THREE ESSAYS ON FINANCIAL DEVELOPMENT IN EMERGING MARKETS

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Abstract

This dissertation collects three essays which deal with financial development in emerging markets. Owing to the appliance of different econometric methods on several data sets, insights in the behavior of and the impacts from financial markets are generated. Usually, the financial markets in emerging countries are characterized by the presence of credit constraints. In the first chapter it is shown that the financial development in 19^{th} century Germany generally affected the economy in a positive way. Additionally, when different economic sectors are under investigation, it is revealed that the reaction due to financial development is not homogeneously across the sectors. A structural vector autoregression (VAR) framework is applied to a new annual data set from 1870 to 1912 that was initially compiled by Walther Hoffmann (1965). With respect to the literature, the most important difference of this analysis is the focus on different sectors in the economy and the interpretation of the results in the context of a two-sector growth model. It is revealed that all sectors were affected significantly by shocks from the banking system. Interestingly, this link is the strongest in sectors with small or non-tradable-goods-producing firms, such as construction, services, transportation and agriculture. In this regard, the growth patterns in 19^{th} century Germany are reminiscent to those in today's emerging markets.

The second chapter deals with the integration of the stock markets of mainland China with those of the United States and Hong Kong. Market integration and the resulting welfare gains as risk sharing, increasing investment and growth benefits has become a central topic in international finance research. This chapter investigates stock market integration after stock market liberalization which is assessed by spillover effects from Hong Kong and the United States to Chinese stock market indices. Dividing the sample in pre- and post-liberalization phases, a causality in variance procedure is applied using four mainland China stock market indices, two indices of the stock exchange in Hong Kong and the Dow Jones Industrials index in the main part. Evidence of global and regional integration is found, but no evidence for increasing integration after the partial opening of the Chinese stock markets, neither with Hong Kong nor with the United States.

Based on the idea presented in the first chapter, the third chapter examines one of today's emerging markets. As China is experiencing remarkable economic growth in the recent decades, it is analyzed if and to what extent the ongoing deregulations in the financial system contribute to this development. Structural VARs for gross domestic product as well as for sectoral output data in conjunction with two different bank lending variables are applied. It is indicated that China is positive affected by financial development and that all sectors benefit from domestic bank lending enlargements but to different degrees. Especially in the sectors where mainly state-owned enterprises are represented - such as construction, trade and transportation - shocks in bank lending have a strong positive influence while sectors where private enterprises are prevalent, seem to be more credit constrained.

Keywords: Causality in Variance, China's Financial System, Credit Market Imperfections, Economic Growth, Emerging Markets, Financial Development, German Industrialization, Information Transmission, Nineteenth Century Germany, Sectoral Asymmetries, Spillover Effects, Stock Market Integration, Stock Market Liberalization

JEL: C22, C23, E44, G15, G21, N13, N23, O11, O16, O41

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Katharina Diekmann

Contents

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List of Abbreviations

A .... Agriculture
ABC .... Agricultural Bank of China
ADBC .... Agricultural Development Bank of China
ADF .... Augmented Dickey-Fuller
AR .... Autoregressive
ARMA .... Autoregressive-Moving Average
ARMA-GARCH-M ...... Autoregressive-Moving Average Generalized Autoregressive Conditional Heteroscedasticity in Mean
B .... Bank Lending
BOC .... Bank of China
C .... Construction
CB .... Corporate Bonds
CCB .... China Construction Bank
CDB .... China Development Bank
Chexim .... Export-Import Bank of China
DJI .... Dow Jones Industrials Index
EC .... Equity Capital
FDI .... Foreign Direct Investment
FI .... Foreign Investment
GNI .... Gross National Income
H .... Hang Seng China Enterprises Index
HP .... Hodrick-Prescott
HSI .... Hang Seng Index
I .... Investment

IB .... Internal Bonds
ICBC .... Industrial and Commercial Bank of China
IN .... Industry
IN2 .... Industry 2
KOR .... Korea Stock Exchange Composite Index
LR .... Likelihood Ratio
M .... Mining
MA .... Moving Average
MF .... Manufacturing
MICs .... Middle-Income Countries
NDP .... Net Domestic Product
NIK .... Nikkei 225 Stock Average Index
NNP .... Net National Product
NPL .... Non-Performing Loans
OECD .... Organisation for Economic Co-operation and Development
PBOC .... People's Bank of China
POE .... Private-Owned Enterprises
PrB .... Private Banks
Prob. .... Probability
PuB .... Public Banks
QDII .... Qualified Domestic Institutional Investor
QFII .... Qualified Foreign Institutional Investor
S .... Services
SHSE .... Shanghai Stock Exchange Composite Index
SHSE A .... Shanghai Stock Exchange A Share Index
SHSE B .... Shanghai Stock Exchange B Share Index
SME .... Small and Medium-Sized Enterprises
SOE .... State-Owned Enterprises
Std. Dev. .... Standard Deviation
SZSE .... Shenzhen Stock Exchange Composite Index
SZSE A .... Shenzhen Stock Exchange A Share Index

SZSE B .... Shenzhen Stock Exchange B Share Index
T .... Trade
TA1 .... Total Assets 1
TA2 .... Total Assets 2
TAI .... Taiwan Stock Exchange Weighted Index
TFP .... Total Factor Productivity
TGOV .... Total Gross Output Value
TR .... Transportation
US .... United States
VAR .... Vector Autoregression
VAR-MVEGARCH ..... Vector Autoregressive Multivariate Exponential Generalized Autoregressive Conditional Heteroskedasticity
WTO .... World Trade Organization

Summary

The three chapters which are presented in this dissertation discuss two specific aspects of financial development and financial liberalization in emerging markets. First, the dependency structure of various sectors on the domestic banking sector is analyzed based on two examples. In chapter 1, Germany at the end of the 19^{th} century and the beginning of the 20^{th} century is under examination whereby similarities to today's emerging markets are revealed. Furthermore, mainland China, one of the most important emerging markets today, is analyzed in the third chapter. Chapter 2 examines the stock market integration of mainland China with the regional market in Hong Kong as well as with the world market in the United States.

Further insights in the sources of growth in emerging markets are provided by assessing the sectoral dependency structure on the domestic banking system. In detail, the role played by the domestic banks in this process is investigated. Furthermore, especially in times of financial crises, financial integration is of particular interest as on the one hand there is a possible risk of contagion and on the other hand the decoupling phenomenon of emerging markets from industrial countries may occur.

To answer the raised research hypothesis, advanced time series econometrics is used. In addition to the main analyses and results of each chapter, extensive appendices with additional information and several robustness checks are provided.

In the following, a more detailed summary of the three chapters are given.

The main stylized and highlighted fact of emerging markets' literature which is under investigation is the presence of credit constraints, enterprises are subject to. These enterprises mainly have in common that they are classified as small and medium-sized firms supplying non-tradable goods on local markets. In the provision of (working) capital, these enterprises are extremely dependent on the domestic banking system as other sources of finance are not available.

Re-examining the banks' contribution in the growth process in 19^{th} century Germany in the first chapter, it is revealed that all sectors are positive affected by the financial development but to different degrees. In contrast to the conventional view, not the industrial sector benefited the most from bank credit enlargements but agriculture, transportation, construction and services. We interpret this result referring to the two-sector growth model of Schneider and Tornell (2004), who show that small, non-tradable-goods producing firms benefit most from domestic bank lending booms in countries with contract-enforceability problems. Hence, these results emphasize that 19^{th} century Germany was faced with the same credit market imperfections as modern emerging markets. Not the large, tradable-goods-producing firms rely on the classical bank credit, but smaller, non-tradable-goods-producing firms as former are able to use (international) capital markets as additional source of finance. Therefore, it seems that the financial development allows for a more balanced growth path as the sectors producing non-tradable goods are allowed to keep pace.

In a broader context, chapter 1 is linked to the persistent discussion how economic growth and financial development interact. Much research - coming to different results - has been done. The focus in this chapter is to answer the question how financial development contributes to economic growth by taking a sectoral perspective. First, three-variable VARs including net domestic product, investment and two bank lending measures are applied and generalized impulse responses as well as variance decompositions are estimated. The hypothesis of a positive effect of bank lending on economic growth which is often discussed in the literature is supported. This is corroborated by using bivariate VARs with Cholesky decomposition and estimating variance decompositions as the positive impact of an unexpected shock in bank lending on economic growth still persists. After this introductive analysis, the sectors mining, industry, agriculture, trade, transportation, service and construction are examined as aggregate measures of output possibly mask asymmetries in sectoral output dynamics. Applying again bivariate VAR frameworks and generate impulse responses with Cholesky decomposition as well as variance decompositions, the findings are interpreted as structurally identified in the context of a theoretical two-sector growth model with credit market imperfections provided by Schneider and Tornell (2004). The sectors are classified as non-tradable (agriculture, construction, transportation and services) and tradable-goods-producing sectors (industry, trade and mining). It is revealed that all subsectors react positive and significant to an unexpected shock in bank lending but interestingly to highly different degrees. While the reaction of the mining, industrial and trade sector is very low, the reaction of the agricultural, construction, transportation and service sector is distinctly stronger regardless which bank lending measure is used. In contrast, using equity capital instead of bank lending as a proxy for other sources of finance besides bank credit, indeed the industry sector shows the strongest reaction.

The contribution of chapter 1 is to provide a new perspective on the role of the domestic banking system in the growth process in 19^{th} century Germany. The traditional opinion that bank lending enlargement has financed the industrial revolution and subsequently the technical progress is called into question as this analysis reveals that the non-tradable-goods-producing sectors were dependent on domestic bank credit while the tradable-goods-producing sectors, in particular the industrial sector, had other source of finance available.

The second chapter sheds light on a different aspect of financial development. Based on a specific stock market liberalization, it is examined whether the reform caused a deeper integration of Chinese stock market indices with those in the United States and Hong Kong. In the empirical research, there is no unanimous view about the effects of financial opening strategies in emerging markets. Next to the proclaimed benefits of a more stable and better regulated financial market, potential risks as for instance the threat of contagion of (financial) crisis are indicated.

A causality in variance approach is applied to Chinese stock market returns series as well as to the return series of stock markets indices from Hong Kong and the United States. In China, there are different types of shares: A shares which were initially restricted to domestic investors, B shares which were designed to foreign investors and H shares, all investors except for Chinese residents are allowed to trade and which are issued in Hong Kong. Additionally, the two stock markets in Shanghai and Shenzhen are included.

Prior to 2002, A and B shares were completely separated. This separation changes with the implementation of the Qualified Foreign Institutional Investor (QFII) program on December 1, 2002. Using four-year samples around this event, the effect of this stock market liberalization on stock market integration is investigated. First, the regional and global integration are analyzed using the bivariate correlations between the Chinese stock market return series and the return series of stock market indices from the United States and Hong Kong indicating a more pronounced regional integration while there is rather weak support of an increase in global integration.

The subsequent analysis applies the causality in variance approach proposed by Cheung and Ng (1996). By estimating autoregressive moving average - generalized autoregressive conditional heteroscedasticity - in mean (ARMA-GARCH-M) models to the return series for both subsamples, cross correlations from the standardized residuals are computed. Afterwards, these cross correlations are used to construct augmented ARMA-GARCH-M models as the significant lagged (squared) returns of the foreign market are incorporated in the mean and variance equations of the original GARCH models. Using the residuals of these augmented models and estimating the cross correlations indicate whether the reported significant cross correlations are caused by the foreign market. Considering both, the cross correlations from the original as well as from the augmented models, no increase of financial integration after the partial opening of the A share market is found as neither regional nor global spillovers occur more often.

In the third chapter, the analysis framework used in chapter 1 is applied with a focus on mainland China. Again, the sectoral reactions on financial development are analyzed. To examine mainland China in this context is of twofold interest. First, it is considered to be one of the most important emerging markets today and secondly, it has become some kind of prominent example in the finance-growth literature as both, its legal and financial system is not well developed but pronounced growth rates are achieved. Therefore, assessing the dependency of various sectors on the domestic banking system is of special interest in order to gain further insights. Furthermore, the effects induced by the ongoing liberalization and restructuring of the Chinese banking system are assessed.

As already revealed in chapter 1, it is shown that the different sectors benefit to different degrees from financial market development in 19^{th} century Germany. This also appears when mainland China is under investigation. Starting with an analysis of gross domestic product, gross capital formation and domestic bank lending in a VAR framework and estimating generalized impulse responses and variance decompositions, it is indicated that bank lending affects economic growth directly as well as indirect through investment. Subsequently, the reaction of the agriculture, manufacturing, construction, transportation and trade sector is investigated. Using impulse responses with Cholesky decomposition as well as variance decompositions, the findings point out that in particular the trade and transportation sector rely on the domestic banking system. In general, those sectors which are dominated by state-owned enterprises rely on the domestic banking system. In contrast, the sectors where mainly privately owned enterprises are existent do not response to bank lending shocks at all. One exception is manufacturing. Although mainly private small and medium-sized enterprises exist, manufacturing is heavily reliant on the domestic banking system. This result may indicate that the ongoing restructuring of the Chinese banking system has been successful at least in this case.

However, these findings show that in mainland China, it is less important if a firm belongs to the tradable- or non-tradable-goods-producing sector. It is far more important whether a firm is state- or privately owned as state-owned firms benefit from preferential treatment in the lending process as lower interest rates are offered and fewer collateral is needed.

Chapter 1 is based on Diekmann and Westermann (2012), "Financial development and sectoral output growth in nineteenth century Germany", *Financial History Review (forthcoming)* and Diekmann and Westermann (2010), "‘Financial development and sectoral output growth in 19^{th} century Germany", *CESifo Working Papers No. 3283*.[1] The second chapter is an

[1] It is also published as *Institute of Empirical Economic Research Working Paper No. 86, University of Osnabrück.*

extension of Diekmann (2011), ”Are there spillover effects from Hong Kong and the United States to Chinese stock markets?” *Institute of Empirical Economic Research, Working Paper No. 89, University of Osnabrück.*

1 Financial Development and Sectoral Output Growth in 19^{th} Century Germany[2]

1.1 Motivation

In this chapter we re-evaluate the hypothesis that bank lending was a key factor in the growth process in 19^{th} century Germany and that it was instrumental in financing the industrial revolution. This hypothesis has been developed, among others, by the influential economic historian Alexander Gerschenkron (1962). This conventional view has been adopted by most researchers and has triggered a literature that discusses the benefits of close bank-firm relationships that were said to be typical of Germany at that time. A survey on papers arguing along these lines is given, for instance, in Guinnane (2002). A notable exception, however, is Edwards and Ogilvie (1996), who challenge this view and point out that large universal banks that serviced the big industrial firms contributed only a small fraction to total bank lending. They argue that universal banks were primarily engaged in organizing the issuance of new shares, but hardly contributed to financing long-term investment by credit.

We employ a new data set to re-investigate whether there has been a positive effect of bank lending on growth and whether indeed the industrial sector - or possibly other sectors in

[2] This chapter is based on Diekmann and Westermann (2012) and Diekmann and Westermann (2010).

the economy - benefited most strongly from the development of domestic credit in Germany. This data set was initially compiled by Walther Hoffmann (1965) for the sample period of 1870-1912 and includes a detailed sectoral disaggregation of output.[3] It therefore allows us to trace the effect of the rapid increase in bank lending on net domestic product, as well as on the sectoral structure underneath it.[4] In this chapter, we focus on the main subsectors mining, industry, construction, agriculture, transportation, trade and services.

In the empirical analysis, we use a vector autoregression (VAR) framework to trace the effect of an unexpected shock in aggregate lending on domestic product and its subsectors. From the VAR coefficients, we generate impulse response functions in two different ways. On the one hand, we use generalized impulse response functions. These can be computed without prior knowledge of the contemporaneous causal relationships among the variables. On the other hand, we use a Cholesky decomposition that was proposed by Tornell and Westermann (2005) and that, using an appropriate ordering, can be interpreted as structurally identified in the context of a theoretical two-sector growth model with credit market imperfections. As output, in the model, depends on investment and credit in period *t-1*, it is assumed not to be affected by bank lending in the same period.[5]

Considering first the aggregate variables, net domestic product (NDP) displays a significant and positive reaction to a standard shock in the bank lending variable, using both identification approaches. We find a direct effect on NDP and an additional indirect channel via its effect on investment. This finding is consistent with most papers on economic history (see,

[3]We also used the updated and corrected series by Burhop (2005) and Burhop and Wolff (2005).

[4]In addition to the historical interest in the German industrial sector, the importance of sectoral information when analyzing the effects of financial deepening on growth, has been emphasized, among others, by Rajan and Zingales (1998) and Schneider and Tornell (2004), as aggregate measures on output often mask deep asymmetries in sectoral output dynamics.

[5]In our empirical exercise a 'period' would be a year, as higher frequencies were unavailable for this time period.

for instance, Burhop (2006) for Germany, Levine (1997), King and Levine (1993), Rousseau and Wachtel (1998, 2000) and Schularick and Steger (2010) for other countries), as well as a large body of literature on finance and growth in the post- World War II period, in particular in today's emerging markets (see Beck et al. (2000) for an overview).

In the sectoral analysis, all subsectors also react significantly to an unexpected shock in aggregate lending. However, it is interesting that the importance of these shocks varies substantially across sectors. In a variance decomposition of the forecast errors, it is revealed that shocks from the banking system only play a minor role for the mining sector, the industrial sector and the trade sector. On the other hand, the agricultural sector, the construction sector, the transportation sector and the service sector are substantially more affected. Although our findings confirm previous empirical studies on the aggregate impact of bank lending on growth, they therefore challenge the conventional view of the role the banking system has actually played in promoting growth. Our results indicate that rather than speeding up the structural change within the industrial sectors, the importance of the bank lending was that it allowed other sectors to keep pace. In a period of rapid technological change, it seems to have allowed for a more *balanced* growth path that could otherwise have taken place. This result appears to be at odds with the hypothesis that the industrial sector benefited most from the development of lending in the banking sector, but is consistent with Edwards and Ogilvie's view that German banking system was primarily engaged in small-firm financing.

The importance of sectoral information, when analyzing the effects of financial deepening on growth, has also been emphasized in Schneider and Tornell (2004), who point out that aggregate measures on output often mask deep sectoral asymmetries in credit-constrained economies.[6] It is interesting that the sectoral patterns observed in today's emerging markets

[6] See also Rajan and Zingales (1998).

are indeed reminiscent of the sectoral growth pattern in 19^{th} century Germany. Tornell, Westermann and Martinez (2003) have documented in a broad cross-section of middle-income countries from 1980-2000 that there exists a pronounced shift toward small firms and those producing non-tradable goods in periods of rapid credit expansion.[7] Schneider and Tornell (2004) motivate theoretically that small firms in non-tradable-goods-producing sectors are likely to benefit most from bank lending, while the tradable sectors typically consist of large firms that have other forms of financial instruments available. In their model, the latter sectors can borrow directly from the (international) capital market and are largely unaffected by the domestic banking system. Taking these characteristics of credit markets into account, Rancière and Tornell (2010) developed a two-sector growth model, in which the non-tradable sector creates a 'bottleneck' to economic growth as it is used as an input in the tradable sectors' production. Relaxing the credit constraints in the non-tradable sector therefore leads to overall higher growth.

The empirical results in this chapter seem to confirm this view. The industrial, mining and trade sectors are classical tradable-goods-producing sectors. In particular, the industrial sector displayed the highest export share during the late 19^{th} and early 20^{th} century in Germany. Also the latter two sectors consist of mainly large firms. Construction, transportation and services are clearly non-tradable. Although agriculture ranks among the more tradable sectors today, it is plausible that due to the lack of modern refrigerating technologies as well as high tariffs, its output was substantially less tradable more than a century ago. Also, this sector is characterized by a large number of relatively small firms.[8] The rapid increase in productivity of small agricultural firms is documented in van Zanden (1991).[9] Its

[7]See also Krueger and Tornell (1999) for a case study on Mexico.

[8]The changing role of the agricultural sector in the late 19^{th} century towards more global interpretation has been documented by O'Rourke and Williamson (1999).

[9]Van Zanden shows that the use of mechanical threshers, reapers or sowing machines was particularly high

importance for the industrial revolution has been discussed for instance in Perkins (1981) and Webb (9822).[10] In the context of the Rancière and Tornell model, it can be seen as an input into the production process, and the financial sector development helps to remove this bottleneck that prevents an overall higher growth path. Finally, the assumptions on credit market imperfection in the Schneider and Tornell (2004) model are likely to be valid for our sample period. Guinnane (2001) has argued that rural credit was a significant problem in 19^{th} century Germany and pointed out that "*credit conditions in Germany sound similar to those found in many developing countries today*" (p.368).

We test for the robustness of our results in several ways. First, we employ three alternative indicators of bank lending, the net contribution of banks to financing investment and total assets in the banking system, reported by Hoffmann (1965), as well as the total assets of joint-stock credit banks, reported by Burhop (2002) and Deutsche Bundesbank (1976). Furthermore, we use data on equity capital to show that the non-tradable sectors did not benefit disproportionately from alternative forms of financing that are typically used by large industrial firms. When using equity capital in our VARs instead of bank lending, the industrial sector is the one that reacts to an unexpected increase in financial resources most strongly.

Section 1.2 provides a description of the data and a preliminary analysis of the unit root and cointegration properties.[11] The VAR analysis of aggregate output is given in Section 1.3. Section 1.4 contains the sectoral analysis and robustness tests. Section 1.5 concludes.

in post-1870 Germany. The development of agricultural finance in the 19^{th} century Germany has also been documented in Blömer (1989).

[10] This has also been documented for other countries. There is a consensus among economic historians that an agricultural revolution has preceded the industrial revolution in several countries (see, for instance, Crafts (1985) who documents growth in the agricultural sector in England prior to 1820).

[11] Additional information about the sources and composition of our variables is provided in Section 1.A.11 in the appendix.

1.2 Description of the data and preliminary analysis

The data in our analysis are drawn from a book written by the German economic historian Walther Hoffmann (1965). This data set is particularly useful for our analysis because it includes a detailed decomposition of sectoral output.

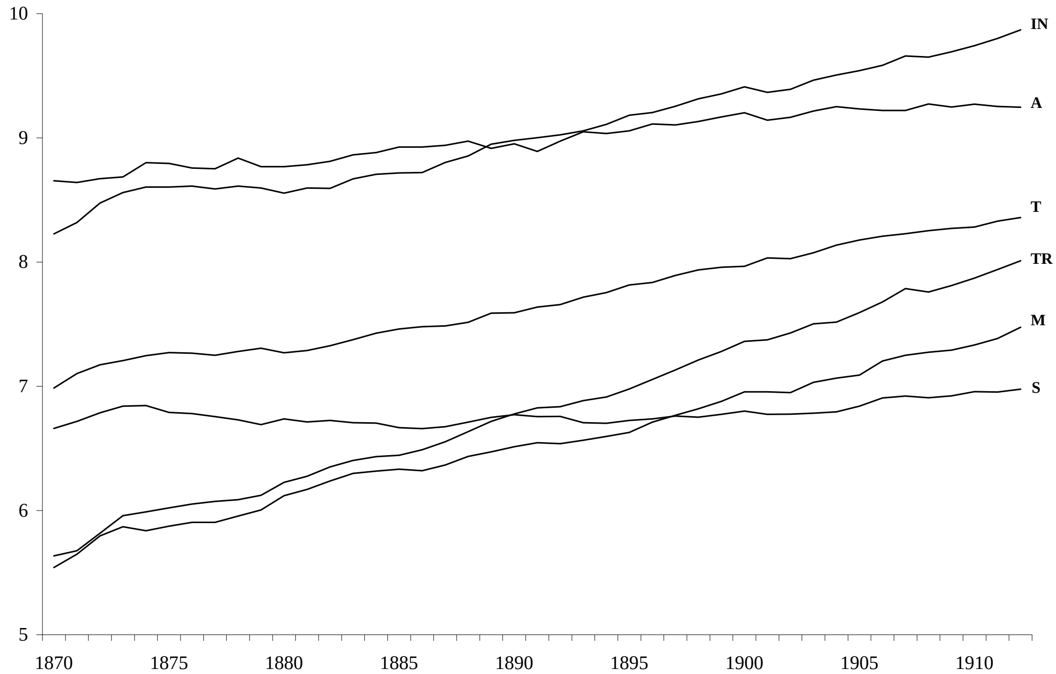
Our main variables are *net domestic product (NDP)*[12], *investment (I)*[13] and *bank lending (B)*[14]. Both, domestic product and investment are expressed in net terms and in constant 1913 prices. Our bank variable captures the contribution of banks in the financing of net investment.

On a disaggregated level we consider the following sectors: *mining (M)*, *industry (IN)*, *agriculture (A)*, *trade (T)*, *transportation (TR)* and *services (S)*.[15] The mining sector contains value added of mining and salines, the industry sectors consists of industry and skilled crafts and the agriculture sector covers the value added of farming, forestry and fisheries. The trade sector contains the value added of trade, banks, insurances and public houses. Figure 1.1 shows the time paths of the sectors in logged terms. While mining and industrial production were growing very fast over our sample period there was also substantial growth in agriculture. Transportation was the fastest growing among all sectors.

We also take an alternative measure of the banks' contribution to financing investment. Our indicator *total assets 1(TA1)* includes the total assets of savings banks, cooperate credit associations, mortgage banks, banks of issue, land mortgage banks and commercial banks.[16] *Total assets 2 (TA2)* represents the total assets of joint-stock credit banks reported in Burhop

[12]See Hoffmann (1965), table 5a, p.26f., converted in level data.
[13]See Hoffmann (1965), table 248, p.825f.
[14]See Hoffmann (1965), table 239, p.812f. Because the data for *bank lending* are only available in nominal terms, we adjusted the values with the price index for the net national product, see table 148, p.598ff.
[15]See Hoffmann (1965), table 103, p.454f.
[16]See Hoffmann (1965), table 202, 203, 205, 206, 207, 208 p.733ff.

Figure 1.1: Sectoral Output (in logs)



Note: The graphs of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR), and services (S) are displayed.

(2002). *Equity capital (EC)* represents the paid-up capital of stock corporations.[17] All data are recorded on an annual basis. The sample period covers the years 1870 to 1912.[18]

We start our empirical analysis by testing the unit root properties of our time series. We first apply the conventional augmented Dickey-Fuller (ADF) test. In Table 1.1, which reports the results for our main variables, all of our time series are non-stationary in levels, but stationary in first differences. The optimal lag length in the test specifications was chosen by the Schwarz information criterion.

In the following sections of this chapter we will estimate the causal linkages among our main variables by using a vector autoregression. In this VAR our variables enter in logged

[17]See Hoffmann (1965), table 220, p.772ff.

[18]Note that some of the data go back to 1850. In our benchmark regressions, we did not take the full time period, however, in order to limit our analysis to a period in which the federal territory of Germany was uniform and to avoid structural breaks. We also avoid the necessary interpolation of some data points in the 1850s. The main results of the analysis are unaffected by the choice of the time window.

Table 1.1: Results of ADF Tests

Variable	Levels			1st Differences		
	ADF	k	Prob.	ADF	k	Prob.
Net domestic product	0.252	0	0.973	-5.493***	0	0.000
Investment	-0.988	1	0.749	-12.507***	0	0.000
Bank lending	-2.455	0	0.134	-6.950***	1	0.000
Total assets 1	-2.840	0	0.061	-4.596***	0	0.000
Total assets 2	-1.691	2	0.428	-4.648***	0	0.001
Equity capital	0.123	4	0.963	-4.938***	3	0.000
Mining	-0.205	0	0.930	-5.679***	1	0.000
Industry	0.119	0	0.964	-4.875***	0	0.000
Agriculture	-0.953	0	0.761	-8.067***	0	0.000
Trade	0.347	0	0.978	-7.984***	0	0.000
Transportation	-0.584	0	0.864	-5.465***	0	0.000
Services	-1.364	1	0.591	-4.804***	0	0.000

Note: The ADF test (allowing for an intercept) is calculated for the levels and first differences of net domestic product (NDP), investment (I), bank lending (B), total assets 1 (TA1), total assets 2 (TA2), equity capital (EC), mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The lag length is selected by the Schwarz information criterion. *** indicates significance at the 1% level.

levels and we therefore need to check the cointegration properties of our data set as second preliminary exercise (see Table 1.2).

Overall, there is substantial evidence on cointegration among our time series, although in some cases the evidence is mixed, when using different techniques of estimation. Using the Engle and Granger (1987) approach, we find evidence of cointegration among all pairs of time series that later enter the VAR analysis, with exception of services and bank lending. However, we cannot generally confirm cointegration using the Johansen (1991) test. In particular the three-variable system of net domestic product, investment and bank lending as well as some bivariate combinations do not appear cointegrated in this second approach.

Although there is only mixed evidence on cointegration, we continue with the VAR specification in levels, as the alternative - an estimation in first differences - seems to have even more severe shortcomings. The time series in the first differences have a much higher variance in the beginning of the sample than towards the end. The intuition of this phenomenon is that at this very early stage of development, the time series start to grow from very low levels.

Table 1.2: Results of Cointegration Tests

	Johansen				Engle/Granger
Variable		Trace		Max-Eigenvalue	
Net domestic product, investment	r=0	61.634**°°	r=0	25.360* °	-4.016*
and bank lending	r≤1	36.275**°°	r=1	18.934* °	
	r≤2	17.340**°°	r=2	17.340**°°	
Net domestic product and bank lending	r=0	38.974**°°	r=0	23.660**°°	-3.417*
	r≤1	15.314**°°	r=1	15.314**°°	
Investment and bank lending	r=0	30.903**°°	r=0	21.465**°	-4.243**
	r≤1	9.438*	r=1	9.438*	
Mining and bank lending	r=0	36.425**°°	r=0	27.208**°°	-3.176*
	r≤1	9.217	r=1	9.271	
Industry and bank lending	r=0	31.528**°°	r=0	20.425**°	-3.467*
	r≤1	11.103* °	r=1	11.103* °	
Agriculture and bank lending	r=0	26.850**°	r=0	15.858*	-3.614**
	r≤1	10.992* °	r=1	10.992* °	
Trade and bank lending	r=0	48.807**°°	r=0	33.476**°°	-3.564*
	r≤1	15.331**°°	r=1	15.331**°°	
Transportation and bank lending	r=0	30.750**°°	r=0	18.707* °	-3.245*
	r≤1	12.043* °	r=1	12.043* °	
Services and bank lending	r=0	11.252	r=0	8.631	-1.567
	r≤1	2.621	r=1	2.621	

Note: * and ** indicate significance at the 5% and 1% level by employing critical values from Osterwald-Lenum. ° and °° indicate significance at the 5% and 1% level for critical values from Cheung and Lai (1993). For Engle and Granger (1987) cointegration, * and ** indicate significance at the 5% and 1% level using critical values from MacKinnon (1991).

Thus, positive as well as the negative growth rates will have a much larger amplitude than in the later part of the sample, where they have reached a higher level.

Proceeding with VARs in levels, we need to keep in mind, however, a potential bias in our results if the time series are not clearly cointegrated. Except for the bivariate combination of services and bank lending, we reject the null of no cointegration at least in one of the three approaches (Engle/Granger, Johansen, Trace/Max-Eigenvalue Statistic).

1.3 Investment, credit and output growth - a VAR analysis

In the subsequent analysis, we take two different approaches of modeling the link between financial development and growth. One of the key issues in a VAR framework is the identification of structural shocks. In our first approach, we apply the concept of generalized impulse responses. This approach has the benefit that the impulse response functions are independent of the ordering of the variables in the VAR. However, its drawback is that the structural shocks are ultimately not identified. We simulate a *system shock* where the contemporaneous reactions of the other variables are already included.

In the second approach we follow the structural identification proposed in Tornell and Westermann (2005). The identification is based on a theoretical two-sector growth model that also guides the analysis in the later sections of this chapter. We employ a Cholesky decomposition, where output cannot contemporaneously react to domestic lending in the same period. The intuition is that output results from investment that is financed by domestic credit in the period t-1. This also applies to sectoral output. As lending, on the other hand, can react to changes in output in the same period, we have a recursive system that can be used to identify shocks from each variable, following the standard Cholesky procedure. The advantage of this approach is that a structural interpretation can be given to the impulse response functions in the context of this model. A drawback is that we need to limit the analysis to bivariate systems. In our view, neither of the two approaches may clearly be better, but jointly, they give a more complete picture of the link between financial development and growth.

Generalized impulse response functions

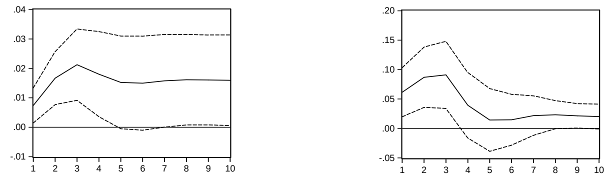
Figure 1.2 reports the generalized impulse responses from our first VAR, which includes net domestic product, investment and bank lending.[19] Our main interest is in the effect that banks have on the net domestic product, which is displayed in panel A. There, a statistically

[19]Generalized impulse response functions including both total assets measures as well as equity capital are available in the appendix, see Section 1.A.2. The main result persists albeit not as distinctively as in the benchmark estimation reported here.

significant effect for about four years exists. In addition, panel B shows that there is another indirect effect. For a period of three to four years, an unexpected increase in bank lending increases investment.[20] It is well known that investment, in turn, has a positive impact on NDP.[21]

Figure 1.2: Generalized Impulse Responses for Net Domestic Product, Investment and Bank Lending

Panel A	Panel B
Reaction of NDP to a shock in B	Reaction of I to a shock in B



Note: The solid lines trace the impulse responses of net domestic product (NDP) and investment (I) to a shock in bank lending (B). The dashed lines show the asymptotic standard errors.

Table 1.3: Variance Decomposition for Net Domestic Product, Investment and Bank Lending

	Years	
Variance Decomposition	5	10
NDP variance due to B (in percent)	24.009	23.129
	[12.374]	[12.294]
I variance due to B (in percent)	30.006	29.281
	[12.470]	[12.541]

Note: The variance decomposition (in percent) of the forecast error is shown for the three-variable VAR, including net domestic product (NDP), investment (I) and bank lending (B). The values in parentheses indicate the standard deviation.

Although the impulse response functions reveal a clear link between aggregate bank credit and net domestic product, they do not allow us to assess the importance of these shocks in the total forecast error variance. For this purpose, we conduct a variance decomposition as a next step. Table 1.3 shows the variance decomposition for a forecast horizon of five and ten

[20] In Section 1.A.8 in the appendix, a VAR including total factor productivity (TFP) as proxy for technical growth next to net domestic product and bank lending is applied. It is shown that TFP did not contribute to Germany's growth process in the 19^{th} century. Only little evidence is found that TFP contributes to the growth of the trade sector.

[21] Indeed, the impulse response for NDP and investment reveals a positive but short-lived impact on NDP when investment is shocked unexpectedly. Because this effect is often reported in the literature, we do not show this graph in this chapter.

years. We find that bank lending explains up to 24.0% of the forecast error variance of net domestic product and up to 30.0% of the forecast error variance of investment. Although this implies that other shocks seem to be more important, this is a relatively high number in a VAR analysis.[22]

Cholesky decompositions

Now, the alternative approach of a Cholesky decomposition proposed by Tornell and Westermann (2005) is estimated. Panel A and panel B of Figure 1.3 show the results of the impulse response functions, generated from two different VARs. In this first VAR, we only include NDP and B, in the second one, we include NDP and I. Panel A displays that there is a positive and significant reaction of net domestic product to an unexpected shock in bank lending. Furthermore, in panel B, we see that there is also a significant reaction of investment to bank lending.[23] The variance decomposition, reported in Table 1.4, indicates that the shock in bank lending explains 21.0% and 25.7% of the forecast error variance. Thus, the results seem to confirm the finding from the previous section that used generalized impulse response functions.[24]

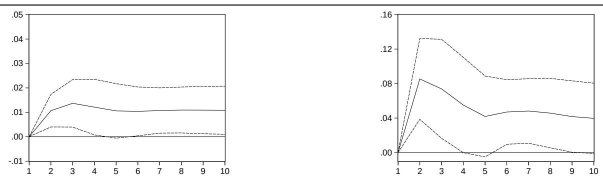
[22]The estimation of generalized impulse response functions is a useful approach as it allows for a representation that needs very few assumptions about the underlying causal structure of the variables. This can be seen in the graphs, for instance, from the fact that none of the impulse response functions starts from zero (due to the assumptions on the recursiveness of the variables). As discussed above, a shortcoming of this approach is the lack of precise identification when the contemporaneous correlation is fairly high.

[23]Note that these impulse response functions come from separate regressions. In a Cholesky decomposition it is not feasible to include the three variables at the same time, as it does not exists a plausible ordering for net domestic product and investment.

[24]In Section 1.A.3 in the appendix, the generalized impulse responses from bivariate VARs using total assets 1, total assets 2 or equity capital instead of bank lending are shown. A positive impact of these variables on economic output is reported. Additionally, generalized impulse responses and variance decompositions from these bivariate VARs confirming the positive link are presented in the Section 1.A.4 in the appendix.

Figure 1.3: Impulse Responses for Net Domestic Product and Bank Lending, and Investment and Bank Lending

Panel A	Panel B
Reaction of NDP to a shock in B	Reaction of I to a shock in B



Note: The solid lines trace the impulse responses of net domestic product (NDP) and investment (I) to a shock in bank lending (B). The dashed lines show the asymptotic standard errors.

Table 1.4: Variance Decomposition for Net Domestic Product and Bank Lending, and Investment and Bank Lending

	Years	
Variance Decomposition	5	10
NDP variance due to B (in percent)	20.777	21.045
	[10.648]	[11.186]
I variance due to B (in percent)	25.256	25.690
	[12.860]	[13.955]

Note: The variance decomposition (in percent) of the forecast error is shown for two-variable VARs, including net domestic product (NDP) and bank lending (B), and investment (I) and bank lending (B). The values in parentheses indicate the standard deviation.

1.4 A sectoral analysis

The findings in the previous sections largely confirmed earlier research on historical data in Germany and other countries. A key question that we would like to address in the present chapter is to understand which sectors of the economy benefited most from the positive link between bank lending and growth. In the literature on today's emerging markets, pronounced sectoral asymmetries are often reported. We find it very interesting to compare how the growth process in 19^{th} century Germany relates to the experiences of the emerging markets of the last 20 to 30 years. We therefore also investigate the sectoral differences in the responses of output to aggregate lending in this section.

In the literature on financial development in emerging markets, sectors are typically classified as small (and non-tradable) or large (and tradable). The motivation for this classification is that the former set of firms finances investment mainly via the domestic banking system, while the latter has other financial instruments available, such as issuing equity or commercial paper, or borrowing on the international capital market. It is often found that the strength of the link between financial development and output growth differs substantially between these two groups. This difference across sectors is quite pronounced in middle-income countries and emerging markets but less prevalent in industrial economies.

The data set of Hoffmann (1965) includes detailed information on the sectoral aggregate accounts of Germany and allows us to perform such a decomposition. We focus on six main subsectors of net domestic product, the industrial sector, mining, agriculture, trade, transportation and services. Figure 1.4 shows the impulse response functions that were generated from bivariate VARs, including the respective measure of output and our bank lending variable. As in the previous section, we generate the impulse response functions from a Cholesky decomposition, where the bank lending variable is ordered at the second position in the VAR.[25]

We find that in all sectors there is a positive reaction of output to an unexpected shock in bank lending. In all sectors, except for the trade sector, this reaction is also statistically significant at the 5% level.[26] However, the variance decomposition in Table 1.5 displays that shocks coming from the banking system are of quite different importance for the various sectors of the economy. The insignificant trade sector is least affected by banks. Shocks from the banking system explain only up to 4.9% of the forecast uncertainty of the trade sector. Interestingly, shocks from the banking system also show little impact on the industry and

[25] In Section 1.A.1 in the appendix, the cointegration characteristics of the bivariate combinations of sectoral output and total assets 1, total assets 2 and equity capital are shown as VARs with these variables are used in Section 1.4. We are able to report cointegration in most cases.

[26] The results remain qualitatively similar regardless of whether we use Cholesky decomposition or generalized impulse responses as well as total assets 1, total assets 2 and equity capital instead of bank lending, see Section 1.A.5 in the appendix.

mining sectors, with values of 9.3% and 5.7%. This finding is interesting as it challenges the conventional wisdom that the industrial revolution was substantially accelerated by the parallel development of the banking system. On the other hand, most affected by shocks in the banking system were agriculture (up to 17.9%), transportation (up to 25.4%) and services (up to 25.1%).[27]

The structure of German exports - that was also recorded, although not on an annual basis, by Hoffmann (1965) - suggests that the industrial sector was indeed the most tradable in Germany. In 1910-13, final goods had the largest share in total German exports - textiles (12.3%), metal and machinery (21%) as well as chemicals (9.9%) - followed by raw materials such as coal (5.3%) and half-manufactured goods such as iron (6.6%). Food products, such as grain (3.4%) and sugar (2.3%) had substantially smaller shares.[28] Exports as a share of production were also quite high within some sectors. The highest shares were recorded for leather products (110%), metal products (93%) and textiles (99%) in 1910-13. Overall the export share of production increased from 70% in 1875-79 to 95% in 1910-13.[29]

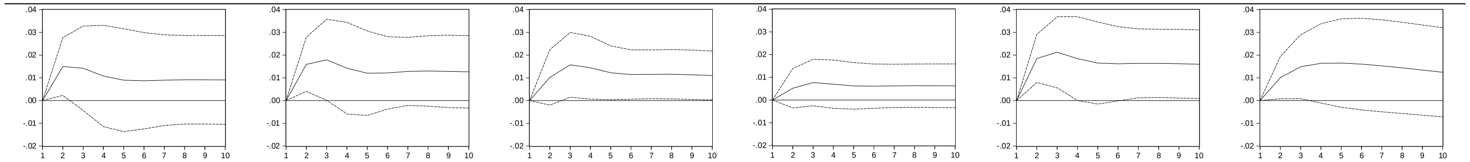
Although this evidence does not support the view that bank development was very important for technological progress that occurred in manufacturing during the industrial revolution, it is remarkable that the patterns in 19^{th} century Germany are very similar to modern emerging markets. In emerging markets, typically the non-tradable sectors are impacted the most by the domestic banking system (see Tornell and Westermann (2005) and IMF (2004)). Table 1.5 shows that this was also the case in 19^{th} century Germany, as both services and transportation are clearly non-tradable. Owing to the lack of modern refrigeration, the out-

[27]Note that the significance level of the variance decomposition is very low in general. However, our robustness tests in the following section show that the contributions of banks to the forecast error variance are also significant at conventional levels when using the alternative banking indicator.
[28]See Hoffmann (1965), table 60, p.154.
[29]See Hoffmann (1965), table 70, p.158.

put of the agricultural sector is likely to have been relatively non-tradable as well. Webb (1977) documents that tariff protection was substantially higher in agriculture than in other industrial sectors.

Figure 1.4: Impulse Responses for Sectoral Output and Bank Lending

Reaction of M to a shock in B	Reaction of IN to a shock in B	Reaction of A to a shock in B	Reaction of T to a shock in B	Reaction of TR to a shock in B	Reaction of S to a shock in B



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in bank lending (B). The dashed lines show the asymptotic standard errors.

Table 1.5: Variance Decomposition for Sectoral Output and Bank Lending

Period	M due to B	IN due to B	A due to B	T due to B	TR due to B	S due to B
5	6.773	9.691	16.049	4.556	24.643	16.559
	[8.496]	[8.481]	[13.064]	[6.939]	[12.972]	[14.152]
10	5.730	9.343	17.969	4.916	25.386	25.095
	[9.577]	[9.213]	[14.958]	[8.264]	[15.532]	[20.331]

Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The values indicate the share of the forecast error variance that is due to a shock in bank lending (B). The values in parentheses represent the standard deviation.

Bank lending measured by total assets

In this subsection we perform some robustness tests to our main findings that (a) banks contributed substantially to investment and growth in 19^{th} century Germany and (b) this has been particularly important for non-tradable sectors. We start by taking an alternative measure of bank lending.

As all of our variables - net domestic product and investment - are in net terms, we initially started the analysis with the net contribution of the banking system to financing investment as our main indicator of bank lending. In the present section we first take the more conventional measure of total assets in the banking system that is also reported in the Hoffmann data set as an alternative (denoted as TA1 in the following tables).

The impulse response functions of the six sectors of the economy are displayed in Figure 1.5. We see that all sectors (except trade) respond positively to a standard shock in our alternative measure of bank lending.[30] Furthermore, Table 1.6 shows, that we find roughly similar results also for the variance decomposition. Overall the share of the forecast error variances is somewhat higher than in the previous tables. The least affected sector is still the trade sector (up to 7.3%), followed by the industrial sector (24.8%), mining (32.1%) and transportation (33.9%). Substantially higher values are found in the agriculture sector (53.3%) and in services (59.9%). Again, the non-tradable sectors appear to have been more strongly affected by bank lending than the industrial or mining sector.[31]

Furthermore, we compare our findings to a second measure of total assets, reported by Burhop (2006) and Deutsche Bundesbank (1976) (denoted as TA2). This second measure of

[30] The results remain similar when using generalized impulse response functions, see Section 1.A.5 in the appendix.

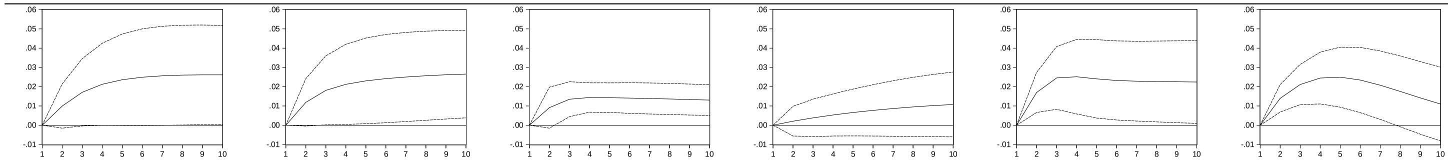
[31] In Section 1.A.9 in the appendix, we examine total assets grouped by public and private banks. Again, it is shown that both variables exert more influence on the non-tradable-goods-producing sectors. Differences of the sectoral reactions are only weakly indicated.

total assets is restricted to the assets of joint-stock credit banks, but has been used in earlier studies, including Burhop (2002) who updated the data set until 1913.[32]

[32]The data of this new total assets variable are extracted from Burhop (2002) for the years 1870 to 1882 and from Deutsche Bundesbank (1976) for 1883 to 1912. We adjusted the values with the price index for the net national product from Hoffmann (1965), table 148, p.598ff.

Figure 1.5: Impulse Responses for Sectoral Output and Total Assets 1

Reaction of M to a shock in TA1	Reaction of IN to a shock in TA1	Reaction of A to a shock in TA1	Reaction of T to a shock in TA1	Reaction of TR to a shock in TA1	Reaction of S to a shock in TA1



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in total assets 1 (TA1). The dashed lines show the asymptotic standard errors.

Table 1.6: Variance Decomposition for Sectoral Output and Total Assets 1

Period	M due to TA1	IN due to TA1	A due to TA1	T due to TA1	TR due to TA1	S due to TA1
5	17.946	13.897	33.133	2.468	31.212	46.562
	[16.247]	[13.224]	[11.584]	[6.010]	[16.796]	[14.979]
10	32.093	24.847	53.348	7.274	33.908	59.882
	[22.455]	[19.798]	[14.181]	[11.766]	[23.282]	[16.409]

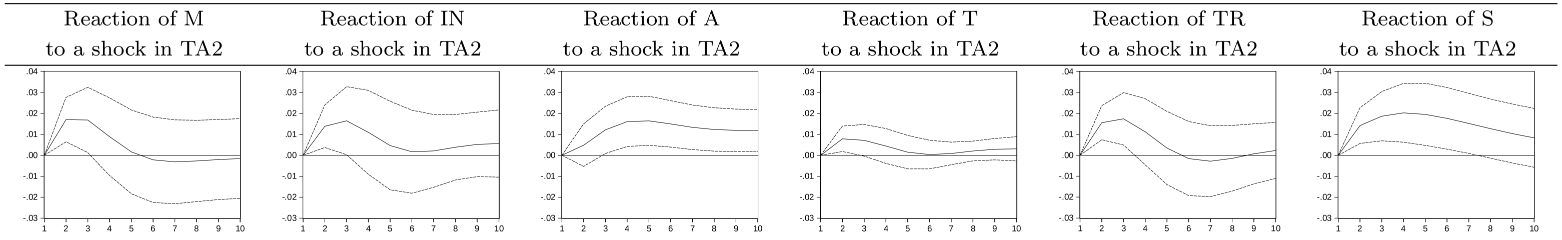
Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The values indicate the share of the forecast error variance that is due to a shock in total assets 1 (TA1). The values in parentheses represent the standard deviation.

An alternative measure of total assets

In this second measure of total assets (TA2), we again find a positive and significant response of output in all sectors to an unexpected change in lending, as documented in Figure 1.6.[33] In Table 1.7, we see that there are substantial differences in the variance decomposition. The largest responses are in the agricultural and service sectors where the responses are statistically significant at the 5% level. Among the remaining sectors, lending seems to be least important for the trade sector, followed by industry, mining and transportation. In all these sectors, the share of the variance that can be explained by shocks from the banking system is statistically insignificant after ten years. Overall, these patterns are quite similar to the previous bank lending measures.

[33] Using generalized impulse responses in contrast to impulse responses with Cholesky decomposition presented here, the results remain unchanged, see Section 1.A.5 in the appendix.

Figure 1.6: Impulse Responses for Sectoral Output and Total Assets 2



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in total assets 2 (TA2). The dashed lines show the asymptotic standard errors.

Table 1.7: Variance Decomposition for Sectoral Output and Total Assets 2

Period	M due to TA2	IN due to TA2	A due to TA2	T due to TA2	TR due to TA2	S due to TA2
5	9.746	6.042	18.185	4.204	10.386	26.621
	[8.573]	[7.554]	[12.117]	[4.604]	[8.667]	[14.055]
10	5.081	3.391	22.476	2.611	5.119	34.821
	[7.001]	[6.595]	[14.280]	[3.823]	[5.833]	[16.824]

Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The values indicate the share of the forecast error variance that is due to a shock in total assets 2 (TA2). The values in parentheses represent the standard deviation.

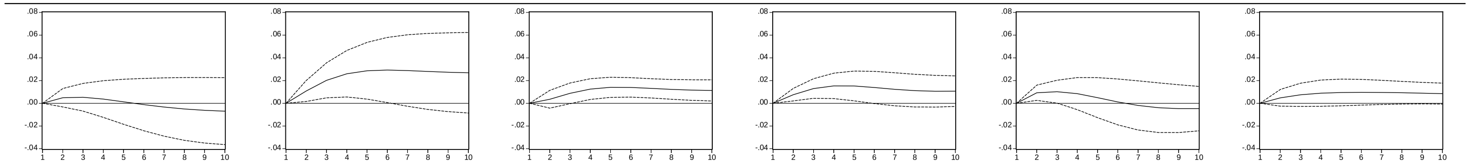
Equity capital

Finally, we perform a plausibility test for our main hypothesis that small, non-tradable-goods-producing sectors were dependent on the banking system, while other sectors, in particular the industrial sector, had other sources of finance available. In the Hoffmann data set, we extracted the time series on total equity capital (denoted as equity capital (EC)) that was raised in the economy by listed stock market companies. Using this indicator in our regressions - instead of bank lending - we find that the industrial sector indeed reacts most strongly to an unexpected change in equity capital that is statistically significant at the 5% level (see Figure 1.7). Most other sectors (except mining) also show a significant but quantitatively smaller reactions than the industrial sector.[34] When looking at the variance decomposition in Table 1.8, this finding is also confirmed. After five years, the industrial sector and the trade sector show the highest share of forecast error variance that is explained by shocks in the equity capital with 20.5% and 23.4%, respectively. After a period of ten years, it is again the agricultural sector that is most affected, followed by the industrial sector and the trade sectors, although with a much smaller lead compared to the previous section. For services the equity financing plays a much smaller role explaining only 5.2% of the variance after five years and 11.1% after ten years.[35]

[34] Again, the main conclusions do not change applying generalized impulse responses. Furthermore, all impulse responses are statistically significant at the 5% level, see Section 1.A.5 in the appendix.

[35] In Section 1.A.7 in the appendix, results for corporate as well as internal bonds are presented, highlighting that corporate bonds are especially useful for the agriculture sector while internal bonds exerts more influence on the industrial and trade sector.

Figure 1.7: Impulse Responses for Sectoral Output and Equity Capital



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in equity capital (EC). The dashed lines show the asymptotic standard errors.

Table 1.8: Variance Decomposition for Sectoral Output and Equity Capital

Period	M due to EC	IN due to EC	A due to EC	T due to EC	TR due to EC	S due to EC
5	0.670	20.532	16.207	23.426	3.594	5.202
	[3.026]	[13.086]	[9.637]	[15.464]	[5.668]	[7.061]
10	0.852	24.775	26.664	20.462	2.272	11.091
	[6.767]	[20.563]	[13.019]	[17.772]	[5.561]	[10.762]

Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The values indicate the share of the forecast error variance that is due to a shock in equity capital (EC). The values in parentheses represent the standard deviation.

Sectoral output data by Burhop/Wolff and further robustness tests

In a further robustness test, we investigate an alternative sectoral data set that was used by Burhop and Wolff (2005) and Burhop (2005). In this alternative data set, we are able to confirm that the industrial sector reacts more strongly to equity capital than to bank lending. Figure 1.8 shows that the industrial sector's reaction to bank lending is statistically insignificant while the reaction to equity capital is significant for three to ten years.

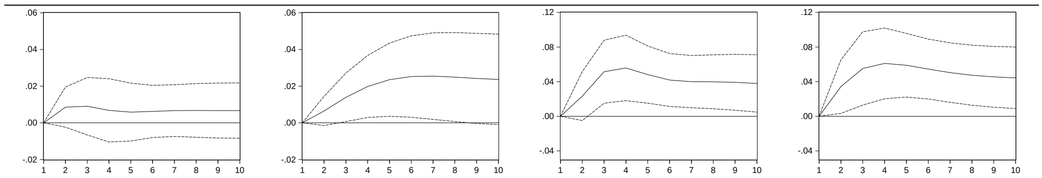
The construction sector, on the other hand, reacts more strongly to changes in bank lending. The reaction is statistically significant and Table 1.9 displays that shocks coming from the banks explain a substantial share of the total forecast error variance. In the variance decomposition of the industrial sector, we see that the share explained by equity capital is substantially larger than the share explained by banks.[36]

We have implemented several further robustness tests to our main specification. In particular, we have extended the VAR to include further control variables, such as interest rates, money and prices. Of course there are some differences in the details but overall the findings reported in this chapter remain quite robust. An advantage of a larger specification is that in a full system, the long-term effects become insignificant reflecting the long-term neutrality of money and credit. However, the VAR specification also suffers from an increasingly severe identification problem and larger standard errors due to the relatively small sample period.

[36]See Section 1.A.6 in the appendix for the graphs, unit root and cointegration properties as well as generalized impulse responses and variance decompositions for industry 2 and construction in conjunction with bank lending, total assets 1, total assets 2 and equity capital. In addition, impulse responses with Cholesky decomposition for industry 2, construction and both total assets variables are displayed. Using generalized impulse responses, it is shown that the reaction of industry 2 is stronger and lasts longer while construction is less affected. The variance decompositions reveal that the forecast error variance of industry 2 is least explained by bank lending. The contribution of bank lending in explaining the total forecast error variance of construction is substantially higher and equity capital is able to explain the highest amount.

Figure 1.8: Impulse Responses for Industry 2 and Construction to shocks in Bank Lending and Equity Capital

Reaction of IN2 to a shock in B	Reaction of IN2 to a shock in EC	Reaction of C to a shock in B	Reaction of C to a shock in EC



Note: The solid lines trace the impulse responses for industry 2 (IN2) and construction (C) to shocks in bank lending (B) and equity capital (EC). The dashed lines show the asymptotic standard errors.

Table 1.9: Variance Decomposition for Industry 2 and Construction to shocks in Bank Lending and Equity Capital

Period	IN2 due to B	IN2 due to EC	C due to B	C due to EC
5	3.244	20.061	26.706	37.071
	[7.003]	[12.780]	[16.374]	[12.767]
10	2.998	30.393	31.968	47.965
	[7.362]	[20.499]	[18.873]	[13.077]

Note: The variance decomposition (in percent) is shown for industry 2 (IN2) and construction (C). The values indicate the share of the forecast error variance that is due to a shock in bank lending (B) and equity capital (EC). The values in parentheses represent the standard deviation.

1.5 Conclusion

In this chapter we attempted to evaluate the role that the banking system played in 19^{th} century Germany by taking a sectoral perspective. We found evidence that the sectors of the economy were affected *asymmetrically* by shocks from bank lending. This evidence is robust to reasonable alternative estimation procedures and alternative indicators of bank lending. Our central finding is that it was not the industrial sector, but transportation, agriculture, services and construction that benefited most from the development of the domestic banking sector.[37]

We explain this new stylized fact, referring to a two-sector growth model of Schneider and Tornell (2004), who show that small, non-tradable-goods-producing firms benefit most

[37] In Section 1.A.10 in the appendix, it is shown that the consideration of a dummy variable controlling for financial crises in our VARs even strengthen this result.

from lending booms in economies with contract-enforceability problems. We point out that our findings are indeed reminiscent to stylized facts that have been documented on today's emerging markets. During boom- bust cycle episodes in the 1980s and 1990s, the non-tradable sector has often grown more strongly during the boom phase and fallen into a more deep and sustained recession in the aftermath of banking crisis.

Several questions remain unanswered, however, that further research might be able to address. First, we found that - similar to today's emerging markets - the tradable sector was hardly affected by the domestic banks. But was this due to a well enough developed *international* capital market or due to the size of the firms in the industrial sector, which had equity finance and other *domestic* financial instruments available? The Hoffmann data set gives some indication that capital markets were indeed quite open. German gross foreign assets increased, for instance, from 7172 million Mark in 1882 to 19396 million Mark in 1912. The foreign emissions of equity and commercial paper increased from 300 million Mark in 1883 to 604 million Mark in 1913 (with a peak of 1108 million Mark in 1905).[38] Also the trade account appears to have been quite open, as between 1880 and 1913 the share of exports to NDP fluctuated between 12.8% and 17.7%.[39] The openness of financial markets in the 19^{th} century has also been documented by Bordo (2002). In addition, it is worth noting that also changes in the tariffs on different sectors might have affected the asymmetries in sectoral growth patterns.

Furthermore, there may have been other influences on the agricultural sector in particular. Institutional barriers in the agricultural sector were dissolved just prior to our sample period. These include the strength of village community institutions, which prevented new crops and

[38]See Hoffmann (1965), table 43, p.262. These numbers are quite high. In the peak year 1905, total domestic equity capital was 8043 million Mark and the total block of commercial paper was 2345 million Mark.
[39]See Hoffmann (1965), table 65, p.151.

rotation systems from being introduced and blocked the privatization of common land. Also agricultural price ceiling, prior to 1850, contributed to investment being relatively unprofitable in the beginning of the century. Starting from a low base, agriculture might therefore been able to benefit more from bank lending than other sectors in the economy.

Firm level data, if available, and individual case studies would help to strengthen the case that today's industrialized countries experienced a similar start up phase in their development process similar to that of today's emerging markets. Several such case studies and a large body of literature on the institutional development of the German banking system already exist and are surveyed for instance in Guinnane (2002). Particularly interesting from our perspective are the origins of German credit cooperatives in the 1840s and 1850s, which, besides financing small businesses and corporations, also engaged directly in purchasing agricultural inputs and the marketing of agricultural products.[40] Also, Edwards and Fischer (1994) and Edwards and Nibler (2000) have documented the development of the banking system in Germany. Continuing to put together these pieces of information is a challenging but worthwhile exercise for researchers in both economic history and development finance.

[40] See also Guinnane (2001).

1.A Appendix

In the following sections, additional results and robustness checks are provided. First, the cointegration properties of the sectoral output variables in conjunction with total assets 1, total assets 2 and equity capital are shown in **Section 1.A.1**. In the subsequent three sections, further evidence from analyses with net domestic product are displayed. In **Section 1.A.2**, generalized impulse responses from three-variable VARs including net domestic product, investment and total assets 1, total assets 2 and equity capital are applied. Furthermore, the variance decompositions of the forecast errors are calculated. **Section 1.A.3** shows the impulse responses with Cholesky decomposition from bivariate VARs including net domestic product and total assets 1, total assets 2 or equity capital. Additionally, the results are presented when investment is used instead of net domestic product. **Section 1.A.4** contains generalized impulse responses from bivariate VARs including net domestic product and bank lending, total assets 1, total assets 2 and equity capital.

The next two sections relate to the sectoral analysis. First, generalized impulse responses from bivariate VARs including the different sectoral variables and bank lending, total assets 1, total assets 2 and equity capital are presented in **Section 1.A.5**. Then, the sectors industry 2 and construction are studied more in detailed in **Section 1.A.6**. First, the graphs as well as the stationary and cointegration properties are given and afterwards, generalized impulse responses as well as impulse responses with Cholesky decomposition - both calculated from bivariate VARs including industry 2 or construction and bank lending, total assets 1, total assets 2 and equity capital - are displayed.

Furthermore, analyses with additional variables which are not used in the main part are given. **Section 1.A.7** adopts to the idea that different sectors have different sources of finance available as revealed for equity capital in the main text. Now *corporate bonds* and *internal bonds* are under investigation.

According to Levine (2001) and others who use total factor productivity as proxy for technical progress as source of growth in this context, **Section 1.A.8** allows for total factor productivity next to net domestic product and bank lending in the VAR analysis. In **Section 1.A.9**, the different types of banks are aggregated to *public* and *private banks* in order to detect whether there are differences in the influence among the different sectors. In **Section 1.A.10** we control for financial crises by employing dummy variables in the VARs.

In addition, further information about the sources and the composition of all variables which are under examination in the main part as well as in the appendix are presented in **Section 1.A.11**.

1.A.1 Additional cointegration tests

Table 1.10 relates to the sectoral analysis of the main part. Here, the cointegration links between the sectoral output variables and total asset 1, total assets 2 and equity capital are displayed as we estimate VARs with these pairs of variables in the main part. For almost all pairs of variables, we are able to report cointegration using the Johansen (1991) procedure as well as the two-step approach of Engle and Granger (1987). Only in the case of mining and total assets 2, industry and equity capital and services and equity capital we are not able to indicate cointegration. Therefore, as VARs in levels are used, we need to keep in mind, however, a potential bias in these results.

Table 1.10: Results of Cointegration Tests for Sectoral Output with Total Assets 1, Total Assets 2 and Equity Capital

	Johansen				Engle/Granger
Variable		Trace		Max-Eigenvalue	
Mining and total assets 1	r=0	39.467**°°	r=0	35.143**°°	-1.780
	r≤1	4.324	r=1	4.324	
Industry and total assets 1	r=0	37.930**°°	r=0	27.574**°°	-0.865
	r≤1	10.357*°	r=1	10.357*°	
Agriculture and total assets 1	r=0	41.665**°°	r=0	30.349**°	-5.061**
	r≤1	11.316*°	r=1	11.316*°	
Trade and total assets 1	r=0	33.608**°°	r=0	24.958**°°	-1.535
	r≤1	8.650	r=1	8.650	
Transportation and total assets 1	r=0	35.883**°°	r=0	30.685**°°	-2.667
	r≤1	5.198	r=1	5.198	
Services and total assets 1	r=0	53.509**°°	r=0	41.822**°°	-0.885
	r≤1	11.686*°	r=1	11.686*°	
Mining and total assets 2	r=0	34.837**°°	r=0	20.422**°	-2.946
	r≤1	14.414**°°	r=1	14.414**°°	
Industry and total assets 2	r=0	33.315**°°	r=0	23.470**°°	-4.320**
	r≤1	9.845*	r=1	9.845*	
Agriculture and total assets 2	r=0	38.601**°°	r=0	27.972**°°	-4.042*
	r≤1	10.629*°	r=1	10.629*°	
Trade and total assets 2	r=0	63.688**°°	r=0	44.759**°°	-4.668**
	r≤1	18.929**°°	r=1	18.929**°°	
Transportation and total assets 2	r=0	37.536**°°	r=0	19.390*°	-4.012*
	r≤1	18.146**°°	r=1	18.146**°°	
Services and total assets 2	r=0	20.217*	r=0	17.625*	-1.133
	r≤1	2.592	r=1	2.592	
Mining and equity capital	r=0	30.182**°°	r=0	21.245**°	-1.715
	r≤1	8.937	r=1	8.937	
Industry and equity capital	r=0	19.347	r=0	12.845	-2.681
	r≤1	6.502	r=1	6.502	
Agriculture and equity capital	r=0	30.736**°°	r=0	21.637**°	-3.526*
	r≤1	9.099	r=1	9.099	
Trade and equity capital	r=0	28.384**°°	r=0	17.852*°	-3.538*
	r≤1	10.533*°	r=1	10.533*°	
Transportation and equity capital	r=0	39.118**°°	r=0	25.066**°°	-2.155
	r≤1	14.052**°	r=1	14.052**°	
Services and equity capital	r=0	14.133	r=0	9.411	-0.895
	r≤1	4.722	r=1	4.722	

Note: * and ** indicate significance at 5% and 1% level by employing critical values from Osterwald-Lenum. ° and °° indicate significance at 5% and 1% level for critical values from Cheung and Lai (1993). For Engle and Granger (1987) cointegration, * and ** indicate significance at 5% and 1% level using critical values from MacKinnon (1991).

1.A.2 Generalized impulse responses from three-variable VARs

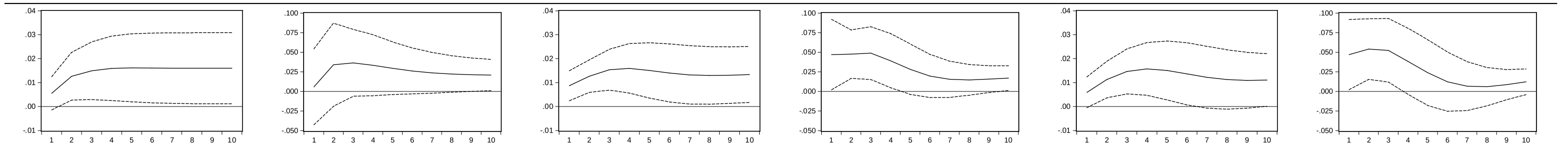
Figure 1.2 and Table 1.3 in the main part show that generalized impulse responses and variance decompositions from a VAR including net domestic product, investment and bank lending indicate a positive impact of bank lending on both, net domestic product and investment. Now, these impulse responses and variance decompositions are presented for the other pairs of variables. Figure 1.9 and Table 1.11 show the impulse responses and variance decompositions of net domestic product, investment and total assets 1 in panel A, total assets 2 in panel B and equity capital in panel C.

All three panels reveal that shocks coming from total assets 1, total assets 2 and equity capital have positive and significant effects on both, net domestic product and investment. Induced by shocks in total assets 1 and total assets 2, the effects on net domestic product are significantly positive for the whole time horizon. Applying equity capital, the reaction lasts for six years. After a shock in total assets 1, total assets 2 or equity capital, investment reacts significantly positive after nine years, for the first four years and for the first three years, respectively. Table 1.11 shows the variance decompositions of the forecast errors for the three panels. Panel A reveals that after ten years shocks in total assets 1 explain 13.6% in case of net domestic product and 15.9% in case of investment. Panel B and panel C reveal that after ten years, 8.1% and almost 24.0% of the forecast error variance of net domestic product as well as 12.4% and 12.0% of the forecast error variance of investment is explained by total assets 2 and equity capital.

Hence, these results are not as unambiguous as in the main part where we report that bank lending affects economic output directly and indirectly through investment, but however, a positive impact of total assets 1, total assets 2 and equity capital is presented as well.

Figure 1.9: Generalized Impulse Responses for Net Domestic Product, Investment and Total Assets 1, Total Assets 2 and Equity Capital

Panel A		Panel B		Panel C	
Reaction of NDP to a shock in TA1	Reaction of I to a shock in TA1	Reaction of NDP to a shock in TA2	Reaction of I to a shock in TA2	Reaction of NDP to a shock in EC	Reaction of I to a shock in EC



Note: The solid lines trace the impulse responses of net domestic product (NDP) and investment (I) to shocks in total assets 1 (TA1), total assets 2 (TA2) and equity capital (EC). The dashed lines show the asymptotic standard errors.

Table 1.11: Variance Decomposition for Net Domestic Product, Investment and Total Assets 1, Total Assets 2 and Equity Capital

	Panel A		Panel B		Panel C	
Period	NDP due to TA1	I due to TA1	NDP due to TA2	I due to TA2	NDP due to EC	I due to EC
5	9.457	8.195	8.880	7.390	23.192	4.812
	[10.542]	[9.176]	[6.620]	[9.857]	[14.176]	[9.360]
10	13.647	15.936	8.060	12.399	23.950	11.970
	[15.977]	[14.626]	[7.627]	[15.603]	[16.319]	[14.933]

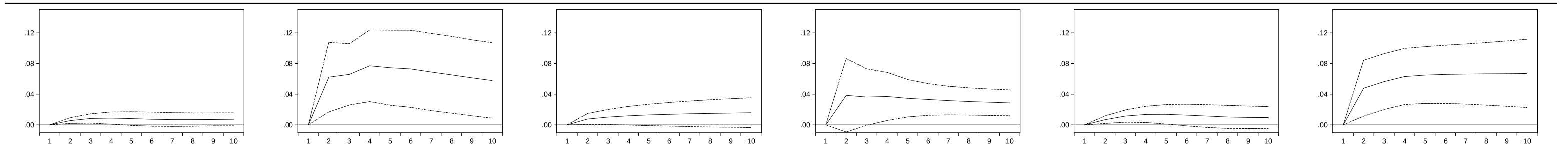
Note: The variance decomposition of the forecast error is shown for the three-variable VAR, including net domestic product (NDP), investment (I) and total assets 1 (TA1), total assets 2 (TA2) and equity capital (EC). The values in parentheses indicate the standard deviation.

1.A.3 Impulse responses with Cholesky decomposition - bivariate VARs

In this section, we include the assumption made in the main part that output depends on bank lending only in period t-1 and is not affected by bank lending contemporaneously. This assumption is applied to total assets 1, total assets 2 and equity capital. Therefore, impulse responses with Cholesky decomposition are employed to VARs which include net domestic product at the first position. Figure 1.10 and Table 1.12 confirm the indicated positive link when total assets 1, total assets 2 or equity capital are applied. Net domestic product or investment are used in combination with total assets 1 in panel A, with total assets 2 in panel B and with equity capital in panel C. All impulse responses show positive and significant reactions. The reactions are comparatively stronger in VARs using investment instead of net domestic product. Furthermore, the variance decompositions indicate that higher values of the forecast error variance of investment are explained compared to the explained forecast uncertainty of net domestic product. Nevertheless, a positive impact from total assets 1, total assets 2 and equity capital on economic output, directly and indirectly through investment, is reported.

Figure 1.10: Impulse Responses with Cholesky Decomposition for Net Domestic Product and Total Assets 1, Total Assets 2 and Equity Capital, and Investment and Total Assets 1, Total Assets 2 and Equity Capital

Panel A		Panel B		Panel C	
Reaction of NDP to a shock in TA1	Reaction of I to shock in TA1	Reaction of NDP to a shock in TA2	Reaction of I to shock in TA2	Reaction of NDP to a shock in EC	Reaction of I to shock in EC



Note: The solid lines trace the impulse responses of net domestic product (NDP) and investment (I) to shocks in total assets 1 (TA1), total assets 2 (TA2) or equity capital (EC). The dashed lines show the asymptotic standard errors.

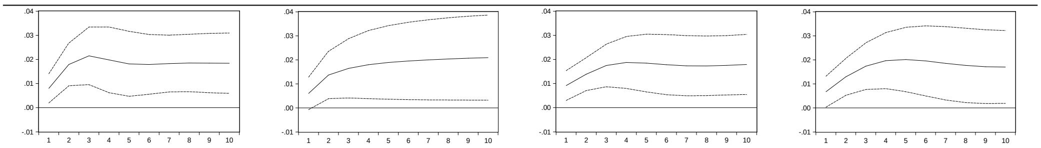
Table 1.12: Variance Decomposition for Net Domestic Product, Investment and Total Assets 1, Total Assets 2 and Equity Capital

	Panel A		Panel B		Panel C	
Period	NDP due to TA1	I due to TA1	NDP due to TA2	I due to TA2	NDP due to EC	I due to EC
5	14.101	14.305	8.477	34.742	19.357	32.249
	[12.706]	[11.881]	[6.762]	[13.906]	[14.067]	[11.903]
10	22.898	23.826	7.683	45.397	17.549	54.616
	[21.242]	[14.353]	[7.351]	[17.388]	[15.896]	[15.441]

Note: The variance decomposition of the forecast error is shown for bivariate VARs, including net domestic product (NDP), investment (I) and total assets 1 (TA1), total assets 2 (TA2) and equity capital (EC). The values in parentheses indicate the standard deviation.

1.A.4 Generalized impulse responses - bivariate VARs

Figure 1.11: Generalized Impulse Responses for Net Domestic Product and Bank Lending, Total Assets 1, Total Assets 2 and Equity Capital



Note: The solid lines trace the impulse responses of net domestic product (NDP) to shocks in bank lending (B), total assets 1 (TA1), total assets 2 (TA2) and equity capital (EC). The dashed lines show the asymptotic standard errors.

Table 1.13: Variance Decomposition for Net Domestic Product and Bank Lending, Total Assets 1, Total Assets 2 and Equity Capital

Period	NDP due to B	NDP due to TA1	NDP due to TA2	NDP due to EC
5	20.777	14.101	8.477	19.357
	[12.731]	[11.237]	[6.818]	[13.264]
10	21.045	22.898	7.683	17.549
	[13.711]	[18.351]	[7.517]	[15.959]

Note: The variance decomposition of the forecast error is shown for the two-variable VARs, including net domestic product (NDP) and bank lending (B), total assets 1 (TA1), total assets 2 (TA2) and equity capital (EC). The values in parentheses indicate the standard deviation.

Again, this section relates to the identification problem in the VARs used in the main part where the assumption that output depends on bank lending in period t-1 is made. As one period means one year in our analysis, further evidence of the correctness of this assumption may achieved through an investigation of generalized impulse responses. In this section, generalized impulse responses and variance decompositions from two-variable VARs are presented (see Figure 1.11 and Table 1.13). Net domestic product reacts positive and significant to shocks coming from bank lending, total assets 1, total assets 2 and equity capital for the whole time horizon. This finding is largely confirmed by the variance decomposition as all values range between 17.5% in case of equity capital and 22.9% in case of total assets

1 after ten years. Only in the case of total assets 2, a substantially lesser value (7.7%) is reported.

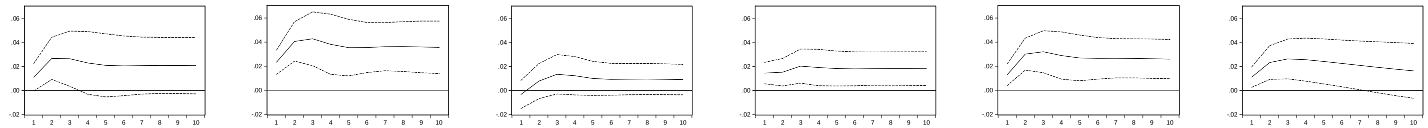
1.A.5 Generalized impulse responses and sectoral output

Again, this section refers to the identification problem raised above as the estimated impulse responses in Section 1.4 in the main part are based on the assumption that output is affected by bank lending, total assets 1, total assets 2 and equity capital only in period t-1. Figure 1.12, 1.13, 1.14 and 1.15 reveal that the usage of generalized impulse responses instead of impulse responses with Cholesky decomposition for the bivariate VARs does not change the results substantially. In almost all cases, the sectors react positive and significant to shocks in the three lending variables bank lending, total assets 1 and total assets 2 as well as in equity capital. The corresponding variance decompositions have been already presented in the main part, see Table 1.5, 1.6, 1.7 and 1.8.

Using bank lending in Figure 1.12, it is shown that all sectors react positive and significant with the exception of agriculture. In general, compared to the impulse responses using Cholesky decomposition as given in the main part in Figure 1.4, the reactions of the impulse responses are stronger and persist longer. This is also revealed for total assets 1 in Figure 1.13. Here, the impulse responses also tend to be longer significant than in the analysis with impulse responses and Cholesky decomposition in Figure 1.5 in the main part. In Figure 1.14 and 1.15 it is displayed that this remains unchanged when total assets 2 (see Figure 1.6 in the main part) and equity capital (see Figure 1.7 in the main part) are used with exception of the trade sector. Therefore, regardless which type of impulse responses is used, the sectoral output reacts positive and in general significant to shocks coming from bank lending, total assets 1, total assets 2 or equity capital.

Figure 1.12: Generalized Impulse Responses for Sectoral Output and Bank Lending

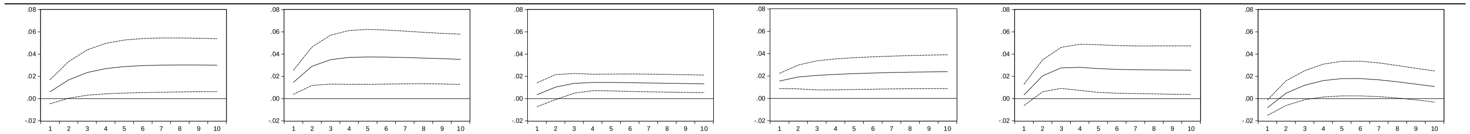
Reaction of M to a shock in B	Reaction of IN to a shock in B	Reaction of A to a shock in B	Reaction of T to a shock in B	Reaction of TR to a shock in B	Reaction of S to a shock in B



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in bank lending (B). The dashed lines show the asymptotic standard errors.

Figure 1.13: Generalized Impulse Responses for Sectoral Output and Total Assets 1

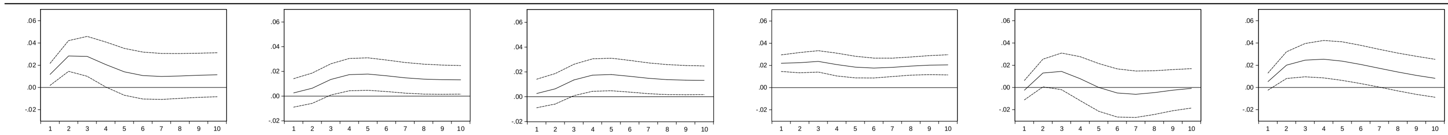
Reaction of M to a shock in TA1	Reaction of IN to a shock in TA1	Reaction of A to a shock in TA1	Reaction of T to a shock in TA1	Reaction of TR to a shock in TA1	Reaction of S to a shock in TA1



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in total assets 1 (TA1). The dashed lines show the asymptotic standard errors.

Figure 1.14: Generalized Impulse Responses for Sectoral Output and Total Assets 2

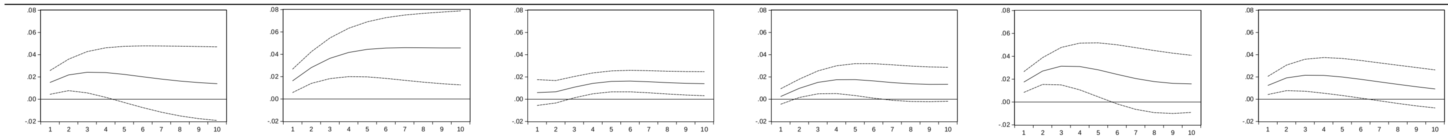
Reaction of M to a shock in TA2	Reaction of IN to a shock in TA2	Reaction of A to a shock in TA2	Reaction of T to a shock in TA2	Reaction of TR to a shock in TA2	Reaction of S to a shock in TA2



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in total assets 2 (TA2). The dashed lines show the asymptotic standard errors.

Figure 1.15: Generalized Impulse Responses for Sectoral Output and Equity Capital

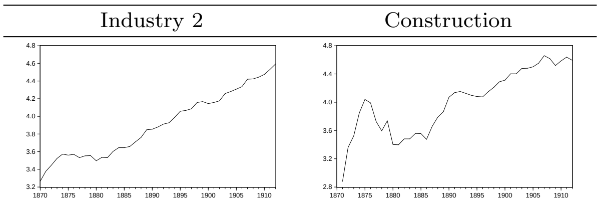
Reaction of M to a shock in EC	Reaction of IN to a shock in EC	Reaction of A to a shock in EC	Reaction of T to a shock in EC	Reaction of TR to a shock in EC	Reaction of S to a shock in EC



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in equity capital (EC). The dashed lines show the asymptotic standard errors.

1.A.6 Industry 2 and construction

Figure 1.16: Industry 2 and Construction (in logs)



Note: The graphs of industry 2 and construction in log levels are displayed for the years 1870 to 1912.

Table 1.14: Results of ADF Tests for Industry 2 and Construction

Variable	Levels			1st Differences		
	ADF	k	Prob.	ADF	k	Prob.
Industry 2	0.043	0	0.957	-5.581***	0	0.000
Construction	-2.366	0	0.157	-5.668***	0	0.000

Note: The ADF test (allowing for an intercept) is calculated for levels and first differences for industry 2 and construction. The lag length is selected by the Schwarz information criterion. *** (**,*) indicates significance at the 99% (95%, 90%) level.

Here, the sectors industry 2 and construction are analyzed more in detail. First, the graphs (see Figure 1.16) as well as the unit root (see Table 1.14) and cointegration characteristics (see Table 1.15) are presented. It is shown that these two sectors are non-stationary in levels but stationary in first differences as well as cointegrated with bank lending, total assets 1, total assets 2 and equity capital. Only in the case of industry 2 and equity capital, no cointegration is found using the Johansen as well as the Engle/Granger approach. Therefore, in this case, the reported impulse response function and variance decomposition should be interpreted with caution.

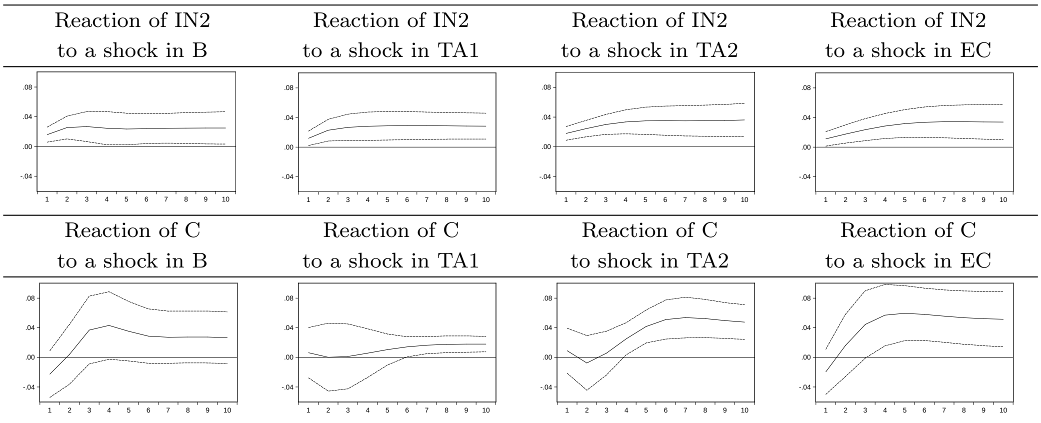
Table 1.15: Results of Cointegration Tests for Industry 2 and Construction with Bank Lending, Total Assets 1, Total Assets 2 and Equity Capital

Variable	Johansen	Trace		Max-Eigenvalue	Engle/Granger
Industry 2 and bank lending	r=0	34.269**°°	r=0	22.991**°°	-3.504
	r≤1	11.279*°	r=1	11.279*°	
Construction and bank lending	r=0	29.938**°°	r=0	23.619**°°	-3.702*
	r≤1	6.319	r=1	6.319	
Industry 2 and total assets 1	r=0	34.020**°°	r=0	26.005**°°	-0.987
	r≤1	8.015	r=1	8.015	
Construction and total assets 1	r=0	34.313**°°	r=0	25.914**°°	-2.793
	r≤1	8.399	r=1	8.399	
Industry 2 and total assets 2	r=0	22.602*°	r=0	14.827	-4.140*
	r≤1	7.775	r=1	7.775	
Construction and total assets 2	r=0	23.517*°	r=0	13.996	-3.403
	r≤1	9.521*	r=1	9.521*	
Industry 2 and equity capital	r=0	15.856	r=0	10.796	-2.830
	r≤1	5.060	r=1	5.060	
Construction and equity capital	r=0	19.608	r=0	12.657	-3.690*
	r≤1	6.951	r=1	6.951	

Note: * and ** indicate significance at the 5% and 1% level by employing critical values from Osterwald-Lenum. ° and °° indicate significance at the 5% and 1% level for critical values from Cheung and Lai (1993). For Engle and Granger (1987) cointegration, * and ** indicate significance at the 5% and 1% level using critical values from MacKinnon (1991).

Figure 1.17 and 1.18 display that both, industry 2 and construction react positive and significant to a shock in bank lending, total assets 1, total assets 2 and equity capital except for construction and bank lending in Figure 1.17 and industry 2 and bank lending in Figure 1.18. Comparing these results with those in the main part, it is revealed that the effects on industry 2 are stronger and last longer while the effects on construction are lower and less significant. The variance decompositions in Table 1.16 and 1.17 reveal that both total assets measures explain the largest parts (35.1% in cases of total assets 1 and 30.4% in case of total assets 2) of the forecast error variance of industry 2 while equity capital and total assets 2 explain most of the forecast error variance of construction (48.0% and 44.5%).

Figure 1.17: Generalized Impulse Responses for Industry 2 and Construction to shocks in Bank Lending, Total Assets 1, Total Asset 2 and Equity Capital

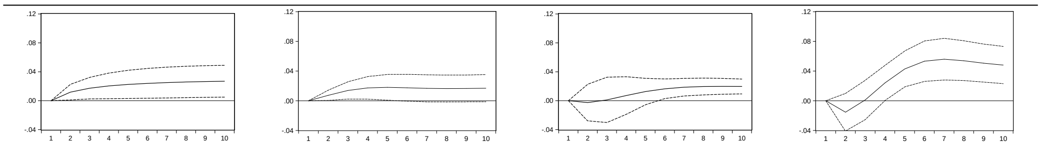


Note: The solid lines trace the generalized impulse responses of the sectoral outputs of industry 2 (IN2) and construction (C) to a shock in bank lending (B), total assets 1 (TA1), total assets 2 (TA2) and equity capital (EC). The dashed lines show the asymptotic standard errors.

The findings of this analysis confirm our hypothesis that the different sectors of the economy classified by tradable- and non-tradable-goods-producing sectors depend differently on the banking system as well as other sources of financing. Especially the variance decomposition of 3% in case of industry 2 and bank lending supports our results.

Figure 1.18: Impulse Responses with Cholesky Decomposition for Industry 2 and Construction to shocks in Total Assets 1 and Total Assets 2

Reaction of IN2 to a shock in TA1	Reaction of IN2 to a shock in TA2	Reaction of C to a shock in TA1	Reaction of C to a shock in TA2



Note: The solid lines trace the impulse responses of the sectoral output of industry 2 (IN2) and construction (C) to a shock in total assets 1 (TA1) and total assets 2 (TA2). The dashed lines show the asymptotic standard errors.

Table 1.16: Variance Decomposition for Industry 2 and Bank Lending, Total Assets 1, Total Assets 2 and Equity Capital

Period	IN2 due to B	IN2 due to TA1	IN2 due to TA2	IN2 due to EC
5	3.244	19.875	13.233	20.061
	[7.003]	[13.466]	[11.291]	[12.780]
10	2.998	35.092	14.874	30.393
	[7.362]	[21.696]	[12.862]	[20.499]

Note: The variance decomposition (in percent) is shown for the sectoral output of industry 2 (IN2). The values indicate the share of the forecast error variance that is due to a shock in bank lending (B), total assets 1 (TA1), total assets 2 (TA2) and equity capital (EC) and the values in parentheses represent the standard deviation.

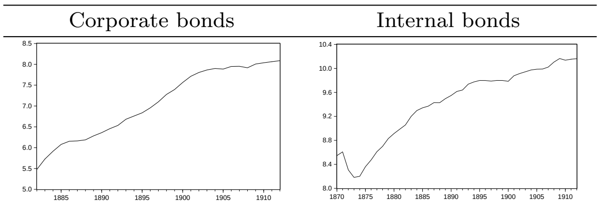
Table 1.17: Variance Decomposition for Construction and Bank Lending, Total Assets 1, Total Assets 2 and Equity Capital

Period	C due to B	C due to TA1	C due to TA2	C due to EC
5	26.706	0.622	12.063	37.071
	[16.374]	[2.618]	[8.810]	[12.767]
10	31.968	5.374	44.486	47.965
	[18.873]	[4.653]	[13.567]	[13.077]

Note: The variance decomposition (in percent) is shown for the sectoral output of construction (C). The values indicate the share of the forecast error variance that is due to a shock in bank lending (B), total assets 1 (TA1), total assets 2 (TA2) and equity capital (EC) and the values in parentheses represent the standard deviation.

1.A.7 Corporate bonds and internal bonds

Figure 1.19: Corporate Bonds and Internal Bonds (in logs)



Note: The graphs of the alternative forms of financing, corporate bonds (CB) and internal bonds (IB), are displayed in log levels for the years 1882 to 1912 and 1870 to 1912, respectively.

Table 1.18: Results of ADF Tests for Corporate and Internal Bonds

Variable	Levels			1st Differences		
	ADF	k	Prob.	ADF	k	Prob.
Corporate bonds	-1.136	1	0.687	-3.149**	0	0.034
Internal bonds	-0.965	1	0.758	-4.112***	0	0.002

Note: The ADF test (allowing for an intercept) is calculated for levels and first differences for corporate bonds and internal bonds. The lag length is selected by the Schwarz information criterion. *** (**,*) indicates significance at the 1% (5%, 10%) level.

This section adopts the idea that large, tradable-goods-producing sectors have other sources of finance available besides bank credit. Therefore, in addition to equity capital, *corporate bonds*[41] and *internal bonds*[42] are used. First, the graphs (see Figure 1.19) as well as the unit root (see Table 1.18) and cointegration properties (see Table 1.19) are presented. Afterwards, the impulse responses and variance decompositions are displayed in the Figures 1.20 and 1.21 and Tables 1.20 and 1.21. Again, Table 1.19 shows that not all pairs of variables are cointegrated displaying the requirement of a careful interpretation. Here, no cointegration is found in case of services and corporate bonds as well as agriculture and internal bonds. The impulse responses with Cholesky decomposition in Figure 1.20 and 1.21 and the variance

[41] See Hoffmann (1965), table 221, p.778ff., adjusted with the price index for the net national product, table 148, p.598ff.

[42] See Hoffmann (1965), table 225, p.789f., adjusted with the price index for the net national product, table 148, p.598ff.

Table 1.19: Results of Cointegration Tests for Sectoral Output with Corporate Bonds and Internal Bonds

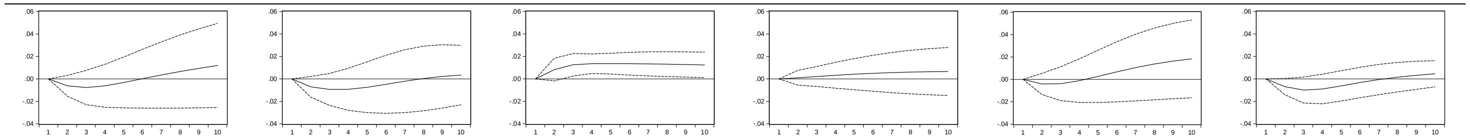
Variable	Johansen	Trace		Max-Eigenvalue	Engle/Granger
Mining and corporate bonds	r=0	20.317*	r=0	17.926*	-0.911
	r≤1	2.391	r=1	2.391	
Industry and corporate bonds	r=0	24.509* °	r=0	20.341**°	-1.558
	r≤1	4.168	r=1	4.168	
Agriculture and corporate bonds	r=0	17.928	r=0	12.706	-4.381**
	r≤1	5.222	r=1	5.222	
Trade and corporate bonds	r=0	22.797*	r=0	20.063* °	-1.128
	r≤1	2.733	r=1	2.733	
Transportation and corporate bonds	r=0	20.944*	r=0	18.255* °	-1.338
	r≤1	2.689	r=1	2.689	
Services and corporate bonds	r=0	16.330	r=0	14.086	-1.308
	r≤1	2.242	r=1	2.242	
Mining and internal bonds	r=0	21.613*	r=0	17.374*	-1.562
	r≤1	4.239	r=1	4.239	
Industry and internal bonds	r=0	37.866**°°	r=0	32.823**°°	-2.055
	r≤1	5.043	r=1	5.043	
Agriculture and internal bonds	r=0	17.765	r=0	11.705	-2.436
	r≤1	6.060	r=1	6.060	
Trade and internal bonds	r=0	48.172**°°	r=0	43.206**°°	-1.414
	r≤1	4.967	r=1	4.967	
Transportation and internal bonds	r=0	38.002**°°	r=0	32.700**°°	-1.205
	r≤1	5.302	r=1	5.302	
Services and internal bonds	r=0	20.496*	r=0	16.269*	-0.772
	r≤1	4.227	r=1	4.227	

Note: * and ** indicate significance at the 5% and 1% level by employing critical values from Osterwald-Lenum. ° and °° indicate significance at the 5% and 1% level for critical values from Cheung and Lai (1993). For Engle and Granger (1987) cointegration, * and ** indicate significance at the 5% and 1% level using critical values from MacKinnon (1991).

decompositions in Table 1.20 and 1.21 reveal that corporate bonds are especially important for agriculture as the impulse response function is positive and significant. In addition, 51.2% of the forecast error variance is explained. In contrast, internal bonds exerts most influence on industry and trade as both impulse responses are significant and the variance decompositions reach values of 12.4% and 24.4%.

Figure 1.20: Impulse Responses for Sectoral Output and Corporate Bonds

Reaction of M to a shock in CB	Reaction of IN to a shock in CB	Reaction of A to a shock in CB	Reaction of T to a shock in CB	Reaction of TR to a shock in CB	Reaction of S to a shock in CB



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in corporate bonds (CB). The dashed lines show the asymptotic standard errors.

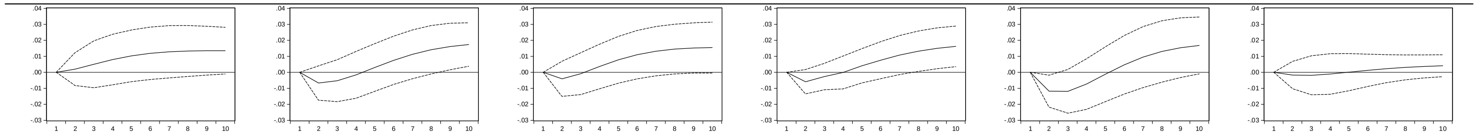
Table 1.20: Variance Decomposition for Sectoral Output and Corporate Bonds

Period	M due to CB	IN due to CB	A due to CB	T due to CB	TR due to CB	S due to CB
5	3.946	7.168	33.308	2.357	1.071	14.018
	[12.697]	[11.095]	[15.784]	[9.324]	[7.526]	[14.383]
10	6.954	5.651	51.199	7.936	14.265	14.747
	[20.524]	[15.424]	[18.557]	[19.502]	[20.918]	[15.704]

Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The values indicate the share of the forecast error variance that is due to a shock in corporate bonds (CB). The values in parentheses represent the standard deviation.

Figure 1.21: Impulse Responses for Sectoral Output and Internal Bonds

Reaction of M to a shock in IB	Reaction of IN to a shock in IB	Reaction of A to a shock in IB	Reaction of T to a shock in IB	Reaction of TR to a shock in IB	Reaction of S to a shock in IB



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in internal bonds(IB). The dashed lines show the asymptotic standard errors.

Table 1.21: Variance Decomposition for Sectoral Output and Internal Bonds

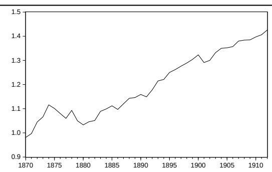
Period	M due to IB	IN due to IB	A due to IB	T due to IB	TR due to IB	S due to IB
5	2.910	1.260	2.711	2.412	7.345	0.159
	[6.632]	[3.464]	[6.834]	[4.481]	[8.484]	[5.503]
10	9.920	12.372	19.328	24.431	17.566	0.993
	[14.146]	[11.034]	[19.156]	[16.502]	[14.623]	[6.853]

Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The values indicate the share of the forecast error variance that is due to a shock in internal bonds (IB). The values in parentheses represent the standard deviation.

1.A.8 Total factor productivity

Figure 1.22: Total Factor Productivity (in logs)

Total Factor Productivity



Note: The graph of total factor productivity (TFP) in log level is displayed for the years 1870 to 1912.

Table 1.22: Result of the ADF Test for Total Factor Productivity

Variable	Levels			1st Differences		
	ADF	k	Prob.	ADF	k	Prob.
Total factor productivity	-0.339	0	0.910	-6.079***	0	0.000

Note: The ADF test (allowing for an intercept) is calculated for the levels and the first differences for the total factor productivity. The lag length is selected by the Schwarz information criterion. *** (**,*) indicates significance at the 1% (5%, 10%) level.

In this section, we additionally employ *total factor productivity*[43] in the three-variable as well as the bivariate context.[44] The graph is displayed in Figure 1.22. Table 1.22 and 1.23 give the result of the ADF test as well as the cointegration results.

In these tables, it is shown that total factor productivity is non-stationary in levels but stationary in first differences as well as that not all pairs of variables are cointegrated. However, we continue to estimate VARs in levels as an estimation in first differences may has even more severe drawbacks. Figure 1.23 reveals that both, bank lending and total factor productivity exert positive and significant effects on net domestic product and additionally that bank lending impacted total factor productivity positive and significant in a generalized impulse response approach. However, the variance decomposition in Table 1.24 shows that

[43]See Hoffmann (1965), table 5a, p.26f., converted in level data.

[44]Similar to the assumption that bank lending in period t-1 exerts influence on (economic) output in period t, this is also likely to be true for total factor productivity and (economic) output.

Table 1.23: Results of Cointegration Tests for Total Factor Productivity

Variable	Johansen	Trace		Max-Eigenvalue	Engle/Granger
Net domestic product, bank lending	r=0	62.532**°°	r=0	32.971**°°	-1.415
and total factor productivity	r≤1	27.260**°°	r=1	5.132	
	r≤2	2.301	r=2	2.301	
Net domestic product and total factor productivity	r=0	28.334**°°	r=0	23.202**°°	-2.111
	r≤1	5.132	r=1	5.132	
Mining and total factor productivity	r=0	18.098	r=0	14.012	-2.010
	r≤1	4.086	r=1	4.086	
Industry and total factor productivity	r=0	19.137	r=0	11.991	-3.187*
	r≤1	7.146	r=1	7.146	
Agriculture and total factor productivity	r=0	18.794	r=0	10.240	-1.603
	r≤1	8.554	r=1	8.554	
Trade and total factor productivity	r=0	40.345**°°	r=0	31.839**°°	-3.470*
	r≤1	8.506	r=1	8.506	
Transportation and total factor productivity	r=0	24.228* °	r=0	17.252* °	-2.220
	r≤1	6.976	r=1	6.976	
Services and total factor productivity	r=0	13.786	r=0	8.290	-1.211
	r≤1	5.496	r=1	5.496	

Note: * and ** indicate significance at the 5% and 1% level by employing critical values from Osterwald-Lenum. ° and °° indicate significance at the 5% and 1% level for critical values from Cheung and Lai (1993). For Engle and Granger (1987) cointegration, *, ** and *** indicate significance at the 10%, 5% and 1% level using critical values from MacKinnon (1991).

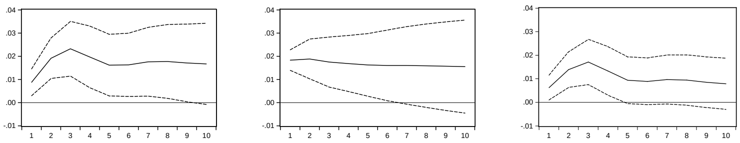
only bank lending is important in explaining the forecast error variance of net domestic product (30.0%) while total factor productivity is not able to explain the forecast error variance of net domestic product. It is shown that bank lending has a positive impact on total factor productivity and that 24.5% of the forecast error variance is explained. Using bivariate VARs and computing impulse responses with Cholesky decomposition (see Figure 1.24) as well as variance decompositions (see Table 1.25) the results remain unchanged.[45] Again, both approaches indicate that bank lending exerts positive effects on net domestic product as well as on total factor productivity but total factor productivity does not influence net domestic product.[46]

[45]Note that a different scaling of the impulse response of bank lending to a shock in total factor production is used in order to uncover the induced effects.

[46]Concerning the variance decomposition, these results challenge the view that bank lending exerts positive impact on total factor productivity leading in turn to economic growth as for instance proposed by Beck et al. (2000) and Calderón and Liu (2003).

Figure 1.23: Generalized Impulse Responses for Net Domestic Product, Bank Lending and Total Factor Productivity

Reaction of NDP to a shock in B	Reaction of NDP to a shock in TFP	Reaction of TFP to a shock in B



Note: The solid lines trace the generalized impulse responses from a three-variable VAR including net domestic product (NDP), bank lending (B) and total factor productivity (TFP). The dashed lines show the asymptotic standard errors.

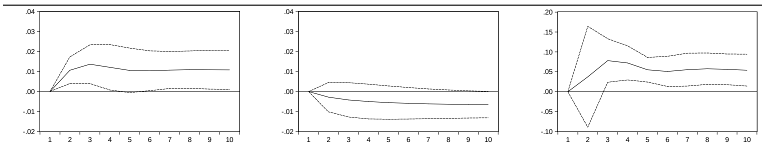
Table 1.24: Variance Decomposition for Net Domestic Product, Bank Lending and Total Factor Productivity

Period	NDP due to B	NDP due to TFP	TFP due to B
5	29.784	0.477	23.971
	[13.249]	[5.211]	[13.718]
10	30.009	0.480	24.481
	[14.022]	[6.767]	[14.046]

Note: The variance decomposition (in percent) of the forecast error is shown for a three-variable VAR including net domestic product (NDP), total factor productivity (TFP) and bank lending (B). The values in parentheses indicate the standard deviation.

Figure 1.24: Impulse Responses with Cholesky Decomposition for Net Domestic Product and Bank Lending and Total Factor Productivity and Bank Lending

Reaction of NDP to a shock in B	Reaction of NDP to a shock in TFP	Reaction of TFP to a shock in B



Note: The solid lines trace the impulse responses with Cholesky decomposition from three bivariate VARs including net domestic product (NDP) and bank lending (B) or total factor productivity (TFP) and total factor productivity (TFP) and bank lending (B). The dashed lines show the asymptotic standard errors.

Table 1.25: Variance Decomposition for Net Domestic Product and Bank Lending and Total Factor Productivity and Bank Lending

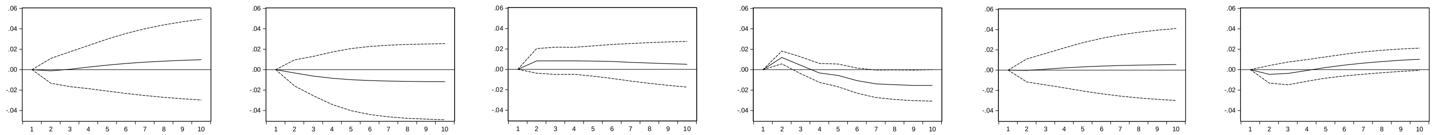
Period	NDP due to B	NDP due to TFP	TFP due to B
5	20.777	3.369	7.322
	[14.229]	[7.954]	[4.127]
10	21.045	7.829	12.109
	[15.838]	[12.723]	[6.256]

Note: The variance decomposition (in percent) from bivariate VARs including net domestic product (NDP) and bank lending (B), net domestic product (NDP) and total factor productivity (TFP), and total factor productivity (TFP) and bank lending (B) is shown. The values in parentheses represent the standard deviation.

From a sectoral perspective, the results appear to be similar. Only the trade sector reacts positive and significant to a shock in total factor productivity (see Figure 1.25) and additionally the variance decomposition indicates an explanation of 33.2% of the forecast error uncertainty (see Table 1.26). Therefore, it is shown that technical progress rather plays a minor role in promoting growth in 19^{th} century Germany.

Figure 1.25: Impulse Responses for Sectoral Output and Total Factor Productivity

Reaction of M to a shock in TFP	Reaction of IN to a shock in TFP	Reaction of A to a shock in TFP	Reaction of T to a shock in TFP	Reaction of TR to a shock in TFP	Reaction of S to a shock in TFP



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in total factor productivity (TFP). The dashed lines show the asymptotic standard errors.

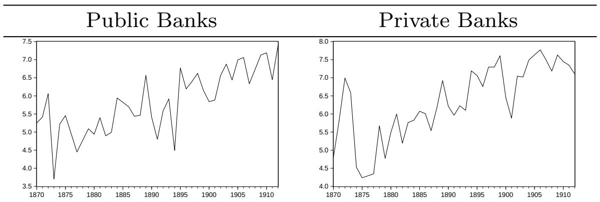
Table 1.26: Variance Decomposition for Sectoral Output and Total Factor Productivity

Period	M due to TFP	IN due to TFP	A due to TFP	T due to TFP	TR due to TFP	S due to TFP
5	0.294	1.723	6.879	12.998	0.197	0.966
	[3.505]	[6.190]	[10.525]	[4.481]	[4.114]	[2.971]
10	1.854	3.183	7.099	33.177	0.788	6.932
	[8.629]	[12.095]	[16.767]	[16.235]	[9.179]	[8.516]

Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The values indicate the share of the forecast error variance that is due to a shock in total factor productivity (TFP). The values in parentheses represent the standard deviation.

1.A.9 Public versus private banks

Figure 1.26: Total Assets from Public Banks and Private Banks (in logs)



Note: The graphs of the added total assets from public and private banks in log levels are displayed for the years 1870 to 1912.

Table 1.27: Result of ADF Tests for Public and Private Banks

Variable	Levels			1st Differences		
	ADF	k	Prob.	ADF	k	Prob.
Public banks	-0.561	2	0.868	-9.211***	0	0.000
Private banks	-2.430	0	0.140	-6.588***	1	0.000

Note: The ADF test (allowing for an intercept) is calculated for levels and first differences for public banks and private banks. The lag length is selected by the Schwarz information criterion. *** (**,*) indicates significance at the 1% (5%, 10%) level.

In this section, the total assets of the different types of banks are combined into two groups, *public* and *private banks*. Thus, the different importance for the economic development in 19^{th} century Germany is assessed.[47] *Public banks* consists of total assets from central banks, saving banks and land mortgage banks while the total assets from mortgage banks, credit banks and cooperative credit associations belong to *private banks*. Figure 1.26 shows the graphs, Table 1.27 reveals that both variables are non-stationary in levels but stationary in first differences and Table 1.28 indicates cointegration for all pairs of variables. Services is not cointegrated with both, public and private banks as well as mining and private banks. Again, results from VARs using these combinations should be interpreted with caution.

Figure 1.27 shows that shocks coming from public banks have positive and significant

[47] As mentioned in the main part, Edwards and Ogilvie (1996) re-investigate the role of universal banks in promoting industrialization in Germany concluding that the universal bank's contribution has been overestimated. They state that credit banks and (some) private banks are among the *universal banks.*

Table 1.28: Results of Cointegration Tests for Sectoral Output with Public Banks and Private Banks

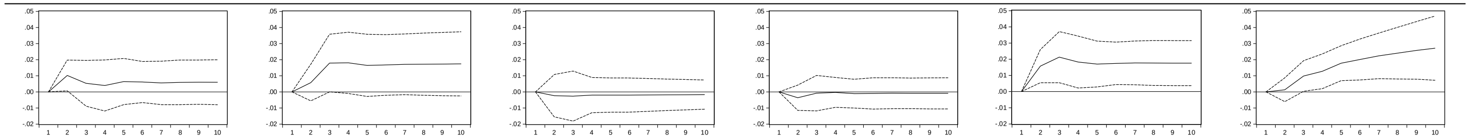
	Johansen				Engle/Granger
Variable		Trace		Max-Eigenvalue	
Mining and public banks	r=0	40.529**°°	r=0	25.155**°°	-4.865***
	r≤1	15.374**°°	r=1	15.374**°°	
Industry and public banks	r=0	43.246**°°	r=0	33.362**°°	-4.715***
	r≤1	9.884*	r=1	9.884*	
Agriculture and public banks	r=0	34.490**°°	r=0	25.432**°°	-4.735***
	r≤1	9.059	r=1	9.059	
Trade and public banks	r=0	46.323**°°	r=0	30.630**°°	-4.953***
	r≤1	15.693**°°	r=1	15.693**°°	
Transportation and public banks	r=0	51.729**°°	r=0	31.884**°°	-4.762***
	r≤1	19.844**°°	r=1	19.844**°°	
Services and public banks	r=0	17.194	r=0	13.465	-2.339
	r≤1	3.729	r=1	3.729	
Mining and private banks	r=0	37.936**°°	r=0	24.578**°°	-2.665
	r≤1	13.358**°	r=1	13.358**°	
Industry and private banks	r=0	27.264**°°	r=0	17.155*	-2.521
	r≤1	10.108*	r=1	10.108*	
Agriculture and private banks	r=0	30.747**°°	r=0	22.264**°	-3.033
	r≤1	8.484	r=1	8.484	
Trade and private banks	r=0	46.850**°°	r=0	35.558**°°	-2.772
	r≤1	11.292* °	r=1	11.292* °	
Transportation and private banks	r=0	43.582**°°	r=0	29.698**°°	-2.657
	r≤1	13.884**°	r=1	13.884**°	
Services and private banks	r=0	11.030	r=0	8.905	-0.920
	r≤1	2.124	r=1	2.124	

Note: * and ** indicate significance at the 5% and 1% level by employing critical values from Osterwald-Lenum. ° and °° indicate significance at the 5% and 1% level for critical values from Cheung and Lai (1993). For Engle and Granger (1987) cointegration, * and ** indicate significance at the 5% and 1% level using critical values from MacKinnon (1991).

impacts on mining, industry, transportation and services. High variance decompositions are only reported in the cases of transportation (20.4%) and services (56.1%), see Table 1.29. Again, all sectors react positive and significant to a shock in private banks with the exception of mining, see Figure 1.28. The variance decompositions in Table 1.30 is generally higher and the highest values are revealed for the transportation (23.2%) and services (43.7%) sector. Therefore, it seems that public banks as well as private banks are generally more important for non-tradable-goods-producing sectors than for tradable-goods-producing sectors. This is also displayed when the aggregated variable total assets 1 is applied. Thus, differences between the importance of public and private banks are only weakly indicated.

Figure 1.27: Impulse Responses for Sectoral Output and Public Banks

Reaction of M to a shock in PuB	Reaction of IN to a shock in PuB	Reaction of A to a shock in PuB	Reaction of T to a shock in PuB	Reaction of TR to a shock in PuB	Reaction of S to a shock in PuB



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in public banks (PuB). The dashed lines show the asymptotic standard errors.

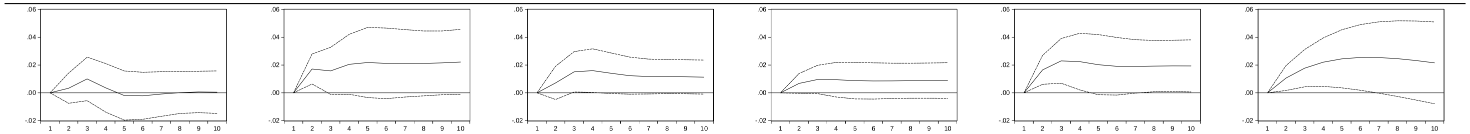
Table 1.29: Variance Decomposition for Sectoral Output and Public Banks

Period	M due to PuB	IN due to PuB	A due to PuB	T due to PuB	TR due to PuB	S due to PuB
5	3.325	7.847	0.393	0.392	18.987	22.036
	[7.622]	[8.223]	[3.973]	[4.158]	[11.476]	[10.119]
10	3.170	8.892	0.438	0.234	20.366	56.080
	[8.779]	[9.054]	[4.726]	[4.792]	[12.550]	[15.784]

Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The values indicate the share of the forecast error variance that is due to a shock in public banks (PuB). The values in parentheses represent the standard deviation.

Figure 1.28: Impulse Responses for Sectoral Output and Private Banks

Reaction of M to a shock in PrB	Reaction of IN to a shock in PrB	Reaction of A to a shock in PrB	Reaction of T to a shock in PrB	Reaction of TR to a shock in PrB	Reaction of S to a shock in PrB



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in private banks (PrB). The dashed lines show the asymptotic standard errors.

Table 1.30: Variance Decomposition for Sectoral Output and Private Banks

Period	M due to PrB	IN due to PrB	A due to PrB	T due to PrB	TR due to PrB	S due to PrB
5	2.674	18.091	15.726	7.245	22.504	26.463
	[8.488]	[13.801]	[13.269]	[6.686]	[14.445]	[15.441]
10	1.505	19.617	18.177	7.450	23.189	43.748
	[10.334]	[16.852]	[15.343]	[7.771]	[16.293]	[20.871]

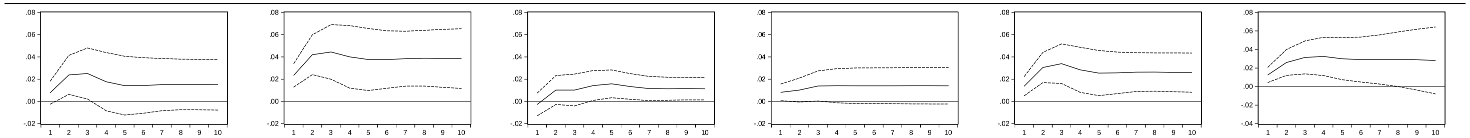
Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The values indicate the share of the forecast error variance that is due to a shock in private banks (PrB). The values in parentheses represent the standard deviation.

1.A.10 Financial crises

In this last section, we control for financial crises by applying a dummy variable which is zero for (financial) crises years. The Figures 1.29, 1.30, 1.31 and 1.32 show the impulse responses for three-variable VARs including sectoral output, the dummy variable and bank lending, total assets 1, total assets 2 or equity capital. It is shown that the consideration of the crises years even strengthen our result that the sectors are affected differently. In Figure 1.29 all sectors react positive and significant to a shock in bank lending. The effects are even stronger than in the benchmark estimation presented in the main part (see Figure 1.4). The variance decomposition in Table 1.31 reports that the non-tradable-goods-producing sectors benefit more from bank lending development as 48.3% of the forecast error variance of agriculture is explained by bank lending. In addition, 19.8% and 26.7% of the forecast error variance of transportation and services are explained. Regarding the tradabe-goods-producing sectors mining and industy, the variance decompositions are small supporting our result. Using total assets 1 (see Figure 1.30) the reactions are also stronger. Again, all sectors react positive and significant to a shock in total assets 1 and the variance decompositions in Table 1.32 show the same pattern. Total assets 1 explains comparatively more of the forecast error variance of non-tradable-goods-producing sectors than of tradable-goods-producing sectors. In Figure 1.31 it is shown that all sectors - with exception of agriculture - react positive and significant to a change in total assets 2. But as Table 1.33 reveals, a substantial amount of the forecast error variance is only explained in case of services (44.9%). In Figure 1.32 and Table 1.34 it is shown - comparable to the main part - that particular the industrial sector benefits from changes in equity capital as the impulse response shows the strongest reactions. Additionally, 20.9% of the forecast error variance is explained.

Figure 1.29: Impulse Responses for Sectoral Output and Bank Lending from VARs including a Dummy Variable for Financial Crises

Reaction of M to a shock in B	Reaction of IN to a shock in B	Reaction of A to a shock in B	Reaction of T to a shock in B	Reaction of TR to a shock in B	Reaction of S to a shock in B



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in bank lending (B) from VARs including a dummy variable for financial crises. The dashed lines show the asymptotic standard errors.

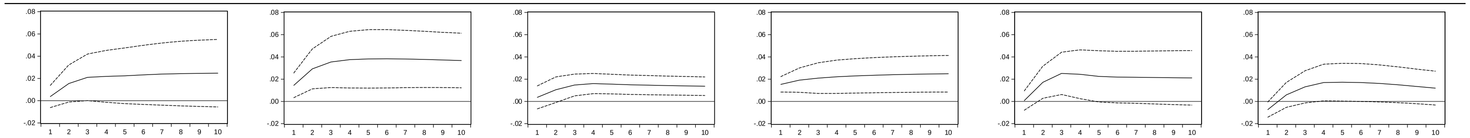
Table 1.31: Variance Decomposition for Sectoral Output and Bank Lending from VARs including a Dummy Variable for Financial Crises

Period	M due to B	IN due to B	A due to B	T due to B	TR due to B	S due to B
5	3.080	8.029	38.331	1.386	19.859	18.340
	[4.785]	[11.340]	[13.729]	[4.267]	[11.463]	[14.021]
10	1.956	7.699	48.151	1.668	19.843	26.680
	[5.003]	[12.463]	[16.247]	[5.524]	[13.185]	[20.742]

Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The values indicate the share of the forecast error variance that is due to a shock in bank lending (B) and the values in parentheses represent the standard deviation. A dummy variable for financial crises is included.

Figure 1.30: Impulse Responses for Sectoral Output and Total Assets 1 from VARs including a Dummy Variable for Financial Crises

Reaction of M to a shock in TA1	Reaction of IN to a shock in TA1	Reaction of A to a shock in TA1	Reaction of T to a shock in TA1	Reaction of TR to a shock in TA1	Reaction of S to a shock in TA1



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in total assets 1 (TA1) from VARs including a dummy variable for financial crises. The dashed lines show the asymptotic standard errors.

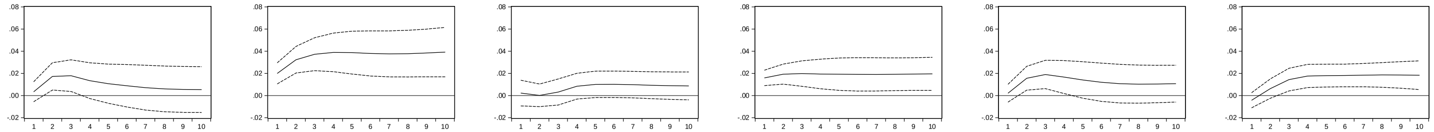
Table 1.32: Variance Decomposition for Sectoral Output and Total Assets 1 from VARs including a Dummy Variable for Financial Crises

Period	M due to TA1	IN due to TA1	A due to TA1	T due to TA1	TR due to TA1	S due to TA1
5	14.997	14.305	32.570	2.711	31.216	37.610
	[11.658]	[11.786]	[11.546]	[5.744]	[16.030]	[15.160]
10	26.076	22.549	52.227	11.824	32.262	49.450
	[17.648]	[18.592]	[13.865]	[11.862]	[21.866]	[16.718]

Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The values indicate the share of the forecast error variance that is due to a shock in total assets 1 (TA1) and the values in parentheses represent the standard deviation. A dummy variable for financial crises is included.

Figure 1.31: Impulse Responses for Sectoral Output and Total Assets 2 from VARs including a Dummy Variable for Financial Crises

Reaction of M to a shock in TA2	Reaction of IN to a shock in TA2	Reaction of A to a shock in TA2	Reaction of T to a shock in TA2	Reaction of TR to a shock in TA2	Reaction of S to a shock in TA2



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in total assets 2 (TA2) from VARs including a dummy variable for financial crises. The dashed lines show the asymptotic standard errors.

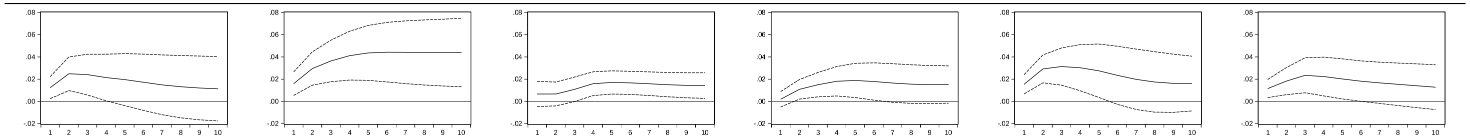
Table 1.33: Variance Decomposition for Sectoral Output and Total Assets 2 from VARs including a Dummy Variable for Financial Crises

Period	M due to TA2	IN due to TA2	A due to TA2	T due to TA2	TR due to TA2	S due to TA2
5	3.879	15.409	7.538	0.310	10.867	28.271
	[4.165]	[12.965]	[6.886]	[1.768]	[8.960]	[13.351]
10	2.060	14.426	13.495	0.206	6.799	44.892
	[4.240]	[15.565]	[11.091]	[2.590]	[9.663]	[15.755]

Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The values show the share of the forecast error variance that is due to a shock in total assets 2 (TA2) and the values in parentheses represent the standard deviation. A dummy variable for financial crises is included.

Figure 1.32: Impulse Responses for Sectoral Output and Equity Capital from VARs including a Dummy Variable for Financial Crises

Reaction of M to a shock in EC	Reaction of IN to a shock in EC	Reaction of A to a shock in EC	Reaction of T to a shock in EC	Reaction of TR to a shock in EC	Reaction of S to a shock in EC



Note: The solid lines trace the impulse responses of the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S) to a shock in equity capital (EC) from VARs including a dummy variable for financial crises. The dashed lines show the asymptotic standard errors.

Table 1.34: Variance Decomposition for Sectoral Output and Equity Capital from VARs including a Dummy Variable for Financial Crises

Period	M due to EC	IN due to EC	A due to EC	T due to EC	TR due to EC	S due to EC
5	0.651	16.921	17.402	20.683	2.727	2.067
	[2.592]	[11.076]	[10.066]	[11.883]	[3.412]	[3.929]
10	1.231	20.858	24.777	19.254	1.869	4.748
	[6.247]	[14.717]	[13.970]	[14.327]	[5.302]	[6.157]

Note: The variance decomposition (in percent) is shown for the sectoral output of mining (M), industry (IN), agriculture (A), trade (T), transportation (TR) and services (S). The values indicate the share of the forecast error variance that is due to a shock in equity capital (EC) and the values in parentheses represent the standard deviation. A dummy variable for financial crises is included.

1.A.11 Data description

This section gives a detailed overview of the sources and compositions of all variables used in the main part and in the appendix. In Table 1.35, the variables which are used in the main part and which are extracted from Hoffmann (1965) are listed. In Table 1.36 the variables proposed by Deutsche Bundesbank (1976), Burhop and Wolff (2005) and Burhop (2002) are shown. Table 1.37 refers to the variables used in the appendix.

Table 1.35: Description and Composition of the Variables; Data Source: Hoffmann (1965)

Variable	Table		Column	Page
Net domestic product (NDP)	5a:	*Die jährlichen Wachstumsraten des Nettoinlandsprodukts und des Kapitalstocks, jeweils in Preisen von 1913, der Beschäftigten und der gesamten Faktorproduktivität (%)*	1: *Nettoinlandsprodukt in Preisen von 1913*	26-7
		The annual growth rates of net domestic product and capital stock, both in prices of 1913, of employment and total factor productivity (%)	Net domestic product in prices of 1913	
Investment (I)	249:	*Die Verwendung des Nettosozialprodukts zu Marktpreisen in Preisen von 1913*	2: *Nettoinvestitionen*	827-8
		The financing of the net domestic product in market prices of 1913	Net investment	
Bank lending (B)	239:	*Die Finanzierung der einheimischen Nettoinvestitionen*	1: *Banken und Bausparkassen*	812-3
		The financing of domestic net investment	Banks and building societies	
Total assets 1 (TA1)	Sum of:			
Saving Banks	202:	*Die Finanzierung durch die Sparkassen*	3: *Bilanzsumme*	733-4
		The financing through saving banks	Total assets	
Cooperative credit associations	203:	*Die Finanzierung durch die Kreditgenossenschaften*	4: *Bilanzsumme*	736-7
		The financing through cooperative credit banks	Total assets	
Mortgage banks	205:	*Die Finanzierung durch die Hypothekenbanken*	4: *Bilanzsumme*	739-40
		The financing through mortgage banks	Total assets	
Central banks	208:	*Die Finanzierungen durch die Notenbanken*	1: *Korrigierte Bilanzsumme*	751-2
		The financing through central banks	Adjusted total assets	
Credit banks	207:	*Die Finanzierung durch die Kreditbanken ohne Notenausgabe*	1: *Aktienkapital* + 2: *Reserven* + 3: *Kreditoren, Depositen* + 4: *Akzepte*	748-9
		The financing through credit banks without bank note issuance	Capital stock + reserves + payables, debtors + acceptances	
Land mortgage banks	206:	*Die Finanzierungen durch die öffentlich-rechtlichen Bodenkreditinstitute*	1/3/6/9: *Pfandbriefe* - 2: *amortisationsfond* + 4/7/11: *Reserven und Kapital* +10: *Kreditoren*	742-3
		The financing through land mortgage banks	Issue of Pfandbriefe - funds of amortization + reserves and capital + payables	

Table 1.35 – continued

Equity capital (EC)	220:	*Das eingezahlte Kapital der Aktiengesellschaften*	18: *Insgesamt*	772-5
		Paid-up capital of stock corporations	Total[48]	
Mining (M)	103:	*Die Wertschöpfung nach Wirtschaftsbereichen in Preisen von 1913*	2: *Bergbau und Salinen*	454-5
		The value added according to economic sectors in prices of 1913	Mining and salines	
Industry (IN)	103:	*Die Wertschöpfung nach Wirtschaftsbereichen in Preisen von 1913*	3: *Industrie und Handwerk*	454-5
		The value added according to economic sectors in prices of 1913	Industry and handcraft	
Agriculture (A)	103:	*Die Wertschöpfung nach Wirtschaftsbereichen in Preisen von 1913*	1: *Landwirtschaft, Forsten, Fischerei*	454-5
		The value added according to economic sectors in prices of 1913	Farming, forestry and fisheries	
Trade (T)	103:	*Die Wertschöpfung nach Wirtschaftsbereichen in Preisen von 1913*	5: *Handel, Banken, Versicherungen, Gaststätten*	454-5
		The value added according to economic sectors in prices of of 1913	Trade, banks, insurances and public houses	
Transportation (TR)	103:	*Die Wertschöpfung nach Wirtschaftsbereichen in Preisen von 1913*	4: *Verkehr*	454-5
		The value added according to economic sectors in prices of of 1913	Transportation	
Services (S)	103:	*Die Wertschöpfung nach Wirtschaftsbereichen in Preisen von 1913*	6: *Häusliche Dienste*	454-5
		The value added according to economic sectors in prices of 1913	Services	

Note: All variables used in the main part of this chapter taken from Hoffmann (1965) are listed with its corresponding abbreviations. In addition to the table and column numbers, table and column names are shown in original terms and in translation.

[48] Linear interpolation for the years 1872/4/5.

Table 1.36: Description and Composition of the Variables; Data Source: Deutsche Bundesbank (1976), Burhop (2002), Burhop and Wolff (2005), Burhop (2002)

Variable		Table	Column	Page
Total assets 2 (TA2)	Data from:			
1870-1883	Burhop (2002)	*Statistik der Aktienkreditbanken 1848-1883*	*Bilanzsumme*	
		(in 1.000 Mark), laufende Preise		128
		Statistics of the joint-stock credit banks 1848-1883	Total assets	
		(in 1.000 Mark), current prices		
1884-1912	Deutsche Bundesbank (1976)	*Aktien-Kreditbanken*	*Bilanzsumme*	56
		Joint-stock credit banks	Total assets	
Industry 2 (IN2)	Burhop and Wolff (2005)	Subseries for calculation of German Compromise NNP	Industrial production	
Construction (C)	Burhop (2005)	Production index	Construction	

Note: All variables used in the main part of this chapter taken from Deutsche Bundesbank (1976), Burhop (2002), Burhop and Wolff (2005) and Burhop (2002) are listed with its corresponding abbreviations in original terms and in translation.

Table 1.37: Description and Composition of the Variables used in the Appendix

Variable	Table	Column	Page
Corporate bonds (CB)	103: *Der Umlauf an Industrieobligationen*	14: *Insgesamt*	778-781
	The circulation of corporate bonds	Total	
Internal bonds (IB)	225: *Der Umlauf an öffentlichen Inlands-Anleihen und verzinslichen Schatzanweisungen*	4: *Insgesamt*	789-90
	The circulation of public internal bonds and interest bearing treasuries	Total	
Total factor productivity (TFP)	5a: *Die jährlichen Wachstumsraten des Nettoinlandsprodukts und des Kapitalstocks, jeweils in Preisen von 1913, der Beschäftigten und der gesamten Faktorproduktivität (%)*	4: *Gesamte Faktorproduktivität*	26-7
	The annual growth rates of net domestic product and capital stock, both in prices of 1913, of employment and total factor productivity	Total Factorproductivity	

Note: All variables used in this chapter are listed with its corresponding abbreviations. Data are taken from Hoffmann (1965). In addition to the table and column numbers, table and column names are shown in original terms and in translation.

2 Are there spillover effects from Hong Kong and the United States to Chinese stock markets?[49]

2.1 Motivation

This chapter empirically analyzes spillover effects from stock markets in Hong Kong and the United States to the two emerging stock exchanges in mainland China - Shanghai and Shenzhen. The implementation of the Qualified Foreign Institutional Investor (QFII) program on December 1, 2002 offers the opportunity to address the question whether this liberalization has led to increased integration. Therefore, we study the interdependencies among stock markets in mean returns and volatility to determine the transfer mechanism of information within the Chinese stock markets and the stock markets in Hong Kong and the United States.

In general, integration links of stock markets and the effects of liberalization and deregulation on stock market comovements in developed and emerging markets have experienced much interest. Particularly China has attracted much research for different reasons. Its high growth rates, ongoing liberalization reforms and the important feature that listed enterprises

[49]This chapter is based on Diekmann (2011).

are allowed to issue different types of equity shares, offer a special research environment to address several questions about integration and relations.

In our research, we concentrate on *A shares* which were initially designed for domestic investors, *B shares* which were restricted to foreign investors and *H shares* which are issued in Hong Kong and which can be traded by all investors with exception of Chinese residents.[50] With the implementation of the QFII program, the A and B share segments are no longer completely separated as it allows foreign institutional investors to purchase and trade A shares.[51]

With regard to the existing literature, the main novelty in our study is the application of the two-stage Lagrange multiplier procedure proposed by Cheung and Ng (1996) on appropriate autoregressive moving average - generalized autoregressive conditional heteroscedasticity-in mean (ARMA(l,m)-GARCH(1,p)-M models, proposed by Engle (1982), Bollerslev (1986), Engle et al. (1987)) estimations of our stock market indices. Four-year samples before and after the implementation of the QFII program are used in order to determine China's stock market integration with regional and global markets. GARCH-M models allow - beside the consideration of different volatility patterns over time - for possible interactions within the conditional mean and conditional variance of the returns of (financial) time series.

The univariate time series are estimated in the first step. In the second step, the resulting (squared) residuals, standardized by the conditional variance, are used to generate cross

[50] In June 1993, China and Hong Kong signed the Chinese-Hong Kong Memorandum of Regulatory Cooperation, allowing Chinese enterprises to list their shares (H shares) on the stock exchange in Hong Kong.

[51] For detailed information about the conditions and restrictions which qualified foreign institutional investors are subject to, see Prasad and Wei (2005). In August 2010, 86 overseas investors gained QFII status. In addition to the deregulation reforms due to the QFII program, the B share markets were opened for domestic investors in February 2001. In 2006, a counterpart of the QFII, the Qualified Domestic Institutional Investor (QDII) program was established, allowing Chinese institutional investors to trade shares abroad. Section 2.A.2 and 2.A.3 in the appendix deal with this liberalization. It is shown that the QDII program has not been substantially more effective in promoting the integration of the Chinese stock markets. It is shown that while the QFII does not promote global or regional integration, the QDII has strengthened the regional integration, in particular with Hong Kong.

correlations and to test the null hypothesis of no causality in variance. Causality in variance explores the conditional volatility dependencies between two variables and is often used to reveal the transmission between as well as the assimilation of news (shocks) in stock markets.

Overall, we do not find evidence that this institutional change had an effect on the time series comovements among these markets as the implementation of the QFII program does not cause increasing spillovers in our analysis. While we are able to report causality in mean and causality in variance in both subsamples, we do not find increased causal links in the post-liberalization phase. This suggests that the implementation of the QFII program neither advances the stock market integration of mainland China to Hong Kong and the United States, nor effectively reduces trading barriers for foreign institutional investors.

This chapter is organized as follows: Section 2.2 gives a brief overview of the literature and Section 2.3 describes the data as well as the unit root properties. In Section 2.4, the ARMA(l,m)-GARCH(1,p)-M adjustments and estimations are displayed. Section 2.5 describes the methodology to test for causality and presents the empirical results and Section 2.6 concludes.

2.2 Related literature

Much research has been done concerning the linkage between stock markets. On the one hand, *developed* stock markets are examined, indicating a leading role of the United States in general, as for instance by Hamao et al. (1990) who analyze short-run interdependencies of Japan, the United Kingdom and the United States, by Heimonen (2002) who investigates price integration and return convergence for the United States, the United Kingdom, Germany, Japan and Finland, and by Liu et al. (2002) who furthermore state that the degree of interdependency has increased after the stock market crash in 1987.

On the other hand, *emerging* markets have triggered much research. Kim and Singal (2000) for instance estimate changes in levels and in volatility of stock returns, inflation, and exchange rates around market openings for 18 emerging markets and find increased efficiency. Other studies use different country samples of *developed* and *emerging* countries, analyzing the integration link between them (see for instance Worthington and Higgs (2004) who use Hong Kong, Japan and Singapore as developed markets and Indonesia, Korea, Malaysia, the Philippines, Taiwan and Thailand as emerging markets) or calculate regional indicators from the main regional stock market indices (see for instance Caporale et al. (2006) who use - besides Japan and the United States - regional indicators for Asia and Europe). In general, these studies report an increasing level of emerging markets' integration to the rest of the world.

In the context of stock market integration, Asia and especially China has attracted much research. Johansson and Ljungwall (2009) for instance, analyze short run spillover effects in the mean and the volatility in the Greater China region (China, Hong Kong and Taiwan) concluding that there are no (direct) spillovers between China and Hong Kong.[52] Using impulse response functions, Phylaktis (1999) reports increased market integration of six Pacific-Basin countries with Japan and the United States after these countries liberalize their financial markets. Kassimatis (2002) indicates decreased volatility as response to financial liberalization for six emerging markets (Argentina, India, Pakistan, Philippines, South Korea and Taiwan) on the basis of news impact curves of exponential GARCH models.

Furthermore, several studies deal with the question of domestic integration in China, namely

[52] In this study, weekly data of the Hang Seng index, Dow Jones China 88 and Taiwan Weighted index are used. The spillovers are revealed in the framework of VAR-MVEGARCH models where the own past returns and innovations as well as the foreign ones are incorporated.

the integration of A shares (originally designed for domestic investors) and B shares (originally restricted to foreign investors) before and after liberalization programs (see for instance Kim and Shin (2000), Brooks and Ragunathan (2003) and Wang et al. (2004)).

Ongoing liberalization in China offers the opportunity to analyze the effectiveness of these policy reforms in the context of regional and global integration.[53] Lin and Swanson (2008) analyze the effects of liberalization reforms in mainland China on stock markets information transmission. They specify four major reform policies and examine the induced effects on China's stock market integration due to causality in the returns and volatility transmission. In their analysis, the opening of the A share market had the greatest impact on China's integration with global markets. Furthermore, they indicate that the reform policies had only minor impact on regional integration, suggesting that China's stock markets remain segmented from regional markets.

In contrast, Chelley-Steeley (2004) claims, based on a study of four Asian countries which continue to liberalize their financial markets, that regional integration is more prevalent and occurs faster than global integration.[54] Ng (2000) analyzes the volatility spillovers from Japan (as proxy for regional markets) and the United States (as proxy for the world market) to six Pacific-Basin equity markets. She concludes that both markets are important but the influence of the world market tends to be greater. Harvey (1995), among others, states that emerging market returns are more influenced by local rather than global information. Beirne et al. (2010) point out that spillovers in mean returns dominate in emerging Asia.

Chui and Kwok (1998) highlight the specific role of Hong Kong in this context. It functions as an intermediary because most of the Chinese news is collected by or funneled through Hong

[53] Some authors examine the changes in the dynamic relationship between stock markets before and in the aftermath of the Southeast Asian crisis, see for instance Caporale et al. (2006).

[54] Bracker et al. (1999) suggest that the dimension of market integration is closely linked with the import dependency structure and the geographical distance between the markets.

Kong. The study by Li (2007) confirms this view. In his asymmetric GARCH model, he finds evidence of unidirectional volatility spillovers from the Hong Kong stock exchange to the mainland China stock exchanges in Shanghai and Shenzhen.[55] Although he finds no evidence of volatility linkages between the stock exchanges in mainland China and the United States, he reports that the stock exchanges in Shanghai and Shenzhen are linked with the United States through Hong Kong, which is in turn integrated with the United States stock market. Hu et al. (1997) examine the spillover effects of volatility among the developed stock markets in the United States and Japan and the emerging stock markets in Hong Kong, Taiwan, Shanghai and Shenzhen.[56] They find a feedback system between the markets of Hong Kong and the United States and, in addition, contemporaneous correlations of the Asian emerging markets with the return volatility of the United States.[57]

2.3 Preliminary data analysis

To investigate Chinese stock market integration with regional and global markets, on the one hand Hong Kong is chosen as indicator for regional integration because of its geographical proximity and the close trading ties with the Chinese economy, and on the other hand, the United States are selected because of its' role as important trading partner and capital provider. Hence, the United States serve as a good indicator for the integration of China with global markets. Daily returns - computed as $log(p_t/p_{t-1})$ where p_t is the daily closing price at time t - of the following stock market indices are used: Shanghai Stock Exchange A

[55]However, small coefficients are reported indicating only weak integration.

[56]Note that in the literature, there is no uniform classification of Hong Kong as either developed or emerging market.

[57]Chow (1993) also shows that there is no evidence of integration between the market in Shanghai and in the United States, analyzing the weekly composite indices from these stock markets by a multiple regression approach for the sample period of January 1992 to February 2002.

share index (SHSE A), Shanghai Stock Exchange B share index (SHSE B), Shenzhen Stock Exchange A share index (SZSE A), Shenzhen Stock Exchange B share index (SZSE B), Hang Seng China Enterprises index (H), Hang Seng index (HSI) and the Dow Jones Industrials index (DJI).[58] All data are collected via Thomson Datastream from the stock exchanges in Shanghai and Shenzhen, the Hang Seng Bank and the Dow Jones.

Although there are two stock exchanges in mainland China, Chinese enterprises are allowed to list their shares only at one of the two stock markets.[59] Obviously, both exchanges are subject to the same macroeconomic and political decisions, even though dual listing is not permitted.

The whole sample covers the period from November 23, 1998 to December 8, 2006. The sample is divided into a pre- and a post-liberalization phase, four years before and after the implementation of the QFII program on December 1, 2002, excluding five trading days before and after this regulatory change.[60]

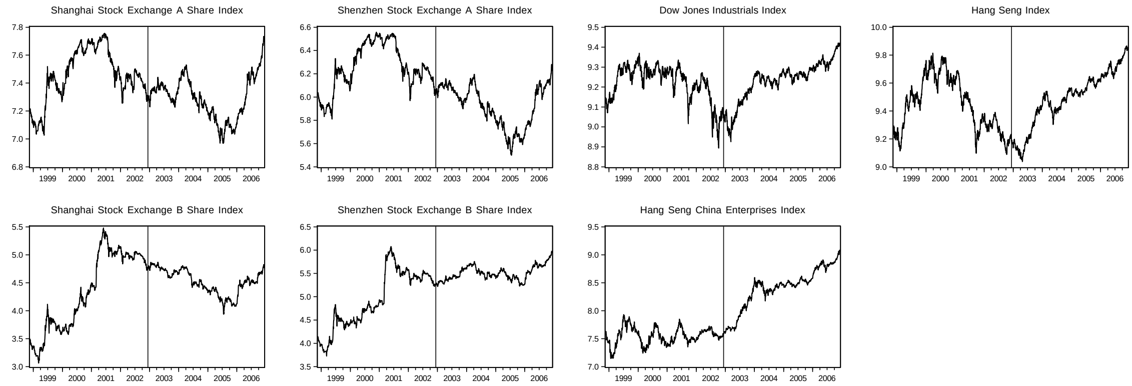
Figures 2.1 and 2.2 display the data series, both in levels and in first differences. The graphs of the Chinese stock market indices - SHSE A, SHSE B, SZSE A and SZSE B - in Figure 2.1 topped out in late 2001, experienced a lengthy setback until 2005 and rallied until the end of the sample. The DJI and the HSI show some similarities as both hit their lowest levels at the turn of the year 2002/2003 and rallied afterwards, again attaining the peak values of the years 1999/2000 at the end of the sample. The H share index seems to fluctuate around a constant value until 2003. Afterwards, it experienced strong positive growth with a short-term peak

[58]The currency of A shares is Chinese Yuan, of B shares US dollars on the stock exchange in Shanghai and Hong Kong dollars on the stock exchange in Shenzhen. The currency of H and HSI is Hong Kong dollars.

[59]In general, those companies which are listed on the Shenzhen Stock Exchange are rather small and export-oriented while those, listed on the Shanghai Stock Exchange are often state-owned enterprises.

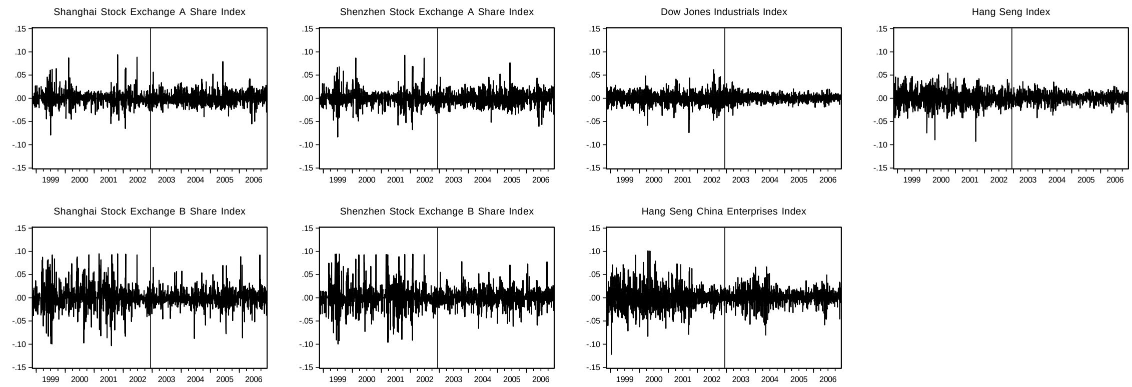
[60]Hence, the pre-liberalization sample is from November 23, 1998 to November 22, 2002 and the post-liberalization phase from December 9, 2002 to December 8, 2006. In addition, our sample period is unaffected by an unusual behavior caused by the Asian financial crisis in 1997.

Figure 2.1: Stock Market Indices (in logs)



Note: The graphs of the Shanghai Stock Exchange A share index (SHSE A), Shanghai Stock Exchange B share index (SHSE B), Shenzhen Stock Exchange A share index (SZSE A), Shenzhen Stock Exchange B share index (SZSE B), Dow Jones Industrials index (DJI), Hang Seng index (HSI) and Hang Seng China Enterprises index (H) in log levels are displayed. The sample covers the period November 23, 1998 to December 8, 2006.

Figure 2.2: Stock Market Returns



Note: The graphs of the returns of SHSE A, SHSE B, SZSE A, SZSE B, DJI, HSI and H are displayed. The sample covers the period November 23, 1998 to December 8, 2006.

at the end of 2003.[61]

The index return series in Figure 2.2 show that both B share indices are more volatile than their A share counterparts. Furthermore, the DJI is the least volatile one with a decreasing volatility pattern over time. This pattern also applies for the HSI. Particularly at the beginning of the sample, the H share index shows high volatility which becomes somewhat smaller towards the end of the sample.

[61]The A shares in both markets, Shanghai and Shenzhen, reached a short-term peak after the announcement of the implementation of the QFII program on November 5, 2002. The levels of the peaks are recovered in case of Shanghai in April 2003 and in case of Shenzhen at the end of the year 2006.

Table 2.1: Results of ADF Tests

	Levels			Returns			Levels			Returns		
	ADF	k	Prob.	ADF	k	Prob.	ADF	k	Prob.	ADF	k	Prob.
	Pre-liberalization						Post-liberalization					
SHSE A	-1.4422	0	0.5626	-31.8979**	0	0.000	0.0305	0	0.9601	-31.7104**	0	0.000
SHSE B	-1.2495	4	0.6546	-14.2751**	3	0.000	-1.3179	1	0.6231	-29.0262**	0	0.000
SZSE A	-1.8281	21	0.3670	-6.1215**	20	0.000	-0.8483	3	0.8043	-17.2490**	2	0.000
SZSE B	-1.6137	8	0.4752	-8.4911**	7	0.000	-0.9862	3	0.7599	-17.4868**	2	0.000
DJI	-2.2986	0	0.1726	-32.1873**	0	0.000	-0.8966	7	0.7896	-13.5038**	6	0.000
HSI	-1.3693	0	0.5985	-31.2839**	0	0.000	-0.4338	1	0.9008	-30.6295**	0	0.000
H	-2.8616	13	0.0503	-8.0551**	12	0.000	-1.3224	20	0.6210	-7.2013**	19	0.000

Note: The ADF test (allowing for an intercept) is calculated from the levels and the returns of SHSE A, SHSE B, SZSE A, SZSE B, DJI, HSI and H for the two subsamples. The lag length is selected by the Akaike information criterion. ** indicates significance at the 1% level.

We start our empirical analysis by testing the unit root properties applying the augmented Dickey-Fuller (ADF) test for both levels and first differences. The results are displayed in Table 2.1.[62] The optimal lag length in the test specification is determined by the Akaike information criterion. All data series are non-stationary in levels but stationary in first differences in both subsamples.

Table 2.2 contains the summary statistics for the return series of both subsamples. These statistics include the mean, the maximum, the minimum, the standard deviation and the range. The mean is nearly zero in all cases. The ranges and the standard deviations seem to decrease in the second subsample compared to the first. In contrast to the findings of Brooks and Ragunathan (2003), the standard deviation of the A share index in both exchanges is lower than for the B share index, as also reported by Chen et al. (2011).[63] This may indicate a higher risk of trading B shares.

In Table 2.3, we depict the bivariate correlations between the returns of the Chinese variables - SHSE A, SHSE B, SZSE A and SZSE B and H - with the returns of DJI as well as

[62] The ADF test is conducted allowing for an intercept. Allowing additionally for a trend in the test specification does not change the results.

[63] Additionally, Brooks and Ragunathan (2003) find negative average returns for both B share indices. In contrast to our results, they also report a higher standard deviation of A shares in comparison to B shares. However, their sample period ranges from January 1994 to October 1998 including - contrary to our sample - the Asian financial crisis in 1997.

HSI of the pre- and post-liberalization sample.

Table 2.2: Descriptive Statistics of the Index Return Series

	Mean	Max	Min	Std. Dev.	Range	Mean	Max	Min	Std. Dev.	Range
	Pre-liberalization					Post-liberalization				
SHSE A	0.0000	0.0940	-0.0792	0.0145	0.1732	0.0004	0.0790	-0.0551	0.0123	0.1341
SHSE B	0.0012	0.0945	-0.1029	0.0258	0.1974	0.0000	0.0921	-0.0877	0.0159	0.1798
SZSE A	0.0000	0.0924	-0.0833	0.0153	0.1747	0.0002	0.0765	-0.0606	0.0131	0.1371
SZSE B	0.0010	0.0940	-0.0997	0.0266	0.1937	0.0007	0.0780	-0.0660	0.0155	0.1440
DJI	0.0000	0.0615	-0.0740	0.0131	0.1355	0.0003	0.0353	-0.0367	0.0077	0.0720
HSI	0.0000	0.0543	-0.2152	0.0165	0.1472	0.0006	0.0360	-0.0418	0.0092	0.0778
H	0.0000	0.1011	-0.1219	0.0230	0.2230	0.0014	0.0665	-0.0803	0.0156	0.1468

Note: Different descriptive statistics for the index return series of SHSE A, SHSE B, SZSE A, SZSE B, DJI, HSI and H are displayed.

Regarding regional and global stock market integration, these correlations suggest a more pronounced regional integration of China's stock markets. In both subsamples, the correlations between China's indices with HSI are much higher than the correlations with DJI.[64] The hint of global integration is rather weak as the correlation coefficients are small. This applies for both, the pre-liberalization phase as well as after stock market liberalization.

Table 2.3: Correlations between the Stock Market Returns of China, the United States and Hong Kong

	Pre-liberalization	Post-liberalization		Pre-liberalization	Post-liberalization
SHSE A and DJI	-0.0284	0.0200	SHSE A and HSI	0.0971**	0.1068**
	(0.3594)	(0.5194)		(0.0017)	(0.0005)
SHSE B and DJI	-0.0049	-0.0062	SHSE B and HSI	0.1227**	0.1020**
	(0.8755)	(0.8410)		(0.0001)	(0.0010)
SZSE A and DJI	-0.0323	0.0233	SZSE A and HSI	0.0991**	0.1038**
	(0.2962)	(0.4512)		(0.0013)	(0.0008)
SZSE B and DJI	0.0087	0.0267	SZSE B and HSI	0.1462**	0.1594**
	(0.7797)	(0.3886)		(0.0000)	(0.0000)
H and DJI	0.0649*	0.0727*	H and HSI	0.4766**	0.7093**
	(0.0361)	(0.0188)		(0.0000)	(0.0000)

Note: The different bivariate correlations between the index return series for the two subsamples are displayed. The values in parentheses display the probability values. ** indicates significant at the 1% level.

In the following sections, we further assess the integration level of Chinese stock markets to regional and global markets by applying the procedure of Cheung and Ng (1996).[65]

[64] H shares represent an interesting alternative for foreign investors to participate in the Chinese stock markets because of lower trading barriers and trading costs while B shares, which were created for foreign investors, receive only little attention.

[65] An advantage of the Cheung and Ng (1996) approach is the consideration of first- and second-moment

2.4 Univariate dynamics

In order to adjust the most parsimonious models to our stock market indices, we apply ARMA(l,m)-GARCH(1,p)-M models (see equation 2.1 and 2.2) to the index return series R_t. The choice of l, m and p is carried out among l=0,...,5, m=0,...,5 and p=1,...,5 using the Ljung-Box Q-statistics as well as the Akaike information criterion.[66]

$$ARMA(l,m) - GARCH(1,p) - M$$
$$R_t = \alpha_0 + \sum_{i=1}^{l} \alpha_i R_{t-i} + \sum_{i=1}^{m} \beta_i u_{t-i} + \gamma_1 h_t + u_t \quad (2.1)$$

$$h_t = \omega_0 + \sum_{i=1}^{p} \omega_i u_{t-i}^2 + \varphi_1 h_{t-1} \quad (2.2)$$

and

$$u_t \sim N(0, h_t)$$

An overview of the maximum-likelihood estimations and diagnostic statistics of the selected models presents Table 2.4. Bollerslev and Wooldridge (1992) standard errors which are robust to non-normality in dynamic models are used. In addition, the Ljung-Box Q-statistics for the first 6 and 12 autocorrelations of the standardized residuals - defined as $u_t/\sqrt{h_t}$ - and their squares are not significant at the 5% level, indicating that the selected models provide an admissible description of our index return series.[67]

Different temporal dynamics before and after the implementation of the QFII program are reported. In the mean equation, the constants and the ARMA terms show relatively small

dynamics. Additionally, the Cheung and Ng procedure is very useful as it is asymptotically robust to violations of the distributional assumptions.

[66] The Bernd-Hall-Hall-Hausman algorithm is used.

[67] In order to generate good diagnostic statistics, we have to keep insignificant coefficients in some cases. Additionally, in the case of HSI we have to skip the constant in the mean equation.

values and are insignificant in most cases. In contrast, all return series display considerable persistence in the conditional variance as φ_1 ranges between 0.58 and 0.98. Almost all coefficients are significant at the 5% level except of the lagged error terms of H in the variance equation. The value of the lagged conditional variance increases in the second sample in all cases except for SZSE B and H, indicating increased persistence to volatility shocks in the post-liberalization sample.

Table 2.4: ARMA(l,m)-GARCH(1,p)-M Models for the Index Return Series

I. ARMA(l,m)-GARCH(1,p)-M Models for the Shanghai Stock Exchange Return Series								
		SHSE A				**SHSE B**		
		Pre		**Post**		**Pre**		**Post**
Mean	α_0	-0.0015*	α_0	-0.0004	α_0	-0.0009	α_0	-0.0033
		(0.0007)		(0.0012)		(0.0009)		(0.0017)
	β_1	0.0302	α_1	0.0026	β_1	0.0763*	α_1	0.0883*
		(0.0414)		(0.0319)		(0.0386)		(0.0380)
Variance	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000**	ω_0	0.0000
		(0.0000)		(0.0000)		(0.0000)		(0.0000)
	ω_1	0.2181**	ω_1	0.0533*	ω_1	0.1985**	ω_1	0.0721*
		(0.0762)		(0.0238)		(0.0458)		(0.0365)
	φ_1	0.6499**	φ_1	0.9056**	φ_1	0.7462**	φ_1	0.8143**
		(0.0789)		(0.0411)		(0.0488)		(0.1135)
Log-likelihood		3061.070		3129.307		2472.895		2882.378
Residual tests	Q(6)	4.344	Q(6)	6.700	Q(6)	7.425	Q(6)	3.096
		(0.501)		(0.244)		(0.191)		(0.685)
	Q(12)	11.305	Q(12)	13.104	Q(12)	12.114	Q(12)	7.942
		(0.418)		(0.287)		(0.355)		(0.718)
	$Q^2(6)$	1.174	$Q^2(6)$	10.307	$Q^2(6)$	4.496	$Q^2(6)$	1.646
		(0.947)		(0.067)		(0.480)		(0.896)
	$Q^2(12)$	2.326	$Q^2(12)$	14.753	$Q^2(12)$	8.222	$Q^2(12)$	3.074
		(0.997)		(0.194)		(0.693)		(0.990)
II. ARMA(l,m)-GARCH(1,p)-M Models for the Shenzhen Stock Exchange Return Series								
		SZSE A				**SZSE B**		
		Pre		**Post**		**Pre**		**Post**
Mean	α_0	-0.0016*	α_0	-0.0004	α_0	-0.0016	α_0	-0.0015
		(0.0007)		(0.0012)		(0.0010)		(0.0018)
	β_1	0.0364	β_1	0.0489	β_1	0.1032*	β_1	0.0920*
		(0.0412)		(0.0325)		(0.0416)		(0.0387)
Variance	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000**	ω_0	0.0000
		(0.0000)		(0.0000)		(0.0000)		(0.0000)
	ω_1	0.2244**	ω_1	0.0482**	ω_1	0.2253**	ω_1	0.1227**
		(0.0719)		(0.0175)		(0.0431)		(0.0456)
	φ_1	0.6527**	φ_1	0.9279**	φ_1	0.6749**	φ_1	0.5821**
		(0.0749)		(0.0272)		(0.0585)		(0.1464)
Log-likelihood		3024.442		3076.295		2464.509		2895.016
Residual tests	Q(6)	4.963	Q(6)	6.316	Q(6)	8.038	Q(6)	5.752
		(0.420)		(0.277)		(0.154)		(0.331)
	Q(12)	15.429	Q(12)	13.453	Q(12)	15.750	Q(12)	8.086
		(0.164)		(0.265)		(0.151)		(0.706)
	$Q^2(6)$	1.266	$Q^2(6)$	7.692	$Q^2(6)$	1.684	$Q^2(6)$	3.470
		(0.938)		(0.174)		(0.891)		(0.628)
	$Q^2(12)$	1.750	$Q^2(12)$	11.411	$Q^2(12)$	3.735	$Q^2(12)$	7.998
		(0.999)		(0.409)		(0.977)		(0.714)
III. ARMA(l,m)-GARCH(1,p)-M Models for the Dow Jones Industrials Index and Hang Seng Index Return Series								
		DJI				**HSI**		
		Pre		**Post**		**Pre**		**Post**
Mean	α_0	-0.0017	α_0	0.0000	-	-	-	-
		(0.0009)		(0.0005)				
	β_1	0.0027	β_1	-0.0509	α_1	0.0371	β_1	0.0217
		(0.0339)		(0.0302)		(0.0308)		(0.0170)
Variance	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000**	ω_0	0.0000
		(0.0000)		(0.0000)		(0.0000)		(0.0000)

Table 2.4 − continued

	ω_1	0.0703**	ω_1	0.0359**	ω_1	0.0410*	ω_1	-0.0522**
		(0.0175)		(0.0123)		(0.0164)		(0.0081)
	-	-	-	-	-	-	ω_2	0.0807**
								(0.0151)
	φ_1	0.8963**	φ_1	0.9487*	φ_1	0.9402**	φ_1	0.9542**
		(0.0208)		(0.0149)		(0.0244)		(0.0131)
Log-likelihood		3107.188		3685.118		2823.028		3448.618
Residual tests	Q(6)	3.203	Q(6)	1.964	Q(6)	3.263	Q(6)	1.386
		(0.669)		(0.854)		(0.766)		(0.926)
	Q(12)	9.792	Q(12)	12.182	Q(12)	9.132	Q(12)	4.295
		(0.549)		(0.350)		(0.610)		(0.960)
	$Q^2(6)$	4.365	$Q^2(6)$	6.598	$Q^2(6)$	1.805	$Q^2(6)$	6.087
		(0.498)		(0.252)		(0.875)		(0.298)
	$Q^2(12)$	6.703	$Q^2(12)$	8.205	$Q^2(12)$	3.198	$Q^2(12)$	10.060
		(0.823)		(0.695)		(0.988)		(0.525)

IV. ARMA(l,m)-GARCH(1,p)-M Models for the H Return Series

		H		
		Pre		**Post**
Mean	α_0	0.0000	α_0	0.0014
		(0.0010)		(0.0008)
	β_1	0.1401**	β_1	0.1345*
		(0.0324)		(0.0329)
Variance	ω_0	0.0000	ω_0	0.0000
		(0.0000)		(0.0000)
	ω_1	0.1837**	ω_1	0.0695**
		(0.0594)		(0.0160)
	ω_2	-0.1059	-	-
		(0.0654)		
	ω_3	0.0063	-	-
		(0.0467)		
	ω_4	-0.0613	-	-
		(0.0467)		
	φ_1	0.9775**	φ_1	0.9129**
		(0.0075)		(0.0201)
Log-likelihood		2545.559		2977.794
Residual test	Q(6)	2.471	Q(6)	3.907
		(0.781)		(0.563)
	Q(12)	9.382	Q(12)	8.950
		(0.587)		(0.627)
	$Q^2(6)$	4.262	$Q^2(6)$	6.557
		(0.512)		(0.256)
	$Q^2(12)$	12.630	$Q^2(12)$	12.505
		(0.318)		(0.327)

Note: The Maximum-Likelihood estimations of the appropriate ARMA(l,m)-GARCH(1,p)-M models are reported. The Bollerslev and Wooldridge (1992) asymptotic standard errors are displayed in parentheses. * and ** indicate significance at the 5% and 1% level. Q(6), Q(12), $Q^2(6)$ and $Q^2(12)$ are the Ljung-Box Q-statistics and their p-values in parentheses for the first 6 and 12 autocorrelations of the standardized residuals and their squares.

2.5 Regional and global spillovers between stock market indices

To reveal how the different indices are linked before and after the implementation of the QFII program, we apply the Cheung and Ng (1996) procedure based on the ARMA(l,m)-GARCH(1,p)-M models displayed in Table 2.4, as well as the cross correlation coefficients based on the residuals from the models which are given in Table 2.5.[68] The standardized residuals and their squares are used to test for causality in the conditional mean and conditional variance equations. The null hypothesis represents the case of no causality. To test causality in mean, the cross correlations of the standardized residuals are used while causality in variance is tested using the squares of the standardized residuals.

The number of lags s displays the number of trading days the second cited return series lags the first cited return series. Spillovers in mean and in variance are indicated by significant cross correlation coefficients in both, levels and squares. As the DJI operates in a different time zone, the interpretation of significant cross correlation coefficients related to the DJI has to take this time difference into account. Therefore, especially significant cross correlation coefficients at lag 0 do not represent situations where the endogeneity problem exists and therefore should be interpreted as evidence that the DJI affects the first cited return series. Thus, in these cases, lag s is factually lag s+1.[69] The results in Table 2.5 report evidence of causal interactions in both subsamples.

[68] As the choice of the lag length is likely to affect the empirical results, we follow the suggestion of Hu et al. (1997) and use five leads/lags as this seems reasonable for daily closing prices.

[69] Factual lags are reported in Table 2.5.

Table 2.5: Cross Correlations of the Standardized Residuals

Pre-liberalization										
	SHSE A and DJI		SHSE B and DJI		SZSE A and DJI		SZSE B and DJI		H and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-0.0297	0.0007	-0.0081	-0.0085	-0.0328	0.0121	-0.0053	0.0108	0.0485	**0.0798***
2	0.0170	0.0231	0.0576	0.0142	0.0214	0.0250	**0.0729***	0.0089	**0.1694***	**0.0620***
3	-0.0117	-0.0164	0.0126	0.0001	-0.0021	-0.0175	0.0027	0.0205	-0.0584	0.0500
4	**-0.0670***	0.0204	-0.0496	-0.0040	-0.0580	0.0201	-0.0519	-0.0009	**0.0711***	-0.0102
5	0.0410	-0.0113	0.0482	-0.0152	0.0376	-0.0107	0.0218	-0.0099	0.0297	-0.0152
	SHSE A and HSI		SHSE B and HSI		SZSE A and HSI		SZSE B and HSI		H and HSI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0608	0.0454	0.0259	0.0248	**0.0664***	0.0472	0.0124	0.0319	-0.0422	-0.0098
2	0.0061	-0.0123	-0.0293	0.0338	0.0096	-0.0145	-0.0230	0.0296	-0.0029	-0.0068
3	**0.0772***	0.0358	0.0499	0.0380	**0.0720***	0.0386	0.0494	0.0517	-0.0131	0.0191
4	0.0412	-0.0094	0.0537	0.0165	0.0433	-0.0107	0.0468	0.0208	0.0231	0.0138
5	0.0367	-0.0258	-0.0475	-0.0234	0.0469	-0.0284	-0.0382	-0.0206	-0.0112	0.0525
Post-liberalization										
	SHSE A and DJI		SHSE B and DJI		SZSE A and DJI		SZSE B and DJI		H and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0187	0.0244	-0.0135	-0.0329	0.0195	0.0215	0.0247	0.0076	**0.0922***	0.0154
2	0.0233	-0.0157	0.0151	-0.0409	0.0105	-0.0103	**0.0735***	-0.0171	**0.2809***	**0.1446***
3	0.0555	0.0059	0.0363	-0.0488	0.0327	0.0155	0.0309	-0.0013	-0.0062	-0.0006
4	0.0069	-0.0053	0.0132	0.0056	-0.0019	-0.0145	0.0242	-0.0231	0.0491	-0.0187
5	0.0232	0.0155	0.0211	0.0466	0.0086	0.0165	0.0049	0.0495	0.0403	-0.0113
	SHSE A and HSI		SHSE B and HSI		SZSE A and HSI		SZSE B and HSI		H and HSI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	**0.0641***	-0.0176	0.0517	-0.0119	0.0391	-0.0070	**0.0929***	0.0015	-0.0601	-0.0231
2	-0.0253	-0.0312	-0.0204	-0.0236	-0.0327	-0.0178	-0.0251	-0.0228	**-0.0634***	-0.0582
3	-0.0026	-0.0130	0.0453	-0.0174	0.0038	-0.0132	0.0313	0.0115	-0.0098	-0.0213
4	-0.0015	-0.0043	0.0128	-0.0013	0.0026	-0.0065	0.0053	0.0040	-0.0097	-0.0205
5	0.0249	-0.0460	-0.0256	-0.0180	0.0170	-0.0330	0.0235	-0.0261	0.0495	-0.0185

Note: The cross correlations of the standardized residuals and the squared standardized residuals computed from the models reported in Table 2.4 are shown. s is the number of periods the second cited return series lags the first cited return series. * indicates significance at the 5% level.

Causality in mean is reported from DJI to SHSE A, to SZSE B and to H in the pre-liberalization phase. In the post-liberalization phase, the causality in mean from DJI to SHSE A disappears while the other two effects still persist although at different lags. Causality in variance is found from DJI to H in both subsamples. This causality pattern indicates that the liberalization of the A share segment does not lead to a higher global integration of Chinese stock markets as DJI's variance does not spill over to more share segments in the second subsample.

Interestingly, we find similar results when analyzing regional integration. Causality in mean is discovered in the pre-liberalization phase from HSI to SHSE A as well as to SZSE A, and additionally from HSI to SHSE A, SZSE B, and H. In the post-liberalization phase, no causality in variance is displayed. This suggests that the liberalization of the Chinese A share segment does not enhance China's stock market integration with regional stock markets. However, at this stage of analysis, we have to interpret these causalities with caution because we did not examine if the causality is actually caused by the foreign market. For this, we control in the next step.

To further investigate the causality patterns of the Chinese stock markets and to verify if the significance in the cross correlations is actually caused by the foreign stock markets, we use these information on the interactions in mean and in variance between the time series in the next step to construct *augmented* ARMA(l,m)-GARCH(1,p)-M models. The effect of one equity return series on the other is incorporated by adding the significant lagged (squared) returns of the 'foreign market' in the mean and variance equation of the original ARMA(l,m)-GARCH(1,p)-M models. With these new models, we indicate whether the reported spillover effects in mean and in variance are caused by the foreign return series. In addition, we avoid potential spurious evidence of causality in variance caused by unconsidered causality in mean.

In equations 2.3 and 2.4, the foreign market is captured by R^{*}_{t-i} and R^{*2}_{t-i}. Table 2.6 reports the augmented ARMA(l,m)-GARCH(1,p)-M models of the equity return series.[70]

$$R_t = \alpha_0 + \sum_{i=1}^{l} \alpha_i R_{t-i} + \sum_{i=1}^{m} \beta_i u_{t-i} + \gamma_1 h_t + u_t + \sum_{i=1}^{n} \delta_i R^{*}_{t-i} \tag{2.3}$$

$$h_t = \omega_0 + \sum_{i=1}^{p} \omega_i u^2_{t-i} + \varphi_1 h_{t-1} + \sum_{i=1}^{q} \lambda_i R^{*2}_{t-i} \tag{2.4}$$

In most cases, the added lagged foreign return series in the mean equation are significant (at least at the 10% level). However, the added squared lagged foreign return series in the variance equation are not significant at the conventional levels and the Q-statistics are insignificant at least at the 5% level.

[70]Not all intermediate models are shown. In some cases, adding significant variables lead to more significant cross correlations which are considered in further steps. Only the estimations of the final augmented models are shown in Table 2.6.

Table 2.6: Augmented ARMA(l,m)-GARCH(1,p)-M Models for the Index Return Series

		SHSE A and DJI				**SZSE B and DJI**		
		Pre		**Post**		**Pre**		**Post**
Mean	α_0	-0.0014*	-	-	α_0	-0.0014	α_0	-0.0015
		(0.0007)				(0.0010)		(0.0018)
	β_1	0.0343	-	-	β_1	0.1014*	β_1	0.0887*
		(0.0414)				(0.0414)		(0.0388)
	δ_3	-0.0564*	-	-	δ_1	0.1259**	δ_1	0.1120*
		(0.0283)				(0.0441)		(0.0523)
Variance	ω_0	0.0000	-	-	ω_0	0.0000	ω_0	0.0000
		(0.0000)				(0.0000)		(0.0000)
	ω_1	0.2275**	-	-	ω_1	0.2238**	ω_1	0.1241**
		(0.0764)				(0.0437)		(0.0458)
	φ_1	0.6358**	-	-	φ_1	0.6781**	φ_1	0.5780**
		(0.0831)				(0.0592)		(0.1471)
Log-likelihood		3053.080	-	-		2465.364		2896.875
Residual tests	Q(6)	4.564	-	-	Q(6)	7.448	Q(6)	5.627
		(0.472)				(0.189)		(0.344)
	Q(12)	12.417	-	-	Q(12)	14.915	Q(12)	7.970
		(0.333)				(0.185)		(0.716)
	$Q^2(6)$	1.157	-	-	$Q^2(6)$	1.701	$Q^2(6)$	3.560
		(0.949)				(0.889)		(0.614)
	$Q^2(12)$	2.251	-	-	$Q^2(12)$	3.479	$Q^2(12)$	8.397
		(0.997)				(0.983)		(0.677)
		H and DJI						
		Pre		**Post**				
Mean	α_0	0.0004	α_0	0.0012				
		(0.0010)		(0.0007)				
	β_1	0.1403**	β_1	0.1116**				
		(0.0326)		(0.0324)				
	δ_3	0.2570**	δ_1	0.1077*				
		(0.0385)		(0.0497)				
	δ_5	0.1019*	δ_3	0.4464**				
		(0.0443)		(0.0554)				
Variance	ω_0	0.0000	ω_0	0.0000				
		(0.0000)		(0.0000)				
	ω_1	0.1914**	ω_1	0.0659**				
		(0.0503)		(0.0159)				
	ω_2	-0.1353*	-	-				
		(0.0626)						
	ω_3	0.0725	-	-				
		(0.0619)						
	ω_4	-0.1084*	-	-				
		(0.0451)						
	φ_1	0.9787**	φ_1	0.9177**				
		(0.0077)		(0.0177)				
	λ_1	0.1523*	λ_2	0.0173				
		(0.0750)		(0.0164)				
	λ_2	-0.1485*	-	-				
		(0.0747)						
Log-likelihood		2557.795		3015.189				
Residual tests	Q(6)	4.379	Q(6)	3.902				
		(0.496)		(0.564)				
	Q(12)	13.263	Q(12)	7.785				
		(0.277)		(0.732)				
	$Q^2(6)$	3.459	$Q^2(6)$	5.779				
		(0.630)		(0.328)				
	$Q^2(12)$	14.810	$Q^2(12)$	11.808				
		(0.191)		(0.378)				

Table 2.6 – continued

	SHSE A and HSI				SZSE A and HSI			
	Pre		Post		Pre		Post	
Mean	α_0	-0.0013**	α_0	-0.0005	α_0	-0.0014**	-	-
		(0.0007)		(0.0012)		(0.0006)		
	β_1	0.0176	α_1	-0.0018	β_1	0.0233	-	-
		(0.0415)		(0.0326)		(0.0414)		
	δ_1	0.0450	δ_1	0.0641	δ_1	0.0455	-	-
		(0.0293)		(0.0382)		(0.0297)		
	δ_3	0.0407	-	-	δ_3	0.0356	-	-
		(0.0247)				(0.0250)		
Variance	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000	-	-
		(0.0000)		(0.0000)		(0.0000)		
	ω_1	0.2350**	ω_1	0.0532*	ω_1	0.2374**	-	-
		(0.0775)		(0.0237)		(0.0711)		
	φ_1	0.6221**	φ_1	0.9035*	φ_1	0.6315**	-	-
		(0.0842)		(0.0410)		(0.0779)		
Log-likelihood		3054.226		3130.569		3017.226	-	-
Residual tests	Q(6)	3.922	Q(6)	6.666	Q(6)	4.296	-	-
		(0.561)		(0.247)		(0.508)		
	Q(12)	10.320	Q(12)	12.859	Q(12)	14.472	-	-
		(0.502)		(0.303)		(0.208)		
	$Q^2(6)$	1.363	$Q^2(6)$	10.824	$Q^2(6)$	1.464	-	-
		(0.928)		(0.055)		(0.917)		
	$Q^2(12)$	2.549	$Q^2(12)$	15.372	$Q^2(12)$	1.968	-	-
		(0.995)		(0.995)		(0.999)		

	SZSE B and HSI				H and HSI			
	Pre		Post		Pre		Post	
Mean	-	-	α_0	-0.0018	-	-	α_0	0.0014
				(0.0018)				(0.0008)
	-	-	β_1	0.0803*	-	-	β_1	0.1252*
				(0.0398)				(0.0336)
	-	-	δ_1	0.1694**	-	-	δ_2	-0.0868
				(0.0520)				(0.0466)
Variance	-	-	ω_0	0.0000	-	-	ω_0	0.0000
				(0.0000)				(0.0000)
	-	-	ω_1	0.1311**	-	-	ω_1	0.0679**
				(0.0461)				(0.0159)
	-	-	φ_1	0.5552**	-	-	φ_1	0.9147**
				(0.1358)				(0.0201)
Log-likelihood	-	-		2900.577	-	-		2979.426
Residual tests	-	-	Q(6)	5.534	-	-	Q(6)	4.976
				(0.354)				(0.419)
	-	-	Q(12)	8.181	-	-	Q(12)	9.986
				(0.697)				(0.532)
	-	-	$Q^2(6)$	3.780	-	-	$Q^2(6)$	5.756
				(0.582)				(0.331)
	-	-	$Q^2(12)$	7.677	-	-	$Q^2(12)$	11.746
				(0.742)				(0.383)

Note: The Maximum-Likelihood estimations of the appropriate ARMA(l,m)-GARCH(1,p)-M models are reported. The Bollerslev and Wooldridge (1992) asymptotic standard errors are displayed in parentheses. * and ** indicate significance at the 5% and 1% significance level. Q(6), Q(12), $Q^2(6)$ and $Q^2(12)$ are the Ljung-Box Q-statistics and their p-values in parentheses for the first 6 and 12 autocorrelations of standardized residuals and their squares.

Table 2.7: Cross Correlations of the Standardized Residuals of the Augmented Models

Pre-liberalization										
	SHSE A and DJI		SHSE B and DJI		SZSE A and DJI		SZSE B and DJI		H and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-0.0307	0.0013	-	-	-	-	-0.0037	0.0116	0.0521	0.0465
2	0.0140	0.0236	-	-	-	-	0.0006	0.0020	0.0164	0.0213
3	-0.0108	-0.0173	-	-	-	-	0.0118	0.0169	-0.0368	0.0592
4	-0.0084	0.0210	-	-	-	-	-0.0476	-0.0009	0.0192	-0.0124
5	0.0387	-0.0099	-	-	-	-	0.0234	-0.0112	0.0369	-0.0391
	SHSE A and HSI		SHSE B and HSI		SZSE A and HSI		SZSE B and DJI		H and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0058	0.0458	-	-	0.0123	0.0479	-	-	-	-
2	0.0071	-0.0102	-	-	0.0106	-0.0124	-	-	-	-
3	0.0291	0.0359	-	-	0.0317	0.0389	-	-	-	-
4	0.0366	-0.0110	-	-	0.0395	-0.0123	-	-	-	-
5	0.0381	-0.0263	-	-	0.0483	-0.0291	-	-	-	-
Post-liberalization										
	SHSE A and DJI		SHSE B and DJI		SZSE A and DJI		SZSE B and DJI		H and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-	-	-	-	-	-	0.0252	0.0082	0.0404	0.0165
2	-	-	-	-	-	-	0.0188	-0.0228	0.0552	**0.0761***
3	-	-	-	-	-	-	0.0399	-0.0006	-0.0415	0.0015
4	-	-	-	-	-	-	0.0242	-0.0205	0.0494	-0.0005
5	-	-	-	-	-	-	0.0035	0.0499	0.0346	0.0015
	SHSE A and HSI		SHSE B and HSI		SZSE A and HSI		SZSE B and DJI		H and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0167	-0.0164	-	-	-	-	-0.0053	-0.0015	-0.0535	-0.0256
2	-0.0275	-0.0307	-	-	-	-	-0.0211	-0.0227	-0.0116	-0.0575
3	-0.0018	-0.0119	-	-	-	-	0.0327	0.0128	-0.0149	-0.0183
4	-0.0017	-0.0021	-	-	-	-	0.0062	0.0050	-0.0096	-0.0209
5	0.0258	-0.0469	-	-	-	-	0.0258	-0.0285	0.0502	-0.0165

Note: The cross correlations of the standardized residuals and squared standardized residuals computed from the models reported in Table 2.4 are shown. *s* indicates the number of periods the second cited return series lags the first cited return series. * indicates significance at the 5% level.

The cross correlations from the augmented models reported above are shown in Table 2.7.[71] Table 2.5 and 2.7 when combined give a more complex picture about the spillover effects of the different markets and the changes before and after stock market liberalization. The consideration of the lagged foreign return series in the mean and variance equations in the ARMA(l,m)-GARCH(1,p)-M models leads to cross correlations which verify causality in mean in all cases and causality in variance in the case of H and DJI in the first but not in

[71] We only show the cross correlations where an improvement of the original ARMA(l,m)-GARCH(1,p)-M models is reasonable. In Section 2.A.1 in the appendix, a clear presentation of the spillovers in mean and in variance which are caused by the stock markets in the United States and Hong Kong is given.

the second subsample.[72] These results show that the liberalization of the A share segment does not lead to more spillover effects in the post-liberalization phase neither in mean nor in variance.[73] Interestingly, adding the foreign return series in the variance equations does not lead to insignificant cross correlations in the squares. This indicates that other factors play a more important role than the markets in Hong Kong and the United States.

2.6 Conclusion

The change in the information flow triggered by the implementation of the QFII program allowing foreign institutional investors to trade A shares on the mainland China stock exchanges in Shanghai and Shenzhen, is analyzed with regard to the impact on Chinese stock market integration to the stock markets in Hong Kong and the United States. A two-stage Lagrange multiplier approach is applied to the return series of the stock market indices.

Using ARMA(l,m)-GARCH(1,p)-M models and computing cross correlations of the (squared) residuals, we find some evidence of a more pronounced global rather than regional integration as more causality in variance is found. However, the partial opening of the A share market to foreign institutional investors has not strengthen the integration of Chinese stock markets to other regional and global markets as volatility spillovers do not increase in the post-liberalization phase and apparently occur more often in the pre-liberalization phase.[74]

[72] Although the cross correlation of H and DJI in the second subsample is still significant, the value decreases substantially.

[73] Section 2.A.3 in the appendix shows that this result is robust to different stock market index classifications. Using the Shanghai Stock Exchange Composite index as well as the Shenzhen Stock Exchange Composite index instead of the A and B shares for both stock markets, again, the liberalization in 2002 does not increase causality in variance. Additionally, the effects of the liberalization through the implementation of the QDII program are analyzed. It is shown that also the QDII program has been effective in promoting Chinese stock market integration with regional markets as spillovers in variance (and in mean) occur more often in the post-liberalization phase. In addition, in Section 2.A.4 in the appendix, it is shown that these results also arise when the full sample is used instead of two separated subsamples.

[74] In Section 2.A.2 in the appendix, we use three additional stock market indices: Taiwan Stock Exchange Weighted index (TAI), Nikkei 225 Stock Average index (NIK) and Korea Stock Exchange Composite index (KOR). We show that due to the liberalization in 2002, the integration of the Chinese stock market

In our analysis, we do not find evidence that the indicated spillovers in variance in the post-liberalization phase are caused by the stock market in the United States. Therefore, it seems that other factors play a more crucial role and that trading barriers still exist. News on regional or global stock markets are not transmitted to and incorporated into the prices of mainland China stock indices.[75]

Our research could be extended in several ways. First of all, higher frequency data would help to understand and trace the information transmission among stock markets (as in Susmel and Engle (1994)). Furthermore, as proposed by Hong et al. (2009) and Li et al. (2008), a weighting function could be used in order to consider the hypothesis that financial markets are influenced the most by recent events and that the influence of past events decreases gradually. Additionally, an asymmetrical consideration of positive as well as negative innovations on changes in volatility could be incorporated (as in Johansson and Ljungwall (2009)). Another extension of our research would be to focus on the spread of financial crises and an explicit reference to the recent financial crises (as for instance done in Zhou et al. (2012)). Knowledge about volatility transmission across emerging and developed stock markets may help to understand this phenomenon.

indices with these regional markets did not increase. These results are comparable to the findings reported for the HSI. In addition, the liberalization due to the implementation of the QDII program in 2006 is under examination. In this case, we are able to show increased spillovers in the post-liberalization phase, particularly with regional markets.

[75] These results may be further evidence that China is decoupled from international and regional stock markets (emphasized for instance by Fidrmuc and Korhonen (2010)).

2.A Appendix

In the following sections, further information and robustness checks related to the main part of this chapter are provided. In **Section 2.A.1**, a concise presentation of the spillovers which are caused by the stock market indices of the United States and Hong Kong are given. **Section 2.A.2** contains the results of two extensions. First, the procedure of the main part is applied to the liberalization that took place in 2006. On April 13, 2006 the Chinese government announced the QDII (Qualified Domestic Institutional Investor) program. This scheme allows authorized institutional investors to invest in foreign financial products and therefore can be viewed as some kind of counterpart to the QFII program, used in the main part as liberalization date. Second, selected index return series of Taiwan, Japan and South Korea are added to the analysis in order to obtain a more complete picture about the regional spillovers.

In **Section 2.A.3**, the *Shanghai Stock Exchange Composite index* instead of the Shanghai Stock Exchange A and B share indices and the *Shenzhen Stock Exchange Composite index* instead of Shenzhen Stock Exchange A and B share indices are applied. The Shanghai (Shenzhen) Stock Exchange Composite index includes all stocks, A shares as well as B shares, which are traded at the Shanghai (Shenzhen) Stock Exchange.

In **Section 2.A.4**, the analysis of the main part is replicated using the same variables but the full sample period from November 23, 1998 to December 8, 2006.

2.A.1 Spillovers in mean and in variance

This section gives an overview of the spillovers in mean and in variance which are caused by the stock markets in Hong Kong and the United States.

Table 2.8: Spillovers in Mean and in Variance

Pre-liberalization

	SHSE A and DJI		SHSE B and DJI		SZSE A and DJI		SZSE B and DJI		H and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1										x
2							x		x	x
3										
4	x								x	
5										

	SHSE A and HSI		SHSE B and HSI		SZSE A and HSI		SZSE B and HSI		H and HSI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1					x					
2										
3	x				x					
4										
5										

Post-liberalization

	SHSE A and DJI		SHSE B and DJI		SZSE A and DJI		SZSE B and DJI		H and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1									x	
2							x		x	(x)
3										
4										
5										

	SHSE A and HSI		SHSE B and HSI		SZSE A and HSI		SZSE B and HSI		H and HSI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	x						x			
2									x	
3										
4										
5										

Note: Spillovers in mean and in variance which are caused by the stock markets in the United States and in Hong Kong are indicated through x. (x) means that a spillover is only potentially indicated as the cross correlation is still significant but smaller as in the case where the foreign market is not considered. s indicates the number of periods the second cited return series lags the first cited return series.

2.A.2 Liberalization in 2002 and 2006, and additional regional stock market indices

In this section, we add stock market indices of Taiwan, Japan and South Korea to our analysis in order to get a deeper insight into the regional integration of China.[76] The Figures 2.3 and 2.4 show the log levels and the return series of the indices. Again, both liberalizations are taken into account, the implementation of the QFII program in 2002 and the implementation of the QDII program in 2006. As already reported in the main part, A and B share indices of the stock exchanges of Shanghai and Shenzhen show a comparable development albeit on a different level.[77] This also applies when the liberalization of 2006 is applied. The four indices show remarkable growth until the year 2007/2008. Subsequently, the series fall down and shrink for one year before the indices turn upwards again. Some similarities in the development are found in the case of DJI and HSI. Both indices show relative constant growth rates until the end of the year 2007 and a downturn until 2008/2009 afterwards. Then both indices start to rise again.

Three new indices, the Taiwan Stock Exchange Weighted index (TAI), Nikkei 225 Stock Average index (NIK) and Korea Stock Exchange Composite index (KOR) are displayed, too.[78] The Taiwanese index shows a clear upwards trend for the first two years of the sample. At the beginning of 2000, the index decreased sharply until the end of 2001 where a recovering begins. This upwards trend continues until 2007 with a setback in 2002/2003. Until the beginning of 2009, a heavily downward movement is revealed as well as a fast recovering until the end of the sample. The Japanese index shows a downtrend until the beginning of

[76] These countries are also used (partly) for instance in Ng (2000), Cheng and Glascock (2005) and Hsiao et al. (2003).

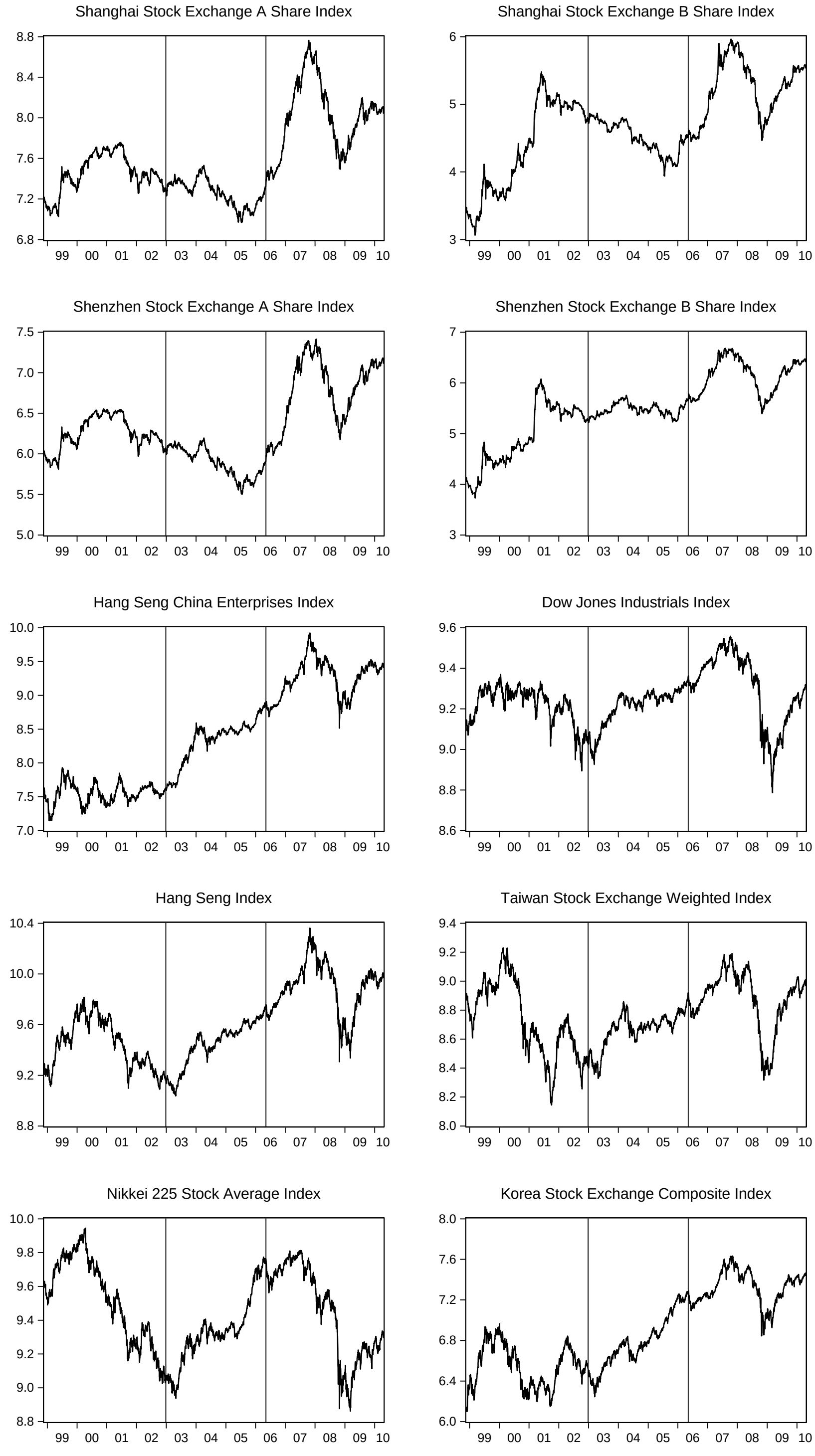
[77] For further description of the graphs before the year 2006, see section 2.3 in the main part.

[78] Again, the data are collected via Thomson Datastream from Taiwan and Korea stock exchange as well as from Nikkei.

2003 after two years of growth, 1998 and 1999. Afterwards, the series rallied until 2007 with two periods with a relatively constant development, from 2004 to 2005 and from 2006 to 2008. Subsequently, the series is characterized by a sharp decrease. A recovering starts at the beginning of 2009 and lasts until the end of the sample. At last, the development of the South Korea index is characterized by two upwards phases until 2003, 1999/2000 and 2002. Until 2003, a relatively constant upward trend took place which lasts until 2007. Afterwards, the series is characterized by a downward trend. A turnaround is marked at the end of 2008, as the index rise until the end of our sample.

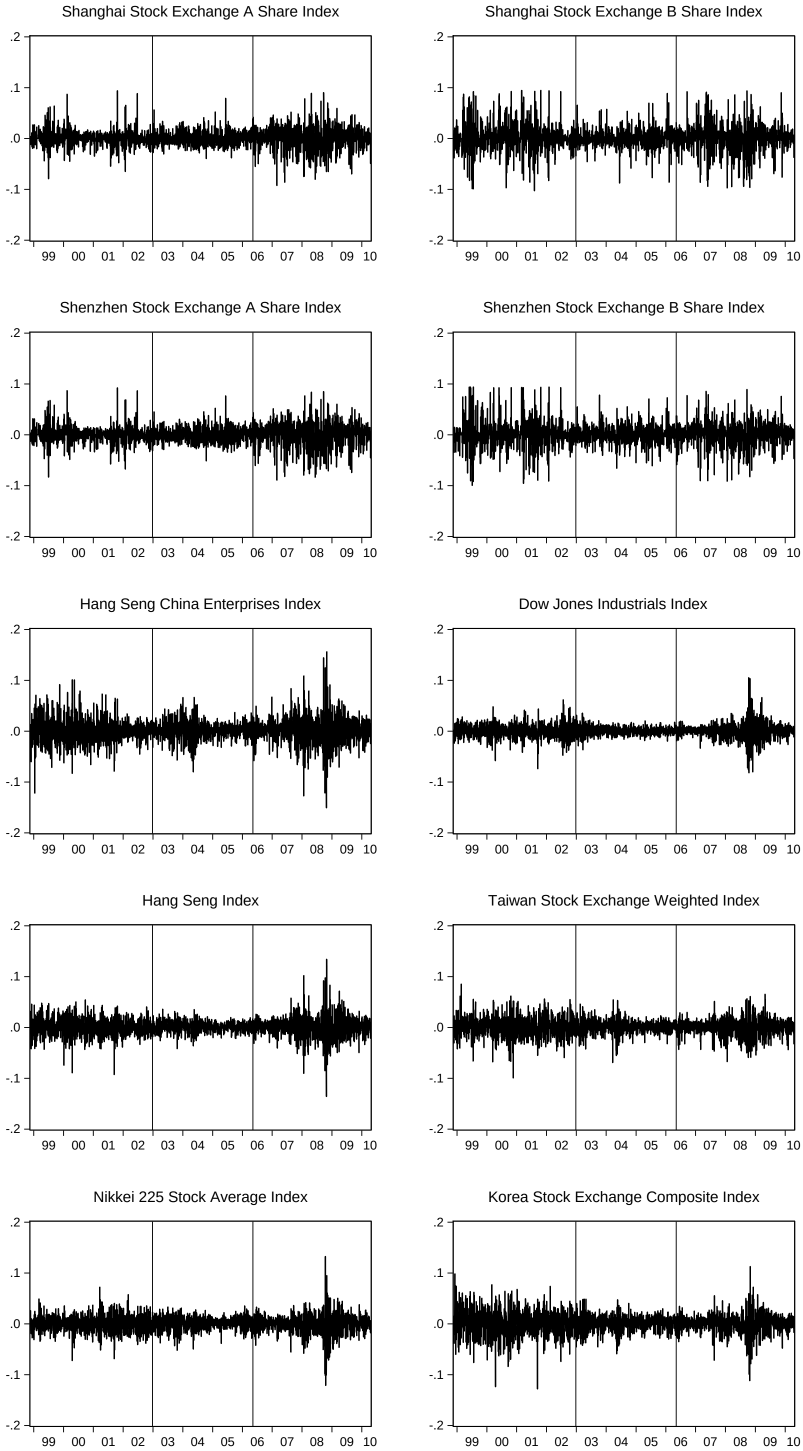
Figure 2.4 reveals that all series exhibit volatility cluster. The Chinese B share indices seem to have the highest volatility while DJI seems to have the lowest one. The vertical lines indicate the liberalization dates in 2002 and 2006.

Figure 2.3: Stock Market Indices of the Main Part Variables and of the Indices of Taiwan, Japan and South Korea (in logs)



Note: The graphs of SHSE A, SHSE B, SZSE A, SZSE B, H, DJI,HSI, TAI, NIK and KOR in logs are displayed. The sample covers the period November 22, 1998 to April 20, 2010.

Figure 2.4: Stock Market Returns of the Main Part Variables and of the Indices of Taiwan, Japan and South Korea



Note: The graphs of the returns of SHSE A,SHSE B, SZSE A, SZSE B, H, DJI, HSI, TAI, NIK and KOR are displayed. The sample covers the period November 23, 1998 to April 20, 2010.

Table 2.9: Results of ADF Tests for both Liberalization Phases

	Levels			Returns			Levels			Returns		
	ADF	k	Prob.	ADF	k	Prob.	ADF	k	Prob.	ADF	k	Prob.
Panel A												
	Pre-liberalization						Post-liberalization					
TAI	-1.0491	0	0.7373	-31.5625**	0	0.000	-1.3481	0	0.6087	-31.0183**	0	0.000
NIK	-0.1655	0	0.9402	-33.5712**	0	0.000	-0.7332	0	0.8362	-32.3404**	0	0.000
KOR	-2.4008	0	0.1418	-31.3593**	0	0.000	-0.4231	0	0.9027	-31.1106**	0	0.000
Panel B												
	Pre-liberalization						Post-liberalization					
SHSE A	-1.6783	0	0.4420	-31.8280**	0	0.000	-2.0136	4	0.2810	-14.2526**	3	0.000
SHSE B	-1.6448	1	0.4592	-29.2151**	0	0.000	-1.5666	4	0.4994	-14.3277**	3	0.000
SZSE A	-1.4262	0	0.5706	-31.2536**	0	0.000	-1.9803	4	0.2957	-14.1967**	3	0.000
SZSE B	-2.1303	1	0.2328	-30.3837**	0	0.000	-1.2672	0	0.6466	-31.0167**	0	0.000
DJI	-1.2909	1	0.6357	-34.4501**	0	0.000	-1.1555	3	0.6953	-19.6116**	2	0.000
HSI	-0.3379	19	0.9167	-7.2785**	18	0.000	-1.6390	1	0.4662	-34.1201**	0	0.000
H	-0.3678	20	0.9120	-7.1503**	19	0.000	-1.6134	14	0.4754	-9.0810**	13	0.000
TAI	-1.4788	0	0.5422	-31.2257**	0	0.000	-1.7096	20	0.4261	-5.8618**	21	0.000
NIK	0.7420	9	0.9930	-12.4236**	8	0.000	-1.2342	4	0.6615	-16.6673**	3	0.000
KOR	0.0009	0	0.9575	-31.2116**	0	0.000	-1.5904	0	0.4871	-32.0889**	0	0.000

Note: In panel A, the ADF test (allowing for an intercept) is calculated from the levels and the returns of TAI, NIK and KOR for both subsamples used in the main part. In panel B, the ADF test is calculated from the levels and the returns of SHSE A, SHSE B, SZSE A, SZSE B, DJI, HSI, H, TAI, NIK and KOR for both subsamples related to the liberalization in 2006. The lag length is selected by the Akaike information criterion. ** indicates significance at the 1% level.

Table 2.9 shows that in both panels, all series are non-stationary in levels but stationary in first differences at the 1% level. Table 2.10 displays the descriptive statistics. It is revealed that the standard deviations and the ranges of TAI, NIK and KOR decreased in the post-liberalization phase of panel A, representing the liberalization in 2002. Interestingly, the result reverses when panel B, the liberalization in 2006, is under examination. There, the standard deviations and the ranges increased in the post-liberalization phase. Again, this may suggest a generally increased trading risk.

Table 2.11 shows the bivariate correlations of the Chinese stock market indices with TAI, NIK and KOR in panel A while in panel B the bivariate correlations between the Chinese stock market indices with DJI, HSI, TAI, NIK and KOR are depicted.[79] Panel A emphasizes the results from the main part as these correlations suggest regional integration particularly

[79]Note, the investigation of the Chinese stock market indices and those from the United States and Hong Kong is subject of the analysis presented in the main part.

Table 2.10: Descriptive Statistics of the Index Return Series for both Liberalization Phases

	Mean	Max	Min	Std. Dev.	Range	Mean	Max	Min	Std. Dev.	Range
Panel A										
	Pre-liberalization					Post-liberalization				
TAI	-0.0004	0.0852	-0.0993	0.0191	0.1845	0.0005	0.0542	-0.0691	0.0118	0.1233
NIK	-0.0005	0.0722	-0.0723	0.0152	0.1445	0.0006	0.0352	-0.0523	0.0116	0.0875
KOR	0.0004	0.0983	-0.1280	0.0240	0.2263	0.0006	0.0488	-0.0590	0.0133	0.1078
Panel B										
	Pre-liberalization					Post-liberalization				
SHSE A	-0.0002	0.0884	-0.0396	0.1280	0.0121	0.0007	0.0903	-0.0926	0.1829	0.0212
SHSE B	-0.0005	0.0923	-0.0877	0.1799	0.0158	0.0010	0.0937	-0.0973	0.1910	0.0248
SZSE A	-0.0004	0.0865	-0.0515	0.1380	0.0128	0.0012	0.0851	-0.0893	0.1743	0.0227
SZSE B	0.0002	0.0929	-0.0660	0.1589	0.0156	0.0007	0.0891	-0.0913	0.1804	0.0212
DJI	0.0001	0.0615	-0.0475	0.1091	0.0102	0.0000	0.1051	-0.0820	0.1871	0.0150
HSI	0.0004	0.0405	-0.0418	0.0823	0.0097	0.0002	0.1341	-0.1358	0.2699	0.0210
H	0.0011	0.0665	-0.0803	0.1468	0.0153	0.0005	0.1561	-0.1509	0.3069	0.0267
TAI	0.0001	0.0548	-0.0691	0.1240	0.0133	0.0001	0.0652	-0.0674	0.1326	0.0154
NIK	0.0004	0.0354	-0.0523	0.0876	0.0124	-0.0004	0.1323	-0.1211	0.2535	0.0184
KOR	0.0004	0.0488	-0.0742	0.1230	0.0151	0.0002	0.1128	-0.1117	0.2246	0.0168

Note: In panel A, the different descriptive statistics for the index return series of TAI, NIK and KOR for both subsamples used in the main part are displayed. In panel B, the descriptive statistics for the index return series of the SHSE A, SHSE B, SZSE A, SZSE B, DJI, HSI, H, TAI,NIK and KOR for both subsamples related to the liberalization in 2006 are displayed.

with South Korea in the post-liberalization phase. In general, more significance is found in the post- than in the pre-liberalization phase, potentially indicating increased integration. Panel B, which is related to the liberalization in 2006, bear a resemblance to the liberalization in 2002. Again, the hint of global integration is rather weak as a significant correlation is only found in the case of H and DJI before as well as after the liberalization. In the post-liberalization phase, all correlations of the Chinese stock market indices with regional markets are significant suggesting a rising integration especially in the case of TAI and NIK while in the pre-liberalization phase, less significance is revealed. In case of HSI and KOR, all correlations are significant in the pre- as well as in the post-liberalization phase.

Panel A of Table 2.12 shows the ARMA(l,m)-GARCH(1,p)-M models for the index return series of TAI, NIK and KOR for the pre-and post-liberalization phase of the liberalization in 2002. Again, the constants and the ARMA terms are insignificant in the mean equations but considerable persistence to volatility shocks is reported as the conditional variance parameter

φ_1 ranges between 0.77 and 0.93. In all three cases, φ_1 is higher in the post- than in the pre-liberalization phase indicating increasing persistence to volatility shocks.

Table 2.11: Correlations between the Stock Market Returns of China, the United States, Hong Kong, Taiwan, Japan and South Korea

Panel A					
	Pre-liberalization	Post-liberalization		Pre-liberalization	Post-liberalization
SHSE A and TAI	-0.0512	0.0432	SHSE A and NIK	0.0492	0.0644*
	(0.0980)	(0.1632)		(0.1122)	(0.0375)
SHSE B and TAI	-0.0701*	-0.0636*	SHSE B and NIK	0.0200	0.0331
	(0.0235)	(0.0398)		(0.5179)	(0.2853)
SZSE A and TAI	-0.0514	0.0471	SZSE A and NIK	0.0480	0.0589
	(0.0972)	(0.1284)		(0.1208)	(0.0568)
SZSE B and TAI	0.0933**	0.1155**	SZSE B and NIK	0.0523	0.0983**
	(0.0026)	(0.0002)		(0.0913)	(0.0015)
H and TAI	0.1359**	0.3545**	H and NIK	0.2440**	0.3372**
	(0.0000)	(0.0000)		(0.0000)	(0.0000)
SHSE A and KOR	-0.0304	0.0978**			
	(0.3261)	(0.0016)			
SHSE B and KOR	-0.0258	0.1077**			
	(0.4047)	(0.0005)			
SZSE A and KOR	-0.0299	0.0974**			
	(0.3347)	(0.0016)			
SZSE B and KOR	0.0270	0.1681**			
	(0.3832)	(0.0000)			
H and KOR	0.2804**	0.4136**			
	(0.0000)	(0.0000)			
Panel B					
	Pre-liberalization	Post-liberalization		Pre-liberalization	Post-liberalization
SHSE A and DJI	-0.0057	0.0515	SHSE A and HSI	0.0875**	0.4508**
	(0.8552)	(0.0964)		(0.0047)	(0.0000)
SHSE B and DJI	-0.0220	0.0441	SHSE B and HSI	0.0732*	0.3976**
	(0.4775)	(0.1551)		(0.0181)	(0.0000)
SZSE A and DJI	-0.0061	0.0353	SZSE A and HSI	0.0794*	0.3819**
	(0.8449)	(0.2551)		(0.0103)	(0.0000)
SZSE B and DJI	0.0109	0.0496	SZSE B and HSI	0.1233**	0.4589**
	(0.7258)	(0.1091)		(0.0001)	(0.0000)
H and DJI	0.0671*	0.2349**	H and HSI	0.6599**	0.9524**
	(0.0301)	(0.0000)		(0.0000)	(0.0000)
SHSE A and TAI	0.0255	0.3032**	SHSE A and NIK	0.0623*	0.2851**
	(0.4110)	(0.0000)		(0.0442)	(0.0000)
SHSE B and TAI	0.0369	0.2591**	SHSE B and NIK	0.0252	0.2518**
	(0.2339)	(0.0000)		(0.4157)	(0.0000)
SZSE A and TAI	0.0235	0.2502**	SZSE A and NIK	0.0477	0.2283**
	(0.4490)	(0.0000)		(0.1235)	(0.0000)
SZSE B and TAI	0.0824**	0.3433**	SZSE B and NIK	0.0837**	0.3243**
	(0.0077)	(0.0000)		(0.0068)	(0.0000)
H and TAI	0.3369**	0.5869**	H and NIK	0.3195**	0.6318**
	(0.0000)	(0.0000)		(0.0000)	(0.0000)
SHSE A and KOR	0.0653*	0.3249**			
	(0.0351)	(0.0000)			
SHSE B and KOR	0.0675*	0.2888**			
	(0.0292)	(0.0000)			
SZSE A and KOR	0.0619*	0.2511**			
	(0.0458)	(0.0000)			
SZSE B and KOR	0.1288**	0.3483**			
	(0.0000)	(0.0000)			
H and KOR	0.3933**	0.6701**			
	(0.0000)	(0.0000)			

Note: The different bivariate correlations between the index return series of the SHSE A, SHSE B, SZSE A, SZSE B and H with TAI, NIK and KOR for both subsamples related to the liberalization in 2002 are displayed in panel A. The different bivariate correlations between the index return series of SHSE A, SHSE B, SZSE A, SZSE B and the H with DJI, HSI,TAI, NIK and KOR for the samples according to the liberalization in 2006 are displayed in panel B. The values in parentheses indicate the probability values. * and ** indicate significance at the 5% and 1% level.

Table 2.12: ARMA(l,m)-GARCH(1,p)-M Models for the Index Return Series of Taiwan, Japan and South Korea - Panel A

		TAI				**NIK**		
		Pre		**Post**		**Pre**		**Post**
Mean	α_0	-0.0027	α_0	-0.0009	α_0	-0.0028*	α_0	-0.0006
		(0.0017)		(0.0006)		(0.0013)		(0.0007)
	β_1	0.0229	β_1	0.0584	α_1	-0.0351	β_1	0.0128
		(0.0311)		(0.0335)		(0.0901)		(0.0306)
Variance	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000
		(0.0000)		(0.0000)		(0.0000)		(0.0000)
	ω_1	0.0695**	ω_1	0.0112	ω_1	-0.0341	ω_1	0.0639**
		(0.0205)		(0.0320)		(0.0121)		(0.0170)
	-	-	ω_2	0.0465	ω_2	0.1147**	-	-
				(0.0455)		(0.0219)		
	φ_1	0.8846**	φ_1	0.9300**	φ_1	0.8499**	φ_1	0.9260**
		(0.0388)		(0.0310)		(0.0274)		(0.0195)
Log-likelihood		2681.423		3245.957		2927.473		3217.806
Residual tests	Q(6)	10.942	Q(6)	2.494	Q(6)	4.152	Q(6)	1.682
		(0.053)		(0.777)		(0.528)		(0.891)
	Q(12)	13.867	Q(12)	4.237	Q(12)	7.514	Q(12)	14.660
		(0.240)		(0.962)		(0.756)		(0.199)
	$Q^2(6)$	8.838	$Q^2(6)$	7.746	$Q^2(6)$	2.486	$Q^2(6)$	1.703
		(0.116)		(0.171)		(0.779)		(0.889)
	$Q^2(12)$	22.525	$Q^2(12)$	10.543	$Q^2(12)$	16.243	$Q^2(12)$	5.291
		(0.021)		(0.482)		(0.132)		(0.916)
		KOR						
		Pre		**Post**				
Mean	α_0	-0.0044	α_0	0.0015				
		(0.0040)		(0.0009)				
	β_1	0.0436	β_1	0.0362				
		(0.0331)		(0.0321)				
Variance	ω_0	0.0000	ω_0	0.0000				
		(0.0000)		(0.0000)				
	ω_1	0.0681*	ω_1	-0.0204				
		(0.0298)		(0.0308)				
	-	-	ω_2	-0.0958*				
				0.0406				
	φ_1	0.7666**	φ_1	0.8964**				
		(0.1022)		(0.0314)				
Log-likelihood		2427.731		3103.275				
Residual tests	Q(6)	1.174	Q(6)	1.377				
		(0.947)		(0.927)				
	Q(12)	2.877	Q(12)	10.030				
		(0.992)		(0.528)				
	$Q^2(6)$	0.749	$Q^2(6)$	2.384				
		(0.980)		(0.794)				
	$Q^2(12)$	2.617	$Q^2(12)$	4.864				
		(0.995)		(0.938)				

Note: The Maximum-Likelihood estimations of the appropriate ARMA(l,m)-GARCH(1,p)-M models for TAI, NIK and KOR are reported. The Bollerslev and Wooldridge (1992) asymptotic standard errors are displayed in parentheses. * and ** indicate significance at the 5% and 1% level. Q(6), Q(12), $Q^2(6)$ and $Q^2(12)$ are the Ljung-Box Q-statistics and their p-values in parentheses for the first 6 and 12 autocorrelations of the standardized residuals and their squares.

Table 2.13 shows the ARMA(l,m)-GARCH(1,p)-M model estimations of all index return series of the pre- and post-liberalization phase of the liberalization in 2006. Again, especially the ARMA terms in the mean equation are largely insignificant while the conditional variance parameter φ_1 reveals considerable persistence of the conditional variance. In contrast to the coefficients which are reported in the main part and in Table 2.12, the persistence to volatility shocks seems to decrease after the liberalization in 2006. In case of TAI, we are not able to determine an ARMA(l,m)-GARCH(1,p)-M model for the pre-liberalization phase which does not exhibit autocorrelation in the residuals. In the post-liberalization phase, we are not able to find appropriate ARMA(l,m)-GARCH(1,p)-M models for SHSE A, SHSE B and SZSE A.

Table 2.13: ARMA(l,m)-GARCH(1,p)-M Models for the Index Return Series of China, the United States, Hong Kong, Taiwan, Japan and South Korea - Panel B

		SHSE A				**SHSE B**		
		Pre		**Post**		**Pre**		**Post**
Mean	α_0	-0.0018*	α_0	-0.0024*	α_0	-0.0028*	α_0	-0.0012
		(0.0009)		(0.0011)		(0.0011)		(0.0010)
	α_1	-0.0007	α_1	-0.0051	β_1	0.0768	β_1	0.0951*
		(0.0362)		(0.0369)		(0.0417)		(0.0369)
Variance	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000
		(0.0000)		(0.0000)		(0.0000)		(0.0000)
	ω_1	0.0883**	ω_1	0.0640**	ω_1	0.0993*	ω_1	0.1732**
		(0.0352)		(0.0197)		(0.0422)		(0.0545)
	φ_1	0.8477**	φ_1	0.9260**	φ_1	0.8239**	φ_1	0.7883**
		(0.0385)		(0.0245)		(0.0776)		(0.0645)
Log-likelihood		3148.582		2603.080		2901.559		2504.940
Residual tests	Q(6)	6.671	Q(6)	11.853	Q(6)	2.252	Q(6)	14.005
		(0.246)		(0.037)		(0.813)		(0.016)
	Q(12)	14.000	Q(12)	14.360	Q(12)	9.441	Q(12)	16.807
		(0.233)		(0.214)		(0.581)		(0.114)
	$Q^2(6)$	4.029	$Q^2(6)$	2.933	$Q^2(6)$	2.312	$Q^2(6)$	2.021
		(0.545)		(0.710)		(0.804)		(0.846)
	$Q^2(12)$	15.756	$Q^2(12)$	9.203	$Q^2(12)$	4.290	$Q^2(12)$	4.845
		(0.150)		(0.603)		(0.961)		(0.938)

		SZSE A				**SZSE B**		
		Pre		**Post**		**Pre**		**Post**
Mean	α_0	-0.0012	α_0	0.0013	α_0	-0.0038*	α_0	0.0000
		(0.0009)		(0.0013)		(0.0017)		(0.0014)
	β_1	0.0428	β_1	0.0594	α_1	0.0891*	α_1	0.0688
		(0.0345)		(0.0384)		(0.0380)		(0.0381)
Variance	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000
		(0.0000)		(0.0000)		(0.0000)		(0.0000)
	ω_1	0.0767**	ω_1	0.1508**	ω_1	0.1596**	ω_1	0.1567**
		(0.0259)		(0.0499)		(0.0609)		(0.0587)
	-	-	ω_2	-0.0830	-	-	ω_2	-0.0671
				(0.0534)				(0.0629)
	-	-	-	-	-	-	ω_3	0.0109
								(0.0477)
	φ_1	0.8835**	φ_1	0.9154**	φ_1	0.5044**	φ_1	0.8267**
		(0.0298)		(0.0338)		(0.1400)		(0.1056)
Log-likelihood		3102.900		2537.539		2891.437		2591.018
Residual tests	Q(6)	4.979	Q(6)	11.597	Q(6)	4.679	Q(6)	8.160
		(0.418)		(0.041)		(0.456)		(0.148)
	Q(12)	13.515	Q(12)	14.263	Q(12)	10.375	Q(12)	9.679
		(0.261)		(0.219)		(0.497)		(0.559)
	$Q^2(6)$	4.506	$Q^2(6)$	0.615	$Q^2(6)$	3.048	$Q^2(6)$	3.036
		(0.479)		(0.987)		(0.693)		(0.694)
	$Q^2(12)$	15.002	$Q^2(12)$	5.327	$Q^2(12)$	8.724	$Q^2(12)$	4.712
		(0.182)		(0.914)		(0.647)		(0.944)

		DJI				**HSI**		
		Pre		**Post**		**Pre**		**Post**
Mean	α_0	0.0000	α_0	0.0007*	α_0	0.0003	α_0	0.0004
		(0.0004)		(0.0003)		(0.0007)		(0.0006)
	β_1	-0.0751*	β_1	-0.0753**	α_1	0.0368	β_1	0.0304
		(0.0306)		(0.0221)		(0.0215)		(0.0294)

Table 2.13 − continued

Variance	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000
		(0.0000)		(0.0000)		(0.0000)		(0.0000)
	ω_1	0.0552**	ω_1	-0.0260	ω_1	-0.0557**	ω_1	-0.0350
		(0.0178)		(0.0301)		(0.0089)		(0.0203)
	-	-	ω_2	0.1492**	ω_2	0.0849**	ω_2	-0.0233
				(0.0324)		(0.0127)		(0.0163)
	-	-	-	-	-	-	ω_3	-0.1011**
								(0.0153)
	φ_1	0.9366**	φ_1	0.8639**	φ_1	0.9646**	φ_1	0.9477**
		(0.0162)		(0.0216)		(0.0100)		(0.0128)
Log-likelihood		3257.221		3685.118		3393.696		3396.554
Residual tests	Q(6)	0.771	Q(6)	4.516	Q(6)	1.086	Q(6)	1.645
		(0.979)		(0.478)		(0.955)		(0.896)
	Q(12)	6.645	Q(12)	10.402	Q(12)	11.239	Q(12)	11.422
		(0.827)		(0.495)		(0.423)		(0.409)
	$Q^2(6)$	7.140	$Q^2(6)$	2.554	$Q^2(6)$	5.764	$Q^2(6)$	4.432
		(0.210)		(0.768)		(0.330)		(0.489)
	$Q^2(12)$	11.397	$Q^2(12)$	10.512	$Q^2(12)$	8.754	$Q^2(12)$	8.811
		(0.411)		(0.485)		(0.645)		(0.639)
		H				**TAI**		
		Pre		**Post**		**Pre**		**Post**
Mean	α_0	0.0008	α_0	0.0012	α_0	0.0006	α_0	0.0007
		(0.0008)		(0.0008)		(0.0008)		(0.0007)
	β_1	0.1345**	β_1	-0.0529	α_1	0.0588	β_1	0.0214
		(0.0334)		(0.0331)		(0.0328)		(0.0318)
Variance	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000
		(0.0000)		(0.0000)		(0.0000)		(0.0000)
	ω_1	0.0579**	ω_1	0.0810	ω_1	-0.0039	ω_1	-0.0059
		(0.0138)		(0.0415)		(0.0364)		(0.0232)
	-	-	ω_2	-0.0001	ω_2	0.1138**	-	-
				(0.0534)		(0.0355)		
	-	-	ω_3	-0.1582**	-	-	-	-
				(0.0506)				
	φ_1	0.9284**	φ_1	0.7454**	φ_1	0.9319**	φ_1	0.8689**
		(0.0157)		(0.0427)		(0.0258)		(0.0298)
Log-likelihood		2989.612		2504.528		3133.967		2987.083
Residual tests	Q(6)	3.645	Q(6)	6.488	Q(6)	3.731	Q(6)	2.833
		(0.602)		(0.262)		(0.589)		(0.726)
	Q(12)	10.120	Q(12)	14.387	Q(12)	8.010	Q(12)	6.687
		(0.520)		(0.212)		(0.712)		(0.824)
	$Q^2(6)$	6.836	$Q^2(6)$	0.632	$Q^2(6)$	6.288	$Q^2(6)$	3.209
		(0.233)		(0.986)		(0.279)		(0.668)
	$Q^2(12)$	14.161	$Q^2(12)$	7.775	$Q^2(12)$	9.508	$Q^2(12)$	7.324
		(0.224)		(0.733)		(0.575)		(0.772)
		NIK				**KOR**		
		Pre		**Post**		**Pre**		**Post**
Mean	α_0	0.0012	α_0	-0.0002	α_0	-0.0020*	α_0	0.0005
		(0.0006)		(0.0005)		(0.0008)		(0.0005)
	β_1	0.0149	β_1	-0.0536	β_1	0.0457	α_1	-0.0203
		(0.0311)		(0.0305)		(0.0312)		(0.0308)
Variance	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000
		(0.0000)		(0.0000)		(0.0000)		(0.0000)
	ω_1	0.0701**	ω_1	0.0124	ω_1	0.0650**	ω_1	-0.0027
		(0.0150)		(0.0123)		(0.0172)		(0.0284)

Table 2.13 – continued

	-	-	ω_2	0.1324**	-	-	ω_2	0.0903*
				(0.0450)				(0.0358)
	φ_1	0.9228**	φ_1	0.8343**	φ_1	0.9188**	φ_1	0.8954**
		(0.0150)		(0.0352)		(0.0203)		(0.0230)
Log-likelihood		3156.616		2934.919		2970.179		2977.580
Residual tests	Q(6)	0.493	Q(6)	3.576	Q(6)	1.923	Q(6)	2.742
		(0.992)		(0.612)		(0.860)		(0.740)
	Q(12)	15.059	Q(12)	7.667	Q(12)	12.307	Q(12)	9.198
		(0.180)		(0.743)		(0.341)		(0.604)
	$Q^2(6)$	0.757	$Q^2(6)$	2.860	$Q^2(6)$	15.011	$Q^2(6)$	3.264
		(0.980)		(0.722)		(0.110)		(0.659)
	$Q^2(12)$	4.861	$Q^2(12)$	15.399	$Q^2(12)$	16.579	$Q^2(12)$	6.510
		(0.938)		(0.165)		(0.121)		(0.837)

Note: The Maximum-Likelihood estimations of the appropriate ARMA(l,m)-GARCH(1,p)-M models are reported. The Bollerslev and Wooldridge (1992) asymptotic standard errors are displayed in parentheses. * and ** indicate significance at the 5% and 1% level. Q(6), Q(12), $Q^2(6)$ and $Q^2(12)$ are the Ljung-Box Q-statistics and their p-values in parentheses for the first 6 and 12 autocorrelations of the standardized residuals and their squares.

In general, the cross correlations of the standardized residuals and the squares in Table 2.14 reveal only little potential causality in mean and in variance in the pre- as well as in the post-liberalization sample. Also increased spillovers in mean and in variance are not indicated. Interestingly, the cross correlations from panel B reported in Table 2.15, present that after the implementation of the QDII program, more spillovers between the stock markets are likely, particular from the United States to the Chinese stock markets.

In the next steps we test whether the significance of the cross correlations are caused by the foreign markets.

Table 2.14: Cross Correlations of the Standardized Residuals - Panel A

Pre-liberalization										
	SHSE A and TAI		SHSE B and TAI		SZSE A and TAI		SZSE B and TAI		H and TAI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0481	-0.0147	0.0500	0.0004	0.0475	-0.0133	0.0448	0.0111	-0.0100	0.0029
2	0.0224	0.0069	0.0060	-0.0021	0.0182	0.0060	0.0273	-0.0086	0.0483	0.0044
3	0.0330	0.0204	0.0491	0.0148	0.0324	0.0260	0.0331	0.0122	0.0094	-0.0274
4	0.0248	0.0175	-0.0064	**0.0805***	0.0261	0.0209	-0.0257	0.0528	0.0060	0.0270
5	0.0178	-0.0335	-0.0215	-0.0036	0.0218	-0.0341	-0.0164	-0.0116	0.0560	0.0276
	SHSE A and NIK		SHSE B and NIK		SZSE A and NIK		SZSE B and NIK		H and NIK	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0380	-0.0228	0.0091	-0.0045	0.0407	-0.0238	0.0283	-0.0253	-0.0303	0.0319
2	-0.0227	0.0153	-0.0313	0.0408	-0.0123	0.0193	-0.0164	0.0518	-0.0255	0.0117
3	0.0383	-0.0012	0.0210	0.0266	0.0321	-0.0005	0.0231	0.0167	0.0058	-0.0222
4	**0.0661***	-0.0214	**0.0663***	-0.0113	**0.0631***	-0.0170	0.0414	-0.0099	0.0349	-0.0340
5	0.0182	-0.0180	-0.0194	0.0342	0.0207	-0.0165	-0.0212	0.0327	-0.0348	0.0066
	SHSE A and KOR		SHSE B and KOR		SZSE A and KOR		SZSE B and KOR		H and KOR	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0481	-0.0232	0.0219	-0.0405	0.0442	-0.0196	0.0149	0.0035	0.0039	0.0384
2	-0.0411	-0.0088	-0.0318	0.0105	-0.0374	-0.0061	-0.0208	0.0271	-0.0103	-0.0202
3	0.0337	0.0179	0.0440	0.0424	0.0231	0.0087	0.0396	0.0357	-0.0062	0.0100
4	0.0016	-0.0257	0.0317	-0.0105	0.0006	-0.0219	0.0020	-0.0277	0.0303	-0.0126
5	-0.0068	-0.0122	-0.0326	-0.0112	0.0032	-0.0120	-0.0291	-0.0009	-0.0332	0.0319
Post-liberalization										
	SHSE A and TAI		SHSE B and TAI		SZSE A and TAI		SZSE B and TAI		H and TAI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0576	-0.0208	0.0400	-0.0083	0.0425	-0.0466	**0.0967***	-0.0047	-0.0450	-0.0042
2	0.0524	0.0413	**0.0644***	0.0084	0.0580	0.0492	0.0429	-0.0270	-0.0387	0.0187
3	0.0330	-0.0024	0.0373	-0.0158	0.0355	-0.0150	0.0508	0.0040	0.0510	**0.0679***
4	0.0226	-0.0027	0.0173	0.0350	0.0078	-0.0094	-0.0039	0.0112	0.0198	-0.0340
5	0.0440	-0.0258	0.0236	-0.0226	0.0388	-0.0202	0.0389	0.0281	0.0212	-0.0082
	SHSE A and NIK		SHSE B and NIK		SZSE A and NIK		SZSE B and NIK		H and NIK	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0212	-0.0254	0.0119	0.0058	0.0125	-0.0254	0.0288	0.0151	-0.0507	0.0105
2	-0.0563	-0.0037	-0.0080	0.0137	-0.0457	0.0134	0.0017	0.0222	-0.0602	0.0088
3	-0.0192	-0.0310	0.0086	-0.0514	-0.0134	-0.0302	-0.0004	**-0.0621***	0.0036	0.0174
4	0.0118	-0.0421	-0.0290	-0.0506	0.0083	-0.0469	-0.0205	-0.0327	0.0352	-0.0044
5	0.0509	-0.0160	0.0035	0.0076	0.0516	-0.0120	0.0533	-0.0043	0.0083	-0.0334
	SHSE A and KOR		SHSE B and KOR		SZSE A and KOR		SZSE B and KOR		H and KOR	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0326	0.0058	0.0095	0.0463	0.0186	-0.0040	0.0194	0.0146	0.0011	0.0051
2	0.0197	-0.0248	0.0456	0.0251	0.0192	-0.0171	0.0577	0.0382	-0.0119	0.0392
3	0.0021	0.0047	0.0423	-0.0214	0.0112	-0.0099	0.0217	-0.0160	0.0147	0.0306
4	-0.0011	-0.0186	0.0016	-0.0246	-0.0056	-0.0153	0.0023	-0.0052	0.0061	0.0055
5	**0.0626***	-0.0219	0.0200	0.0055	0.0526	-0.0231	0.0365	-0.0063	0.0219	-0.0208

Note: The cross correlations of the standardized residuals and the squared standardized residuals computed from the models reported in Table 2.12 are shown. s is the number of periods the second cited return series lags the first cited return series. * indicates significance at the 5% level.

Table 2.15: Cross Correlations of the Standardized Residuals - Panel B

Pre-liberalization										
	SHSE A and DJI		SHSE B and DJI		SZSE A and DJI		SZSE B and DJI		H and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-0.0065	0.0081	-0.0315	-0.0359	-0.0038	0.0052	0.0135	0.0107	**0.0831***	-0.0047
2	0.0127	-0.0211	0.0001	-0.0362	0.0070	-0.0177	**0.0648***	-0.0099	**0.2730***	**0.1226***
3	0.0426	-0.0061	0.0283	-0.0290	0.0263	-0.0102	0.0121	0.0105	-0.0235	-0.0027
4	-0.0235	-0.0020	-0.0199	0.0258	-0.0188	0.0027	0.0039	-0.0372	**0.0799***	**0.0628***
5	0.0248	-0.0236	0.0131	-0.0120	0.0256	-0.0394	0.0231	-0.0060	0.0552	0.0022
	SHSE A and HSI		SHSE B and HSI		SZSE A and HSI		SZSE B and HSI		H and HSI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0407	-0.0059	0.0228	0.0017	0.0206	-0.0092	0.0591	-0.0112	-0.0559	-0.0298
2	-0.0352	-0.0366	-0.0267	0.0032	-0.0327	-0.0228	-0.0312	0.0114	-0.0229	-0.0579
3	0.0035	-0.0169	0.0427	-0.0076	0.0164	-0.0129	0.0390	0.0067	-0.0101	-0.0271
4	0.0008	-0.0317	-0.0009	-0.0038	0.0058	-0.0162	-0.0034	0.0143	-0.0249	-0.0057
5	0.0310	-0.0376	-0.0052	-0.0352	0.0306	-0.0433	0.0301	-0.0303	0.0189	-0.0518
	SHSE A and TAI		SHSE B and TAI		SZSE A and TAI		SZSE B and TAI		H and TAI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0342	-0.0159	0.0074	-0.0357	0.0120	-0.0349	0.0444	-0.0174	-0.0268	0.0039
2	0.0136	-0.0097	0.0368	0.0020	0.0291	0.0105	0.0079	0.0368	-0.0400	0.0174
3	0.0382	0.0163	0.0345	0.0018	0.0407	0.0029	0.0460	0.0194	0.0076	0.0325
4	0.0252	-0.0129	0.0268	0.0193	0.0140	-0.0090	-0.0032	0.0137	-0.0176	-0.0391
5	0.0504	-0.0369	0.0242	-0.0349	0.0468	-0.0367	0.0336	-0.0288	0.0467	-0.0009
	SHSE A and NIK		SHSE B and NIK		SZSE A and NIK		SZSE B and NIK		H and NIK	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0075	-0.0182	-0.0182	0.0063	-0.0032	-0.0202	0.0224	0.0127	-0.0398	0.0181
2	-0.0608	0.0225	0.0225	0.0293	-0.0499	0.0505	-0.0116	0.0458	-0.0404	-0.0279
3	-0.0021	0.0228	0.0228	-0.0018	0.0070	0.0175	0.0263	-0.0378	0.0148	0.0337
4	0.0451	-0.0313	-0.0313	-0.0276	0.0464	-0.0237	-0.0061	0.0021	0.0288	-0.0136
5	0.0489	-0.0001	-0.0001	0.0010	0.0477	-0.0075	0.0512	-0.0169	0.0084	-0.0039
	SHSE A and KOR		SHSE B and KOR		SZSE A and KOR		SZSE B and KOR		H and KOR	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0111	-0.0002	-0.0095	0.0310	-0.0018	-0.0043	-0.0076	0.0053	0.0060	-0.0100
2	0.0012	-0.0057	0.0138	-0.0077	0.0061	0.0103	0.0380	0.0377	-0.0009	0.0016
3	-0.0073	0.0475	0.0222	0.0338	0.0057	0.0159	0.0190	0.0133	0.0067	0.0186
4	-0.0103	-0.0218	-0.0082	-0.0212	-0.0133	-0.0035	-0.0235	0.0304	-0.0215	-0.0207
5	0.0586	-0.0136	0.0284	-0.0104	0.0570	-0.0200	0.0446	0.0064	-0.0025	-0.0036
Post-liberalization										
	SHSE A and DJI		SHSE B and DJI		SZSE A and DJI		SZSE B and DJI		H and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	**0.0676***	**0.1817***	**0.0857***	**0.2170***	**0.0678***	**0.1655***	**0.0803***	**0.2229***	**0.1587***	**0.1040***
2	**0.1566***	0.0238	**0.1724***	0.0106	**0.1205***	0.0247	**0.2046***	-0.0057	**0.3987***	**0.1678***
3	0.0480	0.0475	0.0502	0.0230	0.0389	0.0582	0.0574	0.0429	0.0324	0.0902
4	-0.0006	0.0114	0.0433	0.0089	0.0094	0.0034	0.0328	0.0167	0.0087	0.0208
5	0.0510	0.0104	**0.0709***	0.0528	0.0459	0.0382	0.0505	**0.0677***	0.0158	**0.0770***
	SHSE A and HSI		SHSE B and HSI		SZSE A and HSI		SZSE B and HSI		H and HSI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0478	0.0185	0.0105	-0.0099	0.0078	-0.0082	0.0573	0.0170	-0.0078	0.0174
2	-0.0139	-0.0120	0.0324	-0.0310	-0.0178	0.0113	0.0327	-0.0230	-0.0480	-0.0101
3	0.0496	**0.0836***	**0.0919***	0.0514	0.0464	**0.0660***	0.0522	**0.0627***	0.0324	0.0450
4	0.0540	0.0381	**0.0760***	0.0190	0.0424	0.0195	**0.0664***	0.0440	0.0272	-0.0015
5	0.0285	-0.0221	0.0168	-0.0087	0.0214	-0.0064	0.0594	-0.0057	-0.0075	-0.0046
	SHSE A and TAI		SHSE B and TAI		SZSE A and TAI		SZSE B and TAI		H and TAI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-0.0217	-0.0152	-0.0122	-0.0131	-0.0207	-0.0240	0.0187	-0.0097	-0.0370	0.0216
2	0.0335	0.0300	0.0429	0.0270	0.0384	0.0380	**0.0839***	0.0564	0.0208	0.0479
3	0.0390	0.0015	**0.0696***	0.0033	0.0409	0.0015	0.0364	-0.0070	0.0414	0.0328
4	0.0292	0.0246	0.0316	0.0079	0.0236	0.0118	0.0395	-0.0031	0.0162	-0.0387
5	0.0017	-0.0248	0.0223	-0.0199	0.0113	-0.0254	0.0355	-0.0141	-0.0484	-0.0248

Table 2.15 – continued

	SHSE A and NIK		SHSE B and NIK		SZSE A and NIK		SZSE B and NIK		H and NIK	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0083	0.0332	0.0013	0.0219	-0.0178	0.0329	0.0247	0.0362	-0.0269	**0.0684***
2	0.0279	-0.0362	0.0555	-0.0179	0.0338	-0.0150	0.0617	-0.0230	-0.0145	0.0034
3	-0.0201	0.0197	0.0248	0.0085	-0.0265	0.0223	-0.0169	-0.0169	-0.0031	0.0550
4	0.0372	-0.0036	**0.0635***	-0.0183	0.0325	-0.0192	0.0529	-0.0122	0.0091	-0.0191
5	0.0023	-0.0295	0.0167	-0.0125	0.0188	-0.0213	0.0459	-0.0203	-0.0019	-0.0436
	SHSE A and KOR		SHSE B and KOR		SZSE A and KOR		SZSE B and KOR		H and KOR	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0082	0.0125	0.0279	0.0058	-0.0001	0.0060	0.0439	0.0386	0.0039	0.0607
2	0.0036	0.0137	0.0327	0.0252	0.0063	0.0093	0.0475	0.0234	-0.0118	0.0343
3	-0.0024	0.0235	0.0313	0.0176	-0.0076	0.0283	-0.0227	0.0223	-0.0033	0.0337
4	0.0324	-0.0098	0.0487	-0.0235	0.0344	-0.0196	0.0370	-0.0155	0.0032	0.0008
5	0.0138	-0.0288	0.0179	0.0002	0.0256	-0.0149	0.0392	-0.0056	-0.0178	-0.0165

Note: The cross correlations of the standardized residuals and the squared standardized residuals computed from the models reported in Table 2.13 are shown. s is the number of periods the second cited return series lags the first cited return series. * indicates significance at the 5% level.

Table 2.16 and 2.17 contain the estimations of the augmented ARMA(l,m)-GARCH(1,p)-M models for the liberalization in 2002 (panel A) and 2006 (panel B). As already observed in the tables above, the consideration of the foreign market in the mean equations often leads to significant coefficients while the coefficient of the foreign market in the variance equations of the foreign market is generally not significant. Interestingly, in panel A, the log-likelihood coefficients are not affected uniformly, indicating that the consideration of the foreign market does not lead to superior models in all cases. In panel B, all log-likelihood coefficients are higher in the augmented models as in the initial models, suggesting a superiority of these augmented models.[80] In case of SHSE A and KOR in the post-liberalization phase of panel A, we have to reject the null of no autocorrelation in the residuals at the 10% level. This also applies to the models of SHSE A and DJI, SZSE A and DJI, SHSE A and HSI, SHSE B and HSI, SZSE A and HSI, SHSE B and TAI and SHSE B and NIK in the post-liberalization phase of panel B. The cross correlations of the reported models are estimated and displayed in Table 2.18 and 2.19.

[80] In case of SZSE A, an incorporation of HSI does not alter the log-likelihood parameter.

Table 2.16: Augmented ARMA(l,m)-GARCH(1,p)-M Models for the Chinese Index Return Series - Panel A

	SHSE B and TAI				**SZSE B and TAI**			
	Pre		**Post**		**Pre**		**Post**	
Mean	α_0	-0.0007	α_0	-0.0034	-	-	α_0	-0.0017
		(0.0009)		(0.0017)				(0.0017)
	β_1	0.0732	α_1	0.0849*	-	-	β_1	0.0819*
		(0.0382)		(0.0384)				(0.0397)
	-	-	δ_2	0.0708	-	-	δ_1	0.1123**
				(0.0381)				(0.0378)
	-	-	-	-	-	-	δ_3	0.0897
								(0.0478)
Variance	ω_0	0.0000	ω_0	0.0000	-	-	ω_0	0.0000
		(0.0000)		(0.0000)				(0.0000)
	ω_1	0.1990**	ω_1	0.0745	-	-	ω_1	0.1372**
		(0.0452)		(0.0384)				(0.0468)
	φ_1	0.7392**	φ_1	0.8057**	-	-	φ_1	0.5516**
		(0.0503)		(0.1198)				(0.1418)
	λ_3	0.0250	-	-	-	-	-	-
		(0.0326)						
Log-likelihood		2464.123		2884.096	-	-		2902.071
Residual tests	Q(6)	7.454	Q(6)	2.753	-	-	Q(6)	5.190
		(0.189)		(0.600)				(0.393)
	Q(12)	12.236	Q(12)	8.280	-	-	Q(12)	7.707
		(0.346)		(0.688)				(0.739)
	$Q^2(6)$	4.453	$Q^2(6)$	1.896	-	-	$Q^2(6)$	4.088
		(0.486)		(0.863)				(0.537)
	$Q^2(12)$	7.934	$Q^2(12)$	3.311	-	-	$Q^2(12)$	9.552
		(0.719)		(0.986)				(0.571)
	H and TAI							
	Pre		**Post**					
Mean	-	-	α_0	0.0014				
				(0.0008)				
	-	-	β_1	0.1343**				
				(0.0329)				
Variance	-	-	ω_0	0.0000				
				(0.0000)				
	-	-	ω_1	0.0693**				
				(0.0161)				
	-	-	φ_1	0.9126**				
				(0.0202)				
	-	-	λ_3	0.0015				
				(0.0116)				
Log-likelihood	-	-		2977.812				
Residual tests	-	-	Q(6)	3.881				
				(0.567)				
	-	-	Q(12)	8.891				
				(0.632)				
	-	-	$Q^2(6)$	6.530				
				(0.258)				
	-	-	$Q^2(12)$	12.495				
				(0.328)				

Table 2.16 – continued

	SHSE A and NIK				**SHSE B and NIK**			
	Pre		**Post**		**Pre**		**Post**	
Mean	α_0	0.0014	-	-	α_0	-0.0007	-	-
		(0.0007)			(0.0009)			
	β_1	0.0272	-	-	β_1	0.0707	-	-
		(0.0413)				(0.0385)		
	δ_4	0.0398	-	-	δ_4	0.1126*	-	-
		(0.0243)				(0.0471)		
Variance	ω_0	0.0000	-	-	ω_0	0.0000	-	-
		(0.0000)				(0.0000)		
	ω_1	0.2161**	-	-	ω_1	0.1999**	-	-
		(0.0756)				(0.0458)		
	φ_1	0.6483**	-	-	φ_1	0.7482**	-	-
		(0.0811)				(0.0474)		
Log-likelihood		3045.479	-	-		2466.551	-	-
Residual tests	Q(6)	4.548	-	-	Q(6)	7.999	-	-
		(0.474)				(0.156)		
	Q(12)	11.775	-	-	Q(12)	12.549	-	-
		(0.381)				(0.324)		
	$Q^2(6)$	1.101	-	-	$Q^2(6)$	4.670	-	-
		(0.954)				(0.458)		
	$Q^2(12)$	2.253	-	-	$Q^2(12)$	8.316	-	-
		(0.997)				(0.685)		
	SZSE A and NIK				**SZSE B and NIK**			
	Pre		**Post**		**Pre**		**Post**	
Mean	α_0	-0.0014	-	-	-	-	α_0	-0.0014
		(0.0007)						(0.0010)
	β_1	0.0331	-	-	-	-	β_1	0.0983*
		(0.0413)						(0.0421)
	δ_4	0.0352	-	-	-	-	δ_4	0.0700
		(0.0242)						(0.0454)
Variance	ω_0	0.0000	-	-	-	-	ω_0	0.0000
		(0.0000)						(0.0000)
	ω_1	0.2224**	-	-	-	-	ω_1	0.2222**
		(0.0718)						(0.0423)
	φ_1	0.6530**	-	-	-	-	φ_1	0.6804**
		(0.0767)						(0.0558)
Log-likelihood		3009.125	-	-	-	-		2454.192
Residual tests	Q(6)	5.120	-	-	-	-	Q(6)	8.013
		(0.401)						(0.156)
	Q(12)	15.663	-	-	-	-	Q(12)	15.148
		(0.154)						(0.176)
	$Q^2(6)$	1.214	-	-	-	-	$Q^2(6)$	1.836
		(0.944)						(0.871)
	$Q^2(12)$	1.657	-	-	-	-	$Q^2(12)$	3.792
		(0.999)						(0.976)
	SHSE A and KOR							
	Pre		**Post**					
Mean	-	-	α_0	-0.0005				
				(0.0011)				
	-	-	α_1	-0.0025				
				(0.0321)				
	-	-	δ_5	0.0584*				
				(0.0270)				

Table 2.16 − continued

Variance	-	-	ω_0	0.0000
				(0.0000)
	-	-	ω_1	0.0557*
				(0.0245)
	-	-	φ_1	0.9032**
				(0.0397)
Log-likelihood	-	-		3131.652
Residual tests	-	-	Q(6)	6.841
				(0.233)
	-	-	Q(12)	13.592
				(0.054)
	-	-	$Q^2(6)$	10.870
				(0.055)
	-	-	$Q^2(12)$	15.097
				(0.178)

Note: The Maximum-Likelihood estimations of the appropriate ARMA(l,m)-GARCH(1,p)-M models are reported. The Bollerslev and Wooldridge (1992) asymptotic standard errors are displayed in parentheses. * and ** indicate significance at the 5% and 1% significance level. Q(6), Q(12), $Q^2(6)$ and $Q^2(12)$ are the Ljung-Box Q-statistics and their p-values in parentheses for the first 6 and 12 autocorrelations of standardized residuals and their squares.

Table 2.17: Augmented ARMA(l,m)-GARCH(1,p)-M Models for the Chinese Index Return Series - Panel B

	SHSE A and DJI				**SHSE B and DJI**			
	Pre		**Post**		**Pre**		**Post**	
Mean	-	-	α_0	0.0013	-	-	α_0	0.0005
				(0.0011)				(0.0009)
	-	-	α_1	-0.0157	-	-	β_1	0.0850*
				(0.0366)				(0.0367)
	-	-	δ_1	0.1208*	-	-	δ_1	0.1421*
				(0.0505)				(0.0574)
	-	-	δ_2	0.2857**	-	-	δ_2	0.3509**
				(0.0512)				(0.0555)
	-	-	δ_3	0.0920	-	-	δ_3	0.1220*
				(0.0500)				(0.0519)
	-	-	-	-	-	-	δ_5	0.0802
								(0.0525)
Variance	-	-	ω_0	0.0000	-	-	ω_0	0.0000
				(0.0000)				(0.0000)
	-	-	ω_1	0.0758**	-	-	ω_1	0.2223**
				(0.0260)				(0.0530)
	-	-	φ_1	0.9022**	-	-	φ_1	0.7105**
				(0.0361)				(0.0713)
	-	-	λ_1	0.0768	-	-	λ_1	0.1142
				(0.1100)				(0.0747)
	-	-	λ_2	-0.0629	-	-	-	-
				(0.1112)				
Log-likelihood	-	-		2624.691	-	-		2539.770
Residual tests	-	-	Q(6)	11.437	-	-	Q(6)	8.423
				(0.043)				(0.134)
	-	-	Q(12)	15.588	-	-	Q(12)	12.180
				(0.157)				(0.350)
	-	-	$Q^2(6)$	2.194	-	-	$Q^2(6)$	3.164
				(0.822)				(0.675)
	-	-	$Q^2(12)$	7.867	-	-	$Q^2(12)$	7.364
				(0.726)				(0.769)
	SZSE A and DJI				**SZSE B and DJI**			
	Pre		**Post**		**Pre**		**Post**	
Mean	-	-	α_0	0.0005	α_0	-0.0039*	α_0	0.0002
				(0.0012)		(0.0017)		(0.0011)
	-	-	β_1	0.0555	α_1	0.0879*	α_1	0.0512
				(0.0380)		(0.0380)		(0.0379)
	-	-	δ_1	0.1485**	δ_2	0.0937*	δ_1	0.1500**
				(0.0511)		(0.0366)		(0.0540)
	-	-	δ_2	0.2796**	-	-	δ_2	0.3736**
				(0.0529)				(0.0000)
	-	-	δ_3	0.0873	-	-	δ_3	0.1222*
				(0.0514)				(0.0491)
Variance	-	-	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000
				(0.0000)		(0.0000)		(0.0000)
	-	-	ω_1	0.1743**	ω_1	0.1611**	ω_1	0.1529**
				(0.0526)		(0.0618)		(0.0569)
	-	-	ω_2	-0.0919	-	-	ω_2	-0.0489
				(0.0564)				(0.0621)
	-	-	-	-	-	-	ω_3	0.0595
								(0.0455)

Table 2.17 – continued

	-	-	φ_1	0.8853**	φ_1	0.4945**	φ_1	0.6725**
				(0.0478)		(0.1455)		(0.1448)
	-	-	λ_1	0.0596	-	-	λ_1	0.1106
				(0.0643)				(0.0831)
	-	-	λ_3	-0.0407	-	-	-	-
				(0.0640)				
Log-likelihood	-	-		2555.882		2893.859		2631.525
Residual tests	-	-	Q(6)	10.601	Q(6)	4.869	Q(6)	3.618
				(0.006)		(0.432)		(0.606)
	-	-	Q(12)	13.806	Q(12)	11.312	Q(12)	5.577
				(0.244)		(0.418)		(0.900)
	-	-	$Q^2(6)$	0.823	$Q^2(6)$	3.226	$Q^2(6)$	3.289
				(0.976)		(0.665)		(0.656)
	-	-	$Q^2(12)$	4.527	$Q^2(12)$	8.792	$Q^2(12)$	4.474
				(0.952)		(0.641)		(0.954)

	H and DJI			
	Pre		**Post**	
Mean	α_0	0.0010	α_0	0.0005
		(0.0008)		(0.0006)
	β_1	0.1168**	β_1	-0.0478
		(0.0005)		(0.0343)
	δ_1	0.0774*	δ_1	0.3263**
		(0.0357)		(0.0573)
	δ_2	0.3085**	δ_2	0.8360**
		(0.0375)		(0.0523)
	δ_4	0.0878**	δ_3	0.1712**
		(0.0121)		(0.0587)
	δ_5	0.0274	-	-
		(0.0381)		
Variance	ω_0	0.0000	ω_0	0.0000
		(0.0000)		(0.0000)
	ω_1	0.0573**	ω_1	0.0887*
		(0.0137)		(0.0440)
	-	-	ω_2	-0.0274
				(0.0445)
	-	-	ω_3	0.1243*
				(0.0487)
	φ_1	0.9293**	φ_1	0.5970**
		(0.0158)		(0.0991)
	-	-	λ_1	0.1909**
				(0.0730)
	-	-	λ_3	0.2068
				(0.1270)
	-	-	λ_5	0.0400
				(0.1199)
Log-likelihood		3026.217		2635.655
Residual tests	Q(6)	2.922	Q(6)	13.170
		(0.712)		(0.022)
	Q(12)	13.632	Q(12)	24.883
		(0.254)		(0.009)
	$Q^2(6)$	4.901	$Q^2(6)$	4.837
		(0.428)		(0.436)
	$Q^2(12)$	13.545	$Q^2(12)$	9.725
		(0.259)		(0.555)

Table 2.17 – continued

	SHSE A and HSI				SHSE B and HSI			
	Pre		Post		Pre		Post	
Mean	-	-	α_0	0.0024*	-	-	α_0	0.0008
				(0.0011)				(0.0010)
	-	-	α_1	-0.0420	-	-	β_1	0.0913*
				(0.0369)				(0.0370)
	-	-	-	-	-	-	δ_3	0.0824
								(0.0436)
	-	-	-	-	-	-	δ_4	0.0292
								(0.0366)
Variance	-	-	ω_0	0.0000	-	-	ω_0	0.0000
				(0.0000)				(0.0000)
	-	-	ω_1	0.0637**	-	-	ω_1	0.1731**
				(0.0198)				(0.0555)
	-	-	φ_1	0.9233**	-	-	φ_1	0.7862**
				(0.0291)				(0.0656)
	-	-	λ_3	0.0025	-	-	-	-
				(0.0597)				
Log-likelihood	-	-		2603.261	-	-		2508.373
Residual tests	-	-	Q(6)	11.908	-	-	Q(6)	10.761
				(0.036)				(0.056)
	-	-	Q(12)	14.519	-	-	Q(12)	13.518
				(0.206)				(0.261)
	-	-	$Q^2(6)$	2.757	-	-	$Q^2(6)$	1.775
				(0.737)				(0.879)
	-	-	$Q^2(12)$	8.612	-	-	$Q^2(12)$	4.814
				(0.658)				(0.940)
	SZSE A and HSI				**SZSE B and HSI**			
	Pre		**Post**		**Pre**		**Post**	
Mean	-	-	α_0	0.0013	-	-	α_0	-0.0002
				(0.0013)				(0.0014)
	-	-	β_1	0.0599	-	-	α_1	0.0651
				(0.0382)				(0.0385)
	-	-	-	-	-	-	δ_4	0.0586
								(0.0327)
Variance	-	-	ω_0	0.0000	-	-	ω_0	0.0000
				(0.0000)				(0.0000)
	-	-	ω_1	0.1516**	-	-	ω_1	0.1662**
				(0.0505)				(0.0589)
	-	-	ω_2	-0.0821	-	-	ω_3	0.0070
				(0.0632)				(0.0450)
	-	-	φ_1	0.9099**	-	-	φ_1	0.8417**
				(0.0398)				(0.1008)
	-	-	λ_3	0.0063	-	-	-	-
				(0.0088)				
Log-likelihood	-	-		2537.539	-	-		2592.545
Residual tests	-	-	Q(6)	11.341	-	-	Q(6)	5.494
				(0.045)				(0.359)
	-	-	Q(12)	14.047	-	-	Q(12)	6.964
				(0.230)				(0.802)
	-	-	$Q^2(6)$	0.544	-	-	$Q^2(6)$	2.689
				(0.990)				(0.748)
	-	-	$Q^2(12)$	4.211	-	-	$Q^2(12)$	4.210
				(0.963)				(0.963)

Table 2.17 – continued

	SHSE B and TAI				SZSE B and TAI			
	Pre		Post		Pre		Post	
Mean	-	-	α_0	-0.0010	-	-	α_0	-0.0013
				(0.0010)				(0.0014)
	-	-	β_1	0.0910*	-	-	α_1	0.0637
				(0.0367)				(0.0380)
	-	-	δ_3	0.1028*	-	-	δ_2	0.0828
				(0.0454)				(0.0474)
Variance	-	-	ω_0	0.0000	-	-	ω_0	0.0000
				(0.0000)				(0.0000)
	-	-	ω_1	0.1760**	-	-	ω_1	0.1498**
				(0.0560)				(0.0552)
	-	-	-	-	-	-	ω_2	-0.0579
								(0.0598)
	-	-	-	-	-	-	ω_3	0.0194
								(0.0496)
	-	-	φ_1	0.7879**	-	-	φ_1	0.8067**
				(0.0650)				(0.1103)
Log-likelihood	-	-		2508.100	-	-		2593.079
Residual tests	-	-	Q(6)	11.790	-	-	Q(6)	7.555
				(0.038)				(0.183)
	-	-	Q(12)	14.354	-	-	Q(12)	9.277
				(0.214)				(0.596)
	-	-	$Q^2(6)$	1.885	-	-	$Q^2(6)$	2.874
				(0.865)				(0.719)
	-	-	$Q^2(12)$	4.946	-	-	$Q^2(12)$	4.459
				(0.934)				(0.955)
	SHSE B and NIK				**H and NIK**			
	Pre		**Post**		**Pre**		**Post**	
Mean	-	-	α_0	0.0011	-	-	α_0	0.0011
				(0.0011)				(0.0014)
	-	-	β_1	0.0949*	-	-	β_1	0.0568
				(0.0370)				(0.0330)
	-	-	δ_4	0.0114	-	-	-	-
				(0.0414)				
Variance	-	-	ω_0	0.0000	-	-	ω_0	0.0000
				(0.0000)				(0.0000)
	-	-	ω_1	0.1724**	-	-	ω_1	0.0732
				(0.0542)				(0.0425)
	-	-	-	-	-	-	ω_2	-0.0001
								(0.0521)
	-	-	-	-	-	-	ω_3	0.1661**
								(0.0507)
	-	-	φ_1	0.7882**	-	-	φ_1	0.7272**
				(0.0645)				(0.0482)
	-	-	-	-	-	-	λ_1	0.0348
								(0.0489)
Log-likelihood	-	-		2504.983	-	-		2504.821
Residual tests	-	-	Q(6)	13.754	-	-	Q(6)	6.827
				(0.017)				(0.234)
	-	-	Q(12)	16.572	-	-	Q(12)	14.617
				(0.121)				(0.201)
	-	-	$Q^2(6)$	2.018	-	-	$Q^2(6)$	0.561
				(0.847)				(0.990)

Table 2.17 – continued

-	-	$Q^2(12)$	4.853	-	-	$Q^2(12)$	7.013
			(0.938)				(0.798)

Note: The Maximum-Likelihood estimations of the appropriate ARMA(l,m)-GARCH(1,p)-M models are reported. The Bollerslev and Wooldridge (1992) asymptotic standard errors are displayed in parentheses. * and ** indicate significance at the 5% and 1% level. Q(6), Q(12), $Q^2(6)$ and $Q^2(12)$ are the Ljung-Box Q-statistics and their p-values in parentheses for the first 6 and 12 autocorrelations of the standardized residuals and their squares.

Table 2.18 shows that we are able to confirm the reported significant cross correlations through the incorporation of the foreign markets. Especially Japan causes causality in mean in the pre-liberalization phase and Taiwan in the post-liberalization phase. Spillovers in variance are only indicated from TAI to SHSE B in the pre- and from NIK to SZSE B in the post-liberalization phase. Despite of these verified spillovers, the liberalization in 2002 obviously does not *increase* the integration of the Chinese stock markets with other regional markets as in the pre- and in the post-liberalization phase, the same amount of verified cross correlation in mean as well as in variance are found. Therefore, in contrast to the results presented in the main part, we are able to show that the Chinese stock market indices are integrated with regional markets.

Table 2.18: Cross Correlations of the Standardized Residuals of the Augmented Models - Panel A

Pre-liberalization										
	SHSE A and TAI		SHSE B and TAI		SZSE A and TAI		SZSE B and TAI		H and Tai	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-	-	0.0507	-0.0017	-	-	-	-	-	-
2	-	-	0.0076	-0.0036	-	-	-	-	-	-
3	-	-	0.0508	0.0162	-	-	-	-	-	-
4	-	-	-0.0060	0.0567	-	-	-	-	-	-
5	-	-	-0.0203	-0.0149	-	-	-	-	-	-
	SHSE A and NIK		SHSE B and NIK		SZSE A and NIK		SZSE B and NIK		H and NIK	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0402	-0.0239	0.0143	-0.0074	-0.0249	-0.0248	-	-	-	-
2	-0.0226	0.0165	-0.0309	0.0436	-0.0122	0.0203	-	-	-	-
3	0.0397	-0.0019	0.0211	0.0252	-0.0334	-0.0011	-	-	-	-
4	0.0183	-0.0247	-0.0080	0.0048	0.0217	-0.0209	-	-	-	-
5	0.0217	-0.0167	-0.0143	0.0414	0.0247	-0.0152	-	-	-	-
Post-liberalization										
	SHSE A and TAI		SHSE B and TAI		SZSE A and TAI		SZSE B and TAI		H and TAI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-	-	0.0408	-0.0080	-	-	-0.0013	-0.0090	-0.0450	-0.0039
2	-	-	0.0116	0.0041	-	-	0.0108	0.0050	-0.0385	0.0189
3	-	-	0.0392	-0.0159	-	-	0.0402	-0.0147	0.0509	**0.0661***
4	-	-	0.0187	0.0353	-	-	0.0180	0.0332	0.0197	-0.0345
5	-	-	0.0223	-0.0223	-	-	0.0239	-0.0239	0.0213	-0.0088
	SHSE A and NIK		SHSE B and NIK		SZSE A and NIK		SZSE B and NIK		H and NIK	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-	-	-	-	-	-	0.0261	0.0134	-	-
2	-	-	-	-	-	-	-0.0003	0.0208	-	-
3	-	-	-	-	-	-	-0.0060	-0.0396	-	-
4	-	-	-	-	-	-	-0.0244	-0.0254	-	-
5	-	-	-	-	-	-	0.0535	-0.0015	-	-
	SHSE A and KOR		SHSE B and KOR		SZSE A and KOR		SZSE B and KOR		H and KOR	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0351	0.0051	-	-	-	-	-	-	-	-
2	0.0206	-0.0258	-	-	-	-	-	-	-	-
3	0.0033	0.0048	-	-	-	-	-	-	-	-
4	-0.0006	-0.0214	-	-	-	-	-	-	-	-
5	0.0004	-0.0298	-	-	-	-	-	-	-	-

Note: The cross correlations of the standardized residuals and the squared standardized residuals computed from the models reported in Table 2.16 are shown. s is the number of periods the second cited return series lags the first cited return series. * indicates significance at the 5% level.

Table 2.19 reports that in the pre-liberalization phase, the DJI causes causality in mean in case of SZSE B and H. Spillovers in variance are found from DJI to H. Considerable more significant cross correlations are indicated in the post-liberalization phase. Confirmed causality in mean is shown for DJI and all Chinese stock market return series, including H. Interestingly, HSI and TAI cause spillovers in mean in the B share segment of both Chinese stock market indices. Additional causality in mean is revealed in the case of SHSE B and NIK. We are able to confirm causality in variance in case of H and DJI, SZSE A and HSI as well as SZSE B and HSI. After all, these results indicate that the QDII program leads to increased integration of the Chinese stock markets with regional markets.[81]

[81] In pre- and post-liberalization phase, the global integration is only indicated through the H share segment as in both subsamples, spillovers in variance are found.

Table 2.19: Cross Correlations of the Standardized Residuals of the Augmented Models - Panel B

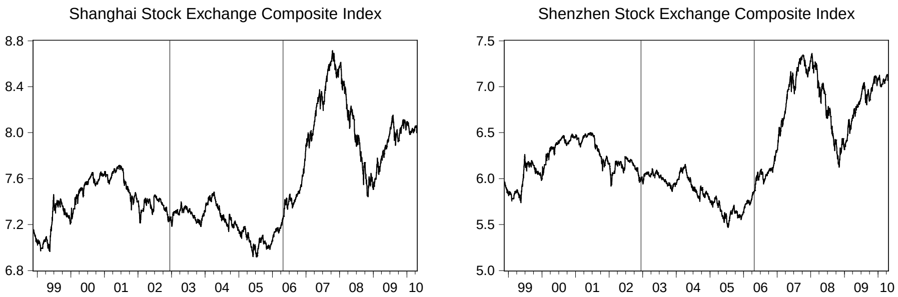
Pre-liberalization										
	SHSE A and DJI		SHSE B and DJI		SZSE A and DJI		SZSE B and DJI		H and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-	-	-	-	-	-	0.0129	0.0120	0.0293	-0.0169
2	-	-	-	-	-	-	0.0070	-0.0175	**0.0697***	0.0604
3	-	-	-	-	-	-	0.0214	0.0103	0.0226	0.0228
4	-	-	-	-	-	-	0.0043	-0.0370	0.0145	-0.0562
5	-	-	-	-	-	-	0.0224	-0.0052	0.0464	-0.0053
Post-liberalization										
	SHSE A and DJI		SHSE B and DJI		SZSE A and DJI		SZSE B and DJI		H and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0007	**0.1795***	0.0124	**0.1465***	-0.0082	**0.1321***	-0.0006	**0.1602***	-0.0073	-0.0013
2	0.0029	0.0193	-0.0004	-0.0167	-0.0154	0.0056	0.0054	-0.0373	0.0219	-0.0101
3	0.0229	0.0577	0.0230	0.0142	0.0238	**0.0724***	0.0266	0.0317	0.0058	0.0573
4	0.0101	0.0109	0.0598	-0.0028	0.0206	0.0022	0.0520	-0.0003	0.0209	-0.0072
5	0.0503	0.0070	0.0261	0.0445	0.0437	0.0308	0.0459	0.0505	0.0167	0.0474
	SHSE A and HSI		SHSE B and HSI		SZSE A and HSI		SZSE B and HSI		H and HSI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0476	0.0183	0.0149	-0.0080	0.0078	-0.0087	0.0553	0.0150	-	-
2	-0.0136	-0.0117	0.0343	-0.0291	-0.0169	0.0113	0.0354	-0.0198	-	-
3	0.0494	**0.0810***	0.0258	0.0455	0.0458	0.0611	0.0541	0.0555	-	-
4	0.0536	0.0340	**0.0620***	0.0293	0.0408	0.0126	0.0126	0.0283	-	-
5	0.0282	-0.0228	0.0244	-0.0033	0.0210	-0.0071	0.0300	-0.0091	-	-
	SHSE A and TAI		SHSE B and TAI		SZSE A and TAI		SZSE B and TAI		H and TAI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-	-	-0.0113	-0.0129	-	-	0.0204	-0.0102	-	-
2	-	-	0.0430	0.0289	-	-	0.0263	0.0508	-	-
3	-	-	0.0032	-0.0023	-	-	0.0398	-0.0074	-	-
4	-	-	0.0372	0.0087	-	-	0.0382	-0.0033	-	-
5	-	-	0.0211	-0.0195	-	-	0.0341	-0.0138	-	-
	SHSE A and NIK		SHSE B and NIK		SZSE A and NIK		SZSE B and NIK		H and NIK	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-	-	0.0013	0.0222	-	-	-	-	-0.0270	**0.0688***
2	-	-	0.0557	-0.0180	-	-	-	-	-0.0144	0.0019
3	-	-	0.0249	0.0087	-	-	-	-	-0.0030	0.0539
4	-	-	0.0558	-0.0188	-	-	-	-	0.0092	-0.0197
5	-	-	0.0179	-0.0123	-	-	-	-	-0.0019	-0.0438

Note: The cross correlations of the standardized residuals and the squared standardized residuals computed from the models reported in Table 2.17 are shown. s is the number of periods the second cited return series lags the first cited return series. * indicates significance at the 5% level.

2.A.3 Shanghai and Shenzhen stock exchange composite indices

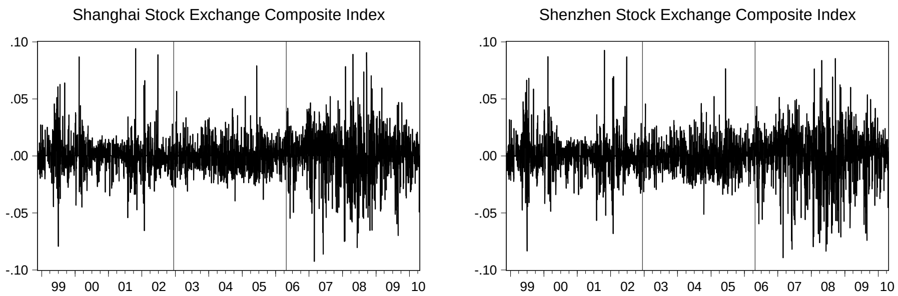
In this section, the Shanghai and the Shenzhen Stock Exchange Composite indices (hereafter SHSE and SZSE) are used instead of the A and B share indices of the Chinese stock exchanges.[82] Both composite indices contain all traded A and B shares at the specific stock exchange and are traded in Chinese Yuan. Figure 2.5 and 2.6 present the graphs of both indices as well as the return series. Both indices show a comparable development with a peak in 2007/2008 and a low in 2005 albeit on different levels. The return series reveal that both indices exhibit comparable volatility pattern with a relatively high volatility for the years 2006 to 2009. The vertical lines indicate the liberalization dates in 2002 and 2006.

Figure 2.5: Shanghai and Shenzhen Composite Indices (in logs)



Note: The graphs of the Shanghai Stock Exchange Composite index (SHSE) and Shenzhen Stock Exchange Composite index (SZSE) in log levels are displayed. The sample covers the period November 23, 1998 to April 20, 2010.

Figure 2.6: Stock Market Returns of both Composite Indices



Note: The graphs of the returns of the Shanghai Stock Exchange Composite index (SHSE) and Shenzhen Stock Exchange Composite index (SZSE) are displayed. The sample covers the period November 23, 1998 to April 20, 2010.

[82] Again, the data are collected via Thomson Datastream from the Shanghai and Shenzhen Stock Exchanges.

Table 2.20: Results of ADF Tests for both Composite Indices

	Levels			Returns			Levels			Returns		
	ADF	k	Prob.	ADF	k	Prob.	ADF	k	Prob.	ADF	k	Prob.
Panel A												
	Pre-liberalization						Post-liberalization					
SHSE	-1.469	0	0.549	-31.932**	0	0.000	0.018	0	0.959	-31.696**	0	0.000
SZSE	-1.629	12	0.467	-8.141**	11	0.000	-0.822	3	0.812	-17.243**	2	0.000
Panel B												
	Pre-liberalization						Post-liberalization					
SHSE	-1.6716	0	0.4455	-31.8185**	0	0.000	-2.0085	4	0.2833	-14.2486**	3	0.000
SZSE	-1.4537	0	0.5568	-31.2462**	0	0.000	-1.9571	4	0.3061	-14.2165**	3	0.000

Note: The ADF test (allowing for an intercept) is calculated from the levels and the returns of SHSE and SZSE. Panel A reports the results for the liberalization in 2002 and panel B contains the results for the liberalization in 2006. The lag length is selected by the Akaike information criterion. ** indicates significance at the 1% level.

Table 2.20 shows the unit root characteristics for the levels and the returns of both indices. Panel A refers to the liberalization in 2002 and panel B refers to the liberalization in 2006. It is shown that in both samples, the indices are non-stationary in levels but stationary in first differences. Table 2.21 displays the descriptive statistics. In panel A, both indices exhibit smaller standard deviations and ranges after the liberalization. In the post-liberalization phase of panel B, the indices show higher standard deviations and higher ranges.

Table 2.21: Descriptive Statistics of the Return Series of the Shanghai and Shenzhen Stock Exchange Composite Indices

	Mean	Max	Min	Std. Dev.	Range	Mean	Max	Min	Std. Dev.	Range
Panel A										
	Pre-liberalization					Post-liberalization				
SHSE	0.0000	0.0940	-0.0792	0.0145	0.1732	0.0005	0.0542	-0.0691	0.0118	0.1233
SZSE	0.0000	0.0924	-0.0833	0.0154	0.1757	0.0006	0.0352	-0.0523	0.0116	0.0875
Panel B										
	Pre-liberalization					Post-liberalization				
SHSE	0.0004	0.0789	-0.0548	0.0123	0.1337	0.0007	0.0903	-0.0926	0.0212	0.1829
SZSE	0.0002	0.0762	-0.0596	0.0130	0.1348	0.0012	0.0852	-0.0893	0.0226	0.1745

Note: The different descriptive statistics for the index return series of SHSE and SZSE are displayed. Panel A reports the results for the liberalization in 2002 and panel B contains the results the liberalization in 2006.

Table 2.22 depicts the bivariate correlations between both indices in conjunction with DJI and HSI. In panel A, the correlations are comparable to those reported for the A share segment in the main part.[83] In panel B, it is remarkable that all correlation coefficients increase in

[83] As SHSE and SZSE consist of the traded A and B shares, higher analogies with the A shares is not surprising as A shares have a higher trading volume than B shares and thus contribute more to both composite indices.

the post-liberalization phase. As already pointed out in the main part, these results indicate a more pronounced regional than global integration as the correlations with HSI are higher than those with DJI.

Table 2.22: Correlations between the Return Series of the Shanghai Stock Exchange Composite Index, Shenzhen Stock Exchange Composite Index and Dow Jones Industrials Index

	Panel A		**Panel B**	
	Pre-liberalization	Post-liberalization	Pre-liberalization	Post-liberalization
SHSE and DJI	-0.0296	0.0195	-0.0060	0.0516
	(0.3389)	(0.5287)	(0.8472)	(0.0961)
SZSE and DJI	-0.0317	0.0235	-0.0054	0.0356
	(0.3055)	(0.4476)	(0.8610)	(0.2503)
SHSE and HSI	0.1000**	0.1071**	0.0877**	0.4512**
	(0.0012)	(0.0005)	(0.0046)	(0.0000)
SZSE and HSI	0.1025**	0.1075**	0.0821**	0.3853**
	(0.0009)	(0.0005)	(0.0080)	(0.0000)

Note: The different bivariate correlations between the index return series of SHSE and SZSE with DJI and HSI are displayed. Panel A reports the results for the liberalization in 2002 and panel B contains the results for the liberalization in 2006. ** indicates significance at the 1% level.

Table 2.23 shows the coefficients of the adjusted ARMA(l,m)-GARCH(1,p)-M models. Again, in the mean equations, the constants and the ARMA terms are small and show only little significance. Considerable persistence is revealed in the variance equations as φ_1 shows relatively high and significant values. In both panels, φ_1 increases in the post-liberalization phase indicating that the persistence to volatility shocks increases after both liberalization programs. The Ljung-Box Q-statistics show that we are not able to fit ARMA(l,m)-GARCH(1,p)-M models in panel B in the post-liberalization phase which do not reject the null of no autocorrelation in the residuals in case of SHSE and SZSE.[84]

[84]The null is even not rejected when the 10% significance level is used.

Table 2.23: *ARMA(l,m)-GARCH(1,p)-M Models for the Return Series of the Shanghai and Shenzhen Stock Exchange Composite Indices*

Panel A								
	SHSE				**SZSE**			
	Pre		**Post**		**Pre**		**Post**	
Mean	α_0	-0.0014	α_0	0.0000	α_0	-0.0015*	α_0	-0.0002
		(0.0007)		(0.0012)		(0.0007)		(0.0012)
	β_1	0.0311	β_1	0.0023	β_1	0.0341	β_1	0.0493
		(0.0417)		(0.0310)		(0.0414)		(0.0325)
Variance	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000
		(0.0000)		(0.0000)		(0.0000)		(0.0000)
	ω_1	0.2181**	ω_1	-0.0030	ω_1	0.2202**	ω_1	0.0470**
		(0.0757)		(0.0233)		(0.0704)		(0.0179)
	-	-	ω_2	0.0706	-	-	-	-
				(0.0386)				
	φ_1	0.6480**	φ_1	0.8798**	φ_1	0.6545**	φ_1	0.9285**
		(0.0000)		(0.0515)		(0.0757)		(0.0292)
Log-likelihood		3055.819		3132.502		3014.779		3079.051
Residual tests	Q(6)	4.078	Q(6)	7.451	Q(6)	4.823	Q(6)	6.336
		(0.538)		(0.189)		(0.438)		(0.275)
	Q(12)	11.480	Q(12)	14.183	Q(12)	15.673	Q(12)	13.281
		(0.404)		(0.223)		(0.962)		(0.275)
	$Q^2(6)$	1.243	$Q^2(6)$	7.854	$Q^2(6)$	1.463	$Q^2(6)$	7.966
		(0.941)		(0.164)		(0.917)		(0.158)
	$Q^2(12)$	2.437	$Q^2(12)$	12.341	$Q^2(12)$	1.929	$Q^2(12)$	11.560
		(0.996)		(0.339)		(0.999)		(0.398)
Panel B								
	SHSE				**SZSE**			
	Pre		**Post**		**Pre**		**Post**	
Mean	α_0	-0.0019*	α_0	0.0023*	α_0	-0.0012	α_0	0.0013
		(0.0009)		(0.0011)		(0.0009)		(0.0013)
	α_1	-0.0006	α_1	-0.0021	β_1	0.0436	β_1	0.0578
		(0.0362)		(0.0369)		(0.0346)		(0.0384)
Variance	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000
		(0.0000)		(0.0000)		(0.0000)		(0.0000)
	ω_1	0.0884*	ω_1	0.0788	ω_1	0.0755**	ω_1	0.1483**
		(0.0355)		(0.0493)		(0.0265)		(0.0499)
	-	-	ω_2	-0.0174	-	-	ω_2	-0.0814
				(0.0511)				(0.0532)
	φ_1	0.8460**	φ_1	0.9292**	φ_1	0.8840**	φ_1	0.9165**
		(0.0392)		(0.0247)		(0.0309)		(0.0335)
Log-likelihood		3148.238		2604.061		3103.708		2542.847
Residual tests	Q(6)	6.609	Q(6)	11.601	Q(6)	4.951	Q(6)	11.477
		(0.251)		(0.041)		(0.422)		(0.043)
	Q(12)	14.029	Q(12)	14.167	Q(12)	13.409	Q(12)	14.089
		(0.231)		(0.224)		(0.267)		(0.228)
	$Q^2(6)$	4.026	$Q^2(6)$	2.449	$Q^2(6)$	4.754	$Q^2(6)$	0.648
		(0.546)		(0.784)		(0.447)		(0.986)
	$Q^2(12)$	15.785	$Q^2(12)$	8.839	$Q^2(12)$	14.796	$Q^2(12)$	5.313
		(0.149)		(0.637)		(0.447)		(0.915)

Note: The Maximum-Likelihood estimations of the appropriate ARMA(l,m)-GARCH(1,p)-M models are reported. The Bollerslev and Wooldridge (1992) asymptotic standard errors are displayed in parentheses. Panel A reports the results for the liberalization in 2002 and panel B contains the results for the liberalization in 2006. * and ** indicate significance at the 5% and 1% level. Q(6), Q(12), $Q^2(6)$ and $Q^2(12)$ are the Ljung-Box Q-statistics and their p-values in parentheses for the first 6 and 12 autocorrelations of the standardized residuals and their squares.

From the ARMA(l,m)-GARCH(1,p)-M models reported in Table 2.23, cross correlations of the standardized residuals are computed and displayed in Table 2.24. In the pre-liberalization phase of panel A, potential causality in mean is indicated in the case of SHSE and DJI, SHSE and HSI and SZSE and HSI, and in the case of SHSE and HSI in the post-liberalization phase. In panel B, causality in mean is potentially indicated only in the post-liberalization phase in the case of SHSE and DJI and SZSE and DJI. Causality in variance is only found in panel B. In the pre-liberalization phase, potential variance spillovers are reported in the case of SZSE and DJI and in the post-liberalization phase for SHSE and DJI, SZSE and DJI and SZSE and HSI.

Afterwards, we incorporate the foreign market into the initial ARMA(l,m)-GARCH(1,p)-M models in order to verify that the significance in the cross correlations is caused by the stock markets of the United States and Hong Kong.

Table 2.25 displays the augmented ARMA(l,m)-GARCH(1,p)-M models where the foreign markets are captured through δ_i in the mean equations, and λ_i in the variance equations. The incorporation leads to insignificant coefficients in the mean in most cases, and in all cases in the variance equations. The log-likelihood parameters show a diffuse picture because the incorporation of the foreign market does not lead to higher values comparing to the initial models in Table 2.23 in all cases. As the Ljung-Box Q-statistics reveal, the incorporation of the foreign markets into SHSE and SZSE in the post-liberalization phase of panel B does not remove the autocorrelation in the residuals.

Table 2.24: Cross Correlations of the Standardized Residuals

Pre-liberalization								
	Panel A				**Panel B**			
	SHSE and DJI		SZSE and DJI		SHSE and DJI		SZSE and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-0.0328	0.0014	-0.0341	0.0142	0.0187	0.0204	0.0197	0.0214
2	0.0192	0.0238	0.0250	0.0246	0.0212	-0.0146	0.0141	-0.0102
3	-0.0105	-0.0166	-0.0018	-0.0174	0.0548	0.0123	0.0323	0.0149
4	**-0.0649***	0.0208	-0.0558	0.0207	0.0059	-0.0070	-0.0009	-0.0147
5	0.0448	-0.0117	0.0397	-0.0106	0.0205	0.0125	0.0078	0.0189
	SHSE and HSI		SZSE and HSI		SHSE and HSI		SZSE and HSI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0594	0.0435	**0.0661***	0.0460	0.0407	-0.0057	0.0461	0.0136
2	0.0073	-0.0119	0.0108	-0.0139	-0.0353	-0.0365	-0.0134	-0.0113
3	**0.0798***	0.0363	**0.0742***	0.0406	0.0040	-0.0170	0.0502	**0.0855***
4	0.0404	-0.0093	0.0440	-0.0105	0.0010	-0.0316	0.0538	0.0351
5	0.0370	-0.0265	0.0449	-0.0286	0.0304	-0.0382	0.0284	-0.0223
Post-liberalization								
	Panel A				**Panel B**			
	SHSE and DJI		SZSE and DJI		SHSE and DJI		SZSE and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-0.0069	0.0072	-0.0030	0.0054	**0.0673***	**0.1813***	**0.0682***	**0.1687***
2	0.0125	-0.0210	0.0102	-0.0174	**0.1577***	0.0232	**0.1231***	0.0242
3	0.0424	-0.0063	0.0256	-0.0094	0.0471	0.0471	0.0395	0.0576
4	-0.0233	-0.0015	-0.0180	0.0016	-0.0002	0.0105	0.0104	0.0040
5	0.0247	-0.0237	0.0254	-0.0383	0.0517	0.0115	0.0463	0.0387
	SHSE and HSI		SZSE and HSI		SHSE and HSI		SZSE and HSI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	**0.0628***	-0.0177	0.0414	-0.0052	0.0228	-0.0085	0.0097	-0.0070
2	-0.0250	-0.0315	-0.0323	-0.0189	-0.0329	-0.0224	-0.0170	0.0105
3	-0.0035	-0.0147	0.0048	-0.0129	0.0174	-0.0138	0.0468	**0.0672***
4	-0.0014	-0.0062	0.0030	-0.0064	0.0061	-0.0163	0.0431	0.0203
5	0.0270	-0.0456	0.0185	-0.0332	0.0305	-0.0435	0.0224	-0.0063

Note: The cross correlations of the standardized residuals and the squared standardized residuals computed from the models reported in Table 2.23 are shown. s is the number of periods the second cited return series lags the first cited return series. Panel A reports the results for the liberalization in 2002 and panel B contains the results for the liberalization in 2006. * indicates significance at the 5% level.

Table 2.25: Augmented ARMA(l,m)-GARCH(1,p)-M Models for the Return Series of both Composite Indices

Panel A								
		SHSE and DJI			**SZSE and DJI**			
		Pre		**Post**		**Pre**		**Post**
Mean	α_0	-0.0013*	-	-	-	-	-	-
		(0.0006)						
	β_1	0.0337	-	-	-	-	-	-
		(0.0416)						
	δ_4	-0.0539	-	-	-	-	-	-
		(0.0283)						
Variance	ω_0	0.0000	-	-	-	-	-	-
		(0.0000)						
	ω_1	0.2258**	-	-	-	-	-	-
		(0.0759)						
	φ_1	0.6373**	-	-	-	-	-	-
		(0.0830)						
Log-likelihood		3048.364	-	-	-	-	-	-
Residual tests	Q(6)	4.264	-	-	-	-	-	-
		(0.512)						
	Q(12)	12.315	-	-	-	-	-	-
		(0.340)						
	$Q^2(6)$	1.231	-	-	-	-	-	-
		(0.942)						
	$Q^2(12)$	2.331	-	-	-	-	-	-
		(0.997)						
		SHSE and HSI			**SZSE and HSI**			
		Pre		**Post**		**Pre**		**Post**
Mean	α_0	-0.0013	α_0	0.0000	α_0	-0.0015*	-	-
		(0.0007)		(0.0011)		(0.0007)		
	β_1	0.0255	β_1	-0.0022	β_1	0.0175	-	-
		(0.0416)		(0.0315)		(0.0415)		
	δ_3	0.0430	δ_1	0.0575	δ_1	0.0438	-	-
		(0.0250)		(0.0378)		(0.0299)		
	-	-	-	-	δ_3	0.0396	-	-
						(0.0256)		
Variance	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000	-	-
		(0.0000)		(0.0000)		(0.0000)		
	ω_1	0.2250**	ω_1	-0.0014	ω_1	0.2309**	-	-
		(0.0774)		(0.0240)		(0.0699)		
	-	-	ω_2	0.0685	-	-	-	-
				(0.0392)				
	φ_1	0.6372**	φ_1	0.8783**	φ_1	0.6369**	-	-
		(0.0762)		(0.0531)		(0.0778)		
Log-likelihood		3048.053		3133.518		3008.360	-	-
Residual tests	Q(6)	4.076	Q(6)	7.370	Q(6)	4.3268	-	-
		(0.538)		(0.195)		(0.503)		
	Q(12)	11.172	Q(12)	13.893	Q(12)	14.637	-	-
		(0.429)		(0.239)		(0.200)		
	$Q^2(6)$	1.297	$Q^2(6)$	8.513	$Q^2(6)$	1.670	-	-
		(0.935)		(0.130)		(0.893)		
	$Q^2(12)$	2.562	$Q^2(12)$	13.106	$Q^2(12)$	2.154	-	-
		(0.995)		(0.286)		(0.998)		

Table 2.25 − continued

Panel B								
	SHSE and DJI				**SZSE and DJI**			
	Pre		**Post**		**Pre**		**Post**	
Mean	-	-	α_0	0.0014	-	-	α_0	0.0005
				(0.0011)				(0.0012)
	-	-	α_1	-0.0144	-	-	β_1	0.0536
				(0.0371)				(0.0380)
	-	-	δ_1	0.1287**	-	-	δ_1	0.1485**
				(0.0499)				(0.0511)
	-	-	δ_2	0.2881**	-	-	δ_2	0.2825**
				(0.0501)				(0.0527)
	-	-	δ_3	0.0861	-	-	δ_3	0.0882
				(0.0499)				(0.0513)
Variance	-	-	ω_0	0.0000	-	-	ω_0	0.0000
				(0.0000)				(0.0000)
	-	-	ω_1	0.0984	-	-	ω_1	0.1721**
				(0.0517)				(0.0524)
	-	-	ω_2	-0.0308	-	-	ω_2	-0.0912
				(0.0542)				(0.0563)
	-	-	φ_1	0.9166**	-	-	φ_1	0.8871**
				(0.0338)				(0.0479)
	-	-	λ_1	0.0064	-	-	λ_1	0.0612
				(0.0099)				(0.0649)
	-	-	-	-	-	-	λ_3	-0.0425
								(0.0646)
Log-likelihood	-	-		2625.373	-	-		2561.648
Residual tests	-	-	Q(6)	11.032	-	-	Q(6)	10.448
				(0.051)				(0.063)
	-	-	Q(12)	14.846	-	-	Q(12)	13.586
				(0.190)				(0.257)
	-	-	$Q^2(6)$	2.011	-	-	$Q^2(6)$	0.856
				(0.848)				(0.973)
	-	-	$Q^2(12)$	7.727	-	-	$Q^2(12)$	4.450
				(0.737)				(0.955)
	SHSE and HSI				**SZSE and HSI**			
	Pre		**Post**		**Pre**		**Post**	
Mean	-	-	-	-	α_0	-0.0013	α_0	0.0013
						(0.0009)		(0.0012)
	-	-	-	-	β_1	0.0433	β_1	0.0583
						(0.0345)		(0.0382)
Variance	-	-	-	-	ω_0	0.0000	ω_0	0.0000
						(0.0000)		(0.0000)
	-	-	-	-	ω_1	0.0802**	ω_1	0.1488**
						(0.0270)		(0.0503)
	-	-	-	-	-	-	ω_2	-0.0826
								(0.0536)
	-	-	-	-	φ_1	0.8685**	φ_1	0.9111**
						(0.0336)		(0.0396)
	-	-	-	-	λ_3	-0.0164	λ_3	-0.0061
						(0.0152)		(0.0087)
Log-likelihood	-	-	-	-		3008.360		2543.750
Residual tests	-	-	-	-	Q(6)	5.740	Q(6)	11.234
						(0.332)		(0.047)

Table 2.25 – continued

-	-	-	-	Q(12)	14.637	Q(12)	13.887
					(0.210)		(0.239)
-	-	-	-	$Q^2(6)$	4.505	$Q^2(6)$	0.570
					(0.479)		(0.989)
-	-	-	-	$Q^2(12)$	2.015	$Q^2(12)$	4.206
					(0.898)		(0.963)

Note: The Maximum-Likelihood estimations of the appropriate ARMA(l,m)-GARCH(1,p)-M models are reported. The Bollerslev and Wooldridge (1992) asymptotic standard errors are displayed in parentheses. Panel A reports the results for the liberalization in 2002 and panel B contains the results for the liberalization in 2006. * and ** indicate significance at the 5% and 1% significance level. Q(6), Q(12), $Q^2(6)$ and $Q^2(12)$ are the Ljung-Box Q-statistics and their p-values in parentheses for the first 6 and 12 autocorrelations of standardized residuals and their squares.

The cross correlations calculated from the augmented models are displayed in Table 2.26. They show that the causality in mean in Table 2.24 is verified in all cases and both panels as none of the cross correlations in the levels is still significant. These results show that the reported spillovers in the main part are robust to different index classifications. Again, the liberalization in 2002 does not lead to an increase of the spillover effects neither in mean nor in variance as in the post-liberalization phase, causality is not indicated more often and causality in variance does not arise. Furthermore, it is shown that the liberalization in 2006, represented through panel B, causes more spillovers. While in the pre-liberalization phase, causality in variance is confirmed for SZSE and HSI, more potential causality in mean and in variance is found in the post-liberalization phase, see Table 2.24. Table 2.26 shows that causality in mean exists for both indices and DJI while the indicated causality in variance in the case of SHSE and DJI and SZSE and DJI as well as SZSE and HSI is not confirmed through the incorporation of the foreign markets. However, in most cases, the cross correlation coefficients decrease. Hence, causality in mean occurs more often in the post-liberalization phase of panel B while we are not able to verify the causality in variance after the liberalization. Therefore, in the sense of causality in variance, neither the QFII program nor the QDII program seem to be effective in the sense of a greater integration of the Chinese stock markets to regional and global markets.

Table 2.26: Cross Correlations of the Standardized Residuals of the Augmented Models

Pre-liberalization								
	Panel A				**Panel B**			
	SHSE and DJI		SZSE and DJI		SHSE and DJI		SZSE and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-0.0335	0.0018	-	-	-	-	-	-
2	0.0175	0.0243	-	-	-	-	-	-
3	-0.0114	-0.0174	-	-	-	-	-	-
4	-0.0100	0.0214	-	-	-	-	-	-
5	0.0421	-0.0104	-	-	-	-	-	-
	SHSE and HSI		SZSE and HSI		SHSE and HSI		SZSE and HSI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0605	0.0431	0.0132	0.0469	-	-	0.0223	-0.0115
2	0.0071	-0.0105	0.0104	-0.0118	-	-	-0.0342	-0.0236
3	0.0268	0.0357	0.0287	0.0408	-	-	0.0190	-0.0070
4	0.0382	-0.0103	0.0401	-0.0125	-	-	0.0065	-0.0065
5	0.0390	-0.0263	0.0456	-0.0291	-	-	0.0331	-0.0378
Post-liberalization								
	Panel A				**Panel B**			
	SHSE and DJI		SZSE and DJI		SHSE and DJI		SZSE and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-	-	-	-	0.0005	**0.1760***	-0.0082	**0.1336***
2	-	-	-	-	0.0023	0.0175	-0.0150	0.0043
3	-	-	-	-	0.0219	0.0568	0.0238	**0.0721***
4	-	-	-	-	0.0106	0.0099	0.0217	0.0028
5	-	-	-	-	0.0511	0.0087	0.0442	0.0312
	SHSE and HSI		SZSE and HSI		SHSE and HSU		SZSE and HSI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0204	-0.0164	-	-	-	-	0.0097	-0.0075
2	-0.0270	-0.0307	-	-	-	-	-0.0160	0.0105
3	-0.0026	-0.0133	-	-	-	-	0.0463	**0.0624***
4	-0.0015	-0.0042	-	-	-	-	0.0415	0.0134
5	0.0277	-0.0463	-	-	-	-	0.0220	-0.0070

Note: The cross correlations of the standardized residuals and the squared standardized residuals computed from the models reported in Table 2.25 are shown. s is the number of periods the second cited return series lags the first cited return series. Panel A reports the results for the liberalization in 2002 and panel B contains the results for the liberalization in 2006. * indicates significance at the 5% level.

2.A.4 Results from the full sample period

Table 2.27 displays the appropriate ARMA(l,m)-GARCH(1,p)-M models of the return series of SHSE A, SHSE B, SZSE A and SZSE B as well as the return series of DJI, H and HSI for the sample period November 23, 1998 to December 8, 2006. The sample period refers to the announcement of the QFII program on December 1, 2002. The lag structure is identified by the Akaike information criterion as well as the Ljung-Box Q-statistics. The results are largely comparable to the estimations reported in the main part. Again the constant and the ARMA terms in the mean equations are small and widely insignificant whereas the variance equations reveal considerable persistence as the conditional variance coefficient φ_1 ranges between 0.70 in the case of SHSE B and 0.95 in the case of DJI. As the Q-statistics show, in the case of SHSE A as well as SZSE A and SZSE B, we are not able to adjust ARMA(l,m)-GARCH(1,p)-M models where the residuals are not autocorrelated. The null of no autocorrelation has to be rejected at the 10% significance level.

Table 2.27: ARMA(l,m)-GARCH(1,p)-M Models for the Index Return Series - Full Sample Period

	SHSE A		SHSE B		SZSE A		SZSE B	
Mean	α_0	-0.0006	α_0	-0.0008	α_0	-0.0009	α_0	-0.0008
		(0.0005)		(0.0006)		(0.0005)		(0.0007)
	β_1	0.0104	β_1	0.1022**	β_1	0.0336	β_1	0.0997**
		(0.0280)		(0.0284)		(0.0279)		(0.0295)
Variance	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000
		(0.0000)		(0.0000)		(0.0000)		(0.0000)
	ω_1	0.0782*	ω_1	0.1617**	ω_1	0.0832**	ω_1	0.1842**
		(0.0307)		(0.0461)		(0.0300)		(0.0327)
	-	-	ω_2	-0.0176	-	-	-	-
				(0.0629)				
	-	-	ω_3	0.0602	-	-	-	-
				(0.0666)				
	-	-	ω_4	-0.1638**	-	-	-	-
				(0.0554)				
	φ_1	0.8942**	φ_1	0.9474**	φ_1	0.8905**	φ_1	0.6976**
		(0.0402)		(0.0244)		(0.0379)		(0.0484)
Log-likelihood		6208.054		5372.154		6114.870		5357.413
Residual tests	Q(6)	10.802	Q(6)	5.121	Q(6)	10.069	Q(6)	10.280
		(0.058)		(0.401)		(0.073)		(0.068)
	Q(12)	19.010	Q(12)	11.171	Q(12)	2.467	Q(12)	17.989
		(0.061)		(0.429)		(0.781)		(0.082)
	$Q^2(6)$	1.829	$Q^2(6)$	2.223	$Q^2(6)$	2.467	$Q^2(6)$	0.994
		(0.872)		(0.818)		(0.781)		(0.963)
	$Q^2(12)$	3.015	$Q^2(12)$	7.015	$Q^2(12)$	3.410	$Q^2(12)$	2.751
		(0.991)		(0.798)		(0.984)		(0.994)

	DJI		HSI		H	
Mean	α_0	0.0000	α_0	0.0013	α_0	0.0004
		(0.0003)		(0.0012)		(0.0004)
	α_1	-0.0212	β_1	0.1346**	α_1	0.0431*
		(0.3569)		(0.0235)		(0.0217)
Variance	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000
		(0.0000)		(0.0000)		(0.0000)
	ω_1	0.0640**	ω_1	0.1266**	ω_1	-0.0045
		(0.0114)		(0.0366)		(0.0259)
	-	-	ω_2	-0.0749*	ω_2	0.0496
				(0.0378)		(0.0278)
	φ_1	0.9317**	φ_1	0.9452**	φ_1	0.9515**
		(0.0099)		(0.0104)		(0.0099)
Log-likelihood		6799.253		5538.791		6290.785
Residual tests	Q(6)	2.497	Q(6)	2.836	Q(6)	1.794
		(0.777)		(0.725)		(0.877)
	Q(12)	8.326	Q(12)	11.267	Q(12)	5.461
		(0.684)		(0.421)		(0.907)

$Q^2(6)$	2.856	$Q^2(6)$	7.022	$Q^2(6)$	2.934
	(0.722)		(0.219)		(0.710)
$Q^2(12)$	6.901	$Q^2(12)$	12.596	$Q^2(12)$	5.920
	(0.807)		(0.321)		(0.879)

Note: The Maximum-Likelihood estimations of the appropriate ARMA(l,m)-GARCH(1,p)-M models are reported. The Bollerslev and Wooldridge (1992) asymptotic standard errors are displayed in parentheses. * and ** indicate significance at the 5% and 1% level. Q(6), Q(12), $Q^2(6)$ and $Q^2(12)$ are the Ljung-Box Q-statistics and their p-values in parentheses for the first 6 and 12 autocorrelations of the standardized residuals and their squares.

Table 2.28 shows the cross correlations based on the ARMA(l,m)-GARCH(1,p)-M models reported in Table 2.27. Again, these cross correlations are used to indicate potential regional and global spillovers between the index return series. It is revealed that the application of the full sample period leads to comparable results: particularly H is (potentially) affected through DJI, both in mean and in variance as well as the SZSE B in mean. In contrast, using the full sample horizon, causality in mean is found for all Chinese indices including H caused by the HSI. In the next step, we have to verify if the causalities are caused by the foreign markets. Therefore, we include the foreign index return series to our initial models.

Table 2.28: Cross Correlations of the Standardized Residuals - Full Sample Period

	SHSE A and DJI		SHSE B and DJI		SZSE A and DJI		SZSE B and DJI		H and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-0.0056	0.0057	-0.0131	-0.0117	-0.0056	0.0145	0.0107	0.0166	**0.0699***	**0.0626***
2	0.0302	0.0072	0.0349	-0.0066	0.0268	0.0094	**0.0741***	0.0093	**0.2221***	**0.0958***
3	0.0222	-0.0010	0.0226	-0.0118	0.0163	0.0011	0.0161	0.0187	-0.0297	0.0322
4	-0.0367	0.0167	-0.0249	0.0110	-0.0360	0.0145	-0.0204	0.0019	**0.0610***	-0.0052
5	0.0355	-0.0064	0.0385	0.0071	0.0286	-0.0047	0.0187	0.0094	0.0357	-0.0049
	SHSE A and HSI		SHSE B and HSI		SZSE A and HSI		SZSE B and HSI		H and HSI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	**0.0544***	0.0338	0.0340	0.0195	**0.0461***	0.0402	**0.0455***	0.0273	**-0.050***	-0.0108
2	-0.0128	-0.0084	-0.0282	0.0082	-0.0137	-0.0046	-0.0261	0.0150	-0.0320	-0.0151
3	0.0304	0.0149	**0.0471***	0.0054	0.0312	0.0149	0.0413	0.0339	-0.0058	0.0140
4	0.0267	-0.0051	0.0353	0.0152	0.0294	-0.0070	0.0293	0.0174	0.0068	0.0035
5	0.0301	-0.0328	-0.0372	-0.0247	0.0315	-0.0311	-0.0140	-0.0189	0.0210	0.0239

Note: The cross correlations of the standardized residuals and the squared standardized residuals computed from the models reported in Table 2.27 are shown. s is the number of periods the second cited return series lags the first cited return series. * indicates significance at the 5% level.

In Table 2.29, the estimations of the augmented ARMA(l,m)-GARCH(1,p)-M models are shown. As already reported in the main part, the coefficients of the foreign market in the mean equations, indicated through δ_i, are partly significant while the coefficients of the foreign market in the variance equations, indicated through λ_i, are insignificant. Furthermore, the incorporation of the foreign markets does not abolish the autocorrelation in the residuals of the adjusted models of SHSE A, SZSE A and SZSE B.

Table 2.29: Augmented ARMA(l,m)-GARCH(1,p)-M Models for the Index Return Series - Full Sample Period

	SHSE A and DJI		**SHSE B and DJI**		**SZSE A and DJI**		**SZSE B and DJI**		**H and DJI**	
Mean	-	-	-	-	-	-	α_0	-0.0007	α_0	0.0013*
								(0.0007)		(0.0005)
	-	-	-	-	-	-	β_1	0.0960**	β_1	0.1260**
								(0.0294)		(0.0238)
	-	-	-	-	-	-	δ_2	0.1192**	δ_1	0.0990**
								(0.0350)		(0.0329)
	-	-	-	-	-	-	-	-	δ_2	0.3220**
										(0.0326)
	-	-	-	-	-	-	-	-	δ_4	0.1000**
										(0.0327)
	-	-	-	-	-	-	-	-	δ_5	0.0450
										(0.1260)
Variance	-	-	-	-	-	-	ω_0	0.0000	ω_0	0.0000
								(0.0000)		(0.0000)
	-	-	-	-	-	-	ω_1	0.1842**	ω_1	0.1115**
								(0.0329)		(0.0317)
	-	-	-	-	-	-	-	-	ω_2	-0.0625
										(0.0346)
	-	-	-	-	-	-	φ_1	0.6978**	φ_1	0.9463**
								(0.0494)		(0.0104)
	-	-	-	-	-	-	-	-	λ_1	0.0508
										(0.0469)
	-	-	-	-	-	-	-	-	λ_2	-0.0486
										(0.0465)
Log-likelihood	-	-	-	-	-	-		5359.943		5587.288
Residual tests	-	-	-	-	-	-	Q(6)	9.619	Q(6)	7.232
								(0.087)		(0.204)
	-	-	-	-	-	-	Q(12)	17.375	Q(12)	16.659
								(0.097)		(0.118)
	-	-	-	-	-	-	$Q^2(6)$	1.013	$Q^2(6)$	5.025
								(0.962)		(0.413)
	-	-	-	-	-	-	$Q^2(12)$	2.620	$Q^2(12)$	11.127
								(0.995)		(0.433)
	SHSE A and HSI		**SHSE B and HSI**		**SZSE A and HSI**		**SZSE B and HSI**		**H and HSI**	
Mean	α_0	-0.0007	α_0	-0.0009	α_0	-0.0009	α_0	-0.0000	α_0	0.0013*
		(0.0005)		(0.0006)		(0.0005)		(0.0007)		(0.0005)
	β_1	0.0060	β_1	0.0965**	β_1	0.0295	β_1	0.0891*	β_1	0.1757**
		(0.0285)		(0.0284)		(0.0283)		(0.0299)		(0.0285)
	δ_1	0.0395	δ_3	0.0533	δ_1	0.0369	δ_1	0.0893*	δ_1	-0.0985*
		(0.0252)		(0.0331)		(0.0260)		(0.0363)		(0.0384)

Table 2.29 – continued

Variance	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000	ω_0	0.0000
		(0.0000)		(0.0000)		(0.0000)		(0.0000)		(0.0000)
	ω_1	0.0781*	ω_1	0.1625**	ω_1	0.0827**	ω_1	0.1878**	ω_1	0.1196**
		(0.0301)		(0.0469)		(0.0294)		(0.0336)		(0.0354)
	-	-	ω_2	-0.0152	-	-	ω_2	-0.0687	-	-
				(0.0635)				(0.0371)		
	-	-	ω_3	0.0576	-	-	-	-	-	-
				(0.0667)						
	-	-	ω_4	-0.1621**	-	-	-	-	-	-
				(0.0560)						
	φ_1	0.8944**	φ_1	0.9446**	φ_1	0.8914**	φ_1	0.6927**	φ_1	0.9457**
		(0.0393)		(0.0254)		(0.0373)		(0.0492)		(0.0103)
Log-likelihood		6206.324		5367.415		6112.788		5358.475		5540.327
Residual tests	Q(6)	9.892	Q(6)	4.699	Q(6)	9.307	Q(6)	9.381	Q(6)	2.2702
		(0.078)		(0.454)		(0.097)		(0.095)		(0.811)
	Q(12)	17.679	Q(12)	10.685	Q(12)	18.313	Q(12)	17.102	Q(12)	10.729
		(0.089)		(0.470)		(0.075)		(0.105)		(0.466)
	$Q^2(6)$	2.021	$Q^2(6)$	7.022	$Q^2(6)$	2.680	$Q^2(6)$	1.045	$Q^2(6)$	7.479
		(0.846)		(0.219)		(0.749)		(0.959)		(0.187)
	$Q^2(12)$	3.286	$Q^2(12)$	12.596	$Q^2(12)$	3.599	$Q^2(12)$	2.888	$Q^2(12)$	12.681
		(0.986)		(0.321)		(0.980)		(0.992)		(0.315)

Note: The Maximum-Likelihood estimations of the appropriate ARMA(l,m)-GARCH(1,p)-M models are reported. The Bollerslev and Wooldridge (1992) asymptotic standard errors are displayed in parentheses. * and ** indicate significance at the 5% and 1% level. Q(6), Q(12), $Q^2(6)$ and $Q^2(12)$ are the Ljung-Box Q-statistics and their p-values in parentheses for the first 6 and 12 autocorrelations of the standardized residuals and their squares.

The cross correlations from the augmented ARMA(l,m)-GARCH(1,p)-M models are shown in Table 2.30. It is revealed that the causality in variance between H and DJI is confirmed albeit not for all lags as the consideration of the DJI leads to insignificant cross correlations for the first lag. Furthermore, in case of the second lag, the cross correlation has decreased. Causality in mean is reported for SZSE B and DJI and in case of H and DJI, as the significance at the first and fourth lag disappears. Furthermore, the cross correlation for the second lag decreases. In case of HSI, we are able to confirm the causality in mean for all cases because of the insignificance of all cross correlations.

In general, this analysis shows that the results remain unchanged when the full sample period is used. Overall, it can be stated that the global market proxied by the United States

Table 2.30: Cross Correlations of the Standardized Residuals - Full Sample Period

	SHSE A and DJI		SHSE B and DJI		SZSE A and DJI		SZSE B and DJI		H and DJI	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	-	-	-	-	-	-	0.0109	0.0174	0.0138	0.0352
2	-	-	-	-	-	-	0.0102	0.0031	**0.0440***	**0.0596***
3	-	-	-	-	-	-	0.0242	0.0165	0.0032	0.0424
4	-	-	-	-	-	-	-0.0200	0.0030	0.0029	0.0002
5	-	-	-	-	-	-	0.0185	0.0087	0.0182	-0.0079
	SHSE A and HSI		**SHSE B and HSI**		**SZSE A and HSI**		**SZSE B and HSI**		**H and HSI**	
Lag s	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares	Levels	Squares
1	0.0139	0.0356	0.0344	0.0196	0.0096	0.0426	-0.0122	0.0296	-0.0067	-0.0104
2	-0.0138	-0.0073	-0.0288	0.0106	-0.0139	-0.0033	-0.0223	0.0164	-0.0348	-0.0180
3	0.0311	0.0150	0.0120	0.0026	0.0318	0.0149	0.0416	0.0344	-0.0048	0.0125
4	0.0255	-0.0052	0.0375	0.0150	0.0283	-0.0070	0.0285	0.0173	0.0084	0.0028
5	0.0298	-0.0334	-0.0370	-0.0244	0.0313	-0.0317	-0.0137	-0.0185	0.0209	0.0201

Note: The cross correlations of the standardized residuals and the squared standardized residuals computed from the models reported in Table 2.29 are shown. s is the number of periods the second cited return series lags the first cited return series. * indicates significance at the 5% level.

exerts little effects on Chinese stock markets' variance while the regional market proxied by Hong Kong only has caused causality in mean and not in variance.

3 The development of the financial system and the effects on sectoral output growth in mainland China

3.1 Motivation

China is experiencing remarkable economic growth since the late 1970s where economic reforms and financial liberalization were initiated. In this chapter we examine if and to what extend the development of the financial system and accordingly the enlargement of bank lending has influenced economic and sectoral output growth.

The question how financial development and economic growth interact is often discussed in the literature, see for instance Sims (1972), King and Levine (1993), Arestis and Demetriades (1997), Levine and Zervos (1998) and Rajan and Zingales (1998) as prominent examples. In this context, a differentiation among various economic sectors is expedient as a shift from agriculture to industry or from industry to services is often indicated for developing and emerging countries.[85] As indicated in Wang and Szirmai (2008), especially the manufacturing sector is viewed as main engine of the present growth process in China. In addition, after the

[85] For the case of China, this is for instance reported in Chow and Lawler (2003).

Asian financial crisis in 1997, the construction sector was chosen as new growth incitement. Therefore, revealing the sectoral dependencies and causal connections on the financial sector is an important challenge as it gives further evidence to derive development strategies in China and other emerging countries.

In our study, we trace the effects of an unexpected shock in bank lending on gross domestic product as well as on the subsectors - agriculture, manufacturing, construction, transportation and trade - underneath it. Therefore, VAR frameworks are applied and impulse responses and variance decompositions are generated. The analysis starts by estimating impulse responses from three-variable VARs including gross domestic product, gross capital formation and bank lending. Since there is no plausible ordering in the three-variable VAR, impulse responses with Cholesky decomposition are estimated for each two-variable combination in order to confirm the finding of a positive link between bank lending and economic growth. We are able to report that an unexpected standard shock in bank lending exerts positive influence via two channels, directly and indirectly through gross capital formation.[86]

We apply impulse responses with Cholesky decomposition on our sectoral data that lead to the result that all sectors react positive and significant to a shock in bank lending. We link this result to the existing literature in two ways. First, we interpret the results as suggested by Tornell and Westermann (2005) in the context of the two-sector growth model proposed by Schneider and Tornell (2004). It is assumed that small and non-tradable-goods-producing firms are likely more dependent on the domestic banking system while large and tradable-goods-producing firms have other sources of finance. Secondly, with regard to the idiosyncratic of China's banking system, we construe the findings in the light of state ownership. As often

[86]The investment channel is well known in this context and has been highlighted for instance in Calderón and Liu (2003), Xu (2000) and Rousseau and Vuthipadadorn (2005).

reported in the literature, state-owned enterprises in China have better access to bank credit while non-state-owned firms - usually small or medium-sized firms - are discriminated (see for instance Allen et al. (2005)).

The chapter is organized as follows. In Section 3.2, a brief literature review is given and subsequently, Section 3.3 provides a review of the financial system in China. Section 3.4 presents a description of the data and the results of unit root and cointegration tests. The VAR analysis of economic output and bank lending is contained in Section 3.5. Section 3.6 displays the results of the sectoral analysis, followed by Section 3.7 where some concluding remarks are given.

3.2 Literature review

The finance-growth nexus has received much interest in research in both, theoretical and empirical analysis. In the empirical work, cross country data, time series and panel data are extensively used and the positive role of finance on growth has become a stylized fact.[87] Odedokun (1996) highlights that the effect of finance on growth is stronger in low income than in high income countries. Calderón and Liu (2003) who analyze 109 developing and industrial countries argue that in developing countries, finance exerts a stronger effect on growth. This effect acts through a capital accumulation and productivity growth channel with the latter being more prominent.[88] Rioja and Valev (2004) divide 74 countries in three groups according to the level of their financial development and show that in financially less developed countries the effect of finance on growth is ambiguous whereas finance has a strong positive

[87] A broad literature overview of the empirical analysis which deals with this topic is given in Ang (2008). Studies which analyze emerging countries (amongst others) are for instance Luintel and Khan (1999), Gupta (1984) and Jung (1986).

[88] Also Rousseau and Vuthipadadorn (2005) report that the financial sector acts as a catalyst particularly through investment.

impact in countries with more developed financial systems. Shan (2005) analyzes China and ten OECD countries, re-examining the question concerning the relationship between financial development and growth, investment and productivity, and presents only weak evidence that financial development ignites economic growth. Hasan et al. (2009) use panel data for the Chinese provinces and indicate that the development of financial markets and the legal environment is positively related to stronger growth.

Another strand of literature deals with the specific financial system in China. Allen et al. (2005), Wei and Wang (1997) and Berger et al. (2009) point out that the banking system in China is highly dominated by state-owned banks. According to them, state-owned banks are operating very inefficient as bank lending decisions are often made due to policy lending or due to other non-economic reasons, causing a large burden of non-performing loans (NPL).[89] In addition, it is well known, that state-owned banks prefer state-owned enterprises in bank lending decisions. Duenwald and Aziz (2003) report that almost two-third of domestic bank credit is directed to state-owned firms. However, private-owned firms have grown much faster in recent decades suggesting that they rely effectively on alternative forms of financing as for instance indicated in Allen et al. (2005) and Tsai (2004).[90] Ayyagari et al. (2010) report that bank financing firms grow faster than firms using informal loans although Chinese private-owned firms have been the fastest growing enterprises. Nevertheless, although the commercial performance of state-owned banks may have been poor, Laurenceson and Chai (2001) highlight that the impact on China's economic development appears to have been both positive and sustainable. Furthermore, due to the high inefficiency of China's banking system in allocating

[89] In Section 3.A.5 in the appendix it is shown that since 2001, the amount of NPL has decreased continuously in the Chinese banking system.

[90] Other studies that concentrate on public and private-owned firms are for instance Aziz and Duenwald (2002) and Cull and Xu (2000). Furthermore, see Acemoglu et al. (2005) for an overview of studies adopting an institutional view.

capital and the distress of non-performing loans, China has become some kind of prominent counterexample in the finance-growth literature as neither its legal nor its financial system is well developed, yet it is one of the fastest growing economies (see for instance Allen et al. (2005)).

3.3 Review of the Chinese financial system

Prior to 1978, China's banking system was characterized by a mono-bank system in which the *People's Bank of China (PBOC)* - founded in 1948 - provides the role of a central bank as well as of commercial lending. After reforming the banking system in 1978, four specialized state-owned banks (the so called 'Big Four') - the Bank of China (BOC), the China Construction Bank (CCB) and the Agricultural Bank of China (ABC) as well as the Industrial and Commercial Bank of China (ICBC) - were separated from the PBOC taking over the commercial lending function. In 1985, the Big Four became national commercial banks, which were allowed to compete in all sectors. However, due to the national production plans, the competition remains rather low. In 1994, three policy-related banks, the Agricultural Development Bank of China (ADBC), the China Development Bank (CDB) and the Export-Import Bank of China (Chexim) were established by the government in order to take over the policy-lending activities from the state-owned banks.

Poor lending decisions for state-owned enterprises (due to the large volume of policy lending decisions or other non-economic reasons as well as weak internal controls) are often reported within the Big Four and have resulted in a huge amount of NPL. In 1999 the government transferred a substantial amount of these NPL (roughly 20% of total loans) to four newly established state-owned assets management companies to liquidate them.[91] Currently, China's

[91] Allen et al. (2005) report a cash recovery from 8% to 60%.

banking system is characterized by a three-tier system with the Big Four state-owned banks representing the first tier and still accounting for two-third of financial system assets. The second tier comprises 12 national-level domestic joint-equity banks and the third tier is represented through about 100 city-level commercial banks.[92] Nevertheless, China's banking system is still underdeveloped, inefficient and mainly controlled by the Big Four.

The two stock exchanges in Shanghai and Shenzhen, established in 1990 have grown very fast but are still relatively unimportant particularly compared to the banking system.[93] Also the venture capital market is underdeveloped and fairly unimportant.

In recent years, state-owned banks have endeavored to enhance their loan structure. More loans are issued to individual lenders as well as more attention is paid to risk management and monitoring.[94] Additionally, more non-state financial institutions (commercial banks, rural and urban credit cooperatives, trust and investment companies etc.) and foreign banks have entered the domestic credit market in China.[95] The share of the Big Four in the providing of total new loans has decreased and NPL have reduced.

Paradoxically, the private, unlisted sector grows much faster providing most of the economy's growth although it obtains least bank credit. Even after the awareness that the private sector is an inherent part of the Chinese economy, the discrimination of private firms against state-owned firms still exists. Owing to asymmetric information and high information cost, banks still regard private-owned firms to be riskier.[96]

As Shen et al. (2009) show, small and medium-sized enterprises (SME) in China obtain

[92]These numbers are reported in Lin and Zhang (2009).

[93]Furthermore, the market capitalization and the total value traded as a fraction of GDP is smaller than in most other transition countries.

[94]Particularly since the entry into the World Trade Organization (WTO) in 2001, further reforms of the banking system has been promoted.

[95]But until now the participation of foreign banks is rather low as for instance reported in Berger et al. (2009).

[96]Huang (2003) reports that it is harder for private-owned firms to collaterize their assets and riskier for banks to grant credit.

12% of their capital from bank loans.[97] Furthermore, Cull and Xu (2003), Batra et al. (2003) and Yao and Yueh (2009) depict that state-owned firms enjoy preferential treatment of state-owned banks. Additionally, Ferri and Liu (2010) and Hale and Long (2011) point out that the costs of financing are twice as high for Chinese private-owned firms compared to state-owned firms.[98] It is assumed that privately owned firms in China have financed themselves mainly via internal funds (retained earnings), informal lending (funds from relatives and friend) and trade credit, especially from the state-owned to the private sector.[99] However, in recent studies a moderate improvement of SME access to external finance and formal finance is often reported as well as an enhanced efficiency of Chinese bank lending due to structural improvements and the emergence of foreign banks. But nevertheless, the Chinese banking system is indeed large but still underdeveloped and inefficient. Additionally, reforms as well as privatization efforts are not only occurring in the banking system but also in the state sector as a privatization of (small) state-owned enterprises, a corporatization of larger state-owned enterprises and the entry of non-state-owned enterprises is taking place.

3.4 Data description and preliminary analysis

In the first part of our analysis we apply *gross domestic product (GDP)* as well as *gross capital formation (GCF)* and the two bank lending variables *domestic credit (DC)* provided by the banking system and *domestic loans (DL)* as source of funds for investment in fixed

[97] Indeed, this is a relatively low number even compared to other Asian countries.

[98] Furthermore, it is reported that among the private-owned firms, larger (and older) ones have better access than smaller private firms.

[99] In Section 3.A.2 in the appendix, self-raised funds, foreign investment and state budget appropriation are used to further assess the sectoral dependency structure. It is shown that solely the tradable-goods-producing sectors agriculture and manufacturing benefit from these options of financing. For agriculture, especially foreign investment and self-raised funds are important financing sources. In case of manufacturing the highest reaction in the impulse response function as well as the highest number in the variance decomposition is revealed for self-raised funds.

Table 3.1: Results of ADF Tests

Variable	Levels		1st Differences	
	ADF	Prob.	ADF	Prob.
Gross domestic product	0.384	0.979	-4.150***	0.003
Gross capital formation	1.328	0.998	-5.366***	0.000
Domestic credit	-0.819	0.799	-5.333***	0.000
Domestic loans	-1.011	0.735	-3.589**	0.013
Agriculture	-2.414	0.147	-4.823***	0.001
Manufacturing	0.202	0.968	-3.241**	0.027
Construction	0.338	0.977	-4.739***	0.001
Transportation	-2.225	0.202	-3.901***	0.006
Trade	-0.883	0.780	-4.019***	0.004

Note: The ADF test (allowing for an intercept) is calculated for the levels and first differences for gross domestic product (GDP), gross capital formation (GCF), domestic credit (DC), domestic loans (DL), agriculture (A), manufacturing (MF), construction (C), transportation (TR) and trade (T) for the years 1981 to 2010. The lag length is selected by the Schwarz information criterion. *** (**,*) indicates significance at the 1% (5%, 10%) level.

assets.[100] Additionally, we apply the sectoral output of *agriculture (A)*, *manufacturing (MF)*, *construction (C)*, *transportation (TR)* and *trade (T)* to assess the importance of financial development and financial liberalization on economic output as well as on the output of the different sectors.[101] All data are collected from the United Nations Statistics Division (see UN (2012)) except for domestic credit which is provided by the World Bank (see World Bank (2012)) and domestic loans which is collected by the National Bureau of Statistics of China (see National Bureau of Statistics of China (2012)). The variables are recorded on an annual basis and in logged terms, denominated in Chinese Yuan and in constant 2005 prices. The sample period covers the years 1981 to 2010.[102]

Table 3.1 displays the unit root properties of the variables. It is shown that using the

[100] Domestic credit includes the lending of credit to various sectors as well as to the central government. The banking system contains monetary authorities and deposit money banks as well as other banking institutions as saving and mortgage banks and building and loan associations. Domestic loans as source of funds for investment in fixed assets are defined as funds which are borrowed by enterprises and institutions from domestic banks and non-bank financial institutions and include various types of loans. It excludes personal mortgage lending.

[101] In addition, agriculture includes the value added of hunting, forestry and fisheries. Manufacturing further includes mining and utilities, and transportation additional contains the value added of storage and communication. Trade includes the value added of wholesale and retail trade, restaurants and hotels.

[102] In Figure 3.5 and 3.6 in Section 3.A.1 in the appendix, the graphs of the variables as well as the logs are shown.

augmented Dickey-Fuller test, all variables are non-stationary in levels but stationary in first differences. Table 3.2 presents the results of two different cointegration approaches. All combinations of variables which later enter the VARs are tested using the Johansen (1991) cointegration test with Trace and Maximum eigenvalue statistics as well as the two-step Engle and Granger (1987) approach. According to the Johansen (1991) technique we are able to report cointegration for all pairs of variables with exception of gross domestic product, gross capital formation and domestic credit. In this case, we are able to indicate cointegration by using the Engle and Granger (1987) approach.

Table 3.2: Results of Cointegration Tests

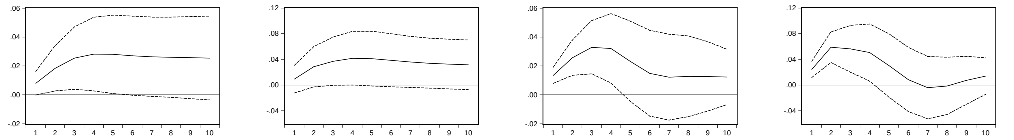
Included variables					Engle/Granger	Included variables					Engle/Granger
GDP,	Trace	r=0	r≤1	r≤2	-4.174**	GDP,	Trace	r=0	r≤1	r≤2	-3.041
GCF,		37.318*	15.660	6.078		GCF,		82.937**°°	39.759**°°	10.013* °	
DC	Max-Eigenvalue	r=0	r=1	r=2		DL	Max-Eigenvalue	r=0	r=1	r=2	
		21.657	9.582	6.078				43.178**°°	29.746**°°	10.013* °	
GDP,	Trace	r=0	r≤1		-2.117	GDP,	Trace	r=0	r≤1		-1.614
DC		23.988* °	5.612			DL		36.180**°°	11.344* °		
	Max-Eigenvalue	r=0	r=1				Max-Eigenvalue	r=0	r=1		
		18.375* °	5.612					24.836**°°	11.344* °		
GCF,	Trace	r=0	r≤1		-1.799	GCF,	Trace	r=0	r≤1		-1.395
DC		25.556**°	6.178			DL		31.811**°°	9.434*		
	Max-Eigenvalue	r=0	r=1				Max-Eigenvalue	r=0	r=1		
		19.378* °	6.178					22.377**°	9.434*		
A,	Trace	r=0	r≤1		-3.434*	A,	Trace	r=0	r≤1		-2.010
DC		37.120**°°	13.344**°			DL		27.784**°	6.874		
	Max-Eigenvalue	r=0	r=1				Max-Eigenvalue	r=0	r=1		
		23.776**°°	13.344**°					20.910**°	6.874		
MF,	Trace	r=0	r≤1		-2.539	MF,	Trace	r=0	r≤1		-2.019
DC		30.429**°°	8.969			DL		27.293**°	5.953		
	Max-Eigenvalue	r=0	r=1				Max-Eigenvalue	r=0	r=1		
		21.460**°	8.969					21.340**	5.953		
C,	Trace	r=0	r≤1		-2.326	C,	Trace	r=0	r≤1		-0.646
DC		30.918**°°	10.555*			DL		27.597**°	4.051		
	Max-Eigenvalue	r=0	r=1				Max-Eigenvalue	r=0	r=1		
		20.363**°	10.555*					23.546**°	4.051		
TR,	Trace	r=0	r≤1		-3.590**	TR,	Trace	r=0	r≤1		-2.049
DC		20.373*	7.126			DL		39.226**°°	8.856		
	Max-Eigenvalue	r=0	r=1				Max-Eigenvalue	r=0	r=1		
		13.247	7.126					30.370**°	8.856		
T,	Trace	r=0	r≤1		-1.800	T,	Trace	r=0	r≤1		-1.098
DC		21.090*	4.014			DL		28.194**°	5.160		
	Max-Eigenvalue	r=0	r=1				Max-Eigenvalue	r=0	r=1		
		17.076*	4.014					23.034**°	5.160		

Note: * and ** indicate significance at the 5% and 1% level by employing critical values from Osterwald-Lenum. ° and °° indicate significance at the 5% and 1% level using finite sample critical values from Cheung and Lai (1993). For Engle and Granger (1987) cointegration, *, ** and *** indicate significance at the 10%, 5% and 1% level using critical values from MacKinnon (1991).

3.5 Economic output and bank lending

Figure 3.1: Generalized Impulse Responses for Gross Domestic Product and Gross Capital Formation to shocks in Domestic Credit and Domestic Loans

Panel A		**Panel B**	
Reaction of GDP to a shock in DC	Reaction of GCF to a shock in DC	Reaction of GDP to a shock in DL	Reaction of GCF to a shock in DL



Note: Panel A represents the impulse responses from a VAR including gross domestic product (GDP), gross capital formation (GCF) and domestic credit (DC) and panel B refers to the impulse responses from a VAR including gross domestic product (GDP), gross capital formation (GCF) and domestic loans (DL). The solid lines trace the impulse responses and the dashed lines show the asymptotic standard errors. The optimal lag length in the VARs are determined by the Schwarz information criterion.

Table 3.3: Variance Decomposition for Gross Domestic Product and Gross Capital Formation to shocks in Domestic Credit and Domestic Loans

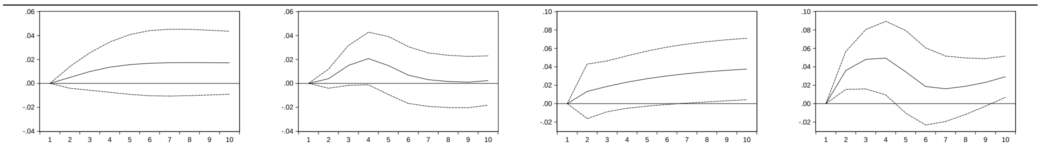
Panel A			**Panel B**		
	Years			Years	
Variance Decomposition	5	10	Variance Decomposition	5	10
GDP due to DC (in percent)	7.519	8.524	GDP due to DL (in percent)	3.720	5.038
	[8.385]	[9.213]		[7.019]	[7.808]
GCF due to DC (in percent)	5.205	6.991	GCF due to DL (in percent)	3.512	8.938
	[7.541]	[10.008]		[5.718]	[7.312]

Note: The variance decomposition of the forecast error is shown. Panel A represent a VAR including gross domestic product (GDP), gross capital formation (GCF) and domestic credit (DC) and panel B represent a VAR including gross domestic product (GDP), gross capital formation (GCF) and domestic loans (DL). The values in parentheses indicate the standard deviation.

The impulse responses and the variance decompositions are estimated within two frameworks. Figure 3.1 shows impulse responses from two different VARs. Panel A displays the impulse responses coming from a three-variable VAR including gross domestic product, gross capital formation and domestic credit. Panel B shows impulse responses from a VAR including domestic loans instead of domestic credit. Since there is no plausible ordering of gross capital formation and our bank lending variables when assuming that gross domestic product depends on gross capital formation already in period t and on bank lending in period t-1, we

Figure 3.2: Impulse Responses with Cholesky Decomposition for Gross Domestic Product and Gross Capital Formation to shocks in Domestic Credit and Domestic Loans

Panel A		**Panel B**	
Reaction of GDP to a shock in DC	Reaction of GCF to a shock in DC	Reaction of GDP to a shock in DL	Reaction of GCF to a shock in DL



Note: Panel A represents impulse responses from two bivariate VARs including gross domestic product (GDP) and domestic credit (DC), and gross capital formation (GCF) and domestic credit (DC). Panel B refers to the impulse responses from VARs including gross domestic product (GDP) and domestic loans (DL) and gross capital formation (GCF) and domestic loans (DL). The solid lines trace the impulse responses and the dashed lines show the asymptotic standard errors. The optimal lag length is determined by the Schwarz information criterion.

generate generalized impulse responses.[103]

Figure 3.1 shows that domestic credit and domestic loans take effect on gross domestic product via two channels. Gross domestic product reacts positive and significant to unexpected shocks in domestic credit and domestic loans. In panel A, gross domestic product reacts for five years and in panel B, the significant reaction persists for four years. Additionally, it is shown that gross capital formation reacts positive and significant to shocks in domestic credit (panel A) and domestic loans (panel B). It is well known and often reported in the literature that capital formation exerts positive impact on output. Therefore, we do not show these impulse responses as they confirm this link. However, in general, the variance decompositions of the forecast errors, displayed in Table 3.3, are small.[104]

In the next step, we apply *bivariate* VARs. Since there is no plausible ordering of the variables in the three-variable VARs reported above, we now use two-variable systems in which an appropriate ordering is feasible. Impulse responses from two separate VARs including gross

[103] For all graphs which are presented in this chapter, we use the Schwarz information criterion to determine the optimal lag length in the VAR specification.

[104] Boyreau-Debray (2003) finds that growth is negatively impacted by bank credit due to the favoritism of state-owned enterprises. As reported, especially privately owned firms contribute to the positive growth in China but are largely excluded from domestic bank credit as state-owned banks are dominating the banking system in China and discriminate private-owned firms against state-owned firms. This may explain the relatively small numbers in the variance decompositions.

Table 3.4: Variance Decomposition for Gross Domestic Product and Gross Capital Formation to shocks in Domestic Credit and Domestic Loans

Panel A			**Panel B**		
	Years			Years	
Variance Decomposition	5	10	Variance Decomposition	5	10
GDP due to DC (in percent)	7.740	13.042	GDP due to DL (in percent)	27.661	23.317
	[10.692]	[17.530]		[19.177]	[19.621]
GCF due to DC (in percent)	9.833	24.521	GCF due to DL (in percent)	43.847	41.853
	[12.576]	[21.841]		[20.253]	[21.814]

Note: The variance decomposition of the forecast error is shown. Panel A represent VARs including gross domestic product (GDP) and domestic credit (DC), and gross capital formation (GCF) and domestic credit (DC) and panel B refers to VARs including gross domestic product (GDP) and domestic loans (DL), and gross capital formation (GCF) and domestic loans (DL). The values in parentheses indicate the standard deviation.

domestic product and domestic credit, as well as gross capital formation and domestic credit are displayed in panel A of Figure 3.2. Panel B shows these impulse responses when domestic loans is used.

It is shown that an unexpected shock in domestic credit does not exert significant influence on gross domestic product and gross capital formation. Nevertheless, Table 3.4 reveals that 24.5% of the forecast error variance of gross capital formation is explained by a shock in domestic credit. In panel B, both impulse responses are positive and statistically significant emphasizing our previous findings. Domestic loans takes effects on gross domestic product directly and indirectly through investment. These significant responses are supported by the variance decompositions which indicate that 23.3% and 41.9% of the forecast error variance of gross domestic product and gross capital formation are explained by domestic loans (after ten years).

3.6 Sectoral output and bank lending

In the second part of our analysis we investigate the relation between financial development and economic growth from a sectoral perspective. In order to derive single-minded policy strategies for China, it is necessary to dissect the reported positive linkage between financial development and growth. Therefore, we disaggregate the economic output into the sectors agriculture, manufacturing, construction, transportation and trade.

Using sectoral output data and domestic credit as bank lending variables, we generate impulse responses from bivariate VARs. Figure 3.3 shows that all sectors react positive and significant to an unexpected standard shock in domestic credit. While the reaction of agriculture is significant after five years, the reaction of the manufacturing and transportation sectors is significant for the whole time horizon. The reaction of construction gets significant after seven years and the reaction of the trade sector is significant from the sixth to the eighth year. In addition, the variance decompositions displayed in Table 3.5 reveal that shocks in domestic credit are of different importance for these sectors. Shocks in domestic credit explain 20.9%, 46.2%, 22.2%, 41.1% and 58.0% of the forecast error variance of the sectors agriculture, manufacturing, construction, transportation and trade. Against the backdrop of the existing literature, these findings have to be interpreted in two ways. First, the literature suggests that in emerging markets the tradable-goods-producing sectors do not rely on the domestic banking system as much as the sectors producing non-tradable goods while the former have other forms of financing (see Tornell and Westermann (2003)).[105] Firms in the tradable sectors are usual large and have access to other (international) capital markets while non-tradable-goods-producing firms tend to be smaller and to be more dependent on the domestic banking system.[106] Second, as reported by the literature, state-owned enterprises have better access to external finance and enjoy a preferential treatment as for instance lower interest

[105] As Tornell and Westermann (2003) refers to *middle-income countries*, the GNI per capita of China is shown in Section 3.A.4 in the appendix, indicating that today China ranks among the (upper) middle-income countries.

[106] In Section 3.A.6 in the appendix it is shown that only a few firms are listed and that the financing via international capital markets has been relatively small and constant over time.

rates are offered and fewer collateral is needed while non-state-owned enterprises face credit constraints and are discriminated against state-owned firms. In our analysis, agriculture and manufacturing are considered as tradable-goods-producing sectors.[107] But as Figure 3.3 and Table 3.5 present, both sectors are affected differently by unexpected shocks in domestic credit. While the impulse response function exhibits a relatively low reaction of agriculture and the variance decomposition is the smallest in case of agriculture, the reaction of the impulse response as well as the variance decomposition in case of manufacturing are obviously higher, indicating a stronger benefit of manufacturing compared to agriculture.

As reported in a study of the OECD (2009), in China, state-owned enterprises are not represented in the primary industry but small individual farmers. Therefore, the agricultural sector has to rely on other sources of funding because most of the formal credit is channeled to state-owned firms.[108] Turvey et al. (2010) point out that in particular informal loans as for instance loans from relatives and friends are widely used in the agriculture sector.[109] Furthermore, as primarily small individual farmers operate in the agriculture sectors as reported in Fan and Chan-Kang (2005), the access to other financial channels as borrowing on international capital markets or issuing equity is unlikely as well.

Again, the manufacturing sector in China is mainly characterized by small and medium-sized non-state-owned firms.[110] Figure 3.3 reveals that manufacturing is positively affected

[107] As reported in Piris (2010) for Argentina, using data on the 500 largest firms, these firms are concentrated in the agriculture and especially in the manufacturing sector. Yasar et al. (2011) report that firms in the agricultural and manufacturing sector of 80 countries used in the World Business Environment Survey tend to be larger compared to non-tradable-goods-producing firms.

[108] Furthermore, in the study of the OECD (2004), it is reported that only 16% of all farmers have access to formal bank credit.

[109] The poor access of SME to formal credit has been recognized by the government and efforts to improve this drawback have been set up. Tsai (2004) states that especially microfinance was used in rural China in order to substitute informal finance, but with only little success as the rural needs are not met. Additionally, crowding-out of labor from agriculture to other non-agricultural sectors as well as from rural to urban regions is often found in emerging markets and reported for instance in Deininger et al. (2012) for China, potentially explaining the very low point estimation.

[110] In National Bureau of Statistics of China (2012) it is reported that 37,882,700 million domestic funded enterprises operate in the manufacturing sector. 27,325,900 million of them (72.13%) are privately owned

by bank credit. In addition, in Table 3.5 it is reported that 46.2% of the forecast error variance is explained by domestic credit. Therefore, this may indicate that the reformation of the banking system eliminates the discrimination of small, private-owned enterprises as the manufacturing sector - where especially small and privately owned enterprises are involved - depends on the domestic banking system and benefits from domestic credit enlargements.

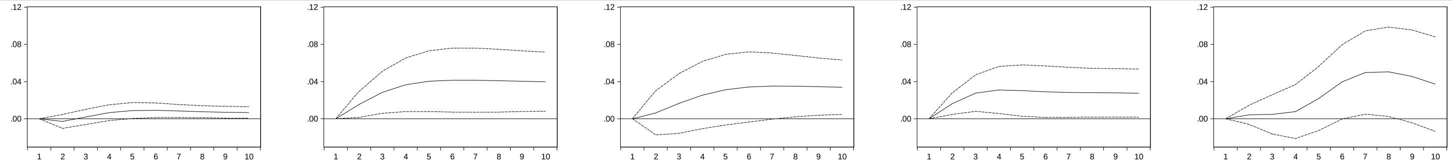
Hence, both tradable-goods-producing sectors - agriculture and manufacturing - seem to differ from the tradable sectors of other emerging and middle-income countries, as in both sectors mainly small and medium-sized enterprises exist. Therefore, the small reaction of agriculture is likely due to the credit constraint of small and medium-sized enterprises, which apparently still exists even after the restructuring of the banking system.

In contrast, the credit constraints of firms in the manufacturing sector - recognized as important economic support and growth engine - are seemingly negotiated as bank lending exerts positive effects on the output of manufacturing. Therefore, our findings support both arguments, first, non-tradable-goods-producing firms rely more on the domestic banking system and second, state-owned enterprises use bank credit more extensively supposable because they enjoy preferential treatment while non-state-owned firms face domestic credit constraints.

contributing 41.9% to the gross industrial output value. Remember, these numbers refer to exclusive private-owned enterprises and neglect mixed ownerships. Therefore, the share of state-owned enterprises is likely to be even smaller. Furthermore, 40,622,400 million small (89.70%), 4,290,600 million medium-sized (9.47%), and 374,200 million large enterprises (0.83%) are reported (these numbers also includes enterprises with funds from Hong Kong and foreign funded enterprises). We follow Tornell and Westermann (2003) and classify manufacturing as tradable-goods-producing sector due to the typically high export share in this sector although large firms are rare.

Figure 3.3: Impulse Responses for Sectoral Output and Domestic Credit

Reaction of A to a shock in DC	Reaction of MF to a shock in DC	Reaction of C to a shock in DC	Reaction of TR to a shock in DC	Reaction of T to a shock in DC



Note: The solid lines trace the impulse responses of the sectoral output of agriculture (A), manufacturing (MF), construction (C), transportation (TR) and trade (T) to a shock in domestic credit (DC). The dashed lines show the asymptotic standard errors.

Table 3.5: Variance Decomposition for Sectoral Output and Domestic Credit

Period	A due to DC	MF due to DC	C due to DC	TR due to DC	T due to DC
5	9.841	30.874	8.610	36.523	7.492
	[9.666]	[17.760]	[10.623]	[19.109]	[13.157]
10	20.880	46.160	22.223	41.120	57.984
	[16.001]	[23.343]	[17.609]	[22.528]	[22.356]

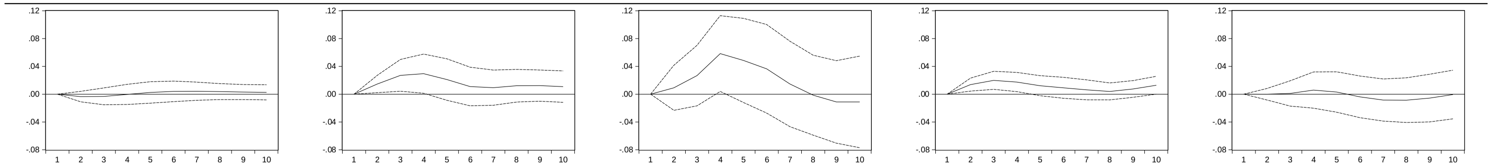
Note: The variance decomposition (in percent) is shown for the sectoral output of agriculture (A), manufacturing (MF), construction (C), transportation (TR) and trade (T). The values indicate the share of the forecast error variance that is due to a shock in domestic credit (DC). The values in parentheses represent the standard deviation.

As Figure 3.4 and Table 3.6 show, the reported results are largely robust to a different classification of bank lending. Using domestic loans referring to the amount of loans borrowed from domestic banks and non-bank financial institutions to invest in fixed assets, a comparable pattern arises. It is shown that the manufacturing, construction and transportation sector reacts significant to a standard shock in domestic loans. This also applies to the variance decompositions. Domestic loans explains 19.0%, 28.3% and 39.6% of the forecast error variance of these sectors. In this case, agriculture as well as the trade sector do not benefit from domestic loans enlargement.

After all, this analysis shows that mainland China differs from other emerging markets. It is revealed that it is less important whether a sector ranks among the tradable-goods or non-tradable-goods-producing sectors - suggesting that in the tradable sector the firms tend to be larger and are able to raise capital different from bank lending while non-tradable-goods-producing firms are small and credit-constrained - but if mainly state-owned enterprises or private-owned firms exist in the particular sector.[111] It is well known that bank credit is particular channeled to state-owned enterprises strengthening the prevailing credit constraint of small and medium-sized enterprises. The institutional reforms of the state-owned sector imply that especially the small and medium-sized enterprises are allowed to become private. Nevertheless, recent reforms of the banking system seem to originate a more efficient banking sector as also manufacturing - a sector with predominantly small firms - benefits from bank lending enlargement.

[111] In section 3.A.3 in the appendix, further information on the construction sector are given. Additionally, we are able to analyze the effects of domestic bank lending on the gross output value with a breakdown by the contribution of state-owned and privately owned enterprises. Using both measures, the gross output value generated by private firms does not react significant on an unexpected shock in bank lending while the reaction of the gross output value generated by state-owned enterprises is positive and significant. The variance decomposition largely supports these results.

Figure 3.4: Impulse Responses for Sectoral Output and Domestic Loans



Note: The solid lines trace the impulse responses of the sectoral output of agriculture (A), manufacturing (MF), construction (C), transportation (TR) and trade (T) to a shock in domestic loans (DL). The dashed lines show the asymptotic standard errors.

Table 3.6: Variance Decomposition for Sectoral Output and Domestic Loans

Period	A due to DL	MF due to DL	C due to DL	TR due to DL	T due to DL
5	1.329	21.598	47.975	43.645	0.474
	[7.391]	[14.261]	[21.265]	[17.854]	[6.281]
10	2.480	19.040	28.267	39.611	1.198
	[12.156]	[14.689]	[21.400]	[18.975]	[7.744]

Note: The variance decomposition (in percent) is shown for the sectoral output of agriculture (A), manufacturing (MF), construction (C), transportation (TR) and trade (T). The values indicate the share of the forecast error variance that is due to a shock in domestic loans (DL). The values in parentheses represent the standard deviation.

3.7 Conclusion

The impact of bank lending on economic as well as on sectoral growth in China is analyzed in this chapter. Using impulse response functions and variance decompositions, we report that shocks in bank lending affect economic growth via two channels - directly as well as indirectly through investment. Furthermore, we analyze the dependency structure of the different sectors of China in light of a subdivision into state-owned or privately owned sectors. In general, it is revealed that the sectors with a huge participation of the state - particularly construction and transportation - are affected by bank lending enlargements. In contrast, the sectors where mainly small and private-owned firms operate - particularly agriculture - react insignificant or only to a minor degree on bank lending enlargements. One exception is manufacturing. Although it largely consists of small and medium-sized enterprises which are usually under private ownership, it benefits from shocks in bank lending. This may indicate that the restructuring of the banking system has been successful. Although mainly small enterprises operate in this sector, the manufacturing sector is affected positively by bank lending enlargements. This result maintains whether *domestic credit* provided by the banking system or *domestic loans* as source of funds for investment in fixed assets are used.

Sectoral asymmetries with regard to financial facilities has become a stylized fact in this context as for instance stated in Catão and Rodriguez (2000) and Krueger and Tornell (1999). The non-tradable-goods-producing sectors are primarily reliant on the domestic banking system and have little or no access to (international) capital markets while the tradable-goods-producing sectors are able to use sources different from bank lending. In case of China, furthermore the specific institutional characteristic that state-owned enterprises have better access to domestic bank credit while private-owned firms are largely excluded from bank lending has to be taken into account. In addition, the ongoing trend to privatize state-owned enterprises, especially expedited in 1995, supports the fact that in China it is less important if a firm belongs to the tradable- or non-tradable-goods-producing sector. It is more important whether the firm is under private or state ownership as state-owned enterprises benefit from preferential treatment in bank lending. In the course of reformations, especially the small state-owned firms are allowed to get private or to go bankrupt while the large state-owned firms are reinforced, still under the control of the local or central government increasing the asymmetries between small and larger firms' access to domestic lending.[112] The fact that large (tradable-goods-producing) firms are less credit-constrained than small (non-tradable-goods-producing) firms is emphasized through the privatization of small state-owned firms, leading to a worsening of the already existing credit constraints. Nevertheless, it is expected that further reforms and liberalizations in the financial sector enhance China's economic development and growth in the future.

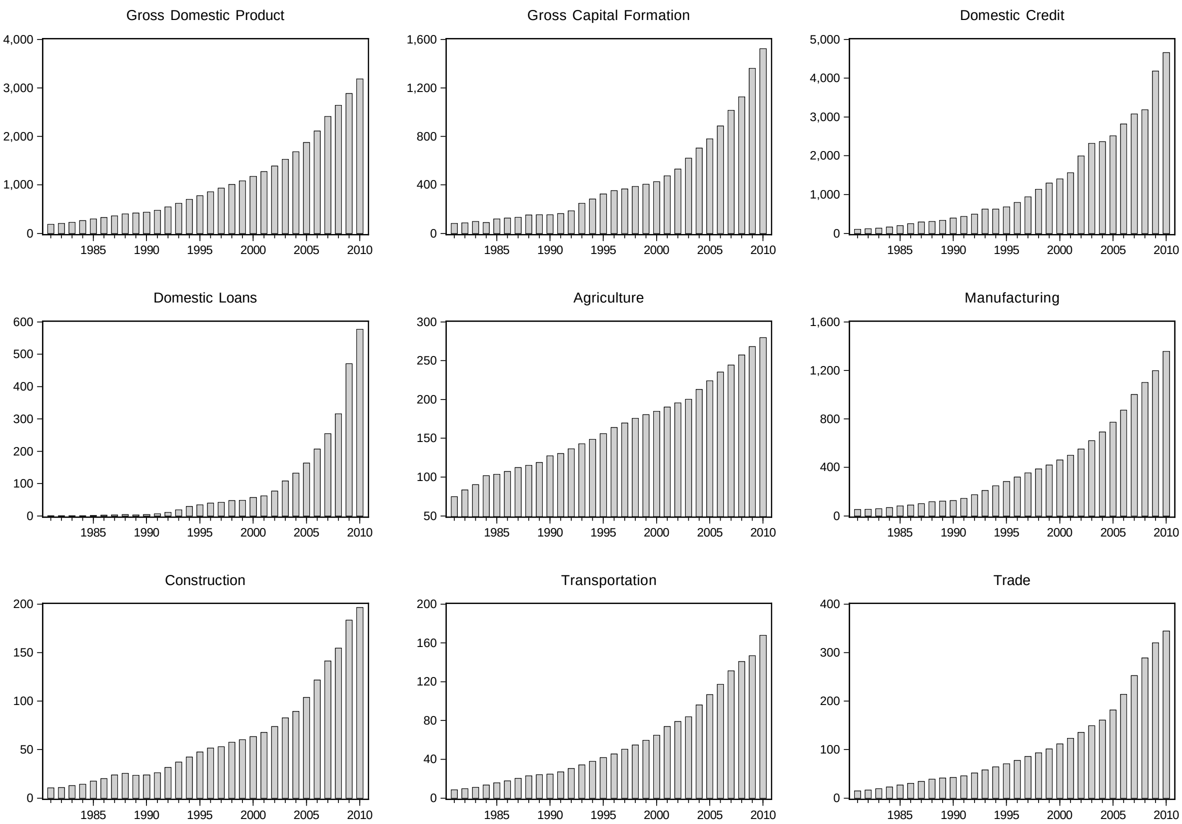
As knowledge about the causal connections is important for development strategies in China and other emerging and middle-income countries, further research should focus on provincial data. Differences between coastal and interior provinces should be expected. Additionally, a distinguishing between the different kinds of banks as well as an incorporation of stock markets, bond markets, informal financial institutions or arrangement seems to be useful in order to gain deeper insights in the sectoral dependency structure of mainland China.

[112]See for instance Cao et al. (1999) for further information.

3.A Appendix

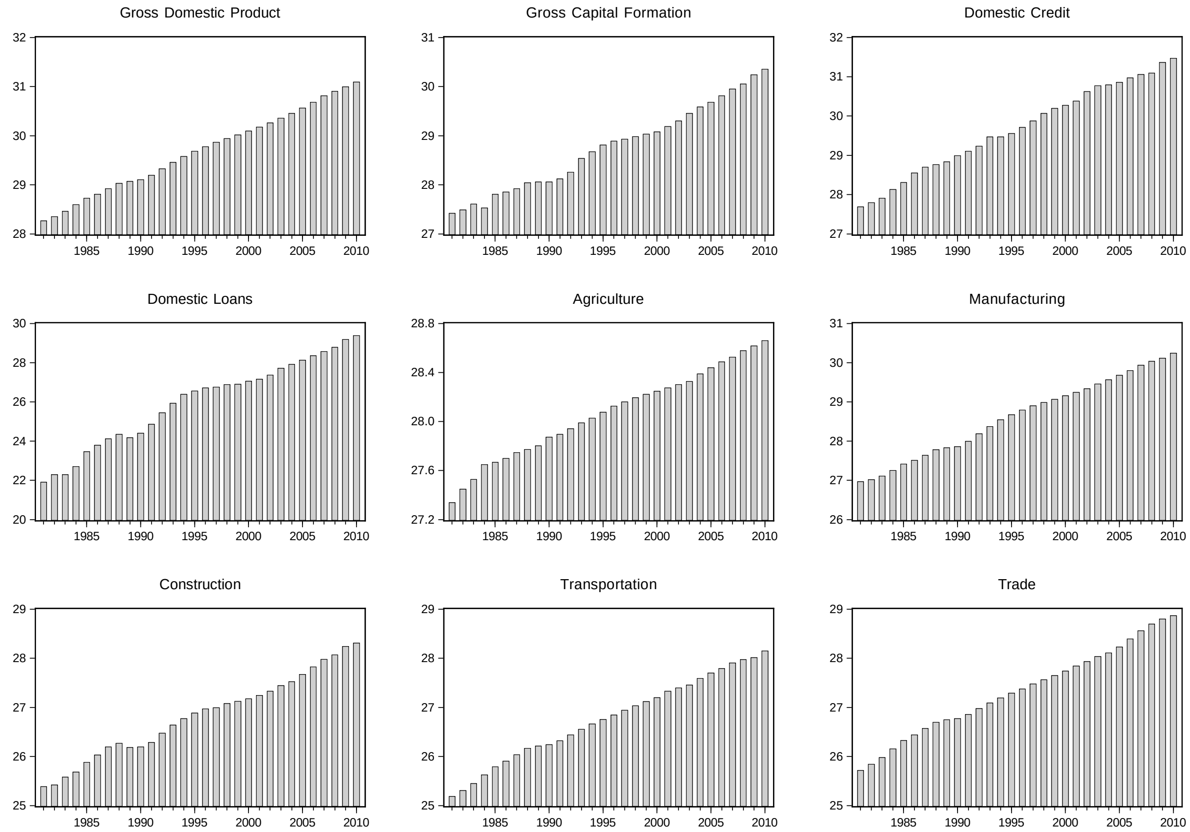
3.A.1 Output, investment and bank lending

Figure 3.5: Development of Sectoral Output and Bank Lending Variables (in levels)



Note: The graphs of all variables are shown (in 10 billion Chinese Yuan and in constant 2005 prices). The years 1981 to 2010 are considered.

Figure 3.6: Development of Sectoral Output and Bank Lending Variables (in logs)



Note: The graphs of all variables in log levels are shown. The years 1981 to 2010 are considered.

3.A.2 Other sources of investment in fixed assets

In this section, we use a different approach to analyze additional sources of funds for investment in fixed assets. Next to domestic loans - used in the main part - we additionally employ the variables *foreign investment (FI)*, *self-raised funds (SRF)* and *state budget appropriation (SBA)*.[113] The application of these variables is prominent in the literature and has also been done for instance by Allen et al. (2005), Liu and Li (2001), Li and Liu (2001) and Guariglia and Poncet (2008). Allen et al. (2005) use the sources of investment in fixed assets to explain private, listed and state sector growth, concluding that especially the private sector grows faster than the other sectors as they use alternative financing channels. Liu and Li (2001) use provincial data and present that the growth of provincial output is positively related to the growth of domestic loans and self-raised funds. Furthermore, they report that state budget appropriation is still a significant source of funds for investment in contrast to foreign investment. Chen et al. (2011) argue that Chinese growth has enhanced by the substitution of loans for state budget appropriation but not by loan expansion.

Additionally, the role of foreign direct investment (FDI) is often discussed in the literature. Most authors highlight a positive impact of foreign direct investment on economic growth (see for instance Jun et al. (2007) and Yao (2006)). Duenwald and Aziz (2003) further state that FDI plays a significant role in the Chinese growth process. A differentiation of developed and developing countries can be found in Li and Liu (2005), reporting that in developing countries, FDI promotes economic growth. Liu et al. (2002) analyze this relation for China

[113] Foreign investment refers to foreign funds in fixed assets. These foreign funds are borrowed and managed by the government and by individual units. It includes foreign funds in joint ventures as well. Self-raised funds includes retained earnings, bonds and shares sold to the employees of the firm and funds from supervising agencies. State budget appropriation refers to projects specified in the state investment plan which are mainly financed through state budget appropriation. It refers to the appropriation in the budget of the central and local governments applied for capital construction and innovation projects and comprise additionally the transfer funds to banks and loan issues for capital construction projects. The data are published in National Bureau of Statistics of China (2012).

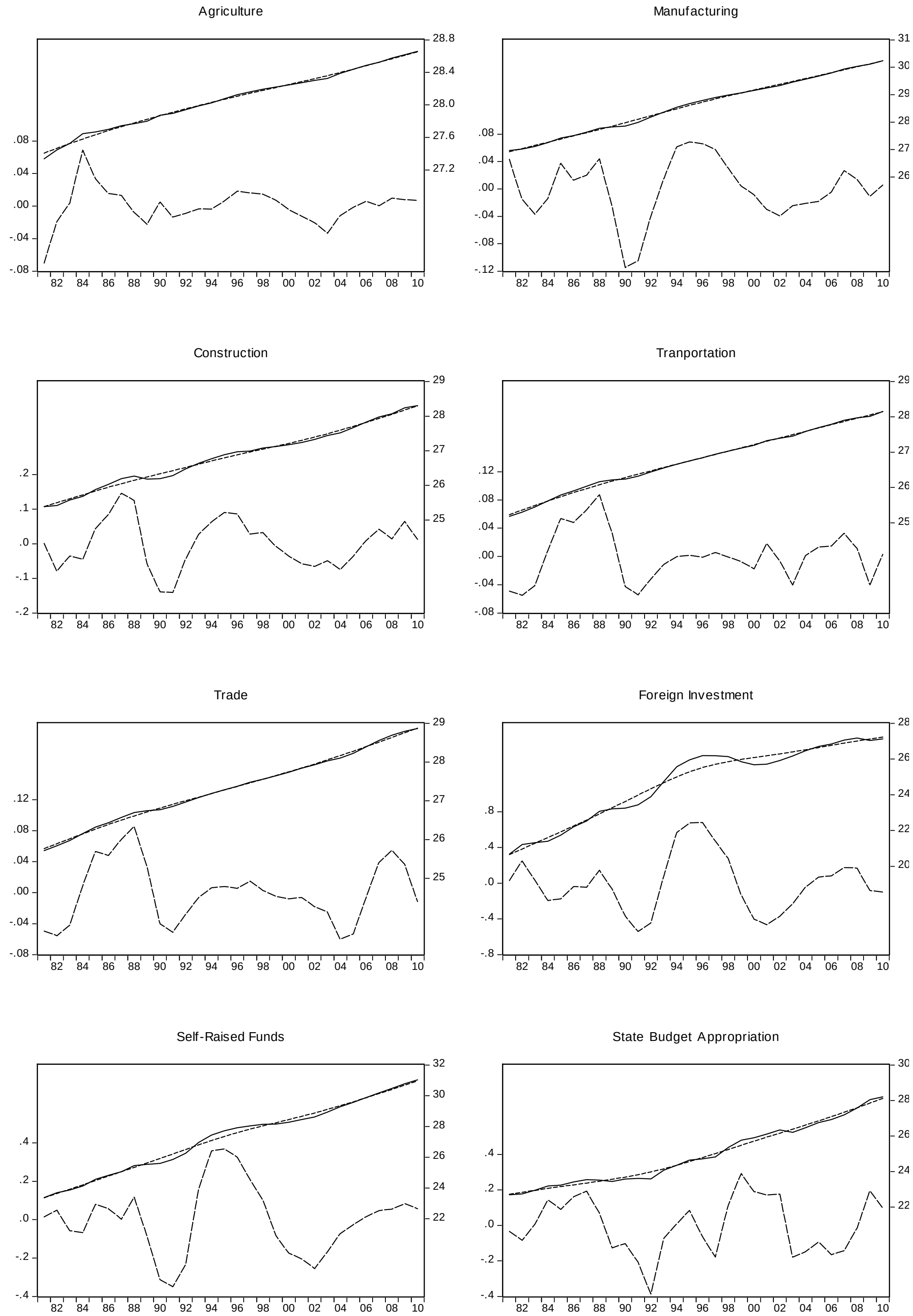
and find bi-directional causality between economic growth, FDI and exports within a long run cointegration framework.

The importance of these financing instruments has been highlighted in a plurality of studies not only for China but also in general (see for instance the recent study of Buera et al. (2011)). Additionally, using these variables is of particular interest in this context as these variables typify other sources of finance. In this section, we detrend our variables using the Hodrick-Prescott filter and apply accumulated impulse responses with Cholesky decomposition on the stationary cycles of the variables.[114]

In Figure 3.7, the original time series as well as the Hodrick-Prescott (HP) trends and cycles of all variables are displayed. In Table 3.7 the results of the augmented Dickey-Fuller test are presented, indicating that the cycles of the variables are stationary at least at the 10% significance level.

[114] We are not able to include these variables in the analysis reported in the main part as the cointegration characteristics are not as straightforward as in the main part. In the further course of this analysis, *accumulated impulse responses* are used due to a better comparability with the impulse responses presented in the main part where pairs of cointegrated non-stationary (I(1)) variables are used.

Figure 3.7: Graphs, Hodrick-Prescott Trends and Cycles



Note: The graphs of the variables (constant lines) and HP trends (dashed lines) are displayed in the upper part of each figure and refer to the right axis. In the lower parts, the HP cycles are shown (left axis). Lambda is defined as 100.

Table 3.7: Results of ADF Tests for the Hodrick-Prescott Cycles

Variable	Levels	
	ADF	Prob.
Agriculture	-3.268**	0.029
Manufacturing	-3.746***	0.009
Construction	-4.012***	0.005
Transportation	-3.962***	0.005
Trade	-5.087***	0.000
Foreign Investment	-4.454***	0.002
Self-Raised Funds	-3.816***	0.007
State Budget Appropriation	-2.670*	0.091

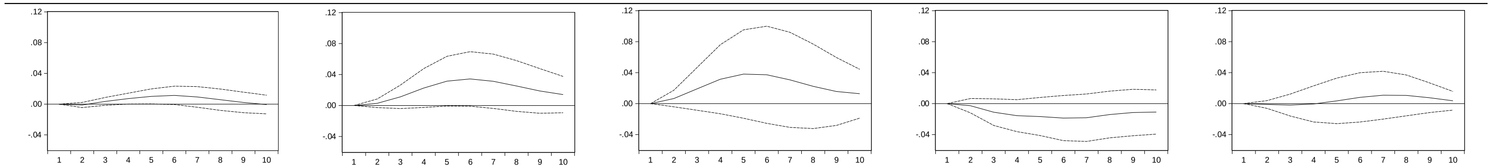
Note: The ADF test (allowing for an intercept) is calculated for the levels of the Hodrick-Prescott cycles of agriculture (A), manufacturing (MF), construction (C), transportation (TR), trade (T), foreign investment (FI), self-raised funds (SRF) and state budget appropriation (SBA). The lag length is selected by the Schwarz information criterion. *** (**,*) indicates significance at the 1% (5%, 10%) level.

Figure 3.8 and Table 3.8 report that solely the tradable-goods-producing sectors agriculture and manufacturing benefit from foreign investment enlargement. Agriculture shows significance after three years which lasts for three years and the manufacturing sector reacts after the fifth year. The variance decompositions show that 53.0% and 19.5% of the forecast error variances are explained after ten years. The variance decompositions of the other sectors are substantially smaller. This result shows that only the tradable-goods-producing sectors are using foreign investment effectively. Thus, as the agriculture sector is generally credit-constrained and does not benefit or benefits only to a minor degree from bank lending enlargement, it is shown that foreign investment is an effective source of finance.[115]

[115] This is also stated in Duenwald and Aziz (2003). Note, Broadman and Sun (1997) among others highlight that there are large geographical and sectoral disparities, as on the one hand, FDI has concentrated especially in the coastal regions and, on the other hand, in the real estate sector.

Figure 3.8: Accumulated Impulse Responses for Sectoral Output and Foreign Investment

Reaction of A to a shock in FI	Reaction of MF to a shock in FI	Reaction of C to a shock in FI	Reaction of TR to a shock in FI	Reaction of T to a shock in FI



Note: The solid lines trace the accumulated impulse responses of the sectoral output of agriculture (A), manufacturing (MF), construction (C), transportation (TR) and trade (T) to a shock in foreign investment (FI). The dashed lines show the asymptotic standard errors. The HP cycles of the variables are used.

Table 3.8: Variance Decomposition for Sectoral Output and Foreign Investment

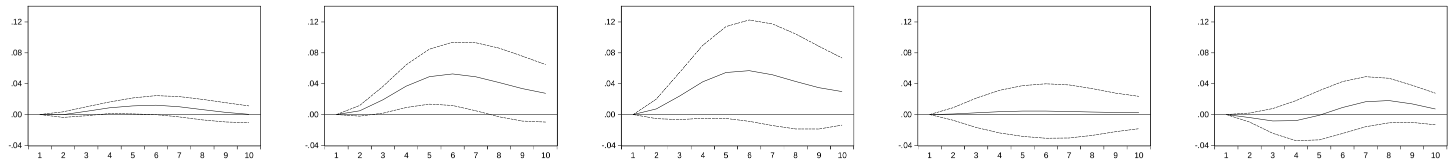
Period	A due to FI	MF due to FI	C due to FI	TR due to FI	T due to FI
5	41.129	15.980	7.945	10.146	1.438
	[14.299]	[12.919]	[9.060]	[12.700]	[7.518]
10	53.002	19.540	9.874	10.564	4.347
	[15.196]	[15.287]	[10.830]	[13.374]	[10.272]

Note: The variance decomposition (in percent) is shown for the sectoral output of agriculture (A), manufacturing (MF), construction (C), transportation (TR) and trade (T). The values indicate the share of the forecast error variance that is due to a shock in foreign investment (FI). The values in parentheses represent the standard deviation. The HP cycles of the variables are used.

Figure 3.9 and Table 3.9 show the sectoral reactions to a shock in self-raised funds. Self-raised funds are used to indicate the need and the usage of refinancing strategies. It is shown that again the tradable-goods-producing sectors agriculture and manufacturing benefit significantly from a shock in this financing instrument. The accumulated impulse response functions reveal a positive and significant reaction from the fourth to the sixth year in case of agriculture and from the third to the eighth year in case of manufacturing.[116] 50.8% and 40.0% of the forecast error variance is explained in these cases after ten years while the variance decompositions of construction, transportation and trade are substantially smaller. Again, especially the agricultural sector benefits from this financing strategy. This is in line with our hypothesis that agriculture has to rely on different sources of finance as it is largely excluded from formal bank credit.

[116] Chow and Fung (1998) report that in Shanghai's manufacturing sector, especially private firms are reliant on internal funds than state-owned firms although private firms are more efficient and have better investment prospects.

Figure 3.9: Accumulated Impulse Responses for Sectoral Output and Self-Raised Funds



Note: The solid lines trace the accumulated impulse responses of the sectoral output of agriculture (A), manufacturing (MF), construction (C), transportation (TR) and trade (T) to a shock in self-raised funds (SRF). The dashed lines show the asymptotic standard errors. The HP cycles of the variables are used.

Table 3.9: Variance Decomposition for Sectoral Output and Self-Raised Funds

Period	A due to SRF	MF due to SRF	C due to SRF	TR due to SRF	T due to SRF
5	38.089	37.290	16.396	0.445	6.575
	[13.045]	[16.769]	[14.726]	[9.327]	[10.556]
10	50.819	40.008	18.129	0.519	18.478
	[14.152]	[16.965]	[15.754]	[11.759]	[15.873]

Note: The variance decomposition (in percent) is shown for the sectoral output of agriculture (A), manufacturing (MF), construction (C), transportation (TR) and trade (T). The values indicate the share of the forecast error variance that is due to a shock in self-raised funds (SRF). The values in parentheses represent the standard deviation. The HP cycles of the variables are used.

Now, the variable state budget appropriation is used in order to indicate which sector benefits the most from central and local governmental efforts for capital construction and innovative projects. Figure 3.10 and Table 3.10 show that only manufacturing benefits from the state budget appropriation. The reaction is positive and significant in the first year after a shock in state budget appropriation has occurred. The variance decomposition reaches 20.6% explanation after ten years.

After all, it is revealed that alternative sources of investment in fixed assets are of different importance for the different sectors. It is notable that solely the tradable-goods-producing sectors agriculture and manufacturing react on these different sources. It seems that the non-tradable-goods-producing firms only rely on domestic bank credit. Especially foreign investment and self-raised funds are important for the agriculture and manufacturing sector while construction, trade and transportation are insignificant using all three variables.[117] This is consistent with the result that state-owned enterprises have better access to domestic bank lending while private firms are credit-constrained and have to rely on other financing strategies.[118] Thus, our analysis indicates that the non-tradable-goods-producing sectors are more dependent on the domestic banking sector while the tradable-goods-producing sectors have other forms of financing available.[119]

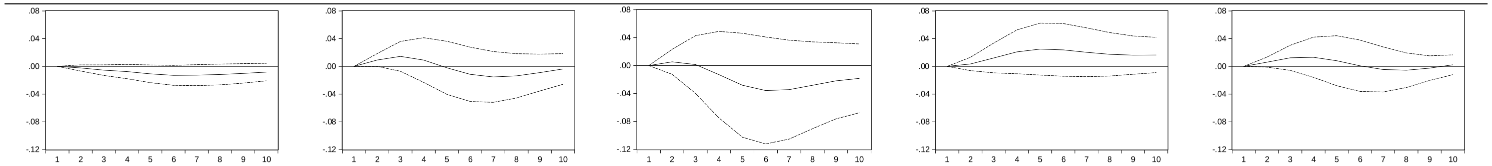
[117] In general a positive contribution of FDI on economic growth is highlighted in the literature, see Yao (2006) among others. Additionally, especially in developing and emerging countries, FDI brings new technology and international business practices to the recipient country. Nevertheless, Yu et al. (2010) note that the opening of the Chinese economy to FDI is still an ongoing process.

[118] As reported already in the main part, manufacturing is notable in this context as it relies on bank credit although mainly small, privately owned firms exists.

[119] The existence of effective alternative financing channels supporting growth is often reported for the private sector in China. In Allen et al. (2005) it is stated that bank loans and self-raised funds are the most important sources of finance.

Figure 3.10: Accumulated Impulse Responses for Sectoral Output and State Budget Appropriation

Reaction of A to a shock in SBA	Reaction of MF to a shock in SBA	Reaction of C to a shock in SBA	Reaction of TR to a shock in SBA	Reaction of T to a shock in SBA



Note: The solid lines trace the accumulated impulse responses of the sectoral output of agriculture (A), manufacturing (MF), construction (C), transportation (TR), and trade (T) to a shock in state budget appropriation (SBA). The dashed lines show the asymptotic standard errors. The HP cycles of the variables are used.

Table 3.10: Variance Decomposition for Sectoral Output and State Budget Appropriation

Period	A due to SBA	MF due to SBA	C due to SBA	TR due to SBA	T due to SBA
5	21.703	16.231	9.116	13.508	8.661
	[15.311]	[14.499]	[11.524]	[13.899]	[11.941]
10	26.287	20.623	10.821	14.729	13.102
	[17.254]	[16.595]	[12.660]	[15.961]	[15.087]

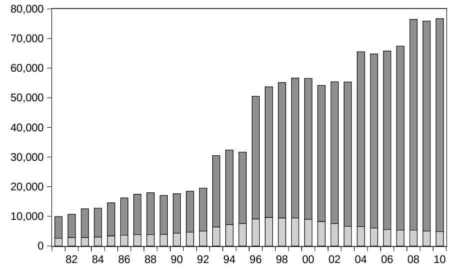
Note: The variance decomposition (in percent) is shown for the sectoral output of agriculture (A), manufacturing (MF), construction (C), transportation (TR) and trade (T). The values indicate the share of the forecast error variance that is due to a shock in state budget appropriation (SBA). The values in parentheses represent the standard deviation. The HP cycles of the variables are used.

3.A.3 Data on the construction sector

To strengthen our hypothesis that private-owned firms are credit-constrained while state-owned firms rely on formal bank credit, a more detailed analysis of construction is given in this section.[120] Figure 3.11, 3.12 and 3.13 display the development of the number of enterprises as well as the growth rates from 1981 to 2010 in the construction sector. Strong increases are revealed in 1993 and 1996. The number of state-owned enterprises peak out in 1997 and declines subsequently. Similar patterns are shown in Figure 3.14, 3.15 and 3.16. There, the number of employed persons - in total and in the state-owned firms - as well as the growth rates are shown. The total number increased almost fourfold between 1981 and 2010. The highest number of employed persons in the state-owned enterprises was reached in the year 1996, reducing substantially until 2010. Figure 3.17, 3.18 and 3.19 display the gross output values and the growth rates, indicating decreasing relevance of the state-owned firms. Interpreting these graphs one should bear in mind that the contribution of state-owned enterprises to the number of firms and employees as well as to the gross output value is heavily underestimated as we are only able to report the data for fully state-owned firms and thereby neglect firms with mixed ownerships.[121]

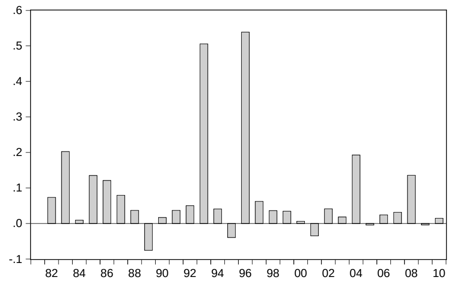
[120]Only for construction, reliable data on the number of enterprises and employed persons as well as the gross output value dissected by state-owned and private-owned firms is provided.
[121]The data are reported by the National Bureau of Statistics of China (2012).

Figure 3.11: Number of Enterprises - in Total and State-Owned Enterprises



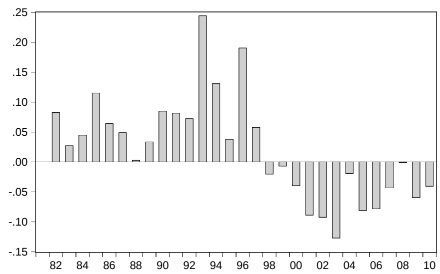
Note: The dark gray bars indicate the total number of enterprises while the light gray bars show the number of state-owned enterprises. The years 1981 to 2010 are considered.

Figure 3.12: Growth Rate of the Number of Enterprises



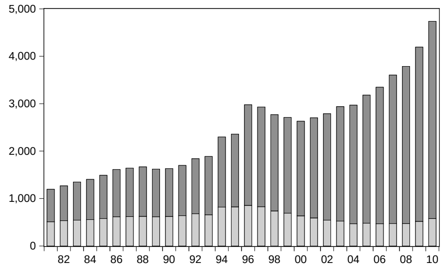
Note: The growth rate of the total number of enterprises are shown. The years 1981 to 2010 are considered.

Figure 3.13: Growth Rate of the Number of State-Owned Enterprises



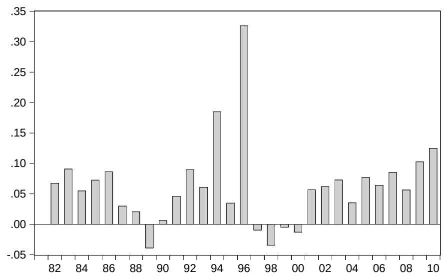
Note: The growth rate of the total number of state-owned enterprises is shown. The years 1981 to 2010 are considered.

Figure 3.14: Number of Employed Persons - in Total and in State-Owned Enterprises



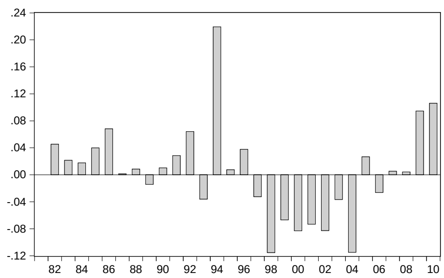
Note: The dark gray bars indicate the total number of employees while the light gray bars show the sum of employees in state-owned enterprises (in 10,000 persons). The years 1981 to 2010 are considered.

Figure 3.15: Growth Rate of Employed Persons



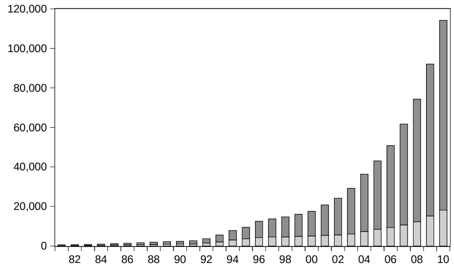
Note: The growth rate of the total number of employed persons is shown. The years 1981 to 2010 are considered.

Figure 3.16: Growth Rate of the Persons Employed in State-Owned Enterprises



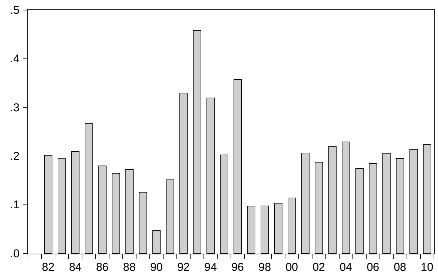
Note: The growth rate of the number of employed persons in state-owned enterprises is shown. The years 1981 to 2010 are considered.

Figure 3.17: Gross Output Value - in Total and by State-Owned Enterprises



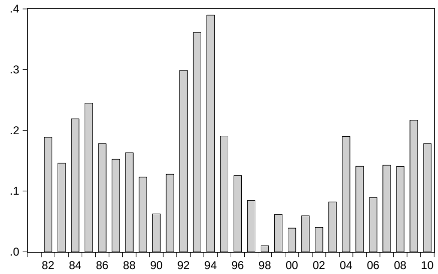
Note: The dark gray bars indicate the total gross output value while the light gray bars indicate the gross output value produced by state-owned enterprises (in 100 million Chinese Yuan). The years 1981 to 2010 are considered.

Figure 3.18: Growth Rate of the Gross Output Value



Note: The growth rate of the total gross output value is shown. The years 1981 to 2010 are considered.

Figure 3.19: Growth Rate of the Gross Output Value generated by State-Owned Enterprises



Note: The growth rate of the gross output value produced by state-owned enterprises is shown. The years 1981 to 2010 are considered.

Now, we are using the gross output value of construction in total as well as of state-owned enterprises as well as the difference of both as indicator of the gross output value generated by private firms. Again, the distinction of state-owned and privately owned firms is somewhat incorrect as firms with mixed ownerships rank in the private sector. Nevertheless, the impulse responses and variance decompositions in Figure 3.20 and panel A of Table 3.11 strengthen our argument that private firms are credit-constrained while state-owned firms have better access to formal bank credit.[122] This also applies when domestic loans is used, see Figure 3.21 and panel B of Table 3.11. Using both, domestic credit and domestic loans, the impulse responses show that the gross output value of construction in total reacts positive and significant to a shock in bank lending. In the first case, the impulse response function is significant after eight years and in the second case, the impulse response shows statistical significance for the first three years. The variance decomposition reveals that after ten years, domestic credit explains 18.9% and domestic loans 16.7% of the forecast error variance. Considering the gross output value of state-owned enterprises in the VAR, the impulse responses react positive and significant in both cases using domestic credit as well as domestic loans. In the first case, the impulse response function gets significant after the third year while in the second case, the impulse response is significant for the first four years. Additionally, 41.2% and 33.4% of the forecast error variances are explained after ten years. The hypothesis that that state-owned enterprises benefit from bank lending enlargements is valid at least in the construction sector.

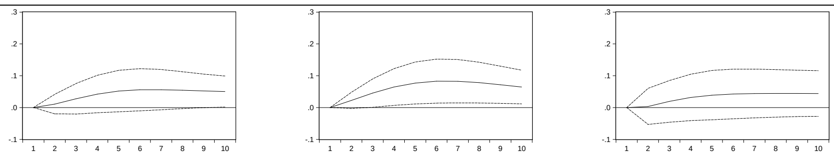
Using the difference of total gross output values and the gross output value of state-owned enterprises as indicator of the gross output value that is generated by privately owned firms, the impulse responses are insignificant regardless of which bank lending variable - domestic

[122] The used variables are non-stationary in levels but stationary in first differences at least at the 5% significance niveau. Furthermore, the pairs are cointegrated applying the approach of Johansen (1991).

credit or domestic loans - is used. But in the latter case, the variance decomposition indicates 31.6% explanation after ten years. However, these results support our hypothesis made in the main part that privately owned enterprises (in the construction sector) are credit-constrained while state-owned enterprises benefit from bank lending enlargement.

Figure 3.20: Impulse Responses for Gross Output Values in the Construction Sector and Domestic Credit

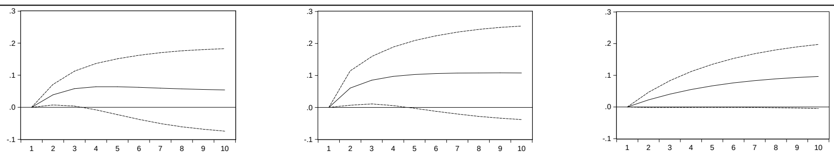
Reaction of TGOV to a shock in DC	Reaction of SOE to a shock in DC	Reaction of POE to a shock in DC



Note: The solid lines trace the impulse responses of the total gross output value of construction (TGOV) as well as the (approximated) gross output values generated by state-owned (SOE) and privately owned enterprises (POE) to a shock in domestic credit (DC). The dashed lines show the asymptotic standard errors.

Figure 3.21: Impulse Responses for Gross Output Values in the Construction Sector and Domestic Loans

Reaction of TGOV to a shock in DL	Reaction of SOE to a shock in DL	Reaction of POE to a shock in DL



Note: The solid lines trace the impulse responses of TGOV as well as the (approximated) gross output values generated by SOE and POE to a shock in DL. The dashed lines show the asymptotic standard errors.

Table 3.11: Variance Decomposition for Gross Output Values in the Construction Sector

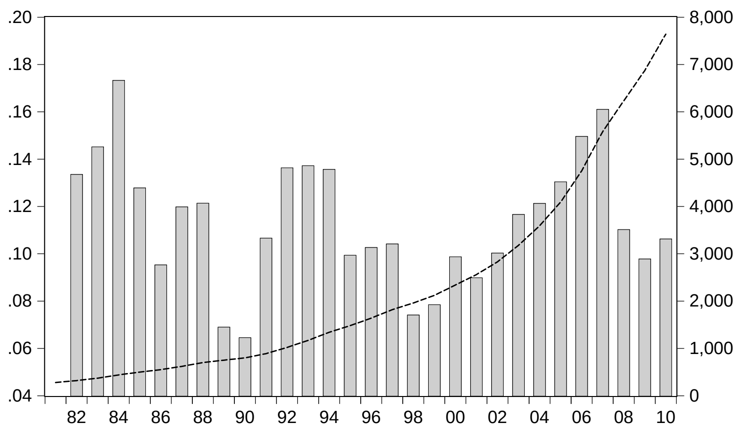
	Panel A			Panel B		
Period	TGOV due to DC	SOE due to DC	POE due to DC	TGOV due to DL	SOE due to DL	POE due to DL
5	8.859	20.162	3.345	16.846	27.239	12.996
	[10.549]	[16.194]	[8.629]	[17.490]	[17.805]	[12.084]
10	18.911	41.225	8.493	16.654	33.431	31.573
	[17.341]	[18.671]	[15.720]	[23.253]	[22.176]	[21.166]

Note: The variance decomposition (in percent) is shown for TGOV as well as the gross output values generated by SOE and POE. Panel A shows the share of the forecast error variance that is due to a shock in DC while in panel B DL is used. The values in parentheses represent the standard deviation.

3.A.4 Gross national income in China

As our interpretation follows the argumentation of Tornell and Westermann (2003), who show that (small) firms producing non-tradable goods are more dependent on domestic bank lending while (large) firms producing tradable-goods have other sources of finance in middle-income countries (MICs), we present in Figure 3.22 the gross national income (GNI) per capita for China to classify its income stage. As suggested by the World Bank, lower MICs are countries with a GNI per capita between \$1,006 and \$3,975 and upper MIC exhibit a GNI per capita between \$3,976 and \$12,275. As Figure 3.22 reports, China reaches the level of a lower MIC in 1992 and of an upper MIC in 2005.[123] Additionally, the growth rates of the GNI per capita are shown.

Figure 3.22: GNI per Capita (in level data and in growth rates)



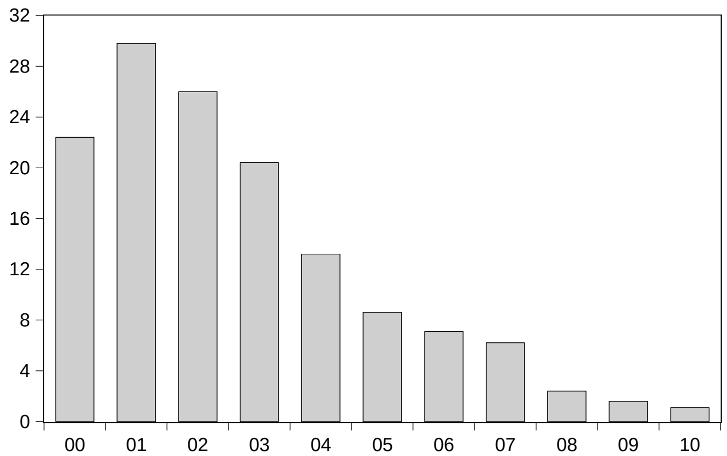
Note: The line indicates the GNI per capita in current US\$ for China (right axis) while the bars indicate the growth rate of the GNI per capita (left axis). The years 1981 to 2010 are considered.

[123] Data are reported by the World Bank (2012).

3.A.5 Non-performing loans

As reported in the main part, one of the heaviest problem in Chinese banking system is the bad performance of the predominant state-owned banks, especially within the *Big Four*. One great burden resulting from this inefficiency is the huge amount of non-performing loans (NLP). The reduction of them has become a key challenge for the Chinese government. Figure 3.23 displays that the amount of NLP decreased substantially from 2000 to 2010.[124]

Figure 3.23: Ratio of Non-Performing Loans to Total Gross Loans (in percent)



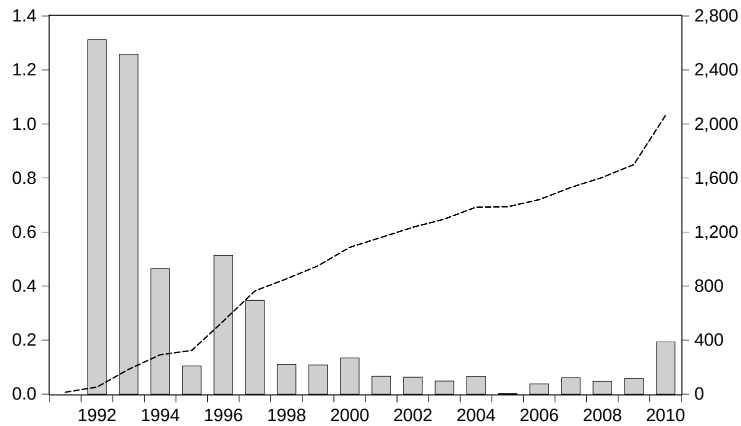
Note: The bars indicate the amount of non-performing bank loans to total gross loans in percent. The years 2000 to 2010 are considered.

[124]Non-performing loans are loans which are classified as substandard, doubtful or lost. The data are reported by the World Bank (2012).

3.A.6 Financial facilities

One key argument in the interpretation of the two-sector growth model proposed by Schneider and Tornell (2004) is that large firms producing tradable-goods have other sources of finance available. As example for a different financing instrument, the number of listed Chinese firms in total are displayed in Figure 3.24. It is indicated that the amount of firms listed on a stock exchange rises steadily but the total value as well as the growth rates are very small especially since 1997. Figure 3.25 shows the market capitalization and the growth rates. Information about the associated sectors of the listed firms are not available.

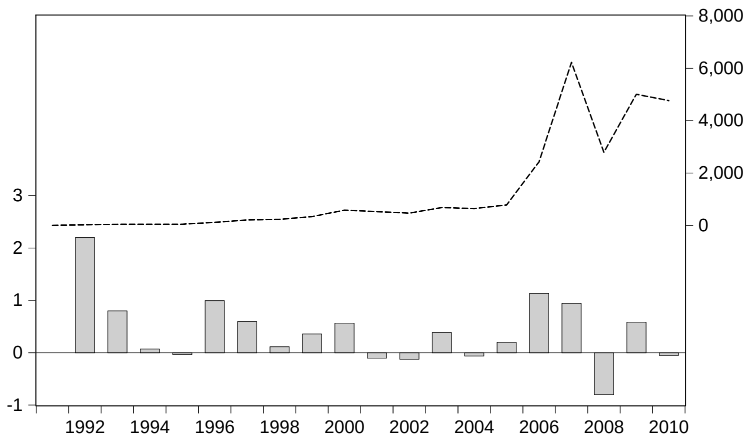
Figure 3.24: Listed Chinese Companies (in total)



Note: The line indicates the amount of the listed Chinese companies in total (right axis). The bars indicate the growth rate (left axis). The years 1991 to 2010 are considered.

Figure 3.26 and 3.27 show the financing via the international capital markets in absolute values and in percent of the GDP. International capital market financing is measured by the sum of the notional amount of bonds issued by the government as well as by public and private sector borrowers in international capital markets. In addition, international bank lending, which is the amount of funds raised by the government as well as public and private sector borrowers via international syndicated lending is taken into consideration as well as the

Figure 3.25: Market Capitalization of the Listed Chinese Companies

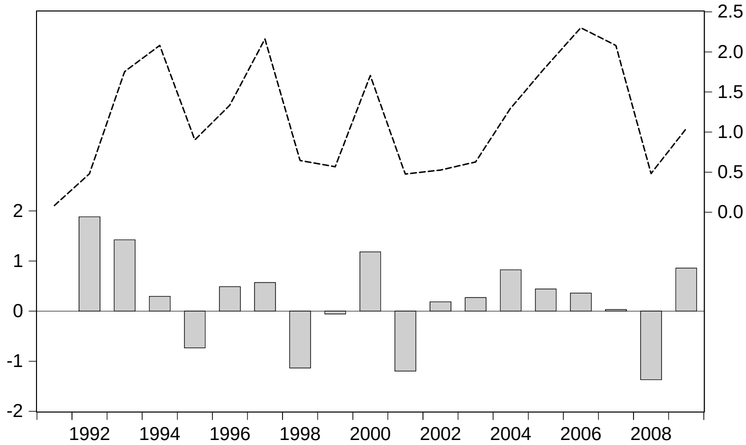


Note: The line indicates the market capitalization (in billion Chinese Yuan) of the listed Chinese companies in total in current US$ (right axis). The bars indicate the growth rate (left axis). The years 1991 to 2010 are considered.

notional amount of equity placement abroad. It is shown that the financing via international capital alternate between 0.08% in 1991 and 2.30% in 2006 of the GDP with a mean of 1.18%. The highest inflows have been reached in 2006. However, both figures indicate a very low financing via international capital markets which highlights the importance of domestic capital markets and domestic lending, especially.[125]

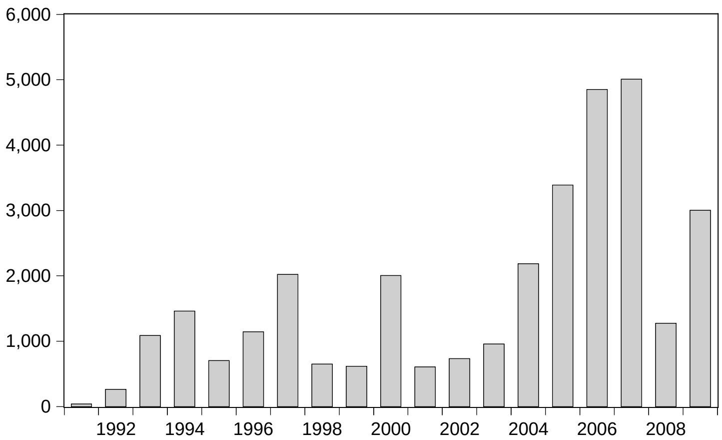
[125]The data are reported by the World Bank (2012).

Figure 3.26: Financing via International Capital Markets, Gross Inflows (in percent of GDP)



Note: The line indicates the financing via international capital markets in % of GDP (right axis). The bars indicate the growth rate (left axis). The years 1991 to 2009 are considered.

Figure 3.27: Financing via International Capital Markets, Gross Inflows (in 100 million Chinese Yuan)



Note: The bars indicate the financing via international capital markets in 100 million Chinese Yuan. The years 1991 to 2010 are considered.

References

Acemoglu, D., Johnson, S., and Robinson, J. A. (2005). Institutions as a fundamental cause of long-run growth. In Aghion, P. and Durlauf, S. N., editors, *Handbook of Economic Growth*, chapter 6, pages 385 – 472. Amsterdam; North-Holland.

Allen, F., Qian, J., and Qian, M. (2005). Law, finance, and economic growth in China. *Journal of Financial Economics*, 77(1):57–116.

Ang, J. B. (2008). A survey of recent developments in the literature of finance and growth. *Journal of Economic Surveys*, 22(3):536–576.

Arestis, P. and Demetriades, P. O. (1997). Financial development and economic growth: assessing the evidence. *The Economic Journal*, 107:783–799.

Ayyagari, M., Demirgüç-Kunt, A., and Maksimovic, V. (2010). Formal versus informal finance: evidence from China. *Review of Financial Studies*, 23(8):3048–3097.

Aziz, J. and Duenwald, C. (2002). Growth-financial intermediation nexus in China. IMF Working Paper No. 02/194. International Monetary Fund.

Batra, G., Kaufmann, D., and Stone, A. H. W. (2003). *The Investment Climate around the*

World: Voices of Firms from the World Business Environment Survey. The World Bank. Washington D.C.

Beck, T., Levine, R., and Loayza, N. (2000). Finance and the sources of growth. *Journal of Financial Economics*, 58:261–300.

Beirne, J., Caporale, G. M., Schulze-Ghattas, M., and Spagnolo, N. (2010). Global and regional spillovers in emerging stock markets: a multivariate GARCH-in-mean analysis. *Emerging Markets Review*, 11(3):250–260.

Berger, A. N., Hasan, I., and Zhou, M. (2009). Bank ownership and efficiency in China: what will happen in the world's largest nation? *Journal of Banking and Finance*, 33(1):113–130.

Blömer, M. (1989). *Die Entwicklung des Agrarkredits in der preussischen Provinz Westfalen im 19. Jahrhundert.* Fritz Knapp Verlag. Frankfurt.

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics*, 31:307–327.

Bollerslev, T. and Wooldridge, J. M. (1992). Quasi-maximum likelihood estimation and inference in dynamic models with time-varying covariances. *Econometric Reviews*, 11:143–172.

Bordo, M. D. (2002). Globalization in historical perspective. *Business Economics*, 37(1):20–29.

Boyreau-Debray, G. (2003). Financial intermediation and growth: Chinese style. Policy Research Working Paper No. 3027. The World Bank.

Bracker, K., Docking, D. S., and Koch, P. D. (1999). Economic determinants of evolution in international stock market integration. *Journal of Empirical Finance*, 6(1):1–27.

Broadman, H. G. and Sun, X. (1997). The distribution of foreign direct investment in China. *The World Economy*, 20(3):339–361.

Brooks, R. D. and Ragunathan, V. (2003). Returns and volatility on the Chinese stock markets. *Applied Financial Economics*, 13(10):747–752.

Buera, F. J., Kaboski, J. P., and Shin, Y. (2011). Finance and development: a tale of two sectors. *American Economic Review*, 101(5):1964–2002.

Burhop, C. (2002). Die Entwicklung der deutschen Aktienkreditbanken von 1848 bis 1913: Quantifizierungsversuche. *Bankhistorisches Archiv*, 28(2):103–128.

Burhop, C. (2005). Industrial production in the German empire, 1871-1913. Mimeo. University of Muenster.

Burhop, C. (2006). Did banks cause the German industrialization? *Explorations in Economic History*, 43(1):39–63.

Burhop, C. and Wolff, G. B. (2005). A compromise estimate of German net national product, 1851-1913, and its implications for growth and business cycles. *Journal of Economic History*, 65(3):613–657.

Calderón, C. and Liu, L. (2003). The direction of causality between financial development and economic growth. *Journal of Development Economics*, 72(1):321–334.

Cao, Y., Qian, Y., and Weingast, B. R. (1999). From federalism, Chinese style to privatization, Chinese style. *Economics of Transition*, 7(1):103–131.

Caporale, G. M., Pittis, N., and Spagnolo, N. (2006). Volatility transmission and financial crises. *Journal of Economics and Finance*, 30(3):376–390.

Catão, L. and Rodriguez, S. L. (2000). Banks and monetary shocks in emerging markets: how far can we go with the "credit view"? IMF Working Paper No. 00/68. International Monetary Fund.

Chelley-Steeley, P. (2004). Equity market integration in the Asia-Pacific region: a smooth transition analysis. *International Review of Financial Analysis*, 13(5):621–632.

Chen, D.-H., Blenman, L. P., Bin, F.-S., and Chen, J. (2011). The effects of open market reforms on the behavior of China's stock prices. *Journal of Chinese Economics and Finance*, 1:41–56.

Cheng, H. and Glascock, J. L. (2005). Dynamic linkages between the Greater China economic area stock markets - Mainland China, Hong Kong, and Taiwan. *Review of Quantitative Finance and Accounting*, 24(4):343–357.

Cheung, Y.-W. and Lai, K. S. (1993). Finite-sample sizes of Johansen's likelihood ratio tests for cointegration. *Oxford Bulletin of Economics and Statistics*, 55(3):313–328.

Cheung, Y.-W. and Ng, L. K. (1996). A causality-in-variance test and its application to financial markets prices. *Journal of Econometrics*, 72(1-2):33–48.

Chow, C. K. W. and Fung, M. K. Y. (1998). Ownership structure, lending bias and liquidity constraints: evidence from Shanghai's manufacturing sector. *Journal of Comparative Economics*, 26(2):301–316.

Chow, G. C. (1993). Capital formation and economic growth in China. *Quarterly Journal of Economics*, 108(3):809–842.

Chow, G. C. and Lawler, C. C. (2003). A time series analysis of the Shanghai and New York stock price indices. *Annals of Economics and Finance*, 4:17–35.

Chui, A. C. W. and Kwok, C. (1998). Cross-autocorrelation between A shares and B shares in the Chinese stock market. *Journal of Financial Research*, 21(3):333–353.

Crafts, N. F. R. (1985). *British Economic Growth during the Industrial Revolution.* Clarendon Press, Oxford.

Cull, R. and Xu, L. C. (2000). Bureaucrats, state banks, and the efficiency of credit allocation: the experience of Chinese state-owned enterprises. *Journal of Comparative Economics*, 28:1–31.

Cull, R. and Xu, L. C. (2003). Who gets credit? The behavior of bureaucrats and state banks in allocating credit to Chinese state-owned enterprises. *Journal of Development Economics*, 71:533–559.

Deininger, K., Jin, S., and Xia, F. (2012). Moving off the farm: land institutions to facilitate structural transformation and agricultural productivity growth in China. Policy Research Working Paper No. 5949. The World Bank.

Deutsche Bundesbank (1976). *Deutsches Geld- und Bankwesen in Zahlen 1876-1975.* Fritz Knapp Verlag. Frankfurt.

Diekmann, K. (2011). Are there spillover effects from Hong Kong and the United States to

Chinese stock markets? Institute of Empirical Economic Research, Working Paper No. 89. University of Osnabrueck.

Diekmann, K. and Westermann, F. (2010). Financial development and sectoral output growth in 19th century Germany. CESifo Working Papers No. 3283. CESifo GmbH.

Diekmann, K. and Westermann, F. (2012). Financial development and sectoral output growth in nineteenth century Germany. *Financial History Review*, (forthcoming).

Duenwald, C. and Aziz, J. (2003). The growth-financial development nexus. In Tseng, W. and Rodlauer, M., editors, *China - Competing in the Global Economy*, chapter 4. International Monetary Fund. Washington.

Edwards, J. and Fischer, K. (1994). *Banks, Finance, and Investment in Germany.* Cambridge University Press. Cambridge.

Edwards, J. and Nibler, M. (2000). Corporate governance in Germany: the role of banks and ownership concentration. *Economic Policy*, 15(31):237–67.

Edwards, J. and Ogilvie, S. (1996). Universal banks and German industrialization: a reappraisal. *Economic History Review*, 49(3):427–446.

Engle, R. F. (1982). Autoregressive conditional heteroskedasticity with estimates of the variance of United Kingdom inflation. *Econometrica*, 50(4):987–1007.

Engle, R. F. and Granger, C. W. J. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica*, 55(2):251–276.

Engle, R. F., Lilien, D. M., and Robins, R. P. (1987). Estimating time varying risk premia in the term structure: the ARCH-M model. *Econometrica*, 55(2):391–407.

Fan, S. and Chan-Kang, C. (2005). Is small beautiful? Farm size, productivity and poverty in Asian agriculture. *American Journal of Agricultural Economics*, 32(1):135–146.

Ferri, G. and Liu, L.-G. (2010). Honor thy creditors beforan thy shareholders: are the profits of Chinese state-owned enterprises real? *Asian Economic Papers*, 9(3):50–71.

Fidrmuc, J. and Korhonen, I. (2010). The impact of the global financial crisis on business cycles in Asian emerging economies. *Journal of Asian Economics*, 21(3):293–303.

Gerschenkron, A. (1962). *Economic Backwardness in Historical Perspective: A Book of Essays*. Harvard University Press. Cambridge.

Guariglia, A. and Poncet, S. (2008). Could financial distortions be no impediment to economic growth after all? Evidence from China. *Journal of Comparative Economics*, 36(4):633–657.

Guinnane, T. W. (2001). Cooperatives as information machines: German rural credit cooperatives, 1883-1914. *Journal of Economic History*, 61(2):366–389.

Guinnane, T. W. (2002). Delegated monitors, large and small: Germany's banking system, 1800-1914. *Journal of Economic Literature*, 40(1):73–124.

Gupta, K. L. (1984). *Finance and Economic Growth in Developing Countries*. Routledge. London.

Hale, G. and Long, C. (2011). What are the sources of financing for Chinese firms? In Cheung, Y.-W., Kakkar, V., and Ma, G., editors, *Frontiers of Economics and Globalization - The Evolving Role of Asia in Global Finance*, volume 9, chapter 13, pages 313–339. Emerald.

Hamao, Y., Masulis, R. W., and Ng, V. (1990). Correlations in price changes and volatility across international stock markets. *Review of Financial Studies*, 3(2):281–307.

Harvey, C. (1995). Predictable risk and returns in emerging markets. *Review of Financial Studies*, 8(3):773–816.

Hasan, I., Wachtel, P., and Zhou, M. (2009). Institutional development, financial deepening and economic growth: evidence from China. *Journal of Banking and Finance*, 33(1):157–170.

Heimonen, K. (2002). Stock market integration: evidence on price integration and return convergence. *Applied Financial Economics*, 12(6):415–429.

Hoffmann, W. G. (1965). *Das Wachstum der Deutschen Wirtschaft seit der Mitte des 19.Jahrhunderts*. Springer. Berlin, Heidelberg.

Hong, Y., Liu, Y., and Wang, S. (2009). Granger causality in risk and detection of extreme risk spillover between financial markets. *Journal of Econometrics*, 150(2):271–287.

Hsiao, F. S. T., Hsiao, M.-C. W., and Yamashita, A. (2003). The impact of the US economy on the Asia-Pacific Region: does it matter? *Journal of Asian Economics*, 14(2):219–241.

Hu, J. W.-S., Chen, M.-Y., Fok, R. C. W., and Huang, B.-N. (1997). Causality in volatility and volatility spillover effects between US, Japan and four equity markets in the South China Growth Triangular. *Journal of International Financial Markets, Institutions and Money*, 7(4):351–367.

Huang, Y. (2003). *Selling China: Foreign Direct Investment During the Reform Era*. Cambridge University Press. New York.

IMF (2004). *World Economic Outlook*. Washington, D.C.

Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica*, 59(6):1551–1580.

Johansson, A. C. and Ljungwall, C. (2009). Spillover effects among the Greater China stock markets. *World Development*, 37(4):839–851.

Jun, Z., Wan, G., and Jin, Y. (2007). The financial deepening-productivity nexus in China: 1987-2001. *Journal of Chinese Economic and Business Studies*, 5(1):37–49.

Jung, W. S. (1986). Financial development and economic growth: international evidence. *Economic Development and Cultural Change*, 34(2):333–346.

Kassimatis, K. (2002). Financial liberalization and stock market volatility in selected developing countries. *Applied Financial Economics*, 12(6):389–394.

Kim, E. H. and Singal, V. (2000). Stock market openings: experience of emerging economies. *Journal of Business*, 73(4):25–66.

Kim, Y. and Shin, J. (2000). Interactions among China-related stocks. *Asia-Pacific Financial Markets*, 7(1):97–115.

King, R. G. and Levine, R. (1993). Finance and growth: Schumpeter might be right. *Quarterly Journal of Economics*, 108(3):717–737.

Krueger, A. and Tornell, A. (1999). The role of bank restructuring in recovering from crises: Mexico 1995-98. NBER Working Paper No. 7042, National Bureau of Economic Research.

Laurenceson, J. and Chai, J. (2001). State banks and economic development in China. *Journal of International Development*, 13(2):211–225.

Levine, R. (1997). Financial development and economic growth: views and agenda. *Journal of Economic Literature*, 35(2):688–726.

Levine, R. (2001). International financial liberalization and economic growth. *Review of International Economics*, 9(4):688–702.

Levine, R. and Zervos, S. (1998). Stock markets, banks, and economic growth. *American Economic Review*, 88(3):537–558.

Li, G., Refalo, J. F., and Wu, L. (2008). Causality-in-variance and causality-in-mean among European government bond markets. *Applied Financial Economics*, 18(21):1709–1720.

Li, H. (2007). International linkages of the Chinese stock exchanges: a multivariate GARCH analysis. *Applied Financial Economics*, 17(4):285–297.

Li, K.-W. and Liu, T. (2001). Financial liberalisation and growth in China's economic reform. *The World Economy*, 24(5):673–687.

Li, X. and Liu, X. (2005). Foreign direct investment and economic growth: an increasingly endogenous relationship. *World Development*, 33(3):393–407.

Lin, A. Y. and Swanson, P. E. (2008). The effect of China's reform policies on stock market information transmission. *Quarterly Journal of Finance and Accounting*, 47(3):49–76.

Lin, X. and Zhang, Y. (2009). Bank ownership reform and bank performance in China. *Journal of Banking and Finance*, 33(1):20–29.

Liu, T. and Li, K.-W. (2001). Impact of liberalization of financial resources in China's economic growth: evidence from provinces. *Journal of Asian Economics*, 12(2):245–262.

Liu, X., Burridge, P., and Sinclair, P. J. N. (2002). Relationships between economic growth, foreign direct investment and trade: evidence from China. *Applied Economics*, 34(11):1433–1440.

Luintel, K. B. and Khan, M. (1999). A quantitative reassessment of the finance-growth nexus: evidence from a multivariate VAR. *Journal of Development Economics*, 60(2):381–405.

MacKinnon, J. K. (1991). Critical values for cointegration tests. In Engle, R. F. and Granger, C. W. J., editors, *Long-Run Relationships: Readings in Cointegration*, chapter 13, pages 266–276. Oxford University Press, Oxford.

National Bureau of Statistics of China (2012). China Statistical Yearbook. http://www.stats.gov.cn/english/.

Ng, A. (2000). Volatility spillover effects from Japan and the US to the Pacific-Basin. *Journal of International Money and Finance*, 19(2):207–233.

Odedokun, M. O. (1996). Alternative econometric approaches for analysing the role of the financial sector in economic growth: time-series evidence from LCDs. *Journal of Development Economics*, 50(1):119–146.

OECD (2004). *Rural finance and credit infrastructure in China - China in the Global Economy.* Organisation for Economic Co-operation and Development.

OECD (2009). State owned enterprises in China: reviewing the evidence. Occasional Paper, Working Group on Privatisation and Corporate Governance of State Owned Assets. Organisation for Economic Co-operation and Development .

O'Rourke, K. H. and Williamson, J. G. (1999). The Heckscher-Ohlin model between 1400 and 2000: when it explained factor price convergence, when it did not, and why. NBER Working Paper No. 7411. National Bureau of Economic Research.

Perkins, J. A. (1981). The agricultural revolution in Germany, 1850-1914. *Journal of European Economic History*, 10:71–118.

Phylaktis, K. (1999). Capital market integration in the Pacific Basin region: an impulse response analysis. *Journal of International Money and Finance*, 18(2):267–287.

Piris, A. (2010). Investment by large firms in Argentina. IMF Working Paper No. 10/3. International Monetary Fund.

Prasad, E. and Wei, S.-J. (2005). The Chinese approach to capital inflows: patterns and possible explanation. IMF Working Paper No. 05/79. International Monetary Fund.

Rajan, R. G. and Zingales, L. (1998). Financial dependence and growth. *American Economic Review*, 88(3):559–586.

Rancière, R. and Tornell, A. (2010). Financial liberalization, boom-bust cycles and production efficiency. IMF Research Department and CEPR.

Rioja, F. and Valev, N. (2004). Does one size fit all? A reexamination of the finance and growth relationship. *Journal of Development Economics*, 74(2):429–447.

Rousseau, P. L. and Vuthipadadorn, D. (2005). Finance, investment, and growth: time series evidence from 10 Asian economies. *Journal of Macroeconomics*, 27:87–106.

Rousseau, P. L. and Wachtel, P. (1998). Financial intermediation and economic performance: historical evidence from five industrialized countries. *Journal of Money, Credit and Banking*, 30(4):657–678.

Rousseau, P. L. and Wachtel, P. (2000). Equity markets and growth: cross-country evidence on timing and outcomes, 1980-1995. *Journal of Banking and Finance*, 24(12):1933–1957.

Schneider, M. and Tornell, A. (2004). Balance sheet effects, bailout guarantees and financial crises. *Review of Economic Studies*, 71:883–913.

Schularick, M. and Steger, T. M. (2010). Financial integration, investment, and economic growth: evidence from two eras of financial globalization. *Review of Economics and Statistics*, 92(4):756–768.

Shan, J. (2005). Does financial development 'lead' economic growth? A vector auto-regression appraisal. *Applied Economics*, 37(12):1353–1367.

Shen, Y., Shen, M., Xu, Z., and Bai, Y. (2009). Bank size and small- and medium-sized enterprise (SME) lending: evidence from China. *World Development*, 37(4):800–811.

Sims, C. A. (1972). Money, income, and causality. *American Economic Review*, 62(4):540–552.

Susmel, R. and Engle, R. F. (1994). Hourly volatility spillovers between international equity markets. *Journal of International Money and Finance*, 13(1):3–25.

Tornell, A. and Westermann, F. (2003). Credit market imperfections in middle income countries. NBER Working Paper No. 9737. National Bureau of Economic Research.

Tornell, A. and Westermann, F. (2005). *Boom-Bust Cycles and Financial Liberalization.* The MIT Press. Cambridge, Massachusetts.

Tornell, A., Westermann, F., and Martínez, L. (2003). Liberalization, growth, and financial crises: lessons from Mexico and the developing world. *Brookings Papers on Economic Activity*, 34(2):1–112.

Tsai, K. S. (2004). Imperfect substitutes: the local political economy of informal finance and microfinance in rural China and India. *World Development*, 32(9):1487–1507.

Turvey, C. G., Kong, R., and Huo, X. (2010). Borrowing amongst friends: the economics of informal credit in rural China. *China Agricultural Economic Review*, 2(2):133–147.

UN (2012). UNdata. http://data.un.org.

van Zanden, J. L. (1991). The first green revolution: the growth of production and productivity in European agriculture, 1870-1914. *Economic History Review*, 44(2):215–239.

Wang, L. and Szirmai, A. (2008). Productivity growth and structural change in Chinese manufacturing, 1980-2002. *Industrial and Corporate Change*, 17(4):841–874.

Wang, P., Lui, A., and Wang, P. (2004). Return and risk interactions in Chinese stock markets. *Journal of International Financial Markets, Institutions and Money*, 14(4):367–384.

Webb, S. B. (1977). Tariff protection for the iron industry, cotton textiles and agriculture in Germany, 1879-1914. *Jahrbuecher für Nationaloekonomie und Statistik*, 192:336–357.

Webb, S. B. (1982(2)). Agricultural protection in Wilhelminian Germany: forging an empire with pork and rye. *Journal of Economic History*, 42:309–326.

Wei, S.-J. and Wang, T. (1997). The siamese twins: do state-owned banks favor state-owned enterprises in China. *China Economic Review*, 8(1):19–29.

World Bank (2012). World Development Indicator. http://data.worldbank.org/data-catalog.

Worthington, A. and Higgs, H. (2004). Transmission of equity returns and volatility in Asian developed and emerging markets: a multivariate GARCH analysis. *International Journal of Finance and Economics*, 9(1):71–80.

Xu, Z. (2000). Financial development, investment, and economic growth. *Economic Inquiry*, 38(2):331–344.

Yao, S. (2006). On economic growth, FDI and exports in China. *Applied Economics*, 38(3):339–351.

Yao, Y. and Yueh, L. (2009). Law, finance, and economic growth in China: an introduction. *World Development*, 37(4):753–762.

Yasar, M., Rejesus, R. M., Chen, Y., and Chakravorty, U. (2011). Political influence of firms in the tradables and non-tradables sectors: a cross-country analysis. *Economics and Politics*, 23(3):297–312.

Yu, P., Chen, K., and Sun, X. (2010). Foreign direct investment and economic growth in China: evidence from a two-sector model. *Journal of Financial Management and Analysis*, 23(1):1–9.

Zhou, X., Zhang, W., and Zhang, J. (2012). Volatility spillovers between the Chinese and world equity markets. *Pacific-Basin Finance Journal*, 20(2):247–270.