

UNIVERSITÄT PADERBORN

DISSERTATION

**Macroeconomic Dynamics  
in Asset and Goods Markets:  
An Analysis of Financial Bubbles  
and Fluctuations in  
Aggregate Demand and Wealth**

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## **Abstract**

This thesis consists of four papers which all analyze fluctuations in asset and goods markets. These market fluctuations – considered as deviations from long-term equilibrium movements – are shown to contain useful informational content for further analyses. With respect to the stock market, two real-time analyses using Standard and Poor’s 500 data lasting back up to 1871 are presented. Based on the finding of a cyclical but asymmetric component in stock pricing, an indicator for forecasting stock market performance in terms of abnormally high and low pricing is derived. Thereupon, rational bubbles are shown to be one factor for stock pricing to deviate from its long-term equilibrium. Estimates of bubble sizes are obtained and periods attributed to bubbles – like the Roaring 20s or the Dotcom Bubble – are found to indeed exhibit pricing paths away from market fundamentals. With respect to the goods market, analogous fluctuations away from the long-term equilibrium, that is potential production, are derived to result in continuously lower economic growth. In an endogenous growth model with market mismatch, growth itself becomes dependent on demand, bridging between neoclassical and Keynesian traditions. The thesis closes with an empirical analysis of US asset markets being affected by quantitative easing conducted between 2008 and 2022. The induced market fluctuations are shown to benefit the upper population percentiles, both in terms of liquid and physical assets.

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# Chapter 1

## Synopsis

*"[It] is not entirely clear how bubbles should be modeled [...]. As always, theoretical arguments depend ultimately on the plausibility of alternative sets of assumptions, about which there is no consensus. Ultimately, it is an empirical question, and the empirical literature on bubbles is not yet well developed. Perhaps some readers will turn their attention to developing empirical tests that can reliably distinguish between bubbles and other phenomena that affect asset prices, of which there is now a shortage" (LeRoy 2004: 785).*

### 1.1 Introduction

Separating economic activity into long-term equilibrium movements and further movements beyond those equilibrium paths is a central issue of modern macroeconomics. Especially in periods of recessions and financial crises, macroeconomic markets may deviate largely from their long-term equilibria: output deviates negatively from its long-term potential and asset prices decrease drastically, causing financial wealth to be destructed and redistributed. Asset and goods markets deviating from their long-term trends have often been connected to inherent market fluctuations, as well as to a persistently instable financial system (Keynes 1936, Minsky 1970 and 1977, Aliber and Kindleberger 2015, Shiller 2015). The analysis of such market fluctuations characterized by market movements beyond those attributed to long-term equilibrium ones, as well as their consequences with regards to asset pricing, asset possessing, and real economic outcomes like sluggish growth is the key issue of this thesis. A deeper understanding of these fluctuations can give several insights, as they contain systematic patterns that are shown to be useful for a variety of economic analyses like forecasting stock market performance, estimating the magnitudes of financial anomalies, or

giving a potential explanation for output to grow below the long-term growth trend.

Though, the shapes of these fluctuations vary from market to market. While business cycle analysis typically employs the output gap as measure for output deviating from potential output in goods markets (see, among others, Álvarez and Gómez-Loscos 2018, Orphanides and van Norden 2002, Quast and Wolters 2022), there is much less consensus between economists concerning long-term market movements and corresponding deviations in asset markets. A potential, but controversial avenue is the consideration of *financial bubbles* forming very specific fluctuations that prevent asset markets to be priced according to their long-term equilibria. Bubbles describing phases of excessive asset market exuberance in which investors seek out large capital gains have fascinated mankind at least since Dutch Tulipmania in the 1630s (see Garber 2000 for an extensive review). Subsequent history gives several examples of episodes that have been commonly labelled as bubbles, like the British South Sea Bubble or the French Mississippi Bubble which both burst in 1720 (Quinn and Turner 2022 and 2023). Later, in the 20<sup>th</sup> century, the Roaring 20s, the 1987 Bubble and the Dotcom Bubble in the 1990s pursue this list of asset market exuberance. Inter alia, in the further course of this thesis, these last-century stock market incidents will be under further consideration by means of empirical analyses. It is analyzed how these periods of anomalous market behavior become apparent in the data, how large these phenomena are, to what extent they might have been foreseen, and whether the term of a financial bubble in fact captures them adequately.

The thesis consists of four scientific papers that form Chapters 2 to 5. They are linked by their underlying conjecture that deviations from long-term equilibria market movements are an ongoing issue and contain extractable informational content themselves. The first two papers "An Early Indicator for Anomalous Stock Market Performance" (which is an extended version of Fritz et al. 2024, see Chapter 2) and "A Real-Time Analysis of Fundamentals and Bubbles in the S&P 500" (Wiechers 2025, see Chapter 3) give empirical stock market analyses in real time and build on each other. As bubbles are defined as asset price movements away from the underlying fundamental value followed by a sudden drop in prices (Brunnermeier 2016), any analysis of bubbles becomes restrictive with respect to the term *fundamental value*. Given its strict definition as a sum of discounted expected future dividends (see for example LeRoy 2004: 786 for a derivation), the resultant bubble term is dropped at first in favor of a more general anomaly definition in Fritz et al. (2024). This step allows for a first empirical analysis that is much less founded on restrictive theoretical grounds. Bubbles in their classical meaning in economics, that is rational bubbles (see Hirano and Toda 2024 for a recent summary of the concept), are then introduced afterwards

in Wiechers (2025).

”An Early Indicator for Anomalous Stock Market Performance” in Chapter 2 addresses the issue of giving early signals to market participants as soon as stock pricing is forecasted to be either unusually high or low compared to its long-term trend. Using post-World War II (WWII) Standard and Poor’s (S&P) 500 stock index data, the paper identifies systematic market deviations away from the long-term movements. Phases of abnormally high and low pricing are found to regularly alternate and are referred to as market anomalies. The paper shows the pricing patterns beyond those long-term equilibrium ones are cyclical and can be used for reliable forecasts with respect to such anomalies. Market investors may use this additional information to flatten market movements towards the long-term equilibrium, thereby decreasing market volatility and corresponding risk in stock investment.

Afterwards, the paper entitled ”A Real-Time Analysis of Fundamentals and Bubbles in the S&P 500” in Chapter 3 explicitly considers *rational bubbles* in contrast to the more loosely defined anomalies. Therefore, estimations rely much more on theoretical considerations, like rational expectations and the market fundamental value reflecting the ought-to-be stock price. The time period under consideration is extended to the pre-WWII period. The empirical analysis starts in 1871 and a large focus is set on analyzing bubbles in a real-time setting. In contrast to ex-post market analyses, market participants are allowed herein to continuously revise their expectations according to newly acquired information about ongoing changes in economic fundamentals. The paper shows that reliable estimates of bubble sizes are obtainable besides identifying explosive time series behavior. This departure is so far disregarded in applications of empirical state-of-the-art bubble identification strategies like Phillips et al. (2011) or Phillips et al. (2015). In consequence, rational bubbles are shown to become analyzable in a holistic approach that comprises bubble size and bubble explosiveness, both in combination with revisions in expectations related to real life.

While the first two papers in Chapters 2 and 3 are related to stock market deviations away from long-term equilibria, the third paper in Chapter 4 is related to analog deviations, but now in the goods market. ”Growth with Mismatch: Theory and Evidence from TFP Estimates” (Fritz et al. 2025) starts with a theoretical part developing a stylized endogenous growth model based on Jones (2021). Within this model, deviations from potential production reflected by the output gap are related to a demand-side driven goods market mismatch that ultimately dampens total factor productivity and economic growth. Growth itself is thus considered not to be purely supply-side driven in the long run, it is the demand side that matters as well. An adjacent panel regression analysis for 15 developed economies gives some empirical evidence for the conclusions of the theoretical model. The output gap

reflecting goods market mismatch is identified to significantly influence total factor productivity and economic growth, vindicating the results of the theoretical growth model. Goods markets deviating from their long-term trends are shown to have not only short-term effects on growth, but even dampen the long-term growth path of an economy resulting in permanent growth losses.

The thesis concludes with returning to asset markets in Chapter 5 but takes in a different perspective. The fourth paper "Unconventional Monetary Policy and Wealth Inequality: Evidence from the US" (which is a slightly revised version of Gries et al. 2023) does not consider asset pricing, or stock pricing in particular, but the holding of wealth in different asset categories, respectively its long-term course being altered by the four quantitative easing (QE) programs engaged by the Federal Reserve (Fed) after the Great Financial Crisis between 2008 and 2022. QE is identified to have increased the net wealth of the upper population percentiles next to having triggered a significant portfolio rebalancing. With respect to the long-term movements in asset markets, QE is identified to have shifted the long-term market dynamics in several asset markets.

## 1.2 Origins and Research Gaps

### 1.2.1 Detecting Financial Anomalies in Fritz et al. (2024)

The origins of "An Early Indicator for Anomalous Stock Market Performance" based on Fritz et al. (2024) in Chapter 2 are founded in decomposing the S&P 500 into long-term market components and mean-reverting short-term ones. By doing so, it is desisted from explicitly applying rational bubble theory due to its rigid definition of fundamentals but also bubble reflecting any deviations that cannot be attributed to fundamental long-term equilibrium pricing. The main idea of the paper is to be reductionist at first with respect to the theoretical underpinning of the empirical analysis and to simply analyze data at first. A fully data-driven and endogenously determined local linear regression (LLR) approach proposed by Beran and Feng (2002) is adopted. The estimated (nonparametric) trend function depicts the long-term market movements while its remaining residuals form short-term ones reflecting any deviations or fluctuations that prevent the market to be priced according to its long-term movement.

Given the LLR procedure, the paper introduces self-exciting threshold autoregressive (SETAR) models developed by Tong (1983). These are fitted to the residual short-term movements and enable the estimation of real-time market forecasts, an issue that is so far disregarded in the current detrending literature concerning asset markets. Moreover, as

Hodrick and Prescott (HP) trends (Hodrick and Prescott 1997) are typically applied for estimations of the long-term market movements (Borio and Lowe 2002, Detken and Smets 2004, Adalid and Detken 2007), the problem of exogenously selecting a suitable smoothing parameter arises. As the LLR approach is capable to endogenize this issue of parameter selection, as elaborated by Fritz et al. (2019a), the necessity of selecting a suitable smoothing parameter is omitted. Moreover, the procedure stands out given its improved estimation quality at boundary points due to the usage of an asymmetric boundary kernel (Fritz et al. 2019b).

In the empirical analysis, the stock market is said to be in line with its long-term movement as long as the earnings-price (EP) or dividend-price (DP) ratios get represented by values that lie inside a corridor around the estimated long-term LLR trend, otherwise the market is said to be priced either abnormally high or abnormally low defining stock market anomalies. This approach follows Bollinger's (1992) approach of Bollinger Bands. Though, technically, the LLR trend is enclosed by suitable nonparametric confidence intervals as proposed by Calonico et al (2018) and Feng et al. (2020). The EP and DP ratios are taken as valuation ratios due to their common appearance in the analysis of stock markets. The EP ratio, or its reciprocal, the price-earnings ratio have become a standard tool in the analysis of stock pricing, see Shiller (2015: xv f.), Aikman et al. (2017), and the ECB (2018). The DP ratio, or its reciprocal, the price-dividend (PD) ratio, already bridge to the theoretical considerations of the efficient markets model and rational bubble theory where dividends are regarded as the ultimate quantity that should *fundamentally* drive stock prices.

### 1.2.2 Estimating Rational Bubbles in Wiechers (2025)

In subsequent Chapter 3, the paper "A Real-Time Analysis of Fundamentals and Bubbles in the S&P 500" (Wiechers 2025) explicitly introduces rational bubbles in opposite to the more general anomalies detected in Fritz et al. (2024). The paper looks for a feasible approach that can give reasonable estimates of both stock price components according to rational bubble theory at the same time, that is the fundamental value and the bubble component. Yet, identifying the size of the bubble component is completely ignored in the empirical literature on bubbles, as in the currently predominant approaches developed by Phillips et al. (2011) and Phillips et al. (2015) or the initial integration and cointegration test procedures introduced by Campbell and Shiller (1987) and Diba and Grossman (1988b). All these empirical approaches on bubbles solely focus on identifying explosive time series behavior as rational bubbles are theoretically derived to grow at a positive rate that is equal to the discount rate (see again for example LeRoy 2004 in deriving rational bubbles). Given this

central conclusion, these approaches do not need to further assume a distinct bubble process out of a vast collection of possible theoretically founded processes (see Section 2.4 in Salge 1997 for an overview of theoretical bubble processes). Instead, detecting *market exuberance* (see also Shiller 2015 for the terminology) in terms of explosive time series behavior is regarded as a sufficient criterion on its own to empirically identify rational bubbles.

However, with dropping any assumption concerning the theoretical bubble process, a distinct decomposition into long-term market movements reflected by the fundamental value next to the rational bubble component depicting any further movements beyond the equilibrium pricing path becomes impossible: The biggest strength of the beforehand mentioned approaches, that is being nihilistic on the bubble process, is also their biggest weakness, as their nihilistic treatment on bubbles leads to their inability to give any estimates of the bubble size. Sticking to this point, the main idea in Wiechers (2025) is to place just one loose assumption with regards to the fundamental value in order to receive distinct estimates of both stock price components. The obtained bubble component containing the bubble size can then be analyzed with regards to explosiveness using the standard, just mentioned, test procedures. Otherwise, more restrictive assumptions on the bubble component are needed, immediately foiling any advantage of those empirical bubble strategies.

Following Froot and Obstfeld (1991), the fundamental value is estimated at first by assuming a geometric random walk (RW) with drift for the exogenous dividend process. Given this explicit fundamental solution, bubbles then become identifiable in size as the residual obtained between the observed stock price and the estimated fundamental price (or fundamental value). Given the recent remarks of Hirano and Toda (2024) on rational bubbles, a focus is set on analyzing fundamentals and bubbles in real time using the notion of enlarging information sets allowing market participants to continuously revise their expectations concerning market fundamentals. These shifts in expectations are also due to the introduction of time-varying discount rates based on the Gordon growth model and Shiller (1981). Thereby, periods of lower and higher expected total market returns in line with real-world data become more pronounced as allowed in the case of constant discounting. Shiller (2014) notes that introducing time-varying discount rates is not in opposition to the efficient markets literature, but merely not considered as discounting with a constant rate is more convenient with regards to calculus. Phillips and Yu (2011) also mention the possibility of time-varying discount rates and their potential influence on fundamentals and bubbles.

Given the distinct estimates of the bubble component in terms of its size over time, further light is shed on the conclusions of Meese (1986) and Evans (1991), both stressing that rational bubbles may resemble mean-reverting autoregressive processes in time series

next to explosive ones. Cyclical patterns in the bubble component are found on basis of three-regime SETAR models in line with Koustas et al. (2008), stressing the notion of a bubble cycle as mentioned in Salge (1997, Section 3.1.2) or derived in Burs (2023).

### 1.2.3 Sluggish Economic Growth in Fritz et al. (2025)

Deviations from long-term market equilibria are not restricted to asset markets and stock markets in particular. While stock markets not behaving according to their long-term movements are attributed to either more generally defined market anomalies next to more rigid rational bubbles in Chapters 2 and 3, an analogous concept for goods markets is the output gap depicting deviations from the long-term production potential of an economy (Orphanides and van Norden 2002).

”Growth with Mismatch: Theory and Evidence from TFP Estimates” (Fritz et al. 2025) in Chapter 4 introduces allocative imperfections in the goods market by means of mismatch in a stylized endogenous growth model based on Jones (2021). Though, this mismatch proxied by the output gap is dependent on aggregate demand and derived to have permanent effects on economic growth, preventing the economy to permanently produce at its production potential. Therefore, increasing aggregate demand (and thus downsizing the output gap for a given level of potential production) is an effective tool for increasing match efficiency in the goods market, thereby shifting the economy to a higher growth path in direction of potential production.

So far, this kind of goods market mismatch has not yet played a role in economic growth analyses. The idea is to consider the demand side to play a role for economic growth like in the models proposed by Harrod (1939), Domar (1946), and more recently Dutt (2006) and Palley (1996, 1997 and 2014), but to nevertheless stick as much as possible to common supply side-driven endogenous growth models as proposed by Romer (1986, 1987 and 1990). Solow (1988: 311) stresses that growth theory is considered ”a systematic way to talk about and to compare equilibrium paths for the economy”. However, it lacks to describe deviations from equilibrium growth what he considers as ”equally important and interesting” (ibid: 311). The idea is to keep the straightforward line of argument given by Jones (2021) using a descriptive endogenous growth model without microfoundations but to implement non-perfect goods markets such that the demand side plays an equally important role next to the supply side.

Empirical approaches on mismatch are so far restricted to supply-side factors and neglect the role of aggregate demand to have a permanent effect on economic growth. Restuccia and Rogerson (2013) identify two empirical approaches to identify mismatch on the supply

side of an economy labelled as misallocation (a term also Jones 2021 uses in his endogenous growth model): a direct one that explicitly considers various factors that may influence misallocation (see, for instance, Hoppenhayn and Rogerson 1993 referring to misallocation of labor, or Banerjee and Duflo (2005) referring to credit market imperfections) and an indirect one that is based on Restuccia and Rogerson (2008) and Hsieh and Klenow (2009) depicting differences in marginal revenue products at the firm level. Concerning the demand side, Gordon (2012 and 2015) is an exception. He stresses increasing inequality to be attributable to the demand side and identifies rising inequality as one headwind of economic growth. According to him, between 1993 and 2008, the average growth rate in US real household income is estimated to be 1.3 % per year. Though, for the bottom 99 % income percentile, growth is estimated to account for only 0.75 % per year. For a given potential production, if inequality had been less severe, the higher level of aggregate demand would have led to an increase in the match efficiency rate according to the proposed growth model containing mismatch, leading to a positive and permanent influence on economic growth.

#### **1.2.4 Redistribution of Wealth in Gries et al. (2023)**

Chapter 5 containing a slightly revised version of "Unconventional Monetary Policy and Wealth Inequality: Evidence from the US" (Gries et al. 2023) connects to inequality in the standards of living having an impact on the long-term growth path. Though, it engages a policy-related perspective. It analyzes the impact of the four QE programs conducted by the US Fed between 2008 and 2022 regarding wealth inequality by means of the possessing of financial and physical assets. Starting with White (2012), the question has been raised whether unconventional monetary policy, and QE in particular, shifts the distributions of income and wealth in favor of the upper population percentiles while the remaining percentiles relatively lose out relatively. Initial literature on the topic considers income inequality. For the US, Montecino and Epstein (2015) find an increase in income inequality due to unconventional monetary policy. Mumtaz and Theophilopoulou (2017) find similar results for the UK, Guerello (2018) for the eurozone, and Saiki and Frost (2014 and 2020) next to Inui (2017) for Japan.

More recently, wealth effects of unconventional monetary policy have been considered more deeply. Mumtaz and Theophilopoulou (2020), as well as Evgenidis and Fasanios (2021) find that wealth inequality increased in the UK due to unconventional monetary policy. Both firstly consider explicit population percentile data, the former also expand the analysis to different categories of wealth in terms of financial and physical assets. "Unconventional Monetary Policy and Wealth Inequality: Evidence from the US" enters this gap by also

focusing on several components of wealth like equities and funds, pension entitlements and real estate, but explicitly considers quantitative measures related to QE as a driving force behind unconventional central bank actions.

## 1.3 Central Results of the Contained Papers

### 1.3.1 Fritz et al. (2024) on S&P 500 Stock Market Performance

Financial anomalies in the S&P 500 – defined as significant deviations from EP or DP ratio LLR trends reflecting long-term market movements – are shown to be identifiable in real time. Using nonparametric 95 % confidence intervals around the LLR trend function, 23 periods of anomalous stock pricing are detected according to the ex-post benchmark between January 1970 and December 2022 when EP ratio data is applied.<sup>1</sup> By means of the proposed anomaly indicator using SETAR forecasts of the LLR residuals, 19 anomalies out of these 23 are correctly forecasted in real time, that is without using any yet unknown future data, up to one year ahead. Those anomalies can be related to events like the 1973 and 1979 Oil Crises, the 1987 Bubble, or the Great Financial Crisis of 2007 resulting in the Great Recession. The corresponding true positive rate criterion concerning the indicator goodness, that is the number of correctly forecasted ex-post periods of abnormal pricing in real time, is equal to 0.8333 (see Figure 2.2). The magnitudes of abnormal pricing commonly do not exceed long-term market movements by more than 20 % (see Table 2.4). For instance, the 1987 Bubble is accompanied by abnormally high pricing up to 18.54 % according to the EP ratio. Two large outliers are found for 1974 and early 1975, as well as for late 2008 and 2009 during the Great Recession. In the former case, pricing is estimated to undershoot the long-term EP ratio trend by up to 33.69 %. In the latter case, abnormally high pricing escalates up to 74.58 %.

### 1.3.2 Wiechers (2025) on S&P 500 Fundamentals and Bubbles

A further evaluation of the S&P 500 data between 1871 and 2023 shows that stock prices can be properly decomposed into a fundamental and a bubble component according to rational bubble theory, the later also being defined in terms of the relative bubble size (RBS). The estimated fundamental component on basis of an explicit fundamental solution

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<sup>1</sup>In "A Real-Time Analysis of Fundamentals and Bubbles in the S&P 500" (Wiechers 2025), the necessity of a similar ex-post benchmark is completely circumvented. In the real-time detection approach regarding rational bubbles therein, Siegel's (2003: 14) notion that "one must wait a sufficient period in time to see how the future plays out before anyone can identify a bubble [or any anomalous pricing]" is dissolved.

(Froot and Obstfeld 1991) responds to real-time changes in the discount rate as expected: low discount rates correspond to high fundamentals, and high discount rates correspond to low discount rates, as expected by the Gordon growth model. Bubbles are properly represented by RBS and their sizes in terms of deviations from real-time fundamentals are obtained. Desired explosive time series behavior is found in RBS according to the Phillips et al. (2015) GSADF test procedure for exuberance. RBS captures market exuberance in all periods commonly attributed to bubbles, that is the Roaring 20s, the 1987 Bubble, and the Dotcom Bubble in the 1990s. Moreover, it captures the 1955 bull market. In contrast to the PD ratio commonly applied in empirical research on bubbles, RBS is found to be slightly more sensitive as it depicts periods of exuberance somewhat earlier and more consistently, a plus for the empirical detection of bubbles in real time.

Figures 3.5 and 3.10 depict the major results concerning the estimated bubble component: Prior to the 1929 Crash, the S&P 500 is estimated to exceed its real-time fundamentals by 30 % leading to a corresponding RBS of 1.3. Prior to the burst of the 1987 Bubble, the bubble component is estimated to be 20 % on top of fundamentals resulting in an RBS of 1.2. The Dotcom Bubble is estimated to be outstanding. As its RBS value is above 2.0, fundamentals are estimated to be exceeded by more than 100 % around the millennium. After the Dotcom Bubble, RBS remains high and does not vanish. At the end of 2023, it is estimated to equal 1.4, outperforming the complete post-WWII period with exception of the Dotcom Bubble itself.

Sticking to growth rates in real stock price (see Figures 3.11 and 3.12), the period between 1920 and 1990 is rather explainable by growth in fundamentals. Before, and after, growth is more driven by nonfundamental growth in RBS. In this respect, the early 21<sup>st</sup> century resembles the late 19<sup>th</sup> one, too. At the end of 2023, about 60 % of growth in real stock price is attributed to nonfundamental growth in RBS.

RBS is found to be trend stationary around LLR and HP trends. In line with Evans (1991), it contains autoregressive patterns attributable to *periodically collapsing bubbles* (Blanchard and Watson 1982). Periods with autoregressive RBS patterns detected by means of the outer two regimes of three-regime SETAR models are found to be a common phenomenon in the data. Interestingly, periods after the Dotcom Bubble identified as not exuberant according to the Phillips et al. (2015) GSADF test are nevertheless identified to contain autoregressive time series behavior.

### 1.3.3 Fritz et al. (2025) on Growth with Mismatch

Goods market mismatch leads to a reduction in total factor productivity (TFP) according to equations (4.30) and (4.31). In doing so, actual production deviates from its potential and an economy is derived to grow at a lower growth path of potential output in the long term.

To find empirical evidence for the conclusions of the theoretical model, match efficiency is introduced into a panel regression analysis where other potentially important variables are selected according to Kim and Loayza (2019) including human capital, research and development and triadic patent families. This match efficiency is modeled by the match efficiency rate, an output gap-based indicator. The empirical models give estimates for the theoretical TFP equations (4.30) and (4.31) in level, as well as in growth rate specification using TFP data from the Penn World Table (PWT 2021) and the Banque de France (BdF 2021). The match efficiency rate is found to be a significant contributor to TFP, respectively its growth rate. With respect to TFP levels, if match efficiency rate increases by one percentage point, TFP is estimated to increase by 1.16 percentage points using PWT (2021) data and 0.51 percentage points using BdF (2021) data. With respect to TFP growth rates, if the growth rate of the match efficiency rate increases by one percentage point, the growth rate of TFP is estimated to increase by 0.74 and 0.32 percentage points respectively (see Tables 4.1 and 4.2). Introducing additional time-fixed effects does not affect the results significantly. The match efficiency rate remains a significant contributor to TFP and its respective growth rate, in line with the theoretical conclusions of the model.

### 1.3.4 Gries et al. (2023) on Unconventional Monetary Policy and Wealth Inequality in the US

The estimated structural vector autoregressive (SVAR) models acknowledge the results Mumtaz and Theophilopoulou (2020), as well as Evgenidis and Fasanios (2021) give for the UK. Concerning the US, wealth inequality is also found to have increased due to unconventional monetary policy. With a focus on the four QE programs conducted by the Fed between 2008 and 2022 using central bank assets relatively to real gross domestic product (GDP) next to the monetary base as central bank policy measures, two main results are found: Firstly, QE significantly affects the distribution of wealth in the US. A one percentage point increase (or shock) in the growth rate of central bank assets relative to real GDP leads to significant cumulative changes in the growth rates of net wealth of the top 10 %, 1 % and 0.1 % population percentiles, each relative to the bottom 50 % population percentile, of

approximately 1.25 percentage points after eight quarters. Considering the monetary base does not change this central result, in fact it leads to slightly higher responses of about 1.7 percentage points after eight quarters.

Secondly, regarding the holdings of overall assets, the upper percentiles gain less than they do in terms of net wealth. Although they gain relatively to the bottom 50 % within the first five quarters after an QE shock, the results become insignificant afterwards at a usual 95 % confidence level. Though, although the effects are rather small with respect to overall assets, QE is nevertheless identified to work significantly through portfolio rebalancing. The presented result questions the common opinion that increases in asset values in real estate and pension entitlements are primarily beneficial for the middle class. Actually, the higher the considered population percentile, the larger the QE effects in real estate and pension entitlements become. For instance, the upper 10 % percentile cumulatively benefits as much in real estate and pension entitlements as it does by equities and funds. This result is in clear contradiction to Albert and Gómez-Fernández (2022) where the wealthiest 10 % in the US gain most in stock holdings.

### 1.3.5 A Subsequent Regard of Applied and Estimated Data

In Figure 1.1, selected data series either applied or estimated within the scientific papers forming Chapters 2 to 5 are depicted. To oppose these series in different settings for some connective descriptive analyses, the period since 1990 covered by all is considered. The data series are: (i) the S&P 500 EP ratio (Shiller 2024, green solid) used as central stock valuation measure in Fritz et al. (2024),<sup>2</sup> (ii) RBS (black dotted) depicting the estimated real-time size of the rational bubble component relative to the underlying fundamental value in Wiechers (2025), (iii) the estimated share of the pure (i.e., speculative and thus not dividend-related) price return in the estimated real-time discount rate also determined therein (red solid), (iv) the output gap (black dashed) depicting goods market mismatch in Fritz et al. (2025) obtained from the International Monetary Fund (IMF 2021a), and (v) the ratio of corporate equities and mutual funds held by the top 10 % US population percentile relative to the bottom 50 % percentile (orange solid) used in Gries et al. (2023) taken from the Fed (2023a).<sup>3</sup>

The S&P 500 EP ratio depicted in Figure 1.1a gives some first hints on financial anomalies and bubbles. For instance, the EP ratio decreases steadily in the second half of the 1990s

<sup>2</sup>In Fritz et al. (2024), as well as in the corresponding version printed in Chapter 2, an older version of the same dataset lasting up to December 2022 is used, see Shiller (2023).

<sup>3</sup>The analysis in Gries et al. (2023) does not start before 2007 when the Fed engaged the QE1 program.

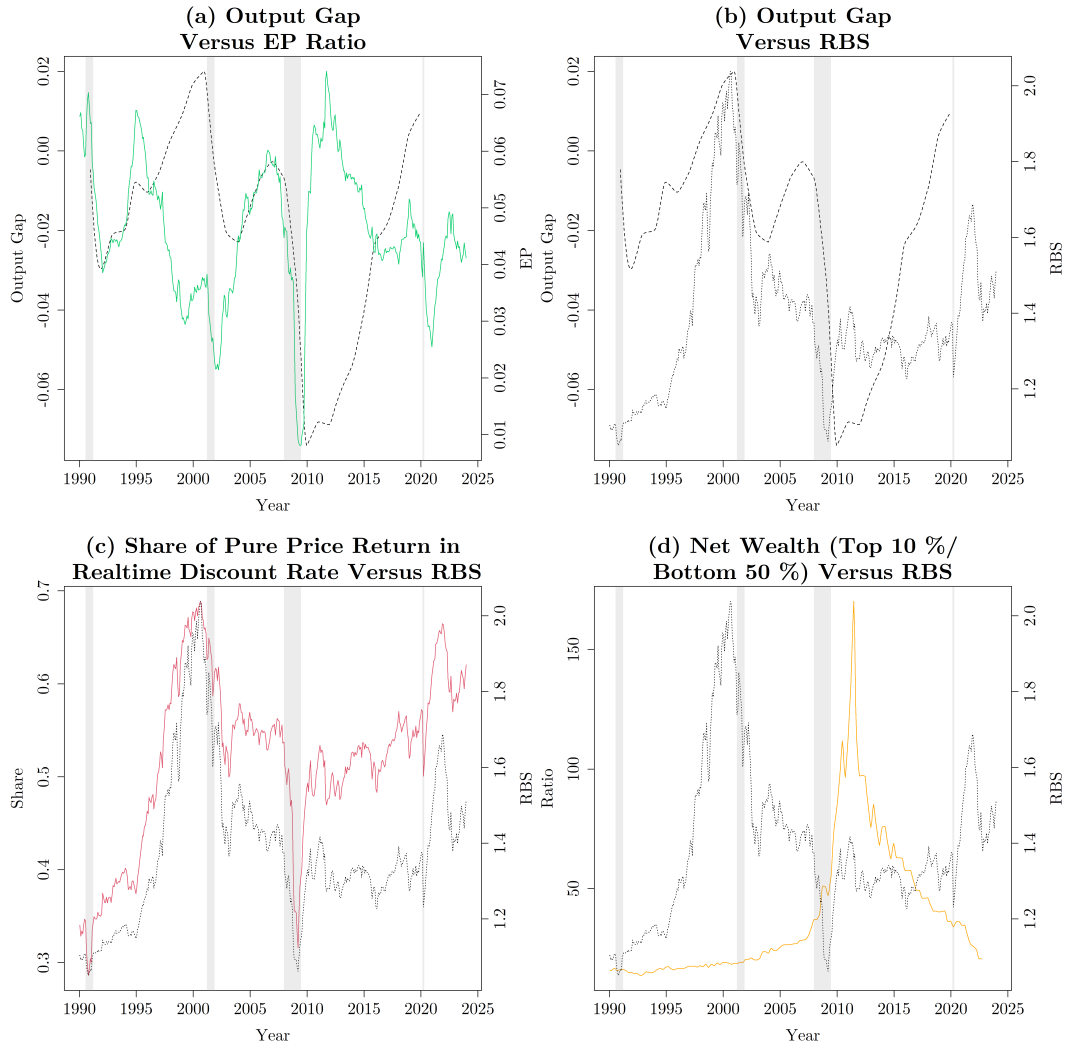


Figure 1.1:

Selected data series applied or estimated within the scientific papers: the S&P 500 EP ratio (green solid), the output gap (black dashed), RBS (black dotted), the share of pure price return in the estimated real time discount (red solid), and the ratio net wealth held by the top 10 % US population percentile relative to the bottom 50 % percentile. The output gap series is transferred from yearly to monthly data. Equities and funds of the top 10 % to the bottom 50 % US population percentiles are transferred from quarterly to monthly data. For both data interpolations, the *imputeTS* package in *R* (Moritz and Bartz-Beielstein 2017) is used. Recession periods obtained from NBER (2025) are depicted by shaded grey areas.

making stocks in the S&P 500 potentially overvalued (or *exuberant*) as stock prices increase more rapidly than admitted by underlying firm's earnings. This is confirmed as a large contemporaneous increase in RBS depicting the rational bubble component in stock pricing – the Dotcom Bubble – becomes observable (see Figures 1.1b, 1.1c, and 1.1d), making S&P

500 prices twice as large as admitted by market fundamentals. The EP ratio downturn in the 1990s also corresponds with a comprising output gap and actual (goods and services) production even exceeding its long-term potential (see Figure 1.1a), indicating that contemporaneous stock market exuberance is accompanied by a boom in the real economy.<sup>4</sup> Though, the Great Recession period (indicated by a grey shaded area as all recession periods according to the National Bureau of Economic Research (NBER 2025)) is different and demonstrates that the EP ratio and RBS obtained from S&P 500 data are not that easily confrontable. Both, the EP ratio and RBS decrease during the Great Recession such that the EP ratio downturn cannot be attributed to a bubble buildup but – in opposite – to a burst. Stock prices in the S&P 500 decrease by 30 % between October 2007 and October 2009 but earnings even decrease by 85 %, <sup>5</sup> making pricing abnormally low according to the EP ratio. The 30 % decrease in prices goes along with a contemporaneous decrease in RBS in Figures 1.1b, 1.1c, or 1.1d. What is more, RBS even decreases much further in between making stock pricing nearly completely fundamental. Simultaneously, the very large decrease in earnings by 85 % transfers to S&P 500 market fundamentals measured by expected future dividend payments according to rational bubble theory (see Figure 3.5d in this regard). The overall decline in the EP ratio thus involves a reduction in prices as well as in fundamentals in this case, the latter reflected by dividends being paid instead of firm's earnings being reported. It thus depends: Declines in the EP ratio may be attributed to buildups of bubbles, as in the 1990s. But they may also reflect a bursting bubble in combination with collapsing fundamentals as during the Great Financial Crises of 2007 and the subsequent Great Recession.

According to Figure 1.1b, RBS remains rather stable around 1.3 in the 2010s while the output gap narrows at the same time, starting from recover from its trough in 2009. Thereby, the recovery of the real economy after the Great Recession is found to be not accompanied increases in bubbles, at least not in the S&P 500. Though, an interesting pattern can be found in Figure 1.1c. It compares the share of pure price return in the estimated real-time discount rate (see also Figure 3.3b) with RBS. The just mentioned share increases steadily but does not immediately transmit to RBS remaining rather constant. Though, this pattern is rather an exception than a regularity. In general, the pure price return share and RBS show a common movement, such that movements in total returns independent from any

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<sup>4</sup>In Fritz et al. (2025) in Chapter 4, the match efficiency rate based upon the output gap is bounded by a maximum value of one as soon as actual production equals potential production, see equation (4.28). Though, the IMF (2021a) output gap in fact allows actual production to exceed potential production, leading to values above one, or alternatively, positive percentage deviations as depicted in Figure 1.1a.

<sup>5</sup>See also Section 2.3.1.

fundamentals directly transfer into bubbles.

Due to its otherwise large similarity to RBS, the share of pure price return in the discount rate depicted in Figure 1.1c may itself be a further candidate for empirically analyzing bubbles, next to the usage of the common PD ratio and RBS. In a nutshell, the just mentioned share shows that total market returns – ultimately defining the discount rate – are far away from being unaffected by stock market exuberance. Obviously, the share of pure price return within the real-time discount rate is prone to explosive time series behavior in very similar periods as RBS itself.

Figure 1.1d is insofar interesting as it at least tries to somehow bridge between the US redistribution of wealth analyzed in Gries et al. (2023) and stock market bubbles in the S&P 500 in terms of RBS. As holdings in corporate equities and mutual funds examined within this paper soonest relate to stock market developments, the respective ratio of equities and funds hold by the top 10 % population percentile relative to the bottom 50 % one is depicted. No clear and uniform relationship with RBS is found.<sup>6</sup> Yet, this comparison shows that the redistribution of wealth in favor of the wealthiest is not attributable to stock market bubbles, at least not ones in the S&P 500. According to Gries et al. (2023), and in line with Figure 1.1d, the four QE programs conducted by the Fed between 2008 and 2022 have significantly altered the distribution of wealth in the US, including equities and funds, towards the upper percentiles. For further statements in this direction, additional research is necessary, as the simple descriptive tools applied here do not deliver any fruitful insights.

## 1.4 Concluding Remarks and Outlook

This thesis argues for the usage of informational content resulting from decomposing asset and goods market data into long-term equilibrium components and components beyond those equilibrium paths. The latter ones, reflecting fluctuations preventing markets from behaving according to their long-term equilibria, are considered in various ways and are shown to contain extractable content for further analyses like forecasting stock market performance, estimating sizes of financial anomalies and rational bubbles, or giving explanations for economies to grow below their long-term growth trend.

The four scientific papers in this thesis are (i) an extended version of Fritz et al. (2024) where cyclical patterns around long-term S&P 500 market movements are used to identify

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<sup>6</sup>With respect to the holdings of total assets (also containing real estate and pension entitlements), the corresponding ratio starts to decrease again by 2021 after having steadily increased before as well (see Figure 5.1 in this respect). Though, it also remains unclear to what extent – if at all – this is relatable to the decline in RBS in the early 2020s.

and forecast anomalous stock pricing by means of an anomaly indicator, (ii) Wiechers (2025) where rational bubbles in the S&P 500 are detected in real time, highlighting both their explosiveness and their estimated size, (iii) Fritz et al. (2025) theoretically deriving how deviations of production from its potential have an impact on long-term growth, adding goods market mismatch to an otherwise endogenous growth model, and (iv) a slightly revised version of Gries et al. (2023) where the impact of QE on the US distribution of wealth is analyzed.

With respect to both analyses concerning the S&P 500 stock market data, periods that are often labelled as bubbles by the public like the Roaring 20s, the 1987 Bubble, and the Dotcom Bubble, are confirmed to be bubbles according to rational bubble theory. As outlined in Wiechers (2025), all these periods are exposed to explosive time series behavior, a necessary condition for rational bubbles, next to increasing sizes of the bubble component itself. Market fundamentals estimated to be exceeded by up to 30 %, 20 %, and 100 %, respectively. At the same time, bubbles may be represented by forecastable financial anomalies defined as systematic deviations from long-term EP and DP ratios as considered in Fritz et al. (2024). However, declines in the EP ratio are attributable to buildups of bubbles, like in the 1990s during the Dotcom Bubble, but potentially also to a bursting bubble component. The latter is found to be the case during the Great Financial Crises of 2007 and the subsequent Great Recession. Thus, financial anomalies as defined in Fritz et al. (2024) on the one hand, and bubbles on the other, do not necessarily move uniformly.

Concerning the further analysis of financial anomalies and bubbles, future research should basically center around two issues: (i) initially, the analysis in Wiechers (2025) should be reconducted by applying smoothed, thus less volatile, real-time discount rates next to shading more light on the share of pure price return within this rate (see Section 1.3.5 and Figure 1.1c for a preliminary descriptive analysis in this regard), and (ii) what is more, look for a deeper relation of financial anomalies and bubbles towards the emerging literature on bubble cycles and financial cycles.

With regards to (i), as the estimated real-time discount rates in Wiechers (2025) are a potential avenue for obtaining bubble periods together with reasonable estimates of bubble sizes, they may nevertheless be argued to be too volatile. It is rather undisputed that discount rates should be not considered as constant over decades (see Phillips and Yu 2011 and Shiller 2014) as initially assumed in the efficient market model, but too volatile real-time discount rates may nonetheless be regarded as too prone regarding potentially exuberant and thus nonfundamental revisions in expectations. Yet, as there is no rule of thumb stating when variations in discount rates should be considered too large, just smoothing the real-

time discount rate in a purely data-driven manner seems to be a reasonable approach. To do so, the endogenous LLR-based detrending method applied in Fritz et al. (2024) might be transferred to the analysis conducted in Wiechers (2025). Fritz et al. (2024) already consider the DP ratio next to the EP ratio, the former already being part of the estimated real-time discount rates in Wiechers (2025). Thus, this detrending could serve as an alternative method to obtain real-time discount rates for ultimately decomposing stock prices into fundamentals and bubbles.

Regarding (ii), bubble cycles are so far only considered in Salge (1997, Section 3.1.2) and in Burs (2023). The large gap in the literature might be explained by difficulties to connect empirical findings of bubbles with trend stationary processes that contain cyclical autoregressive patterns as stressed by Evans (1991). Wiechers (2025) is a step in this regard, as such cycles are found in the S&P 500 rational bubble component. In opposite to bubble cycles, financial cycles cover a much broader field as they consider several asset markets at once and often bridge towards the business cycle, see for example Galati et al. (2016), Schüller et al. (2015), Strohsal et al. (2019), or Verona (2016). What is more, financial cycles already regard bubbles as one potential driver of financial crises next to excess credit creation (Rey 2015).

The financial cycle literature with its multi-market perspective is thus a suitable departure for combining so far single-market analyses. Appropriately, the two stock market papers within this thesis could be related with the other two ones regarding the goods market and further asset markets beyond the stock market. Methodologically, the approach proposed by Beaudry and Portier (2006) and Beaudry and Lucke (2010) seems appropriate to achieve this goal. In SVAR analyses like in Gries et al. 2023, they ask for the "main driving forces behind macroeconomic fluctuations" (Beaudry and Lucke 2010: 452), thereby connecting goods and asset markets (including the stock market) with TFP and monetary policy. Responding to the question what actually drives asset and goods markets, they consider TFP shocks central to the theory of real business cycles as well as monetary and (demand-side) preference shocks following the Keynesian tradition. Applying this approach, and following the notion of Fritz et al. (2025), it could be analyzed how output gap-based movements depicting goods market mismatch affect TFP, deepening the already conducted panel regression exercise for 15 developed economies. At the same time, preference shocks might be attributed to fundamental values of assets like stocks (as estimated in Wiechers 2025) as they are derived on investors revising their expectations with regards to market environments. With regards to Gries et al. (2023) asking for the effects of QE on the US distribution of wealth, these particular monetary shocks could be further analyzed with a

view to often mentioned *asset price inflation* triggered by central banks (see Bhattarai and Neely 2022 for a recent summary on unconventional monetary policy shocks).

To end with the notion of LeRoy's (2004: 785) quote at the beginning of this synopsis, future research should center around those "other phenomena that affect asset prices" next to bubbles. Finally, this means to leave single market analyses and to put effort towards multi-market perspectives where asset markets and the goods market are in fact interrelated and prone to several fluctuations at the same time, may it be due to bubbles, other financial anomalies, TFP, the output gap, or various forms of monetary policy. This thesis so far gives some impetus regarding single-market analyses. Engaging a multi-market perspective, thereby bringing the analysis at a higher-level depicting a *bigger picture*, is open for future research.

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