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ORIGINAL PAPER

Global financial crisis as a phenomenon of stock market overshooting

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Abstract Inspired by Dornbusch's model of exchange rate overshooting we develop a theory of stock market behaviour and its impact on the real economy. The idea is that stock market prices overshoot and undershoot their long-run equilibrium values which are determined by the development in the real economy. The overshooting is triggered primarily by a loose monetary policy. With our model we explain the genesis of the global financial crisis (GFC) 2008/2009 primarily as the result of a loose monetary policy in the USA. Following the overshooting and crash in the stock market the real economy dropped into a recession. After modelling the interaction of three markets with different speed of adjustment—money, stocks and goods—for a closed economy we expand it to an open economy and lastly study the spillovers of a financial market crisis between countries (from a large to a small country) by introducing the transmission channels of external trade or cross-border financial transactions. A long-lasting monetary easing as exhibiting by the Fed and the ECB since 2007 and 2008, respectively could—according to our model—generate another boom-bust cycle.

Keywords Financial crisis · Open economy macroeconomics · Stock markets · Business cycles

JEL Classification E32 · E44 · E52 · F41

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1 Introduction

The Global Financial Crisis (GFC) evolved in three phases: it started as a financial crisis (2007/2008), leading to a "Great Recession"[1] (2009) and since 2010 sparked a sovereign-debt crisis. The Greek crisis marked only the tip of the iceberg of inherent public debt problems in many member states of the euro area. The GFC was triggered by "financial innovations" in the USA by which unsecured mortgages (subprime credits) were bundled into Collateral Debt Obligations (CDOs) and sold world-wide. The burst of the house price bubble devalued these assets to near-junk.[2] Bank failures occurred. Some were rescued by the state, one, although a bank "too big to fail", Lehman Brothers went bankrupt on 15 September 2008. This triggered an international banking crisis because of the loss of trust between banks and the following stop of interbank lending. A credit squeeze was the consequence. The latter caused the Great Recession in the real economy which translated into a global economic crisis and impacted on world trade (global merchandise trade declined by an unprecedented 12.2 per cent in 2009) in a harsh manner (Maurer and Degain 2010). Despite the severity of the global financial crisis and its widespread impact on economies around the world, governments have—in contrast to the development in the thirties—largely resisted resort to trade barriers (see WTO 2010; OECD et al. 2010). In the meantime a bulk of literature is emerging describing and explaining the causes of the complexity of the GFC 2008/2009.[3]

In contrast to the restrictive stance of monetary policy during the "Great Depression", both the Federal Reserve System (Fed) and the European Central Bank (ECB) steered an expansionary course during the current financial market crisis. Interest rates were slashed, in the USA earlier than in the euro area, by 5 percentage points (USA) and 3¼ percentage points (euro area), respectively. As soon as from September 2007, the Fed started lowering the Federal Funds Rate in several steps, from 5.25 percent to 0–0.25 percent in December 2008. The ECB, with a view to the inflation hike at the time, still raised the key refinancing rate in July 2008 by ¼ percentage point to 4.25 percent, turning to stepwise rate cuts only after the bankruptcy of Lehman Brothers in October 2008. Since May 2009, the key intervention rate has been held constant at 1 percent. Only the massive and early intervention of the major central banks (in particular the Fed and the ECB via interest cuts and "quantitative easing" and other unconventional measures (see

[1] This term was coined by Krugman (2009) to differentiate the economic situation in 2009 from that of the "Great Depression" in 1929–1933. The "Great Depression" received its name from Lionel Robbins (1934).

[2] Some (see Cassidy 2008) have dubbed this constellation a "Minsky moment" (Minsky 1986).

[3] Some of this literature comprises: Krugman (2008), Akerlof and Shiller (2009), Larosière Report (2009), European Commission (2009b), Stiglitz (2010), Lewis (2010), Roubini and Mihm (2010), Tichy (2010). A comprehensive investigation into common traits and differences between past financial market and economic crises is offered by Reinhart and Rogoff (2009). Comparisons of the development of the main macroeconomic and foreign trade variables during the Great Depression 1929 with that during the Great Recession 2009 can be found in Eichengreen and O'Rourke (2009) and in Aiginger (2009). DG ECFIN jointly with Université Libre de Bruxelles (ULB) and University of British Columbia (UBC) organized a conference on "Advances in international macroeconomics—Lessons from the crisis", in Brussels on 23–24 July 2010 (see DG ECFIN 2010).

Minegishi and Cournède 2010) ensured sustained liquidity and cut interest rates to historical lows), together with the bank rescue operations and fiscal stimulus programmes adopted by most industrialised countries prevented economies from falling into a depression with output losses and unemployment levels of similar dimension as in the Great Depression 1929–1933 (see Breuss et al. 2009; OECD 2009, pp. 60–61). The "collateral damage" in the form of rising unemployment and extremely high and rapidly rising public debts will weigh on the advanced economies for many years going forward. While governments, by rescuing banks via deposit guarantees, underwriting of financial operations and equity capital participation assumed the role of "lender of last resort", not least because many banks were deemed "too big to fail", they created a dangerous precedence for future crises, accepting "moral hazard" as normal strategy of banks.

The GFC 2008/2009 was not only the biggest crisis since the thirties, the dimension of it had not been foreseen by the major international institutions (European Commission, IMF, OECD), as the growth forecasts for the euro area differed from the actual outcome by 4–6 percentage points (European Commission 2009c, p. 8). It was only in early 2009 that the fall of economic activity into a deep recession became adequately reflected in the forecasts. Since autumn 2009 the recession seems to have come to an end. Some experts envisaged specific aspects of the GFC but nobody foresaw the whole complexity and its international dimension (see Tichy 2010). The Question "Why didn't anybody notice?", framed by Her Majesty The Queen on a visit to the London School of Economics on 5 November 2008 initiated a broad debate within the economics profession about the right (macro)economic model in times of a crisis.[4]

We want to deal with one of the complex aspects of the causes and consequences of the GFC, namely the interaction of three markets in times of "irrational exuberance", a phrase used by the then Federal Reserve Board Chairman, Alan Greenspan describing the stock market boom in the 1990s. In analogy to developments on foreign exchange markets (Dornbusch 1976), stock market behaviour is here interpreted as an overshooting phenomenon. The model of an economy which consists of three markets money, stocks and goods with different speed of adjustment can explain some of the major aspects of the financial market and economic crisis which had its origin in loose monetary policy in the USA that triggered a recession. This theoretical explanation of the financial market crisis by means of a three-market-model may also contribute towards a better understanding of the mortgage boom and the following subprime crisis on the US housing market and how this led to a global crisis. Abstracting from the more complex origins of the current financial market and economic crisis,[5] the main focus is set on the influences from the monetary policy side. Institutional aspects of the financial crisis (the failed

[4] Only to mention a few of such platforms of discussion, e.g. see the "Global Crisis Debate" on VoxEU: http://www.voxeu.org/ or the newly created Institute for New Economic Thinking (INET): http://intereconomics.org/ or Ökonomenstimme: http://www.oekonomenstimme.org/.

[5] Jan In't Veld et al. (2010) use an estimated open economy DSGE model with financial frictions for the US and the ROW, to evaluate various competing explanations about the recent boom bust cycle (innovation in US mortgage market (securitisation/expansion of sub prime lending); savings glut/flight to safety hypothesis; monetary policy; TFP growth; stock market and housing bubble). Accordingly, the

behaviour of banks, the banking crises, unregulated financial markets etc.) are questions of better international regulation and governance of the financial industry dealt with under the auspices of the G20 (see G20 2009, 2010) for the world economy and by the European Commission and the Council for the European Union (see European Commission 2009a; Mooslechner 2010). The EU and the USA are both implementing the G20 commitments, the USA was faster than the EU. On July 21, 2010 U.S. President Barack Obama has signed the "Wall Street Reform" (Dodd-Frank Wall Street Reform and Consumer Protection Act; see http://www.whitehouse.gov/). The new laws are the broadest reform of the U.S. financial industry since the Great Depression of 1930s. After a positive decision by the European Parliament on September 22, 2010, the new European Supervisory Authorities will be set-up on January 1, 2011 (see European Commission 2010).[6]

The paper is structured as follows: The stock market overshooting model, firstly for a closed economy, is exposed in chapter 2. A graphical representation explains the mechanism involved in the theory. Simulations with the calibrated model demonstrate the model's dynamic behaviour. The model is then extended to the open economy case and demonstrated by simulations in chapter 3. That the model is able to capture the major features of the financial crisis and its international spill-overs or contagion is demonstrated in chapter 4. With our stock market overshooting model we can also demonstrate (in chapter 5) that a volatile monetary policy may lead to boom-bust cycles. Conclusions are drawn in chapter 6.

2 A stock market overshooting model for the closed economy

Besides other factors, part of the blame for the current global financial crisis has fallen, justly or not, on monetary policy (e.g. see Taylor 2009). The story goes more or less like this: persistently low interest rates fuelled a boom in asset prices and securitized credit and led financial institutions to take on increasing risk and leverage. More recent studies verified this so-called "risk-taking channel of monetary policy" (see Altunbas et al. 2010; De Nicolò et al. 2010; Gambacorta 2009; Borio and Zhu 2008; European Central Bank 2010 for an overview). In a three-market macro model[7] we will try to catch the relationship of monetary policy,

Footnote 5 continued
loose monetary policy and more so bubbles in the stock and housing market played an essential role in the US crisis.

[6] This financial supervision framework will consist of a new European Systemic Risk Board (ESRB) and three new European Supervisory Authorities (ESAs) for the financial services sector: A European Banking Authority (EBA) based in London, a European Insurance and Occupational Pensions Authority (EIOPA) in Frankfurt and a European Securities and Markets Authority (ESMA) in Paris. The new authorities will be made up of the 27 national supervisors. This framework is to give Europe the control tower and the radar screens it needs to detect the risks which can accumulate across the financial system as we witnessed in the run up to and at the height of the financial crisis (see European Commission 2010 and for more information on the EU Financial Supervision System, see: http://ec.europa.eu/internal_market/finances/committees/index_en.htm).

[7] The empirical "three-market barometer" (i.e., indicators for the stock market, the goods market and the money market) of the Austrian Institute for Business Cycle Research (today WIFO), introduced by its

risk-taking of banks, stock market behaviour and the development in the real economy.

We will assume a closed economy with a functioning stock market. The model combines a slow adjustment of goods markets relative to money and stock markets. Departing from Dornbusch (1976) we study the stock market overshooting over its long-run equilibrium values after a short-run money shock. This produces also an overheating in the real economy.

Only after the slow adjustment in the goods market has reached its equilibrium income values, we are in the long-run equilibrium in all three markets: money, goods and stock markets, all reach their long-run equilibrium values at increased money supply, higher price levels and long-run stock market prices which are in line with the long-run equilibrium growth rate of income.

2.1 The stock market

The stock market[8] is modelled in combination with the money market. Low interest rates seduce economic agents to riskier business. Banks are taking higher risks ("risk-taking channel of monetary policy") and finance more generously investors in the stock market. In such a favourable environment market participants price asset risks close to zero. In such a risk-neutral environment all assets (bonds, shares, real estate etc.) become nearly perfect substitutes.[9] Hence, an injection of money via an easing of monetary policy decreases interest rates (i) below its long-run values (i*).[10] This enhances an expansion on the stock market via an error correction mechanism (ECSM):

$$i = i^* + \text{ECSM} \tag{1}$$

Where the error correction mechanism is modeled as follows:

$$\text{ECSM} = \theta\,(\bar{p}^{sm} - p^{sm}) \tag{2}$$

Equation 2 states that the error correction is proportional to the discrepancy between the long-run stock market price, $\bar{p}^{sm}$, and the current price, p^{sm}. The coefficient of adjustment θ is for the present taken as a parameter. The adjustment parameter represents the behaviour on the stock market (the inclination of traders to

Footnote 7 continued
founder, F.A. von Hayek in Austria along the lines of the Harvard Barometer, predicted relatively well the crisis of the 1930s (Tichy 1973, pp. 61–62).

[8] Other approaches to deal with the "irrational exuberance" of stock market behaviour are those of the catastrophe theory, developed by René Thom (1927). Zeeman (1974) tried to analyse theoretically the behaviour of stock market crashes. Aschinger (1987, 2001) applied this methodology to the 1987 US stock market crash. The catastrophe theory approach, however, has not very much economic "flesh" in it. Hayek (1929) introduced the notion of overheating in its business cycle theory.

[9] The extremely loose monetary policy of the Fed during the period 2002–2005 apparently has caused such a special precondition. The relationship of monetary policy and stock market behaviour in our model (Eqs. 1 and 2) may apply only to such a special case of risk-neutrality. Normally, bonds and shares are far from being perfect substitutes.

[10] The long-run rate (i*) can be thought as to be determined by a Taylor rule or to be in line with the long-run real interest rate according to the Fisher equation (Fisher 1930).

overshoot while taking higher than usual risks—or for short the "greed" parameter) and it indicates also the necessity to correct these exuberances later. In the model, the long-run stock market price is assumed known, and an expression for that can be derived by setting $\dot{p} = 0$ and $i = i^*$ in the long-run where markets clear (see Eq. 9).

The idea behind this mechanism is that, in the long-run stock markets tend to develop in line with the overall activity of an economy (see Fig. 1).

As Fig. 1 shows, the Dow Jones Industrial Index (DJI) ratcheted up in several waves until overshooting in 2007, before caving in up to the beginning of 2009 and deteriorating again in spring 2010 (DJI fell from peak 10/2007 to trough 2/2009 by 49%). Via several transmission channels (inter-bank connections) the stock markets in Europe, less so in Asia and Latin America followed the US pattern. From the early 1970s until the late 1990s, the DJI had been below its long-term equilibrium (approximated here by the trend in nominal GDP). On 19 0ctober 1987 ("Black Monday"), the Dow Jones Index precipitated by over 20 percent. In March 2000, the "dot-com bubble" burst. Since it was mainly the share prices of New Economy firms that slumped, this event is almost exclusively reflected in the NASDAQ Index. The collapse of share values (in many instances by over 90 percent) lasted until March 2003. In addition, the shock following the terrorist attack on the World Trade Centre in New York in 2001 ("9/11") undermined confidence on US stock markets. Only in 1929 and in 2009, such events took on the dimension of a global financial market and economic crisis. The crises of 1987 and 2002 were confined to the US stock market. In the 1990s, a banking crisis in Japan led to economic stagnation lasting for a whole decade. Asia and Russia suffered a balance of payments crisis in

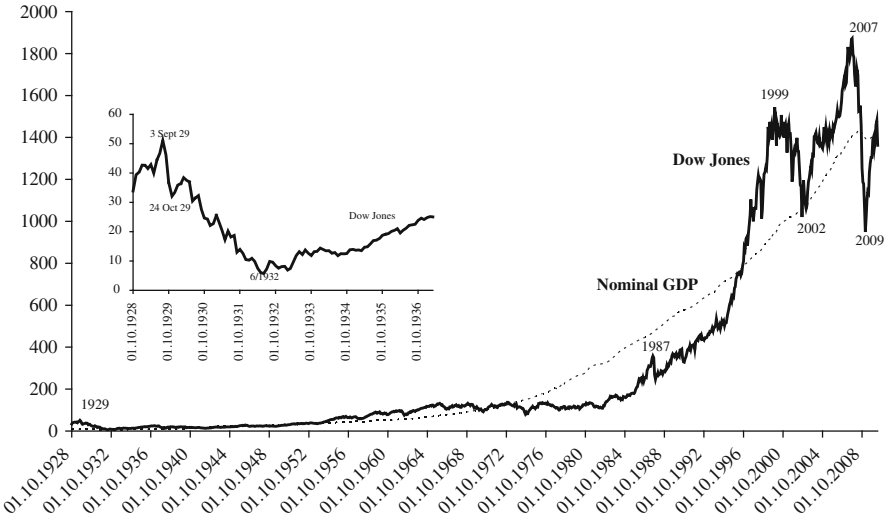

Fig. 1 Dow Jones Industrial Average and nominal GDP, USA: 1928–2010 (DJI-Index: 1M1970 = 100) Sources: Bureau of Economic Analysis; Gordon (1986), Dow Jones Industrial Average Index (DJI): http://de.finance.yahoo.com; Average annual growth between 1929 and 2009: DJI = 4.7%, nom. GDP = 6.4%; 1950 and 2009: DJI = 6.6%, nom. GDP = 6.7%; 1970 and 2009: DJI = 6.9%, nom. GDP = 7.0%

1997–1998. Argentina also faced a balance of payments crisis in 1998. Local crises were the Tequila crisis in Mexico in 1994–1995 and the savings-and-loan crises in the USA in the 1980s and early 1990s.

2.2 The money market

The domestic interest rate is determined by the condition of equilibrium in the domestic money market. The demand for real money balances is assumed to depend on the domestic interest rate and real income and will, in equilibrium, equal the real money supply $(m^s - p)$. Assuming a conventional demand for money, the log of which is linear in the log of real income and in interest rates, we have[11]

$$m^d = p + \phi\, y^d - \lambda\, i \tag{3}$$

Combining (1), (2), and (3) will give us a relationship between the current stock market price, the goods price level, and the long-run stock market price, given that the money market clears and net asset yields are equalized:

$$p - m^d = -\phi\, y^d + \lambda\, i^* + \lambda\theta(\bar{p}^{sm} - p^{sm}) \tag{4}$$

Equation (4) can be simplified by noting that with a stationary money supply long-run equilibrium will imply equality between interest rates, because current and expected stock market prices are equal. This implies that the long-run equilibrium goods price level, $\bar{p}$, will equal

$$\bar{p} = m^d + (\lambda\, i^* - \phi\, y^d) \tag{5}$$

Substituting (5) in (4) gives us a relationship between the stock market price and the goods price level:

$$p^{sm} = \bar{p}^{sm} - (1/\lambda\theta)(p - \bar{p}) \tag{6}$$

Equation 6 is one of the key equations of the model. For given long-run values of stock market prices and goods prices, it serves to determine the current stock market price as a function of the current level of goods prices.

2.3 The goods market

The goods market reacts very slowly to disturbances originating from policy interventions or from outside. It consists of two equations, the price change and the aggregate demand.

The demand for domestic output (real GDP) y^d depends on real stock market prices $(p^{sm} - p)$, long-run real income or potential output $(\bar{y} = y^{PO})$, real public expenditures (g) and nominal interest rates (i). The demand function is assumed to have the form

$$y^d = \delta\,(p^{sm} - p) + \gamma\,\bar{y} + g - \sigma\, i \tag{7}$$

[11] Equation 3 is obtained by taking the logarithm of the money market equilibrium condition $M/P = Y^{\phi}\exp(-\lambda i)$.

Where potential output and public expenditures are exogenously given; the latter can be changed by active fiscal policy. δ, γ, σ are behavioral parameters. y^d, $\bar{y}$, p and g denote the logs of the real income, potential output, price level and real public expenditures. These variables are to be interpreted as deviations from their long-run equilibrium values. In departing from Dornbusch (1976) we substitute the term relative price of domestic goods (the real exchange rate), influencing net-exports with the term real stock market prices $(p^{sm} - p)$.[12] Taking this into consideration, we allow for an additional source of financing domestic demand. However, skipping the real exchange rate as determinant of net-exports, we restrict our model to a model for a closed economy in which net-exports are exogenous. In the next chapter we will augment the model to one for an open economy which allows also for exchange rate determination. We note that an increase in the stock market prices p^{sm} or a decrease in the domestic price level (p) raises demand, as does an increase in income ($\bar{y}$) and public expenditures (g) or a reduction in interest rates (i).

The rate of increase in the price of domestic goods, $\dot{p}$, is described in (2) as proportional to an excess demand measure (Lucas supply function):

$$\dot{p} = \pi\,(y^d - \bar{y}) \tag{8}$$

The speed of adjustment,π, could be either infinite (full price flexibility) or zero (Keynesian type flexibility). We assume a sticky price adjustment, i.e. one between these two extreme cases.

We note that the long-run equilibrium stock market price implied by (1) is

$$\bar{p}^{sm} = \bar{p} + (1/\delta)[\sigma i^* + (1-\gamma)\bar{y} - g] \tag{9}$$

where $\bar{p}$ is defined in (5). From (9) it is apparent that the long-run stock market price depends with the conventional homogeneity properties on monetary variables, but obviously on real variables, too.

The price equation in (8) can be simplified by using the definition of the long-run rate in (9) and the fact that interest differences equal the error correction mechanism, $i - i^* = \theta(\bar{p}^{sm} - p^{sm})$, to become a first-order linear differential equation with constant coefficient and constant non homogeneity

$$\dot{p} = -\pi\,[(\delta + \sigma\theta)/\theta\lambda + \delta](p - \bar{p}) = -\upsilon(p - \bar{p}) \tag{10}$$

Where[13]

$$\upsilon \equiv \pi\,[(\delta + \sigma\theta)/\theta\lambda + \delta] \tag{11}$$

The price adjustment equation in (10) can be solved to yield the following differential equation[14]

[12] Stock market prices can be identified with indices like the Dow Jones Industrial (DJI) or the DAX or the ATX etc.

[13] The rate of convergence to equilibrium is a function of the adjustment coefficient in the error correction mechanism θ in (2). In case of perfect foresight, in order to correctly predict the actual path of stock market prices it must be true that $\theta = v$. The consistent adjustment coefficient, $\tilde{\theta}$, obtained as the solution to Eq. (2) if $\theta = v$, is a function of the structural parameters of the economy (see Dornbusch 1976, p. 1167): $\tilde{\theta}(\lambda, \delta, \sigma, \pi) = \pi(\sigma/\lambda + \delta)/2 + \left[\pi^2(\sigma/\lambda + \delta)^2/4 + \pi\delta/\lambda\right]^{1/2}$.

[14] For solving differential equations, see Chiang (1984), chapter 14.

$$p(t) = \bar{p} + (p_0 - \bar{p}) \exp(-\upsilon t) \tag{12}$$

Which shows that the price of domestic output will converge to its long-run level at a rate determined by (11). Substitution of (12) in (6) gives the time path (differential equation) of the stock market price

$$\begin{aligned} p^{sm}(t) &= \bar{p}^{sm} - (1/\lambda\theta)(p_0 - \bar{p}) \exp(-\upsilon t) \\ &= \bar{p}^{sm} + (p_0^{sm} - \bar{p}^{sm}) \exp(-\upsilon t) \end{aligned} \tag{13}$$

From (13) the stock market price will likewise converge to its long-run level.

2.4 A graphical representation of the model

The interaction of the three markets, the goods, the money and the stock market can be studied either separately (like in Dornbusch 1976, p. 1166, 1169 or in Obstfeld and Rogoff 1996, p. 613). Here we follow the exposition as in Gärtner-Lutz (2004), S. 103 and in Breuss (2006, p. 308, 313).

The *goods market* is represented in the first quadrant of Fig. 2. The equilibrium locus is named IS curve.[15] The positive slope of this curve is one and is derived from the goods market Eqs. (7) and (8). Substituting (8) into (7) and considering that prices are constant in equilibrium, i.e. $\dot{p} = 0$ and, hence $y^d = \bar{y}$ one can solve for p:

$$p = p^{sm} + \frac{g}{\delta} - \frac{(1-\gamma)\bar{y}}{\delta} - \frac{\sigma\, i}{\delta} \tag{14}$$

In order to sustain equilibrium in the goods market the stock market prices and the goods market prices must change proportionally.

If prices at given stock market prices increase, real financial wealth decreases and reduces domestic demand. In this disequilibrium position on the goods market, demand is below potential output ($y^d < \bar{y}$) and we are above the IS curve (the case of a recession). Analogously, if goods prices decline at given stock market prices there will be excess demand ($y^d > \bar{y}$) and we are below the IS curve (the case of a business cycle upswing or boom).

The *money market* is drawn in the third quadrant of Fig. 2. In equilibrium, one can derive the LM curve by solving Eq. (3) for the interest rate, i:

$$i = \frac{1}{\lambda}\left(p - m + \phi\, y^d\right) \tag{15}$$

The positively sloped LM curve states for which p/i combinations a given nominal money supply (m^s) will be demanded ($m^s = m^d$). If goods prices increase real money supply decreases ($m^s - p$). In order to match with the decreasing money demand, interest rate i must also increase. Because of the flexible interest rate, demand for money is balanced with the supply of money at each period of time and we are always in equilibrium in the money market.

The *stock market* is represented in the second quadrant of Fig. 2. The Eqs. (1) and (2) describe its equilibrium. Substituting (2) into (1) one gets

[15] The IS curve represents the combination of goods prices relative to stock market prices at constant prices. Therefore it would be more appropriate to call this curve the $\dot{p} = 0$ curve.

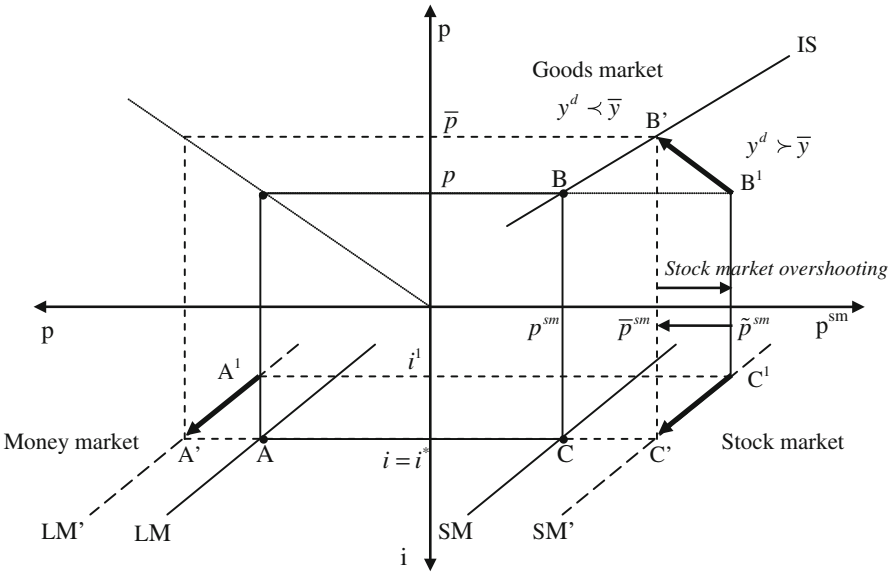

Fig. 2 Stock Market Overshooting Model: Closed Economy

$$i = i^* + \theta\ (\bar{p}^{sm} - p^{sm}) \tag{16}$$

The negative relationship of interest rate, i and stock market prices, p^{sm} is depicted by the SM curve. Given the long-run interest rate, i^* and the long-run stock market price, $\bar{p}^{sm}$ an equilibrium on the stock market can occur at different combinations of actual interest rates i and stock market prices p^{sm}. The SM curve says that the stock market is in equilibrium only if an increasing interest rate is accompanied by a respective declining stock market price and vice versa.

The economic rational behind this relationship is fact that an easing of monetary policy leads to a boom or bubble on the stock market because it was cheap to buy stocks on credit ("risk-taking channel" argument). An overly expansionary monetary policy stance adopted by the Federal Reserve System (Fed) under Alan Greenspan over the years from 2002 to 2005 has evidently led to cyclical overheating in the USA. In particular, the low level of interest rates led to a price bubble on real estate markets which, coupled with the extension of poorly asset-backed credits (subprime credits) and the development of sophisticated financial products, set speculation on financial markets in motion (Larosière Report 2009, p. 7). Taylor (2009) also cited the low-interest-rate policy as major cause of the financial market crisis. The Federal Funds Rate and short-term interest rates in the USA between 2002 and 2005 were indeed far below the respective levels predicted by the Taylor rule. For the recession year 2009, the latter would even produce negative values (Fig. 3).

Such monetary stimulus led to overheating (overshooting) of stock markets. Stock market prices surpass their long-run values. Like all speculative bubbles, such a phase never lasts for long. As soon as monetary policy turns more restrictive and

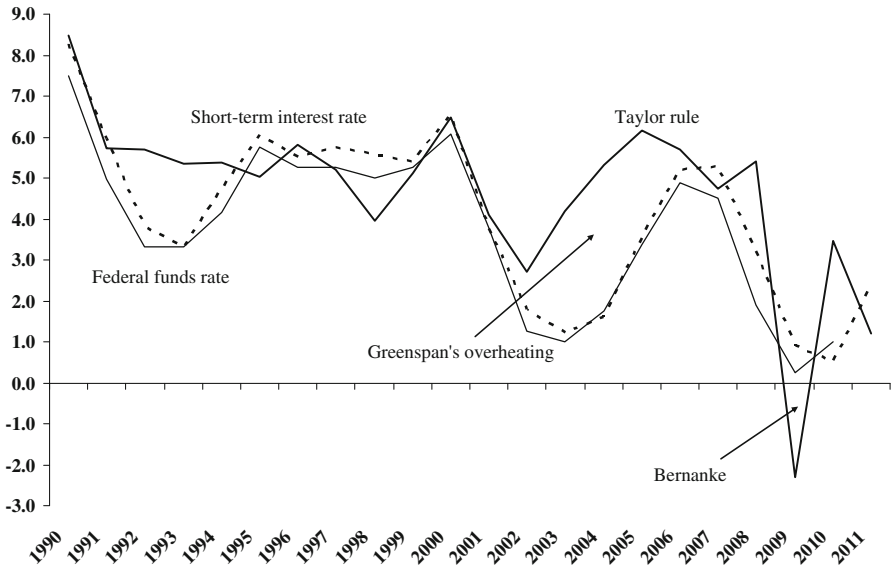

Fig. 3 Greenspan's Overheating the US Economy? Source: OECD (2010)

expectations of price hikes are disappointed, the bubble bursts and stock market values adjust to their long-term equilibrium. The error correction mechanism built-into Eq. (2) warrants that this bubble will be corrected downwards so that stock market prices will converge to its long-run equilibrium values.

At the outset we are in *equilibrium* on all three markets in the points A, B and C. If money supply increases, the LM curve shifts to left to LM′. Because of the asymmetry in the speed of adjustment on the different markets—slow adjustment in the goods market and the rapid adjustment on the money and stock markets—one has to differentiate between the adjustment in the short and in the long-run.

2.4.1 Long-run adjustment

In the long-run the interest rate is equal to and fixed at the long-run rate ($i = i^*$). The potential output ($\bar{y}$) is fixed, too. The excess supply of money can therefore only be adjusted to demand of money by increasing the goods prices. This reduces the real money supply back to its original value. The long-run equilibrium on the *money market* shifts horizontally from A to A'. In the long-run the nominal money supply increases by the same rate as the goods prices, according to the quantity theory of money ($Mv \equiv PY$).

On the *goods market*, the original equilibrium would only occur if the real stock market price reaches its original value $(p^{sm} - p)$. However, the price level increases to $\bar{p}$ and, hence, also the stock market price must increase to $\bar{p}^{sm}$. The equilibrium on the goods market changes from B to B'.

$\bar{p}^{sm}$ is the new equilibrium price of *stock markets*. The stock market is in the long-run equilibrium in point C' at prices $\bar{p}^{sm}$ and interest rate i^*. C′ is situated on the new stock market equilibrium curve SM'.

2.4.2 Short-run adjustment

Due to the assumed slow adjustment at the goods market, in the short-run the only variable to adjust excess supply to demand for money is the flexible interest rate. An expansionary monetary policy leads to a decrease of the interest rate from i to i^1 and we are at position A^1 on the new LM' curve. The fall of the interest rate below its long-run equilibrium i^* leads to a correction on the stock market in order to fulfil the equilibrium condition of Eq. (1). In the course of this correction, the stock market price $\tilde{p}^{sm}$overshoots above its long-run value $\bar{p}^{sm}$. This *overshooting* mechanism is analogous to that of Dornbusch (1976) in case of exchange rates. Overshooting the stock market prices leads to a disequilibrium on the goods market in point B^1, because the increase in real stock markets $(p^{sm} - p)$ mock a higher potential for expanding production over potential output. This excess demand for domestic goods induces an increase in the goods price levels and slowly, the adjustment from B^1 to B' takes place on the goods market. During this adjustment process the interest rate gap $i < i^*$shrinks and, on the stock market we walk downwards the SM' curve from C^1 to C' and on the money market from A^1 to A'. The endpoint is again the long-run equilibrium on all three markets.

2.4.3 Overshooting phenomenon

From (4), noting that $d\bar{p}^{sm} = dm^d = d\bar{p}$, we obtain a formal expression for the impact of a monetary expansion on the current stock market prices:

$$dp^{sm}/dm^d = 1 + 1/\lambda\theta. \tag{17}$$

Equation (17) confirms that in the short run, before goods market prices can react ($dp = 0$) the stock market prices increase faster than money supply, i.e. stock market prices will overshoot.[16] The extent of overshooting will depend on the interest response of money demand and the adjustment coefficient of the error correction mechanism on the stock market.

2.5 Simulations

By calibrating the stock market overshooting model with some plausible values it is possible to demonstrate the dynamic behaviour of the model. We have chosen the following parameter values:

[16] In case of rational expectations concerning the adjustment path of stock market prices—in analogy to the solution for rational expectations concerning the development of exchange rate changes in Dornbusch (1976, p. 1170)—one can obtain the following equation of the overshooting phenomenon (by substituting the expression of footnote 9): $dp^{sm}/dm^d = 1 + 1/\lambda\tilde{\theta} = 1 + 1//(\pi(\sigma/\lambda + \delta)/2 + [\pi^2(\sigma/\lambda + \delta)^2/4 + \pi\delta/\lambda]^{1/2})$.

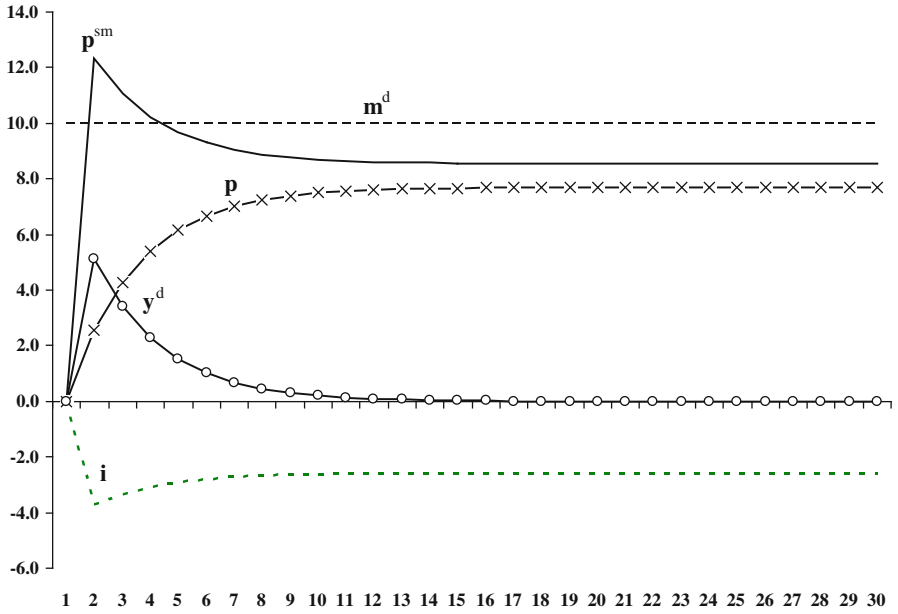

Fig. 4 Model of stock market overshooting in a closed economy: simulations (Deviations from equilibrium solution in percentage points)

$\pi = 0.5,\ \delta = 0.3,\ \gamma = 0.4,\ \sigma = 0.8,\ \phi = 0.8,\ \lambda = 0.9,\ \theta = 0.3$. The model is solved with Eviews 6.0 by inverting the money demand Eq. (3) and solving for the interest rate (i). Similarly, the stock market Eqs. (1) and (2) are solved for the current stock market price (p^{sm}). The speed of adjustment—according to Eq. (11)—implied by our calibration exercise is: $v = 0.96$. The variables are to be interpreted as deviations from their long-run equilibrium values which are zero. The simulation runs over a fictitious period of 30 years. For the results of the model simulations see Fig. 4.

A 10% increase in the supply of money ($m^s = m^d$) immediately leads to a decline in interest rates (i). As expected from the theoretical model stock market prices p^{sm} overshoot, i.e. they increase by more than 10%. The boom on the stock market leads to the impression on the goods market that real financial wealth has increased and hence creates also a boom in the demand of domestic goods. Real GDP (y^d) jumps over its potential long-run values and creates a business cycle upswing. Only slowly, goods market prices (p) adjust and bring the goods market into equilibrium, i.e. real GDP shrinks. The inherent correction mechanism leads to an adjustment of the stock market prices down to its long-run values. In the long-run all three markets converge to their equilibrium values.

3 A stock market overshooting model for the open economy

In the following we combine the original overshooting mechanism of exchange rates by Dornbusch (1976) with our error correction mechanism leading to an

overshooting in the stock markets. By doing so, we generate a model for a small open economy with four markets: goods market, money market, stock market and international capital market. Besides considering the equations which represent the international capital market we have only to adjust the equation for the aggregate demand on the goods market. Instead of a graphical representation we demonstrate the two overshooting mechanisms by a simulation of this adjusted model.

3.1 Model adjustments

3.1.1 International capital market and exchange rates

Here we implement the original mechanism of the exchange rate overshooting by Dornbusch (1976, pp. 1162–1163). The international capital market is characterized by an arbitrage condition which says that assets denominated in terms of domestic and foreign currency are assumed to be perfect substitutes given a proper premium to offset anticipated exchange rate changes. Accordingly, if the domestic currency is expected to depreciate, interest rates on assets denominated in terms of domestic currency will exceed those abroad by the expected rate of depreciation. That relationship is expressed in (18) where i is the domestic interest rate, i^f is the given world rate of interest, and $E(\dot{e})$ is the expected rate of depreciation of the domestic currency. The equilibrium on the international capital market is represented by the following arbitrage (UIP) condition:

$$i = i^f + E(\dot{e}). \tag{18}$$

The hypothesis on the expectations formation distinguishes between the long-run exchange rate, to which the economy will ultimately converge, and the current exchange rate. Denoting the logarithms of the current and long-run rate by e and $\bar{e}$, respectively, we assume with Dornbusch (1976, p. 1163) that

$$E(\dot{e}) = \varepsilon\ (\bar{e} - e) \tag{19}$$

where ε is the coefficient of adjustment, taken as a parameter. As Dornbusch (1976, pp. 1167 ff.) demonstrated this adaptive expectation mechanism is consistent also with perfect foresight.

Taking into consideration two overshooting mechanism, one on the stock market and one on the international capital market, we are confronted with two exogenous, long-run interest rates, i^* the long-run domestic interest rate and i^f the long-run world interest rate. We therefore assume that both are identical, $i^* = i^f$.

3.1.2 Goods market

Equation (7) representing aggregate demand on the goods market for the closed economy case is now extended by the influence of real exchange rates on net-exports. This makes the model one of an open economy:

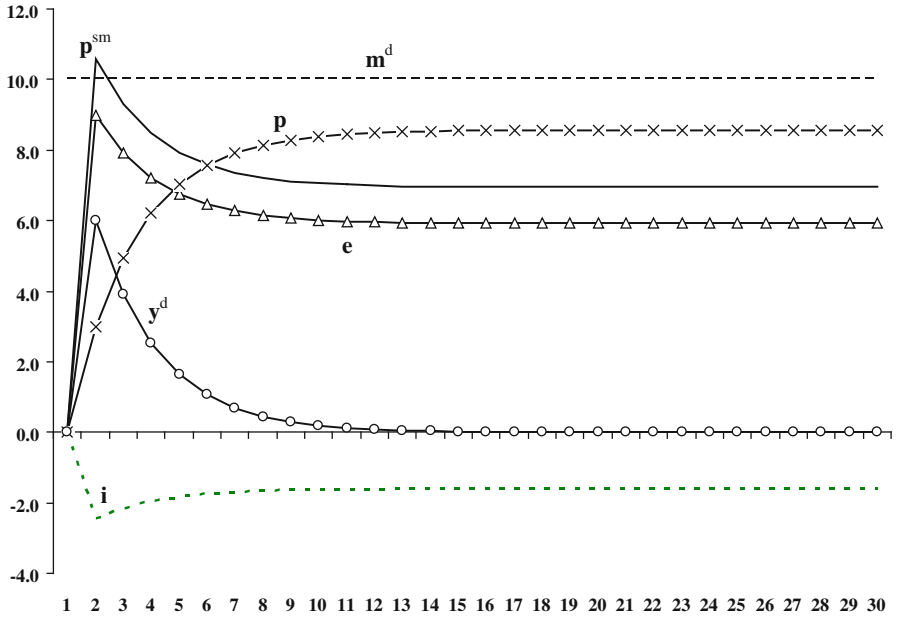

Fig. 5 Model of stock market and exchange rate overshooting in an open economy: simulations (Deviations from equilibrium solution in percentage points)

$$y^d = \rho(e - p) + \delta\,(p^{sm} - p) + \gamma\,\bar{y} + g - \sigma\,i. \tag{20}$$

The demand for domestic output depends now also on the relative price of domestic goods, $e - p$, also called the real rate of depreciation.[17]

3.2 Simulations

In addition to the chosen parameters of the stock market overshooting model for the closed economy in section (2.5) we have two new parameters which we calibrate with: $\rho = 0.3$ and $\varepsilon = 0.27$. The adjustment parameter in the error correction mechanism on the stock market is slightly changed to: $\theta = 0.23$. The model is then solved again with Eviews 6.0 by solving the money demand Eq. (3) for the current domestic interest rate (i). The stock market Eqs. (1) and (2) are solved for the current stock market price (p^{sm}) as before. And the Eqs. (18) and (19), representing the equilibrium on the international capital market, is solved for the exchange rate e. At the outset all variables are assumed to be in equilibrium and, hence they are deviations of the actual values from their equilibrium values, are therefore all zero. The results of the model simulations are presented in Fig. 5.

A 10% increase in the supply of money m^dimmediately leads to a decline in interest rates (i). In this model version, taking two overshooting mechanism into account, the interest rate effect is smaller than in the model for the closed economy.

[17] The complete relative price argument in this equation is $(e + p^* - p)$ where p^* is the logarithm of the foreign price level. Setting the foreign price level equal to unity implies that $p^* = 0$.

As expected from the theoretical model stock market prices p^{sm}overshoot, i.e. they increase more than by 10%. However, according to our calibration, the increase of the exchange rate (the depreciation) is smaller than the increase in money supply, implying that there is no true overshooting effect in the international capital market. This, however, depends only on the parameter constellation chosen. A double-overshooting effect is not impossible in this model context. The boom on the stock market and the real depreciation leads to a boom in the demand of domestic goods. Real GDP (y^d) jumps over its potential long-run values and creates a business cycle upswing. Only slowly, goods market prices (p) adjust and bring the goods market into equilibrium, i.e. real GDP shrinks. The inherent correction mechanism for stock market prices and the expectation formation mechanism for the exchange rates lead to an adjustment of the stock market prices and exchange rates down to their long-run values. In the long-run all four markets converge to their equilibrium values.

4 Overshooting model with international spillovers

The stock market and exchange rate overshooting model can also be used to study the spillovers in a two-country setting. Here we assume that in the large economy, in the United States the monetary shock (e.g. in the Greenspan period) occurs and that it has spill-overs to the small country Austria. Stock market prices in the USA are represented by the Dow Jones Industrial index (DJI) and in Austria by the ATX. The model has links via goods trade and via the international capital markets in the tradition of the two-country Mundell-Fleming model.

4.1 A two-country model

The international capital market and the spill-over mechanism of the exchange rate is the same as in the previous section. The only exception is that the foreign interest rate is no longer fixed but determined endogenously within the model context of both countries. The stock market overshooting mechanisms are the same as before with the assumption that in both countries the stock market prices, after the overshooting following a monetary policy shock, adjust to their respective long-run values. The assumed long-run interest rates may differ from country to country, but are assumed as deviations from the equilibrium, and are, therefore zero.

4.1.1 Goods market

The Eq. (20) representing aggregate demand on the goods market for the closed economy case is now extended by the spill-over effects as follows. In home we have:

$$y^d = \rho(e + p_f - p) + \delta(p^{sm} - p) + \gamma\bar{y} + g - \sigma i + \eta_1 y_f^d \tag{21}$$

and in foreign, we define the aggregated demand function with spill-overs as

$$y_f^d = -\rho(e + p_f - p) + \delta(p_f^{sm} - p_f) + \gamma\bar{y}_f + g_f - \sigma i_f + \eta_2 y^d \tag{22}$$

The demand for domestic output in home is now also influenced by the demand in foreign, y_f^d. When assuming two countries of different size, one can calibrate the spill-over parameter, η with different values.

The rate of increase in the price of domestic goods, $\dot{p}$, described in (2) is adjusted for price spillovers from abroad as follows. For home (the large country):

$$\dot{p} = \pi(y^d - \bar{y}) + \beta_1(p_f + e) \tag{23}$$

and for foreign (the small country):

$$\dot{p}_f = \pi(y_f^d - \bar{y}_f) + \beta_2(p - e) \tag{24}$$

In both countries imported prices, corrected for the exchange rate changes influence also the development of domestic prices.[18] The parameter β may in a two-country case with asymmetric country sizes differ from each other in the same way as the spill-over parameter in the equation for aggregate demand of domestic goods.

4.2 Simulations

The parameterisation is the same for both countries as in Sects. 2.5 and 3.2. In order to capture the different size of both countries (home = large = U.S.; foreign = small = Austria), the spillovers coefficients in the price and goods demand equations are calibrated differently: $\beta_1 = \eta_1 = 0.10$ and $\beta_2 = \eta_2 = 0.20$.

A 10% increase in the supply of money m^dimmediately leads to a decline in interest rates (i) in home (U.S.; see Fig. 6). In the very short-run this spills over also to the small foreign country (Austria; see Fig. 7). As expected from the theoretical model stock market prices p^{sm} overshoot, i.e. they increase more than by 10%. Also the exchange rate increases, i.e. home depreciates. Increases of share prices and depreciation of the exchange rate (USD/€) creates a boom in home. Share price and output increases spill also over to foreign, but only in the short-run. In the medium and long-run the appreciation of the € dominates the income effects stemming from home and, hence output and share prices start to decline. Parallel to this development interest rates increase in foreign, adding to the decline in output and share prices (see Fig. 7). In home as well as in foreign the break of the bubble on the stock market (the correction of stock market price overshooting) leads to a recession in the real economy ($y^d < \bar{y}$).

5 Boom-bust cycles

If our overshooting model is able to roughly capture the major features of the development leading to the GFC 2008/2009 it should also be able to predict the

[18] With this usual model specification we consider also the transmission of world raw material prices from one country to the other. According to Schulmeister (2009) the huge boom in world raw material and oil prices up to the middle of 2008 was the forerunner of the present global economic crisis.

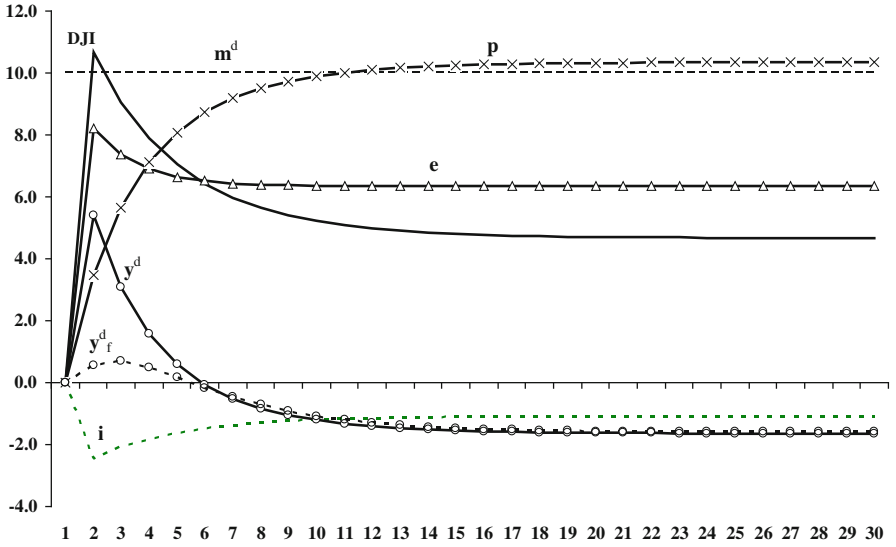

Fig. 6 Model of stock market and exchange rate overshooting with spill-overs: USA DJI = Dow Jones Industrial = stock market price (p^{sm}) in USA; y^d_f = real GDP development in Austria

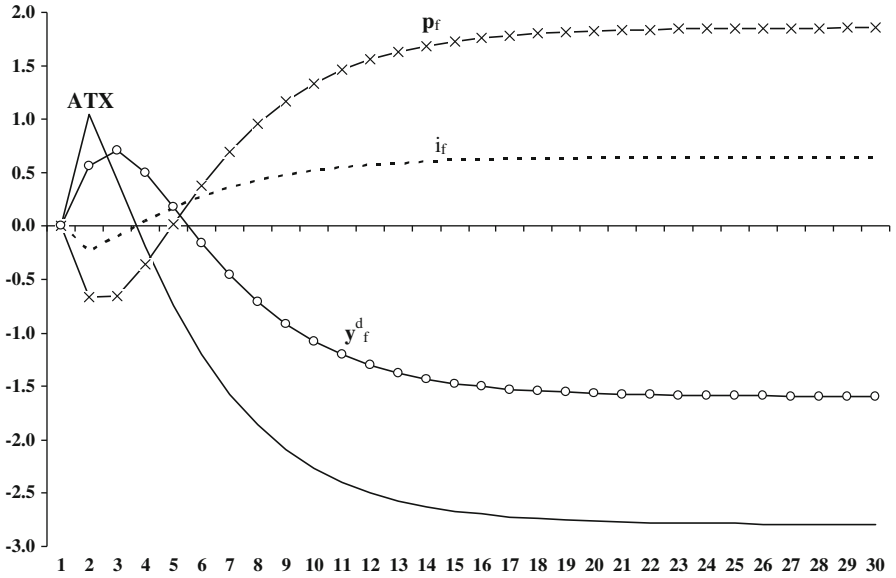

Fig. 7 Model of stock market and exchange rate overshooting with spill-overs: Austria. ATX = stock market price (p^{sm}) in Austria

future outcome of the "Great Recession" of the year 2009 following the deepest financial crisis since the Great Depression of 1929.

Whereas Greenspan could be blamed of having ignited the financial overshooting via its too easy monetary policy during 2002–2005, the massive flooding of the

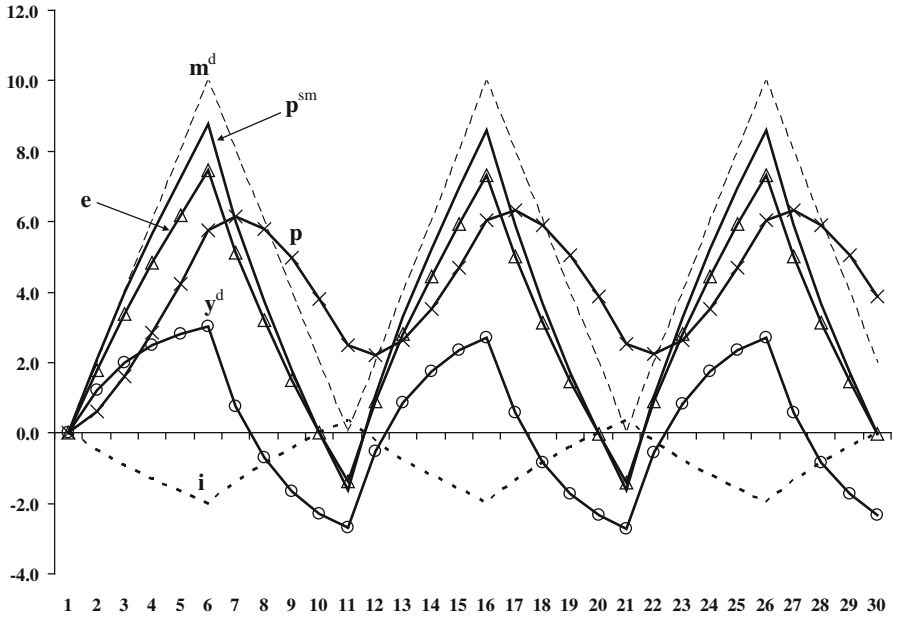

Fig. 8 Boom-bust cycles caused by ups and downs in monetary policy

economy by the Fed (already starting in September 2007) and other National Banks (the ECB only after the Lehman Brothers failure in October 2008) around the globe could give rise to the next overshooting in stock markets. This would then be to blame Bernanke, the present president of the Federal Reserve Board of the United States. However, as the theoretically calculated Taylor rule indicated even a "negative" short-term interest rate for the year 2009 (see Fig. 3) the US monetary policy could be even more expansionary. So the "quantitative easing" in addition to the near-zero interest rate policy by Bernanke can be qualified as adequate to counter the GFC 2008/2009, also in the light of the Taylor rule philosophy. In view of an insecure outlook of the US economy the Federal Open Market Committee of the Fed prolonged this extremely loose monetary policy in August 10, 2010.

Anyhow, the up and down of monetary policy reaction can lead to boom and bust credit and also economic cycles.[19] This is demonstrated with our model via simulations in Fig. 8. The definitions of the variables are the same as in the previous experiments.

Monetary overheating leads to the overshooting phenomena in the stock market and exchange rates and to an economic upswing. A following monetary restraint leads to the contrary, namely eventually to a recession ($y^d < \bar{y}$). Parallel to the boom-bust cycles our model also replicates the usual cycles in prices following business cycle fluctuations.

[19] For the explanations of boom-bust cycles, see also Tornell and Westermann (2002).

6 Conclusions

The erroneous projections of most international institutions in the face of the "Great Recession" 2009 show that economic wisdom (conventional models used) is unable to correctly assess recessions of such dimension. The academic economic community is thus called upon to review the models hypothesising economic agents of largely rational behaviour. Approaches in this regard have been made at a rather early stage, e.g., the theory of cyclical overheating by Hayek (1929), and most recently: thus, De Grauwe (2009) distinguishes between top-down and bottom-up models. The first group includes models used so far (e.g., DSGE models[20]) with agents having perfect information and rational expectations; the second group assumes that economic agents have imperfect information and acquire their economic understanding via a search process (Hayek 1945).

The three-markets macro model in the spirit by Dornbusch's model of exchange rate overshooting presented here also attempts to better understand the major repercussions of excesses on stock markets (and, by way of generalisation, also on the US housing market) which have led to the crisis on financial markets and in the real economy. Starting with the case of a closed economy it is then extended to an open-economy model and lastly is also able to capture spillovers (contagion) effects of the economic and financial crisis from a large country to a smaller one.

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[20] Brunnermaier and Sannikov (2009) try to save the reputation of DSGE models (attacked heavily by Buiter 2009) by constructing a macroeconomic model with a detailed financial sector in order to capture the interbank trade which collapsed after the Lehman Brothers failure and was one of the reasons to cause the "Great Recession". A New Keynesian (NK) model with durable goods and collateral constraints (credit squeeze) by Monacelli (2009) tries to capture features of the GFC. Kiyotaki and Moore (1997) demonstrated earlier in their model of credit cycles that the dynamic interaction between credit limits and asset prices turns out to be a powerful transmission mechanism by which the effects of shocks persist, amplify, and spill over to other sectors.

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