Stock market returns and GDP growth*

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Despite strong theoretical arguments, econometric evidence for a long-term relationship between stocks and real economic activity is mixed. If anything, previous studies seem to indicate a link between stocks and growth before the 1980ies, while the relationship breaks down in later decades. We reconsider these findings based on recent data and take into account additional aspects that seem relevant in this context: First, we allow for an asymmetric influence of increases and decreases in stock indices. Second, we take into account the influence of global economic developments based on a trade-weighted GDP of the rest of the world. Third, we look into the influence of the distribution of incomes on the relationship. Fourth, we integrate long-term interest rate into the estimation. However, these modifications do not substantially change the result that the link between stock prices and GDP is, at best, unstable.

1 Introduction

Stock market indices experienced high growth rates above GDP growth during the 2000s and 2010s in several OECD countries (see 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 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

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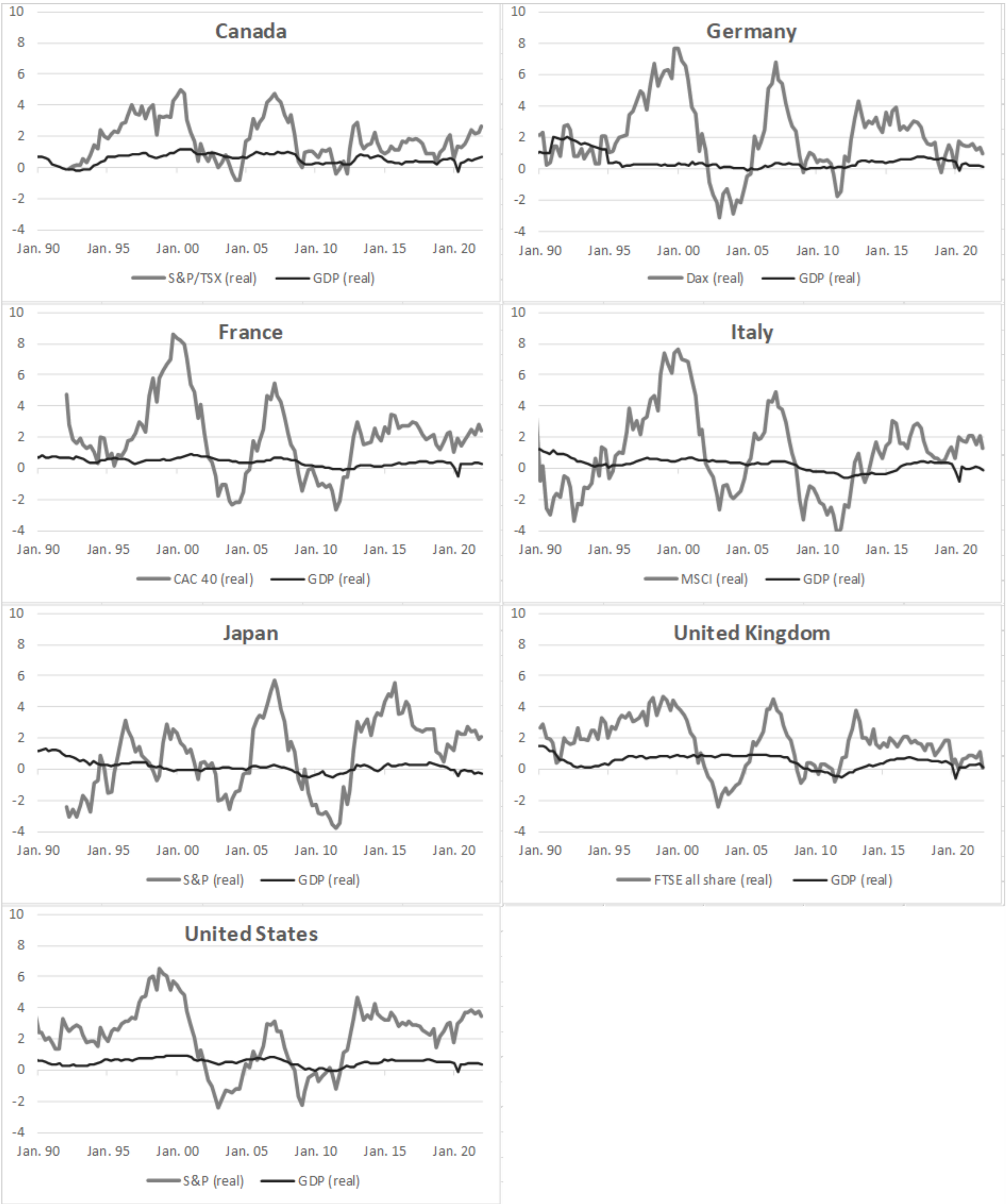
in the US, Binswanger (2000) finds evidence for a decoupling of stock returns from economic activity starting in the early 1980s and lasting throughout the 1990s. Binswanger (2004) confirms these findings for the G7 countries.

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 seems to be more adequate regarding data properties (see below).

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 also 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 declining wage shares in many countries, declining interest rates and increasing globalization. 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 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 trade weighted GDP of the rest of the world. Yet, we only find a stable long-term relation between stock market indices and GDP for Canada and France. For all other G7 countries, none of our model specifications results in a stable co-integration relation for the main period and sub-periods.

The next 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 re-



Notes: Figures portray rolling 4 year-windows of 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.

sults of econometric regressions, and discusses the results. Section 5 provides conclusions.

2 Literature review on stock market indices 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 economic activity (ECB, 2012): 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). 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). 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. While the theoretical literature stresses the effects from stock prices to economic activity, reverse causality may also play a role (see the discussion in Croux and Reusens, 2013).

While 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 causality to run from stock prices to 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 use Granger causality tests in vector autoregressive (VAR) models, often combined with tests about forecasting power.

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 Stock returns and GDP growth

3.1 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[1]).

We use the following stock indices: for Canada, S&P/TSX Composite, starting in 1988; for Germany, the DAX, starting in 1959; for France, the CAC 40, starting in 1987; for Italy, we use the MSCI starting in 1970, 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 100 starting in 1986 and for the US the S&P 500 starting in 1960.

GDP data mainly stem from national statistical offices or the OECD or the IMF IFS data base. GDP and stock index data are both deflated by CPI. Using the same price indicator, CPI, as a deflator for stocks and GDP, has the advantage that differences in stock returns in

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

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 Developments over time

Figure 1 portrays four-year-rolling moving averages of quarterly real growth rates of domestic stock market indices and domestic GDP of the G7 countries since the first quarter of 1990 up to the first quarter of 2022. As a first glance on the data shows, stock market returns are much more volatile than GDP growth, but appear to be related to GDP developments. Global shocks like the bursting of the dot.com bubble in 2000/1, and the global financial crisis 2007/8 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, yet, the effect might not yet be fully reflected in the data (figure 1).

In order to compare average growth levels over longer periods of time, Table 1 contains average yearly growth rates for varying periods of time. As can be seen in the table, stock market returns are higher than growth rates for all countries and sub-periods, except for Japan during 1988-1998 and 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.

4 Econometric analysis

4.1 Econometric approach

Even though theoretical considerations suggest a stochastic trend in GDP data as well as in stock market data, the Augmented Dickey Fuller (ADF)-tests does confirm this expectation: real stock market indices and real GDP are not always detected as instationary of order 1 [I(1)] over all sub-periods, as can be seen in the results for the ADF-test in the appendix. The ADF test has been conducted with intercept and (with and without) trend, as most data series indicate a trending behavior. The Akaike information criterion has been used for selecting the appropriate lag length. Especially GDP seems to be characterized by deterministic trends during the analyzed periods. This implies that the precondition for using cointegration approaches based on the Engle-Granger two-step procedure or the Johansen cointegration test are violated.

We therefore 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

	Canada*		**Germany**		**France***	
	Stock return	GDP growth	Stock return	GDP growth	Stock return	GDP growth
1991-2019	8.4	4.4	7.9	2.8	7.8	3.1
1991-2021	8.8	4.4	8.0	2.7	8.0	3.0
1980*-1998	10.0	4.0	13.9	5.3	12.9	4.5
1991-2008	7.9	5.0	6.8	2.5	6.5	3.8
2001-2019	7.3	4.1	5.4	2.7	5.0	2.6
2001-2021	8.1	4.2	5.8	2.6	5.6	4.2
	Italy		**Japan***		**United Kingdom***	
	Stock return	GDP growth	Stock return	GDP growth	Stock return	GDP growth
1991-2019	4.7	2.8	2.5	0.4	7.2	4.1
1991-2021	5.0	2.7	3.1	0.3	8.0	4.2
1980*-1998	13.5	9.5	-4.0	3.0	15.8	6.9
1991-2008	5.9	4.0	-1.2	0.3	6.7	4.5
2001-2019	3.4	1.7	4.3	0.3	4.7	3.7
2001-2021	3.9	1.6	5.0	0.2	6.2	3.8
	United States					
	Stock return	GDP growth				
1991-2019	9.7	4.5				
1991-2021	10.6	4.6				
1980*-1998	16.8	6.5				
1991-2008	6.7	5.1				
2001-2019	8.0	4.0				
2001-2021	9.5	4.1				

*Remarks: The table portrays average yearly growth rates of the total return stock market index and nominal GDP (based on quarterly data). *) 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).

series being I(0), I(1) or mutually cointegrated. 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), we mainly concentrate on using GDP as the dependent variable and stocks as the explanatory variable[2] in an error correction model (ECM): an autoregressive distributed lag (ARDL) model that also contains the long-run relationship. This is what we call the basic model. Lag length is selected based on AIC, as the PSS-test is sensitive to serial correlation in residuals (Pesaran et al., 2001). Once this leads to a model with autocorrelation in residuals, we re-run the regression with a fixed lag lenths of six lags for both variables. If we do not have evidence for autocorrelation in residuals, we first check if the FPSS-test indicates a stable relationship in levels. Once this is the case, we continue by evaluating if the t-test indicates an adjustment to long-run levels.

Due to the trending data, we conduct the PSS-test for the case of a constant with and without trend. Yet, the trend is mostly insignificant, such that the two test specifications lead to similar conclusions about the existence of a long-run relation. The appendix therefore only presents the results for the case without trend.

When testing for an asymmetric relationship between GDP and stocks, we follow the approach advanced by Shin and Yu (2005): We first construct two series out of the former stock index: starting with the first observation, series one contains only positive changes (and keeps the former value until the next positive change), series two only contains negative changes (and again keeps the former value until the next negative change is added). Both newly constructed series replace the former stock variable in the ECM model. We then first check as before, if there is evidence for a long-run relationship and if we find significance for adjustment to that long-run relationship, before we test with an F-test for significance of asymmetric effects.

We also test three alternative extensions of the basic model by adding a third variable to the long-run relationship: foreign demand,[3] the profit share,[4] and long-term interest rates.

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

[3]Foreign demand is approximated by taking a trade weighted average of the remaining G7 countries. Trade weights are based on 5yr moving averages over trade shares derived from the IMF Direction of Trade Statistics.

[4]The profit share is gross operating surplus relative to the sum of gross operating surplus and compensation

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

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

We use the return on government bonds with a remaining maturity of 10 years or more as a proxy for the discount rate. While we show the results for including foreign demand and the profit share, we do not show it for the long-term interest rate, as it does not seem to improve the regression. Probably due to the global decrease in long-term rates during our period under study, this variable seems to have a similar effect to including a deterministic trend in regressions.

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 periods: 1991-2019, 1991-2008 and 2001-2019.

4.2 Regression results

According to the results of the Pesaran et al. (2001) bounds testing approach, we have little evidence for stable long-run relationships between the stock market index and domestic GDP in each G7 country, respectively. This can be seen in Table 2 that summarizes the findings. Filled squares indicate evidence for a long-run relationship for the respective model specification. The appendix provides more detailed explanations. For Germany, Japan, 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, UK and Japan

of employees in the national accounts.

during 1991-2012. The few evidence of long-run relationships is restricted to sub-periods: a symmetric relationship for Germany during 1991-2008 for the basic model, for Japan during 2001-2019 for the basic symmetric and asymmetric model as well as the extension by foreign GDP, and for the US an asymmetric relationship of the basic variables in both sub-periods. For Italy, we can not find any stably relationship for the three different periods, whatever the specification of the model.

Canada and France are the only countries for which we find evidence of a co-integration relation between the stock index and GDP for the main period and for both sub-periods: We can reject the null hypothesis that there is no long-run relationship in levels (by using critical values assuming that all variables are I(1)), the estimated adjustment coefficient to the long-run relationship is negative and significantly different from zero, and coefficients for the estimated long-run relationship have the expected positive sign. Allowing for an asymmetric reaction of GDP to positive versus negative changes in stock prices does not seem to be important, as we already find a stable relationship by assuming a symmetric reaction, and coefficient estimates do not differ in a significant way according to an F-test. Adding foreign demand or the profit share to the long-run relationship does not improve the regression; 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.

4.3 Discussion of results

We find little 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.

Our hypothesis that such a relationship nevertheless exists but may be camouflaged by an asymmetric reaction (GDP reacting differently to positive changes in stock prices than negative ones) has to be rejected. We can neither find 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 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. Yet, the period is characterized by several shocks (that we do not control for). We can neither control for the combined effect of all mentioned structural changes due to limited data points.

5 Conclusions

We focus on analyzing 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 seems to be more adequate regarding stochastic properties of the data. This 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) given the global shocks during this period that 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 global 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 basic 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 as indicated by Alexius and Spång (2018), 3) the profit share, and 4) long-term interest rates.

Based on the bounds testing approach developed by Pesaran et al. (2001), we find little evidence for stable long-run relationships between the stock market index and domestic GDP in each G7 country, respectively. For Germany, Italy, Japan, UK and the US, there is no evidence of a stable long-run relationship for the whole period 1991-2019, whatever the specification of the model. This is in line with findings by Binswanger (2004) for G7 countries as well as M. K. Hossain and A. Hossain (2015) for the US, UK and Japan. Canada and France are the only countries for which we find evidence of a co-integration relation between the stock index and GDP for the main period and for both sub-periods, and based on the basic model. As a consequence, we do not find evidence for any of our four hypotheses. Yet, we cannot exclude that this is due to the combined effect of several changes during the period 1991-2019.

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Appendix: 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)
F-statistic; significance of H0: 'no level relationship' in paranth.	1.794 (>10%)	0.4606 (>10%)	13.30 (1%)	2.643 (>10%)	5.059 (10%)	2.523 (>10%)	2.636 (>10%)
LM test up to 6 lags finds no serial corr. (probability >10%)	true	true	true	true	true	true	true
Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth.	-0.035 (>10%)	-0.0062 (>10%)	-0.043 (1%)	-0.039 (>10%)	-0.11 (10%)	-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)	0.164 (3.29)	0.0539 (1.66)	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, 1, 5)	*ARDL(6, 6, 6)*	ARDL(6, 1, 3)
F-statistic; significance of H0: 'no level relationship' in paranth.	5.882 (2.5%)	0.5840 (>10%)	10.75 (1%)	1.691 (>10%)	3.272 (>10%)	1.037 (>10%)	2.513 (>10%)
LM test up to 6 lags finds no serial corr. (probability >10%)	true	true	true	true	true	false	true
Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth.	-0.13 (1%)	-0.027 (>10%)	-0.091 (1%)	-0.040 (>10%)	-0.11 (>10%)	-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)	0.156 (3.12)	0.0184 (0.558)	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)	0.151 (2.72)	0.0225 (0.719)	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)
F-statistic; significance of H0: 'no level relationship' in paranth.	1.626 (>10%)	1.687 (>10%)	5.125 (5%)	0.6915 (>10%)	3.483 (>10%)	0.8537 (>10%)	3.384 (>10%)
LM test up to 6 lags finds no serial corr. (probability >10%)	true	true	true	true	true	true	true
Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth.	-0.053 (>10%)	-0.011 (>10%)	-0.17 (2.5%)	-0.026 (>10%)	-0.12 (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)	0.145 (1.63)	0.0237 (0.923)	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)	0.0747 (0.296)	0.0524 (1.15)	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, 2, 4)	*ARDL(6, 6, 6)*	ARDL(5, 2, 1)	*ARDL(6, 6, 6)*
F-statistic; significance of H0: 'no level relationship' in paranth.	2.255 (>10%)	1.835 (>10%)	7.366 (1%)	1.942 (>10%)	2.366 (>10%)	2.892 (>10%)	2.997 (>10%)
LM test up to 6 lags finds no serial corr. (probability >10%)	true	true	true	true	true	true	false
Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth.	-0.034 (>10%)	-0.0085 (>10%)	-0.040 (1%)	-0.042 (>10%)	-0.093 (>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)	0.112 (2.06)	0.0712 (1.75)	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)	-0.000104 (-0.00756)	0.0120 (1.73)	-0.0244 (-1.67)	0.00740 (0.316)

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(3, 2)	ARDL(5, 6)	ARDL(1, 1)	ARDL(5, 3)
F-statistic; significance of H0: 'no level relationship' in paranth.	7.092 (2.5%)	3.373 (>10%)	5.231 (10%)	1.121 (>10%)	5.321 (10%)	2.039 (>10%)	0.5579 (>10%)
LM test up to 6 lags finds no serial corr. (probability >10%)	true	true	true	true	true	true	true
Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth.	-0.056 (2.5%)	-0.089 (>10%)	-0.037 (5%)	-0.033 (>10%)	-0.17 (5%)	-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)	0.165 (2.53)	-0.0367 (-1.34)	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(5, 0, 2)	*ARDL(6, 6, 6)*	ARDL(1, 1, 0)	ARDL(5, 0, 3)
F-statistic; significance of H0: 'no level relationship' in paranth.	10.46 (1%)	5.762 (2.5%)	6.483 (1%)	1.807 (>10%)	3.407 (>10%)	8.555 (1%)	7.734 (1%)
LM test up to 6 lags finds no serial corr. (probability >10%)	true	true	true	true	false	true	true
Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth.	-0.33 (1%)	-0.31 (1%)	-0.16 (1%)	-0.12 (>10%)	-0.17 (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)	0.0528 (1.97)	-0.0455 (-0.700)	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)	-0.0383 (-0.914)	-0.0444 (-0.919)	-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)
F-statistic; significance of H0: 'no level relationship' in paranth.	5.508 (5%)	1.795 (>10%)	7.626 (1%)	0.8682 (>10%)	2.251 (>10%)	6.908 (1%)	0.2749 (>10%)
LM test up to 6 lags finds no serial corr. (probability >10%)	true	true	true	true	true	true	true
Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth.	-0.23 (1%)	-0.17 (>10%)	-0.33 (1%)	-0.10 (>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)	-0.00422 (-0.0904)	0.00648 (0.252)	-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)	0.799 (4.25)	0.139 (2.68)	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, 2, 0)	*ARDL(6, 6, 6)*	ARDL(5, 2, 2)	ARDL(5, 3, 0)
F-statistic; significance of H0: 'no level relationship' in paranth.	5.076 (5%)	5.567 (2.5%)	3.699 (>10%)	3.499 (>10%)	4.089 (>10%)	2.953 (>10%)	0.8295 (>10%)
LM test up to 6 lags finds no serial corr. (probability >10%)	true	true	true	true	false	true	true
Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth.	-0.041 (2.5%)	-0.23 (1%)	-0.036 (10%)	-0.040 (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)	0.140 (2.18)	-0.00841 (-0.149)	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)	0.0646 (1.33)	0.00344 (0.334)	-0.0342 (-2.37)	0.0597 (1.66)

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(5, 2)	ARDL(1, 0)	ARDL(4, 0)	ARDL(6, 0)
F-statistic; significance of H0: 'no level relationship' in paranth.	1.783 (>10%)	5.506 (10%)	9.843 (1%)	3.365 (>10%)	4.798 (10%)	5.736 (5%)	11.60 (1%)
LM test up to 6 lags finds no serial corr. (probability >10%)	true	true	true	true	true	true	true
Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth.	-0.078 (>10%)	-0.046 (5%)	-0.063 (1%)	-0.086 (>10%)	-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)	0.0822 (2.21)	0.0645 (2.74)	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(5, 1, 0)	ARDL(1, 0, 0)	ARDL(4, 0, 0)	ARDL(6, 3, 3)
F-statistic; significance of H0: 'no level relationship' in paranth.	6.691 (1%)	4.454 (10%)	9.554 (1%)	4.117 (>10%)	5.281 (5%)	3.779 (>10%)	6.631 (1%)
LM test up to 6 lags finds no serial corr. (probability >10%)	true	true	true	true	true	true	true
Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth.	-0.27 (1%)	-0.073 (5%)	-0.16 (1%)	-0.12 (5%)	-0.29 (2.5%)	-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)	0.0861 (3.01)	0.0825 (5.34)	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)	0.0922 (3.50)	0.0998 (5.33)	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(3, 0, 1)	ARDL(4, 0, 3)	ARDL(1, 0, 6)	*ARDL(6, 6, 6)*
F-statistic; significance of H0: 'no level relationship' in paranth.	2.038 (>10%)	6.258 (2.5%)	2.069 (>10%)	1.248 (>10%)	2.864 (>10%)	4.257 (10%)	3.357 (>10%)
LM test up to 6 lags finds no serial corr. (probability >10%)	true	true	true	true	true	true	false
Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth.	-0.11 (>10%)	-0.063 (1%)	-0.12 (>10%)	-0.049 (>10%)	-0.19 (>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)	0.128 (2.26)	0.0822 (2.39)	-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)	-0.0708 (-0.395)	-0.183 (-1.53)	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, 0, 6)	ARDL(1, 0, 1)	*ARDL(6, 6, 6)*	*ARDL(6, 6, 6)*
F-statistic; significance of H0: 'no level relationship' in paranth.	0.5086 (>10%)	9.602 (1%)	8.711 (1%)	6.960 (1%)	5.868 (2.5%)	7.678 (1%)	6.776 (1%)
LM test up to 6 lags finds no serial corr. (probability >10%)	true	true	true	true	true	false	false
Coeff. of CointEq; signific. of H0: 'no level relationship' in paranth.	0.021 (>10%)	-0.16 (1%)	-0.085 (1%)	-0.14 (1%)	-0.095 (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)	0.0832 (4.28)	0.0551 (1.63)	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)	0.00481 (0.970)	0.0381 (2.07)	0.0294 (2.23)	0.00435 (0.809)