal rate of return, whereas $r/q + \hat{p}_e$ is a real rate ..a statement which may require a second thought.

To complete the model, it remains to formulate the output adjustment mechanism on the goods market. The simple dynamic multiplier here assumed is given by

$$\dot{Y} = \beta_y (Y^d - Y). \tag{2.6}$$

Output of “rms adjusts, as in simple textbook stories, with speed β_y towards the thereby changing level of aggregate demand currently observed by “rms. Taken by itself and based on the assumption of a marginal propensity to spend of less than one, we know that this adjustment process converges to goods market equilibrium (when interest rates and stock prices are considered as given).

2.3 Analysis of the Blanchard model

2.3.1 Reduced-form dynamics

Equations (2.1)…(2.6) are easily transformed to a two-dimensional core system with output Y and Tobin•s q as dynamic state variables. The differential equation for Y is obtained from (2.6) by substituting (2.1) for Y^d; the equation for q derives from $\hat{q} = \hat{p}_e$ (because p, K, E are constant and in fact set equal to one), solving (2.5) for $\hat{p}_e$, and using (2.2) and (2.3). Thus, the following system has to be studied:

$$\dot{Y} = \beta_y [-(1-a_y)Y + b_y q + c_y] \tag{2.7}$$

$$\dot{q} = i(Y)q - r(Y) \tag{2.8}$$

Apparently, long-term bonds do not feed back on these adjustments and can therefore be ignored; the dynamics of p_b are a mere appendix to equations (2.7), (2.8).[6] Note that, although the static relationships are linear speci“cations, equation (2.8) exhibits an intrinsic nonlinearity.

2.3.2 The IS curve: $\dot{Y} = 0$

Setting the “rst law of motion equal to zero and solving for q gives the locus of pairs (Y, q) that constitute temporary goods market equilibrium. It is analogous to the textbook IS curve, with the role of the short-term interest rate now being taken by Tobin•s q. Hence this locus, too, may be safely called the model•s IS curve. As q impacts positively on aggregate demand (while in the familiar textbook story the interest rate impacts negatively on Y^d), this IS curve is upward-sloping (rather than downward-sloping, when Y^d depends on i). In addition, if q is held constant, then all non-equilibrium points are attracted by the IS curve. These features are illustrated in Figure 2.4. Note that the IS curve must cut the horizontal

6 In Blanchard and Fischer (1989, ch. 10.4) and Chiarella et al. (2003), the role of equities is taken by the long-term bonds. Equities then become an appendix to the core system.

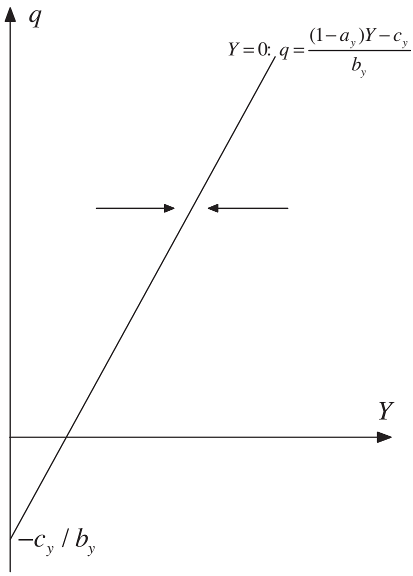

Figure 2.4 The IS curve (representing goods market equilibrium).

axis at a positive value, since the autonomous term in the aggregate demand function has been assumed as positive (representing basically the in”uence of “scal policy on aggregate demand). The IS curve will shift to the right if “scal policy is expansionary and it will be steeper with smaller a_y, the value of the marginal propensity to spend.

2.3.3 The LM Curve: $\dot{q} = 0$

In analogy to the treatment in the previous subsection, the second law of motion may be set to rest. This means that the stock market is in temporary equilibrium … in conjunction with money market equilibrium, which by (2.2) and $i(Y)$ entering (2.8) is presupposed anyway. Although $i(Y)$ was said to derive from a familiar LM condition, it will be convenient from now on to call the locus of pairs (Y, q) giving rise to (2.8) $= 0$ an LM curve. We stress that the LM curve of this chapter represents money market and stock market equilibrium and is thus more complex than the usual LM curve of the textbook literature (and in particular, not always positively sloped as in the case of the simple money market LM curve, see below).

This curve, however, is unstable. Suppose share prices and, thus, Tobin•s q are so high that $i(Y)q - r(Y) > 0$, which says that the short-term interest rate i exceeds the direct returns rpK from holding equities when these are related to the value of shares (this rate of return being given by $rpK/p_eE = r/q$). In this situation share prices are driven up even higher, according to $\dot{q} > 0$ in (2.8). Likewise, adjustments take place in the other direction if the right-hand side of (2.8) is negative. This instability corresponds, in condensed form, to the positive stock market feedback mechanism mentioned in the introduction to this chapter (see Figure 2.3).

The equality (2.8) = 0 can be explicitly solved for q, so that the LM equilibrium value of $q = q_{LM}$ with respect to output Y is given by the function

$$q_{LM}(Y) = r(Y)/i(Y) \tag{2.9}$$

Depending on the relative (positive) slopes of $r(\cdot)$ and $i(\cdot)$, q_{LM} may rise or fall as Y increases. Blanchard calls the "rst case, $q'_{LM} > 0$, the *good news case*, and the second, $q'_{LM} < 0$, the *bad news case*. The following proposition assures us that either case unambiguously prevails over the entire range of economically meaningful levels of production, which are associated with a positive rate of interest $i = i(Y)$. It also establishes that in the good news case the LM curve is always convex, and is concave in the bad news case. On the basis of this information, the two cases are sketched in Figures 2.5 and 2.6.

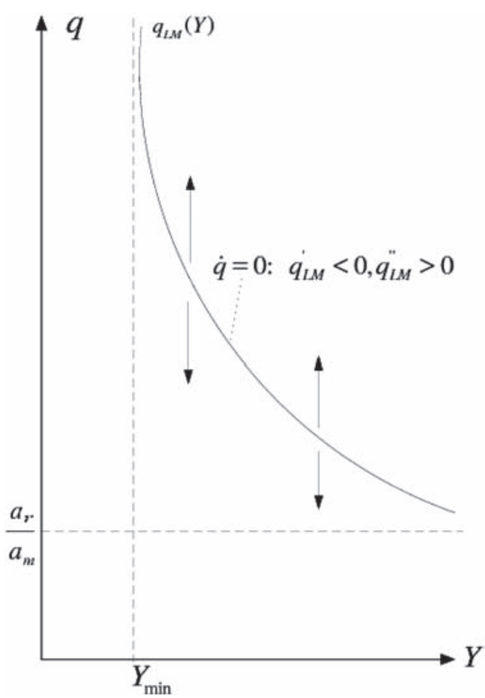

Figure 2.5 The LM curve (representing money market and equity market equilibrium): Blanchard•s bad news case (BNC).

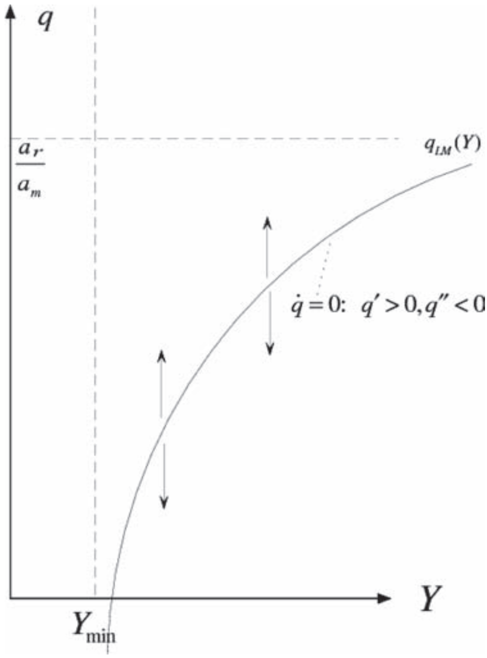

Figure 2.6 The LM curve (representing money market and equity market equilibrium): Blanchard•s good news case.

Proposition 2.1:

Let $Y_{min} := (b_m \ln M)/a_m$ be the level of output at which the short-term interest rate in (2.2) would become zero. Then, for all $Y > Y_{min}$, the following equivalence relationships hold true:

$$q'_{LM}(Y) > 0 \iff q''_{LM}(Y) < 0 \iff r(Y_{min}) < 0$$

$$q'_{LM}(Y) < 0 \iff q''_{LM}(Y) > 0 \iff r(Y_{min}) > 0$$

Proof: Differentiating the function $q_{LM}(\cdot)$ yields $i^2(Y)q'_{LM}(Y) = -a_r b_m \ln M - a_m c_r = -a_m[a_r(b_m \ln M)/a_m + c_r] = -a_m r(Y_{min})$. The second derivative $q''_{LM}(Y)$ is easily seen to have the same sign as $r(Y_{min})$ if $Y > Y_{min}$. The statements of the proposition then immediately follow. □

***Proof details*:** Making use of the de“nition of Y_{min}. one can easily show that

$$q_{LM}(Y) = \frac{a_r(Y - Y_{min}) + r(Y_{min})}{a_m(Y - Y_{min})}$$

holds true, since we have $a_m Y_{min} - b_m \ln M + c_m = 0$. This gives

$$q'_{LM}(Y) = \frac{a_m r(Y_{min})}{(a_m(Y - Y_{min})^2}$$

and

$$q''_{LM}(Y) = \frac{a_m r(Y_{min}) 2 a_m (Y - Y_{min}) a_m}{(a_m(Y - Y_{min}))^4}.$$

These two derivatives show that the sign of the rate of pro“t at Y_{min} is of decisive importance for the signs of these two derivatives, and in the way it is asserted in proposition 1.

2.3.4 Steady-state positions and local dynamics

The economy is in a state of long-run equilibrium, or, synonymously, in a steady state, if (Y, q) brings about $\dot{Y} = \dot{q} = 0$ in (2.7) and (2.8). Referring to Figures 2.7[7] and 2.8,[8] which, regarding the IS and LM curves, combine Figure 2.4 with Figures 2.5 and 2.6, respectively, Proposition 2.2 on the existence of such equilibrium points is straightforward. (The two curves rest on different parameters and are thus independent.)

Proposition 2.2:

In the bad news case, $q'_{LM} < 0$, system (7), (8) has exactly one economically meaningful steady-state position (Y^o, q^o). On the other hand, in the good news case, $q'_{LM} > 0$, there may be two, one, or no equilibrium (Y^o, q^o).

In the good news case, the equilibrium is unique if the LM curve is tangent to the IS curve. Of course, this can only happen by a ”uke. It may furthermore be remarked that the problem of two or no equilibria is due to the special circumstances in the present, simpli“ed framework. As a matter of fact, the phenomena seem to be rather spurious. Existence and uniqueness are easily re-established if the model is put in a broader (growth) perspective where, in particular, K and E vary over time. In this case, the motions of q are no longer so tightly linked to p_e, and the equilibrium value of q is formally derived in another part of the model; see Chapter 7 in this book. Table 2.1 summarizes some steady-state comparisons for the main policy variables of the model (monetary and “scal policy) and the case of real wage increases (or productivity decreases). It shows …viewed from the common sense of textbook approaches …strange results for the bad stable equilibrium (BSE)

7 Note that there is a further equilibrium to the left of Y_{min} in Figure 2.7.

8 Note that the LM curve is also de“ned left of Y_{min} in Figure 2.8, but is economically meaningless there.

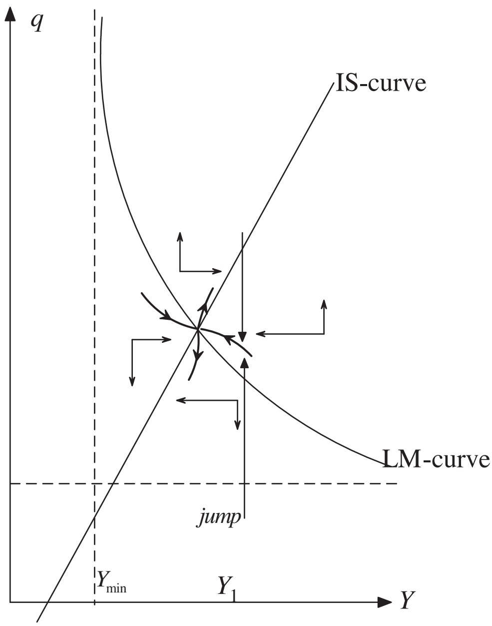

Figure 2.7 A uniquely determined steady state in Blanchard•s bad news case, which, due to its economic meaninglessness, is excluded from consideration.

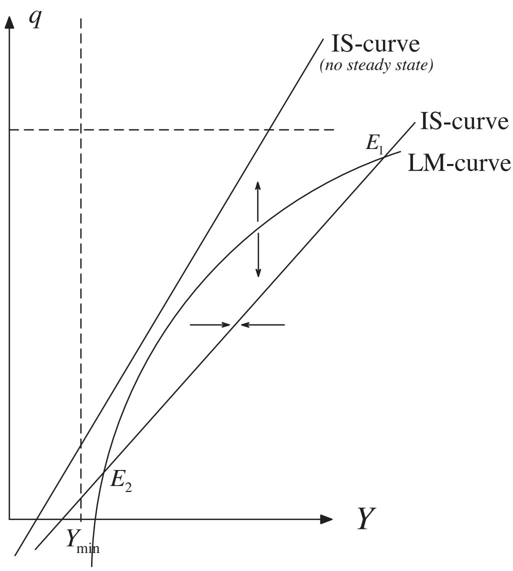

Figure 2.8 Two or no steady states in Blanchard•s good news case.

Table 2.1 Comparative statics: monetary expansion, “scal expansion and real wage increases

Cases	*Variables*	M	c_y	$\omega = w/p$
Bad news case	Y	$+$	$+$	$-$
	q	$+$	$-$	$-$
	i	?	$+$	?
Good news case	Y	$+$	$+$	$-$
	q	$+$	$-$	$-$
	i	$+$	$+$	?
Bad stable Equilibrium	Y	$-$	$-$	$+$
	q	$-$	$-$	$+$
	i	$-$	$-$	?

case and also an unusual range of stock prices with respect to “scal expansion in the bad news case (BNC). In Blanchard•s good news case (GNC), all results are as one would have expected them to be. We will come back to these results when the dynamics implied in these three cases is considered. In contrast to Blanchard, we will however not conclude that the uncommon comparative static features of the BSE case allow us to exclude this equilibrium from consideration, since unusual results will also characterize the BNC (where a booming economy is bad news for the stock market in the long run), while we will “nd methodological problems in the solution technique that is applied by Blanchard (1981) in the good news case.

The local dynamics around a steady state is determined by the Jacobian matrix J of the partial derivatives of (2.7), (2.8) (evaluated at this point). The properties derived from an investigation of J are summarized in the next theorem.

Proposition 2.3:

In the bad news case, $q'_{LM} < 0$, the (unique) steady state of (2.7), (2.8) is a saddle point. In the good news case $q'_{LM} > 0$, with two equilibria. The equilibrium at which the LM curve cuts the IS curve from above (point E_1 in Figure 2.9) is a saddle point. The other equilibrium, where the LM curve cuts the IS curve from below (point E_2 in Figure 2.9), is locally asymptotically stable if $i^o = i(Y^o) < \beta_y(1-a_y)$, while it is repelling if this inequality is reversed.

Proof: The Jacobian matrix evaluated at an equilibrium point (Y^o, q^o) with associated short-term interest rate $i^o = i(Y^o)$ is given by

$$J = \begin{bmatrix} j_{11} & j_{12} \\ j_{21} & j_{22} \end{bmatrix} = \begin{bmatrix} -\beta_y(1-a_y) & \beta_y b_q \\ a_m q^o - a_r & i^o \end{bmatrix} = \begin{bmatrix} - & + \\ ? & + \end{bmatrix}$$

The slopes of the IS and LM curves are obtained from the implicit function theorem (or more informally from the equations $j_{11}\, dY + j_{12}\, dq = 0$ for the IS schedule,

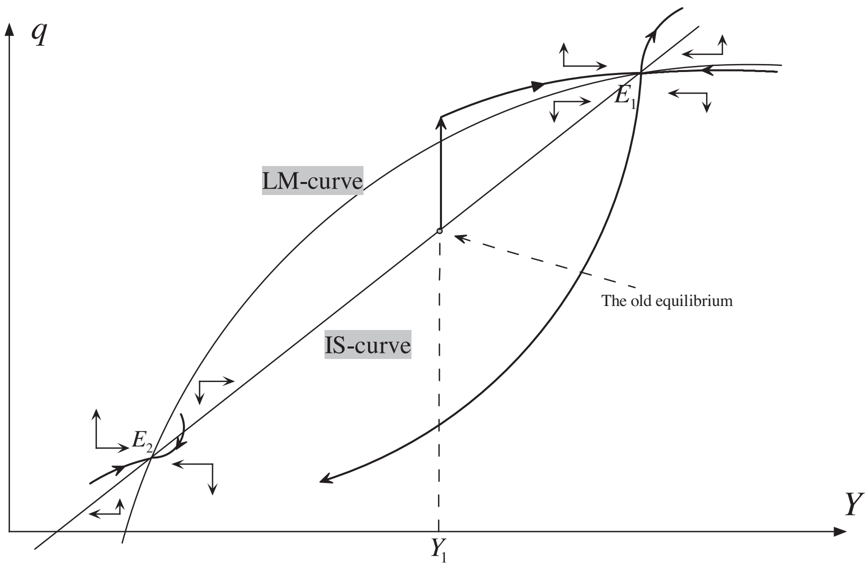

Figure 2.9 Dynamics in the good news case: saddle point and stable node or focus.

$j_{21}\,dY + j_{22}\,dq = 0$ for the LM schedule). This gives

$$\begin{array}{lllll} \text{Slope IS} & = & -j_{11}/j_{12} & = & (1-a_y)/b_y \\ \text{Slope LM} & = & -j_{21}/j_{22} & = & -(a_m q^o - a_r)/i^o \end{array}$$

As LM is downward-sloping in the bad news case, we have $j_{21} > 0$ and thus $\det J < 0$, so that the equilibrium is a saddle point. In the good news case, slope IS > slope LM at an equilibrium is equivalent to $-\det J = -j_{11}j_{22} + j_{12}j_{21} > 0$, that is, this point is also a saddle. If slope IS < slope LM, $\det J > 0$ results, so that here local stability depends on the trace. $i^o < \beta_y(1-a_y)$ rewrites the second condition, $\text{trace}J < 0$, which is now necessary and suf"cient for both eigenvalues to have negative real parts.[9] □

The dynamic behavior is illustrated in Figure 2.7 for the bad news case. Figure 2.9[10] sketches the global dynamics that may arise in the presence of two equilibria in the good news case, assuming local stability for the lower equilibrium, which seems only natural in the light of the condition stated in the proposition.

9 Note here that the difference in the slopes of the IS and the LM curves is given by:

$$IS' - LM' = -\frac{J_{11}}{J_{12}} + \frac{J_{21}}{J_{22}} = -\frac{\det J}{J_{12}J_{22}}.$$

10 E_1 is the good news case (GNC) and E_2 the bad stable equilibrium (BSE).