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# STOCK MARKET RETURNS AND GDP GROWTH

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## ABSTRACT

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# Stock market returns and GDP growth*

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*Keywords:* macroeconomic fluctuations; financial markets; stock prices; ARDL bounds test; asymmetric cointegration.

*JEL class: C53, E44, E47, G12*

## 1 Introduction

Stock market indices experienced high growth rates above GDP growth during the 2000s and 2010s in several OECD countries (Figure 1). The 1990s can similarly be seen as a period of exceptionally high returns (Türk and Mum, 2015; Türk and Mum, 2016, and Figure 1). Based on theoretical considerations, stock market returns should not decouple from economic activity over longer periods of time, because stocks should reflect expected discounted earnings of listed firms (Shapiro, 1988), and firms' earnings should not develop

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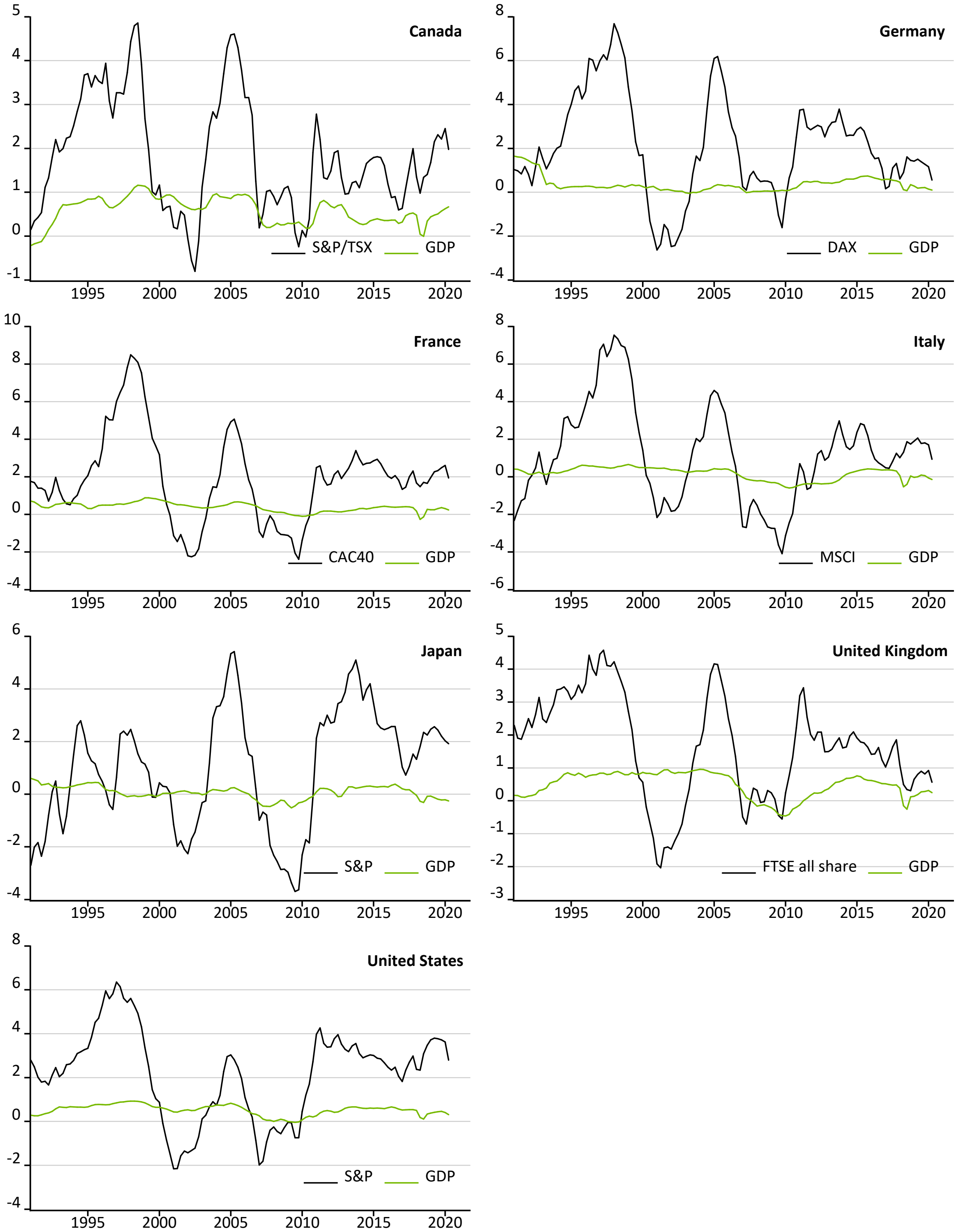
independently of economic activity. Yet, evidence for a long-term relationship between stocks and economic activity is mixed (e.g. ECB, 2012): While a strong link between stock prices and economic activity is confirmed by Fischer and Merton (1984) for earlier periods and Binswanger (2000) for the 1950s to 1980s, Binswanger (2000) finds evidence for a decoupling of stock returns from economic activity in the early 1980s. Binswanger (2004) confirms these findings for the G7 countries.

As stocks play an important role for income and wealth developments as well as for retirement plans but are concentrated among high-income households, such a decoupling would contribute to rising income and wealth inequality. This raises the question if stock markets develop in line with economic activity over longer periods of time, especially considering more recent periods, or if stock returns really decoupled from economic activity. We therefore focus on analyzing the relationship between national stock market indices and national GDP over longer periods of time, and including recent developments. We basically follow Binswanger (2004) in trying to identify a cointegration relationship for both variables in levels for the G7 countries. Yet, instead of relying on the Engle-Granger two-step or the Johansen vector error correction approach as the author does, we use the bounds testing approach developed by Pesaran et al. (2001), as this approach is more flexible regarding data properties and the form of the co-integration relationship (section 4).

We consider G7 countries and concentrate on the period between 1991 to 2019, this way starting after German unification and ignoring the effects of the pandemic. We also consider the sub-periods 1991-2008 and 2001-2019. The main period contains two severe global shocks (the bursting of the “dot.com bubble” in 2000/1 and the global financial crisis 2007/8 with the resulting global recession 2008/9) that led to sudden strong corrections in asset prices as well as GDP developments, yet, it excludes the COVID-19 pandemic starting in 2020. As it is possible that falling stock prices have a different effect on GDP than growing prices, we test for asymmetries in adjustment to the long-run relationship. The bounds testing approach allows for a nonlinear relationship between the variables, for example asymmetric reactions to positive versus negative changes (see e.g. Shin and Yu, 2005).

The period is also characterized by changes in the functional income distribution in many countries, declining interest rates and an increasing role of foreign demand. A declining wage share goes hand in hand with an increasing profit share, and may therefore contribute to increasing stock values. The expectation of further decreasing long-term interest rates might have led to a decreasing discount rate for expected future earnings. A lower discount rate would imply a higher stock market valuation. Until stock valuation has adjusted to the new, higher level, returns would be above GDP growth. Increasing trade with the rest of the world may imply that the co-integration relationship with domestic GDP alone is not capturing profit opportunities of globally oriented companies. Alexius and Spång (2018) provide empirical evidence for G7 countries that foreign demand is an additional factor in the long-run relationship of stock indices and domestic GDP. We therefore control for all these factors step by step, adding each of these factors separately to the co-integration relation between stock market index prices and GDP: the profit share, long-term interest rates and foreign demand.

Consistent with large parts of the literatur, we find limited evidence for a stable long-run relationship between national stock market indices and domestic GDP for the period




*Notes: Figures display 4 year centered moving averages of q-o-q changes (in %). Calculations are based on total return stock market indices deflated by CPI; nominal GDP is also deflated by CPI.*

Figure 1: Moving averages of real stock market returns and real GDP growth for G7 countries, 1991-2021.

starting in 1991. Unexpectedly, we find no empirical evidence that changes of the relevance of foreign demand, changes in the profit share, or changes in long-term interest rates in the respective countries were relevant factors.

While allowing for an asymmetric response of GDP to changes in stock market indices does not fundamentally alter our results for the whole sample period, there is some evidence that in more recent decades – namely after the turn of the millennium – an asymmetric link between stocks and GDP might play a role in explaining the empirically found instable relationship between the two variables.

Allowing for asymmetry and focusing on the last two decades, our estimates indicate that an increase of the stock market index by one percent goes along with an increase of GDP by 0.2 percent in the following two to three years. The effect is weaker in the case of a decreasing stock market index and less pronounced for non-Anglo-Saxon economies.

Section 2 provides an overview on existing theoretical explanations for stock market returns and empirical findings, with a focus on G7 countries. Section 3 presents the data and data developments. Section 4 explains the empirical approach, provides the results of econometric regressions, and discusses the results. Section 5 draws some conclusions.

## 2 Literature review on the link between stock market developments and economic activity

### 2.1 Theoretical approaches

Theoretically, stock prices should move in line with economic activity, as the stock price of a firm should equal expected and discounted future payouts (mainly dividend payments) that should be linked to the firm's real activity (Shapiro, 1988). This is in line with asset valuation models according to which prices should be determined by fundamentals such as expected future activity (e.g. Lucas, 1978). If dividend payouts are roughly in line with firms' earnings (see e.g. ECB, 2012), stock market indices should contain information about future economic activity of a country.

Apart from this "passive" relationship, stock market developments may also "actively" influence (ECB, 2012) or "cause" economic activity (Croux and Reusens, 2013, pp. 2-3), as prices affect behaviour: First, a more developed financial system – often measured by market capitalization of stock markets – is expected to support economic activity by easier access to finance for investment at lower costs (see e.g. Hahn, 2003).[1] Second, higher share prices of a firm may ease firm's access to finance and lower investment costs via the confidence channel for investment, the balance sheet channel and a higher Tobin's Q (stock value of the firm in relation to replacement costs, see Mishkin, 2021, ch. 26 for an overview of channels). Third, higher share values increase wealth and thereby consumption out of permanent income, also furthered by higher confidence in times of higher stock values.

[1] Yet, an increasing literature points to negative effects to income and income equality once financial motives, actors and institutions become too dominant for economic developments, a problem discussed under the term "financialization" (see Epstein, 2005 ).

All the mentioned factors point to a positive relationship between stock returns and GDP growth. Domestic stock market returns may nevertheless be higher than GDP growth over longer periods of time: First, capital income (including profits) is only one part of GDP. The other parts like wages and salaries, depreciation, and net consumption by the government, are presumably less closely related to stock market valuation of firms. Second, the stock market index does not represent all firms in a country, but only contains some selected firms that are by tendency bigger than the average firm (this way benefiting more from economies of scale) and more export oriented, such that not only domestic GDP plays a role for stock value developments. Third, equity risk premia are completely neglected, yet, are a relevant part of stock market valuation of firms. Fourth, as stocks are assumed to reflect the present value of expected future payouts, any change in discount rates would affect the valuation of stocks. A lower discount rate would imply a higher stock market valuation. Until stock valuation has adjusted to the new, higher level, returns would develop at higher rates than economic activity.

Apart from these considerations, a stable relationship between stock index values and economic activity would also imply a stable profit share, no major structural changes in production and productivity, as well as stable shares of global activities of firms. None of these stability requirements is met for the period since the 1980s.

### 2.2 Empirical findings

In line with those theoretical approaches that suggest that stock prices precede future economic activity, several studies concentrate on this aspect and tend to confirm forecasting ability of stock returns for future economic activity, yet, results depend on the analyzed country and time period: Fischer and Merton (1984) and Schwert (1990) confirm the forecasting ability for the US for earlier decades of the 20th century, while Binswanger (2000) indicates that this relationship broke down in the early 1980s. Stock and Watson (2001) find evidence that the forecasting power for output (as well as for inflation) seems to depend on the selected stocks, the country and the time period: "These results provide some evidence that asset prices have small marginal predictive content for output at the two, four, and eight quarter horizon. However, no single asset price works well across countries over multiple decades." (Stock and Watson, 2001, p. 41). Tsouma (2009) indicates forecasting abilities of stocks for mature and emerging markets during 1991-2006, similarly to Croux and Reusens (2013) for G7 countries for the period up to 2010, as well as Camilleri et al. (2019) on select European countries during 1999-2017. Most approaches rely on Granger causality tests in vector autoregressive (VAR) models, often combined with tests about forecasting power. Research concentrating on turning points for business cycle developments confirms a relevant role of stock market developments (Estrella and Mishkin, 1998; Berge, 2013; Proaño and Theobald, 2014).

As we are less interested in the forecasting ability of stocks for GDP, we rather focus on approaches that try to identify a long-run relationship between stock market indices and economic activity in levels. According to Alexius and Spång (2018, p. 119), this relationship is "relatively unexplored". The few studies that try to identify a long-run relationship in levels test for co-integration relationships. Using quarterly data for the period 1960 to

1999 and sub-periods, Binswanger (2004) tests for co-integration relation between the real stock index and real domestic GDP (or, real industrial production, alternatively) for each G7 country. In addition, he also constructs a "European Union aggregate" comprising out of aggregating the data of the four European countries. Identification of co-integration is based on the Engle and Granger (1987) two step procedure as well as the test for co-integration in the Johansen vector error-correction model (VECM). Binswanger (2004) finds evidence for a co-integration relation between real stocks and real GDP, yet, only for the sub-periods up to 1983. The relationship seems to break down in the early 1980s. The author points to bubble formation in stock markets to explain the break.

Alexius and Spång (2018) also concentrate on identifying a co-integration relation for real stock prices and real GDP in G7 countries during 1969 and 2014. In contrast to Binswanger (2004), they use the respective MSCI index (inflation adjusted total returns) for each country instead of national stock indices, and they add trade weighted foreign GDP as a third variable to the long-run relationship in levels between stock prices and domestic GDP. Relying on the trace statistic for the Johansen VECM, they find at least one co-integration relationship in levels for each country between stock prices, domestic and foreign GDP, and the coefficient for stock prices is positive. The exception are the US, as the authors cannot detect a co-integration relationship: the coefficient for stock prices in the error correction term is not significant. The finding for the US is in line with M. K. Hossain and A. Hossain (2015), a study that can neither detect a co-integration relationship for stocks and GDP for the US, the UK, or Japan, albeit for the shorter time period 1991 to 2012.

Alexius and Spång (2018) point to the irritating finding, that coefficient estimates for trade weighted foreign GDP in the cointegration relationship are negative for three out of seven countries: Canada, Germany, and Italy (Alexius and Spång, 2018, pp. 112, 116). Motivated by the negative signs, they also control for a relationship between relative stocks (national MSCI over world MSCI) and relative GDP (domestic over foreign). While they do not find evidence for co-integration in single country equations (as residuals are not stationary), there seems to be cross country co-integration between relative stocks and relative GDP in a panel approach. The relationship appears to be stronger for those countries where domestic GDP developments differ from those of foreign GDP. To control for co-integration between stocks and GDP by also allowing for a global orientation of listed firms seems to provide more evidence of long-run relationships, yet, it is not clear in how far results depend on the used data and the period.

## 3 A descriptive look at the data

### 3.1 Stocks and GDP data

In order to study the link between stock prices and economic activity, we follow Binswanger (2004) by concentrating on the long-term relationship between stocks and GDP in levels in G7 countries. We use quarterly data for real GDP (yet, not industrial production) as an indicator for economic activity and quarterly data for real stock price indices. The preference for GDP over GNI is due to availability of quarterly GDP data on a longer time period, in contrast to theoretical considerations that would point to using GNI over GDP. To avoid seasonality, we use seasonally (and calendar) adjusted data.

In line with Binswanger (2004), we focus on national stock indices, with the exception of Italy, where we use the MSCI. As theory points to the role of dividend payouts for the relationship with GDP, we focus on total return index data, if long time series are available. Total return index data includes stocks' price appreciation (or losses) and other payments like dividends or interest income, assuming that all payments are reinvested into the stocks (see e.g. Forbes Advisor[2]).

We use the following stock indices: for Canada, S&P/TSX Composite; for Germany, the DAX; for France, the CAC 40; for Italy, we use the MSCI, as the FTSE Italia MIB Index is only available from 1997 onwards; for Japan, we use the S&P total return index, as the Nikkei 225 total return index only starts in 2013; for UK, the FTSE All-Share index (yet, similarly developing to the FTSE 100) and for the US, the S&P 500.

GDP data mainly stem from national statistical offices, the OECD or the IMF. GDP and stock index data are both deflated by CPI, again following Binswanger (2004). Using the same price indicator, CPI, as a deflator for stocks and GDP, has the advantage that differences in stock returns in comparison to growth rates are not caused by level differences of different price deflators. Using CPI has the advantage of having access to long time series; broader price indicators in contrast are mainly offered for more recent periods only.

While cointegration relationships may exist between nominal GDP and nominal stock price indices as well as real GDP and real stock price indices, we concentrate on the relationship for real variables for theoretical arguments, as those refer to the relationship of real investment in firms driving real stock prices and therefore real GDP in the future due to increasing productivity in the economy.

### 3.2 Stock and GDP developments

Figure 1 displays four-year moving averages of quarterly real growth rates of domestic stock market indices and domestic GDP of the G7 countries. A first glance at the data indicates that stock market returns are much more volatile than GDP growth, but might be related to GDP developments. Global shocks like the bursting of the dot.com bubble in 2000/01, and the global financial crisis 2007/08 significantly lowered stock returns for all G7 countries, seemingly aligning them with GDP growth. The effects of the COVID-19 pandemic starting in 2020 also dampened growth rates, albeit the effect might not yet be fully reflected in the data.

To compare average growth over longer periods of time, table 1 displays average yearly growth for different periods. As can be seen, stock market returns are persistently higher than growth rates for all countries and sub-periods, except for Japan during 1991-2008. This is in line with theoretical arguments that stock market returns are expected to be higher than GDP due to the following reasons: The stock market index represents bigger, more trade-oriented firms compared to the average firm in a country, a relevant part of returns are equity risk premia, and GDP does not only reflect firms' earnings.

[2] https://www.forbes.com/advisor/investing/what-is-total-return/.

| | Canada* | | Germany | | France* | |
|---|---|---|---|---|---|---|
| | Stock return | GDP growth | Stock return | GDP growth | Stock return | GDP growth |
| 1991-2019 | 9.6 | 4.3 | 10.0 | 3.5 | 9.7 | 3.1 |
| 1991-2021 | 9.9 | 4.3 | 10.2 | 3.4 | 9.9 | 3.0 |
| 1980*-1998 | 11.1 | 6.5 | 14.9 | 5.5 | 16.4 | 6.0 |
| 1991-2008 | 11.1 | 5.0 | 10.9 | 3.9 | 10.6 | 3.9 |
| 2001-2019 | 6.9 | 4.0 | 6.0 | 2.7 | 5.0 | 2.7 |
| 2001-2021 | 7.6 | 4.0 | 6.7 | 2.6 | 5.8 | 2.6 |

| | Italy | | Japan* | | United Kingdom* | |
|---|---|---|---|---|---|---|
| | Stock return | GDP growth | Stock return | GDP growth | Stock return | GDP growth |
| 1991-2019 | 7.2 | 3.2 | 4.3 | 0.7 | 9.6 | 4.3 |
| 1991-2021 | 7.5 | 3.0 | 5.1 | 0.6 | 9.3 | 4.1 |
| 1980*-1998 | 23.0 | 10.7 | -1.2 | 4.8 | 16.3 | 8.3 |
| 1991-2008 | 9.2 | 4.6 | 2.6 | 0.9 | 10.1 | 5.0 |
| 2001-2019 | 2.6 | 2.0 | 4.3 | 0.2 | 6.4 | 3.9 |
| 2001-2021 | 3.4 | 1.8 | 5.4 | 0.1 | 6.2 | 3.7 |

| | United States | |
|---|---|---|
| | Stock return | GDP growth |
| 1991-2019 | 11.4 | 4.5 |
| 1991-2021 | 12.2 | 4.5 |
| 1980*-1998 | 18.3 | 6.8 |
| 1991-2008 | 10.9 | 5.2 |
| 2001-2019 | 7.5 | 4.0 |
| 2001-2021 | 9.0 | 4.0 |

*Remarks: The table displays the mean over the yearly growth rates of the total return stock market index and nominal GDP. *) A star indicates a later start than 1980, as stock market data start in 1988 for Canada, France, and Japan, in 1986 for UK. Matching average GDP growth rates refer to the respective shorter periods.*

Table 1: Average stock market returns vs. GDP growth (average yearly growth rates of nominal data for selected periods).

### 3.3 Additional control variables

We have four hypotheses why the relationship between stocks and GDP may have changed: 1) The period 1991-2019 is characterized by major global shocks that provoked sudden strong declines in stock price notations. As GDP may react differently to positive stock market changes in contrast to negative ones, we test for an asymmetric reaction. 2) During the period, the relevance of global demand for national GDP and stocks increased. 3) Wage shares in many countries declined, such that profit shares increased. 4) Long-term interest rates declined globally and may have provoked declining discount rates.

In order to control for an asymmetric effect (1), we decompose the stock index into two separate series following Shin and Yu (2005): Starting with the first observation, one series reflects only positive changes (and keeps the respective last value until the next positive change), and the other series contains only negative changes (and again keeps the respective last value until the next negative change is added). These constructed series are then used as regressors instead of the original stock variable. To test for the growing role of foreign demand (2), we construct an indicator for foreign demand by summing up the trade weighted average of the remaining G7 countries for each country.[3] Trade weights are based on 4yr moving averages over trade shares derived from the IMF Direction of Trade Statistics. To control for changes in factor income distribution (3), we use the profit share. As historical series for most countries are only available on an annual basis, we calculate the profit share as gross operating surplus relative to the sum of gross operating surplus and compensation of employees in national accounts, this way ignoring changes in the share of self-employed. Corrected series can only be constructed for Germany and UK, where we can calculate profit rates based on quarterly data for the adjusted wage share from national sources. The effect of declining discount rates (4) is proxied by the return on benchmark rates: the return on government bonds with a remaining maturity of 10 years or more. Detailled information on data sources and construction is provided in appendix A.

## 4 Econometric analysis

### 4.1 Econometric approach

Theoretical considerations suggest a stochastic trend in GDP data as well as in stock market data. However, augmented Dickey Fuller (ADF) tests do not unambigously confirm this expectation for all G7 economies over all periods. As the tables show, real stock market indices and real GDP are mostly detected as instationary of order 1 [I(1)] during 1991-2019 and the two sub-periods (appendix B).[4] Yet, stocks seems to be partly characterized by deterministic (rather than stochastic) trends during the analyzed periods. This implies that the preconditions for using cointegration approaches based on the Engle-Granger two-step procedure or the Johansen cointegration test are not always fulfilled.

[3] We also checked if including China into the indicator improves results; yet, this was not the case.

[4] The ADF test has been conducted with intercept and (with and without) trend, as most data series indicate a trending behavior.

This is one motivaton to use the Pesaran/Shin/Smith (PSS) bounds testing approach (Pesaran et al., 2001), as this approach allows to test for a long-run relationship in levels irrespective of series being I(0), I(1) or mutually cointegrated. The approach can also be used to test for asymmetric relationships (see below). The authors suggest estimating the error correction model, for which they have tabulated critical values for the FPSS-test with the null hypothesis of no long-run relationship (implying that the coefficients of the variables in levels are all equal to zero). If one of the coefficients is significantly different to zero, a long-run relationship exists. The authors calculated critical values first under the hypothesis that variables in levels are all I(0), providing the lower bound, and second, that they are all I(1), providing the upper bound. If the FPSS-test statistic is smaller than the lower bound, the hypothesis of a relationship in levels has to be rejected; if the FPSS test statistic exceeds the upper bound, the test points to a relationship in levels. For FPSS-values between the lower and upper bound, the test is inconclusive. Critical values are tabulated for different test cases (with or without (restricted) constant and trend). The authors have also tabulated critical values for the $t$-test advanced by Banerjee et al. (1998).

As theoretical approaches point to stock market indices leading GDP and as this is in line with empirical findings (especially Granger causality tests and forecasting tests, see section 2.2), we mainly concentrate on using GDP as the dependent variable and stocks as the explanatory variable[5] in an error correction model (ECM), i.e. an autoregressive distributed lag (ARDL) model of variables in first differences that also contains the long-run relationship:

$$Y_t = \alpha + \sum_{i=1}^{p} \Psi_i Y_{t-i} + \sum_{l=0}^{q} \beta_l X_{t-l} + \varepsilon_t, \tag{1}$$

where $Y_t$ denotes the log of real GDP at time $t$ and $X_t$ the log of the respective country's real stock index. This is what we call the **baseline model**.[6]

Lag lengths $p$ and $q$ are selected using the Akaike info criterion, where we set the maximum number of lags for both the dependent and the explanatory variable to 6. If AIC yields a model with autocorrelation in the residuals, we fix the number of lags to 6 for both the dependent variable and the regressors, since the PSS-test is sensitive to serial correlation in the residuals (Pesaran et al., 2001). We test for autocorrelation in the residuals up to 4 lags using the Breusch-Godfrey serial correlation LM test.

Following Pesaran et al. (2001), eq. (1) can be reformulated in first differences containing an error correction term as in the traditional Engle-Grange approach. The $F$ statistic of the resulting conditional error correction (CEC) model can then be compared against the PSS critical values for the null hypothesis of no levels relationship between the dependent variable and the regressor(s) in the model. Furthermore, we check the sign of the coefficient associated with the equation's error correction term, which we expect to be negative and significant, if the variables are cointegrated. Finally, we check the coefficients of the re-

[5]We also tried to find a stable relationship in levels by reverse order, using GDP as the explanatory variable for stocks, yet, without success.

[6]We also estimate the model including a linear trend. Yet, the trend is mostly insignificant, such that the two test specifications of the PSS test lead to similar conclusions about the existence of a long-run relation. We therefore only present the results for the case without trend.

gressor(s) in the level equation, which are also expected to be negative - with the exception of the one for interest rates, where we expect a positive coefficient.

In addition to the baseline model, we consider several **extended equations**. First, we allow for an asymmetric relationship between GDP and stocks, following the approach advanced by Shin and Yu (2005). For that, we use the decomposed stock index series (explained in section 3.3), one series reflecting only positive changes, and keeping the respective last value until the next positive change, and the other series containing only negative changes, keeping the last value until the next change, respectively. These newly constructed series are used as regressors in the ECM model instead of the previously used stock variable.

Second, we separately include additional explanatory variables besides the stock index in the model (see section 3.3): Foreign demand, the profit share, and long-term interest rates. To allow for all these variables in a long-run relationship simultaneously and/or check for asymmetries at the same time is impossible due to the limited number of observations. As a robustness check, we estimate the relationship for three different sample periods: 1991-2019, 1991-2008 and 2001-2019.

The long-run relationship is considered stable if

1. the LM test does not find, with a probability above 10%, serial correlation in the residuals,
2. the $p$-value derived from the PSS $F$-bounds test is below 10%,
3. the $p$-value derived from the PSS $t$-bounds test is below 10%,
4. the coefficient of the error correction term is negative, and
5. all coefficients of the regressors in the error correction term have the theoretically expected sign (implying a negative sign in most cases, with the exception of a positive one for the interest rate).

### 4.2 Regression results

The procedure described in the previous section provides limited evidence for stable long-run relationships between stock market indices and GDP in G7 countries (Table 2 summarizes the findings, appendix C provides the details). For Germany, UK and the US, there is no evidence of a stable long-run relationship for the whole period 1991-2019, independently of the model-specification. This is in line with findings by M. K. Hossain and A. Hossain (2015) who can neither detect co-integration for the US nor the UK (or Japan) during 1991-2012. For France, Italy and Japan, we find some evidence.

We find more evidence of long-run relationships if we look into sub-periods of our sample: Generally speaking, there is more evidence for a robust long-term relationship between stocks and GDP in the second half of our sample (2001-2019) than in the sample that covers the period 1991 to 2008. This is particularly the case for the Anglo-Saxon economies, Japan and Italy. A potential explanation for more evidence of long-run relationships during the second sub-period might be that two major global financial crises (the bursting of the

| **Sample 1: 1991 2019** | **CA** | **DE** | **FR** | **IT** | **JP** | **UK** | **US** |
|---|---|---|---|---|---|---|---|
| Baseline model | □ | □ | ■ | ■ | ■ | □ | □ |
| ... with asymmetric stocks | ■ | □ | ■ | ■ | ■ | □ | □ |
| ... with foreign GDP | □ | □ | ■ | □ | □ | □ | □ |
| ... with profit ratio | □ | □ | □ | □ | □ | □ | □ |
| ... with interest rate | □ | □ | ■ | ■ | □ | □ | □ |
| **Sample 2: 1991 2008** | **CA** | **DE** | **FR** | **IT** | **JP** | **UK** | **US** |
| Baseline model | ■ | □ | ■ | □ | □ | □ | □ |
| ... with asymmetric stocks | ■ | ■ | ■ | □ | □ | □ | □ |
| ... with foreign GDP | □ | □ | ■ | □ | □ | □ | □ |
| ... with profit ratio | ■ | ■ | □ | □ | □ | □ | □ |
| ... with interest rate | □ | ■ | ■ | □ | ■ | □ | □ |
| **Sample 3: 2001 2019** | **CA** | **DE** | **FR** | **IT** | **JP** | **UK** | **US** |
| Baseline model | □ | ■ | ■ | ■ | □ | ■ | ■ |
| ... with asymmetric stocks | ■ | ■ | ■ | ■ | ■ | □ | ■ |
| ... with foreign GDP | □ | ■ | □ | □ | □ | □ | □ |
| ... with profit ratio | □ | □ | □ | □ | ■ | □ | □ |
| ... with interest rate | □ | ■ | ■ | ■ | □ | ■ | □ |

Table 2: Overview over the estimation results. Details in appendix C. A filled square indicates evidence for a stable long-run relationship between stocks and GDP.

dot.com bubble in 2000/01 and the global financial crisis in 2007/8) provoked strong corrections of stock price developments, aligning them more with GDP. The first subperiod, in contrast, is one where several factors motivating our hypotheses overlap: global trade increased especially from the 1990s onwards, the factor income distribution changed in several countries in favor of profit income, and benchmark rates declined by tendency. All factors may interact, but we cannot control for the combined effect.

We find evidence of a link for Germany in the period between 1991 and 2008 if we allow for an asymmetric influence of stocks on GDP or if we add the profit ratio as a regressor to the equation. The latter might reflect that the decrease of the wage ratio (and, vice versa, the increase of the profit ratio) following the "Agenda 2010" reforms (i.e. after the turn of the millennium) need to be controlled for in order to find a stable link between GDP and stock market developments.

With few exceptions for Canada, Germany and Japan in subperiods, it does not seem to be important to allow for an asymmetric reaction of GDP to positive versus negative changes in stock prices, as we already find a stable relationship by assuming a symmetric reaction. Coefficient estimates do not differ in a significant way according to an $F$-test. Yet, the following sub-section shows that asymmetric effects are relevant for the adjustment process to the long-run relationship (see below). With few exceptions for single countries during only one of the three time periods, adding foreign demand or the profit share to the long-run relationship does not improve the regression;[7] on the contrary: either it is causing autocorrelation in residuals and/or leads to unexpected signs for the estimated effect of variables that are not fully in line with theoretical considerations. The finding of irritating signs for foreign demand is in line with Alexius and Spång (2018).

### 4.3 Adjustment to the long-run equilibrium

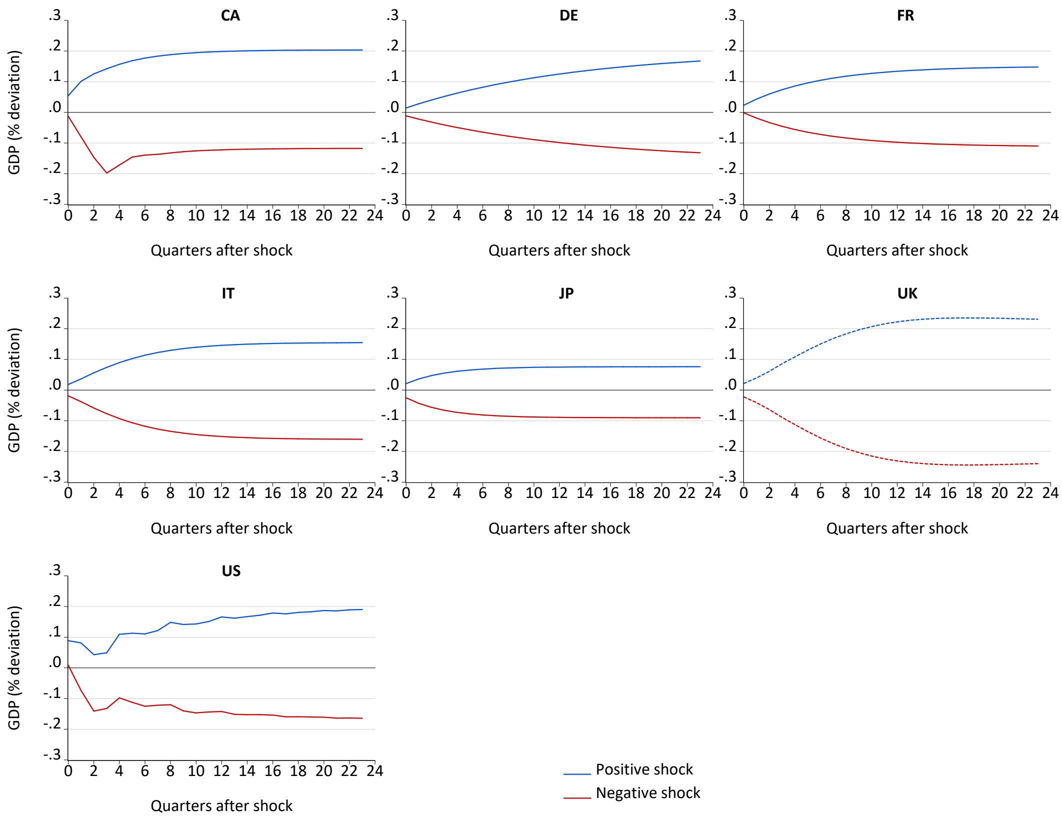
In order to show the long-run effect of stock price changes on GDP, appendix D presents impulse responses indicating the long-term impact of a permanent one-percent increase in stock prices on GDP, utilizing the forecasts of our models estimated over the three sample periods.

As expected, the effect on GDP is positive for all countries – at least once we ignore estimations where one of our five conditions for a stable relationship is violated (dashed lines).The figures in appendix D further indicate that our five conditions are not sufficient to fully rule out implausible results, as they do not exclude extremely slow adjustments to the long-run equilibrium. This can be exemplified for Canada: We find a stable long-run relationship for the baseline model in the sample 1991-2008, yet, adjustment to the long-run equilibrium is only reached after more than 24 quarters (more than six years), such that attraction to the equilibrium seems to be too slow to be relevant. Concentrating on stable and converging modles, the long-run effect of a permanent one-percent change of stock prices on GDP appears to be around 0.2 percent. The effect mostly materializes within two to three years. In Anglo-Saxon economies (Canada, the UK and the US), stock increases appear to have a stronger impact on GDP than in the other G7 economies in our sample (Germany, Italy, France and Japan).

Interestingly, our analysis reveals a notable increase of stock markets' impact on GDP between the first and the latter half of our sample period. This trend is especially prominent in non-Anglo-Saxon economies within our dataset. Specifically, our findings pertaining to Germany, France, and Italy suggest an increasing relevance of stock market dynamics for GDP over time (results for Japan are instable for the first half of our sample). This is evidenced by a more pronounced response of GDP to a one-percent shock on the respective stock index.

Once we allow for asymmetric adjustment, some additional insights emerge. Focusing on the results of the second half of our sample period (other results in appendix D), where the asymmetric model proved particularly useful,[8] we find that, overall, the effect of negative and positive stock market developments on GDP is fairly symmetric (fig. 2). Upon closer examination, our estimates reveal that GDP tends to demonstrate a stronger response to *increases* in stock prices compared to *declines*. The asymmetry is notably pronounced in Canada, Germany, and France. This could be related to the fact that these countries were more indirectly affected by financial crises over the past two decades. Consequently, pronounced stock market declines in these nations stemmed more from financial contagion than from severe macroeconomic imbalances, thus sparing a collapse in GDP.

[7] The profit-ratio model for Italy is based on a sample starting in 1995 due to lack of data. See appendix A.
[8] Refer back to table 2 for an overview over the different models' stability.




*Note that we reject stability of the asymmetric UK model for the sample period 2001–2019 due to the p-value derived from the PSS F-bounds test being higher than 10% (see appendix C).*

Figure 2: Response of the model with asymmetric shock adjustment (estimation sample 2001–2019) to a positive and a negative one-percent shock on stock prices.

## 5 Conclusions

This paper analyzes the relationship between national stock market indices and national GDP during 1991-2019. We basically follow Binswanger (2004) in trying to identify a cointegration relationship for both variables in levels for the G7 countries. Yet, instead of relying on the Engle-Granger two-step or the Johansen vector error correction approach as the author does, we use the bounds testing approach developed by Pesaran et al. (2001), as this approach can also be used if variables are not clearly integrated of order one. Our approach also allows for testing asymmetric reactions of GDP to stock price developments.

As Binswanger (2004) claims that the former stable long-run relationship between stock market indices and economic activity measured by GDP decoupled during the early 1980s for G7 countries, we formulate four hypotheses why this relationship may have changed: 1) Global shocks during this period provoked sudden strong declines in stock price notations, GDP may react differently to positive stock market changes in contrast to negative ones, 2) an increasing role of foreign demand, 3) the effect of variations in the profit share, and 4) the effect of globally declining long-term interest rates that may have provoked declining discount rates. In order to test these hypotheses, we formulate four variations of the baseline model that assumes a stable relationship of stock market prices and GDP: 1) We allow for asymmetric co-integration, and we extend the basic co-integration relation by 2) foreign demand, 3) the profit share, and 4) long-term interest rates.

Based on the bounds testing approach developed by Pesaran et al. (2001), we find limited evidence for a stable long-run relationship between national stock market indices and domestic GDP for the period starting in 1991. Our results are in line with findings by Binswanger (2004) who claims that such a relationship existed in earlier decades for G7 countries, yet, broke down in the early 1980s. Results are also in line with M. K. Hossain and A. Hossain (2015), who neither find a co-integration relation between the mentioned variables for the US, UK and Japan during 1991-2012.

The relationship may be camouflaged by an asymmetric reaction (GDP reacting differently to positive changes in stock prices than negative ones), however. While allowing for an asymmetric response does not fundamentally alter our results for the whole sample period, there is some evidence that in more recent decades – namely after the turn of the millennium – an asymmetric link between stocks and GDP might play a role in explaining the empirically found instable relationship between the two variables.

Allowing for asymmetry and focusing on the last two decades, our estimates indicate that an increase of the stock market index by one percent goes along with an increase of GDP by 0.2 percent in the following two to three years. The effect is slightly weaker in the case of a decreasing stock market index and less pronounced for non-Anglo-Saxon economies. This most likely reflects that in Anglo-Saxon economies, stock markets play a more important role for finance, while in the other countries, finance is more bank-based in comparison.

We cannot find strong evidence for the theoretically convincing idea that not only domestic demand, but also foreign demand may play an important role for listed firms that tend to be more export oriented than non-listed companies in a country. This is in contrast to Alexius and Spång (2018) who find a stable relationship between domestic GDP, the MSCI index of the country and foreign GDP for all G7 countries except the US. Apart from their usage of different stocks data, the earlier start of their sample may explain the different results: as their data start in 1969, their regression is based on more years during which a stable relationship existed according to Binswanger (2004). It is not clear if a later start of the sample would provide similar results. As coefficient estimates for foreign demand do not consistently show the expected positive sign, results may be restricted to the chosen data and period of study.

While we assume that several structural changes during the period 1991-2019 contribute to the problem in identifying a stable relationship, we find no empirical evidence that changes of the relevance of foreign demand, changes in the profit share, or changes in long-term interest rates in the respective countries were relevant factors, at least not by controlling for these factors separately. Yet, the period is characterized by several shocks and overlapping structural changes. We can not simultaneously control for the combined effect of all factors due to limited data points.

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## Appendix A: Data sources

Real stock index: Daily data for the national total return stock index in national currency, converted to quarterly data and deflated by national CPI (Canada: S&P/TSX Composite; Germany: DAX; France: CAC 40; Italy: MSCI in USD, converted to EUR[9]; Japan: S&P total return index[10]; UK: FTSE All-Share Index; US: S&P 500).

Real GDP: Seasonally adjusted (and, if available, calender-adjusted) quarterly GDP from national accounts in current prices from national sources (Germany: Destatis; Japan: Cabinet Office; UK: ONS; US: BEA), Eurostat (France), OECD Economic Outlook (Italy), IMF IFS (Canada). Series are deflated by CPI.

CPI: National offices.

Foreign demand: Own construction as explained in section 3.

Profit share: Gross operating surplus relative to national income (i.e. gross operating surplus and compensation of employees). As we cannot correct for changes in the number of self-employed due to missing data, we use the "unadjusted" series with the exception of Germany and UK, where the profit share is based on quarterly series for the adjusted wage share from national sources. For the other countries, variables for gross operating surplus also stem from quarterly national accounts data. Data start for Italy in 1995. For Japan, we can only calculate gross operating surplus relative to gross national income.

Long-term benchmark interest rates: Return on benchmark government bond yields with a remaining maturity of 10 years or more. All countries: Macrobond, except US: Treasury.

## Appendix B: ADF test results

The following tables report, for the three samples considered in the econometric analysis, the *p*-values associated with the ADF statistics for the log of real GDP and the log of real stock indices; statistics are estimated including (1) an exogenous constant and (2) a constant plus a linear trend, respectively. The Akaike information criterion has been used to select the appropriate lag length.

| **Sample 1: 1991 2019** | **CA** | **DE** | **FR** | **IT** | **JP** | **UK** | **US** |
|---|---|---|---|---|---|---|---|
| GDP, w/o trend | 0.5838 | 0.9898 | 0.2311 | 0.4142 | 0.0920 | 0.3907 | 0.6937 |
| GDP, w/ trend | 0.8194 | 0.9273 | 0.7536 | 0.8198 | 0.3289 | 0.8476 | 0.4525 |
| Stock idx, w/o trend | 0.6382 | 0.5309 | 0.6282 | 0.3669 | 0.1915 | 0.5699 | 0.8035 |
| Stock idx, w/ trend | 0.0885 | 0.3347 | 0.5411 | 0.6217 | 0.1618 | 0.3899 | 0.7540 |

[9] The FTSE Italia MIB Index is only available from 1997 onwards.
[10] The Nikkei 225 total return index only starts in 2013.

| **Sample 2: 1991 2008** | **CA** | **DE** | **FR** | **IT** | **JP** | **UK** | **US** |
|---|---|---|---|---|---|---|---|
| GDP, w/o trend | 0.9204 | 0.5316 | 0.7193 | 0.8342 | 0.1947 | 0.9532 | 0.4558 |
| GDP, w/ trend | 0.1642 | 0.1932 | 0.3514 | 0.8826 | 0.5185 | 0.0175 | 0.7835 |
| Stock idx, w/o trend | 0.5159 | 0.4333 | 0.2703 | 0.6033 | 0.0327 | 0.3528 | 0.3252 |
| Stock idx, w/ trend | 0.7605 | 0.8154 | 0.5016 | 0.9250 | 0.1027 | 0.9478 | 0.9916 |

| **Sample 3: 2001 2019** | **CA** | **DE** | **FR** | **IT** | **JP** | **UK** | **US** |
|---|---|---|---|---|---|---|---|
| GDP, w/o trend | 0.6187 | 0.9933 | 0.7411 | 0.2906 | 0.2749 | 0.5620 | 0.9048 |
| GDP, w/ trend | 0.1285 | 0.5348 | 0.2612 | 0.5481 | 0.5923 | 0.1912 | 0.1264 |
| Stock idx, w/o trend | 0.5957 | 0.7023 | 0.7656 | 0.1614 | 0.7197 | 0.8752 | 0.9737 |
| Stock idx, w/ trend | 0.0955 | 0.0470 | 0.3095 | 0.4777 | 0.6430 | 0.0374 | 0.6020 |

# Appendix C: Estimation details

| Sample 1: 1991 2019 | CA | DE | FR | IT | JP | UK | US |
|---|---|---|---|---|---|---|---|
| **Baseline model (lhs: GDP_REAL_LOG, rhs: IDX_REAL_LOG)** | | | | | | | |
| Selected model (AIC; if fixed lags: in italics) | ARDL(3, 4) | ARDL(1, 3) | ARDL(1, 0) | ARDL(3, 2) | ARDL(1, 0) | ARDL(5, 1) | ARDL(6, 5) |
| LM test up to 4 lags finds no serial corr. (probability >10%) | true | true | true | true | true | true | true |
| F-statistic; significance of H0: 'no level relationship' in paranth. | 1.794 (>10%) | 0.4606 (>10%) | 13.30 (1%) | 5.996 (5%) | 6.150 (5%) | 2.523 (>10%) | 2.636 (>10%) |
| Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth. | -0.035 (>10%) | -0.0062 (>10%) | -0.043 (1%) | -0.054 (5%) | -0.15 (2.5%) | -0.025 (>10%) | -0.025 (>10%) |
| Coeff. of IDX_REAL_LOG in CointEq; tStat in paranth. | -0.374 (-6.81) | -0.390 (-0.488) | -0.246 (-8.99) | -0.196 (-5.61) | -0.0654 (-2.78) | -0.328 (-3.91) | -0.275 (-4.62) |
| **... with asymmetric stocks (lhs: GDP_REAL_LOG, rhs: P_IDX_REAL_LOG N_IDX_REAL_LOG)** | | | | | | | |
| Selected model (AIC; if fixed lags: in italics) | ARDL(2, 0, 6) | ARDL(1, 0, 3) | ARDL(1, 0, 1) | ARDL(3, 0, 2) | ARDL(1, 0, 0) | *ARDL(6, 6, 6)* | ARDL(6, 1, 3) |
| LM test up to 4 lags finds no serial corr. (probability >10%) | true | true | true | true | true | false | true |
| F-statistic; significance of H0: 'no level relationship' in paranth. | 5.882 (2.5%) | 0.5840 (>10%) | 10.75 (1%) | 4.353 (10%) | 4.496 (10%) | 1.037 (>10%) | 2.513 (>10%) |
| Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth. | -0.13 (1%) | -0.027 (>10%) | -0.091 (1%) | -0.059 (5%) | -0.15 (5%) | -0.030 (>10%) | -0.055 (>10%) |
| Coeff. of P_IDX_REAL_LOG in CointEq; tStat in paranth. | -0.252 (-6.72) | -0.107 (-1.08) | -0.163 (-6.61) | -0.179 (-4.98) | -0.0764 (-2.97) | -0.164 (-1.07) | -0.200 (-4.11) |
| Coeff. of N_IDX_REAL_LOG in CointEq; tStat in paranth. | -0.156 (-2.61) | -0.0670 (-0.545) | -0.118 (-3.37) | -0.172 (-4.15) | -0.0817 (-2.89) | -0.0530 (-0.228) | -0.127 (-1.63) |
| **... with foreign GDP (lhs: GDP_REAL_LOG, rhs: IDX_REAL_LOG ROWGDP_LOG)** | | | | | | | |
| Selected model (AIC; if fixed lags: in italics) | ARDL(3, 4, 2) | ARDL(1, 1, 2) | ARDL(3, 1, 3) | ARDL(3, 2, 1) | ARDL(1, 0, 2) | ARDL(2, 1, 4) | ARDL(5, 1, 6) |
| LM test up to 4 lags finds no serial corr. (probability >10%) | true | true | true | true | true | true | true |
| F-statistic; significance of H0: 'no level relationship' in paranth. | 1.626 (>10%) | 1.687 (>10%) | 5.125 (5%) | 2.392 (>10%) | 4.043 (>10%) | 0.8537 (>10%) | 3.384 (>10%) |
| Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth. | -0.053 (>10%) | -0.011 (>10%) | -0.17 (2.5%) | -0.043 (>10%) | -0.15 (10%) | -0.015 (>10%) | -0.14 (10%) |
| Coeff. of IDX_REAL_LOG in CointEq; tStat in paranth. | -0.151 (-1.11) | -0.0584 (-0.283) | -0.0131 (-0.978) | -0.184 (-3.20) | -0.0489 (-1.74) | -0.145 (-0.302) | -0.0632 (-2.18) |
| Coeff. of ROWGDP_LOG in CointEq; tStat in paranth. | -1.06 (-1.81) | -1.21 (-0.910) | -0.834 (-18.9) | -0.0722 (-0.489) | -0.00407 (-0.0882) | -0.353 (-0.141) | -1.25 (-8.72) |
| **... with profit ratio (lhs: GDP_REAL_LOG, rhs: IDX_REAL_LOG PROFITRATIO)** | | | | | | | |
| Selected model (AIC; if fixed lags: in italics) | ARDL(6, 3, 1) | *ARDL(6, 6, 6)* | ARDL(1, 0, 3) | ARDL(5, 0, 4) | *ARDL(6, 6, 6)* | ARDL(5, 2, 1) | *ARDL(6, 6, 6)* |
| LM test up to 4 lags finds no serial corr. (probability >10%) | true | true | true | true | true | true | true |
| F-statistic; significance of H0: 'no level relationship' in paranth. | 2.255 (>10%) | 1.835 (>10%) | 7.366 (1%) | 4.820 (10%) | 1.764 (>10%) | 2.892 (>10%) | 2.997 (>10%) |
| Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth. | -0.034 (>10%) | -0.0085 (>10%) | -0.040 (1%) | -0.054 (2.5%) | -0.094 (>10%) | -0.032 (>10%) | -0.041 (>10%) |
| Coeff. of IDX_REAL_LOG in CointEq; tStat in paranth. | -0.368 (-6.89) | -0.630 (-0.557) | -0.214 (-6.45) | -0.166 (-3.63) | -0.0448 (-1.03) | -0.312 (-5.15) | -0.323 (-4.05) |
| Coeff. of PROFITRATIO in CointEq; tStat in paranth. | -0.0309 (-1.61) | +0.0261 (0.331) | +0.0161 (0.705) | +0.00519 (0.504) | -0.00559 (-0.813) | +0.0244 (1.67) | -0.00740 (-0.316) |
| **... with interest rate (lhs: GDP_REAL_LOG, rhs: IDX_REAL_LOG INT)** | | | | | | | |
| Selected model (AIC; if fixed lags: in italics) | ARDL(3, 4, 4) | ARDL(1, 0, 3) | ARDL(1, 0, 5) | ARDL(3, 0, 0) | ARDL(1, 0, 0) | *ARDL(6, 6, 6)* | ARDL(6, 5, 0) |
| LM test up to 4 lags finds no serial corr. (probability >10%) | true | true | true | true | true | false | true |
| F-statistic; significance of H0: 'no level relationship' in paranth. | 2.303 (>10%) | 2.642 (>10%) | 9.584 (1%) | 6.831 (1%) | 4.067 (>10%) | 2.305 (>10%) | 2.015 (>10%) |
| Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth. | -0.053 (>10%) | -0.072 (>10%) | -0.057 (1%) | -0.069 (1%) | -0.15 (10%) | -0.035 (>10%) | -0.035 (>10%) |
| Coeff. of IDX_REAL_LOG in CointEq; tStat in paranth. | -0.210 (-1.84) | -0.0179 (-0.392) | -0.143 (-2.78) | -0.143 (-3.41) | -0.0644 (-2.51) | +0.0439 (0.215) | -0.223 (-3.37) |
| Coeff. of INT in CointEq; tStat in paranth. | +0.0380 (1.51) | +0.0375 (3.75) | +0.0223 (2.09) | +0.00677 (1.59) | +0.000455 (0.0984) | +0.0704 (2.02) | +0.0244 (1.15) |

The table displays parameters and detailed estimation results of the model variants used in the analysis of section 4. Red color highlights a violation of one of the stability criteria outlined in section 4.1. The profit-ratio model for Italy is based on a sample starting in 1995 due to lack of data (appendix A).

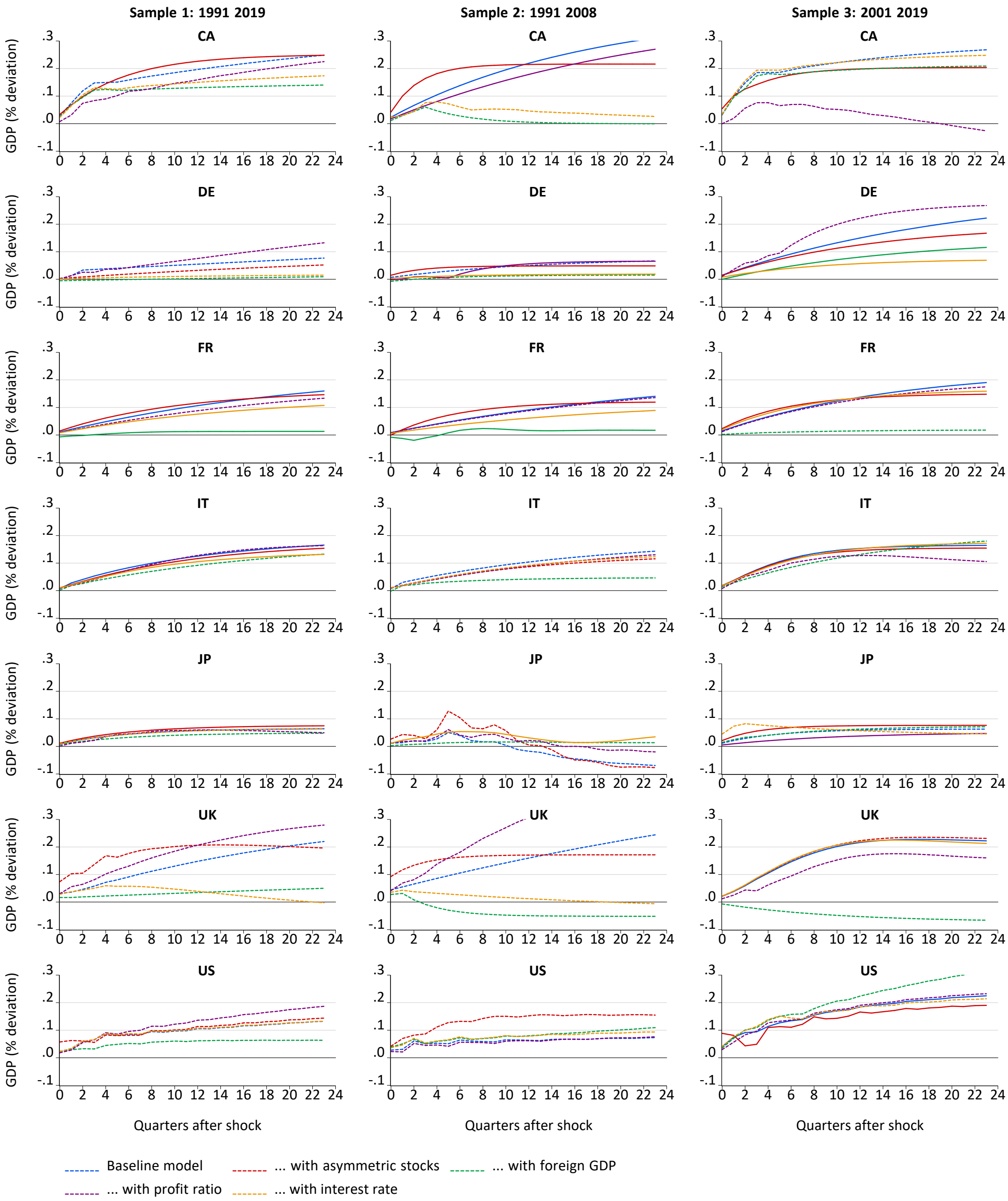
| **Sample 2: 1991 2008** | **CA** | **DE** | **FR** | **IT** | **JP** | **UK** | **US** |
|---|---|---|---|---|---|---|---|
| **Baseline model (lhs: GDP_REAL_LOG, rhs: IDX_REAL_LOG)** | | | | | | | |
| Selected model (AIC; if fixed lags: in italics) | ARDL(1, 0) | ARDL(2, 0) | ARDL(1, 0) | ARDL(1, 2) | ARDL(5, 6) | ARDL(1, 1) | ARDL(5, 3) |
| LM test up to 4 lags finds no serial corr. (probability >10%) | true | true | true | true | true | true | true |
| F-statistic; significance of H0: 'no level relationship' in paranth. | 7.092 (2.5%) | 3.373 (>10%) | 5.231 (10%) | 4.040 (>10%) | 4.627 (>10%) | 2.039 (>10%) | 0.5579 (>10%) |
| Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth. | -0.056 (2.5%) | -0.089 (>10%) | -0.037 (5%) | -0.056 (>10%) | -0.10 (10%) | -0.020 (>10%) | -0.012 (>10%) |
| Coeff. of IDX_REAL_LOG in CointEq; tStat in paranth. | -0.416 (-10.2) | -0.0801 (-3.31) | -0.239 (-5.35) | -0.188 (-5.19) | +0.0770 (0.714) | -0.592 (-2.64) | -0.157 (-0.646) |
| **... with asymmetric stocks (lhs: GDP_REAL_LOG, rhs: P_IDX_REAL_LOG N_IDX_REAL_LOG)** | | | | | | | |
| Selected model (AIC; if fixed lags: in italics) | ARDL(1, 1, 0) | ARDL(1, 0, 1) | ARDL(1, 1, 0) | ARDL(1, 0, 2) | *ARDL(6, 6, 6)* | ARDL(1, 1, 0) | ARDL(5, 0, 3) |
| LM test up to 4 lags finds no serial corr. (probability >10%) | true | true | true | true | false | true | true |
| F-statistic; significance of H0: 'no level relationship' in paranth. | 10.46 (1%) | 5.762 (2.5%) | 6.483 (1%) | 2.483 (>10%) | 2.849 (>10%) | 8.555 (1%) | 7.734 (1%) |
| Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth. | -0.33 (1%) | -0.31 (1%) | -0.16 (1%) | -0.075 (>10%) | -0.14 (>10%) | -0.31 (1%) | -0.27 (1%) |
| Coeff. of P_IDX_REAL_LOG in CointEq; tStat in paranth. | -0.217 (-18.0) | -0.0489 (-6.15) | -0.122 (-7.88) | -0.137 (-2.09) | +0.0569 (0.696) | -0.172 (-13.3) | -0.156 (-15.6) |
| Coeff. of N_IDX_REAL_LOG in CointEq; tStat in paranth. | -0.0560 (-2.69) | -0.0233 (-2.19) | -0.0334 (-1.38) | -0.106 (-0.979) | +0.0699 (0.849) | +0.0665 (3.20) | +0.00735 (0.453) |
| **... with foreign GDP (lhs: GDP_REAL_LOG, rhs: IDX_REAL_LOG ROWGDP_LOG)** | | | | | | | |
| Selected model (AIC; if fixed lags: in italics) | ARDL(1, 4, 0) | ARDL(1, 1, 2) | ARDL(5, 3, 3) | ARDL(3, 2, 1) | ARDL(5, 0, 2) | ARDL(1, 2, 0) | ARDL(5, 3, 6) |
| LM test up to 4 lags finds no serial corr. (probability >10%) | true | true | true | true | true | true | true |
| F-statistic; significance of H0: 'no level relationship' in paranth. | 5.508 (5%) | 1.795 (>10%) | 7.626 (1%) | 1.313 (>10%) | 2.304 (>10%) | 6.908 (1%) | 0.2749 (>10%) |
| Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth. | -0.23 (1%) | -0.17 (>10%) | -0.33 (1%) | -0.11 (>10%) | -0.18 (>10%) | -0.28 (1%) | 0.019 (>10%) |
| Coeff. of IDX_REAL_LOG in CointEq; tStat in paranth. | +0.00100 (0.0288) | -0.0154 (-1.09) | -0.0172 (-2.01) | -0.0477 (-1.13) | -0.0137 (-0.455) | +0.0522 (2.54) | +0.136 (0.156) |
| Coeff. of ROWGDP_LOG in CointEq; tStat in paranth. | -1.87 (-11.8) | -0.349 (-5.87) | -0.830 (-27.5) | -0.620 (-3.60) | -0.120 (-2.25) | -1.97 (-23.6) | -2.14 (-0.572) |
| **... with profit ratio (lhs: GDP_REAL_LOG, rhs: IDX_REAL_LOG PROFITRATIO)** | | | | | | | |
| Selected model (AIC; if fixed lags: in italics) | ARDL(1, 0, 1) | ARDL(1, 6, 1) | ARDL(1, 0, 0) | ARDL(1, 0, 4) | *ARDL(6, 6, 6)* | ARDL(5, 2, 2) | ARDL(5, 3, 0) |
| LM test up to 4 lags finds no serial corr. (probability >10%) | true | true | true | true | false | true | true |
| F-statistic; significance of H0: 'no level relationship' in paranth. | 5.076 (5%) | 5.567 (2.5%) | 3.699 (>10%) | 3.867 (>10%) | 4.079 (>10%) | 2.953 (>10%) | 0.8295 (>10%) |
| Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth. | -0.041 (2.5%) | -0.23 (1%) | -0.036 (10%) | -0.050 (10%) | -0.16 (5%) | -0.041 (>10%) | -0.028 (>10%) |
| Coeff. of IDX_REAL_LOG in CointEq; tStat in paranth. | -0.430 (-4.00) | -0.0665 (-6.88) | -0.231 (-5.09) | -0.185 (-2.77) | +0.0142 (0.304) | -0.277 (-3.04) | -0.132 (-1.23) |
| Coeff. of PROFITRATIO in CointEq; tStat in paranth. | -0.00808 (-0.453) | -0.00867 (-5.08) | -0.0406 (-0.795) | -0.0362 (-0.962) | -0.00767 (-1.77) | +0.0342 (2.37) | -0.0597 (-1.66) |
| **... with interest rate (lhs: GDP_REAL_LOG, rhs: IDX_REAL_LOG INT)** | | | | | | | |
| Selected model (AIC; if fixed lags: in italics) | *ARDL(6, 6, 6)* | ARDL(2, 0, 4) | ARDL(1, 0, 3) | ARDL(3, 0, 0) | ARDL(6, 0, 1) | ARDL(2, 2, 4) | ARDL(5, 3, 6) |
| LM test up to 4 lags finds no serial corr. (probability >10%) | true | true | true | true | true | true | true |
| F-statistic; significance of H0: 'no level relationship' in paranth. | 3.249 (>10%) | 4.730 (10%) | 4.232 (10%) | 3.352 (>10%) | 5.586 (2.5%) | 5.028 (5%) | 2.482 (>10%) |
| Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth. | -0.059 (>10%) | -0.17 (2.5%) | -0.050 (5%) | -0.063 (10%) | -0.38 (1%) | -0.050 (2.5%) | -0.073 (>10%) |
| Coeff. of IDX_REAL_LOG in CointEq; tStat in paranth. | +0.0271 (0.167) | -0.0193 (-1.02) | -0.126 (-1.97) | -0.148 (-1.95) | -0.0306 (-2.23) | +0.0381 (0.314) | -0.116 (-2.84) |
| Coeff. of INT in CointEq; tStat in paranth. | +0.112 (2.71) | +0.0207 (3.25) | +0.0266 (1.43) | +0.00603 (0.643) | +0.0133 (5.11) | +0.108 (3.89) | +0.0864 (5.38) |

The table displays parameters and detailed estimation results of the model variants used in the analysis of section 4. Red color highlights a violation of one of the stability criteria outlined in section 4.1. The profit-ratio model for Italy is based on a sample starting in 1995 due to lack of data (appendix A).

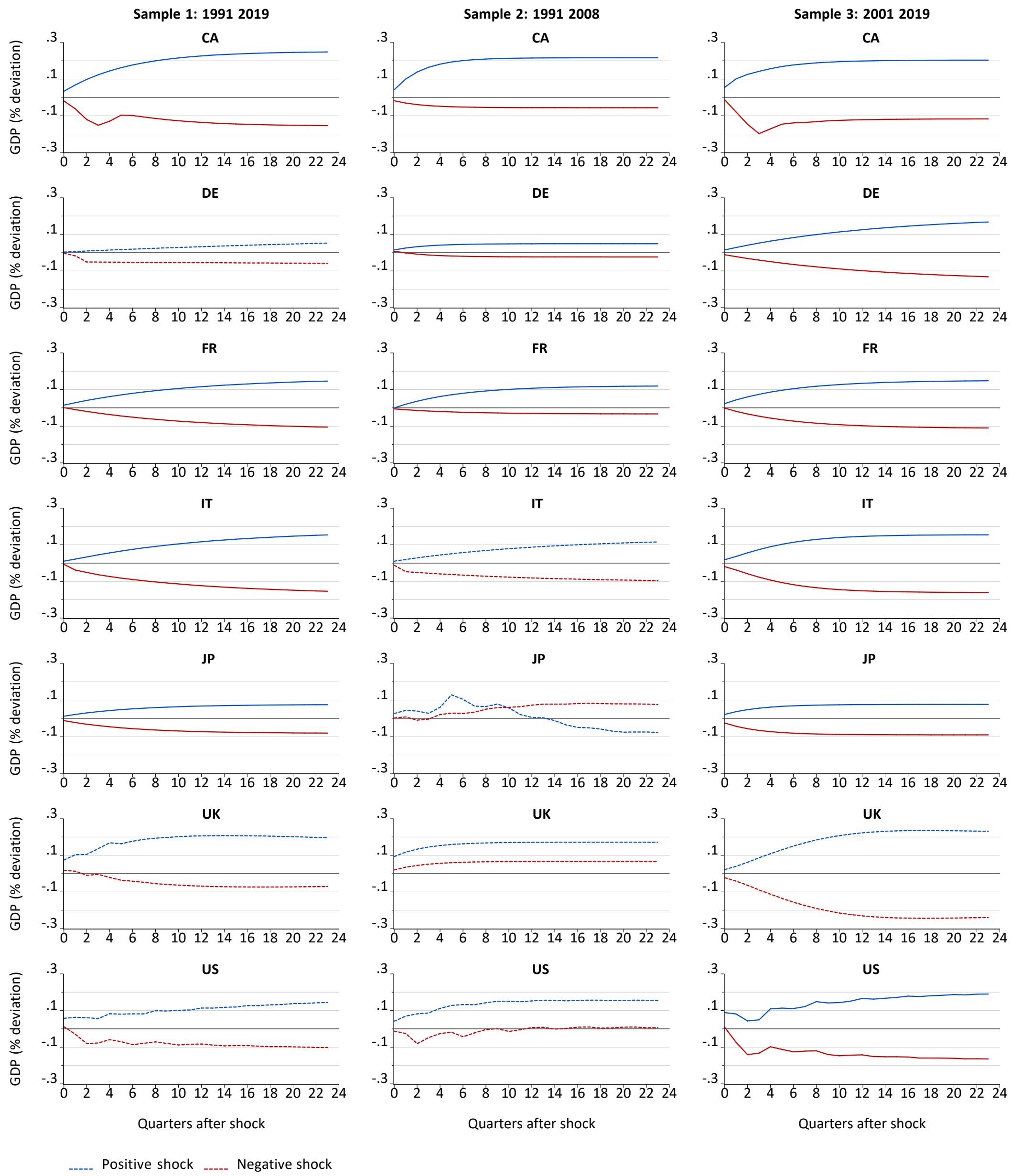
| **Sample 3: 2001 2019** | **CA** | **DE** | **FR** | **IT** | **JP** | **UK** | **US** |
|---|---|---|---|---|---|---|---|
| **Baseline model (lhs: GDP_REAL_LOG, rhs: IDX_REAL_LOG)** | | | | | | | |
| Selected model (AIC; if fixed lags: in italics) | ARDL(3, 4) | ARDL(1, 0) | ARDL(1, 0) | ARDL(3, 0) | ARDL(1, 0) | ARDL(4, 0) | ARDL(6, 0) |
| LM test up to 4 lags finds no serial corr. (probability >10%) | true | true | true | true | true | true | true |
| F-statistic; significance of H0: 'no level relationship' in paranth. | 1.783 (>10%) | 5.506 (10%) | 9.843 (1%) | 10.91 (1%) | 4.625 (>10%) | 5.736 (5%) | 11.60 (1%) |
| Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth. | -0.078 (>10%) | -0.046 (5%) | -0.063 (1%) | -0.11 (1%) | -0.18 (10%) | -0.096 (5%) | -0.16 (1%) |
| Coeff. of IDX_REAL_LOG in CointEq; tStat in paranth. | -0.302 (-5.07) | -0.330 (-3.12) | -0.242 (-5.85) | -0.166 (-4.83) | -0.0634 (-2.83) | -0.217 (-6.68) | -0.250 (-15.5) |
| **... with asymmetric stocks (lhs: GDP_REAL_LOG, rhs: P_IDX_REAL_LOG N_IDX_REAL_LOG)** | | | | | | | |
| Selected model (AIC; if fixed lags: in italics) | ARDL(3, 0, 4) | ARDL(1, 0, 0) | ARDL(1, 0, 1) | ARDL(3, 0, 0) | ARDL(1, 0, 0) | ARDL(4, 0, 0) | ARDL(6, 3, 3) |
| LM test up to 4 lags finds no serial corr. (probability >10%) | true | true | true | true | true | true | true |
| F-statistic; significance of H0: 'no level relationship' in paranth. | 6.691 (1%) | 4.454 (10%) | 9.554 (1%) | 7.319 (1%) | 4.407 (10%) | 3.779 (>10%) | 6.631 (1%) |
| Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth. | -0.27 (1%) | -0.073 (5%) | -0.16 (1%) | -0.12 (1%) | -0.28 (5%) | -0.096 (10%) | -0.21 (1%) |
| Coeff. of P_IDX_REAL_LOG in CointEq; tStat in paranth. | -0.204 (-6.60) | -0.201 (-3.00) | -0.151 (-7.14) | -0.156 (-4.28) | -0.0765 (-4.83) | -0.226 (-3.84) | -0.203 (-9.35) |
| Coeff. of N_IDX_REAL_LOG in CointEq; tStat in paranth. | -0.117 (-2.57) | -0.157 (-1.90) | -0.111 (-4.21) | -0.160 (-4.70) | -0.0897 (-4.81) | -0.233 (-2.51) | -0.171 (-4.89) |
| **... with foreign GDP (lhs: GDP_REAL_LOG, rhs: IDX_REAL_LOG ROWGDP_LOG)** | | | | | | | |
| Selected model (AIC; if fixed lags: in italics) | ARDL(3, 4, 2) | ARDL(1, 1, 2) | ARDL(1, 0, 1) | ARDL(1, 0, 1) | ARDL(4, 0, 3) | ARDL(1, 0, 6) | *ARDL(6, 6, 6)* |
| LM test up to 4 lags finds no serial corr. (probability >10%) | true | true | true | true | true | true | false |
| F-statistic; significance of H0: 'no level relationship' in paranth. | 2.038 (>10%) | 6.258 (2.5%) | 2.069 (>10%) | 6.124 (2.5%) | 2.828 (>10%) | 4.257 (10%) | 3.357 (>10%) |
| Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth. | -0.11 (>10%) | -0.063 (1%) | -0.12 (>10%) | -0.066 (1%) | -0.20 (>10%) | -0.095 (5%) | -0.087 (10%) |
| Coeff. of IDX_REAL_LOG in CointEq; tStat in paranth. | -0.215 (-2.15) | -0.150 (-2.04) | -0.0187 (-0.669) | -0.225 (-3.72) | -0.0738 (-2.46) | +0.0732 (0.673) | -0.487 (-0.786) |
| Coeff. of ROWGDP_LOG in CointEq; tStat in paranth. | -0.505 (-1.16) | -0.642 (-2.06) | -0.779 (-7.88) | +0.0417 (0.346) | +0.145 (1.40) | -0.988 (-2.48) | +1.54 (0.395) |
| **... with profit ratio (lhs: GDP_REAL_LOG, rhs: IDX_REAL_LOG PROFITRATIO)** | | | | | | | |
| Selected model (AIC; if fixed lags: in italics) | ARDL(5, 5, 3) | ARDL(1, 6, 5) | ARDL(2, 1, 1) | ARDL(5, 3, 6) | ARDL(1, 0, 1) | *ARDL(6, 6, 6)* | *ARDL(6, 6, 6)* |
| LM test up to 4 lags finds no serial corr. (probability >10%) | true | true | true | true | true | false | false |
| F-statistic; significance of H0: 'no level relationship' in paranth. | 0.5086 (>10%) | 9.602 (1%) | 8.711 (1%) | 3.706 (>10%) | 5.699 (2.5%) | 7.678 (1%) | 6.776 (1%) |
| Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth. | 0.021 (>10%) | -0.16 (1%) | -0.085 (1%) | -0.11 (10%) | -0.097 (1%) | -0.16 (1%) | -0.20 (1%) |
| Coeff. of IDX_REAL_LOG in CointEq; tStat in paranth. | -0.419 (-1.88) | -0.277 (-10.6) | -0.209 (-8.13) | -0.104 (-2.52) | -0.0513 (-1.57) | -0.159 (-4.56) | -0.261 (-12.7) |
| Coeff. of PROFITRATIO in CointEq; tStat in paranth. | +0.0603 (0.523) | +0.0107 (3.39) | +0.0136 (1.51) | -0.00646 (-1.03) | -0.0380 (-2.03) | -0.0294 (-2.23) | -0.00435 (-0.809) |
| **... with interest rate (lhs: GDP_REAL_LOG, rhs: IDX_REAL_LOG INT)** | | | | | | | |
| Selected model (AIC; if fixed lags: in italics) | ARDL(3, 4, 0) | ARDL(1, 0, 3) | ARDL(1, 0, 5) | ARDL(3, 0, 0) | ARDL(1, 3, 2) | ARDL(4, 0, 1) | *ARDL(6, 6, 6)* |
| LM test up to 4 lags finds no serial corr. (probability >10%) | true | true | true | true | true | true | false |
| F-statistic; significance of H0: 'no level relationship' in paranth. | 1.410 (>10%) | 6.754 (1%) | 13.80 (1%) | 7.727 (1%) | 0.6603 (>10%) | 4.382 (10%) | 5.312 (5%) |
| Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth. | -0.12 (>10%) | -0.11 (1%) | -0.12 (1%) | -0.10 (1%) | -0.081 (>10%) | -0.10 (5%) | -0.17 (2.5%) |
| Coeff. of IDX_REAL_LOG in CointEq; tStat in paranth. | -0.257 (-4.12) | -0.0745 (-1.55) | -0.167 (-4.69) | -0.176 (-4.32) | -0.0376 (-0.576) | -0.208 (-4.10) | -0.237 (-9.93) |
| Coeff. of INT in CointEq; tStat in paranth. | +0.0177 (1.12) | +0.0393 (3.66) | +0.00944 (1.53) | +0.00677 (0.973) | -0.0130 (-0.454) | +0.00331 (0.332) | +0.00378 (0.425) |

The table displays parameters and detailed estimation results of the model variants used in the analysis of section 4. Red color highlights a violation of one of the stability criteria outlined in section 4.1.

## Appendix D: Impulse responses




Charts display the estimated models' response to a positive one-percent shock on stock prices. Solid lines represent the effect in models where we find a stable long-run relationship (as defined in section 4.1). Dashed lines indicate that at least one of the five stability criteria outlined in section 4.1 is violated.




Charts display the asymmetric models' response to a positive and a negative one-percent shock on stock prices. Solid lines represent the effect in models where we find a stable long-run relationship (as defined in section 4.1). Dashed lines indicate that at least one of the stability criteria outlined in section 4.1 is violated.

## Imprint

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