

STOCKHOLM SCHOOL OF ECONOMICS

DEPARTMENT OF ECONOMICS

ACADEMIC YEAR 2013

5350 THESIS IN ECONOMICS

Financial depth, economic growth, private investment rate and private savings rate:

A clarification on the variables' dynamics in two European countries

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Abstract:

For many years the direction of causality between financial depth and economic growth has been at the center of attention for economists. Still no consensus has been reached. Globalized financial and economic markets expand the spectra of possible interactions among macro-economic variables. Earlier studies have refrained from including savings and investment simultaneously, even though empirical findings and theory suggest so. This paper analyzes the dynamic interactions between the financial and economic sectors in two European countries given that the private savings rate and investment rate are incorporated. An eight variable panel VARX model is applied to enable test of Granger causation, as well as sensitivity analyses from a shock in financial depth. The study's result suggests that financial markets are uninformative for predicting economic growth. In contrast, economic growth Granger causes financial depth. Furthermore, financial deepening and private savings rate are found to Granger cause each other. The sensitivity analyses show that financial depth in the long run negatively affects private savings rate. The role and priority policy makers assign to the financial market should, in a wider perspective, possibly be reconsidered since evidence suggests that it does not lead to economic growth and it is detrimental to the private savings rate.

JEL classification: E130, E200, E210, E230, F320, F430, F400

Keywords:

Panel VARX, financial depth, Granger causality, demand-following hypothesis, Orthogonalized impulse response function

Date of submission: May 15, 2013

Date of presentation: May 24, 2013

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Acknowledgements

We would like to thank our supervisor Yoichi Sugita for his support throughout this research project. We are especially grateful for his valuable guidance in choosing the right focus of study, his thorough approach to structure and of course his friendly attitude. A special thanks goes to Rickard Sandberg for being a *deus ex machina* regarding issues with the methodology and for always being available for a quick talk yielding creative solutions. Finally, we would like to thank Andreas Slotte, Connor Craik and Adam Vallin for their comments and suggested improvements.

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Glossary

Economic terms

Demand-following hypothesis	Financial development follows economic growth due to an increased demand for financial products
McKinnon-Shaw hypothesis	The removal of financial repression shall lead to an increase in real interest rates that is followed by an increase in savings and investment
National income identity	Defined as $Y=C+I+G+(NX)$, where Y , C , I , G and NX stand for GDP, consumption, investment, public consumption and net exports, respectively
Supply-leading hypothesis	Claims that financial markets spur economic growth
Marginal propensity to save	Refers to the fraction of increased savings when income rises by one unit

Economic unions

Benelux Economic Union	An economic union established between Belgium, the Netherlands and Luxembourg in 1958 to promote free movement of goods, capital, services and people
EMU	Economic and Monetary Union of the European Union

Econometric terms

AIC	Akaike Information Criterion
Causally prior	Variable A is causally prior to B if B does not have a contemporaneous effect on A
ERS test	A test for detecting unit roots in time series samples
Granger Causality	A time series X is said to Granger cause Y if the X values provide information on future values of Y
Jarque-Bera	A goodness-of-fit test of whether sample data have skewness and kurtosis that match a normal distribution
LM test	A test for determining if the error terms are serially correlated or not
OIRF	Orthogonalized impulse response function traces out the effects on the system, when an innovation of one standard deviation occurs in one of the variable’s error terms. Note that the error terms are force to be uncorrelated
Random walk	A random process consisting of a sequence of discrete steps of fixed length
SBC/SBIC	Schwarz Bayesian Criterion
Stationary	Integrated of order zero, $I(0)$. The mean and variance are constant. Also, the autocovariance is finite and time-independent

Unit root	The time series has a constant mean but the variance and the autocorrelation are time-dependent. If a unit root is present the process is nonstationary
VAR model	Vector Autoregressive model. It describes the evolution of n variables as a linear function of their lags
VARX model	A VAR model with the addition of exogenous variables
Zivot and Andrews test	A unit root test allowing for structural breaks in intercept and/or in trend

Variables

Financial depth (FD)	Measures the size of the financial institutions and the markets within a country. Ideally, it should reflect how easily creditors and debtors are matched and how much confidence they have in each other. Financial depth is sometimes referred to as financial development. Observe that the first difference of the natural logarithm is used in the model
Real GDP per capita (GDP)	Calculated as nominal GDP deflated via a price deflator (2005=100), divided by population size. The first difference of the natural logarithm is used in the model
Private investment rate (I)	Defined as gross capital formation in the economy minus gross fixed capital formation of the government, divided by nominal GDP. Note that the first difference of the natural logarithm is used in the model
Private savings rate (S)	The measure includes non-financial and financial corporations relating to the private sector, private households and non-profit organizations serving the households. The aggregate is divided by nominal GDP. The first difference of the natural logarithm is used in the model

1 Introduction

Ever since the beginning of the 20th century, it has been argued that the financial depth of a country’s economy influences the economic growth through the services that intermediaries and markets offer (see Schumpeter, 1912). Yet, this argument has met resistance from well-known economists, who claim that financial products are of minor importance or even irrelevant for economic development (see Robinson, 1952; Lucas, 1988). The most recent literature has focused on the causal relationship, rather than the correlation, between depth and growth. Disagreement on the causal direction may stem from the fact that some common omitted variables (such as households’ savings) drive both the financial sector and the economic development (Rajan and Zingales, 1998). Economic reasoning may suggest that private savings indirectly affect GDP via the national income identity, and financial depth via the demand for new financial products. In contrast, GDP and financial depth are said to influence savings through the marginal propensity to save and supply of financial services, respectively. Despite these contemporaneous or lagged dependencies little research has been done using depth, growth and savings simultaneously in a dynamic model and utilizing data from developed countries (see for example Bandiera et al., 2000; Loayza, Schmidt-Hebbel and Servén, 2000). Rather, previous empirical literature has emphasized the dynamics between financial depth, growth and investment in the developing world (see Luintel and Khan, 1999; Benhabib and Spiegel, 2000; Xu, 2000).

To this day, dynamic models on depth and GDP have provided mixed results on the causal relationship. Furthermore, these models have not simultaneously incorporated savings and investment. In a closed economy, including both savings and investment would be redundant since theory does not distinguish between them (Solow, 1956). However, if capital markets liberalize and financial regulations across countries converge (the European Union in the end of the 20th century is one example that satisfies both events; see European Commission, 1997), domestic savings and investment must not necessarily equalize since international borrowing may occur.

Furthermore, empirical findings confirm that financial depth and economic growth are related to savings and/or investment (see King and Levine, 1993; Liu and Woo, 1994; Loayza, Schmidt-Hebbel and Servén, 2000; Balamoune and Chowdhury, 2003; Ozcan et al., 2003; Kelly and Mavrotas, 2008; Townsend and Ueda, 2010). It has also been found that there is low correlation between savings and investments in the short term in countries with liberalized capital regimes¹ (European Commission, 1997). In light of this, including private savings and investment rates simultaneously in the dynamic setting may not only change the magnitude of the estimates but also the direction of causality between financial depth on one hand and economic growth, private savings and investment rate on the other hand.

The purpose of this thesis is to study the links between the financial depth (FD)², real GDP per capita (GDP), private investment rate (I) and private savings rate (S); within and across countries. An eight variable³ panel vector auto regression (VARX) model is applied. After the directions of Granger causation have been established (which would indicate the variables' interactions), the dynamic effects of a shock in financial depth on the real GDP per capita, private investment rate and private savings rate are determined. The exogenous shocks could for instance come from changes in interest rate policy, monetary policy or borrowing constraints. Blanchard and Quah (1989) argued that information from more than one time series, or from more than one sector in the economy (Lee and Pesaran, 1993) provides better foundation for understanding persistence of shocks. By analyzing the variables' reaction to a shock, we hope to acquire knowledge of how our endogenous macroeconomic variables' respond, over time, to changes in domestic and foreign financial depth. This will bring insights to the duration of changes in financial depth in an economy and also the sign of impact (positive or negative) within and across nations. As financial deepening may not only affect growth, but also the current account balance, this knowledge could affect the priority and prudence policy makers attach to financial reforms (Xu, 2000; Levine, 2005).

1 The short-term correlation between private savings and investment rates, within and across countries, is low in this study's sample. The correlation matrix including all variables of interest is available upon request.

2 The proxy for financial depth is: private credit by deposit money banks and other financial institutions as a percentage of GDP. This measure is widely used in the literature.

3 Since the incorporated variables are allowed to have *cross-country* interactions the panel VARX can be viewed as an eight variable VARX model.

The study at hand contributes to previous research in three ways: First, it incorporates private savings rate and private investment rate simultaneously in an attempt to solve the omitted variable bias potentially prevalent in earlier work. Second, it provides insights into the *dynamic effects within* and *across* countries as opposed to prior work that tends to disregard interdependencies between nations when modeling dynamics. Given that events such as the most recent financial crisis showed marks of contagion, the scope for current policy analysis has to be widened to consider the potential increased interdependencies across countries and markets. Third, this empirical study addresses the causal relationship in two *developed European* countries, whereas others have examined developing countries or regions other than Europe.

The results from the Granger Causality tests, along with the shock analysis suggest that interdependencies within and across counties exist. When the domestic or foreign financial sector develops the private savings rate falls but economic growth stays unchanged for both Belgium and the Netherlands. Furthermore, the causal relationship between real GDP per capita and financial depth, as well as the Granger causation between private investment rate and depth give support for the demand-following hypothesis within nations.

The reminder of this paper is divided into the following sections: Section 2 reviews the relevant theoretical and empirical literature. Section 3 describes the research question and our hypotheses. The methodology is covered in section 4, while section 5 presents the data. In section 6, the results are reported, whilst they are analyzed in section 7. Finally, section 8 provides some concluding remarks

2 Literature review

This section summarizes previous studies. The theoretical background is presented first, and then the early empirical research and the recent empirical work follow.

2.1 Theoretical review

Levine (2005) argued that in a world where acquiring information and making transactions would come at no cost, there would be fewer incentives for financial institutions to exist. Financial markets arise to ease these requests in case of instable environments (Merton and Bodie, 1995). As shown in theoretical models, this easing brings about changes in incentives and constraints for economic agents that may influence savings rates, economic growth and investment decisions (Levine, 2005).

One of the earliest proponents of the positive relationship between financial development and economic growth was Schumpeter (1912). He argued that financial services were important for technical innovation and economic development since they help mobilize and allocate savings, ameliorate investments and risk management as well as facilitate transactions. Schumpeter’s theory constitutes the basis for the *supply-leading hypothesis* in which finance causes growth. McKinnon (1973) and Shaw (1973) had a similar, yet alternative, approach to this hypothesis. They argued that a repressed financial market impedes growth. This is known as the *McKinnon-Shaw hypothesis*. More specifically, the hypothesis claims that a shallow financial system suffers from low or negative real interest rates. This would in turn discourage financial saving, leading to a shortage of investable funds. This process decreases the efficiency of capital and inhibits growth. At the other end of the spectrum, one finds Lucas (1988, p. 6) who bluntly argued that the role of financial markets in economic development was “badly overstressed.”

Robinson (1952, p. 86) took an opposing view to Schumpeter (1912) by proclaiming that “where enterprise leads finance follows.” In detail, Robinson argued that when an economy grows, there is an increased demand by investors and savers for financial institutions and services leading to an expansion of the financial sector. This is known as the *demand-following hypothesis*.

2.2 Early empirical research

One of the first to empirically illustrate the links between the financial sector and economic growth was Goldsmith (1969). Using a dataset of 35 countries, covering a period between 1860 and 1963, Goldsmith (1969, p. 48) concluded that “a rough parallelism can be observed between economic and financial development if periods of several decades are considered.” He admitted that no further conclusion could be drawn whether it was financial development affecting growth or vice versa.

Empirical work on the direction of causality between financial development and economic growth is rather meager (for an overview see Levine, 2005). An early attempt to incorporate the dynamics was done by Jung (1986). By applying a vector autoregression model on annual data in levels he concluded that the direction of Granger causality was different for developed and developing countries. For the developed countries he found support for the demand-following hypothesis, while for the less developed countries the supply-leading hypothesis seemed more appropriate. Patrick (1966) hypothesized about these differences decades ago; arguing precisely that the direction of causality depended on the stage of an industry’s or a country’s development. Despite Patrick’s support, Jung’s findings may be questioned because of the applied estimation technique. For a VAR model to be valid the included variables must be stationary (Sims, Stock and Watson, 1990). Since macroeconomic time series usually have unit roots, it was incorrect of Jung to assume, with no further discussion or econometric testing, that his level variables –real GNP per capita and monetization– were stationary.

2.3 Recent empirical research

Based on cross-country evidence from 80 developing countries, King and Levine (1993) found evidence in favor of the supply-leading hypothesis. They claimed that financial development had a causal impact on both contemporaneous and future values of growth.

Their result should though be viewed with some caution since their cross-section estimation technique may have some limitations: First, it is assumed that the countries are homogenous; an assumption that is unrealistic. Second, they weigh the sampled countries inappropriately since large and small economies are assigned equal weights (Demetriades and Hussein, 1996).

Demetriades and Hussein (1996) took a different approach to determine the causal direction. After running unit root, cointegration and Granger causality tests on their 16-country data set they ended up with very mixed results. There was little support to their hypothesis that finance should be a driving factor of economic growth. Rather, many countries had a bidirectional relationship between financial depth and GDP per capita. For several countries they also found substantial evidence in line with the demand-following hypothesis.

None of the aforementioned empirical studies have incorporated investment and savings simultaneously. On a whole the empirical literature on savings/investment and financial depth is not as dense as it is on finance and economic growth. Moreover, the empirical work that has been done tend to be rather indecisive on the relationship between financial markets and savings. For less developed countries financial development was found to increase savings. On the contrary it exerted a detrimental effect on savings in developed countries (Jappelli and Pagano, 1994; Bandiera et al., 2000; Chinn and Ito, 2008; Ang, 2011). The latter finding was attributed to be the result of easier access to credit and decreased need for precautionary savings. Also, savings was found to suffer from inertia⁴ (Loayza, Schmidt-Hebbel and Servén, 2000).

⁴They were serially correlated even after controlling for relevant factors

Building on the ignorance of dynamic interactions in previous literature, Xu (2000, p. 333) applied a multivariate VAR model including financial depth, real GDP and real domestic investment. Xu (2000) found that financial development Granger caused real GDP. After performing an impulse response analysis, shocking financial development, he further concluded that investment was an important channel in which the causal relationship between financial development and growth worked.

Worried about the potential problem of invalidity from omitting savings, as was prevalent in some earlier research, Odhiambo (2008) used a three variable framework to study the relationship between financial development and economic growth in Kenya. His results revealed that the causality ran from economic growth to both financial depth and savings. His Granger causality test further showed that savings drove financial development.

Theory as well as shortcomings in earlier empirical studies motivates an extension of Odhiambo's (2008) and Xu's (2000) works. An eight variable VARX model including financial depth, real GDP per capita, private investment rate and private savings rate is thus used.

3 Research question

This study focuses on the relationship between the financial depth, real GDP per capita, private investment rate and private savings rate. By examining the dynamics between these variables, we hope to learn more about the role of financial markets in a globalized world. Previous research has provided mixed results on the direction of Granger causality between financial depth and economic growth (for example see Demetriades and Hussein, 1996; Xu, 2000). Due to omitted variable bias caused by the omission of private savings rate and/or private investment rate as well as inappropriate estimation techniques, some of the results could be deemed questionable. Moreover, the vast majority of the studies have been conducted on cross-sectional data or individual countries, usually from the developing world (see King and Levine, 1993; Bandiera et al., 2000; Odhiambo, 2008).

In this empirical study, both the private savings rate and the private investment rate are included in the model since they are related to the other variables of interest. The empirical analysis is conducted on panel data on two developed countries with a long history of liberalized capital regimes: Belgium and the Netherlands (European Commission, 1997). The use of panel data on two similar countries allows for cross-border interdependencies, making it particularly interesting to study the dynamic effects of a shock in financial depth in Belgium (the Netherlands), on real GDP per capita, private investment rate and private savings rate. The shock analysis will hopefully broaden the understanding of the variables' sensitivity, the development of the examined countries' economies, and how the increased economic and financial integration translates into cross-country dependencies. This knowledge may thus have important policy implications for developed countries or countries approaching a similar stage. All in all, this study shall provide further insights on the following issues:

1. *What is the direction of Granger causality between financial depth and the other variables in a developed country, given that private savings rate and private investment rate are simultaneously incorporated in the model?*

2. *How does the real GDP per capita, private investment rate and private savings rate respond to a domestic and/or a foreign shock in financial depth of a developed country?*

The hypotheses presented below are *our* own. These will be confirmed or rejected in sections 6.1 and 7.

3.1 Granger causality

In a two-country setting, the following hypotheses attempt to clarify the direction of Granger causality with respect to financial depth. The hypotheses are believed to be true based on economic theory, earlier empirical research and the simultaneous inclusion of the private savings and investment rates. The arrows constitute the source from where the causation emanates; the left variable Granger causing the right variable. In some cases a two-way arrow is apparent, indicating that the relationship is bidirectional.

$$FD_{i,l} \leftrightarrow S_{i,l} \quad (H1)$$

$$FD_{i,l} \leftrightarrow GDP_{i,l} \quad (H2)$$

$$FD_{i,l} \leftrightarrow I_{i,l} \quad (H3)$$

$$FD_i \rightarrow S_l \quad (H4)$$

$$FD_i \rightarrow GDP_l \quad (H5)$$

$$FD_i \leftrightarrow I_l \quad (H6)$$

$$FD_i \leftrightarrow FD_l \quad (H7)$$

where FD , S , GDP and I stand for financial depth, private savings rate, real GDP per capita and private investment rate, respectively. The subscripts indicate country and the

comma is used to separate them so that *i relates* to *i* and *l* to *l*. Thus, hypotheses H1 – H3 refer to within country dependencies, while H4 – H7 denote linkages across countries.

3.2 Orthogonalized impulse response function

Building on earlier empirical research, the impact that financial depth exerts on savings is ambiguous, and seems to depend on a country’s characteristics and institutions. In less developed countries an innovation in financial depth boosts savings. Since Belgium and the Netherlands are classified as developed countries, we hypothesize that a shock in their domestic financial variable has a negative effect on both domestic and foreign private savings rates. We further believe that these reactions are delayed because Loayza, Schmidt-Hebbel and Servén (2000) argued that savings suffers from inertia. In contrast, domestic and foreign real GDP per capita and domestic and foreign private investment rates are hypothesized to respond positively to a domestic shock in depth. The within country beliefs of higher output and investment rates reflect Xu’s (2000) findings. Both the national and the cross-country effects on GDP and investment rates are expected to be visible before the reaction in savings rates.

4 Method

The VAR model captures linear dependencies between several time-series by allowing the dependent variables to be affected by their own lags, as well as lags of the other *endogenous* variables (Enders, 2009). To account for dynamic effects in a system all variables’ equilibrium values must be determined simultaneously; a function that the VAR model can handle. It also allows for differences between entities, which is appropriate when more than one country is examined (Xu, 2000). Compared to structural models with simultaneous equations, knowledge about the dynamic interactions in a VAR framework must not be extensive, only hypothesized (Sims, 1980).

The subsequent text starts with a description of the hypothesized dynamic interactions between domestic and foreign variables. First, financial depth’s relation to the other variables is presented. The possible links between the secondary variables are thereafter discussed. The section rounds off by stating the methodical approach taken with respect to the basic model, the Granger causality tests and the orthogonalized impulse response functions.

4.1 Dynamic interactions between the key variables

Financial depth and private savings rate

Higher savings rate suggests that the demand for savings products rises. To meet the new demand, supply of financial products increases, which makes the financial market deeper. At the same time, a large financial sector has a well-diversified menu of savings products. In this sense, it can offer products that are tailored to the individual’s precise needs and hence attract more savers. Empirical evidence, however, suggests that financial deepening could have detrimental effects on savings (see for example Bandiera et al., 2000; Loayza, Schmidt-Hebbel and Servén, 2000). The theory behind this is twofold. First, easier access to credit reduces the incentive to save for future needs

(Loayza, Schmidt-Hebbel and Servén, 2000). Second, more developed financial markets lower uncertainty, which in turn may decrease the need for precautionary savings (Chinn and Ito, 2008). The bidirectional links are allowed only within borders. The second relationship may exist across countries because low capital controls may encourage people to save abroad in order to take advantage of higher returns.

Financial depth and real GDP per capita

Financial depth should not only relate to the supply of intermediaries and markets, but also to their efficiency to evaluate, supervise and distribute financial services and credit (Rajan and Zingales, 1998). A deep system aid in mobilizing savings, overcome informational frictions, and improves risk taking. It also efficiently allocates credit to profitable investments that spur growth through the increased return on capital. The possibility to hold a more diversified portfolio also enables investors to invest in riskier projects. Usually high-risk renders high-yield. So, with a financial system that improves risk diversification, high-yield investments are made possible which drive further growth (Obstfeld and Rogoff, 1996).

On the other hand, a boost in output could cause a surge in demand for financial services, which is then followed by an expansion in supply. These reactions indicate that the relationship within a country could be bidirectional. The link *across* nations may instead be unidirectional since neither theory nor empirical findings support that foreign GDP affects domestic depth⁵. Domestic financial depth could however drive foreign output because capital from a deep market may be invested or consumed abroad. The latter relationship most likely applies to Belgium and the Netherlands since they actively collaborate to promote capital mobility (Treaty of the Benelux Economic Union, 1958).

Financial depth and private investment rate

Since deep markets allocate savings and make more funds available they simplify borrowing for investors to use in investment projects. This relationship is expected to occur within and across countries because a well-developed financial sector and low capital controls enable people to invest both domestically and internationally. In 2011

⁵ This argument can be discussed if countries with less developed financial markets are studied, since these nations may have incentives to provide better financial services in order to attract foreign investors.

about 40% of the European Union's (EU) direct investment in Belgium came from the Netherlands, whereas approximately 15% of the EU's direct investments in the Netherlands originated from Belgium (Eurostat, 2013). This suggests that their capital markets and investment flows could be interlinked. However, the reverse relationship that high investment rates require more financial services, which in turn enlarge and deepen the market, is only expected to apply nationally.

4.2 Dynamic interactions between the secondary variables

The private savings rate and the private investment rate

The dynamic effect of the private savings rate on the private investment rate has already been explained in the previous paragraph. Earlier reasoning also states that higher investment rates are associated with higher growth, which in turns causes income to rise. Keynes proposed that the consumption function is concave so that the fraction consumed falls as income rises (Keynes, 1936). This implies that savings' relation to income grows as earnings increase (the marginal propensity to save). Both feedback effects are applicable in the national setting, but only the first link applies to the international setting.

The private savings rate and real GDP per capita

In Solow's (1956) neoclassical exogenous growth model an increase in the savings ratio shifts the savings curve upwards, resulting in a short-term expansion of the closed economy. Romer (1986) challenged this view by presenting an endogenous growth model, the AK-model⁶. In a closed economy, the AK-model shows that savings rates affect economic growth via

$$g = \frac{1}{Y} * \frac{dY}{dt} = \frac{1}{K} * \frac{dK}{dt} = sA - \delta \quad (M.1)$$

⁶ Already in the 1960's Frankel (1962) produced an early version of the AK-model.

where g, Y, K, s, A and δ is the growth rate, the aggregate output, the aggregate capital stock, the fraction saved, the level of technology and the depreciation rate, respectively⁷. In contrast to the closed economy, the private savings rate may not foster growth in the open economy but rather inhibit it. The latter explanation allows for cross-country effects because high savings rates in one country could lower the nation’s consumption of foreign goods, thereby affecting foreign GDP. The reverse relationship, that the real GDP per capita drives the private savings rate, could be described by the marginal propensity to save. As argued in preceding section this link is believed to only exist within a country.

The private investment rate and real GDP per capita

Extending his fundamental argument of demand (as opposed to supply) being the key to economic activity, Keynes (1936) acknowledged investments as an important determinant for the level of spending in an economy since investments increased demand for goods and services. Additional theory (see for instance Schumpeter, 1942) proposes that investments stimulate innovation and technological change encouraging even more projects. Since the projects in the private sector do necessarily remain within national borders, the private investment rate can affect both domestic and foreign GDP. At the same time GDP, or income, affects the amount of realized investments. This direct link is believed to apply to the national level. In general, the studied countries offer similar investment opportunities, why it is believed that GDP in one country does not have a substantial effect on the investment rate in the other.

4.3 Introduction to VAR models

Throughout this section bold lowercase letters denote vectors, whereas bold uppercase letters are used for matrices. Note that the text briefly covers the theory of vector time series in Hamilton (1994); Enders (2009); Canova and Ciccarelli (2013) if not stated otherwise.

The general representation of an eight-variable vector autoregression model, VAR(p), in structural form is given by

⁷ See Romer (1986) for a derivation of the AK-model.

$$y_{1t} = c_{10} + \alpha_{1,11} y_{1,t-1} + \alpha_{1,12} y_{2,t-1} + \dots + \alpha_{1,17} y_{7,t-1} + \alpha_{1,18} y_{8,t-1} \\ + \dots + \alpha_{p,11} y_{1,t-p} + \alpha_{p,12} y_{2,t-p} + \dots + \alpha_{p,17} y_{7,t-p} + \alpha_{p,18} y_{8,t-p} + \varepsilon_{y1t}$$

$$y_{2t} = c_{20} + \alpha_{1,21} y_{1,t-1} + \alpha_{1,22} y_{2,t-1} + \dots + \alpha_{1,27} y_{7,t-1} + \alpha_{1,28} y_{8,t-1} \\ + \dots + \alpha_{p,21} y_{1,t-p} + \alpha_{p,22} y_{2,t-p} + \dots + \alpha_{p,27} y_{7,t-p} + \alpha_{p,28} y_{8,t-p} + \varepsilon_{y2t}$$

$$\vdots$$

$$y_{7t} = c_{70} + \alpha_{1,71} y_{1,t-1} + \alpha_{1,72} y_{2,t-1} + \dots + \alpha_{1,77} y_{7,t-1} + \alpha_{1,78} y_{8,t-1} \\ + \dots + \alpha_{p,71} y_{1,t-p} + \alpha_{p,72} y_{2,t-p} + \dots + \alpha_{p,77} y_{7,t-p} + \alpha_{p,78} y_{8,t-p} + \varepsilon_{y7t}$$

$$y_{8t} = c_{80} + \alpha_{1,81} y_{1,t-1} + \alpha_{1,82} y_{2,t-1} + \dots + \alpha_{1,87} y_{7,t-1} + \alpha_{1,88} y_{8,t-1} \\ + \dots + \alpha_{p,81} y_{1,t-p} + \alpha_{p,82} y_{2,t-p} + \dots + \alpha_{p,87} y_{7,t-p} + \alpha_{p,88} y_{8,t-p} + \varepsilon_{y8t}$$

where $t = 1, \dots, T$ indexes time series observations, y_{nt} are the endogenous variables denoted by subscript $n = 1, \dots, N$ and the disturbance terms ε_{ynt} are assumed to satisfy the white noise condition

$$E(\varepsilon_{ynt}) = 0 \tag{M.2}$$

$$E(\varepsilon_{ynt} \varepsilon_{yn\tau}) = \begin{cases} \sigma^2 & \text{if } t = \tau \\ 0 & \text{otherwise} \end{cases} \tag{M.3}$$

The representation of the model can in standard form be written more compactly by

$$\mathbf{y}_t = \mathbf{c} + \mathbf{A}_1 y_{t-1} + \dots + \mathbf{A}_p y_{t-p} + \mathbf{e}_t \tag{M.4}$$

where $\mathbf{y}_t = (y_{1t}, \dots, y_{nt})'$ is an $(n \times 1)$ vector of n stationary variables⁸, $\mathbf{c} = (c_{10}, \dots, c_{n0})'$ is an $(n \times 1)$ vector of constants, $\mathbf{A}_j$ is an $(n \times n)$ matrix of coefficients for lags $j = 1, 2, \dots, p$ and $\mathbf{e}_t$ is an $(n \times 1)$ column vector of the error terms $(e_{1t}, \dots, e_{nt})$. As is the case of the structural form, $\mathbf{e}_t$ is assumed to have an expected value of zero (M.2), a constant variance (M.3) and its entities are individually serially uncorrelated ($E[e_{1t}, e_{1t-s}] = 0 \forall s \neq 0$), even though two different shocks at time t may correlate.

A panel VAR(p) model uses the same structure as a standard VAR(p), but adds a cross-country dimension to the analysis of the endogenous and interdependent variables. Thus, the model is represented by

$$\mathbf{y}_{it} = \mathbf{c}_i + \mathbf{A}_{i1}\mathbf{y}_{t-1} + \dots + \mathbf{A}_{ip}\mathbf{y}_{t-p} + \mathbf{e}_{it} \quad (\text{M.5})$$

where $\mathbf{y}_{it}$ is a column vector of n variables for each country i at time t , $\mathbf{A}_{ij}$ is a $(ni \times ni)$ coefficient matrix and $\mathbf{e}_{it}$ is a $(ni \times 1)$ column vector with error terms. As inspection makes clear, the setup of a panel VAR allows country i to be dependent on the lags of the other country's endogenous variables, and the disturbance terms across countries may correlate if $\sigma_{i,l} \neq 0, i \neq l$ in the variance/covariance matrix Σ . When panel data is used one must impose cross-sectional homogeneity on the regressors' relationship. Since this restriction does not hold in practice, one can circumvent it and allow for individual heterogeneity by including a $(ni \times 1)$ vector of country-specific intercepts (Beetsma and Giuliodori, 2011) denoted $\mathbf{c}_i = (c_{i,10}, \dots, c_{i,n0})'$ in equation M.5.

When small open economies are analyzed a variation of the panel VAR(p) may be used; a panel VARX(p) model which allows $\mathbf{y}_{it}$ to be dependent on both endogenous and exogenous variables. The general representation of the panel VARX(p), which is the model used in the study at hand, can be written as

$$\mathbf{y}_{it} = \mathbf{c}_i + \mathbf{A}_{i1}\mathbf{y}_{t-1} + \dots + \mathbf{A}_{ip}\mathbf{y}_{t-p} + \mathbf{B}_{i1}\mathbf{x}_{t-1} + \dots + \mathbf{B}_{ip}\mathbf{x}_{t-p} + \mathbf{e}_{it} \quad (\text{M.6})$$

⁸ Stationary series imply that the mean, the variance and the covariance are constant for all t and $t-s$ (Enders, 2009). Only when the series are stationary, the expected value, the variance and the autocorrelation can be well approximated by long enough time averages from the single set of realizations. If the variables instead are nonstationary one can end up with meaningless and spurious regression results. Hence, for nonstationary series it is recommended to test for cointegration, or if the residuals include a stochastic trend the series should be differenced before estimation (Enders, 2009).

where the notations from equation (M.5) hold with the addition that $\mathbf{B}_{ij}$ is a $(ni \times d)$ matrix and $\mathbf{x}_{t-j}$ is a $(d \times 1)$ vector.

To be able to conduct the Granger causality tests and plot the orthogonalized impulse response functions, the panel VARX(p) model must first be specified, estimated and evaluated. The rest of the methodology is therefore organized as follows

1. Specification of the panel VARX(p) model. This step involves unit root testing and determination of the appropriate lag length.
2. Estimation of the model chosen in step 1. Modification and re-estimation of the model if necessary.
3. Evaluation of the final model from step 2.
4. Test of Granger causality. Observe that focus is put on the forecasting performance of financial depth on the other variables, and vice versa.
5. Plotting and tabulating the orthogonalized impulse response functions, where a shock is only sent in through financial depth.

4.4 Specification of the panel VARX(p) model

Unit root testing

After determining the appropriate endogenous variables $-FD, GDP, S$ and I for Belgium and the Netherlands– to include in the model, their time paths were examined. Each series’ plot indicates if the process is stationary or not, which is formally tested using the Elliott, Rothenberg, and Stock (ERS) test or the Zivot and Andrews test (Elliott, Rothenberg and Stock, 1996; Zivot and Andrews, 1992). The characteristics of the plotted data determine which of the two tests to run. The ERS test is very powerful if the series has a near-unit root, an unknown mean or trend (Elliott, Rothenberg and Stock, 1996; Enders, 2009). The null and alternative hypotheses are

$$H_0: a_{ij} = 1, \text{unit root and difference – stationary} \quad (\text{M.7})$$

$$H_1: a_{ij} \in (-1, 1), \text{trend} - \text{stationary} \quad (\text{M.8})$$

Depending on the data’s features the critical values differ⁹.

However, if a structural break is present in either the intercept or the trend, and the date is not entirely known, the Zivot and Andrews test¹⁰ is better at identifying a unit root (Enders, 2009). Again, the null of a unit root is tested against the alternative of a stationary process. Mathematically the null is represented by

$$H_0: y_t = \mu + y_{t-1} + e_t \quad (\text{M.9})$$

where μ is the intercept. After reading section 5.3.1, it will be clear that the majority of the variables are tested with means of the ERS test, and only one variable (financial depth in Belgium) requires the Zivot and Andrews test.

If the null hypotheses of a unit root cannot be rejected, that is the level of the variable is a random walk process with or without a drift or noise component, the variable is transformed by taking the first difference of the natural logarithm of each series. A transformation in this manner is necessary because it can both remove unit roots¹¹ and eliminate trends¹². The transformed series are then plotted and unit root tested according to the procedure described above. As stated in section 5.3.1, the transformed series are the one used in the subsequent analysis.

Determination of lag length

To select the number of lags to include in the unit root tests, information criterions such as the Akaike information Criterion (AIC) or the Schwarz Bayesian Criterion (BIC/SBC) are used (Akaike, 1974; Schwarz, 1978). If either criterion chooses a lag length of zero, the other recommendation is followed because dynamic effects are otherwise not allowed. This does however come at the cost of efficiency which translates into large

⁹ If the data is trending the critical values are reported in Elliott, Rothenberg and Stock’s work (1996) Table C, while series with intercept but no trend uses the critical values given by the Dickey-Fuller test in Table A in Enders (2009).

¹⁰ In contrast with the Perron test, the Zivot and Andrews test does not take the structural break as an exogenous occurrence (Zivot and Andrews, 1992).

¹¹ If the series include unit roots, the least square estimators and predictors have unusual properties and the test statistics are unreliable. Consequently, the results become meaningless or spurious (Hill, Griffiths and Lim, 2008).

¹² Non-trending independent variables are not likely to be able to explain dependent variables that are trending.

standard errors and large confidence intervals for the impulse response functions (Enders, 2009).

4.5 Estimation of the model

Before estimating the parameters, a number of zero-restrictions are imposed on certain cross-country dependencies. These constraints are enforced because economic reasoning does not support that the variables in question dynamically interact across borders (see sections 4.1 and 4.2 for details). As argued later, some series contain outliers¹³, which must be controlled for with means of dummy variables. Otherwise they could distort statistical tests based on sample means and variances. Bias or distortion of estimates and/or p-values may lead to false conclusions, hence it is particularly important to acknowledge these unusual values. The full set of the constraints is presented in Appendix A.

When estimating the semi-restricted model, unconstrained parameters could turn out to be insignificant¹⁴. In order to obtain a parsimonious panel VARX model, zero-restrictions are in that case put on these variables as well (Brüggemann, 2004). The system is thereafter re-estimated and additional equation-specific constraints are imposed on variables with insignificant coefficients. This procedure continues until all non-restricted parameters are significant (Linzert, 2001).

4.6 Evaluation

To validate that the final estimated model is well specified diagnostic checking in three steps will follow. First, the Lagrange-multiplier (LM) test of no remaining autocorrelation in the disturbance terms is performed (Johansen, 1995). If the null hypothesis of no autocorrelation at lag j is rejected, the obtained standard errors are inaccurate and may result in misleading hypothesis tests¹⁵ (Hill, Griffiths and Lim, 2008). Second, the Jarque-Bera statistic reports if the residuals are normally distributed. Failure to reject the null of multivariate normality indicates that the model is well

¹³ A value is considered as an outlier if it deviates more than 2 standard deviations from the mean. The summary statistics for the examined time series are presented in Appendix B.

¹⁴ A significance level of 25% is used due to many parameters and to retain as much feedback effect as possible.

¹⁵ If this is the case, the appropriate remedy would be to add more lags to the model.

specified and that the point estimates are valid, whereas rejection implies that the drawn conclusions may be incorrect (Jarque and Bera, 1987). The third and last diagnostic check is to test whether the system is stable. If all the eigenvalues lie inside the unit circle, the VARX model satisfies the stability condition. Only then are the interpretations of the impulse response functions known (Enders, 2009).

4.7 Test of Granger causality

The Granger causality test reflects feedback effects in VARX models. Although the test, in conjunction with several assumptions, may aid in determining the true direction of causality it does not establish it (Hamilton, 1994). This derives from the fallacy of *post hoc ergo propter hoc*¹⁶ that cannot be excluded¹⁷. The test reveals if past values of one variable are helpful in predicting future values of another variable in the system (Enders, 2009). Building on this fact, interdependencies between domestic and foreign variables could be identified.

The null hypotheses in the *bivariate tests*¹⁸ are

$$\begin{array}{lll}
 H_0: S_i \nrightarrow FD_i & H_0: FD_i \nrightarrow S_i & H_0: FD_i \nrightarrow S_l \\
 H_0: GDP_i \nrightarrow FD_i & H_0: FD_i \nrightarrow GDP_i & H_0: FD_i \nrightarrow GDP_l \\
 H_0: I_i \nrightarrow FD_i & H_0: FD_i \nrightarrow I_i & H_0: FD_i \nrightarrow I_l \\
 & & H_0: FD_i \nrightarrow FD_l
 \end{array}$$

where the earlier stated notations hold. A rejection of the null hypothesis indicates that the left hand variable Granger cause the right hand side.

¹⁶ Latin for "after this, therefore because of this". It is a fallacy stating that since X followed Y, Y must have caused X. This is not necessarily true.

¹⁷ The fallacy is on the other hand prevalent for all causality testing.

¹⁸ Block-exogeneity tests will also be conducted in order to determine whether the private savings rate and the private investment rate should be incorporated in the model.

4.8 Orthogonalized impulse response function (OIRF)

One of the objectives of this study is to investigate how the endogenous variables interact with one another. Another aim is to examine how they react to an innovation in financial depth¹⁹. For the latter purpose, either impulse response functions (IRF) or orthogonalized impulse response functions (OIRF) are to be used. If it is case that the residuals in the variance/covariance matrix are correlated, a shock in one error term might be accompanied by a shock in another. In this scenario the IRF are not good at isolating the impulse from one specific error term²⁰. Following Beetsma and Giuliodori (2011), the correlations between the disturbances are therefore computed. The correlation is given by

$$\rho_{12} = \frac{\sigma_{12}}{\sigma_1 \sigma_2} \quad (\text{M.12})$$

where ρ_{12} is the correlation coefficient between e_{1t} and e_{2t} and σ_{12} , σ_1 and σ_2 are given by the variance/covariance matrix, see Appendix C.1 (Enders, 2009). If $\rho_{12} \neq 0$ the OIRF is preferred since it assesses how a shock in the error term of financial depth transmits over time in the VARX, while forcing all other shocks to be zero (Love and Zicchino, 2006).

Ordering

Regarding the OIRF analysis in this study, the approach follows the methodology suggested by Hamilton (1994) and Enders (2009). That is, theoretical reasoning determines the ordering of the variables, which is important when the Choleski decomposition²¹ is considered. As Hamilton (1994) argues, the particular ordering depends on how the research question is formulated. In this study, the variables are therefore entered according to $[FD_t, FD_i, S_t, S_i, I_t, I_i, GDP_t, GDP_i]'$, where the first is considered to be more exogenous than the ones listed later. The assumptions behind the

¹⁹ Given that the financial markets in Europe have changed much over time, for example by the introduction of free capital movements and the EMU, it is expected that more innovations are to come (European Commission, 2011). The shock is thus sent into financial depth.

²⁰ The magnitude of the shock is one standard deviation of financial depth.

²¹ Choleski decomposition imposes a minimal set of constraints on the parameters so that the VAR is not underidentified and the impulse response functions can be determined (Enders, 2009).

ordering, described in the following paragraphs, are based on the theories and findings presented in section 2.

Financial depth is believed to be causally prior to the private savings rate, which in turn is causally prior to the private investment rate. The private investment rate is further assumed to be causally prior to real GDP per capita. Thus, economic growth only affects the investment rate, savings rate and depth through its lags. The investment rate does not have any contemporaneous effect on the private savings rate and financial depth. Moreover, the savings rate does not have any contemporaneous effects on depth. Below is an in-depth discussion of this identification scheme.

In line with Schumpeter's (2012) argument that financial sectors aid in mobilizing and allocating savings and improve investments, it is assumed that *financial depth is causally prior to the private savings rate and the private investment rate*. Hence, a development in the financial sector is allowed to have a contemporaneous effect on the savings rate and the investment rate, but savings and investment will only affect depth via their lags. The last mentioned relationship is based on arguments similar to the demand-following hypothesis. That is, demand for new savings products and more credit will after some time lead to developments of the financial market. An example that reflects this is subprime lending in the US (Keys et al., 2012).

Over the years, it has been standard to view monetary variables –financial depth in this case– as more exogenous than output. Following the McKinnon-Shaw hypothesis and King and Levine's (1993) findings, it is believed that *financial depth has a contemporaneous effect on real GDP per capita*. At the same time, it is assumed that real GDP per capita only affects financial depth through its lags because even if a country experiences high economic growth it takes time to change the financial structure.

The *private savings rate directly affects the private investment rate as well as the real GDP per capita*. This is reasonable because financial intermediaries can match depositors and creditors within a time period. If the saved money is invested, real GDP per capita increases contemporaneously. However, neither the private investment rate nor real GDP per capita are assumed to have a direct effect on savings since the decision to save

is based on the past level of investment and income (Crockett and Friend, 1967; Checherita and Rother, 2010).

Finally, the *private investment rate is causally prior to real GDP per capita* because investments automatically drives output. This argument is mainly based on the GDP identity. As in the case of savings, the decision to invest relates to historic income. Hence, real GDP per capita only effects investment through its lags.

Observe that every second variable in the ordering corresponds to country i . This structure is used since it does not fully distinguish between entities by saying that one country's whole set of variables are more exogenous than the other's. Imposing an order of the countries *within* one variable is on the other hand inevitable. The absence of prior information about a logical causal ordering of the countries and variables in the VARX model does carry some arbitrariness²² into the system and may have implications for the interpretations (Koop, Pesaran and Potter, 1996). Enders' (2009) suggestion to verify the obtained result by changing the order and re-estimating the OIRF was therefore used as robustness check.

²² This emanates from the fact that the ordering cannot be determined with statistical methods but has to be specified by the economist

5 Data

In this section, the method of data collection as well as its appearance in levels is demonstrated. The transformation of the data leading up to the key analysis –the Granger causality tests and the OIRF– then follows.

5.1 Data collection

One of the contributions of this study is to apply the VARX framework on data from developed countries. For this reason Europe was studied. To account for the variables’ dynamic interactions across countries, the sample was narrowed down to the members of the Economic and Monetary Union (EMU), where it is assumed that feedback effects are more observable since these countries share many characteristics. Data restrictions, particularly in the financial depth measure, further scaled down the sample size.

To avoid working with unbalanced panel data, a list-wise deletion technique was applied on countries with missing values for more than two consecutive years. This technique was motivated by the seemingly randomness of the dropouts. For the countries not excluded, albeit suffering from loss of information, a linear interpolation method was used to replace missing observations. The method fits a straight line between the two closest data points in order to find the intermediate value. As for missing observations in the end of a sample, an extrapolation method was applied, using the last two available observations to extend a line to the missing value.

The new sample contained six countries. Due to risk of over-parameterization of the VARX model, resulting in few degrees of freedom, the final sample however only included Belgium and the Netherlands. These nations’ formal bond dates at least back to 1958 when the Benelux Economic Union was founded. The union’s aim was to achieve total economic integration through free movement of workers, capital, services and goods (Treaty of the Benelux Economic Union, 1958). To this day, the countries are still

closely related. For example, both are members of the EMU and the North Atlantic Treaty Organization (NATO), and they have cultural and geographical similarities (European Commission, 2013; North Atlantic Treaty Organization, n.d). Hence, the interdependencies between the examined countries’ variables could be large.

To account for the Belgian and Dutch adoption of the Euro, a dummy variable was constructed, whereby every year after 1998 was coded as 1. This exogenous variable, which was included in every series, shall capture the collaboration that the EMU brought about. The other variables –nominal GDP, gross capital formation in the economy, gross fixed capital formation of the government, and private savings– were extracted from Ameco (2013), the macroeconomic database of the European Commission. The database, last updated on February 22, 2013, covers the EU-27, candidating member countries to the EU and ten OECD countries. The data was collected from 1970 to 2011 on an annual basis. All variables are reported in the European currency unit (€), if not otherwise stated. The nominal GDP was converted into real GDP per capita by using both a price deflator with a base year of 2005 and estimates on population size, both retrieved from Ameco. Furthermore, private investment was calculated as gross capital formation of the economy as a whole minus gross fixed capital formation of the government. The *private investment rate* was then computed as a share of nominal GDP. This definition follows previous empirical work within the finance-growth field (see for instance Goldsmith, 1969; King and Levine, 1993; Levine and Zervos, 1998; Levine, Loayza and Beck, 2000). The usage of *private savings rate* is also in line with earlier work (see Feldstein and Horioka, 1980) and it was defined as private savings in the economy divided by nominal GDP. Following Xu’s (2000) logic, the latter two variables must not be transformed into real terms since they were divided by nominal GDP. Note that the investment rate and savings rate only relate to the private sector because the public sector usually has easier access to credit and therefore it is less sensitive to changes in financial depth.

Finally, data on financial depth between 1970 and 2011 was retrieved from the Financial Development and Structure Dataset, updated in April 2013 by Beck et al. (2013). The dataset includes numerous proxies, where *private credit by deposit money banks and other financial institutions as a percentage of GDP* was used in this study (for

support see King and Levine, 1993; Demetriades and Hussein, 1996; Rajan and Zingales, 1998; 2003; Townsend and Ueda, 2010). The proxy is more accurate than the World Bank’s (2013) and King and Levine’s (1993) measure of private credit because the first did not include other financial institutions and the second comprised credit issued by monetary authorities and governments. Thus, the measure used here is broader and it isolates private credit issued by financial intermediaries only. On the other hand, recent research shows that as economies develop services provided by the stock market become relatively more important than those provided by banks (Demirguc-Kunt, Feyen and Levine, 2012). Stock market capitalization as a proxy for financial depth could thus be a superior measure. However, data on private credit to GDP was the only measure available for a long enough time horizon and it was therefore preferred.

5.2 Data appearance

In the beginning of the 1980s, capital controls were extensive in Europe. Contrary to many other European nations, both Belgium and the Netherlands have had a long history of high capital mobility (European Commission, 1997). The financial markets in Belgium and the Netherlands are therefore expected to be quite deep, which Figure B.3 confirms. The time series of the variable in levels display that the markets have deepened over time. In 1970, the proxy for financial depth was around 18 per cent of GDP in Belgium and 31 per cent of GDP in the Netherlands. Visual inspection indicates that there is a structural break in Belgium’s trend in 1992-1993, after which the deepening continues in the same pace as before the break. When the Euro is introduced, both countries face a deepening that is approximately four times larger than in the 1970s. However, the proxy has declined recently due to the financial crisis that struck Europe in 2008.

Real GDP per capita in levels also show a trending behavior (see Figure B.4). Belgium and the Netherlands’ economic growth seem to move together and be affected by the same macroeconomic events, which the small dip in 1975 and the large decline in 2009 indicate. The patterns for private investment and private saving, both in levels, are however less clear. As depicted in Figures B.1 and B.2, the series fluctuate much over the years. The variances for investment seem to be changing and the series would therefore

be nonstationary and follow a random walk. Private saving, on the other hand, departs temporarily from a positive value, but inspection suggests that the variance is stable over time, making the series stationary.

5.3 Transformation of the data

5.3.1 Specification of the panel VARX(p) model

The number of lags, j , included in the unit root tests below are based on the information criterion: AIC and BIC. Since BIC suggested a lag length of zero, AIC’s recommendation of two lags was followed.

The belief that the countries’ private investment rates in levels were nonstationary was confirmed by the ERS test without trend since the null was not rejected. At convenient significance levels, the ERS test without trend also indicated that the level of the private savings rate for Belgium contained a unit root. However, the private savings rate in levels in the Netherlands was stationary since the ERS test without trend lead to a rejection of the null at 5% significance level. Table B.2 reports these results.

Since both countries’ real GDP per capita in levels as well as the Netherlands’ proxy for financial depth in levels were showing a trending behavior, the ERS test with trend was implemented. Yet again, the null hypothesis of a unit root could not be rejected for any of the series at conventional significance levels (see Table B.2). The visual inspection of the variables in levels indicated that there was a structural break in the intercept in Belgium’s financial depth (see Figure B.3). Consequently, the Zivot and Andres test was used, also represented in Table B.2. The null hypothesis of a unit root was rejected at 5% significance level, confirming the time series to be stationary.

As recommended in section 4.4, series containing unit roots shall be transformed into the first difference of the natural logarithm. In order to simplify the subsequent analysis all series were transformed since the majority followed a random walk process. The ERS test without trend indicated that all new series were stationary at the 5% significance level. The results from the new unit root tests are to be found in Table B.4. These

transformed variables are the ones used in the VARX model, in the Granger causality tests and in the shock analysis.

Table B.3 presents the summary statistics of the new variables and their plots are depicted in Figures B.5-B.8. Visual inspection suggests that the trending behavior has disappeared, and each series seems to meander around a constant mean and have constant variance. Although the natural logarithm narrowed the range of the data as Wooldridge (2009) anticipated, outliers remained (see for example Figure B.7). To assure that these observations do not influence the result year dummies are inserted.

5.3.2 Estimation of the model

After ensuring that the series were stationary, the initial model with its 52 constraints was estimated. This estimation resulted in several insignificant parameters, especially in the equation of the private investment rate. Re-estimation of the system till all unconstrained variables were significant yielded

$$FD_{BE,t} = FD_{BE,t-1} + GDP_{BE,t-2} + S_{BE,t-1} + I_{BE,t-1} + I_{BE,t-2} + FD_{NL,t-1} + D9293_t$$

$$S_{BE,t} = cons + FD_{BE,t-1} + FD_{BE,t-2} + GDP_{BE,t-2} + S_{BE,t-1} + I_{BE,t-2}$$

$$GDP_{BE,t} = cons + GDP_{BE,t-1} + I_{BE,t-2} + GDP_{NL,t-2} + D2009_t$$

$$I_{BE,t} = S_{BE,t-1} + FD_{NL,t-1} + FD_{NL,t-2} + D2009_t + D1981_t$$

$$FD_{NL,t} = FD_{NL,t-1} + FD_{NL,t-2} + I_{NL,t-2} + GDP_{NL,t-1} + GDP_{NL,t-2}$$

$$S_{NL,t} = cons + GDP_{NL,t-1} + GDP_{NL,t-2} + I_{NL,t-1} + S_{NL,t-1} + FD_{BE,t-2} + D2008_t$$

$$GDP_{NL,t} = cons + GDP_{NL,t-2} + S_{NL,t-2} + S_{BE,t-2} + D2009_t$$

$$I_{NL,t} = cons + FD_{NL,t-2} + GDP_{NL,t-1} + S_{NL,t-2} + FD_{BE,t-1} + D2009_t + D1981_t$$

Where FD , GDP , S and I have the same interpretation as mentioned in section 3.1, and $cons$, $D1981$, $D9293$, $D2008$ and $D2009$ are the constant and the year dummies, respectively. Also, the subscripts BE and NL stand for Belgium and the Netherlands. These equations represent the structural form of the final VARX model. Observe that the

VARX parameters in themselves are not particularly interesting to interpret²³ but rather the Granger causation and the orthogonalized impulse response functions are (Brüggemann, 2004).

5.3.3 Evaluation

Depicted in Appendix C.3, the diagnostic checking of the final VARX model revealed whether the three assumptions of no remaining serial correlation, normally distributed errors and a stable system were met. First, Table C.3 shows that the LM test did not reject the null hypothesis of no remaining serial correlation in the residuals. This held true at any conventional significance levels. Hence, the obtained standard errors and the subsequent hypothesis tests will be accurate. Second, the Jarque-Bera statistic reported that the errors were normally distributed, making the model well specified (see Table C.4). Third, Figure C.1 in Appendix C.3 confirms that the system was stable since all eigenvalues were inside the unit circle. Thanks to these three outcomes the next step is Granger causality testing and orthogonalized impulse response analysis.

²³ Due to the large number of parameters that has to be estimated in relation to the available time period the degrees of freedom become rather small. The coefficients in a VAR model are thus not very precise.

6 Results

In the process of fulfilling this study’s objective, the subsequent section will provide the relevant results. The findings of the bivariate Granger causality tests, where focus is placed on financial depth, are first summarized. Thereafter follows the empirical evidence on the shock analyses.

6.1 Test of Granger causality²⁴

Although the null hypotheses in section 4.7 are written in general form, the final VARX model did not contain every variable in each equation. This fact led to a modification of the null hypotheses so that they corresponded to the *actual* equations.

Bivariate tests within countries

The null hypotheses for the bivariate tests given in section 4.7 were changed as to fit the final VARX model. For domestic effects the null became

$$\begin{aligned}
 H_0: S_{BE} &\nrightarrow FD_{BE} & H_0: GDP_{NL} &\nrightarrow FD_{NL} \\
 H_0: GDP_{BE} &\nrightarrow FD_{BE} & H_0: I_{NL} &\nrightarrow FD_{NL} \\
 H_0: I_{BE} &\nrightarrow FD_{BE} & H_0: FD_{NL} &\nrightarrow I_{NL} \\
 H_0: FD_{BE} &\nrightarrow S_{BE}
 \end{aligned}$$

Regarding the null hypotheses of no bivariate relationship between savings and financial depth in Belgium, both tests were rejected. This implies that they Granger cause each other. Continuing with Belgium, real GDP per capita did Granger cause financial depth. The same unidirectional causality was true for the Netherlands’s domestic variables. In both countries the domestic private investment rate Granger caused domestic financial

²⁴ Block-exogeneity tests confirmed that private savings and investment rate should be included in the model. Results available upon request.

depth. However, when testing the reverse order for the Netherlands the test failed to reject the null at 10% significance level, implying that financial depth did not Granger cause the private investment rate.

Bivariate tests across countries

The revised null hypotheses for the cross-country relationships were

$$\begin{aligned} H_0: FD_{BE} \nrightarrow S_{NL} & \quad H_0: FD_{NL} \nrightarrow I_{BE} \\ H_0: FD_{BE} \nrightarrow I_{NL} & \quad H_0: FD_{NL} \nrightarrow FD_{BE} \end{aligned}$$

Significant dependencies across countries were found, as shown by Table 1. In short, financial depth in Belgium Granger caused both the private savings rate and the private investment rate in the Netherlands. Financial depth in the Netherlands Granger caused the Belgian private investment rate and depth variable.

Table 1 and 2 below summarize the outcomes from the bivariate tests as well as our hypotheses. As can be seen, the null hypotheses of no Granger causality were rejected at 5% significance level for all combinations but one; namely the Dutch financial depth on the Dutch private investment rate.

Table 1: Test for Granger causality

Variable	prob > chi2	Chi2	Granger Causation
$FD_{BE} \rightarrow S_{BE}$	0.0377	4.32	Yes
$S_{BE} \rightarrow FD_{BE}$	0.0000	16.62	Yes
$GDP_{BE} \rightarrow FD_{BE}$	0.0078	7.07	Yes
$GDP_{NL} \rightarrow FD_{NL}$	0.0000	45.06	Yes
$I_{BE} \rightarrow FD_{BE}$	0.0004	15.74	Yes
$I_{NL} \rightarrow FD_{NL}$	0.0001	15.62	Yes
$FD_{NL} \nrightarrow I_{NL}$	0.2177	1.52	No
$FD_{BE} \rightarrow I_{NL}$	0.0172	5.68	Yes
$FD_{BE} \rightarrow S_{NL}$	0.0276	7.18	Yes
$FD_{NL} \rightarrow I_{BE}$	0.0183	8.00	Yes
$FD_{NL} \rightarrow FD_{BE}$	0.0126	6.23	Yes

Table 2: Outcome of our hypotheses

No.	Hypothesis	Outcome
H1	$FD_{i,l} \leftrightarrow S_{i,l}$	Confirmed
H2	$FD_{i,l} \leftrightarrow GDP_{i,l}$	Rejected. Unidirectional: Belgian (Dutch) GDP Granger cause Belgian (Dutch) FD
H3	$FD_{i,l} \leftrightarrow I_{i,l}$	Rejected. Unidirectional: Belgian (Dutch) I Granger causes Belgian (Dutch) FD. Dutch FD does not Granger cause Dutch I.
H4	$FD_i \rightarrow S_l$	Confirmed. Unidirectional: Belgian FD Granger causes Dutch S.
H5	$FD_i \rightarrow GDP_l$	Rejected. One country’s FD does not enter the other country’s GDP equation.
H6	$FD_i \leftrightarrow I_l$	Rejected. Unidirectional: Belgian FD Granger causes Dutch I.
H7	$FD_i \leftrightarrow FD_l$	Rejected. Unidirectional: Dutch FD Granger causes Belgian FD.

*The arrows indicate in what direction the Granger causality was believed to be found.

Note: The definition of the variables are: $FD = \Delta \ln$ (financial depth), $GDP = \Delta \ln$ (real GDP per capita)

$I = \Delta \ln$ (private investment rate), $S = \Delta \ln$ (private savings rate)

6.2 Orthogonalized impulse response (OIRF)

The results from the Granger causality tests provide valuable information for the subsequent analysis and discussion (section 7). Nonetheless, the Granger causality test falls short of quantifying the dynamic effect in a response variable (S , I and GDP) from an innovation in an impulse variable (FD). For this purpose, being one of the main objectives of this empirical research, shock analyses were conducted. As explained in section 4.8, the contemporaneous residuals might correlate; a prediction that turned out to be true (see the Covariance/Variance matrix in Appendix C.1). Therefore the *Orthogonalized impulse functions* were used, since they trace out the variables’ reaction to an isolated one standard deviation shock in the error term of financial depth.

Appendix C.4 presents the response functions. The shaded area constitutes the 90% confidence interval. Consequently, whenever the lower and upper bound of the interval contains the zero the effect is insignificant.

Shock in Belgium's financial depth

The effect of a shock in the variable itself seemed to be rather persistent, showing a positive response in several periods. Gradually the effect leveled off and Belgium's financial depth reached its initial value. The short run response in the Belgian private savings rate was negative before bouncing back to positive values, and subsequently stabilizing around zero. The private investment rate in the Netherlands behaved rather similarly. That is, the variable decreased at the beginning and remained below zero until the medium term where it returned to its initial level²⁵. The response in the Dutch private savings rate was *insignificant*, although more negative than positive.

Shock in the Netherland' financial depth

The contemporaneous positive response in the variable itself endured in the short run. Later on, the variable turned negative²⁶ before it stabilized around its original state. Regarding the response in the domestic private investment rate, the early positive effect sustained for barely one period. Following that, a decline was observed. However, the variable resumed its original value rather quickly. The cross-country effect of a shock in the Dutch financial depth on the Belgian depth was initially significantly positive. Before the Belgian market returned to its normal level, a dip below zero was observed. This drop happened in the long run. As for the savings rate in Belgium, the response function indicated a positive reaction at first but it turned negative after a while before returning to its initial stage.

Comparing the results between countries and variables the results were quite mixed. Overall, the system appeared to be stable as all variables gradually returns to their before-shock-level.

7.3 Robustness check of the OIRF

The preceding OIRF analysis was carried out using a predetermined order, see section 4.8. To test the credibility of the obtained result Enders (2009) suggested that it is compared with the findings of the reversed order. However, as the focus was on impulse

²⁵However, in the long run the effect is not significant.

²⁶ Although not completely significant the OIRF seems to exhibit a tendency of negative persistence.

responses to financial depth shocks, the other variables should not be affected by another relative ordering since they were all ordered after depth (Christiano, Eichenbaum and Evans, 1999 cited in Beetsma and Giuliadori, 2011, p. F12).

Nevertheless, since this study allows for a shock from both Belgium and the Netherlands the relative ordering of the countries should be controlled. The robustness check indicated that there were no major discrepancies between the two orders (see section C.4 in the Appendix). Only when the impulse variable was financial depth in the Netherlands and the response variable was financial depth in Belgium did the result differ. This stems from the fact that the restriction on the contemporaneous correlation between their error terms has changed.

7 Analysis and discussion

In the following, the results are analyzed in relation to earlier empirical research and theories. Also, references are made to our hypotheses as presented in section 3. The findings of the Granger causality tests are first discussed; thereafter the implications of the OIRF are stated.

7.1 Reflections on the Granger causality tests

The result from the bivariate Granger causality tests indicates that there is bidirectional causality between private savings rate and financial depth in *Belgium*. This relationship combines Odhiambo’s (2008) finding of a one-way causation in Kenya going from savings to depth, and Bandiera’s, et. al., (2000) and Chinn and Ito’s (2008) conclusion of the reversed relationship in other developing countries. The dynamics between financial depth and savings thus seem to be sensitive to the specific characteristic of a country and/or appearance of the model²⁷.

In line with Robinson (1952) and Jung (1986), convincing support is provided for the demand-following hypothesis that finance follows growth within a country. The hypothesis is further strengthened by the causal effect that the private investment rate has on financial depth. Together they provide evidence that demand for financial services drives the development of the financial market, and not the other way around. That recent empirical work within the finance-growth nexus has been unsuccessful in finding a unidirectional causation from growth to depth (see for example Xu, 2010) could be due to the fact that savings and investment have not been incorporated simultaneously.

²⁷ For example, Hamilton (1994) argued that the results of Granger causality tests depend on the used lag length or the methods applied when transforming random walk processes into stationary series.

Although financial depth did not provide useful information about the domestic private investment rate, it did so on the foreign rate. The countries under consideration, Belgium and the Netherlands, have a long history of developed and integrated financial markets. It could be argued that the marginal effect of an increase in financial depth is no longer visible within a country. Thanks to a well-functioning financial system much of the national investment opportunities have already been exploited. This may also serve as an explanation to why the results gave no support for the supply-leading hypothesis within a country. Policies such as the Benelux Economic Union and EMU have presumably contributed to a changed focus, from the domestic to the international level, with regards to identifying profitable investments.

All in all, the results of this paper does not support Lucas (1988, p. 6) claim that the role of the financial system is “badly over-stress.” Rather, financial depth seems to be important when the private savings and investment rate are included in a VARX model when applied to European data. This is to some extent confirmed by Table 2 in section 6.1 that shows the outcome of *our* hypotheses; predictions that often turned out wrong but still unidirectional relationships to/from financial depth were prevalent. The table below summarizes the outcomes of the bivariate tests.

Table 3: Summary of Granger causality tests

Variables*	Causality
$S_B \leftrightarrow FD_B$	Dynamic causality within a country. Belgian S and FD Granger cause each other.
$GDP_B \rightarrow FD_B$	Uni-directional causality, within a country. Belgian GDP Granger causes Belgian FD.
$GDP_N \rightarrow FD_N$	Uni-directional causality, within a country. Dutch GDP Granger causes Dutch FD.
$I_B \rightarrow FD_B$	Uni-directional causality, within a country. Belgian I Granger causes Belgian FD.
$I_N \rightarrow FD_N$	Uni-directional causality, within a country. Dutch I Granger causes Dutch FD.
$FD_N \nrightarrow I_N$	No uni-directional causality, within the Netherlands. Dutch FD does not Granger cause Dutch I.
$FD_B \rightarrow I_N$	Uni-directional causality, across countries. Belgian FD Granger causes Dutch I.

$FD_B \rightarrow S_N$	Uni-directional causality, across countries. Belgian FD Granger causes Dutch S.
$FD_N \rightarrow I_B$	Uni-directional causality, across countries. Dutch FD Granger causes Belgian I.
$FD_N \rightarrow FD_B$	Uni-directional causality across countries. Dutch FD Granger causes Belgian FD.

*The arrows indicate in what direction the Granger causality was found, or not found.

Note: The definition of the variables are:

$FD = \ln \Delta$ (financial depth), $GDP = \ln \Delta$ (real GDP per capita)

$I = \ln \Delta$ (private investment rate), $S = \ln \Delta$ (private savings rate)

7.2 Reflections on the OIRF

This empirical study shall provide insights into *how* some macroeconomic variables – real GDP per capita, private savings rate and investment rate– respond over time to a shock in financial depth, within and across two European countries. The succeeding discussion, based on the results from the OIRF, intends to fulfill this objective.

Although the McKinnon-Shaw hypothesis argued that a well-developed financial sector should boost savings through the increased efficiency in intermediation, the results from the OIRF suggested otherwise. In the medium run the savings rate experienced a negative response to an innovation in both domestic and foreign financial depth. This finding is in line with earlier empirical work by Jappelli and Pagano (1994); Bandiera et al. (2000); Worldbank (2013) and Chinn and Ito (2008), who all argued that reduced need for precautionary savings and easier access to credit lower the savings rate.

A shock in Belgium had a detrimental effect on investments in the Netherlands, while a shock in the Netherlands transformed, at least in the short term, into a positive response in Belgium’s investment rate. The response in investment from a shock in foreign financial depth provided two interesting cross-country implications, one general and one specific. With regard to the former, it reinforces the earlier argument that a deepening of financial markets in developed countries has no marginal effect on the

domestic economy, but rather on the foreign. In the specific case one could argue that the investment landscape is considered to be more profitable in Belgium.

In short, *our* hypotheses regarding the OIRF were in large confirmed. The only incorrect prediction relates to the response in real GDP per capita, a variable that was not dependent on financial depth. Consequently, Xu’s (2000) finding that investment was an important channel through which financial development affects economic growth could not be validated.

7.3 Policy implications

Expanding the implications of this analysis to the current account²⁸, some interesting policy implications can be drawn. It has been argued above that financial depth seems to have detrimental effects on both domestic and foreign private savings rates. Given that this decrease is not counteracted by an increase in governmental savings the current account will decrease²⁹, *ceteris paribus*. For a country to maintain its investment level it must borrow capital from abroad. In 2011, Belgium and the Netherlands had a public debt of 95% and 65%, respectively. In light of the current debt crisis, most prevalent in the European countries, a deepening of the financial market may not be an appropriate strategy as it stimulates current account deficits that worsen public debt. On the other hand, if one views Europe as a unity instead of many separate nations, a deepening in one market could be beneficial since it affects the foreign current account positively; remember that an innovation in Belgium reduced the Dutch investment rate and did not affect the Dutch savings rate. Depending on a country’s objective, less priority should maybe be given to financial reforms since they impact the foreign market more than the domestic. What can be concluded is that policy makers must consider dynamics *between* countries when making decisions with regard to financial markets.

²⁸ In general, current account equals national saving minus investment. The minuend and subtrahend are crucial channels through which economic policies and turbulences affect the balance (Obstfeld and Rogoff, 1996).

²⁹ Obstfeld and Rogoff (1996) argued that it might be misleading to look at a change in either savings or investment as the “cause” of a changed current account since the three variables are jointly determined and respond to common exogenous shocks. If the private savings or investment rates shift it is, however, inevitable to not get a changed current account, given constant *public* consumption and savings level.

8 Concluding remarks

The finance-growth nexus has been examined ever since the beginning of the 20th century. To this day, researchers have provided mixed evidence on the variables’ Granger causality. The validity of their diverse findings could be questioned due to biases from omitting one or more variables. In this study neither the private savings rate nor the private investment rate were omitted when studying the relationship between financial development and economic growth. By extending the prior dynamic models, this study tries to clarify the direction of causality between *financial depth* on one hand, and *real GDP per capita*, *private investment rate* and *private savings rate* on the other hand. This extension further entails studying the dynamics within and across countries in Europe. The second aim of the paper at hand is to determine how an innovation in financial depth in one country affects the other variables of interest. By examining the Granger causation and the OIRF, insights into the variables’ relationship within and across countries may be obtained. A VARX model on panel data from Belgium and the Netherlands is employed in order to meet the two objectives.

In contrast to earlier empirical work, this study provides evidence that there is bidirectional Granger causality between financial depth and private savings rate within a country (Belgium). One explanation for the contradiction could be that developed rather than undeveloped countries are examined. Performing the OIRF further deepens the understanding of the two variables’ dynamics. It is observed that the private savings rate falls when the financial sector in the home and/or foreign market is innovated. This behavior is reasonable given the theoretical arguments and empirical findings in earlier work. Furthermore, Robinson’s (1952) demand-following hypothesis is indeed supported as real GDP per capita Granger causes financial depth, within a country. That domestic investment rate Granger causes domestic financial depth provides additional evidence of the demand-following hypothesis. The reversed causality between investment rate and depth is, however, only observed across countries, indicating that international dynamics exists. It could be argued that well-developed markets already

have exploited domestic investment opportunities, thereby motivating the desire to invest abroad. The response in the investment rate when financial depth is shocked also suggests that international interdependencies exist. It is recommended that the European policy makers take the cross-country dynamics into consideration when reforming the financial system, especially since economic growth in the home market seems to be unaffected by financial innovations.

It seems reasonable to assume that other European nations with a long history of cooperation would react in accordance with this study's main findings if deepening occurs. However, the findings above should be interpreted within its proper context. The VAR model is known for the flexibility it offers when modeling interrelations between variables and the lack of a priori restrictions. The drawback is its less precise coefficients that stems from few degrees of freedom when many parameters and short time series are used. Since this empirical study includes as many as eight endogenous variables only two countries could be examined, or else the loss of power would be too great. The moderate number of variables further brings attention to a potential issue of omitted variable bias, as there might exist macroeconomic variables that are correlated with both financial depth and one or more of the included independent variables. Further research should both try to verify the presented empirical findings for other European countries and study more countries simultaneously. The relatively arbitrary ordering of the variables in the OIRF analysis is another limitation. The generalized impulse response function may be of help for future studies since it is invariant of the variables' ordering. What also is left to further research is to determine the Granger causation and the variables' reaction to a shock in another proxy for financial depth. By comparing the outcomes of different proxies guidance can be provided on which reforms to implement. Today, data availability constraints this possibility for Belgium and the Netherlands, but hopefully this is changed in the future.

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Appendix A Method

Constraints

Constraint 1-4: j-order lag of ln private savings rate in Belgium (the Netherlands) equals zero in the Netherlands (Belgium's) financial depth equation.

Constraint 5-8: j-order lag of ln private investment rate in Belgium (the Netherlands) equals zero in the Netherlands (Belgium's) financial depth equation.

Constraint 9-12: j-order lag of ln real GDP per capita in Belgium (the Netherlands) equals zero in the Netherlands (Belgium's) financial depth equation.

Constraint 13-16: j-order lag of ln private savings rate in Belgium (the Netherlands) equals zero in the Netherlands (Belgium's) ln private savings rate equation.

Constraint 17-20: j-order lag of ln private investment rate in Belgium (the Netherlands) equals zero in the Netherlands (Belgium's) ln private savings rate equation.

Constraint 21-24: j-order lag of ln real GDP per capita in Belgium (the Netherlands) equals zero in the Netherlands (Belgium's) ln private savings rate equation.

Constraint 25-28: j-order lag of ln real GDP per capita in Belgium (the Netherlands) equals zero in the Netherlands (Belgium's) ln private investment rate equation.

Constraint 29-30: dummy for extreme value in year 1981 equals zero in the Netherlands (Belgium's) financial depth equation.

Constraint 31-32: dummy for extreme value in year 1981 equals zero in the Netherlands (Belgium's) ln private savings rate equation.

Constraint 33-34: dummy for extreme value in year 1981 equals zero in the Netherlands (Belgium's) ln real GDP per capita equation.

Constraint 35: dummy for extreme value in year 1992-1993 equals zero in the Netherlands financial depth equation.

Constraint 36-37: dummy for extreme value in year 1992-1993 equals zero in the Netherlands (Belgium's) ln private savings rate equation.

Constraint 38-39: dummy for extreme value in year 1992-1993 equals zero in the Netherlands (Belgium's) ln private investment rate equation.

Constraint 40-41: dummy for extreme value in year 1992-1993 equals zero in the Netherlands (Belgium's) of ln real GDP per capita equation.

Constraint 42-43: dummy for extreme value in year 2008 equals zero in the Netherlands (Belgium's) financial depth equation.

Constraint 44: dummy for extreme value in year 2008 equals zero in Belgium's ln private savings rate equation.

Constraint 45-46: dummy for extreme value in year 2008 equals zero in the Netherlands (Belgium's) ln private investment rate equation.

Constraint 47-48: dummy for extreme value in year 2008 equals zero in the Netherlands (Belgium's) ln real GDP per capita equation.

Constraint 49-50: dummy for extreme value in year 2009 equals zero in the Netherlands (Belgium's) financial depth equation.

Constraint 51-52: dummy for extreme value in year 2009 equals zero in the Netherlands (Belgium's) ln private savings rate equation.

Appendix B Data

B.1 Data appearance

Plots of series in level form

Figure B. 1: Plot of private investment rate in levels

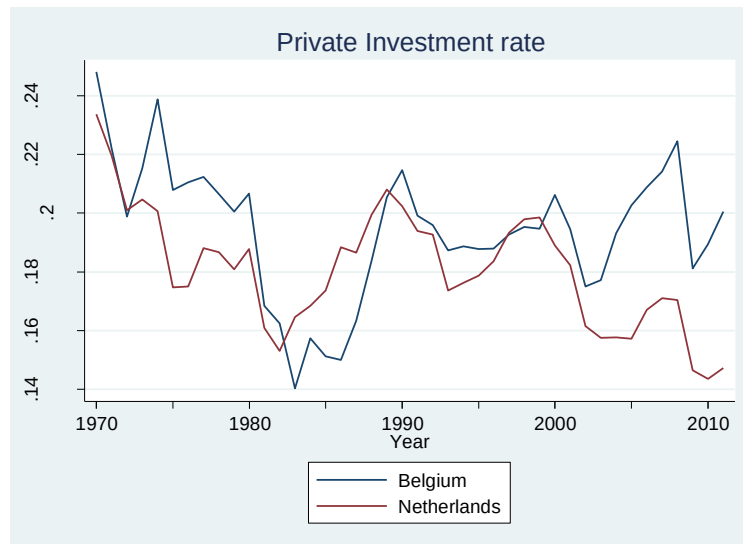


Figure B. 2: Plot of private savings rate in levels

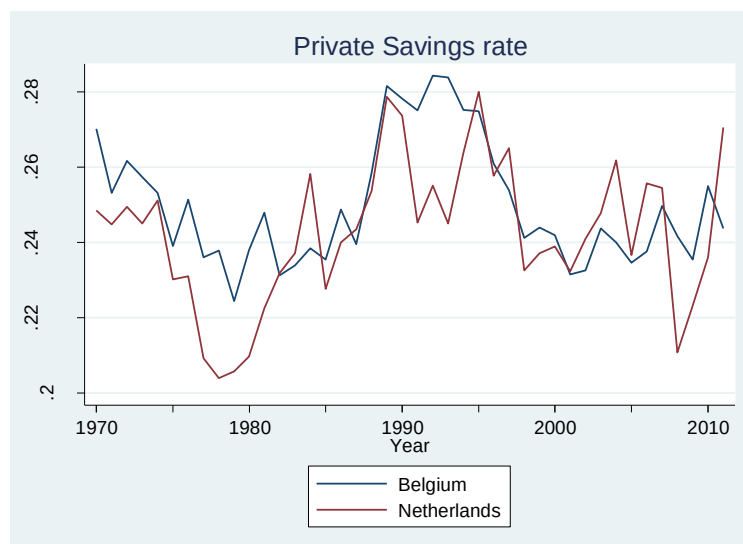


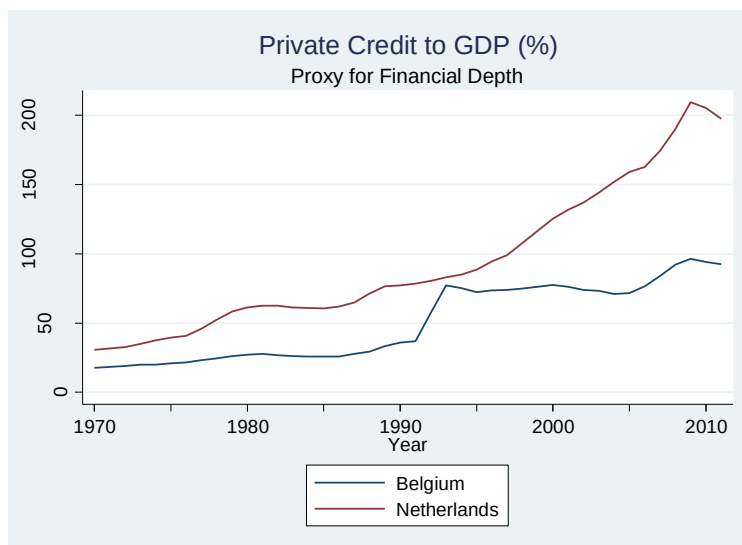
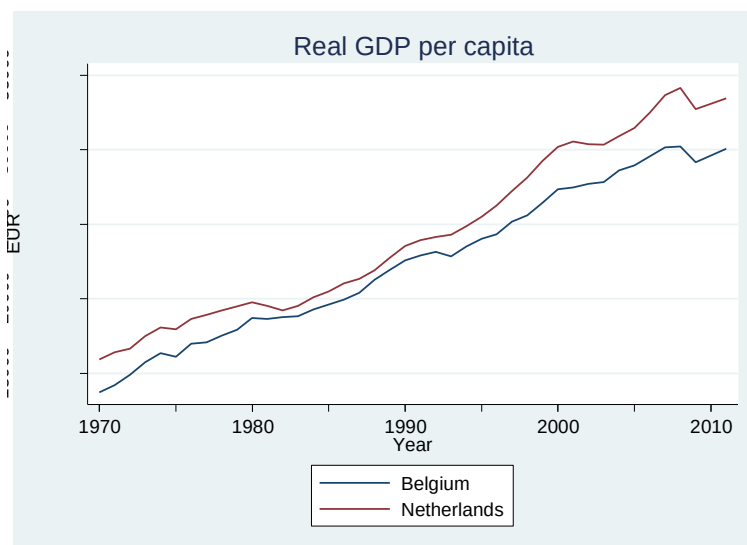
Figure B. 3: Plot of financial depth in levels**Figure B. 4:** Plot of real GDP per capita in levels

Table B. 1: Summary statistics for time series in levels

Variable	Mean	Std. Err.	Min	Max	T
Belgium					
Private investment	0.19	0.02	0.14	0.25	42
Private savings	0.25	0.02	0.22	0.28	42
Financial depth	50.44	27.60	17.50	96.28	42
Real GDP per capita	22509.37	5097.19	13715.90	30226.50	42
The Netherlands					
Private investment	0.18	0.02	0.14	0.23	42
Private savings	0.24	0.02	0.20	0.28	42
Financial depth	93.97	52.11	30.76	209.45	42
Real GDP per capita	24410.16	5753.66	15939.75	34160.20	42

Notes: Private savings are measured as rate of GDP, while Financial depth as % of GDP.

Table B. 2: Unit root tests for time series in levels

Variable	α	Std. Err.	H0: $\alpha = 0^1$	p	T	Time trend
Belgium						
Private investment	-0.114	0.0790	t = -1.43	1	39	No
Private savings	-0.135	0.0934	t = -1.45	1	39	No
Financial depth ²			t = -7.06***	2	39	Yes
Real GDP per capita	-0.323	0.127	t = -2.55	1	39	Yes
The Netherlands						
Private investment	-0.0535	0.0693	t = -0.77	1	39	No
Private savings	-0.355	0.145	t = -2.45**	1	39	No
Financial depth	-0.145	0.0696	t = -1.98	1	39	Yes
Real GDP per capita	-0.0828	0.0417	t = -2.08	1	39	Yes

¹ Number of lags was chosen to account for remaining serial correlation.

² The Zivot Andrews test revealed no unit root. Found break at time=23 (year 1992)

Notes: Significance levels for ERS tests with a constant but no time trend: -1.95 (5%), -1.6 (10%).

Significance levels for ERS test with constant and time trend: -3.19 (5%), -2.89 (10%). *** $p < 1\%$, ** $p < 5\%$, * $p < 10\%$.

B.2 Data transformation

Plots of series in logarithmic first difference

Figure B. 5: Plot of private investment rate in logarithmic first difference

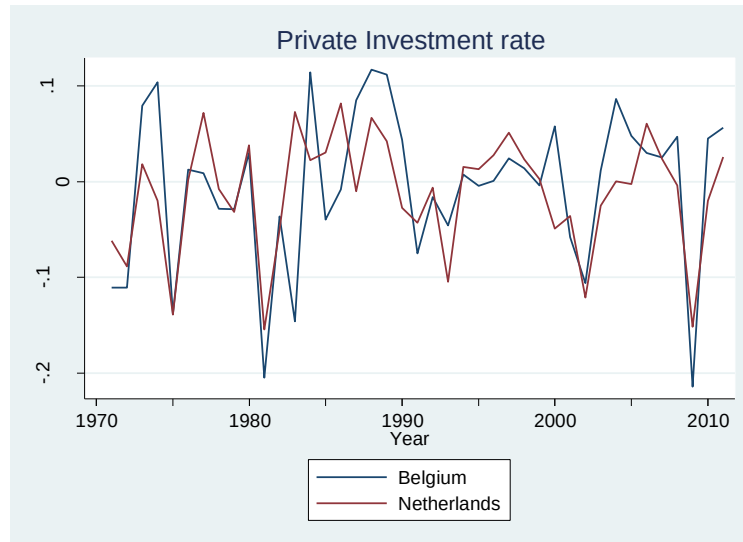


Figure B. 6: Plot of private savings rate in logarithmic first difference

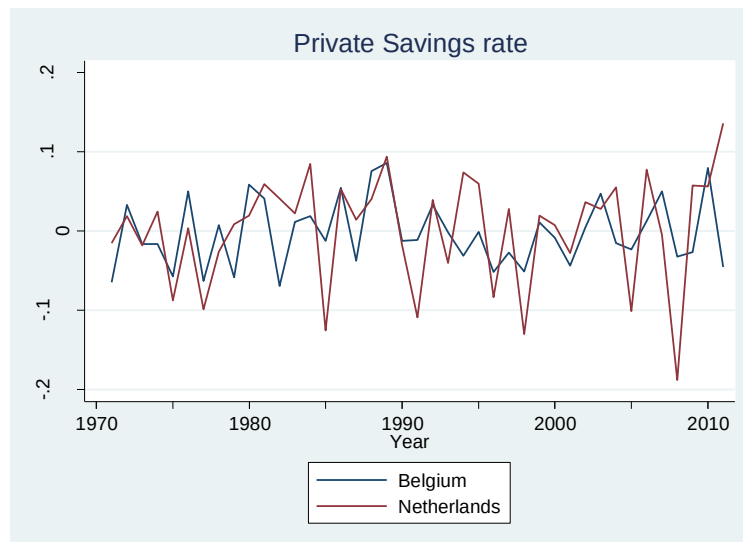


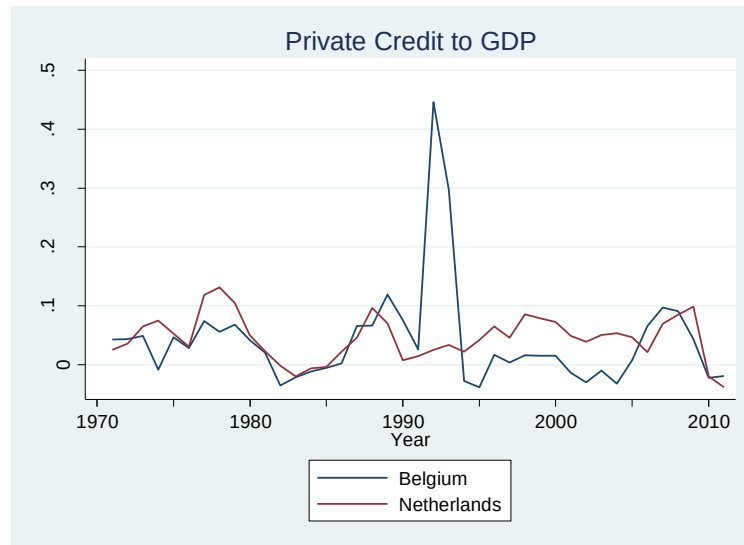
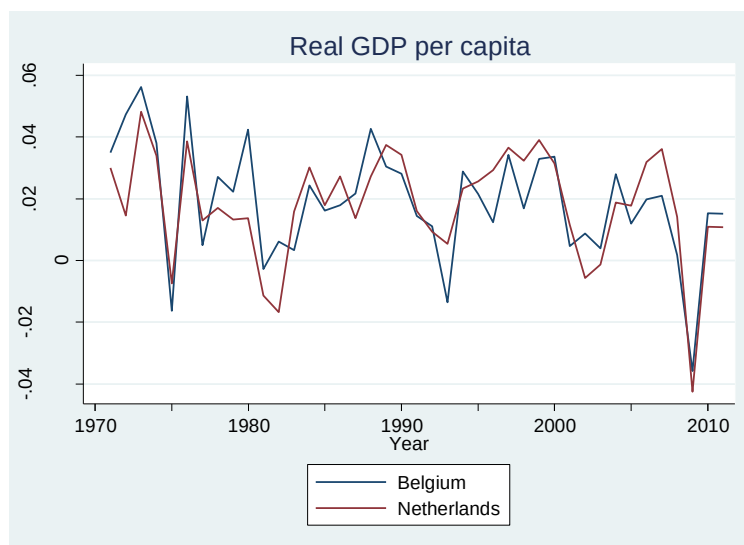
Figure B. 7: Plot of financial depth in logarithmic first difference**Figure B. 8:** Plot of real GDP per capita in logarithmic first difference

Table B. 3: Summary statistics for time series in logarithmic first difference

Variable	Mean	Std. Err.	Min	Max	T
Belgium					
Private investment ($\Delta \ln$)	-.0052	.0820	-.2144	.1171	41
Private savings ($\Delta \ln$)	-.0025	.0428	-.0694	.0858	41
Financial depth ($\Delta \ln$)	.0406	.0874	-.0385	.4454	41
Real GDP per capita ($\Delta \ln$)	.0191	.0185	-.0358	.0563	41
The Netherlands					
Private investment ($\Delta \ln$)	-.0113	.0603	-.1544	.0819	41
Private savings ($\Delta \ln$)	.0021	.0696	-.1882	.1359	41
Financial depth ($\Delta \ln$)	.0454	.0382	-.0385	.1311	41
Real GDP per capita ($\Delta \ln$)	.0181	.0176	-.0426	.0482	41

Notes: Private savings are measured as rate of GDP, while Financial depth as % of GDP.

Table B. 4: Unit root tests for time series in logarithmic first difference

Variable	α	Std. Err.	H0: $\alpha = 0^1$	p	T	Time trend
Belgium						
Private investment	-0.700**	0.214	t = -3.27	1	38	No
Private savings	-0.249*	0.170	t = -1.63	2	38	No
Financial depth	-0.728**	0.173	t = -4.21	1	38	No
Real GDP per capita	-0.735**	0.206	t = -3.57	1	38	No
The Netherlands						
Private investment	-0.846**	0.209	t = -4.04	1	38	No
Private savings	-1.232**	0.279	t = -4.42	1	38	No
Financial depth	-0.479**	0.139	t = -3.45	1	38	No
Real GDP per capita	-0.721**	0.186	t = -3.88	1	38	No

¹ Number of lags, p, was chosen to account for remaining serial correlation.

Notes: Significance levels for ERS tests with a constant but no time trend: -1.95 (5%), -1.6 (10%).

** p < 5%, * p < 10%.

Appendix C Results

C.1 Covariance/Variance matrix

Variables	Netherlands Financial depth ($\Delta \ln$)	Belgium Financial depth ($\Delta \ln$)	Netherlands Private savings ($\Delta \ln$)	Belgium Private savings ($\Delta \ln$)	Netherlands Private investment ($\Delta \ln$)	Belgium Private investment ($\Delta \ln$)	Netherlands Real GDP per capita ($\Delta \ln$)	Belgium Real GDP per capita ($\Delta \ln$)
Netherlands Financial depth ($\Delta \ln$)	.00058118							
Belgium Financial depth ($\Delta \ln$)	.00042598	.00136104						
Netherlands Private savings ($\Delta \ln$)	-.00030779	-.00034271	.00245779					
Belgium Private savings ($\Delta \ln$)	-.00018517	.00021294	.00104446	.0014881				
Netherlands Private investment ($\Delta \ln$)	.00036388	.00120288	-.00033087	.00015202	.0022194			
Belgium Private investment ($\Delta \ln$)	.00025965	.00057739	.00093431	.00072733	.00138965	.00325616		
Netherlands Real GDP per capita ($\Delta \ln$)	5.034e-06	.00020847	.00001442	.00006704	.00050722	.00056436	.00022095	
Belgium Real GDP per capita ($\Delta \ln$)	.0000524	.00020713	.00024547	.00020434	.00041981	.00075007	.00018884	.00026957

Notes: The top diagonal displays the variance (in bold). The lower triangular matrix displays the covariance. Symmetric $\sigma(8,8)$

C.2 Estimation

Table C. 1: Estimation of the restricted VARX(2) model

Variables	Financial Depth (Δ ln)		Private savings rate (Δ ln)		Private investment rate (Δ ln)		Real GDP per capita (Δ ln)	
	Netherlands	Belgium	Netherlands	Belgium	Netherlands	Belgium	Netherlands	Belgium
L1.Financial depth Netherlands (Δ ln)	0.793*** (0.115)	0.296** (0.119)				0.506*** (0.181)		
L2.Financial depth Netherlands (Δ ln)	-0.417*** (0.0992)				-0.157 (0.127)	-0.436** (0.184)		
L1.Financial depth Belgium (Δ ln)		-0.178*** (0.0610)		0.147** (0.0646)	-0.127** (0.0535)			
L2.Financial depth Belgium (Δ ln)			0.154** (0.0741)	-0.145** (0.0653)				
L1.Private savings rate Netherlands (Δ ln)			-0.417*** (0.0991)		0.196*** (0.0745)		0.0315 (0.0214)	
L2.Private savings rate Netherlands (Δ ln)								
L1.Private savings rate Belgium (Δ ln)		0.418*** (0.103)		-0.366*** (0.130)		0.592*** (0.137)		
L2.Private savings rate Belgium (Δ ln)							-0.0817** (0.0318)	
L1.Private investment rate Netherlands (Δ ln)			0.235 (0.144)					
L2.Private investment rate Netherlands (Δ ln)	-0.226*** (0.0573)							
L1.Private investment rate Belgium (Δ ln)		0.112** (0.0546)						
L2.Private investment rate Belgium (Δ ln)		0.187*** (0.0547)			0.179** (0.0755)			-0.0435** (0.0219)
L1. Real GDP per capita Netherlands (Δ ln)	0.782*** (0.174)		-1.044** (0.520)		-0.607** (0.253)		0.314*** (0.0840)	0.451*** (0.120)
L2. Real GDP per capita Netherlands (Δ ln)	0.598** (0.235)		-1.524*** (0.443)					-0.108 (0.0756)
L1. Real GDP per capita Belgium (Δ ln)								
L2. Real GDP per capita Belgium (Δ ln)		0.690*** (0.259)		-0.840** (0.348)		-0.176*** (0.0343)		
D1981					-0.0711*** (0.0259)			
D9293		0.413*** (0.0206)						
D2008			-0.129*** (0.0370)					
D2009					-0.160*** (0.0350)	-0.218*** (0.0507)	-0.0629*** (0.0138)	-0.0645*** (0.0146)
Constant			0.0456*** (0.0128)	0.0146 (0.00963)	0.0196** (0.00988)	0.0123*** (0.00249)	0.0114*** (0.00306)	

Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

C.3 Evaluation

Table C. 2: Selection-order criteria

	L(0)	L(1)	L(2)
AIC	-31.77	-32.56	-33.73*
BIC	-29.38*	-27.44	-25.88

Notes: Table displays AIC and BIC selection-order criteria.

Table C. 3: The LM test for no remaining serial correlation

	LM(1)	LM(2)
VARX model	0.2417	0.6756

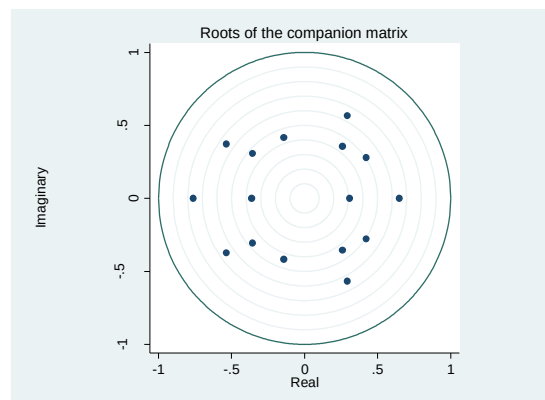
Notes: Table displays p-values. They reveal that no serial correlation remains at lag 2

Table C. 4: Test of multivariate normality

	chi2	prob > chi2	df
Jaque-Bera	23.00	0.114	16
Skewness	18.50	0.02	8
Kurtosis	4.50	0.81	8

Notes: The table shows that the errors are normally distributed

Figure C. 1: Graph of the eigenvalue stability condition



All eigenvalues lie inside the unit circle – VARX satisfies the stability condition

C.4 The orthogonalized impulse response functions

OrderNB: $FD_{NL}, FD_{BE}, S_{NL}, S_{BE}, I_{NL}, I_{BE}, GDP_{NL}, GDP_{BE}$

OrderBN: $FD_{BE}, FD_{NL}, S_{BE}, S_{NL}, I_{BE}, I_{NL}, GDP_{BE}, GDP_{NL}$

Figure C. 2: OIRF of Financial depth Netherlands from a shock in Financial Depth Netherlands

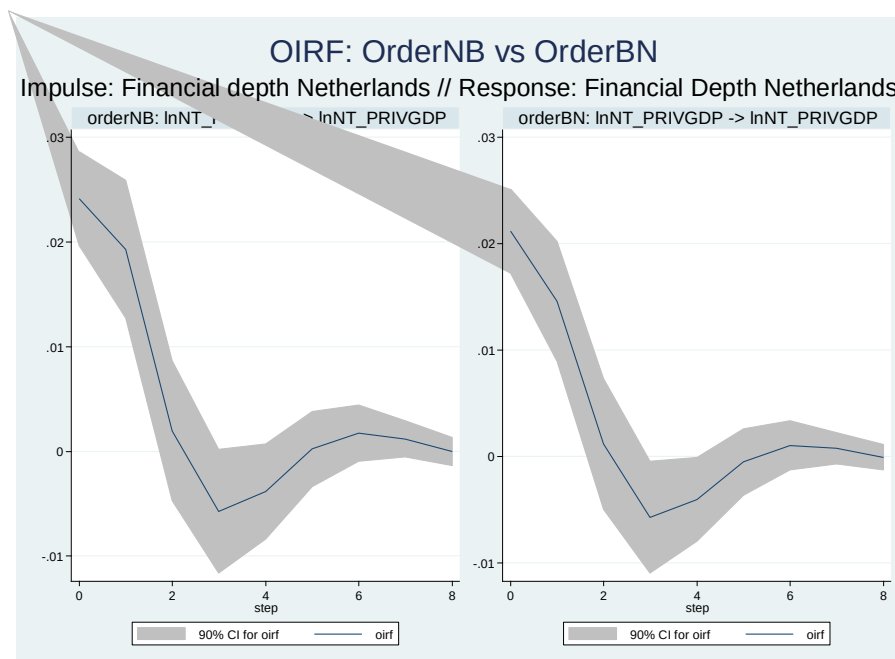


Figure C. 3: OIRF of Financial depth Belgium from a shock in Financial Depth Netherlands

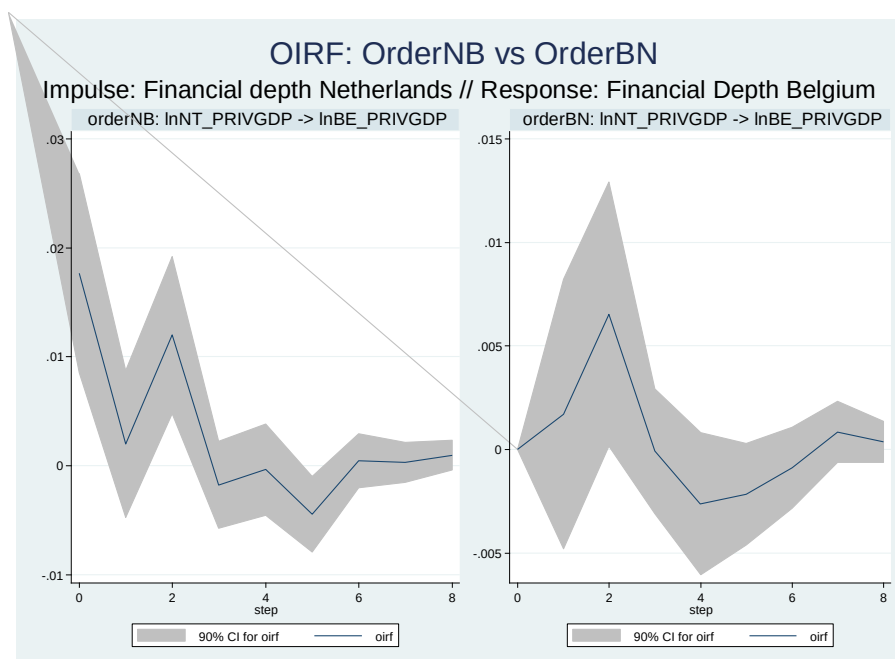


Figure C. 4: OIRF of Private investment rate Netherlands from a shock in Financial Depth Netherlands

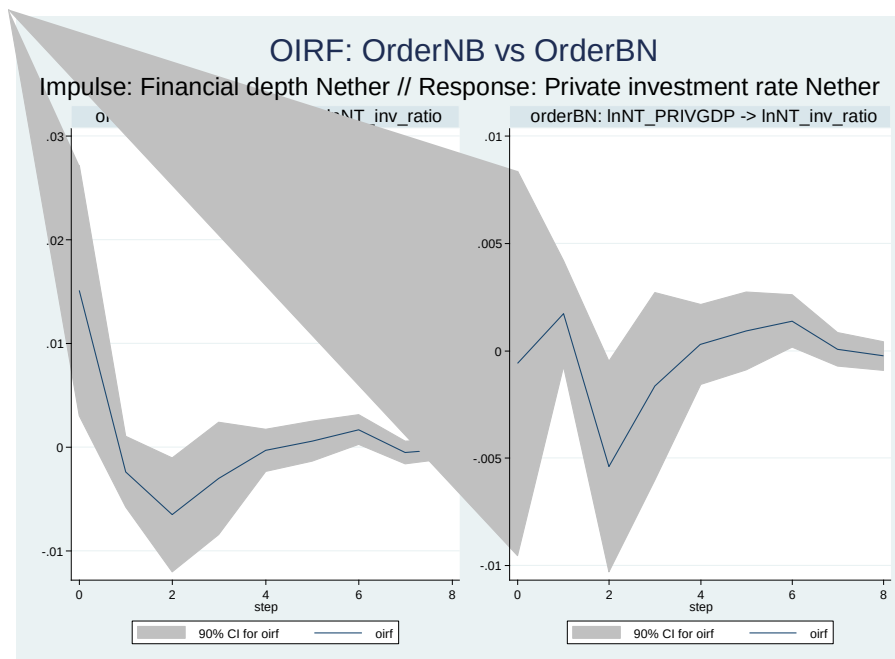


Figure C. 5: OIRF of Private investment rate Belgium from a shock in Financial Depth Netherlands

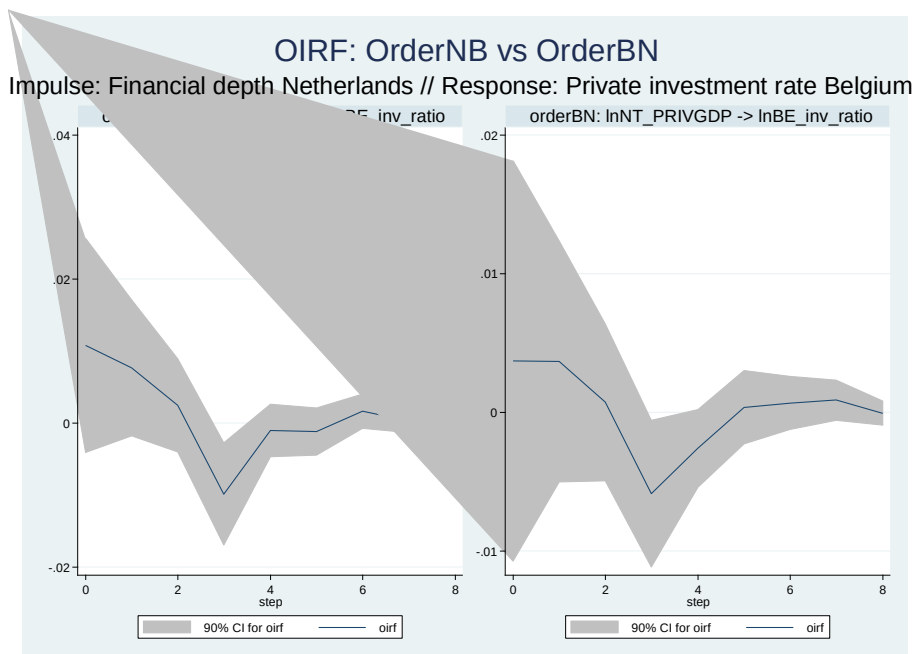


Figure C. 6: OIRF of Financial depth Belgium from a shock in Financial Depth Belgium

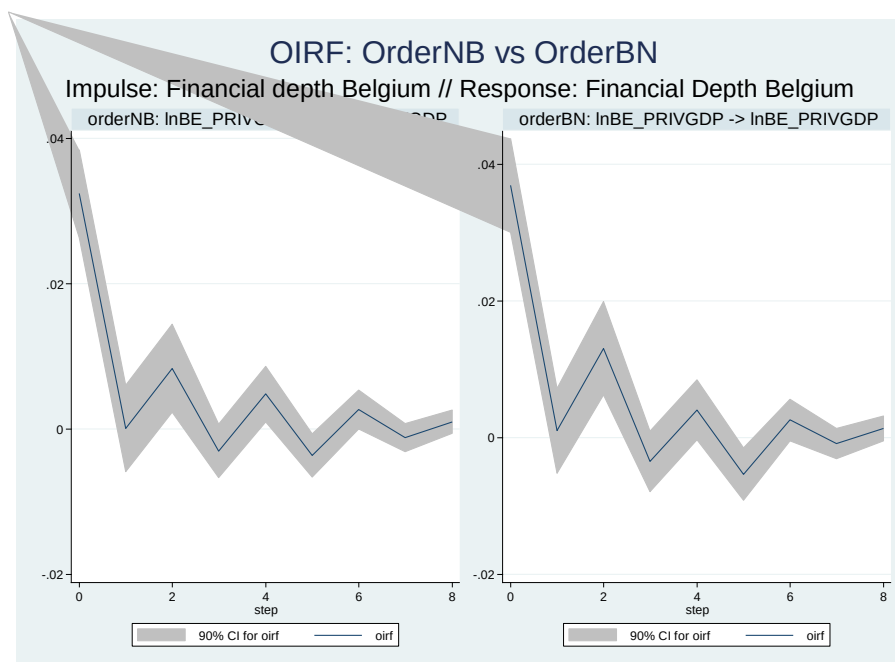


Figure C. 7: OIRF of Private savings rate Netherlands from a shock in Financial Depth Belgium

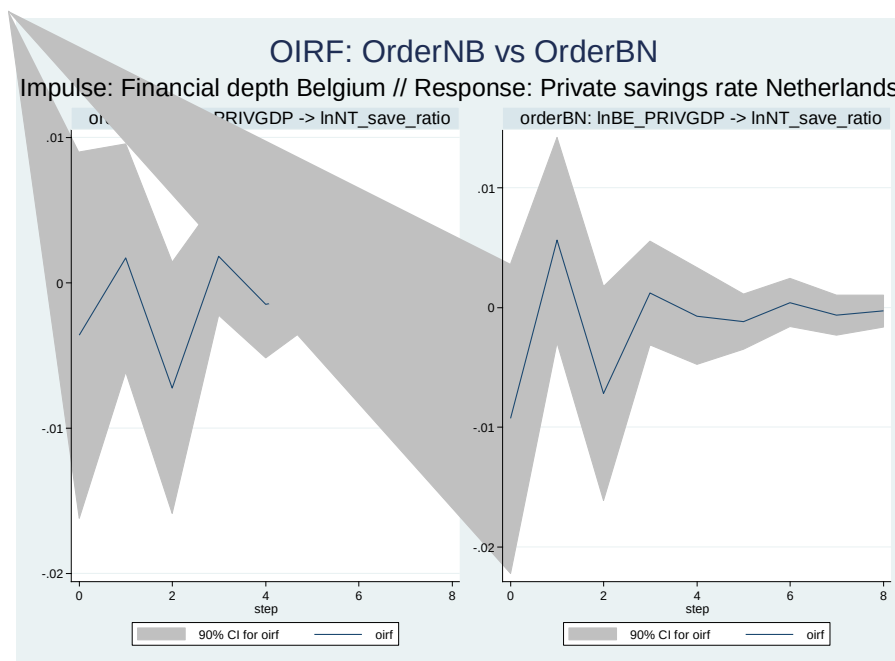


Figure C. 8: OIRF of Private savings rate Belgium from a shock in Financial Depth Belgium

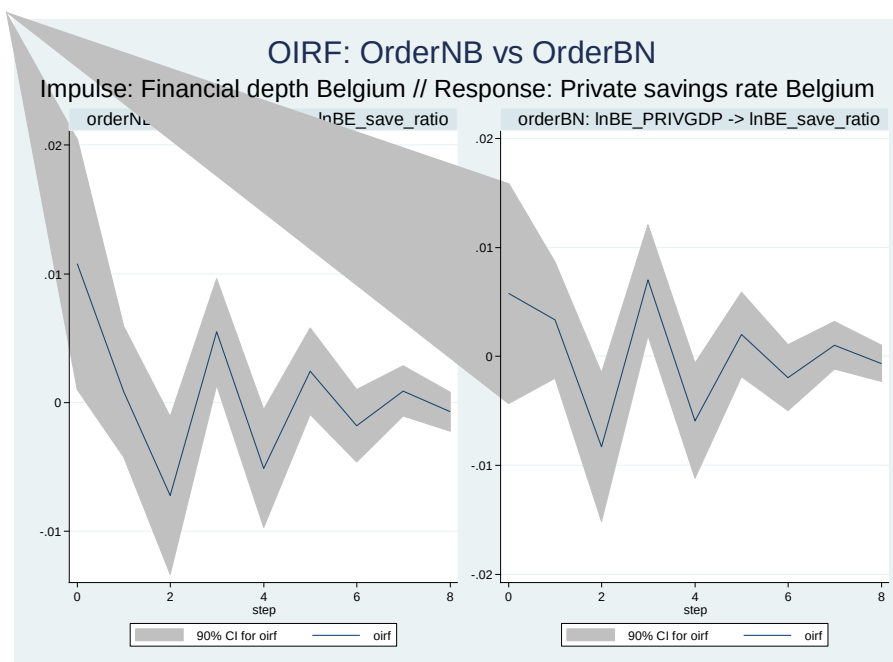


Figure C. 9: OIRF of Private investment rate Belgium from a shock in Financial depth Netherlands

