EMPIRICAL INVESTIGATIONS INTO SYSTEMIC RISK, ECONOMIC GROWTH AND INTERDEPENDENCE OF FACTORS IN FAMA-FRENCH FIVE FACTOR ASSET PRICING MODEL

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ABSTRACT

This dissertation consists of three chapters all of which are empirical investigations of various aspects of the financial markets aimed on developing practical recommendations for investors, regulators and other market participants to improve risk and return characteristics of their portfolios.

In Chapter 1 analysis of the interdependence of the factors in the Fama-French five-factor asset pricing model is presented. The model posts various challenges for its application as it is qualitatively different from the two currently used models: Fama-French three-factor model and CAPM. One of these challenges is interdependence of the factors. I applied panel vector autoregression methodology to address this issue. The analysis revealed number of important results that offer valuable insights for the investors who are using Fama-French five-factor asset pricing model for their portfolio formation.

Chapter 2 is dedicated to the analysis of the systemic risk based on Minsky's financial instability hypothesis (Minsky, 1992). Among a great variety of ideas regarding financial system stability, the "Financial instability hypothesis" gained significant popularity after the Global Financial Crisis because it was able to explain the nature of the crisis way before it. Although Minsky's work provides a detailed conceptual description of the reasons for instability of the financial system, it does not offer an applied system of measures that would signal about the potential crisis. This Chapter aims to close this gap by providing such a measure – Systemic Risk Index (SRI).

In Chapter 3 is an empirical investigation of a popular topic of macroeconomic impact of the financial markets. The Global Financial Crisis (2008) triggered a new wave of research on the topic (Jacobs and Mazzucato, 2016; Foroohar, 2016; Stiglitz, 2012; Stiglitz, 2016; Turner, 2015a; Turner, 2015b) suggesting that the structural changes that took place in the financial system in the late 1980s and early 1990s have fundamentally changed the impact the financial system has on the overall economy. The aim of this Chapter is to empirically test if the relationship between financial system capital and economic growth changed in the US in the last three decades.

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LIST OF ABBREVIATIONS

CAPM – Capital Asset Pricing Model

CDO - Collateralized debt obligations

CPI – Consumer Price Index

CRSP – Center for Research in Security Prices

DDM – Dividend Discount Model

FF3 – Fama-French Three-Factor Asset Pricing Model

FF3 – Fama-French Five-Factor Asset Pricing Model

FSC – Financial System Capital

FSG – Financial System Growth

GDP – Gross Domestic Product

GMM – Generalized Method of Moments

IRF(s) – Impulse-Response Function(s)

JRCEC – Joint Research Centre-European Commission

OLS – Ordinary Least-Squares

P/E – Price / Earnings per Share Ratio

PE&VC – Private Equity & Venture Capital Funds

PVAR – Panel Vector Autoregression

S&P – Standard & Poor's

SRI – Systemic Risk Index

VAR – Vector Autoregression

CHAPTER 1. INTERDEPENDENCE OF THE FACTORS IN FAMA-FRENCH FIVE-FACTOR ASSET PRICING MODEL. EVIDENCE FROM PANEL VAR[1]

1.1 Introduction

There is significant interest in the literature in statistical models that are focused on characterizing average stock returns. Most recognized of those models are Capital Asset Pricing Model (CAPM) of Sharpe (1964) and Lintner (1965) and Fama and French three-factor model, FF3, Fama and French (1993). Recent major developments in the field include Novy-Marx (2012) and Fama-French five-factor model, FF5, Fama and French (2016). While CAPM and FF3 are relatively simple and had fewer issues related to interdependence of the factors, FF5 is more complicated, and understanding patterns and fundamental reasons of factor interdependence offers practical advantages for investors who use the model to form their portfolios. The issue was addressed in the original paper Fama and French (2016) using correlation analysis and comparative analysis of portfolios formed using various criteria; however, this was just a first step in the interdependence investigation. Our paper offers a deeper analysis of the interdependence of the factors using panel vector autoregression technique (PVAR). Our analysis allows for not just identifying correlations but understanding the directions of the mutual impacts as well as their patterns in time. This analysis adds value for investors who use FF5 for their portfolio formations.

[1] Co-authored with Yiwen Yang, assistant professor in Soochow University, Taiwan

Majority of the asset pricing models used, including FF3 and FF5, are based on CAPM, Sharpe (1964):

$$R_{it} – R_{Ft} = \alpha_i + \beta_i(R_{Mt} – R_{Ft}) + e_{it} \quad (1.1)$$

and Fama-French three-factor model:

$$R_{it} – R_{Ft} = \alpha_i + \beta_i(R_{Mt} – R_{Ft}) + s_i SMB_t + h_i HML_t + e_{it} \quad (1.2)$$

where R_{it} is the return on portfolio i for period t, R_{Ft} is the risk-free return, and R_{Mt} is the return on the market portfolio (value-weighted). β_i (known as Beta) is a measure of systematic risk of a portfolio; SMB_t is "small minus big", the difference between the returns of a portfolio of the small stocks and the returns of a portfolio of the big stocks. HML_t is "high minus low", the difference between the returns of a portfolio with high Book-to-Market ratio (here and after referred as Value) and low Value stocks, and e_{it} is a zero-mean residual.

CAPM being a one-factor model naturally does not pose any interdependence issues. FF3 has Beta, book-to-market and Size. Beta is a theoretical concept that is not observable outside in particular asset price model, so is not considered in the analysis of the interdependence. Book-to-market and Size naturally might have a certain level of interdependence by construction through market capitalization. However, such type of relationship has little practical value for building investment strategies as there is just one channel of impact – through market capitalization.

Opposite to the factors that characterize specifics of the market demand, there are fundamental factors. Those are the factors that determine the stock price based on certain economic theory, most commonly on Dividend Discount Models (DDM), described, for example, in Brealey, Myers, and Marcus (1995). DDM links stock price to dividends and interest rate. Dividends are linked to operational performance of the company, in particular, profitability. Naturally, fundamental factors have a certain level of interdependence as they all are related to the operational performance of the company.

Novy-Marx (2012) establishes profitability as one of the major factors in explaining returns, which creates confusion as profitability is at the same time one of the major fundamental factors determining the stock price. This is seemingly a paradoxical result: if markets are efficient then current prices should reflect the fair value of stocks that are predominantly calculated using dividend discount models which are based to large extent on profitability. Then how could profitability be a good predictor of future returns as it should be already accounted for? It turns out that the market consistently underestimates the fact that currently profitable companies tend to be profitable in future as well, Novy-Marx (2012). Exploiting this tendency allows investors to generate excess returns. Here it is important to understand that fundamental analysis is forward-looking while models explaining stock returns are based on historical data. So, although profitability plays a key role in both types of models it is a different profitability. DDM is based on future expected profitability, and Novy-Marx (2012) is based on historical analysis of profitability.

Novy-Marx (2012) findings along with some other new developments were incorporated in FF5. Fama-French five-factor model:

$$R_{it} – R_{Ft} = \alpha_i + \beta_i(R_{Mt} – R_{Ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + e_{it} \quad (1.3)$$

Where RMW_t is "robust minus weak", the difference between the returns of a portfolio of stocks with robust and weak profitability. CMAt is "conservative minus aggressive" which stands for the difference between the returns of a portfolio of the stocks of firms with low and high investments. The rest of the parameters are the same as described above for (1.2).

Thus, FF5 became a mix of three old market factors from FF3 and two new fundamental factors: profitability and investments. Combining such factors in one model naturally raises questions about their interdependence as one can expect that a firm's performance (measured by profitability or/and investments) should have an impact on its value and size. In fact, Fama and French talk a lot about it while introducing the FF5 model (Fama and French, 2016). Their analysis is based on the correlation analysis of the performance of the portfolios formed based on various combinations of the factors. However, correlation analysis is very limited in its description of the interdependence of the factors, and this motivated us to investigate the problem further.

In our paper, we use panel vector autoregression (PVAR) model to capture this interdependence. PVAR allows for dealing with simultaneity as well as illustrates reaction of the factors to each other in time. Although our results are not directly comparable with the correlation analysis in the Fama and French (2016) as we analyze factors directly and their focus is on portfolios constructed using those factors, comparison of the results still adds value to the literature.

In this paper, we use PVAR as described in Love and Zicchino (2005); Abrigo and Love (2015); Holtz-Eakin, Newey, and Rosen (1988). This methodology combines the benefits of panel data analysis with traditional VAR and allows treating all variables as endogenous (traditional VAR) and also allows for unobserved individual heterogeneity (panel-data approach).

There are a few valuable advantages of panel VAR compared to methods used in previous works. First, VAR has significantly fewer strict requirements for the structural model prior to the analysis. The only assumption that is required prior to the analysis is the ordering of the time of the impacts. Ordering means that shocks originated in one variable affect other variables in some specific time order. The ordering of the variables in this paper is discussed later in 1.3. Empirical methodology.

Second, VAR is specifically developed to address the issue of endogeneity which is a serious problem for multifactor asset price models. In VAR, all variables are treated as endogenous; that allows for capturing their interdependence without the need to pre-define the relationship.

Last but not least, impulse-response function as the essential part of VAR analysis can capture the mutual impact of the variables in time. As VAR is an extension of the autoregression model, it contains lags of all variables and investigates how their interdependence develops with time. These dynamic effects would not have been captured by the cross-sectional regression that is commonly used in asset pricing. This is quite important for portfolio formation as allows for estimating how long the shock in one variable will affect other variables. For example, panel VAR analysis allows answering questions like how long shock in profitability will have an impact on average returns, etc.

Our analysis revealed a few important results. First, using impulse-response functions (IRFs), we analyze the impact of all the factors on returns. Specifically, Profitability has long-lasting significant impact on Returns which is further evidence to the results found in Novy-Marx (2015) that serial correlation in profitability is behind returns momentum phenomena. Next, we analyze impact of Investments on Returns which has a similar pattern to the one Profitability has on Returns but weaker. This result expands on the findings of Aharoni, Grundy, and Zeng (2013) by illustrating a pattern of the response of Returns to the shock in Investments. Analysis of Value confirmed a significant and long-lasting impact of the factor on Returns, but it also revealed an issue related to the fact that Value is measured by the book-to-market ratio that includes market capitalization that often has the same source of variation as Returns. Although Value was proven to be valuable for investment strategies formation (Fama and French, 1993), it is problematic to use it for short-term strategies that are based on the analysis of the shocks. If a positive shock in Profitability is likely to transfer into positive Returns, positive shock in Value might be just a result of the negative returns in the current period (negative returns result in decrease of market capitalization that will increase book-to-market ratio). Although Value and Profitability have similar impacts on Returns, due to this issue Profitability is more suitable for the investment strategies based on analyzing shocks.

Second, also by using IRFs, we analyze interdependence of the factors. Mostly we are interested in the interdependence of Profitability, Investments, and Value to determine which of the factors has more impact on the others. The analysis revealed that Profitability has a visible impact on both Investments and Value while neither Investments nor Value has an impact on it which makes Profitability the most influential factor among all. This provides additional evidence to the idea that Profitability might be behind the momentum phenomena (Novy-Marx, 2015). Investments and Value have a very interesting relationship as described in Aharoni, Grundy, and

Zeng (2013). Basically, an increase in Investments is aimed at increasing Value (through increasing book value of equity) but is likely, at least in short and medium terms, to decrease it. This happens due to the market anticipation of the future increased book value of equity, so earlier increase of the market capitalization decreases the Value. Our results confirm this intuition illustrating significant negative impacts of the shock in the Investments on Value. The impact of Value on Investments is unambiguous as argued in Aharoni, Grundy, and Zeng (2013) as it might come from change in market capitalization as well as from change in book equity. Our results illustrate a weak positive impact which supports the findings in Aharoni, Grundy, and Zeng (2013)[2].

Further, we use variance decomposition to analyze which factors are better in explaining returns. The factors are able to explain only 10% of the variation of returns. This poor result is, however, consistent with the literature, including Fama and French (2016). It is a common believe that it is impossible to model stock returns. This stylized fact stands behind typical methodology of the analysis when factors are not analyzed directly but rather are used to form portfolios; then portfolios performance is analyzed. Factors themselves might not be capable to explain the returns, but they still allow for forming portfolios that can outperform the market. Variance decomposition also allows us to capture one important issue that is related to the measurements used. Returns, Size and Value are all directly influenced by the stock price change which leads to the illusion that one factor can explain a significant part of the variation in another two. To avoid this problem specifically in explaining Returns, Returns is placed first in the model specification ordering (for details see Empirical Methodology below). Then, the issue will be only with

[2] As our methodology is different, results are not directly comparable.

significant power of Returns to explain Size and Value, but these relationships are not of particular interest.

All together our results support the previous findings and expand the literature by providing new information about the direction and time patterns of the impacts of the factors that affect shareholders' returns.

The reminder of this Chapter is structured as follows. In section 1.2, we describe the data used in this research. In section 1.3, the empirical methodology is discussed. Section 1.4 is where the results are shown and analyzed, and section 1.5 is the conclusion.

1.2 Data

In our empirical analysis we define the factors that we analyze in the same way as they were defined in FF5 model. Profitability is defined as net profit margin; investments is defined as assets growth; value is measured by the book-to-market ratio; size is measured by the market capitalization and returns are shareholder's returns. All indicators are firm-level, estimated quarterly, from 1967 to 2016. Data is drawn from COMPUSTAT and CRSP databases and merged using a common identifier. The following short names are used in the PVAR coding: Profw (Profitability), Iw (Investments), BMw (Value), DSizew (Size) and Rw (Returns).

It is important to distinguish factors from portfolios formed using certain factors. Typical FF5 application is to form portfolios and compare their performance. Our goal is to investigate interdependence of the factors, we analyze factors directly.

We used asymmetric winsorizing procedure for data cleaning. Details could be found in Appendix A.1. Summary statistics are presented in Table 1.

Table 1. Summary statistics

Variable	**Obs**	**Mean**	**Std. Dev**	**Min**	**Max**
Profitability	82419	0.0742	0.3912	-1.2823	0.5958
Investments	77613	0.0155	0.0872	-0.2633	0.2377
Value	82419	0.6929	0.6694	0	4.2636
Size	82419	3.1255	5.6984	0.00001	22.4721
Returns	77436	0.0540	0.2920	-0.5593	1.3843

Table 2. Correlation matrix

	Profitability	*Investments*	*Value*	*Size*	*Returns*
Profitability	1				
Investments	0.2057	1			
Value	0.0221	-0.1017	1		
Size	0.0266	0.1016	-0.0782	1	
Returns	0.0292	0.1390	-0.1317	0.3635	1

1.3 Empirical methodology

The main benefit of panel VAR is that it allows for treating all variables as endogenous and at the same time also allows for unobserved individual heterogeneity (panel-data approach). We specify our model as follows:

$$z_{it} = \Gamma_0 + \Gamma_1 z_{it-1} + \Gamma_2 z_{it-2} + \Gamma_3 z_{it-3} + \theta_t + F_i + e_{ti} \quad (1.4)$$

where z_i is five-variable vector {Profitability, Investments, Value, Size, Returns} as defined in Table 1; Γ_{it} – coefficient matrixes; θ_i – time effects; F_i – fixed effects variables introduced to allow for individual heterogeneity in the levels of variables (Love and Zicchino, 2005) necessary for correct application of VAR methodology to panel data; e_{ti} – errors. The model is estimated by system GMM as in Abrigo, Love (2016).

One of the advantages of VAR is the possibility of including lags. We have chosen to include one lag as financial markets are quite fast to respond to shocks. We also estimated the model with three lags in our robustness check and find no difference for major results.

Panel VAR also allows for time differencing effects t_i which are included in the model (2.4) to capture any macro shocks that affected all companies in the same way.

The major benefit of VAR analysis is that it can estimate the impact of the shock in one variable on another variable while keeping the rest of variables constant, known as orthogonal shocks estimation. This is done using impulse-response functions. However, as the variance-covariance matrix of the errors is usually not diagonal, to isolate shocks of one variable in the system we need to decompose the residuals in such a way that they will be orthogonal. This is achieved by setting up the specific ordering, allocating any correlation between the residuals of any two variables to the one that comes first in the ordering. This procedure is equivalent to transforming the system in a recursive VAR for identification purposes (Hamilton, 1994), also known as Cholesky decomposition of variance-covariance matrix of residuals.

The identifying assumption of such ordering is that the variable that comes earlier in the ordering affects the following variables simultaneously. The variables that come later have impact on previous variables only with a lag of one period. In our specification we assume that the market will react faster to the information shock. An example of such a shock could be a release of the new product: it is likely that market will react to the news of the new product release before the actual release while fundamental factors will react with delay, after the new product will be sold. As known from previous literature Returns are forward-looking indicators (Fama and French, 1988) which means returns should go first in the ordering. As mentioned above, there is issue with the construction of Value and Size measures (they both are based on market capitalization which directly respond to price increase) that results in over-reporting the ability of the indicator that comes first to explain the indicator that follows. Same issue of over-reporting due to construction is with the impact of Returns on both Size and Value. However, these relationships are of little research interest in general and is not the main focus of this analysis. We will use Returns->Size->Value ordering as our main choice, and, in our robustness check, we test Returns->Value->Size order of these three variables to check if the results hold. Fundamental factors will react with a lag. Among the fundamental factors we believe profitability will react faster than investments to the information shock described above. It is reasonable to assume that in case of launching new successful product the company will first experience the increase in profitability and only later increase in investments as it takes time for the investments to become fully operational. To summarize, the ordering for the main model will be the following: Returns->Size->Value->Profitability->Investments.

IFRs are a graphical representation of the response of one variable (response variable) to a one standard deviation shock in another variable (impulse variable) along 10 periods. IRF also show 95% confidence intervals of the response that are generated using 100 Monte-Carlo simulations[3]. The matrix of impulse-response functions is obtained from estimation of VAR coefficients and so their standard errors should be considered. As analytical standard errors are difficult to calculate we use Monte Carlo simulation to obtain them.

Along with IFRs, variance decomposition is a major part of VAR analysis as it illustrates the explanatory power of variables by showing what part of the variance of one variable could be explained by shocks of other variables accumulated over time. We provide the total effect accumulated for 10 periods.

All variables are tested for stationarity using Fisher-type unit-root test based on augmented Dickey-Fuller tests. All variables are proven to be stationary except for Size. Thus, Size is taken in first differences while other variables enter the model in levels.

Finally, to minimize the influence of outliers, we applied 2-stage data cleaning procedure. First, we deleted all cross-sectional data where at least one of the observations was missing. Then

[3] Limited number of simulations is used due to limited processing power available. Key results, however, were tested with 1000 simulations and no major differences were found.

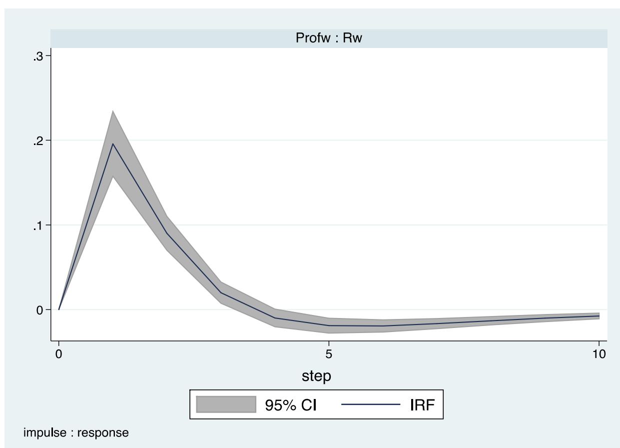
winsorizing was applied. Because of asymmetric distribution of the raw data, we applied asymmetric winsorizing to all the variables (1% and 5%). (For details see Appendix A.1).

1.4 Results

We estimate the model (1.4) and present the results in the form of impulse-response functions and variance decomposition.

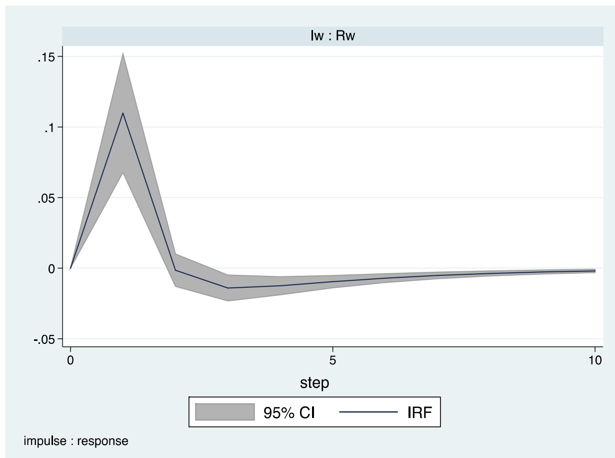
First, we analyze impulse response-functions. Each graph represents the response of one variable (response) to the one standard deviation shock in another variable (impulse) over the period of ten quarters (as we are using quarterly data). X-axis represents time periods while Y-axis shows response measured in the units of the response variable.

Figure 1. IRF. Profitability-> Returns



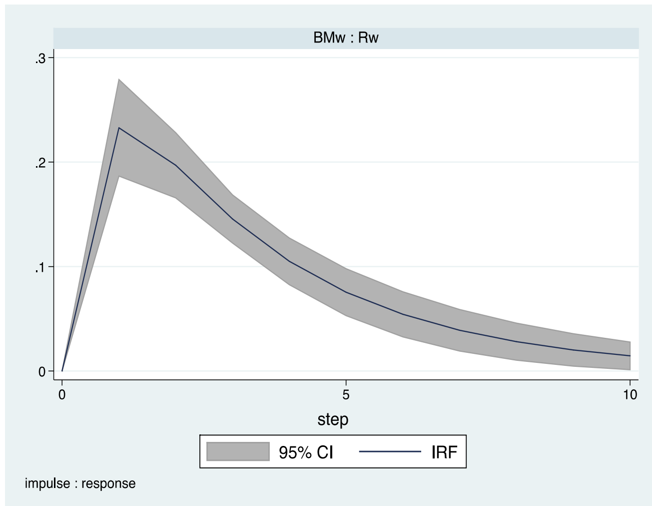
Relationship between Profitability and Returns is of particular interest due to Novy-Marx (2013, 2015). Specifically, in Novy-Marx (2015) it was shown that there is serial correlation in profitability, meaning that shock to profitability is persistent in time and companies that are highly profitable today will be highly profitable tomorrow. At the same time market usually follows conservative forecasts about profitability. This phenomenon was used to explain the returns momentum phenomena, arguing that returns momentum is not some special market characteristic but is, to a large extent, driven by fundamental momentum in profitability. Our analysis supports the findings in Novy-Marx (2015). Figure 1 illustrates the long-lasting response of returns to the shock in probability. Such a pattern gives investors some time to reevaluate portfolios after the shock in profitability and potentially get extra returns.

Figure 2. IRF. Investments-> Returns



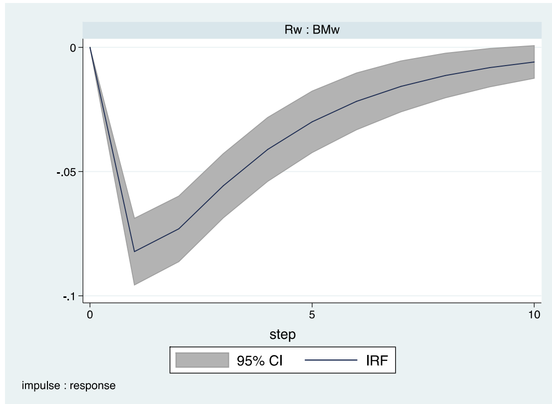
The relationship between investment and returns is harder to study as they might go both directions, as studied in a number of studies, in particular, in Aharoni, Grundy, and Zeng (2013). Increase in investments is likely to result in an increase of the book value of equity as argued in (Fama and French, 2016) and increase the book-to-market ratio. At the same time, the market is likely to react positively to investment increases earlier than the actual impact on book value of equity appears, which will drive book-to-market down, making the stock less appealing for the investors. Overall Aharoni, Grundy, and Zeng (2013) found a weak but statistically significant relationship between investments and returns. Our results presented in Figure 2 supports this previous finding: impact of investments is significant but, compared to profitability, is shorter and with wider confidence intervals.

Figure 3. IRF. Value->Returns



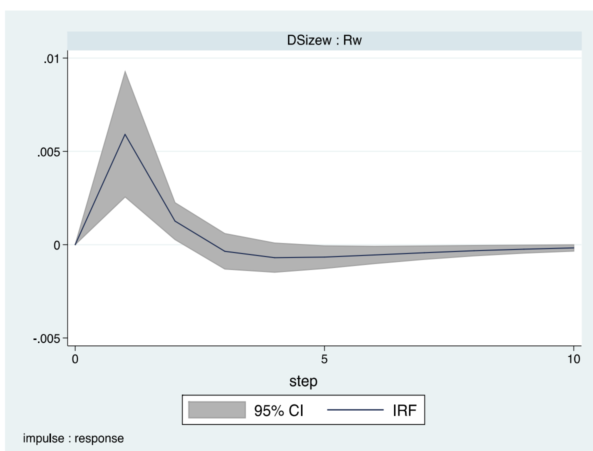
Relationship between Value and Returns is one of the most studied (in particular, as a factor in FF3) and practically used by investors, so the results in Figure 3 are not surprising: increase in Value has long-lasting impact on Returns. For example, if there is unexpected positive shock to equity (due to increased profits) this will increase Value and motivate not only short-term investors (who react fast to the market news) but also strategic growth investors (for whom it takes some times few periods to reevaluate portfolios) to invest in the company. Another important part of our analysis is comparison between the factors. Specifically, comparing the patterns in Figure 1 and 3 we can see that Profitability and Value have very similar patterns which makes it hard to determine which one is better. It is quite interesting result considering that some researchers argue that profitability is the most “powerful” factor (Novy-Marx, 2015) in explaining Returns while since FF3 it is more common to see Value as the most “powerful” factor. Partly, this result could be attributed to the way Value factor is defined: book-to-market ratio has market capitalization in it which is naturally effected by the price change. The problem becomes more clear when we analyze how Value is used in investment strategies. There are two main drivers that may increase Value and motivate investors to invest. The first one is unexpected (not priced by the market) increase in book value of equity (most often through higher than expected reported profits). Book value goes up while market value is flat and that makes company more valuable. In this scenario there are no issues related to the construction. The second scenario is when there is negative “speculative shock”, meaning that fundamentals of the company remains unchanged but for some reason there is selloff of the stocks and the market capitalization goes down which makes the company more valuable. Now, in this case current Returns are negative while expected future returns are positive (basically expectations are that the price bounces back to its fundamental value). Typically, the analysis is done by forming portfolios using factors as sorting criteria. For example, certain cut off for the Value is chosen, so that investors buy only stocks with high value. In this case, the stock before the selloff would not be in the portfolio and only after the price drop and Value will increase the stock will appear in the portfolio. While in our case, as we analyze direct relationship between the factors, the total impact of the shock in Value on Returns is measured (as if we had the stock in the portfolio for the whole time). This has a “construction” issue that price drop will increase Value but decrease Returns. This issue is illustrated more clearly on Figure 4 where impact of Returns on Value is illustrated.

Figure 4. IRF Returns->Value



While Figure 4 illustrates impact of Returns on Value we should consider these results with caution as most likely significant part if not all of the impact is due to the construction problem described above. Price drop effects Returns and Value simultaneously. We can see that the impact (measured on Y-axis in the units of the response variable) is significantly smaller compared to the impact of Value on Returns which reinforces our belief that Figure 3 accurately captures the impact of Value on Returns.

Figure 5. IRF. Size->Returns



In FF3 it was shown that Size is an important factor for explaining the Returns as small companies tend to generate higher, more volatile returns (Fama and French, 1993). However, in more recent studies (for example, Van Dijk, 2011) it was shown that the Size premium has disappeared (and sometimes is reversed, depending on the time periods analyzed) that is explained mostly by the rise of the institutional investors in recent decades and the fact that institutional investors are low-risk investors and mostly invest in large established companies (Van Dijk, 2011). In our impulse-response analysis, shock in Size has small positive impact on Returns, however, it could be attributed to construction issue mentioned above: both variables will be affected by the price change simultaneously (price increase will increase the Returns and Size at the same time).

One of the main applications of PVAR is investigating simultaneity which is crucial for this analysis. Specifically, we are interested in interdependence of Profitability, Investments and Returns.

Figure 6. IRF. Profitability-> Investments.

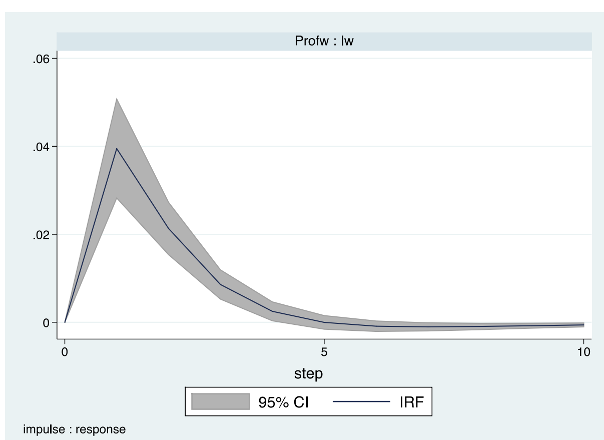
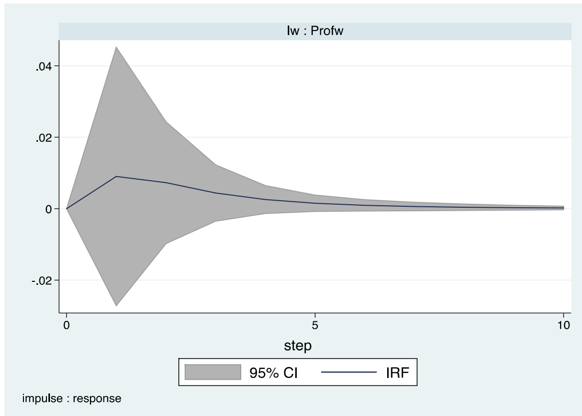


Figure 7. IRF. Investments-> Profitability



The relationship between profitability and investments is fundamentally unambiguous. On one side profitable companies tend to invest more as they have more resources for the investments (Hubbard, 1997). On the other side the primary reason for investments of mature companies is expansion and equity growth, but that does not necessary improve profitability (Aharoni, Grundy, and Zeng, 2013). Most of mature companies invest not in creating new capital assets but rather in acquisitions of other companies, building vertical and horizontal integration. This directly increases equity of the company. As for profitability it depends on each particular case but in general there are no proven channels to increase profitability through expansion (unless the company is successful in building monopoly but there are severe regulatory restrictions for such expansions). In the correlation analysis of FF5 portfolios (Fama and French, 2016, Table 4. Panel C) the correlation between the returns of portfolios formed on profitability and investments was -0.11, indicating a slightly negative relationship. FF5 analysis captures only the second situation as they have selected only highly profitable companies (so companies that had low profitability and then experienced increase in it and, so, are likely to increase investments, are not selected in the portfolios). Our analysis helps to break down the impacts. As we can see on Figure 6, impact of profitability on investments is positive and significant that confirms the idea that more profitable companies invest more. At the same time impact of Investments on Profitability is insignificant which confirms skepticism about the impact of the increase in Investments on Profitability. This is a great illustration of the benefits of PVAR as opposite to correlation or simple regression analysis. It illustrates that both ideas described above are not mutually exclusive and could be true at the same time.

Figure 8. IRF. Profitability-> Value

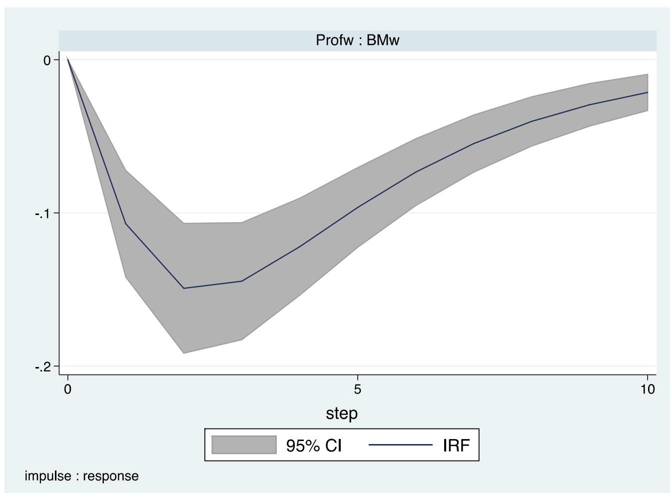


Figure 9. IRF. Value-> Profitability

Another important fundamental relationship is between Profitability and Value. As mentioned in Fama and French (2016) it is unusual for a highly profitable company to offer high Value at the same time as this would mean that there is company with strong fundamentals but undervalued by the market. Such a company would be attractive to any type of investors unless there is certain credible reason that the company will not be able to maintain its profitability in future or there are some serious management problems with it. There might be some rare cases of such a company to exist but on average it is a very unlikely situation. In fact, in the FF5 cross-section of the two factors there was not a single large company with that characteristic. This means that increase in Profitability must result in decrease in Value. The opposite situation is, however, relatively common: companies might have low profitability and offer low value at the same time. This happens if the company is associated with low (or decreasing) risks and considered to be a safe asset, then investors ready to accept lower profitability and will value the company high anyway. This means that negative shock in Profitability is not necessary followed by the increase of Value. However, in aggregate as presented in Figure 8 one can see that shock in Profitability leads to inverse shock in Value which means that the first type of relationship described above is more common. At the same time as seen in Figure 9 shock in Value does not have significant impact on Profitability which makes sense as market factors are not expected to have impact on fundamental factors (meaning there is little impact of market value of the company on its operating activity). In the FF5 the correlation between the two factor-based portfolios was 0.08 (Fama and French, 2016, Table 4. Panel C) which shows again the benefits of PVAR that allows for the impacts separation.

Figure 10. IRF. Investments-> Value

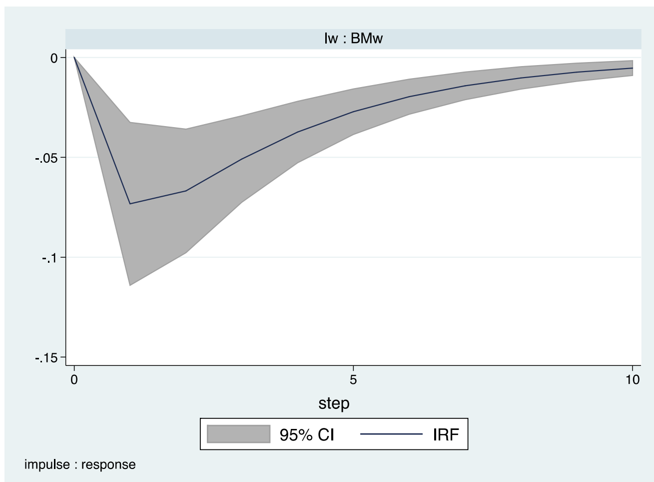
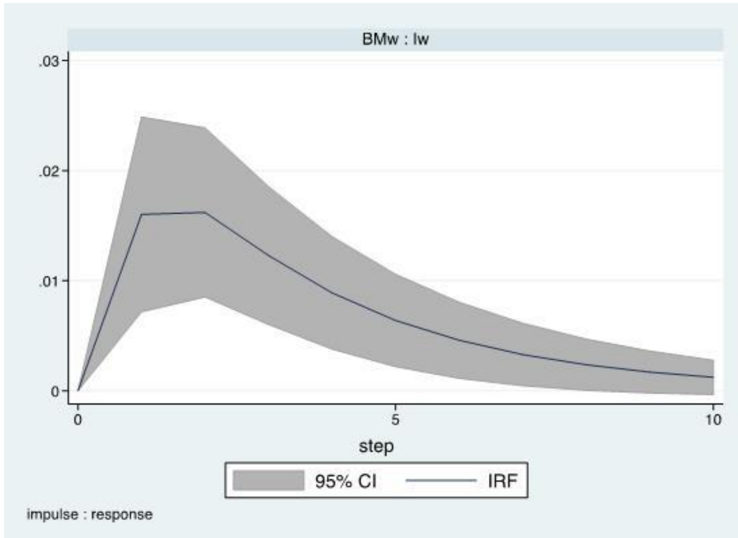


Figure 11. IRF. Value-> Investments



As described in Aharoni, Grundy, and Zeng (2013) and mentioned above, Investments and Value have two channels of impacts that go in opposite directions. Investments, specifically through acquisitions, are aimed at increasing the book value of equity, but the market prices such an increase and market capitalization also goes up. This means Value could go either way depending on how optimistic the market is about the investment. The average effect is hard to predict. Aharoni, Grundy, and Zeng (2013) found a weak positive relationship in their analysis. However, in FF5 correlation analysis the returns of the portfolios based on Value and the portfolios based on investment have an impressively high correlation of 0.7 (Fama and French, 2016, Table 4. Panel C). This means that companies with high value tend to make larger investments. This is explained by the idea that companies with high value (meaning that they are undervalued by the market) do not want to stay undervalued and so try to improve the situation by the increase in investments. Our analysis presented in Figures 9 and 10 are in line with the previous results. We can see a weak positive impact of Value on Investments which illustrates an idea that higher Value is associated with an increase of investments. This was first explained by

Tobin (1982) with the introduction of the "Tobin's Q theory of investments": if the Value is high it is relatively cheaper for the company to finance investments (through additional stock issuance), so it will invest more. The Figure 9 shows a negative impact of Investments on Value which corresponds to the same logic: companies with high value make investments to become less undervalued by the market. And when they do that, they indeed become more appreciated by the market and their Value goes down.

As a part of the robustness check, we used alternative ordering to check if the results hold, and the impulse-response patterns described above hold (for details see Appendix A4.)

Impulse-response analysis is complemented by the variance decomposition analysis which illustrates explanatory power of the variables. Table 3 summarizes the results.

Table 3. Variance decomposition (cumulative for 10 periods)

Response variable	**Impulse Variable**				
	Returns	Size	Value	Profitability	Investments
Returns	0.90	0.00	0.07	0.02	0.01
Size	0.14	0.85	0.00	0.01	0.00
Value	0.43	0.00	0.55	0.02	0.00
Profitability	0.01	0.00	0.01	0.98	0.00
Investments	0.03	0.00	0.02	0.04	0.91

As we can see overall, all variables have little explanatory power to characterize variation in returns. Only 10% of variation is explained as could be seen in Table 3. (first line), 7% of which is attributed to the Value and is mostly due to construction as was explained above. This is in fact a common result in the literature, as it is close to impossible to build a factor model that would capture a significant amount of variation of the returns. That is the motivation in FF3, FF5 and most of other asset pricing models to compare factor-based portfolio returns rather than factors themselves (Fama and French, 1993). It is also worth mentioning that by construction Returns, Size and Value are tightly related through the stock price. For example, all else being equal, if the price goes up, Returns and Size will go up as well while Value will decrease. This misleadingly resulted in high explanatory power of Returns over the variation of Size (14%) and Value (43%. Table 3, line 2 and 3). This result entirely depends on the ordering of the variables in the PVAR model. As Returns go first the analysis indicates that it can explain significant portion of the variation in Size and Value, however, all the variation in reality is caused by the price changes. In our robustness test we checked alternative ordering, and the variable that goes first among these three picks up this property (for details see Appendix A4).

All together our results expand the literature by providing new information about the direction and time patterns of the impacts of the factors that affect shareholders returns. Our analysis particularly favors Profitability as it affects Returns directly and through other factors. Value along with Profitability is confirmed as a reasonable factor to build investment strategies on; however, because market capitalization is a part of book-to-market measure of Value, it is rather problematic to estimate what part of the impact is due to the fundamental reasons (based on the idea that market price of the stock tends to catch up with its fundamental value) and what part is because of construction of the estimators.

1.5 Conclusion

In this paper we apply the panel vector autoregression technique to factors from the Fama-French five-factor asset pricing model to identify interdependence of the factors as well as returns response patterns to the shocks in the factors. The analysis revealed a number of interesting results that expand asset pricing literature, specifically works on Profitability, Value and Investments as factors for investments strategies development. We identified that Profitability affects Returns directly and through other factors as well. This result expands on previous findings of Novy-Marx (2013, 2015) that Profitability is major factor explaining returns. At the same time, we identified that by construction Value has certain issues as a factor for stock returns. Although our analysis confirmed a significant impact of Value on Returns, the fact that market capitalization is a part of Value measure is problematic for the impact analysis.

On a practical side, our results could be used in portfolio reevaluations. While Fama and French (1993, 2016) and Novy-Marx (2013, 2015) works are applied for portfolio formation, our approach allows an alternative, potentially more efficient, way for portfolio reevaluation. Impact-response analysis that we use offers investors an opportunity to reevaluate portfolios in reaction to shocks which is a less costly option. The idea is that investors form initial portfolios following FF5 or any other similar model but then reevaluate portfolios based on shocks to the factors. For example, if there is positive shock to Profitability this triggers additional investments in this stock. However, to prove validity of such a strategy, testing is required. This test would include formation portfolios, their reevaluation based on shocks and comparison of this strategy to simple FF5 strategies. This testing goes beyond the scope of this paper and offers opportunity for further research.

CHAPTER 2. SYSTEMIC RISK INDEX: AN APPLICATION OF THE FINANICIAL INSTABILITY HYPOTHESIS

2.1 Introduction

Financial system stability is one of the cornerstones of sustainable economic development and one of the major economic policy goals. However, during the last two decades, the global financial system has experienced two major financial crises: the Dot-com bubble and the Global Financial Crisis. Both had their origins in the US, a low-risk, developed country. In both cases markets, regulators, and economists were unable to predict and effectively prevent them (Lagarde and Yellen, 2015). Ten years after the Global Financial Crisis, economists still disagree on the measures that are needed to prevent similar crises in the future. This could be seen in the discussion about the Dodd-Frank Act that was adopted as a regulatory response to the crisis. One set of works including Acharya, Pedersen, Philippon, and Richardson (2017) argue that the adopted measures are enough to prevent similar crises in the future. Another set of works including Turner (2015a, 2015b), Varoufakis (2016) and Jacob and Mazzucato (2016) argue that the measures taken are not sufficient. There is also a strong political movement aimed at repealing the Dodd-Frank Act led by the current US Secretary of Treasury, Steven Mnuchin who argues that the regulation is limiting economic growth (Sorkin, November 30, 2016).

Among a great variety of ideas regarding financial system stability, the “Financial instability hypothesis” gained significant popularity after the Global Financial Crisis because it was able to explain the nature of the crisis way before it happened (Minsky 1986, 1992). To illustrate how valuable this theory has become, it is worth quoting then Fed Chairman Janet Yellen who, during the height of the financial crisis, said at a keynote address: “Suffice it to say that, with the financial world in turmoil, Minsky’s work has become required reading.” Yellen (2009). Although Minsky’s work provides a detailed conceptual description of the reasons for instability of the financial system, it does not offer an applied system of measures that would signal about the potential crisis. This paper aims to close this gap by providing such a measure – Systemic Risk Index (SRI).

Before getting into the details of the financial instability hypothesis, it is important to introduce some concepts and look briefly at other approaches that have been used to measure systemic risk.

According to Kaufman and Scott (2003), “systemic risk refers to the risk or probability of breakdowns in an entire system, as opposed to breakdowns in individual parts or components, and is evidenced by co-movements (correlation) among most or all the parts” (p. 371). However, measuring systemic risk as a probability leads to significant challenges of its estimation due to the nature of this risk. Although financial crises happen relatively often, there are different types, and each type is a relatively rare event, and estimating the probability of rare events is a well-known challenge (King and Zeng, 2001). To avoid this challenge, it is common in the literature to look at the deviation of various indicators from their normal values as a measure of risk (Acharya, Pedersen, Philippon, and Richardson, 2017). The same approach is dominant in the set of banking regulations known as “Basel III” (BIS, 2017). The SRI introduced in this paper is also based on this logic.

There are research studies from different fields of economics and finance that address the problem of identifying an increased probability of a financial crisis. Benoit et al. (2017) serves as a good summary of various approaches and the gaps between them. Besides, the problem itself is different depending on whether the financial crisis had its origins in the economic crisis or not. Although the focus of this research is on the crisis that originated within the financial system, specifically asset price bubbles, findings from studies on economic crises that had led to collapse of a financial system also provide valuable insights for this work. Furthermore, the research on financial crises could be divided into the following groups: works in neoclassical macroeconomic tradition, papers in Keynesian tradition, papers originated in econometrics and data analysis, and works related to the central bank financial supervision.

Among the works on financial crises caused by economic imbalances, Kaminsky and Reinhart (1999, 2000) provide the most useful insights. Their work is focused on balance of payments and currency crises. Although my research is focused on situations without any balance of payment issues, it is worth noting that Kaminsky and Reinhart (1999, 2000) show that measures of leverage are useful indicators of economic crises. This is due to the fact that banking loans serve as a transition mechanism through which the crises becomes systemic. The same logic for the same reason is also applied in Minsky’s work (Minsky, 1992) which serves as a theoretical basis for this research. Therefore, in this paper, leverage indicators are also used in the construction of the SRI. Although the motivation for using leverage in the systemic risk estimation in SRI comes from a different theory, it is important to indicate the similarity between our works.

Next, a significant amount of work was done by econometricians who applied innovations in data analysis methods to develop, indicators of financial stability that could signal about potential financial crises. Specifically, the Recession Index and Index of Leading Economic Indicators were introduced in Stock and Watson (1989). A more advanced approach using dynamic factor models was introduced in Stock and Watson (2010). Although these models have a lot of benefits and might be useful for general analysis of economic stability, they are based on different assumptions about the dynamics of the financial system and origins of the crisis. Stock and Watson's (2010) methodology assumes that all variables in the model share a common factor that drives their behavior; this factor is usually the unobserved business cycle. However, Minsky's framework assumes capital flows in different markets are independent and crises are caused by an asset price bubble in one market, while the other markets show no signs of stress. This type of behavior was seen during the Dot-com bubble and Global Financial Crisis. In both cases, the asset price bubble was limited to just one part of the financial system (IT stocks and mortgage derivatives respectfully). There are, however, similarities between the two methodologies: when the bubble burst the entire system ran into stress through money market and leverage channels. Therefore, leverage risk across the system is used in both approaches.

Another group of literature on this topic originated from the analysis of the central bank regulatory functions. In this dissertation, this type of research is called institution-specific risk analysis. Economists in this group try to identify a set of indicators to measure systemic risk generated by each institution in the system separately and then estimate the level of interdependence of the institutions. This approach is backed-up by the existing regulatory structure that historically appeared to oversee financial stability. The Federal Reserve System and the central banks all over the world focus their resources on identifying and preventing such institution-specific threats. There was a substantial amount of publications in the last decade on the systemic risk estimation using the "by institutions" approach[4]. However, all these works have a significant drawback: due to complex accounting it is essentially impossible to estimate effectively the systemic risk even of a single bank. Acharya, Pedersen, Philippon, and Richardson (2017) serves as a summary of previous findings and introduces a system of indicators that could potentially estimate the systemic risk of a single bank; however, it is a set of qualitatively different indicators that are not integrated. Having couple of dozens characteristics for each of the banks in the system makes the estimation of the entire system stability very difficult. On top of these hardships, there is a high level of interdependence of the financial institutions through various channels in the system which creates notable synergy that is very difficult to estimate (Acemoglu, Ozdaglar, Tahbaz-Salehi, and Alizera, 2015). Another approach was introduced in Rodriguez-Moreno and Peña (2013). Their focus is on the use of Credit Default Swaps (CDS) as indicators of the systemic risk. Although, by design CDS are a great indicator of the rising risks, as was shown in Lewis (2015), CDS pricing is far from fair as it is an over-the counter market where sellers define their prices arbitrarily. As an example, in 2008 many CDS on MBS (Mortgage-backed securities) did not change in price even when the underlying MBS price dropped significantly.

On a practical side of measuring financial stability, the most common indicators of a country's financial stability are sovereign credit ratings and US Fed Stress Indexes (for the US). The main problem with the sovereign credit ratings is that they estimate the risk of a default of the government, and financial crises do not necessary influence the ability of a county to repay its

[4] Acemoglu, Ozdaglar, Tahbaz-Salehi, and Alizera (2015); Acharya and Naqvi (2012); Acharya, Pedersen, Philippon, and Richardson (2017); Brownlees and Engle (2016); Bernal, Gnabo, and Guilmin (2014); Fostel and Geanakoplos (2012); Lehar (2005); Sabato (2010); Sherbina (2013); Wang and Wen (2012).

debt, especially if the debt is denominated in the local currency, as in case of the US, and there are no currency risks. For developing countries with large borrowings in foreign currencies the risks are quite related to each other as shown in Kaminsky and Reinhart (1999). The US kept its highest credit rating during the Global Financial Crisis from all of the Big Three rating agencies and lost its S&P Rating in 2011, when there was no financial crisis but problems with approving the federal budget. This clearly indicates that systemic risk and government default risks are two different things for the US.

The same could be said about the Fed Financial Stress Index. The index is based on data from banking balance sheets and does not capture the market sentiments (that are important for the systemic risk estimation as explained further in the text). Below at Figure 12, you can see the dynamics of one the most popular among the stress indexes: St. Louis Fed. One can see that the Dot-com bubble is completely ignored, and the index started reacting to the Global Financial Crisis right in the middle of it.

Figure 12. St. Louis Fed Financial Stress Index

Finally, there is a vast amount of literature on financial stability developed in the neoclassical macroeconomic tradition aimed at illustrating that financial markets are inherently stable, including Bernanke and Gertler (1989), Colander et al. (2009); De Nicolò and Lucchetta (2011). However, after the Global Financial Crisis in 2008, this approach was criticized by researchers from other groups. Keynesian economists, who disapproved of this approach long before the crisis, were the most critical.

According to Keynesian economists (Keynes, 1936; Minsky, 1986; Marcuzzo 2017), the main weakness of the neoclassical approach to monetary policy and managing financial crises is reliance on the quantity theory of money (Friedman, 2017). This theory resulted in a belief that financial crises appear only if the central bank "prints too much money", so central banks, including the US Federal Reserve System (Fed), were persuaded that no crisis would happen as long as they monitored the quantity of money they created (Marcuzzo, 2017). The Keynesian approach is based on the idea that our financial system is a credit system and with the central bank serving as the lender of last resort that can provide credit when needed. Such a system becomes subject to a liquidity risk – risk of not meeting your payment commitments at a certain point in time (Minsky, 1992). And unlike financial crises caused by "printing too much money" and inflation, liquidity crises require much more work from the central bank to prevent them. The idea of liquidity crises itself is not new and can be traced to Keynes (1936) and Copeland (1952), however, it was Minsky (1986, 1992) who developed an economic theory based on it. This theory links liquidity problem to the business cycle framework introduced in Keynes (1936). Hyman Minsky showed that financial assets amplify the business cycle as demand for the financial assets grow faster than the economy during the growth part of cycle and falls faster during the recession (Minsky, 1986, 1992). In his work, Minsky argued that this pattern along with the existing money market structure where the central bank acts as a lender of last resort, supplying liquidity to the market when needed, creates the foundation for financial instability. For example, certain risk-loving agents at the market will borrow short-term capital at the money market (usually as short-term as overnight) and invest in various long-term financial assets. In case of a price drop of those financial assets (known as an asset price bubble burst) those agents will not be able to refinance and will collapse causing a systemic crisis (through not being able to repay debts to low-risk lenders, which will collapse as well unless the central bank interferes). To avoid this type of crisis, the central bank should monitor not only banking system stability but the entire financial system (Minsky, 1986, 1992) and not only in current time but also with respect to the future commitments.

According to Minsky the best way to identify liquidity crises is to use the flow of funds methodology introduced by Copeland (1952); however, that approach would require knowing all future monetary commitments of all the agents in the system (including banks, nonbanking financial institutions, firms and households). Although some pieces of this information are available, there is no centralized way to gather and process this information. Besides, there is also substantial international demand for the US dollar which should be accounted for. Due to these reasons this approach has never been developed and Minsky’s theory left without an applied methodology to support it. This could be one of the main reasons why the theory has not become a part of common practice in the monetary policy. However, a number of recent works, including Yellen (2009), Hodgson (2009), Palma (2009) and Perez (2009), Turner (2015a, 2015b), Foroohar (2016), Jacob and Mazzucato (2016), Mazzucato (2017) linked Minsky's theory to the Global Financial Crisis, and the interest in the theory reemerged.

This research is an attempt to develop an applied indicator that would be able to signal about potential Minsky-type financial crises. According to Minsky (1992) there are two major processes that precede this type of financial crisis: substantial increase of leverage in the system (leverage risk) and asset price bubble. Asset price bubbles are characterized by what is defined in this paper as structural risk. The logic behind this definition is that an asset price bubble is the result of an incorrect structure of capital allocation: overinvestment in one type of assets and underinvestment in all others. This paper attempts to estimate the level of these two risks.

Leverage risk is the risk of not being able to repay the borrowed capital. One of the very few ideas in Economics on which economists of different backgrounds seem to agree on is the idea, first postulated by Keynes (1936) and later expanded by Minsky (1992) and supported by Reinhart and Rogoff (2009), Turner (2015a) that financial crises are always associated with the excessive amount of debt and overly optimistic expectations about the future. Those two processes are interdependent: optimistic expectations motivate people and firms to borrow more money, borrowed money is usually spent on consumer goods or financial assets, the stock market and GDP rise, and optimism continues to increase until the bubble is large enough to burst.

It is also important to mention that debt is crucial for the financial crisis to become systemic as it links aggressive speculators with low-risk financial institutions (Minsky, 1986). In fact, after the Great Depression of the 1930s, in accordance with Keynes' idea, a legal boundary (known as the Glass-Steagall Act) was established between the capital market and banking system to prevent such type of borrowing. This boundary was essentially eliminated in 1998 opening a path to a higher level of interdependence of banking system and capital markets.

The second source of the systemic risk is structural risk which is introduced in this paper based on the intuition provided in Minsky (1992). In this paper I define structural risk as the risk of excessive investments into speculative assets which are the assets that are not expected to generate higher cash flow from operating activities but expected to be of higher demand for any other reason (most often historical performance is such a reason: investors are focused not on future cash flow but on historical performance of an asset[5]). Contrary to speculative, there are value assets (those that are expected to increase their price due to higher cash flow from operating activities). In practice, any asset could be speculative, and speculation is often triggered by value investments. A good example of such a pattern is the Dot-com bubble. Prior to the bubble many IT companies were reasonably expected to generate a significant increase in cash flow, so they attracted value investors. This resulted in a very good performance of the companies' stocks that attracted speculators which created a bubble and boosted valuations. The peak P/E (price-to-earnings ratio) of some companies was over 100 with historical market average at 12.

There are a couple of other challenges that should be addressed while developing an indicator of the systemic risk: financial system definition and integration process of different risks.

[5] Prior to Dot-com bubble there was common belief that values of IT companies can only go up; prior to Global Financial Crisis, investors believed that real estate prices can only go up, etc. Both believes were based on historical performance rather than on fundamental analysis of future cash flows.

Defining the financial system itself is a challenge as there are different financial markets to consider. Developed financial systems, like the one in the US, consists of the following markets: stock, bond, derivatives markets, and banking and private equity (including venture capital). Each of the markets is a source of the systemic risk. Ignorance of the systemic risk even in the smallest one could lead to a crisis like the Dot-com bubble in early 2000s[6].

In terms of the markets, most of the research focus including Acemoglu, Ozdaglar, Tahbaz-Salehi (2015) and Acharya, Pedersen, Philippon, and Richardson (2017) is on the banking system stability. There are a number of studies about stock market stability including Keynes (1936), Minsky (1992), Chirinko and Schaller (1996). Other markets are largely ignored due to a lack of data and methodology. In this research, banking (only mortgage, consumer and business loans), stock, and bond (sovereign, municipal, corporate non-financial and corporate financial) markets are considered together which makes it more inclusive than the previous works on this topic. As explained below, I assume that despite their differences, each of the three markets is analyzed have the same sources of systemic risk: leverage risk and structural risk.

Another challenge is whether to combine different risk measures into one single indicator of systemic risk or to have separate indicators. I personally believe that financial stability could be achieved not so much through certain imposed regulations but through market awareness about the level of systemic risk and its sources. If a vast amount of investors in the market knew the true risks behind mortgage-backed securities, it is unlikely that so many of them would have invested in those securities. This idea could be traced to Keynes (1936), Minsky (1986) and

[6] Most IT companies that caused the Dot-com bubble were funded up to their IPOs by the venture capital funds which form the smallest of the financial markets by capitalization.

many other works that are focused on the importance of expectations in the financial markets. For this purpose, I believe it is much more beneficial to have a single indicator of systemic risk (even with flaws that appear while integrating different types of risk measures into one) as such an indicator has a greater chance to be used by wide range of investors. SRI as a single country-wide systemic risk indicator is created using three levels of integration: standardizing all risk estimators to one scale, so they become comparable; combining balanced estimators into SRI for each market separately (SRI Stocks, SRI Bonds and SRI Banking); combining the three market-level SRIs into an aggregated SRI.

The developed indicator was applied to the US data for the period 1962-2016. While the Results section offers a detailed illustration of the SRI and its components, I would like to summarize the key findings here. First, SRI spikes precede each major financial crisis in the US during the period analyzed which opens the opportunity to use the SRI as a crisis predictor. However, to claim SRI as a crisis predictor, thorough econometric tests are needed to identify the level of confidence with which spikes in the SRI precede a crisis). For those tests to be conclusive one would require more data. Specifically, I would use US firm-level data (SRI is designed to make it possible) and use SRI not only as an indicator of the systemic crisis but also as a risk measure of each individual financial asset. This is a feasible way to test how confident one can be that a substantial increase. This is a feasible way to test how confident one can be that a substantial increase in the SRI for each asset would precede its significant drop in value. I would suggest testing one and two standard deviation increases. This extension goes beyond the scope of this paper and is left for further research.

Another valuable result is that the average systemic risk level in the last two decades is significantly higher than before. Even after the Global Financial Crisis, the risk remains high. With regard to specific markets, SRI Stocks is the most volatile with clear spikes prior to the Dot-com bubble and Global Financial Crisis. In recent years, the risk is declining although the level of the risk is still high. SRI Bonds is currently the major source of concern in financial system stability. In the period of 2001-2007, the systemic risk is driven by MBS, but after that SRI Bonds are now growing on the increased risks of the sovereign bonds. As for banking, there was a significant spike in SRI Banking during 2001-2010, signaling about a potential crisis and the risk index declined afterwards.

To summarize, the SRI is introduced in this paper, an attempt to develop an application of Hyman Minsky's financial instability hypothesis that could be used by wide range of market agents and regulators to identify potential instabilities. Although the developed index does not contain all the possible risks described in the hypothesis (specifically timing of leverage risks is left out) and the application is not based on firm-level data (that does not allow it to be tested thoroughly), I believe the SRI framework can be a useful contribution to the literature on systemic risk estimation.

The rest of the Chapter is structured as follows: 2.2 covers the methodology of the SRI; in 2.3, I describe the data used; 2.4 is dedicated to results description; and in 2.5, I draw conclusions and explicate the Chapter's contribution to the literature on financial stability.

2.2 Methodology

To create a single, country-wide estimator of systemic risk, it is first necessary to estimate the leverage and structural risks for different types of financial assets separately. In this research the following types of financial assets are analyzed: stocks, bonds, and banking loans. Bonds are divided into sovereign, municipal, corporate non-financial, and corporate financial bonds. As for banking loans, due to data and methodological limitations, only three types of loans are analyzed in this paper: business, consumer, and mortgage.

Leverage risk estimation is straightforward. Debt-to-equity is commonly used for stocks; Debt-to-GDP is used for sovereign, municipal and corporate non-financial bonds[7]; and Debt-to-Income (Household Income) is used for bonds of financial corporations (essentially banks) and banking. The logic behind the last one is that one of the major risks for the banking system is non-performing loans that heavily depend on household income dynamics, while the leverage level of the banks is under tight regulation of the central bank and is rarely the source of problems. Therefore, Debt-to-Income does not characterize the ability of banks to repay their debts but, rather, the ability of banks' clients (specifically households) to repay their debts to the banks. That makes sense, considering the fact, that 85% of bank loans are directly or indirectly (like investments in MBS) dependent on household income (Turner, 2015a; Foroohar 2016).

As for the structural risk, different indicators are used for each of the three markets analyzed.

[7] Ideally, for the corporate bonds it would be best to use debt-to-equity, however, those data are not available to the author at this point

Stock market structural risk is estimated using the most common fundamental value indicator, P/E. A higher P/E ratio indicates higher level of optimism at the market. This optimism could have various reasons: some are fundamental (for example, expectations of higher economic growth entering the growth period of economic cycle) and some are speculative (as explained above, they are usually based on expectations that the past growth will continue). In this case, historical average serves as a good indicator of whether market valuations (P/E) are driven by speculative motives or not. Let's say P/E riches historical maximum, does this correspond with the best economic conditions ever recorded? Most likely it is not and so those high valuations are not justified. Needless to say that it is common practice of stock valuation to compare the current indicators to the historical average for this exact purpose (CFA Institute, 2017). There is a notion about P/E: it stops being meaningful during the crisis periods when earnings drop significantly or become negative, and P/E explodes. It no longer indicates market sentiments and practically is not used for valuations during such times (CFA Institute, 2017). To address this issue P/E is capped at 50 in the years of the Dot-com bubble and the Global Financial Crisis[8].

Structural risk of banking is measured by the ratio of mortgage (M) and consumer (C) loans to business (B) loans. This is a new indicator introduced in this paper, and it is based on the intuition introduced in Turner (2015a, 2015b) and further analyzed in Foroohar (2016). Business loans are the type of loans that are aimed at creating new value and are usually associated with an increase of the future cash flow. At the same time, mortgage and consumer loans are

[8] Alternatively, Shiller P/E could be used, however this would make SRI less sharp in reaction to changes of risks (Shiller P/E uses 10Y average earnings).

associated with consumption and do not directly generate additional income (especially with large amount of consumption goods being imported).

As for the bonds market, the structural risk is ignored in this paper due to lack of methodology. Conceptually, there should be different indicators for each type of bond. Structural risk of sovereign and municipal bonds depends on fiscal policy effectiveness and ability of the government and municipalities to generate additional income in future. There are no accepted indicators of such quality. As for corporate non-financial bonds, with some exceptions they all are associated with future income. Corporate financial bonds are in general hard to link to a specific activity, so it is difficult to define structural risk for this type of assets, even conceptually.

Below in Table 1 you can see the summary of the indicators.

Table 4. Financial System Risks

Risks/Assets	**Stocks**	**Corp NF**	**Sov & Muni**	**Corp F**	**Banking**
Structural	P/E	N/A	N/A	N/A	(M+C)/B
Leverage	Debt-to-equity	Debt-to-GDP	Debt-to-GDP	Debt-to-income	Debt-to-income

Another challenge in constructing an aggregated indicator of the systemic risk is integration. In this work one of the standard approaches to constructing composite indicators is used. According to JRCEC (2008), the main challenges of constructing composite indexes is standardizing variables and selecting the weights. In this paper one of the proposed methods is used. First, to address different absolute values and ranges of the different indicators that are used, all of them are standardized using z-score method:

$$Zi = \frac{Xi - Xav}{S}$$

Where Zi are assigned z-scores, Xi – observations, Xav – average of the Xi and S – standard deviation of the sample. After standardization, all risk measures have the same mean, equal to zero, and the same standard deviation, equal to one (Menard, 2004).

The next step is to construct SRI for each of the three markets. Standardized measures of structural and leverage risks are combined using addition.

SRI Stocks:

$$SRI\ Stocks = \frac{P}{E} + \frac{Debt}{Equity}$$

SRI Bonds:

$$SRIbonds = \frac{Csov}{Cbonds} * \frac{Csov}{GDP} + \frac{Cmuni}{Cbonds} * \frac{Cmuni}{GDP} + \frac{Ccnf}{Cbonds} * \frac{Ccnf}{GDP} + \frac{Ccf}{Cbonds} * \frac{Ccf}{Income}$$

Where Cbonds, Csov, Cmuni, Ccnf, Ccf stand for total capitalization of the respectful market. Logically, Cbonds = Csov + Cmuni + Ccnf + Ccf. Income is total household income. All bonds but corporate financial bonds are measured relatively to GDP. Corporate financial bonds are measured relatively to household income as banks (which are dominant issuers of those bonds) depend more on household income dynamics than on GDP (as majority of bank loans are to the households).

SRI Banking:

$$SRI = \frac{(M + C)}{B} + \frac{(Cbanking)}{Income}$$

SRIs for the three markets above are combined into one aggregated SRI using a capital-weighted average, so markets with larger capital have larger weights in the aggregated SRI. This method has certain issue: market capitalization of the stock market increases during the asset price bubbles and so, stock market increases its share in the SRI. Usually, it is also accompanied by the increased SRI Stocks and so, overall SRI will be exaggerated. However, I believe that is a minor drawback as the goal of the SRI is to signal about potential problems assuming they are further investigated, and some exaggeration of those problems is not critical to this goal.

SRI (aggregated):

$$SRI = \frac{Cstocks}{TC} * SRI\ Stocks + \frac{Cbonds}{TC} * SRI\ Bonds + \frac{Cbanking}{TC} * \text{SRI Banking}$$

Where Cstocks is total capital of the stock market and Cbanking is total amount of the loans outstanding (only mortgage, consumer and business loans are considered); TC is total capital of the financial system and is equal to Cstocks + Cbonds + Cbanking.

2.3 Data

Bonds, income, and banking loans data are from Federal Reserve Bank of St. Louis database; stock market data are from COMPUSTAT database, and GDP data are from BEA (US Bureau of Economic Analysis). All data are annual.

Table 5. Summary statistics

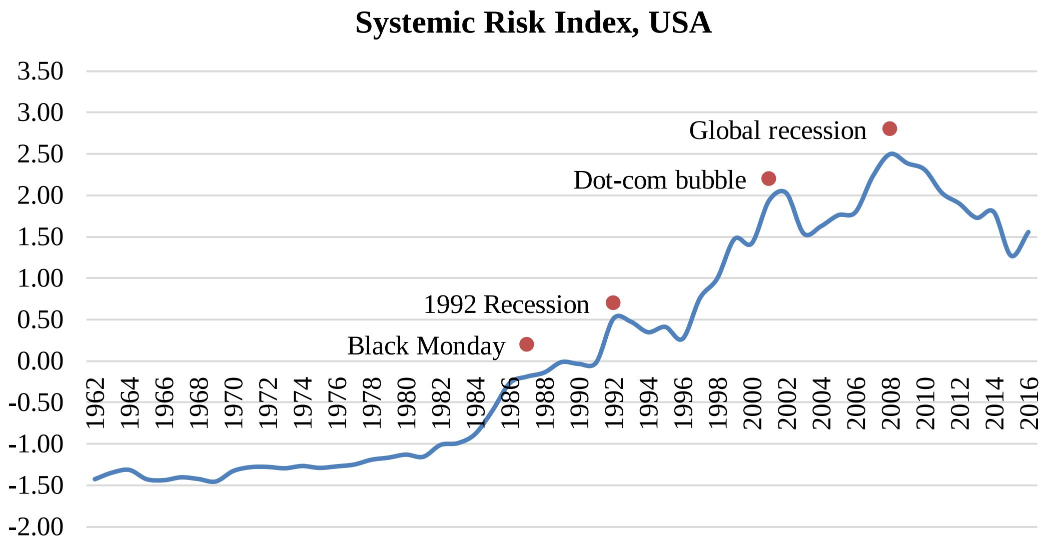
	# obs.[9]	Min	Max	Mean	StDev
P/E	70	0.80	50.0	15.6	14.9
Debt-to-equity	70	0.25	2.4	1.5	0.6
Sov. Bonds, $B	70	214.18	15873.0	2607.9	3547.8
Muni. Bonds, $B	70	12.68	3162.8	902.1	1060.7
Corp. NF Bonds, $B	70	27.67	5072.3	1164.6	1384.8
Corp. F Bonds, $B	70	0.32	6378.4	1309.4	1982.5
Business Loans, $B	70	13.65	2101.5	555.3	548.8
Mortgage Loans, $B	70	54.28	14758.4	4333.3	5056.9
Consumer Loans, $B	70	19.05	3660.4	948.5	1068.7
Household Income, $B	70	194.62	15928.7	4640.2	4812.4
GDP, $B	70	249.95	18624.5	5586.7	5687.8

[9] Some data are not available for the entire period of 70 years.

2.4 Results

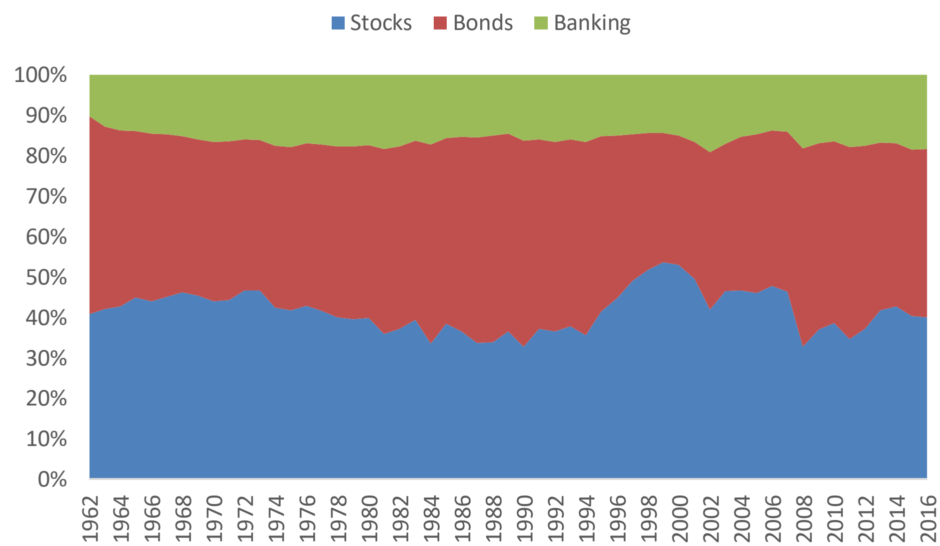
The SRI models described in the Methodology of this Chapter were applied to the US data for the period of 1962-2016. First, results for the aggregated SRI are presented.

Figure 13. Systemic Risk Index, US (smoothed)



As we can see on Figure 13, the index was relatively flat until the early 1980s. The first major increase of the SRI was followed by the Black Monday stock market crash on Oct 09, 1987. The next spike was followed by the 1992 recession. After that, one can see the huge run of the SRI peaked on the Dot-com bubble followed by another run in 2005-2008 which ended with Global Recession. This illustrates that the crises were not some random shocks but, rather, the result of the systemic risk accumulation. It is also interesting to see that every crisis changed the prior upward trend of the systemic risk to a more conservative one. This is a vivid illustration of an idea originated in Keynes (1936) and advanced in Mehrling (2010); financial crises are essentially a “run for quality” – investors get rid of the speculative assets and buy high quality assets. Another interesting pattern is that SRI after the crisis never goes back to the pre-crisis level. This could be explained by the monetary and fiscal policy interventions: expansionary monetary policy that is typical for the crisis periods supports the value of financial assets and expansionary fiscal policy (also typical during the crisis) is associated with increase of sovereign bonds risk that is part of SRI (you can see illustration of this pattern below, in the SRI Bonds section, Figure 17, specifically after 2008 crisis when fiscal expansion was very large relatively to the market size).

Figure 14. US Financial system structure

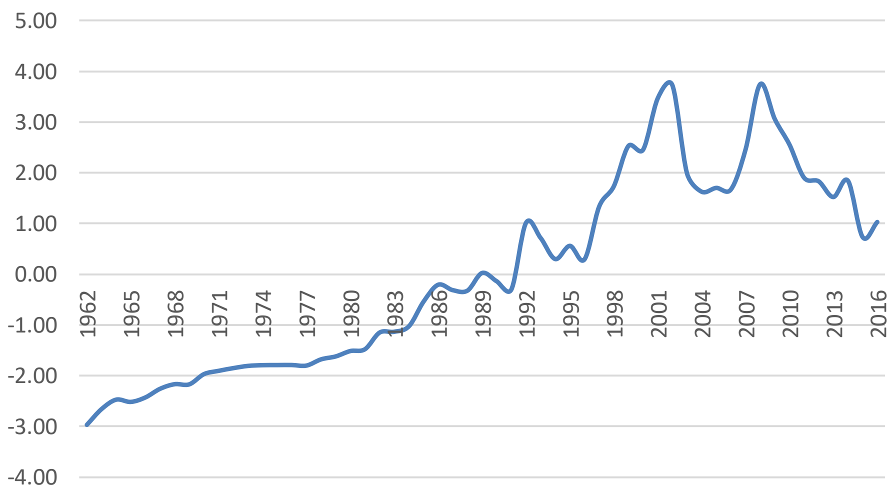


Second, it is important to analyze the structural shifts in the financial system over time. Increase of the market share of one of the markets should be a signal to look into that market risks more carefully. It might be a case of fundamental shifts in the financial system towards one of the markets but quite often it is a sign of an asset price bubble. As we can see in Figure 14, there is a significant shift towards the stock market in the late 1990s, prior to the Dot-com bubble; after the bubble, there is a shift towards the bond market, which is discussed below in the SRI Bonds section. Such shifts become even more important after 1998 when the Glass-Steagall Act was eliminated, which made the transfer of capital between the markets easier.

Next, the SRIs for the three markets analyzed are presented.

As we can see in Figure 15, systemic risk of the US stock market was constantly growing since the start of the observational period until 2002, the burst of Dot-com bubble. In 2007, SRI Stocks picked up again right before the Global Financial Crisis; afterwards, it was on a declining trend. It is also evident that the period from 1997 until 2016 is associated with a much higher level of systemic risk than before.

Figure 15. SRI Stocks (smoothed)



As the bonds market consists of four types of bonds, it is crucial to analyze SRI Bonds together with the US Bond Market structure illustrated in Figure 18. Right after the Second World War the US had a significant amount of sovereign debt; so the SRI Bonds was driven almost exclusively by the sovereign debt. During the 1947-1980 period, the risk was constantly declining as was the share of the sovereign bonds in the US Bond Market Structure. In the 1980s, however, there was a surge in the sovereign bonds and the corporate financial bonds shares; that was where the systemic risk started to increase. From 1995-2007, the surge of the SRI Bonds was mostly due to corporate financial bonds, which also includes MBS. SRI Bonds vividly illustrates the rise of the systemic risks due to this group of assets prior to 2008. Interestingly enough, the SRI Bonds does not go down after the 2008 crisis as sovereign bonds pick up. That is an illustration of the government bailout program to reduce the effect of the crisis and also effect of the recession on the debt-to-GDP ratios (GDP went down, risks went up). This strategy, however, did not reduce the risk of the entire system but just reallocated it from one type of assets to another, leaving a significant chance of the crisis to repeat in this market. SRI Bonds keeps growing and is likely to reach an all-time high in 2017-2018, mostly due to the increase of sovereign bonds.

Figure 16. SRI Bonds (smoothed)

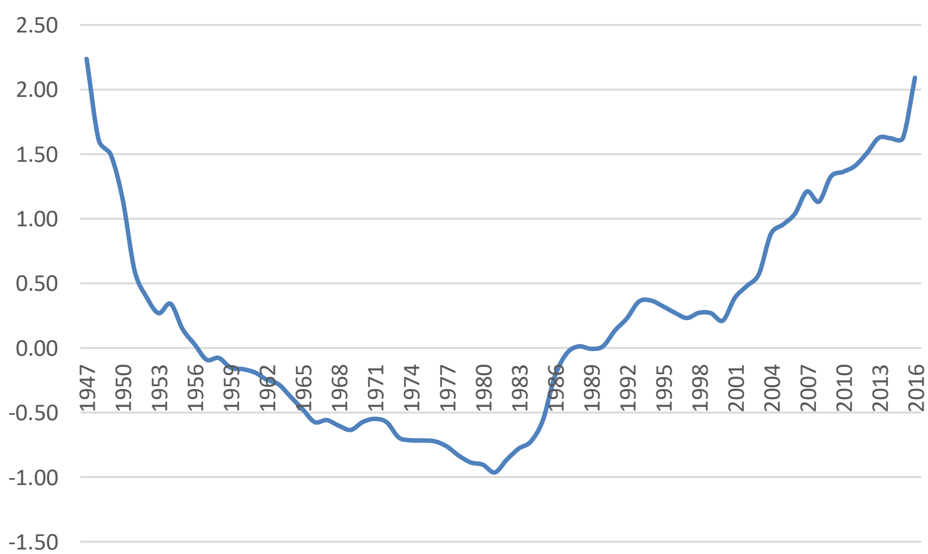
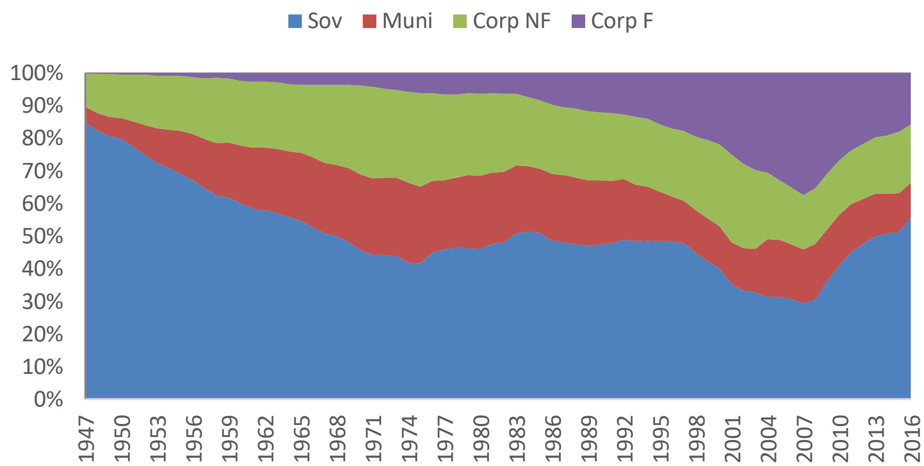


Figure 17. US Bond Market Structure



Moving on to the analysis of the banking loans, we can see that the structure of banking loans remains roughly constant since the 1950s with mortgage loans dominating the system, except the 2002-2008 period where mortgage shares increased significantly. At the same time, SRI Banking experienced a sharp spike signaling about potential problems with the financial stability in banking. This spike is caused by the simultaneous dramatic increase in both structural risk (peaked in 2005-2006 at the level 2.6) and leverage risk (peaked in 2009 at the level 2.4).

Figure 18. SRI Banking (smoothed)

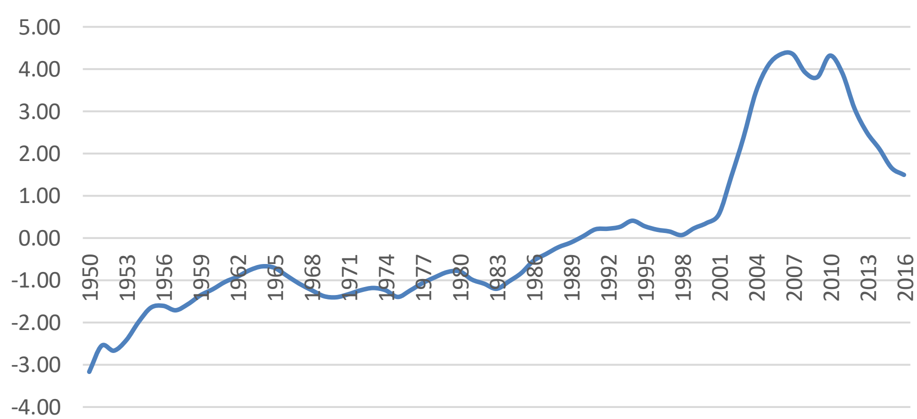
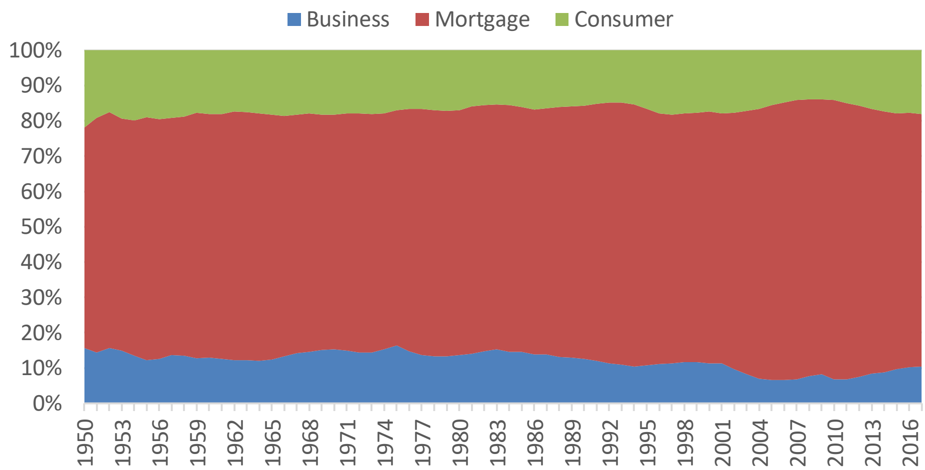


Figure 19. US Banking Structure



Overall, the systemic risk indexes introduced in this paper proved illustration to the Hyman Minsky's hypothesis of risks building up prior to the crisis (Minsky 1986, 1992). At the same time, I recognize that to transfer SRI to a thorough forecasting tool, one should use firm-level data and apply it not only as a aggregated systemic risk indicator but also as micro-level risk tool This means to test if SRI significant increase (I would consider two standard deviations increase as significant) would predict crisis of each individual financial asset it is applied to. But this goes beyond the scope of this paper and is left for further research.

2.5 Conclusion

This Chapter introduces the Systemic Risk Index that is based on the intuition provided by the financial instability hypothesis (Minsky 1992). Among a vast among of attempts to estimate systemic risk and to understand the nature of financial crises, Minsky's work gained significant recognition due to the Global Financial Crisis as it was able to explain how such a crisis could happen. However, Minsky left his theory without developing applied indicators that would help to use it in practice (mostly due to its complexity). This research takes on this challenging task, but with a few shortcomings. First, SRI does not fully capture all the risks that Minsky pointed out in his works (specifically, liquidity risks are not evaluated explicitly). Second, there is room to improve the design of the SRI, in particular by creating a structural risk measure for the bond market. Finally, to transform SRI into a forecasting tool that could predict financial crises, one should have a larger data sample. Longer time series is not a solution here as the modern financial system is very different from the one prior to WWII. One way to improve the data sample is to divide the financial system into "sub-markets": smaller parts of the financial system. The stock market could be divided either by industry or by market capitalization (large, medium, small). The bond market could be divided based on risks and duration for each type of bond. Banking could include more types of loans, and mortgage loans (as the largest group) could be divided into subgroups as well. According to Minsky (1986), systemic risk usually appears in one or very few of these "sub-markets". Such an approach might be a valuable extension of the SRI and will offer more data to create a forecasting model as it will include, not only large crises like the Dot-com bubble or Global Financial Crisis, but also smaller crises that affected only a part of the financial system but still had a systemic nature. However, due to absence of this type of data at this point, the idea is left for further research.

Despite these drawbacks, I believe the developed indicator is an important contribution to the literature, as it has illustrated that financial crises are preceded by the periods of increased systemic risk. Therefore, they potentially could be identified in advance and prevented.

CHAPTER 3. EMPIRICAL INVESTIGATION OF THE RELATIONSHIP BETWEEN FINANCIAL SYSTEM CAPITAL, SYSTEMIC RISK, AND ECONOMIC GROWTH IN THE US

3.1 Introduction

What is the impact of the financial system on the overall economy? Traditional economic theory (Solow, 1956) suggests that this impact is significant and positive as financial system growth (FSG) stimulates economic growth. It is also well-known that such events as financial crises have a negative impact on economic growth (Keynes, 1936). As the US managed to avoid large systemic financial crises in the period between 1939-2008, most of the theoretical and empirical literature of that time tends to conclude that the positive impact of the financial system significantly overcompensates the negative impact of the crises in the long-run (Bernanke and Gertler, 1989; King and Levine, 1993). However, the Global Financial Crisis (2008) triggered a new wave of research on the topic (Jacobs and Mazzucato, 2016; Foroohar, 2016; Stiglitz, 2012; Stiglitz, 2016; Turner, 2015a; Turner, 2015b) suggesting that the structural changes that took place in the financial system in the 1990s have fundamentally changed the impact the financial system has on the overall economy. The aim of this paper is to empirically test if the relationship between FSG and economic growth changed in the US in the last three decades.

First, it is important to identify what those structural changes in the financial system are. According to Turner (2015b) and later expanded in Foroohar (2016), one of the key changes that the financial system had experienced in the late 1980s and early 1990s is the dramatic increase of the demand for financial assets due to the rise in institutional investors. According to SIFMA US

Fact Book 2017, as of 2016, institutional investors have $30T in assets under management. This shift of the demand for financial assets was, not only in the volume but also, in the type of financial assets demanded. Unlike private investors that usually have no limitations on the type of financial assets they can hold in their portfolios, institutional investors have specific qualitative characteristics of their demand, specifically they demand low-risk, highly liquid, highly capitalized assets (CFA Institute, 2017). Turner (2015b) pointed out that the supply of the financial assets, in particular from the non-financial corporate sector, has decreased significantly. Because of the technological revolution, development of IT, and globalization, the need for capital from corporations has dropped. Companies no longer need as much capital to support their activity as before, especially the new generation of hi-tech companies, many of which have more cash than their capital investments require.

The second significant structural change, according to Mehrling (2010) and Turner (2015a), is related to financial innovations. In particular, the securitization of bank loans and invention of credit and risk derivatives, such as CDOs (Collatorized Debt Obligations) and CDS (Credit Default Swaps). The utilization of these derivatives is known as "shadow banking" (Mehrling, 2010), and these innovations were not properly understood by regulators until the 2008 Global Financial Crisis.

Finally, there was a major legal structural change – the repeal of the Glass-Steagall Act in 1999 (by the Gramm–Leach–Bliley Act). The Glass-Steagall Act served as a legal boundary between the capital and money markets. Once the border was eliminated, it created a path for the above-mentioned "shadow banking" and it allowed essentially "low-risk money market funding of high-risk capital market lending" (Mehrling, 2010).

These major changes along with various smaller ones (financial globalization, lack of regulatory coordination within the US regulatory authorities, as well, globally between the countries, etc.) resulted in what is summarized in Foroohar (2016) as the disconnect between the financial system and the overall economy. Providing an empirical illustration of this disconnect is the main goal of this research. There are three major methodological differences between this paper and other empirical research on this topic: an analysis of the relationship between the financial system and economic growth before and after the structural changes, inclusion of the systemic risk measure in the analysis, and a focus only on the US.

As described above, the structural changes took place in late 1980s and early 1990s. Those changes were not sudden and lasted for a number of years, but this paper captures the differences by doing a separate analysis for 1962-1989 and 1990-2016.

Systemic risk inclusion is the most important innovation of this research. One of the problems with the empirical analysis of an asset price bubble is that its negative impact is only evident after the bubble bursts. This leads to a scenario where, as an asset price bubble is growing, capital in the financial system and GDP are growing. However, during the crisis period when the bubble bursts, financial system capital and GDP growth contract (Turner, 2015b). Since a bubble bursting is a direct consequence of its formation, the negative impact of an asset price bubble really starts before it bursts. To capture this phenomena one should include some measure of the systemic risk in the analysis. This is not common in the literature, to a large extent due to a lack of indicators of the systemic risk. A few recent works that do include certain risk measures in the analysis like Loayza, N., Ouazad, A., & Ranciere, R. (2017) and Roubini and Mihm (2010) indicate that there is indeed a trade-off between growth and systemic risk: higher financial system growth is accompanied by higher risks. Ranciere, Tornell, and Westermann (2008) in their cross-country analysis came to the similar conclusion: countries that allow more systemic risk experience on average higher growth. However, unlike Loayza, N., Ouazad, A., & Ranciere, R. (2017) and Roubini and Mihm (2010), they saw it as an argument for less regulation and to allow for systemic risk to build as a way to promote economic growth. Kubinschi and Barnea's (2016) study of European countries concluded that the financial system became more vulnerable to shocks over time due to the larger interdependence of the financial institutions. In this paper, the SRI that was introduced in the Chapter II, is used as a measure of the systemic risk.

Finally, although many countries experience similar patterns in the financial development, the structural changes I am trying to illustrate influenced the US financial system the most. Large cross-country analysis that is typical in the empirical literature (King and Levine, 1993) on this topic provides a broader perspective, however, is not suitable for the purpose of this analysis. Focusing only on the US helps to capture the structural changes in the most explicit way.

One of the main challenges in the analysis of the relationship between the financial system and economic growth is measurement. While economic growth is typically measured by the GDP, financial system growth is a more complicated concept. The financial system in its broad definition includes money markets, represented mostly by banking; capital markets, represented by stocks, bonds, and derivatives markets; and private equity funds. Combining all parts of the financial system into one analysis is challenging due to data availability, different regulatory framework, and different valuation methodologies. For that reason, most of the research is focused on banking and the stock market. Major research on the macroeconomic impact of banking was done in King and Levine (1993). The analysis covered 77 countries and revealed a positive and significant impact of financial system growth on GDP. Beck and Levine (2004) also confirmed that banking and the stock market have a positive impact on economic growth. Several publications that followed, including Levine (2003), Pradhan, Arvin, and Bahmani (2015), Rousseau and Wachtel (2011) were generally positive about the macroeconomic impact of the financial system. At the same time, a number of more recent works, including Beck, Degryse, and Kneer (2014); Arcand, Berkes, and Panizza (2015); Gambacorta, Yang, and Tsatsaronis (2014); Samargandi, Fidrmuc, and Ghosh (2015) and some older ones like Shen and Lee (2006), Manning (2002) and Rioja and Valev (2004) provides evidence that the relationship between the financial system growth and economic growth is not that unambiguous. In particular, Shen and Lee (2006) hypothesize that there is a certain limit to the FSG after which the positive effect on the economic growth starts to decrease, so the relationship is best described by an inverse U-shape. However, their research is focused primarily on developing countries. Beck, Degryse, and Kneer (2014) divide the financial system into financial intermediaries (essentially banks) and other financial institutions and show that, while banking is beneficial for the overall economic growth, other financial institutions have no significant impact on GDP dynamics.

In terms of the markets analyzed in this paper, in addition to banking and the stock market, I have also included the bond market. The bond market is divided into sovereign, municipal, corporate nonfinancial, and corporate financial bond markets (also includes mortgage-backed securities, MBS); [10]. Although the bond market is harder to analyze due to its complexity, it

[10] MBS are included in the financial corporate bonds by FED despite the fact that they are essentially derivatives.

played a key role during the Global Financial Crisis (due to MBS) and in the period after it (due to a dramatic increase of sovereign bonds), so it is essential for a broader understanding of the relationship between the FSG and economic growth.

Despite the large variety of research papers on this topic, none of them are backed by the recent theoretical developments about the structural changes in the financial system described above. This makes it difficult to interpret results, particularly with the works that support the claim that, under some conditions, FSG is not beneficial for economic growth. This research is designed specifically to identify if the structural changes have an impact on the relationship between the financial system and economic growth, so, despite being similar in a broader sense to the empirical literature described above, this research is an attempt to provide empirical evidence to the theoretical works like Turner (2015a, 2015b), Jacobs and Mazzucato (2016), Marcuzzo 2017, Foroohar (2016), Mehrling (2010), all of which have roots in Minsky (1986, 1992).

While the Results section contains a detailed description of the findings, here is a short summary. First, the descriptive analysis revealed a few concerning trends that are in line with the new literature on the financial system structural changes. The level of systemic risk in the second period is significantly (on average two standard deviations) higher than in the first period, and financial system capital growth in the second period is visibly faster than economic growth. Whereas, the growth rates were relatively similar in the first period. Second, however, regression analysis has not confirmed the hypothesis that the structural changes made the financial system "disconnected" from the overall economy (Turner, 2015b; Foroohar 2016). Stock and bonds market capital growth were significant predictors of the GDP growth in both periods analyzed, while banking was significant only in the second period. Banking results are especially controversial, however, and could be better understood by taking into account that the the systemic risk index is significant in the second period with a positive coefficient. In general, one would expect a negative relationship between the systemic risk and economic growth because systemic risk is measured relative to the economy, so an increase in the size of the economy will decrease the level of risk. On the other hand, one could also expect no relationship between the two as risks are not necessarily aligned with economic growth patterns. Rather, they are a reflection of expectations – higher expectations of future growth motivate agents to take more risk. However, a positive relationship between the systemic risk and economic growth is a sign of an asset price bubble: an increase in the economic growth is accompanied by the acceleration of the systemic risk. This may not be a problem in the short term, particularly at the beginning of an economic growth cycle. But the fact that it is true on average for the entire second period is a sign that asset price bubbles are typical in the banking system during this period. An asset price bubble in banking is defined as a situation where there is an increase in banking loans without a simultaneous increase in the income of the borrowers. Specifically, there was significant increase of residential mortgages without a proper corresponding increase of household income.

Overall, the analysis did not confirm the postulated hypothesis, which could be attributed to the main drawback of the analysis – a lack of observation. As the analysis is done on the aggregated country-level data, there are only 54 observations for the two periods analyzed, which limits opportunities for a robust econometric analysis. This could be overcome in future by using firm-level data. However, that analysis will face another challenge: identifying an indicator of economic success on a firm-level. And while obvious candidates for such an indicator are corporate profits and capital expenditures, there are significant drawbacks of using them described in Stiglitz (2012), Turner (2015b) and Foroohar (2016), so the challenge is harder than it might seem.

The rest of the paper is structured as follows: 3.2 describes the methodology of the analysis; 3.3 covers the data used; 3.4 is dedicated to the results; in 3.5, I draw conclusions and explicate the paper's contribution to the literature on financial stability and economic growth.

3.2 Methodology

There are several methodological challenges of the macroeconomic impact of the financial system analysis. The first challenge is measurements. There are several approaches to measure economic growth and financial system performance that depend on the type of analysis that is done. In the research papers focused on cross-country analysis, certain ratios or growth indicators are usually used to account for the size of the economy. The financial system could be measured either by turnover ratio or capital-to-GDP ratio while economic growth is measured by the GDP growth. In this paper, the focus is entirely on the US, so more direct indicators are used. Financial system is measured by the absolute value of financial system capital (FSC) in USD, and economic growth is measured by GDP in USD. To exclude the impact of inflation, all variables are considered in constant prices. The financial system is divided into three markets: stocks, bonds, and banking loans (only business, mortgage, and consumer loans are included).

As mentioned in the Introduction of the Chapter, inclusion of the systemic risk measure is essential for the analysis as it allows to pinpoint asset price bubbles prior to their bursts (situations when growth is accompanied by the systemic risk increase). Measuring systemic risk is a greater challenge compare to measuring economic growth and financial system growth as there is no indicator that would be widely accepted in the literature and classical works on topic such as King and Levine (1993) and Beck and Levine (2004) ignore the risk in their analysis. Still, there are number of works that include systemic risk in their analysis like Loayza, N., Ouazad, A., & Ranciere, R. (2017); Roubini and Mihm (2010); Ranciere, Tornell, and

Westermann (2008) and Kubinschi and Barnea (2016). In those works, the systemic risk is usually measured by some sort of the leverage risk. In this paper I am using the Systemic Risk Index introduced in the Chapter 2 of this dissertation. There are few benefits of using SRI over other available measures. First, SRI includes structural risk along with the leverage risk which makes it a broader indicator than simple leverage measure. Second, SRI is available for stock, bond markets and is based on different indicators for each of the market. This allows to make analysis for the three parts of the financial system in the similar fashion while other papers that include systemic risk are forced on just one of the markets. But the most important motivation of using SRI as a measure of systemic risk comes from the theoretical background of this research. The goal of this paper is add empirical evidence to the new literature on structural changes in the financial system. And that literature (Turner, 2015b; Mehrling, 2010) is largely based on the vision of financial system postulated in Minsky (1986, 1992). SRI is also based on Minsky's theory and so it is more consistent with the goal of this paper from the theoretical point of view. In this chapter, SRI Stocks, SRI Bonds, and SRI Banking are used as measures of the systemic risk on each of the markets respectfully. Aggregated SRI is used only for illustrative purposes.

Empirical analysis is subject to the issues such as stationarity, cointagration and endogeneity. While stationarity and cointagration could be resolved using standard tests, adjustments and proper selection of the variables, endogeneity remains a key challenge for a macroeconomic empirical analysis, especially the one that involves GDP as there are many factors that have impact on it. However, adjusting for the endogeneity usually comes at cost. To deal with this issues four different estimations are used. The model (3.1) has all the variables at the same time which is likely the most correct way from the theoretical point of view as I assume the largest impact financial system has on GDP happens within the same year. At the same time this models struggles most from potential endogeneity.

$$Y_t = \alpha FSC_t + \beta SRI_t + \gamma X_t + \varepsilon_t \qquad (3.1)$$

Where, FSC, depending on the market, is presented by stock market capitalization real growth, bonds outstanding real growth, or bank loans outstanding real growth; SRI is presented by SRI Stocks, SRI Bonds, or SRI Banking, as described in the Chapter 2 of this dissertation; and Xt is a set of control variables described below.

One of the popular methods of dealing with endogeneity is to lag independent variables (Sims, 2011) which would allow to avoid simultaneity (when omitted variable effects both dependent and independent variables). The model (3.2) reflects this approach. The model (3.2) is also estimated using instrumental variable regression which is even better way to deal with the endogeneity issue (Bascle, 2008), the results for this analysis in the Results section below are marked (3.2.IV).

$$Yt = \alpha FSC_{t-1} + \beta SRI_{t-1} + \gamma X_{t-1} + \epsilon t \qquad (3.2)$$

Finally, another popular method that allows to reduce endogeneity (by using lagged variable) but at the same time preserve simultaneous impact of the independent variables on the dependent one is to use moving averages, specifically three-year moving average is typical for a macroeconomic analysis (Beck and Levine, 2004). Model (3.3) captures reflects this approach.

$$Yt = \alpha FSC_{3yav} + \beta SRI_{3yav} + \gamma X_{3yav} + \epsilon t \qquad (3.3)$$

As mentioned above X_t is a set of control variables. In this research following previous literature, in particular, King and Levine (1993) and Beck, Dygreese, & Kneer (2014), inflation growth and share of government spending to GDP growth is used. The original logic of this choice is motivated by the economic fundamentals, such as an output decomposition on private consumption, investments and government spending (Keynes, 1936). As the financial system capital reflects investments, inflation is chosen to reflect changes in private consumption (based on idea that higher consumption with everything else being equal will drive inflation up) and share of government spending to GDP logically corresponds to the government influence on the output.

3.3. Data

Financial system capital data for all the three markets are from the Federal Reserve Bank of St. Louis database; GDP data are from BEA (US Bureau of Economic Analysis), and systemic risk indexes are described in Chapter 2 of this dissertation. All data are annual.

Table 6. Summary statistics

Variable	Observations	Minimum	Maximum	Mean	StDev
GDP, $B	55	1,978	7,714	4,623	1,717
Stocks Cap, $B	55	1,130	11,329	4,443	3,290
Bonds Cap, $B	55	1,360	11,811	4,381	3,082
Banking Cap, $B	55	1,174	8,953	4,139	2,415
SRI Stocks	55	-2.97	3.74	0.00	1.91
SRI Bonds	55	-0.96	2.09	0.11	0.83
SRI Banking	55	-1.41	4.36	0.42	1.84
GDP Growth	54	-0.046	0.068	0.026	0.024
Stocks Cap Growth	54	-0.419	0.384	0.055	0.151
Bonds Cap Growth	54	-0.060	0.198	0.042	0.046
Banking Cap Growth	54	-0.057	0.105	0.037	0.036
SRI Stocks Growth	54	-0.126	0.135	0.009	0.044
SRI Bonds Growth	54	-0.013	0.040	0.004	0.011
SRI Banking Growth	54	-0.061	0.087	0.005	0.028

Note: GDP and financial markets capital are in constant prices, average for 1981-1984

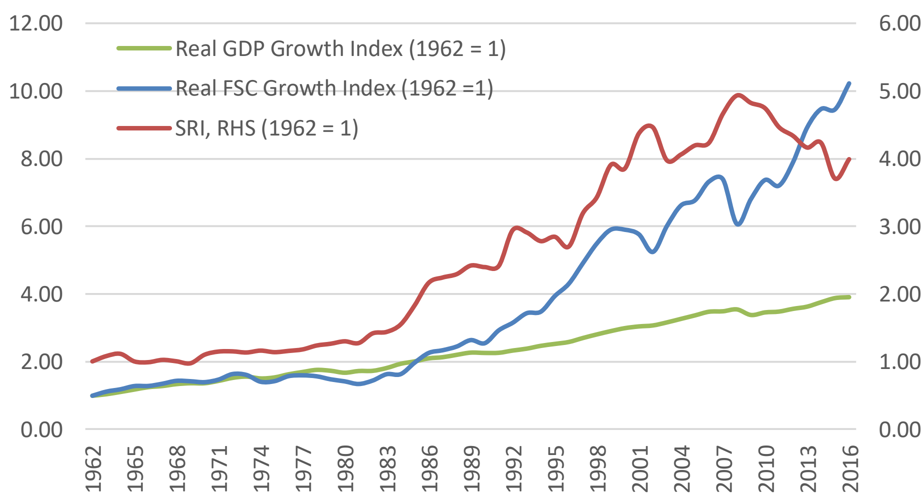
Table 7. Correlation matrix

Variables	*GDP*	*Stock Cap*	*SRI Stocks*	*Bonds Cap*	*SRI Bonds*	*Banking Cap*	*SRI Banking*
GDP Growth	1.00						
Stock Cap Growth	0.20	1.00					
SRI Stocks Growth	0.11	-0.12	1.00				
Bonds Cap Growth	0.38	0.37	-0.01	1.00			
SRI Bonds Growth	-0.22	0.21	-0.01	0.74	1.00		
Banking Cap Growth	0.42	0.01	0.30	0.21	0.01	1.00	
SRI Banking Growth	0.09	0.02	-0.13	0.36	0.26	0.41	1.00

3.4 Results

First, for illustrative purposes, descriptive results for all three markets combined are presented. On Figure 20, a comparative analysis of real cumulative growth rates is presented (1962 = 1). FSC and GDP are shown at the LHS axis while SRI is shown on the RHS scale. That is due to the fact that SRI is based on relative indicators and it has certain limits of growth while FSC and GDP are absolute indicators without such limitations and they are expected to grow faster than risk measures. Same logic is applied in Figures 21-24.

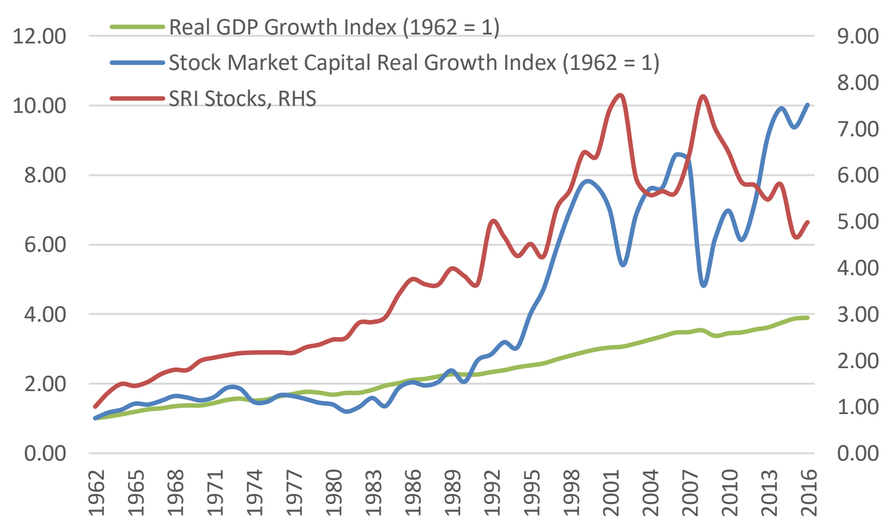
Figure 20. US Financial Sector vs. Overall Economy. Nominal growth



During the period of 1962-1989, FSC increased 2.6 times, and real GDP – 2.3 times. Average SRI for the period is -1.1 (while 0 is historical average). During the period of 1990-2016, FSC increased 3.9 times, while GDP only 1.7 times. At the same time, average SRI during 1990-2016 was much higher – 1.4 (it corresponds to two standard deviation increase). Coming back to structural changes described in Turner (2015b) we can see illustration that the relationship between FSC and GDP has changed. In particularly, while in the first period financial system was growing almost in line with the GDP, in the second period financial system has grown twice faster in real terms than GDP. And while there are many potential factors that influenced GDP and FSC during that time and one cannot attribute this change in pattern exclusively to the structural changes in the financial system, the relationship has changed and not in the favorable direction (assuming GDP growth as a measure of economic success and FSC as means to stimulate GDP).

The next step is to analyze each financial market in detail.

Figure 21. US Stock Market vs. Overall Economy. Real growth



As for the US stock market capital, during the period of 1962-1989, it increased 2.4 times in real terms, almost in line with GDP (2.3 times as mentioned above). Average SRI Stocks for the period was -1.6 (historical average is the same for all SRIs and is equal to 0). During the period of 1990-2016, stock market capital increased 4.2 times in real terms while GDP only 1.7. This illustrates a significant difference in the dynamics of the stock market and overall economy in the second period. Average SRI Stocks during 1990-2016 was 1.7, about two standard deviations higher than in the first period. Such a difference in the dynamics of the stock market and GDP in the second period illustrates the ideas made in Foroohar (2016) about the recent disconnect between the stock market and overall economic system. At the same time simultaneous increase of the FSC and systemic risk that happened during the second period is a sign of the asset price bubbles.

To further investigate relationship between the US stock market and economic growth, regression analysis was performed separately for the two periods for the models described in the methodology section: model (3.1), where all the variables are in time t; model (3.2) where all independent variables are with lag 1; and model (3.3) where all independent variables are three-year averages of t, t-1 and t-2 years.

Table 8. Analysis of relationship between Stock Market Capital, SRI Stocks and GDP

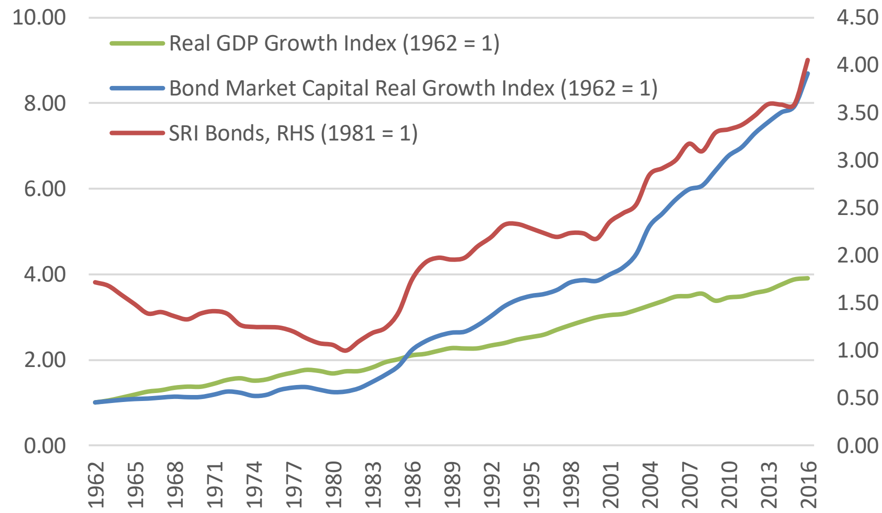
Variables	Models							
	(3.1)	(3.2.IV)	(3.2)	(3.3)	(3.1)	(3.2.IV)	(3.2)	(3.3)
	1963-1989				1990-2016			
Stock MCap	0.020 (0.610)	-0.083 (0.403)	0.031 (0.614)	0.16** (0.029)	0.014 (0.531)	-0.050 (0.917)	0.053*** (0.009)	0.091*** (0.004)
SRI Stocks	-0.540** (0.048)	-0.246 (0.525)	-0.175 (0.619)	-0.61** (0.015)	0.039 (0.555)	0.232 (0.553)	-0.006 (0.904)	0.031 (0.661)
CPI	-0.68*** (0.000)	-0.90** (0.017)	-0.55*** (0.010)	-0.40*** (0.009)	-0.537 (0.119)	3.273 (0.326)	0.244 (0.360)	-0.428 (0.143)
Gov	0.052 (0.761)	-0.058 (0.900)	0.200 0.375	0.081 (0.500)	0.103 (0.551)	-1.327 (0.234)	-0.176 (0.230)	0.220 (0.119)

Notes: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. P-values are in parenthesis. For details, see Appendix.

Regression analysis provides some interesting and surprising results. First, stock market capital is insignificant in both periods in the model (3.1) estimation which indicates the weak relationship between the stock market and GDP within the same year. It is also evident that it is not a new phenomenon and it could not be attributed to the new structural changes. At the same time, in the model (3.3) the relationship is significant in both periods which indicates that along longer period of time (three years) the relationship is indeed significant. However, again there are no evidence of the weakening of the relationship in the second period. Results of the estimation of the model (3.2) are even more surprising as the relationship is significant only in the second period. Overall, the conclusion is that there is no evidence of the dramatic change in the relationship between the stock market capital and GDP.

It is also interesting that the systemic risk index is significant in the first period (in models (3.1) and (3.3)) with negative coefficients. This result is actually expected for the period of time without asset price bubbles: as economy grows systemic risk automatically decreases if there is no bubble because it is based on relative to the size of the economy indicators (for example, level of debt stays the same but GDP goes up and then Debt-to-GDP goes down). In the second period this pattern is not observed and the relationship is insignificant that indicates that was a period of mixed asset price bubbles and sustainable economic growth. Another important result is that inflation reduction is important for economic growth in the first period. As one can recall, the US experienced a period of stagflation in the 1970s which explains this result: although analysis is done in real terms, inflation during that period was associated with economic crisis and its decrease – with economic growth. The same result is found in regression analyses of the other two markets that are presented below.

Figure 22. US Bond Market vs. Overall Economy. Real growth



As for the bond market, during the period of 1962-1989, the bond market capital increased 2.6 times in real terms, and the average SRI for the period was -0.6. It is worth mentioning that the sovereign bonds had a significant risk in the postwar period that was constantly declining until the 1980s. On average, during the period of 1990-2016, the US bonds capital increased 3.3 times in real terms, while average SRI Bonds for the period was 0.8 (quite significant increase considering that the standard deviation is 0.83). In general, the bond market seems to be more stable in comparison to the stock market; however, similar to the stock market pattern, one can observe an acceleration of the capital and risk growth in the bond market compared to the GDP growth in the last two decades.

The regression analysis, presented below in Table 9, revealed a significant relationship between bond market capital, SRI Bonds, and GDP.

Table 9. Analysis of relationship between Bond Market Capital, SRI Bonds and GDP

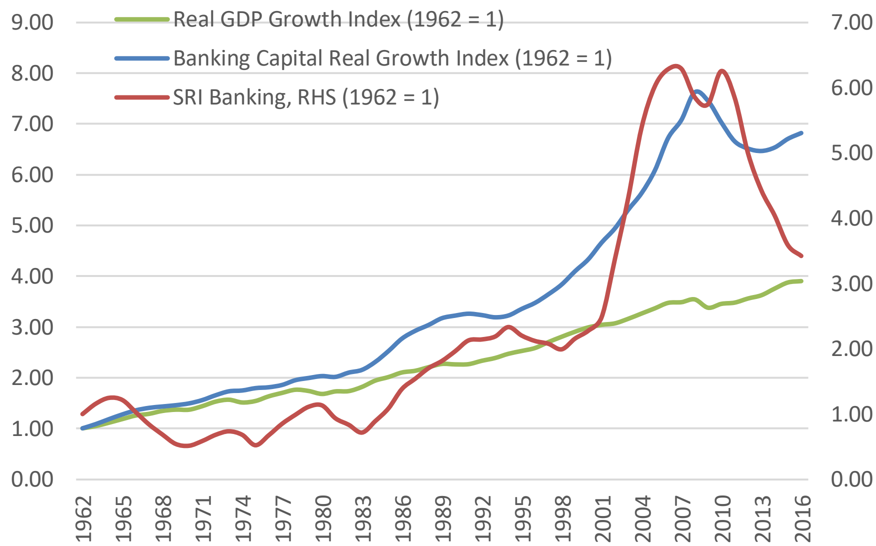
Variables	Models							
	(3.1)	(3.2.IV)	(3.2)	(3.3)	(3.1)	(3.2.IV)	(3.2)	(3.3)
	1963-1989				1990-2016			
Bond MCap	0.559*** (0.000)	0.54*** (0.000)	-0.147 (0.407)	0.473*** (0.000)	0.410** (0.021)	0.04 (0.982)	0.156 (0.421)	0.433** (0.037)
SRI Stocks	-2.76*** (0.000)	-2.8*** (0.000)	0.541 (0.476)	-2.34*** (0.000)	-1.49*** (0.006)	-1.14 (0.725)	0.038 (0.955)	-1.92** (0.018)
CPI	-0.28*** (0.000)	-0.3*** (0.000)	-0.69*** (0.00)	-0.33*** (0.000)	-0.379 (0.188)	2.13 (0.763)	0.384 (0.199)	-0.377 (0.220)
Gov	0.013 (0.839)	-0.06 (0.646)	0.168 (0.435)	0.015 (0.805)	0.045 (0.729)	-0.82 (0.647)	-0.329** (0.029)	0.091 (0.450)

Notes: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. P-values are in parenthesis. For details, see Appendix.

Results for the bond market are also rather interesting. Estimations for the model (3.1) and (3.2) confirm significant impact of the bond market growth on GDP growth in both periods, although the level of significance is smaller in the second period (99% confidence for the first period and 95% confidence for the second). Again, there are no strong evidence of the change in the relationship between the two periods. Results for the estimation of the model 3.2.IV, however, show significant relationship only in the first period which just illustrates that during the first period relationship was so strong that even after adjustments for the potential endogeneity it is still significant. Results for the SRI are also significant and meaningful: similar to the stock market during the first period systemic risk and GDP have negative relationship. For bonds market this relationship holds during the second period as well that is actually surprising as it was a period of the Global Financial Crisis cause to large extent by MBS (that are included in bonds).

Next, banking loans are analyzed. Figure 23 illustrates descriptive results, and Table 10 presents the results of the regression analysis.

Figure 23. US Banking vs. Overall Economy. Real growth



During the period of 1962-1989, banking loans increased 3.2 times in real terms, beating stock and bond markets. Average SRI for the period is -1.0. During the period of 1990-2016, banking loans increased 2.2 times in real terms, falling substantially behind the stock and bonds markets, while being ahead of the GDP. The average SRI during 1990-2016 was 1.9, however, during the period 2004-2010 SRI skyrocketed to the average of 4.0 (with standard deviation 1.8). This spike in SRI Banking is due to simultaneous increase of the leverage and structural risks which means on aggregate the system borrowed more capital to invest in non-productive loans (for details see Chapter II).

The regression analysis of the relationship among banking loans, SRI Banking, and GDP is presented below in Table 10.

Table 10. Analysis of relationship between Banking, SRI Banks and GDP

Variables	Models							
	(3.1)	(3.2.IV)	(3.2)	(3.3)	(3.1)	(3.2.IV)	(3.2)	(3.3)
	1963-1989				1990-2016			
Banking MCap	-0.109 (0.662)	-0.212 (0.602)	-0.332 (0.262)	0.170 (0.411)	0.30** (0.027)	6.44 (0.892)	0.26** (0.015)	0.50*** (0.000)
SRI Banking	0.298 (0.438)	0.219 (0.699)	0.130 (0.771)	0.379 (0.286)	0.115 (0.328)	0.87 (0.880)	0.34*** (0.001)	-0.03 (0.736)
CPI	-0.69*** (0.003)	-0.78** (0.04)	-0.78*** (0.004)	-0.45** (0.013)	-0.287 (0.374)	34.3 (0.900)	0.58** (0.022)	0.44* (0.087)
Gov	0.070 (0.757)	-0.181 (0.711)	0.237 (0.373)	0.248 (0.247)	-0.426 (0.103)	-16.6 (0.894)	-1.00*** (0.000)	-0.58*** (0.003)

Notes: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. P-values are in parenthesis. For details, see Appendix.

The analysis revealed interesting results. Growth of the banking loans, as well as SRI Banking, was not significant for GDP growth in the first period, as was expected based on the Turner (2015b), however, in the second period, capital growth was significant in three models. At the same time, based on Stiglitz (2012) this could be explained by the recent tendency that banking takes larger share of the GDP in recent two decades and so relationship between the banking system and GDP increases because of that. Another result that is surprising is that that SRI Banking is significant in the model (3.2) but with a positive sign (unlike in the stock and bond market cases described above). As described above the normal situation is inverse relationship between the systemic risk and economic growth but positive relationship is a strong sign of an asset price bubble. This result is most likely caused by the years prior to Global Financial Crisis when there was simultaneous acceleration of the banking capital growth, GDP growth and SRI Banking growth. Altogether, results for the banking sector also do not support the idea that recent structural changes have caused disconnect between the financial system and overall economy but rather on the contrary – the relationship got stronger in the recent period compare to the previous one.

Overall, despite the graphical analysis that illustrated visible increase of the systemic risk and capital at all three markets in the second period compared to the first one, the regression analysis provided has not indicated any significant changes in the relationship between the financial system and economic growth in the two periods analyzed. At the same time relationship was not identified as significant in many instances and especially in the model 3.2.IV which controls best for the endogeneity. These weak results could be explained by the main drawback of the analysis – not large enough data sample. Analyzing annual aggregated data does not offer much room for the robust analysis, that is why moving forward I would suggest to use firm-level or industry level data. This would require, however, inventing certain indicators of country's economic success on a firm / industry level (instead of traditionally used GDP). Obvious choice would be corporate profits, wages or capital investments but there are multiple issues with using these indicators, described in Stiglitz (2012) and Foroohar (2016), and overall this discussion goes beyond the scope of this paper and offers opportunities for further research.

3.5 Conclusion

The global financial crisis has triggered new wave of research including Stiglitz (2012), Stiglitz, (2016), Turner (2015a), Turner (2015b), Mehrling (2010), Jacobs and Mazzucato (2016); Marcuzzo (2017), Varoufakis (2016), and Foroohar (2016). All those works provide different angles of the analysis of the structural changes that took place in the financial system in late 1980s and early 1990s which made this crisis possible. These structural changes included changes in the demand and supply of capital, changes in the regulatory environment and changes in the level of market concentration. However, the question of whether those changes altered the fundamental positive impact that economists believe the financial system has on the overall economy remained open. This paper is an attempt at empirically testing the idea that this relationship has changed. The results obtained are rather mixed: on one hand, all three parts of the financial system that are analyzed (stock, bond markets, and banking) experienced a significantly larger than average level of the systemic risk in the second period (1990-2016) compared to the first one (1962-1989). Graphical analysis also illustrates the visual difference in the growth paths of the financial system and GDP. However, the regression analysis does not confirm this intuition. In fact, for the stock and bond markets, the relationship remains significant in both periods, while for banking it is significant only in the second one. Interesting results were obtained for the systemic risk behavior. In the bond markets and first period of the stock market, systemic risk is significant with negative coefficients. This is expected as risk decreases as the size of the economy increases. However, the relationship with banking in the second period is significant with a positive coefficient; this is a strong indicator of an asset price bubble. In general, further analysis is required to make a definite conclusion about how deep the structural changes had influenced the relationship of the financial system and overall economy. One of the possible extensions of this research would be an analysis based on firm or industry level data that would mitigate the main drawback of this analysis – a small number of observations. This, however, would require a firm-level indicator of economic success, and it is a challenge as obvious candidates like corporate profits and capital expenditure have been dramatically influenced by these structural changes (Turner, 2015b; Stiglitz, 2012). It is clear that this topic requires further analysis that goes beyond the scope of this paper, nevertheless, I believe that this paper is a valuable contribution to the literature on topic and could serve as foundation for the further analysis.

APPENDICES

Appendix A. Interdependence of the Factors in Fama-French Five-Factor Asset Pricing Model. Evidence from panel VAR

Appendix A.1 Data cleaning

Histograms of the variables after the winsorizing.

Figure 24. Appendix A.1 Profitability

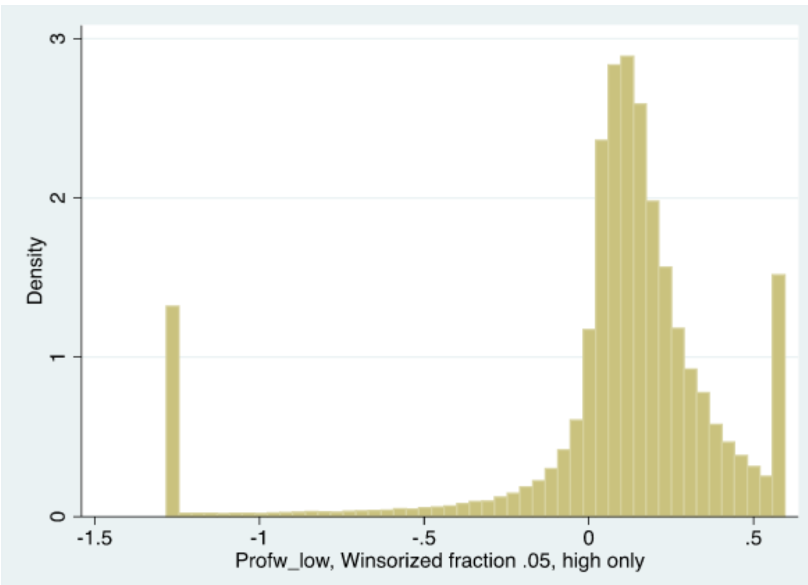


Figure 25. Appendix A.1 Investments

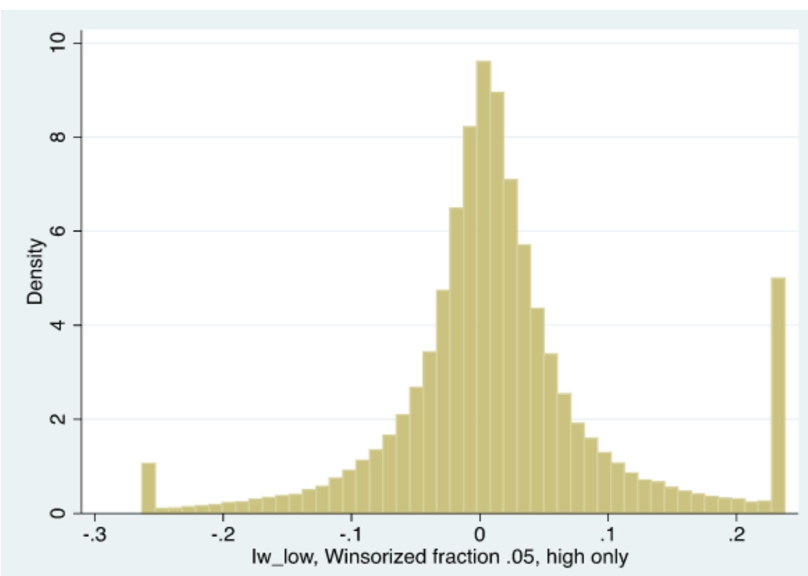


Figure 26. Appendix A.1 Value

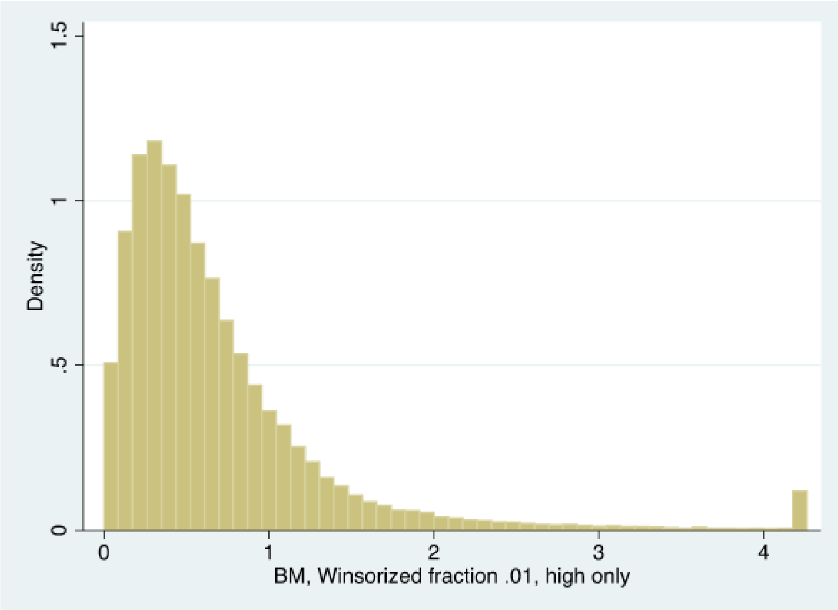


Figure 27. Appendix A.1 Size

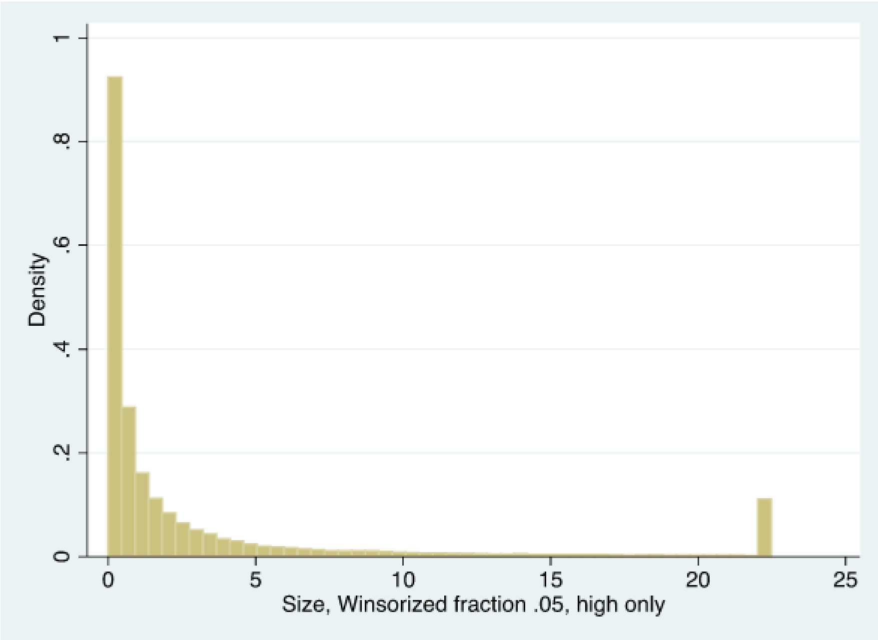
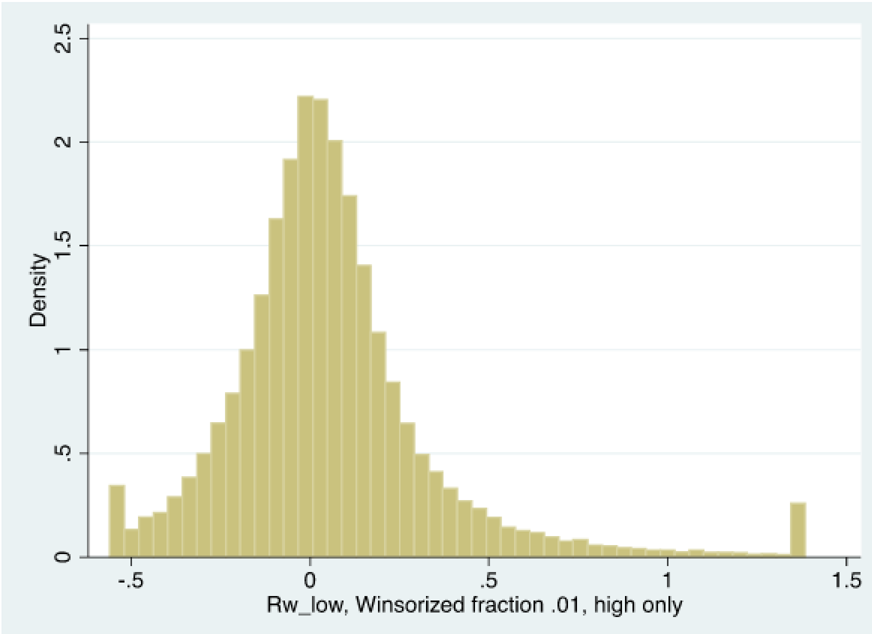


Figure 28. Appendix A.1 Returns



Appendix A.2 Unit Root Tests

Table 11. Appendix A.2 Unit Root Test. Profitability

Result: there is no unit root

```
Fisher-type unit-root test for Profw
Based on augmented Dickey-Fuller tests
--------------------------------------
Ho: All panels contain unit roots           Number of panels       =  4954
Ha: At least one panel is stationary        Avg. number of periods = 15.63

AR parameter: Panel-specific                Asymptotics: T -> Infinity
Panel means:  Included
Time trend:   Not included
Drift term:   Not included                  ADF regressions: 4 lags
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(7872)  P     8070.5284       0.0577
 Inverse normal             Z       17.3600       1.0000
 Inverse logit t(13314)     L*       7.7223       1.0000
 Modified inv. chi-squared Pm        1.5822       0.0568
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------
```

Table 12. Appendix A.2 Unit Root Test. Investments

Result: there is no unit root

```
Fisher-type unit-root test for Iw
Based on augmented Dickey-Fuller tests
--------------------------------------
Ho: All panels contain unit roots           Number of panels       =  4954
Ha: At least one panel is stationary        Avg. number of periods = 15.63

AR parameter: Panel-specific                Asymptotics: T -> Infinity
Panel means:  Included
Time trend:   Not included
Drift term:   Not included                  ADF regressions: 4 lags
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(7872)  P     9292.2524       0.0000
 Inverse normal             Z        2.1473       0.9841
 Inverse logit t(13969)     L*      -8.9754       0.0000
 Modified inv. chi-squared Pm       11.3190       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------
```

Table 13. Appendix A.2 Unit Root Test. Value

Result: there is no unit root

```
Fisher-type unit-root test for BMw
Based on augmented Dickey-Fuller tests
--------------------------------------
Ho: All panels contain unit roots           Number of panels       =  4954
Ha: At least one panel is stationary        Avg. number of periods =  15.63

AR parameter: Panel-specific                Asymptotics: T -> Infinity
Panel means:  Included
Time trend:   Not included
Drift term:   Not included                  ADF regressions: 4 lags
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(7872)  P     9716.5367       0.0000
 Inverse normal             Z       18.9465       1.0000
 Inverse logit t(13659)     L*       5.8257       1.0000
 Modified inv. chi-squared Pm       14.7004       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------
```

Table 14. Appendix A.2 Unit Root Test. Size

Table A4.1. Size: there is a unit root

```
Fisher-type unit-root test for Sizew
Based on augmented Dickey-Fuller tests
--------------------------------------
Ho: All panels contain unit roots           Number of panels       =  4954
Ha: At least one panel is stationary        Avg. number of periods =  15.63

AR parameter: Panel-specific                Asymptotics: T -> Infinity
Panel means:  Included
Time trend:   Not included
Drift term:   Not included                  ADF regressions: 4 lags
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(7872)  P     7629.0133       0.9745
 Inverse normal             Z       24.1026       1.0000
 Inverse logit t(13004)     L*      15.2909       1.0000
 Modified inv. chi-squared Pm       -1.9365       0.9736
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------
```

Table 15. Appendix A.2 Unit Root Test. Size FD

```
Fisher-type unit-root test for DSizew
Based on augmented Dickey-Fuller tests
--------------------------------------
Ho: All panels contain unit roots           Number of panels       =   4954
Ha: At least one panel is stationary        Avg. number of periods =  15.63

AR parameter: Panel-specific                Asymptotics: T -> Infinity
Panel means:  Included
Time trend:   Not included
Drift term    Not included                  ADF regressions: 4 lags
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(7872)  P      1.10e+04       0.0000
 Inverse normal             Z     -11.4927        0.0000
 Inverse logit t(13434)     L*    -26.1902        0.0000
 Modified inv. chi-squared Pm      25.0527        0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------
```

Table 16. Appendix A.2 Unit Root Test. Returns

Table A5. Returns: there is no unit root

```
Fisher-type unit-root test for Rw
Based on augmented Dickey-Fuller tests
--------------------------------------
Ho: All panels contain unit roots           Number of panels       =   4954
Ha: At least one panel is stationary        Avg. number of periods =  15.63

AR parameter: Panel-specific                Asymptotics: T -> Infinity
Panel means:  Included
Time trend:   Not included
Drift term    Not included                  ADF regressions: 4 lags
------------------------------------------------------------------------------
                                  Statistic      p-value
------------------------------------------------------------------------------
 Inverse chi-squared(7872)  P     8827.8087       0.0000
 Inverse normal             Z       -2.2825       0.0112
 Inverse logit t(14014)     L*     -11.7948       0.0000
 Modified inv. chi-squared Pm        7.6175       0.0000
------------------------------------------------------------------------------
 P statistic requires number of panels to be finite.
 Other statistics are suitable for finite or infinite number of panels.
------------------------------------------------------------------------------
```

Appendix A.3 PVAR analysis results. Main model

Table 17. Appendix A.3 PVAR analysis results. Main model

```
. pvar Profw Iw BMw DSizew Rw, lags(1) //my idea of order, let's see how it works

Panel vector autoregresssion



GMM Estimation

Final GMM Criterion Q(b) =  5.45e-35
Initial weight matrix: Identity
GMM weight matrix:     Robust
                                                  No. of obs      =     52729
                                                  No. of panels   =      4446
                                                  Ave. no. of T   =    11.859
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Profw						
Profw L1.	.4453024	.0197396	22.56	0.000	.4066136	.4839913
Iw L1.	.0094308	.0187774	0.50	0.615	-.0273723	.0462339
BMw L1.	-.0248256	.0218347	-1.14	0.256	-.0676208	.0179697
DSizew L1.	.0042246	.0015954	2.65	0.008	.0010976	.0073516
Rw L1.	.0139352	.0050242	2.77	0.006	.004088	.0237824
Iw						
Profw L1.	.0432873	.0066702	6.49	0.000	.0302141	.0563606
Iw L1.	.0222669	.0073717	3.02	0.003	.0078186	.0367151
BMw L1.	.0299406	.0070833	4.23	0.000	.0160576	.0438235
DSizew L1.	.0014807	.0005714	2.59	0.010	.0003608	.0026006
Rw L1.	.020972	.002165	9.69	0.000	.0167287	.0252154

BMw						
Profw						
L1.	**-.0603071**	**.0216834**	**-2.78**	**0.005**	**-.1028057**	**-.0178085**
Iw						
L1.	**-.0117263**	**.024931**	**-0.47**	**0.638**	**-.0605901**	**.0371375**
BMw						
L1.	**.904462**	**.04999**	**18.09**	**0.000**	**.8064835**	**1.00244**
DSizew						
L1.	**-.0063175**	**.0023236**	**-2.72**	**0.007**	**-.0108717**	**-.0017633**
Rw						
L1.	**-.0518239**	**.0078679**	**-6.59**	**0.000**	**-.0672448**	**-.0364031**
DSizew						
Profw						
L1.	**.0152366**	**.0447864**	**0.34**	**0.734**	**-.0725431**	**.1030163**
Iw						
L1.	**-.0318505**	**.047763**	**-0.67**	**0.505**	**-.1254643**	**.0617634**
BMw						
L1.	**.003912**	**.0469145**	**0.08**	**0.934**	**-.0880387**	**.0958626**
DSizew						
L1.	**.1056939**	**.0177946**	**5.94**	**0.000**	**.0708171**	**.1405706**
Rw						
L1.	**.0337614**	**.0129445**	**2.61**	**0.009**	**.0083908**	**.0591321**
Rw						
Profw						
L1.	**.1522586**	**.0198511**	**7.67**	**0.000**	**.1133512**	**.1911659**
Iw						
L1.	**.0687089**	**.0219429**	**3.13**	**0.002**	**.0257016**	**.1117163**
BMw						
L1.	**.1189074**	**.0303376**	**3.92**	**0.000**	**.0594467**	**.1783681**
DSizew						
L1.	**.0078122**	**.0018579**	**4.20**	**0.000**	**.0041708**	**.0114536**
Rw						
L1.	**.058513**	**.0074421**	**7.86**	**0.000**	**.0439268**	**.0730992**

Instruments : **l(1/1).(Profw Iw BMw DSizew Rw)**

```
. pvargranger // Granger

  panel VAR-Granger causality Wald test
    Ho: Excluded variable does not Granger-cause Equation variable
    Ha: Excluded variable Granger-causes Equation variable
```

Equation \ Excluded	chi2	df	Prob > chi2
Profw			
Iw	**0.244**	**1**	**0.621**
BMw	**1.327**	**1**	**0.249**
DSizew	**6.975**	**1**	**0.008**
Rw	**7.761**	**1**	**0.005**
ALL	**29.752**	**4**	**0.000**
Iw			
Profw	**41.993**	**1**	**0.000**
BMw	**17.839**	**1**	**0.000**
DSizew	**6.792**	**1**	**0.009**
Rw	**93.525**	**1**	**0.000**
ALL	**199.717**	**4**	**0.000**
BMw			
Profw	**7.701**	**1**	**0.006**
Iw	**0.228**	**1**	**0.633**
DSizew	**7.426**	**1**	**0.006**
Rw	**43.252**	**1**	**0.000**
ALL	**89.521**	**4**	**0.000**
DSizew			
Profw	**0.116**	**1**	**0.733**
Iw	**0.436**	**1**	**0.509**
BMw	**0.007**	**1**	**0.934**
Rw	**6.803**	**1**	**0.009**
ALL	**7.804**	**4**	**0.099**
Rw			
Profw	**58.702**	**1**	**0.000**
Iw	**10.153**	**1**	**0.001**
BMw	**15.219**	**1**	**0.000**
DSizew	**17.963**	**1**	**0.000**
ALL	**84.812**	**4**	**0.000**

Appendix A.4 Robustness check: alternative ordering. PVAR analysis result

Table 18. Appendix A.4 Robustness check. Alternative ordering

```
. pvar BMw Iw Profw DSizew Rw, lags(1)

Panel vector autoregresssion



GMM Estimation

Final GMM Criterion Q(b) =  4.80e-35
Initial weight matrix: Identity
GMM weight matrix:     Robust
                                                   No. of obs      =     52728
                                                   No. of panels   =      4446
                                                   Ave. no. of T   =    11.859
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
BMw						
BMw L1.	.9047345	.0500004	18.09	0.000	.8067355	1.002733
Iw L1.	-.0117889	.0249437	-0.47	0.636	-.0606777	.0370998
Profw L1.	-.0602337	.021681	-2.78	0.005	-.1027277	-.0177397
DSizew L1.	-.0063172	.002324	-2.72	0.007	-.0108721	-.0017623
Rw L1.	-.051805	.0078652	-6.59	0.000	-.0672206	-.0363895
Iw						
BMw L1.	.0299114	.0070829	4.22	0.000	.0160292	.0437937
Iw L1.	.0222973	.0073729	3.02	0.002	.0078466	.036748
Profw L1.	.0432555	.0066697	6.49	0.000	.030183	.0563279
DSizew L1.	.0014831	.0005714	2.60	0.009	.0003633	.002603
Rw L1.	.0209449	.0021642	9.68	0.000	.0167031	.0251868

Profw						
BMw						
L1.	**-.0251809**	**.0218379**	**-1.15**	**0.249**	**-.0679823**	**.0176205**
Iw						
L1.	**.0093023**	**.0187789**	**0.50**	**0.620**	**-.0275036**	**.0461082**
Profw						
L1.	**.4452814**	**.0197387**	**22.56**	**0.000**	**.4065942**	**.4839686**
DSizew						
L1.	**.0042209**	**.0015954**	**2.65**	**0.008**	**.0010939**	**.0073479**
Rw						
L1.	**.0139216**	**.0050229**	**2.77**	**0.006**	**.0040768**	**.0237664**
DSizew						
BMw						
L1.	**.0039541**	**.0469138**	**0.08**	**0.933**	**-.0879951**	**.0959034**
Iw						
L1.	**-.0315974**	**.0477732**	**-0.66**	**0.508**	**-.1252311**	**.0620364**
Profw						
L1.	**.0153015**	**.0447824**	**0.34**	**0.733**	**-.0724705**	**.1030735**
DSizew						
L1.	**.105701**	**.0177952**	**5.94**	**0.000**	**.070823**	**.140579**
Rw						
L1.	**.0337616**	**.0129425**	**2.61**	**0.009**	**.0083948**	**.0591284**
Rw						
BMw						
L1.	**.1186586**	**.0303475**	**3.91**	**0.000**	**.0591785**	**.1781386**
Iw						
L1.	**.0686258**	**.0219478**	**3.13**	**0.002**	**.025609**	**.1116426**
Profw						
L1.	**.1522316**	**.0198498**	**7.67**	**0.000**	**.1133268**	**.1911364**
DSizew						
L1.	**.0078239**	**.0018581**	**4.21**	**0.000**	**.0041821**	**.0114657**
Rw						
L1.	**.0583452**	**.007441**	**7.84**	**0.000**	**.0437611**	**.0729293**

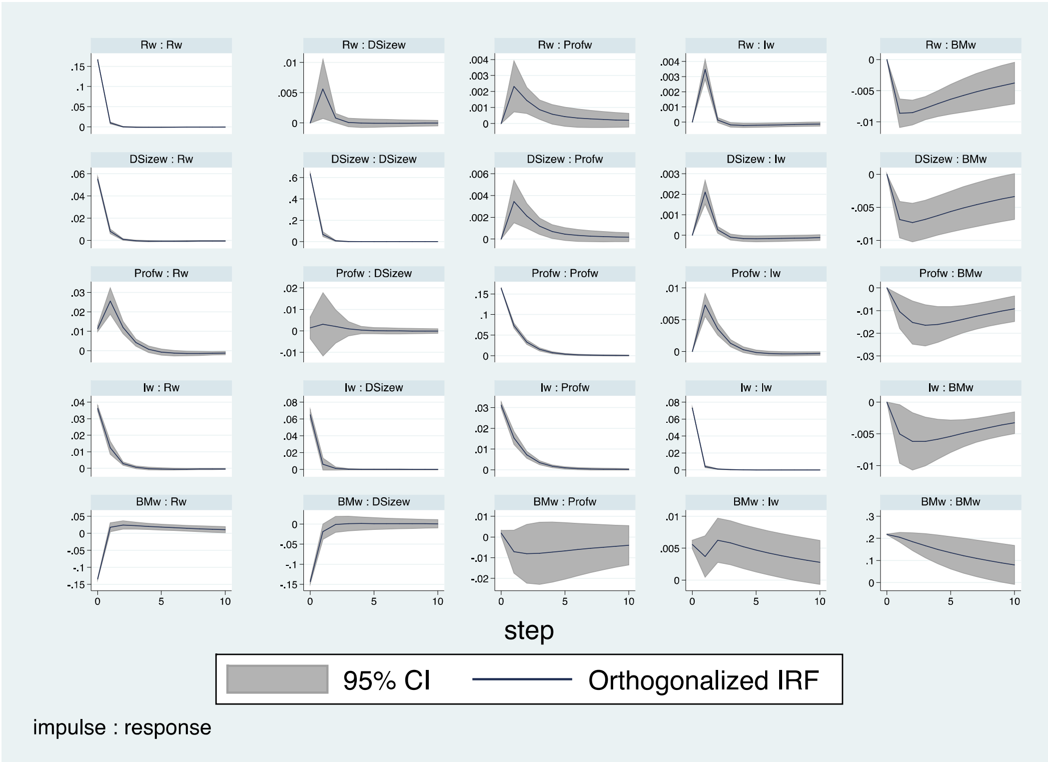
Instruments : **l(1/1).(BMw Iw Profw DSizew Rw)**

```
. pvargranger // Granger

  panel VAR-Granger causality Wald test
    Ho: Excluded variable does not Granger-cause Equation variable
    Ha: Excluded variable Granger-causes Equation variable
```

Equation \ Excluded	chi2	df	Prob > chi2
BMw			
Iw	**0.223**	**1**	**0.636**
Profw	**7.718**	**1**	**0.005**
DSizew	**7.389**	**1**	**0.007**
Rw	**43.383**	**1**	**0.000**
ALL	**89.663**	**4**	**0.000**
Iw			
BMw	**17.834**	**1**	**0.000**
Profw	**42.060**	**1**	**0.000**
DSizew	**6.738**	**1**	**0.009**
Rw	**93.658**	**1**	**0.000**
ALL	**199.829**	**4**	**0.000**
Profw			
BMw	**1.330**	**1**	**0.249**
Iw	**0.245**	**1**	**0.620**
DSizew	**6.999**	**1**	**0.008**
Rw	**7.682**	**1**	**0.006**
ALL	**29.688**	**4**	**0.000**
DSizew			
BMw	**0.007**	**1**	**0.933**
Iw	**0.437**	**1**	**0.508**
Profw	**0.117**	**1**	**0.733**
Rw	**6.805**	**1**	**0.009**
ALL	**7.806**	**4**	**0.099**
Rw			
BMw	**15.288**	**1**	**0.000**
Iw	**9.777**	**1**	**0.002**
Profw	**58.817**	**1**	**0.000**
DSizew	**17.730**	**1**	**0.000**
ALL	**84.264**	**4**	**0.000**

Figure 29. Appendix A4. Robustness check. Alternative ordering. IRFs.



Appendix A.5 Robustness check: alternative lags. PVAR analysis result

Table 19 . Appendix A.5 Robustness check: alternative lags.

```
. pvar Profw Iw BMw DSizew Rw, lags(3) //my idea of order, let's see how it works

Panel vector autoregresssion



GMM Estimation

Final GMM Criterion Q(b) =  1.70e-34
Initial weight matrix: Identity
GMM weight matrix:     Robust
                                                   No. of obs      =     39034
                                                   No. of panels   =      4111
                                                   Ave. no. of T   =     9.495
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Profw						
Profw						
L1.	.4515457	.0241364	18.71	0.000	.4042391	.4988523
L2.	.1130795	.0199029	5.68	0.000	.0740706	.1520885
L3.	.1180366	.0187158	6.31	0.000	.0813543	.1547188
Iw						
L1.	.0055071	.0261843	0.21	0.833	-.0458133	.0568274
L2.	-.0473937	.0242409	-1.96	0.051	-.0949051	.0001177
L3.	-.1037129	.0229619	-4.52	0.000	-.1487173	-.0587084
BMw						
L1.	-.0730828	.0323671	-2.26	0.024	-.1365212	-.0096444
L2.	.036709	.0143679	2.55	0.011	.0085485	.0648695
L3.	.0055881	.0104286	0.54	0.592	-.0148516	.0260278
DSizew						
L1.	.0049364	.0019278	2.56	0.010	.001158	.0087147
L2.	.0005056	.0018156	0.28	0.781	-.0030528	.0040641
L3.	-.0007185	.0016386	-0.44	0.661	-.0039301	.002493
Rw						
L1.	.0002936	.0094495	0.03	0.975	-.0182271	.0188144
L2.	.0214011	.0087221	2.45	0.014	.004306	.0384962
L3.	.0230494	.0053371	4.32	0.000	.012589	.0335099
Iw						
Profw						
L1.	.0475657	.007885	6.03	0.000	.0321115	.0630199
L2.	.02289	.005333	4.29	0.000	.0124375	.0333425
L3.	.0259167	.0049273	5.26	0.000	.0162593	.0355741
Iw						
L1.	.0318608	.0107356	2.97	0.003	.0108194	.0529023
L2.	.0060168	.009931	0.61	0.545	-.0134475	.0254811
L3.	-.0021836	.0092594	-0.24	0.814	-.0203318	.0159646
BMw						
L1.	.0439761	.0101951	4.31	0.000	.0239939	.0639582
L2.	.00479	.0040247	1.19	0.234	-.0030984	.0126783
L3.	.0002783	.0035351	0.08	0.937	-.0066504	.0072069
DSizew						
L1.	.0020019	.0006995	2.86	0.004	.0006309	.0033728
L2.	.0012204	.0006577	1.86	0.064	-.0000687	.0025096
L3.	.0010936	.0006289	1.74	0.082	-.0001389	.0023262
Rw						
L1.	.0285988	.0035322	8.10	0.000	.0216758	.0355217
L2.	.0248918	.0034217	7.27	0.000	.0181854	.0315983
L3.	.0092898	.0022753	4.08	0.000	.0048303	.0137492

BMw						
Profw						
L1.	-.0353718	.0301198	-1.17	0.240	-.0944055	.023662
L2.	.0728967	.0218552	3.34	0.001	.0300612	.1157322
L3.	.0119524	.0185095	0.65	0.518	-.0243254	.0482303
Iw						
L1.	.0746011	.0473328	1.58	0.115	-.0181694	.1673717
L2.	.0918223	.0421717	2.18	0.029	.0091673	.1744774
L3.	.0626601	.0363965	1.72	0.085	-.0086758	.1339959
BMw						
L1.	1.072552	.0735236	14.59	0.000	.9284481	1.216655
L2.	-.0125144	.0292228	-0.43	0.668	-.0697901	.0447612
L3.	.0728187	.0230953	3.15	0.002	.0275527	.1180848
DSizew						
L1.	-.003825	.0027034	-1.41	0.157	-.0091236	.0014736
L2.	.0103445	.0032912	3.14	0.002	.0038939	.0167952
L3.	-.0029438	.0025412	-1.16	0.247	-.0079246	.0020369
Rw						
L1.	-.0517771	.0154358	-3.35	0.001	-.0820307	-.0215235
L2.	-.0121319	.0144946	-0.84	0.403	-.0405409	.0162771
L3.	.0561615	.0091295	6.15	0.000	.0382679	.074055
DSizew						
Profw						
L1.	.0490817	.0574766	0.85	0.393	-.0635705	.1617338
L2.	-.0421019	.0375234	-1.12	0.262	-.1156464	.0314426
L3.	-.0446037	.0340489	-1.31	0.190	-.1113383	.0221309
Iw						
L1.	.0164047	.0736057	0.22	0.824	-.1278598	.1606693
L2.	.0248361	.0654544	0.38	0.704	-.1034522	.1531244
L3.	-.0339747	.0618819	-0.55	0.583	-.1552611	.0873116
BMw						
L1.	-.0717576	.0668792	-1.07	0.283	-.2028384	.0593231
L2.	.0257056	.0311067	0.83	0.409	-.0352625	.0866737
L3.	-.0572945	.0237545	-2.41	0.016	-.1038524	-.0107366
DSizew						
L1.	.0892027	.0202551	4.40	0.000	.0495035	.1289019
L2.	-.0634334	.0184039	-3.45	0.001	-.0995045	-.0273624
L3.	-.0503505	.018287	-2.75	0.006	-.0861923	-.0145088
Rw						
L1.	.0580315	.0240483	2.41	0.016	.0108978	.1051653
L2.	.0549089	.0219406	2.50	0.012	.011906	.0979117
L3.	-.024397	.0143547	-1.70	0.089	-.0525317	.0037376
Rw						
Profw						
L1.	.1467973	.0241594	6.08	0.000	.0994456	.1941489
L2.	-.0285835	.0168072	-1.70	0.089	-.061525	.004358
L3.	.0118588	.01553	0.76	0.445	-.0185795	.0422972
Iw						
L1.	.0770825	.033976	2.27	0.023	.0104908	.1436742
L2.	-.0124574	.0315106	-0.40	0.693	-.074217	.0493023
L3.	-.0369306	.0278036	-1.33	0.184	-.0914247	.0175634
BMw						
L1.	.0240579	.0413245	0.58	0.560	-.0569368	.1050525
L2.	.0176245	.0170577	1.03	0.301	-.0158079	.051057
L3.	-.0272733	.0142614	-1.91	0.056	-.0552251	.0006785
DSizew						
L1.	.0064353	.0022809	2.82	0.005	.0019648	.0109057
L2.	-.0065148	.0023357	-2.79	0.005	-.0110927	-.001937
L3.	-.0022322	.0021218	-1.05	0.293	-.0063907	.0019264
Rw						
L1.	.0470911	.0123541	3.81	0.000	.0228775	.0713047
L2.	-.0103266	.0115747	-0.89	0.372	-.0330127	.0123595
L3.	-.0559568	.0077342	-7.24	0.000	-.0711154	-.0407981

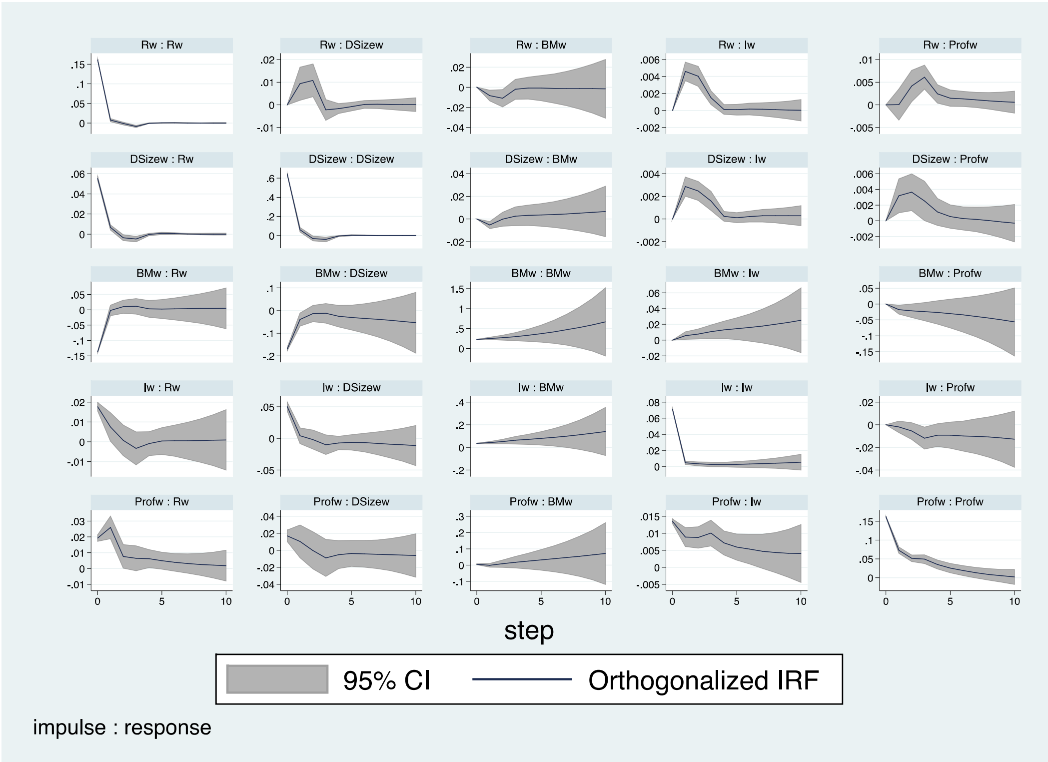
Instruments : **l(1/3).(Profw Iw BMw DSizew Rw)**

```
. pvargranger // Granger

  panel VAR-Granger causality Wald test
    Ho: Excluded variable does not Granger-cause Equation variable
    Ha: Excluded variable Granger-causes Equation variable
```

Equation \ Excluded	chi2	df	Prob > chi2
Profw			
Iw	**29.920**	**3**	**0.000**
BMw	**15.468**	**3**	**0.001**
DSizew	**6.889**	**3**	**0.076**
Rw	**22.622**	**3**	**0.000**
ALL	**111.296**	**12**	**0.000**
Iw			
Profw	**40.611**	**3**	**0.000**
BMw	**20.735**	**3**	**0.000**
DSizew	**10.790**	**3**	**0.013**
Rw	**95.832**	**3**	**0.000**
ALL	**286.451**	**12**	**0.000**
BMw			
Profw	**28.132**	**3**	**0.000**
Iw	**4.902**	**3**	**0.179**
DSizew	**16.478**	**3**	**0.001**
Rw	**53.197**	**3**	**0.000**
ALL	**114.025**	**12**	**0.000**
DSizew			
Profw	**12.615**	**3**	**0.006**
Iw	**1.111**	**3**	**0.774**
BMw	**5.953**	**3**	**0.114**
Rw	**14.065**	**3**	**0.003**
ALL	**39.809**	**12**	**0.000**
Rw			
Profw	**86.758**	**3**	**0.000**
Iw	**17.760**	**3**	**0.000**
BMw	**4.692**	**3**	**0.196**
DSizew	**22.288**	**3**	**0.000**
ALL	**139.008**	**12**	**0.000**

Figure 30. Appendix A5. Robustness check. Alternative lags. IRFs.



Appendix B. Macroeconomic impact of financial system: systemic risk and economic growth

Appendix B.1 Data

Financial System Capital includes US companies' stock market capitalization, US companies' bonds outstanding, and banking loans outstanding. Bank loans include consumer loans, mortgage loans, and business loans. Economic growth is measured by nominal GDP. All data are retrieved from Federal Reserve Economic Data of the Federal Reserve Bank of St. Louis. Data that are required to contract SRI are described in Ivanets (2017) (Chapter II of this dissertation).

Appendix B.2 Cointegration tests

Table 20. Appendix B.2 Cointegration tests

Lambda max test:

H0 (Nbr. of cointegrating equations)	Eigenvalue	Statistic	Critical value	p-value
None	0.298	18.784	24.161	0.226
At most 1	0.126	7.113	17.797	0.800
At most 2	0.103	5.754	11.225	0.379
At most 3	0.022	1.165	4.130	0.327

Lambda max test indicates 0 cointegrating relation(s) at the 0.05 level.

Trace test:

H0 (Nbr. of cointegrating equations)	Eigenvalue	Statistic	Critical value	p-value
None	0.298	32.816	40.175	0.225
At most 1	0.126	14.032	24.275	0.534
At most 2	0.103	6.919	12.321	0.333
At most 3	0.022	1.165	4.130	0.327

Trace test indicates 0 cointegrating relation(s) at the 0.05 level.

Appendix B.3 Stationarity tests in first differences

Prior tests revealed that all variables are I(1). The following tests are already in first differences.

Table 21. Appendix B.3 Stationarity test. GDP

Dickey-Fuller test (ADF(stationary) / k: 3 / GDP):

Tau (Observed value)	-5.679
Tau (Critical value)	-3.468
p-value (one-tailed)	0.000
alpha	0.05

Test interpretation:

- ✓ H0: There is a unit root for the series.
- ✓ Ha: There is no unit root for the series. The series is stationary.
- ✓ As the computed p-value is lower than the significance level alpha=0.05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.
- ✓ The risk to reject the null hypothesis H0 while it is true is lower than 0.01%.

Table 22. Appendix B.3 Stationarity test. FSC

Dickey-Fuller test (ADF(stationary) / k: 3 / FSC):

Tau (Observed value)	-3.687
Tau (Critical value)	-3.468
p-value (one-tailed)	0.029
alpha	0.05

Test interpretation:

- ✓ H0: There is a unit root for the series.
- ✓ Ha: There is no unit root for the series. The series is stationary.
- ✓ As the computed p-value is lower than the significance level alpha=0.05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.
- ✓ The risk to reject the null hypothesis H0 while it is true is lower than 2.94%.

Table 23. Appendix B.3 Stationarity test. SRI

Dickey-Fuller test (ADF(stationary) / k: 3 / SRI):

Tau (Observed value)	-4.506
Tau (Critical value)	-3.468
p-value (one-tailed)	0.003
alpha	0.05

Test interpretation:

- ✓ H0: There is a unit root for the series.
- ✓ Ha: There is no unit root for the series. The series is stationary.
- ✓ As the computed p-value is lower than the significance level alpha=0.05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.
- ✓ The risk to reject the null hypothesis H0 while it is true is lower than 0.31%.

Table 24. Appendix B.3 Stationarity test. CPI

Dickey-Fuller test (ADF(stationary) / k: 3 / CPIgr):

Tau (Observed value)	-5.294
Tau (Critical value)	-3.468
p-value (one-tailed)	0.000
alpha	0.05

Test interpretation:

- ✓ H0: There is a unit root for the series.
- ✓ Ha: There is no unit root for the series. The series is stationary.
- ✓ As the computed p-value is lower than the significance level alpha=0.05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.
- ✓ The risk to reject the null hypothesis H0 while it is true is lower than 0.04%.

Table 25. Appendix B.3 Stationarity test. Gov

Dickey-Fuller test (ADF(stationary) / k: 3 / GOV):

Tau (Observed value)	-3.735
Tau (Critical value)	-3.468
p-value (one-tailed)	0.027
alpha	0.05

Test interpretation:

- ✓ H0: There is a unit root for the series.
- ✓ Ha: There is no unit root for the series. The series is stationary.
- ✓ As the computed p-value is lower than the significance level alpha=0.05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.
- ✓ The risk to reject the null hypothesis H0 while it is true is lower than 2.65%.

Appendix B.4 Regression analysis: period 1963-1989, without controls

Table 26. Appendix B.4 Regression analysis: period 1963-1989, without controls

Analysis of variance (GDP):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Model	2	159619.797	79809.899	9.043	0.001
Error	24	211816.498	8825.687		
Corrected Total	26	371436.295			

Computed against model Y=Mean(Y)

Model parameters (GDP):

Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Intercept	104.848	26.683	3.929	0.001	49.778	159.919
FSC	0.295	0.077	3.844	0.001	0.137	0.454
SRI	-663.8	508.1	-1.306	0.204	-1712.5	385.0

Appendix B.5 Regression analysis: period 1963-1989, with one control

Table 27. Appendix B.5 Regression analysis: period 1963-1989, with one control

Analysis of variance (GDP):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Model	3	161465.052	53821.684	5.896	0.004
Error	23	209971.243	9129.184		
Corrected Total	26	371436.295			

Computed against model Y=Mean(Y)

Model parameters (GDP):

Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Intercept	105.07	27.142	3.871	0.001	48.92	161.22
FSC	0.290	0.079	3.681	0.001	0.127	0.454
SRI	-581.4	548.3	-1.060	0.300	-1715.6	552.8
CPIgr	341.9	759.3	0.450	0.657	-1229.4	1912.1

Appendix B.6 Regression analysis: period 1963-1989, with two controls

Table 28. Appendix B.6. Regression analysis: period 1963-1989, with two controls

Analysis of variance (GDP):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Model	4	172142.844	43035.711	4.751	0.006
Error	22	199293.452	9058.793		
Corrected Total	26	371436.295			

Computed against model Y=Mean(Y)

Model parameters (GDP):

Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Intercept	104.440	27.043	3.862	0.001	48.356	160.525
FSC	0.267	0.082	3.275	0.003	0.098	0.436
SRI	-314.6	598.908	-0.525	0.605	-1556.7	927.4
CPIgr	218.941	764.764	0.286	0.777	-1367.1	1805.0
GOV	-3819.6	3518.124	-1.086	0.289	-11115.7	3477.0

Appendix B.7 Regression analysis: period 1990-2016, without controls

Table 29. Appendix B.7 Regression analysis: period 1990-2016, without controls

Analysis of variance (Var1):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Model	2	50894.317	25447.159	0.475	0.628
Error	24	1286989.863	53624.578		
Corrected Total	26	1337884.180			

Computed against model Y=Mean(Y)

Model parameters (Var1):

Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Intercept	446.986	57.166	7.819	0.000	329.001	564.972
FSC	0.015	0.016	0.954	0.350	-0.018	0.048
SRI	-0.439	106.278	-0.004	0.997	-219.8	218.908

Appendix B.8 Regression analysis: period 1990-2016, with one control

Table 30. Appendix B.8 Regression analysis: period 1990-2016, with one control

Analysis of variance (Var1):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Model	3	60533.250	20177.750	0.363	0.780
Error	23	1277350.931	55536.997		
Corrected Total	26	1337884.180			

Computed against model Y=Mean(Y)

Model parameters (Var1):

Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Intercept	440.572	60.179	7.321	0.000	316.082	565.063
FSC	0.018	0.017	1.023	0.317	-0.018	0.053
SRI	-6.214	109.041	-0.057	0.955	-231.78	219.35
CPIgr	-1419.5	3407.313	-0.417	0.681	-8468.1	5629.1

Appendix B.9 Regression analysis: period 1990-2016, with two controls

Table 31. Appendix B.9 Regression analysis: period 1990-2016, with two controls

Analysis of variance (Var1):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Model	4	363652.449	90913.112	2.053	0.122
Error	22	974231.732	44283.261		
Corrected Total	26	1337884.180			

Computed against model Y=Mean(Y)

Model parameters (Var1):

Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Intercept	457.903	54.144	8.457	0.0001	345.615	570.191
FSC	-0.001	0.017	-0.073	0.943	-0.036	0.034
SRI	25.813	98.135	0.263	0.795	-177.707	229.333
CPIgr	-479.621	3063.705	-0.157	0.877	-6833.357	5874.115
GOV	-22741.5	8692.250	-2.616	0.016	-40768.1	-4714.9

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