LUND UNIVERSITY
School of Economics and Management

Analysis of US Sectoral Business Cycles

- A Quantitative Study of Austrian Business Cycle Theory

Ralf Elfving
Anders Lindén

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Supervisor: Fredrik NG Andersson

Abstract

According to Austrian Business Cycle Theory a policy-induced lowering of the short policy interest rate below an unobservable natural interest rate can lead to an unsustainable boom in the economy, resulting in misallocated capital. As the unsustainability of this boom eventually becomes apparent and corrected the misallocated capital gets liquidated and causes a recession. It is thus of interest to evaluate the theory to find if and how a policy-induced lowering of the interest rate affects the output of an economy.

This thesis investigates the validity of the Austrian Business Cycle Theory using series of capital's share, labour's share and output for ten sub-industries of the American economy between 1947 and 1997. These are included in a sector-specific Cobb-Douglas production function. Given the characteristics of the data and the cointegrating relationship between the series we deploy a Vector Error Correction Model, using the difference (spread) between three estimated natural interest rates and the short policy interest rate as an exogenous variable. We treat a positive spread as an expansionary policy and investigate how it affects the output of each industry.

Although parts of the results in our study lend support to the Austrian Business Cycle Theory we conclude that there is not enough evidence to support it; the results are largely inconsistent with theory and not statistically significant to a sufficient extent.

Keywords: Austrian Business Cycle Theory, Natural Rate of Interest, Cointegration, Business Cycles, Vector Error Correction Model.

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1 Introduction

Over a weekend in March 2003, the Bank of International Settlements held a conference on the subject "Monetary stability, financial stability and business cycle". One of the papers presented at the conference was *The Great Depression As a Credit Boom Gone Wrong*, by Eichengreen & Mitchener (2003). In the introduction the authors suggest that following the experiences of the 1990s the role of credit in the macroeconomic environment once again had gained interest;

> *"The policy implication drawn by some is that central banks should not simply set monetary policy with an eye toward inflation; they should also attend to conditions in credit markets and contemplate preemptive action to prevent the development of excesses that threaten economic stability even if there is no sign of inflationary pressure."* Eichengreen & Mitchener (2003, p. 1).

Four years later the world saw its greatest financial crisis since the Great Depression unwind. To tackle the crisis governments conducted large stimulus packages and central banks lowered interest rates to historical lows, close to zero. The actions carried out stand in sharp contrast to those proposed by the Austrian School of Economics, which claim that this hurts rather than helps the economy in the long run. (Rothbard 1969, p. 88)

This thesis presents an empirical study of US business cycles using the approach of Austrian Business Cycle Theory ("ABCT"); analyzing if, and how, low interest rates influenced US business cycles measured on sub-industry level over the period 1947 - 1997. The purpose is to see if a lowering of the interest rates, as conducted by current monetary authorities, is harmful to the economy, as suggested by ABCT.

Current policies are mainly based on the frameworks of the Keynesian and Monetarist schools. The Keynesian model focuses mainly on the aggregate demand in the economy. In this framework business cycles are the result of exogenous shocks to aggregate demand, e.g. results from changes in consumer demand or fiscal policy. As seen from this point of view, problems arise because of the rigidity of prices and wages in the short run, with the implication that the economy will not automatically recover during that timespan. However, aggregate demand can be influenced by policy makers in the form of fiscal policy (Minsky, 1986). The monetarist theory is among laymen perhaps most known for Friedman & Schwartz's quote that *"Inflation is always and everywhere a monetary phenomena"*. In their 1963 paper, where the quote can be found, they find that there's a fairly close connection between the magnitude of monetary changes and associated cyclical movement in business during the course of the economic cycles. Thus, the monetarists ascribe an important role to monetary authorities. By controlling the amount of money in circulation, it can influence the national output in the short run and the price level in the long run. This is the common implication of Keynesian and Monetarist policies; prescriptions of interventionism in one or another form.

For Austrians credit creation is precisely that, the problem that some see as a solution; consider Rothbard (1969, p. 87): *"The government must not try to inflate again, in order to get out of the depression. For even if this re-inflation succeeds, it will only sow greater trouble later on."* This is because Austrian theory builds on the belief that intervening with how prices are set by the free market can create or exaggerate already existing problems as the information contained in prices no longer reflect real underlying economic conditions and decisions. As a consequence the economy move away from an equilibrium. (Cochran & Glahe 1999, p. 6) Austrian theories also underline the importance of looking at sub-aggregates rather than the aggregate of the economy to identify and understand how they are influenced by interventions. This is evident when looking at what the Austrian business cycle theory suggests as the underlying mechanisms. In absence of a central bank the interest rate change with supply and demand for loanable funds; an increase in savings lowers the interest rate as more funds are available to borrow, ceteris paribus. As individuals save for future consumption entrepreneurs can invest at the lower interest to meet the anticipated increase in future demand; the interest rate and prices holds information about the time preferences of consumers.

A lowering of the interest rate through credit creation by a monetary authority distorts the information inherent in the interest rate and prices and encourages investments even though there has been no change in the time preferences of consumers. At the lower interest rate entrepreneurs find the longer-term investment projects relatively more attractive and the underlying capital structure of the the economy is changed and is no longer at odds with the underlying preferences of consumers. The relatively more capital intensive industries, typically in the earlier stages of the production chain, are favored from a lowering of the interest rate as these increase their investments in durable equipment, capital goods, raw material and Construction in order to meet future demand. There has however been no decrease in current consumption by individuals, leading to an increase in overall demand for products in the economy; a boom. This stretches the economy in two directions which inevitable is unsustainable; the boom turns into bust. (Garrison 2001, p. 72) Much of the variation of these effects would be lost if looking only at the aggregate, rather than each specific industry.

There has been few published quantitative studies of Austrian theories[1], although those published generally find evidence that in part lend support to the theories. Keeler (2001), Carilli & Dempster (2008) and Bisman & Mouegot (2009) all conduct their analysis using aggregate US GDP data and interest series of different maturities. The two latter primarily build on the findings and methods of Keeler who uses an error correction model to find that relative price changes, derived from an interest rate gap, stimulate responses in the resource utilization and income. Carilli & Dempster (2008) extend this finding by investigating if GDP growth has a turning point endogenous to the interest rate gap. Though they find support for a negative GDP growth a set of months after an interest rate gap has appeared their results vary between the two different natural interest rates estimated. Bisman & Mougeot (2009)

[1] This is likely down to a mixture of the fact that Austrian economists historically has been opposed to statistical analysis as general models are deemed incapable of representing the complex reality, as well as Austrian theories not reaching the same popularity within academic and political spheres. See e.g. Cochran & Glahe (1999, p. 73).

also build on research by Keeler (2001) but extends the analysis to aggregate data for four countries in time and cross-section using a fixed effects panel data setup. They find that expansions are created as interest rates are lowered below their natural interest rate estimate and lasts until the financial rate moves back towards it, lending support to Austrian theories. They also find that the end of an expansion corresponds to over-investment from looking at the ratio of consumption and investment expenditure.

Mulligan (2006) utilizes a cointegrating relationship between US consumption and a cumulative term-spread. He finds that lowering the interest rate by one percent lowers the consumable output between 0,95 and 1,2 trillion USD (chained 1996 USD) per month in the long run, although he believes that the monthly data is dominated by shorter-term adjustments inflating the figures making inference for the long-run poor. In previous research Mulligan (2002) use output and labour data on sub-industry level, as opposed to aggregate data used by most previous researchers. He analyzes the structure of production through the Hayekian triangle model using labour data as a proxy for capital and five interest rates of different maturities, utilizing cointegrating relationships. Although the framework is built around the capital share of the economy, Mulligan claims that analysis with labour as a proxy is relevant. The results support the Hayekian triangles as a model that explains intertemporal resource allocation and production, although results also can be interpreted as somewhat mixed compared to what theory predicts.

Our study builds on findings of previous research but differs from these and other previous studies in that it uses a Cobb-Douglas production function in a Vector Auto Regressive framework for disaggregated data of the american economy over 51 years; overall presenting a more coherent model. Although Mulligan (2002) has previously conducted analysis with sub-aggregates, he's done so with series of labour only. Using a Cobb-Douglas model we also include capital, which to our knowledge has been absent in published quantitative studies of ABCT. Based on the presence of cointegrating relationships between our series in each industry a Vector Error Correction Model ("VECM") is deployed. In line with previous research our study includes interest rate gaps based on the difference between a short term interest rate ("Fed rate") and three estimates of the natural rate of interest ("NRI"), used as an exogenous variable in the VECM. As noted by e.g. Carilli & Dempster (2008), results vary depending on the estimate of the NRI, for sensitivity reasons the analysis is extended with a third estimate of the NRI: real GDP growth. According to ABCT the impact of a positive interest rate gap, interpreted as an expansionary monetary policy, should translate into moving away from the equilibrium of the economy. In terms of the VECM in this study this would mean that the adjustment process would force the movement of output in the subindustries above their long run equilibrium, constituting a credit-induced boom.

The remainder of this thesis is organized as follows. Chapter 2 introduces the relevant theory for the subject. Chapter 3 presents the methodologies used. Chapter 4 defines the data on which the study builds and presents the empirical findings of the study. Finally, Chapter 5 concludes the findings of this thesis.

2 Theory

2.1 Austrian Business Cycle Theory

The origins of the Austrian school of economics dates back to the late 19th century and University of Vienna professor Carl Menger (1871, 1883). Menger proposed an approach to economics of philosophical logic based on axioms of human motives and the social interaction, which was deemed too complex to study statistically; a view that since has had great influence on Austrian economics. The Austrian theory of the business cycle was first proposed by von Mises (1912) and borrowed inspiration from Swedish economist Knut Wicksell, the British Currency School as well as theoretical frameworks of Menger and Böhm-Bawerk. Wicksell showed that market processes can be systematically affected by a discrepancy between the bank rate of interest and the natural rate and the British Currency School had also showed that this effect is self-reversing. (Garrison 1996, p. 8) von Mises showed that an interest rate that was kept artificially low by credit expansion lead to misallocated capital with the consequence that the production process was elongated and did not match the temporal consumption patterns of consumers. This process, which constitutes a boom, can not undergo indefinitely and the eventual reallocation of such misallocated capital is what constitutes the bust.

2.1.1 Theoretical Framework

The interaction of monetary change and the changes in the structure of production in an economy is considered the core of the Hayek-von Mises trade cycle theory but is largely ignored by other business cycle theories. (Cochran & Glahe 1999, p. 174) Hayek claims monetary changes are non-neutral in the short run and that they can cause cyclical movements in economic activity through investment booms. (Cochran & Glahe 1999, p. 177) Variability in the interest rate change relative prices and this in turn could mean that prices systematically carry wrong information that drive the economy away from its equilibrium as entrepreneurs act on this information. A monetary injection first lowers the margin between the costs and price of sale and thus lowers the rate of profit. Methods of production that take more time to complete but also are more productive gain a relative advantages over those that are less time consuming but also less productive; longer investment projects that require less labour and are more durable are preferred. But the changes brought about by monetary forces will be temporary and the preferences of the consumers will reassert itself in the patterns of consumption. As the money has flowed through the system, from the point of entry to the input owners, there will be an increased demand for consumer goods as more money chase the same amount of goods. The prices of consumer goods increase relative to the costs of them, increasing the rate of profit. At the same time increased investments increases the demand for scarce input factors. In the long run, the readjustment of the economy will take place and correct the errors caused by the monetary expansion. In this sense, expansionary policy can be a cause and not the cure of crisis as well as creating increased unemployment and disequilibrium in the economy. (Cochran Glahe 1999, p.184)

The common theoretical model of Austrian Business Cycle Theory is the Hayekian Triangle. (Garrison 2001, p. 35) The triangle, as depicted in *Figure 2.1*, shows output of consumer goods on the vertical axis and the time-dimension, or longetivity, of the production-side of the economy on the horizontal axis. The relative length of the legs reflects the inverse relationship between the consumption in the economy and it's counterpart, the structure of production; an increase in the length of the consumption side translates to a higher nominal value of consumption and an increase in the base to an increase in the structure of production. The triangle consists of different stages of production, where the segment furthest to the left corresponds to the first and most crude stage. Output from each stage is treated as input into the next stage, which in the final stage consists of finished consumer products and corresponds to the amount consumed in the economy. The ratio between output of consumer products or goods to that of producer goods is altered with a change in the market interest rate and absent influences of monetary regimes constitute the intertemporal resource allocation; a reflection of consumer time preferences between consumption today to consumption in the future. (Garrison 2001, ch. 3-4)

A change in the ratio between output of consumer goods to that of producer goods can come about over time as an economy responds to changing real underlying factors. Such a change would reflect changes in the intertemporal resource allocation that reflect consumer time preferences between consumption today and consumption in the future. The structure can also be altered with a change in the market interest rate, without any change in the time preferences of consumers. In this case a lowering of the interest rate makes capital-intensive investment projects in the early stages of the production process, in the left part of the triangle, more profitable and that part of the economy expands but without a corresponding decrease in the consumption. (Garrison 2001, ch. 3-4)

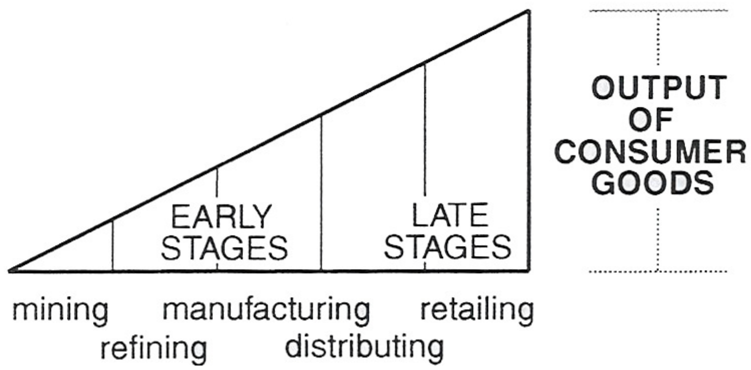

Figure 2.1. Hayek triangle. Taken from Garrison (2001, p. 47).

To better understand the framework of Austrian Business Cycle Theory one needs to understand the distinction it makes between sustainable and unsustainable growth, as explained by Garrison (2001, ch. 4) and summarized below.

Growth in an economy can come about in many ways. Technological advancements shift the production possibility frontier (PPF) outwards, with the new shape dependent on which industries that benefit from the advancement. The new technology also increase the demand for loanable funds as entrepreneurs seek to invest to utilize the new technology. Sustainable growth can also come about through gradual changes in the intertemporal preferences of consumers. If thriftiness is increased, consumers substitute future consumption for current consumption through increased savings. The increase in savings lowers interest rates as the supply of loanable funds increase; we move along the PPF and the slope of the hypotenuse of the Hayekian triangle becomes less steep as resources are reallocated from later to earlier stages.

With the labour force divided between specific and non-specific input, depending on their skills, there will be a shift as demand for labour increases in the earlier stages of production. The division of labour into two groups is similar to that of capital; non-specific capital such as trucks that previously Transported consumer goods can shift to Transporting more input or output goods in the early stages whereas production machines that produced a specific good cannot as easily be reconstructed to produce a different good that has increased in demand. This difference in mobility influences the supply and relative prices of the input goods; the specific factors undergo price adjustments while non-specific factors undergo quantity adjustments.

The adjustment processes explained above is those of sustainable growth in an economy where loanable funds consists only of savings; where the equilibrium between supply and demand of loanable funds represent what is called the natural rate of interest ("NRI"). In the presence of a monetary authority that can create credit in excess of savings a credit expansion can create a boom and bust behavior, despite absence of changes in consumer preferences or technological advancements. In *Figure 2.2* below a credit-induced expansion on the market for loanable funds takes place, artificially lowering the interest rate below the natural interest rate. Without changes in consumer preferences the saving decrease at the new level while consumption increases. Investments increase, as more projects seem profitable at the lower interest rate for loanable funds.

This increase in consumption and investments leads to a move outside the PPF, as can be seen in *Figure 2.2*, which represent an unsustainable level. There is an increase in demand for input resources at both ends of the Hayekian triangle. As prices of inputs increase due to demand, investment projects become less profitable or unprofitable as compared to when they were initiated. Increased demand for capital raises interest rates at which further loans are granted. As certain investment projects are forced to be abandoned the unsustainability of the growth and structure that moved the economy outside the PPF is exposed and a correctional move towards and into the PPF takes place as misallocated capital and resources are liquidated. According to Austrian theory the credit induced boom has turned into bust because the expansion was not consistent with intertemporal consumer preferences.

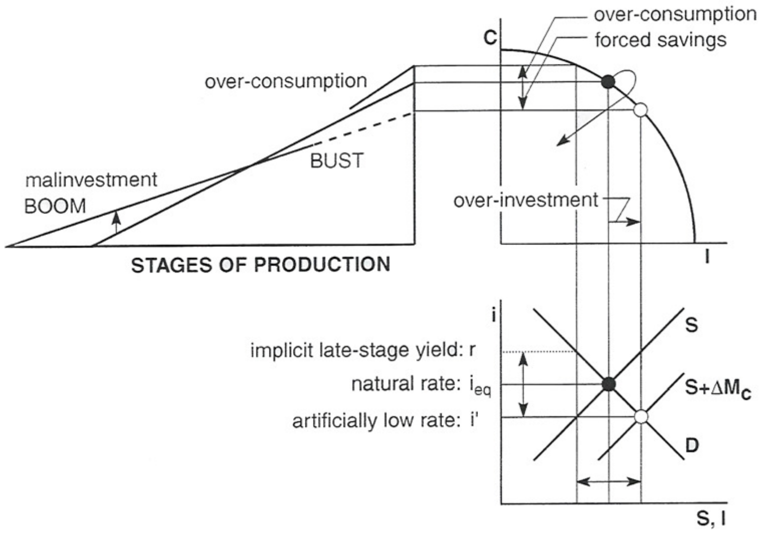

Figure 2.2. Boom and bust in Hayekian framework. Taken from Garrison (2001, p.69).

2.2 Natural Interest Rate

As the Austrian business cycle theory points to monetary changes as the cause of business cycles behaviour it also gives the interest rate a central role (Keeler 2001, p. 332); it's role is allocating resources within the capital structure of the economy (Garrison 2001, p. 6). As Rothbard (Keeler 2001) explains, the interest rate holds vital information for economic decision making of agents; it represents information of margins between different stages of production as well as the feasibility to changing the longevity of the production processes. A monetary expansion lowers the interest rate below a natural interest rate ("NRI") that would prevail if the market were left untouched and distorts the information contained in the natural interest rate. Austrian theory often apply a Wicksellian interest rate to represent the NRI. Wicksell defined his concept of the NRI as: "*... the same as the rate of interest which would be determined by supply and demand if no use were made of money and all lending were effected in the form of real capital goods.*" (Wicksell, 1898, p. 102 via Beenstock & Ilek 2010, p. 367). It is the divergence between the market interest rate and the natural interest rate that is of interest and importance. (Garrison, 2001, p. 69)

3 Method

The foundation of the empirical work in this thesis is to establish long run relationships between the series Capital share, Labour share and Output for the different sectors, as given by the Cobb-Douglas production function. This long run equilibrium is represented by a cointegration relationship, which is the result when several non-stationary time series are characterized by the same stochastic trends. The method used is the one of multivariate cointegration, also known as the Johansen method, as outlined below.

3.1 The Johansen Method

The base for Johansen's method is a Vector Autoregression ("VAR"), including the variables output, capital share and labour share. Methods to find cointegration between variables integrated of different order exist, but these are more complex than for variables of the same order of integration (Harris & Sollis, 2005, p.112). In the representation below it is therefore assumed that all variables are integrated of order one. The VAR of order p, is written as

$$Y_t = \delta + \Theta_1 Y_{t-1} + \cdots + \Theta_p Y_{t-p} + \epsilon_t, \tag{1}$$

where Y_t is a $k \times 1$ vector containing k variables and δ a $k \times 1$ vector of constants. If cointegration exist, this equation can be rewritten in the form of a vector error correction model ("VECM") by differentiation,

$$\Delta Y_t = \delta + \Gamma_1 \Delta Y_{t-1} + \cdots + \Gamma_{p-1} \Delta Y_{t-p+1} + \Pi Y_{t-1} + e_t, \tag{2}$$

where $\Gamma_i = -(\Theta_i + \cdots + \Theta_p)$ and $\Pi = (\Theta_1 + \cdots + \Theta_p - I_n)$, I_n denoting the n-dimensional identity matrix and δ denoting a vector of constants, not necessarily equal to δ in (1). The intuition with this separation is that, if all variables in ΔY_t are integrated of order one, their first difference will be stationary. In (2), all variables except the last part, Y_{t-1}, is thus stationary. And so if all residuals from (2) are stationary, the matrix Π must contain the cointegrating relationships. Π is thus called the cointegration matrix, and there are three possible setups of this matrix which yield stationary residuals. If the matrix is of full rank, meaning the matrix span the entire n-dimensional space, all different linear combinations give stationary residuals. This imply that all variables has to be stationary by themselves, and cointegration analysis is not necessary. In the second possible setup the matrix have rank zero, implying that Π is the zero matrix, and thus no cointegrating vector exists. The last possibility is $0 < rank(\Pi) < (n-1)$, meaning at least one cointegration relationship exists. Further, the cointegration matrix can be separated into two matrices, $\Pi = \alpha\beta'$, where α and β are both of size $(n \times p)$, α represents the speed of adjustment to equilibrium and β represents the long-run relationship.

Johansen (1991) proposed a method to estimate $\Pi = \alpha\beta'$ by running two auxiliary VAR-models, as given below.

$$\Delta Y_t = \hat{\delta} + \hat{P}_1 \Delta Y_{t-1} + \cdots + \hat{P}_{p-1} \Delta Y_{t-p+1} + u_t \quad (3)$$

$$Y_{t-1} = \hat{\delta} + \hat{\zeta}_1 \Delta Y_{t-1} + \cdots + \hat{\zeta}_{p-1} \Delta Y_{t-p+1} + v_t \quad (4)$$

(3) consist only of variables in their first difference and will thus give stationary residuals by definition. (4) contain the variables in levels, and so the residuals will not necessarily be stationary. The basis for the cointegration space is given by the basis in which the residual sets show a high correlation, this because both sets of residuals need to be stationary to be able to show a significant correlation and this can only happen if ΠY_{t-1} give stationary, and thus cointegrated, combinations. This basis is found by calculating the eigenvectors of the block covariance matrix from the residual series u_t and v_t, as given below.

$$\Sigma = \begin{bmatrix} \Sigma_{\mathbf{uu}} & \Sigma_{\mathbf{uv}} \\ \Sigma_{\mathbf{vu}} & \Sigma_{\mathbf{vv}} \end{bmatrix}, \quad (5)$$

where $\Sigma_{i,j}, \{i,j\} = \{u,v\}$, denote the covariance matrix between residual sets i and j. The eigenvalue to this matrix contain information regarding the significance of the cointegration vector, and testing for cointegration thus come down to testing the significance of the eigenvalues of this matrix. The number of cointegrating vectors, i.e. the number of cointegrating relations, equal the number of significant eigenvalues of the matrix. For a more detailed presentation, see Johansen (1991) or Hamilton (1994).

3.2 Measuring the Natural Rate of Interest

As noted by e.g. de Soto (2009), the NRI can not be observed. To be able to carry out our analysis, we will anyhow have to find some suitable measure. We will use several measures; a measure based on Austrian theory, a measure widely proposed by economists, as well as an interest rate of long maturity.

A measure proposed by Austrian scholars such as Rothbard (1993) is given by the saving-consumption ratio, i.e.

$$\text{Austrian NRI} = \frac{\text{Total saving in the economy}}{\text{Total consumption in the economy}}, \quad (6)$$

which is considered to represent the time preferences of consumers. A standard measure of the NRI is the real growth rate in the economy, which is proposed by among others Laubach & Williams (2003), and used in an Austrian framework by Carilli & Dempster (2008). We denote this measure as Real GDP Growth NRI. A third measure we use is the 10 year Treasury Bond interest rate, which experience market forces and is therefore not a policy set rate, and is used by among others Mulligan (2006). In our thesis, this measure is denoted 10 Year NRI.

For a NRI measure to be considered a good measure, it must be unaffected by changes in the Fed rate. That is, it must be exogenous to this rate. (Carilli & Dempster 2008, p. 274) To test for this, Granger causality tests will be employed, where the NRI measure is considered exogenous to the Fed rate if it is not Granger caused by it. (Engle et al 1983, p. 282)

3.3 Modeling the Yield Spread Effects

Our model is built on a cointegration relationship between the sector specific amount of labour input, capital input and the sector's output, as given by a Cobb-Douglas production function. The cointegration model is then rewritten and estimated in VECM form, as in (2), where the yield spread, i.e. the spread between the short term Fed interest rate and our NRI measure, will be incorporated as an exogenous variable in the model. This setup incorporates the long term growth trends found in the series, and allow us to measure what short term effects a lowering of the short term interest rate below the NRI has on output. This however assumes that the yield spread is both stationary and exogenous to the model.

Since possible imbalances caused by policy set interest rates need some time to build up, both the spread in time t, $t-1$ and $t-2$ are included.[2] This way it is possible to see both contemporaneous effects as well as lagged time effects. Consider the output equation of the VECM model below

$$\Delta y_{i,t} = \theta_i \Delta x_{i,t} + \alpha_i(y_{i,t-1} - \beta_i x_{i,t-1}) + \gamma_{i,0}\xi_t + \gamma_{i,1}\xi_{t-1} + \gamma_{i,2}\xi_{t-2} + \varepsilon_t, \tag{7}$$

where $y_{i,t}$ is the logarithmic sector specific output, $x_{i,t}$ is a vector containing the logarithmic sector specific capital and labour inputs and $\xi_{t-i}, i = \{0, 1, 2\}$, denote the yield spread with a lag of 0, 1 and 2 years. Since the Austrian analysis is mainly concerned with credit induced booms, we will make a distinction between positive yield spreads and negative yield spreads. This is done by separating the variables using indicators, and we are thus given estimates of effects from both low and high interest rates. A positive yield spread is denoted as $\xi_i > 0$ and a negative yield spread as $\xi_i < 0$. A positive yield spread in time t, all other equal, will be transferred to the change in output through $\gamma_{i,j}$. A negative γ imply that a positive yield spread will decrease the output, and the same logic apply to opposite values of the coefficients. However, transmission through the other equations of the model might also occur, that is, a shock in the yield spread will be transferred to the capital or labour series from where it will be transferred to output.

[2]Fewer than 2 years and more than 2 years was tested as a lag window, but generally with lesser fit, as measured by adjusted R^2. Due to short time series, more than 2 lags would affect the degree of freedom negatively.

4 Empirical Analysis

4.1 Data

Data series were obtained from the website of U.S. Bureau of Economic Analysis (www.bea.gov). The series consists of the categories value added by industry; gross output by industry; intermediate inputs by industry; components of value added by industry; and employment by industry. All are measured in nominal US dollar annually over the period 1947 to 1997, the longest possible period for data reported according to the Standard Industry Classication System ("SIC"). Starting 1997 the data at BEA is reported according to the North American Industry Classification System ("NAISC") which is incompatible with SIC and not possible to translate in a consistent way. In total there are 89 series presented in different levels of the US industry for the categories presented above. This study is performed on eight third level industries and two fourth level industries where the latter constitute the third level manufacturing industries. In *Table 4.1* below the series are presented with degree of level, full name as presented by BEA and short names used from here on in this study. *Figure 7.1* in Appendix A include graphs of the logarithm of all series in levels.

Table 4.1. Data Series

Level of aggregation$^{(*)}$	Full name as presented by BEA	Name in study
3	Agriculture, forestry and fishing	Agriculture
3	Mining	Mining
3	Construction	Construction
4	Manufacturing of durable goods	Durable goods
4	Manufacturing of nondurable goods	Nondurable goods
3	Transportation and public utilities	Transportation
3	Wholesale trade	Wholesale
3	Retail trade	Retail
3	Finance, insurance and real estate	Finance
3	Services	Services

(∗): The first level of aggregation represents the GDP of the entire economy, the second level is private industries under which level three and four are found. The highest available degree of disaggregate data is level five.

Put together the industries presented above constitute on average 86% of total gross output in the US economy over the time period. Of the remainder almost the entirety, 13,5% of total gross output, consist of output related to the government sector. The reason for why this has been excluded from the study is twofold. First, the capital series are negative which disallows taking the logarithm of them. Secondly, as government is not a private actor they necessarily don't act on information inherent in relative prices in the same way as private actors do; changes in output could e.g. reflect policy decisions. When including government the series used in our study represent 99,5% of total output over the period. Gross output and compensation of employees, i.e. labour's share of output, are directly observable in the collected dataset and the series of the capital's share of output was constructed using multiple series in the collected data and BEA guidelines. (Lum et al. 2000, p. 30) The series were then transformed into real values by deflating them using a GDP deflator obtained from the St. Louis Federal Reserve Economic Database (www.research.stlouisfed.org).

The study is thus performed on 51 annual observations of real gross output, compensation to labour and compensation to capital owners for each of the ten industries in *Table 4.1* between 1947 and 1997. For simplicity reasons we will from here on refer to the series as "output", "labour" and "capital".

The foundation for the analysis will be the long run cointegrating relationship between these three variables for the different sectors, as given by a Cobb-Douglas production function. *Table 8.1* in Appendix B give regression coefficients for a standard Cobb-Douglas regression model, showing that the parameters sum to roughly 1 in most cases and with adjusted R^2 values close to 1 in all cases but Agriculture, validating this choice of model. For cointegration to exist, the series need to be non-stationary and preferably integrated of the same order. *Table 4.2* below include test statics and p-values from the Augmented Dickey Fuller test (ADF), the Phillip-Perron test (PP) and the KPSS test, all values given for tests run with drift term and with drift term and linear trend. In most cases integration of order 1 is evident. In all cases except one[3], order 1 integration is suggested with at least one model parametrization, i.e. inclusion of drift term and/or linear trend. The different tests suggest the same parametrization in all instances, hence we conclude that all series are $I(1)$.

[3]The tests give contradicting results for Labour costs for Agriculture. Here we use the ADF test, which suggest $I(1)$.

Table 4.2. Unit Root Tests Data Series

Sector	ADF inter.	ADF trend	PP inter.	PP trend	KPSS inter.	KPSS trend
			Production Series			
Agr	-2.073 (0.266)	-2.183 (0.497)	-3.112 (0.032)	-3.145 (0.107)	0.181 (0.100)	0.133 (0.073)
Con	-1.651 (0.447)	-1.677 (0.737)	-1.639 (0.453)	-1.572 (0.787)	1.186 (0.010)	0.185 (0.021)
Dur	-2.235 (0.197)	-2.792 (0.209)	-2.521 (0.117)	-2.528 (0.334)	1.664 (0.010)	0.363 (0.010)
Fin	-3.471 (0.013)	-3.286 (0.080)	-2.974 (0.044)	-2.576 (0.316)	1.498 (0.010)	0.376 (0.010)
Min	-2.247 (0.193)	-2.309 (0.437)	-1.855 (0.360)	-1.988 (0.590)	1.690 (0.010)	0.353 (0.010)
Ndur	-3.084 (0.034)	-1.842 (0.658)	-2.907 (0.051)	-1.563 (0.791)	1.764 (0.010)	0.410 (0.010)
Ret	-2.602 (0.099)	-1.495 (0.817)	-1.791 (0.387)	-1.288 (0.879)	1.729 (0.010)	0.420 (0.010)
Ser	-1.114 (0.679)	-1.730 (0.711)	-0.861 (0.789)	-1.634 (0.757)	1.752 (0.010)	0.328 (0.010)
Tra	-2.399 (0.147)	-2.457 (0.368)	-3.412 (0.015)	-2.227 (0.476)	1.760 (0.010)	0.369 (0.010)
Who	-1.201 (0.641)	-1.659 (0.745)	-0.749 (0.824)	-1.558 (0.793)	1.779 (0.010)	0.271 (0.010)
			Capital Costs			
Agr	0.457 (0.983)	-2.907 (0.169)	0.929 (0.995)	-2.607 (0.296)	1.649 (0.010)	0.174 (0.026)
Con	-1.648 (0.449)	-1.373 (0.855)	-1.286 (0.605)	-0.961 (0.940)	1.196 (0.010)	0.203 (0.014)
Dur	-3.007 (0.041)	-2.810 (0.200)	-2.841 (0.059)	-2.268 (0.457)	1.623 (0.010)	0.390 (0.010)
Fin	-4.471 (0.001)	-2.635 (0.283)	-3.011 (0.040)	-1.542 (0.801)	1.479 (0.010)	0.411 (0.010)
Min	-4.007 (0.003)	-1.607 (0.770)	-3.718 (0.007)	-1.208 (0.897)	1.590 (0.010)	0.434 (0.010)
Ndur	-2.502 (0.125)	-0.858 (0.957)	-1.898 (0.343)	-0.766 (0.962)	1.739 (0.010)	0.382 (0.010)
Ret	-2.752 (0.073)	-0.895 (0.948)	-1.859 (0.358)	-0.692 (0.968)	1.757 (0.010)	0.416 (0.010)
Ser	-2.102 (0.253)	-0.903 (0.947)	-1.807 (0.380)	-0.739 (0.964)	1.736 (0.010)	0.403 (0.010)
Tra	-2.057 (0.272)	-1.809 (0.674)	-2.039 (0.280)	-1.547 (0.799)	1.776 (0.010)	0.337 (0.010)
Who	-1.048 (0.708)	-1.276 (0.881)	-0.395 (0.901)	-1.627 (0.761)	1.786 (0.010)	0.267 (0.010)
			Labour Costs			
Agr	-2.312 (0.172)	-2.333 (0.426)	-3.427 (0.014)	-3.885 (0.019)	0.658 (0.017)	0.095 (0.100)
Con	-1.734 (0.412)	-1.913 (0.625)	-1.925 (0.329)	-2.070 (0.551)	1.068 (0.010)	0.184 (0.021)
Dur	-1.218 (0.634)	-4.154 (0.010)	-1.701 (0.426)	-3.261 (0.084)	1.705 (0.010)	0.173 (0.027)
Fin	-1.973 (0.309)	-3.551 (0.044)	-2.503 (0.122)	-3.754 (0.027)	1.360 (0.010)	0.169 (0.030)
Min	-0.368 (0.906)	-3.389 (0.065)	-0.354 (0.908)	-4.131 (0.010)	1.746 (0.010)	0.052 (0.100)
Ndur	-2.669 (0.086)	-2.919 (0.166)	-3.074 (0.035)	-2.712 (0.247)	1.741 (0.010)	0.317 (0.010)
Ret	-0.875 (0.782)	-2.285 (0.449)	-0.622 (0.855)	-2.624 (0.288)	1.705 (0.010)	0.205 (0.013)
Ser	-0.543 (0.873)	-3.754 (0.028)	-0.462 (0.889)	-3.464 (0.054)	1.608 (0.010)	0.055 (0.100)
Tra	-0.068 (0.946)	-1.465 (0.827)	-0.438 (0.893)	-1.284 (0.879)	1.379 (0.010)	0.202 (0.015)
Who	-1.677 (0.436)	-2.418 (0.386)	-1.446 (0.536)	-1.717 (0.718)	1.731 (0.010)	0.294 (0.010)

Note: Given values are test statistics and p-values, the latter given in parentheses. Tested hypotheses are:
ADF and PP; H_0: Non-stationary data. KPSS; H_0: Stationary data.
MATLAB, where the tests where conducted, do not report p-values below 0.01 for the KPSS test.

For the natural interest rate based on the 10 year interest rate measure the yield spread has been below zero, indicating a contractionary phase, at six different times; the length varying from one to five years. Of the 51 yearly observations the yield spread is positive in 38, corresponding to almost 75% of the sample. With the Austrian measure of the natural interest rate the yield spread has been below zero at three times, each time for three years in a row; during the periods 1979-1981, 1988-1990 and 1995-1997. Also here the majority of observations indicate an expansionary phase, corresponding to roughly 82% of the sample. For the real GDP growth estimation of the NRI the case is reverse as only 16 observations indicate an expansionary policy. The seven periods that are expressed as expansionary phases last from one to six years; 1947-48, 1950-1953, 1955, 1959, 1961-66, 1972 and 1976. Thus, only 31% of the data for this NRI is considered to be in an expansionary phase. Based on the dummy variables constructed for these series they will take the same value for all series only during the years 1947-48, 1950-53, 1959, 1961-65, 1972 and 1976 for the expansive phases and 1979-81 as well as 1989 for the contractive phases. *Figure 4.1* below depicts the three NRI measures.

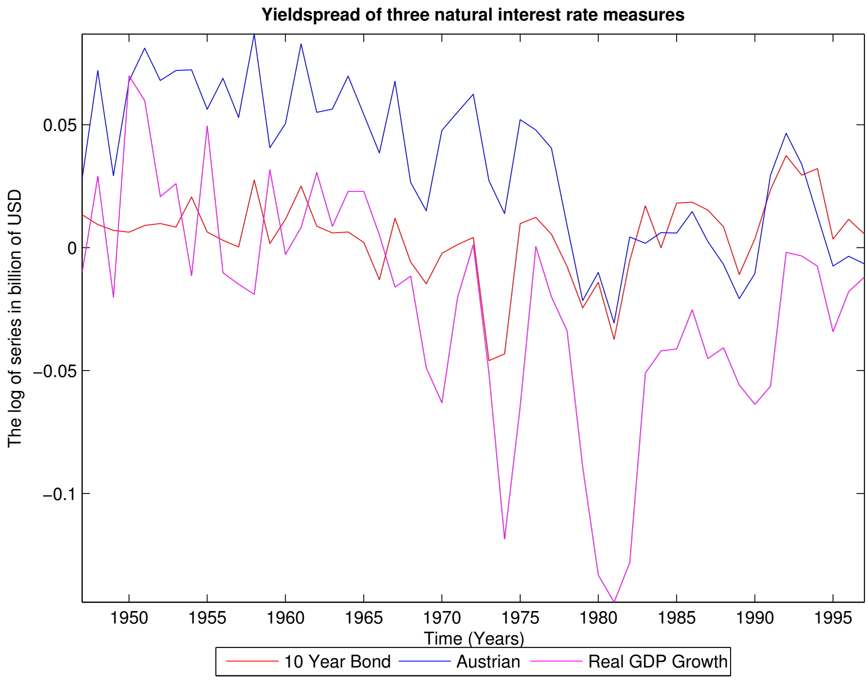

Figure 4.1. Natural rate of interest measures.

A requirement of the NRI measures is that they are exogenous to the Fed rate. *Table 8.2* in Appendix B presents p-values to Granger causality tests, showing that all measures are exogenous to the policy rate. It is also required that the measures give stationary yield spreads, otherwise they can not be included in levels in the VECM. *Table 4.3* below show unit root test values for the three NRI measures, it is evident that the 10 Year NRI and the real GDP growth NRI are stationary, while the Austrian NRI is most likely trend stationary.

Table 4.3. Unit Root Tests Yield Spreads

Series	ADF int.	ADF trend	PP int.	PP trend	KPSS int.	KPSS trend
10 year NRI	-4.097 (0.002)	-4.062 (0.013)	-4.143 (0.002)	-4.046 (0.013)	0.400 (0.080)	0.402 (0.010)
Austrian NRI	-2.553 (0.110)	-4.860 (0.001)	-2.361 (0.158)	-4.878 (0.001)	3.100 (0.010)	0.173 (0.027)
GDP growth NRI	-2.903 (0.052)	-3.150 (0.107)	-2.776 (0.069)	-3.405 (0.062)	0.371 (0.010)	1.850 (0.010)

Note: Given values are test statistics and p-values, the latter given in parentheses. Tested hypotheses are:
ADF and PP; H_0: Non-stationary data. KPSS; H_0: Stationary data.
MATLAB, where the tests where conducted, do not report p-values below 0.01 for the KPSS test.

In section 3.3 we mentioned that the yield spread need to be exogenous to the model, that is the VECM model of the Cobb-Douglas equation. This is tested statistically with Granger causality tests, where the yield spread is considered exogenous if it is not Granger caused by the residual sets from the VECMs run without inclusion of the yield spread. (Lütkepohl 2005, p. 389) *Table 8.3* in Appendix B show p-values to these tests. In only 4 instances out of 90 the null hypothesis can be rejected, and we can thus conclude that the different NRI measures give yield spreads that are exogenous to the VECMs.

4.2 Regression Results

From an Austrian perspective, it is expected that capital intensive industries, in the so called early stages of production, will experience relatively large upswings during early periods of expansionary interest rate policies, but will experience relatively large downswings during later periods of expansionary policy. Industries located in the center of the Hayekian triangle will not experience much change caused by expansionary policies, while industries located in the late stages are expected to experience relative upswings in the early period of expansion, due to discouraged saving and encouraged spending, and relative downswings in the later periods of expansion. The sectors that are expected to belong to the early stages are the sectors by BEA classified as production oriented sectors; Agriculture, Mining, Construction, Manufacturing of Durable Goods and Manufacturing of Nondurable Goods. The sectors that are expected to belong to the late stages are the sectors by BEA classified as service oriented sectors; Transportation, Wholesale, Retail, Finance and Services. From here on we divide the sectors into these two groups. The sectioning here described is to some extent confirmed by the empirical findings of Mulligan (2002).

When choosing a suitable lag structure of the VAR model, we have based our conclusions on suggestions made by the Akaike Information Criterion (AIC), the Schwartz Information Criterion (SIC) and Hannan Quinn Information Criterion (HQIC). Values from all information criterions are presented in *Table 8.4* in Appendix B. When testing for cointegration the number of cointegrating vectors in Π, more emphasis has been put on results suggested by the Trace test over results suggested by the λ_{max} test, since the Trace test is a consistent estimator, which the λ_{max} test isn't. (Harris & Sollis, 2003, p. 123) The cointegration test results are given in *Table 8.5* in Appendix B.

In the sections below we present the results of main interest in this thesis, focusing mainly on parameters for the yield spread lags. All models are presented in full in *Table 8.8 - Table 8.37* in Appendix B, together with Information Criterion scores and adjusted R^2 values. Together with parameters, accompanying test statistics are given. These can be compared roughly to quantiles from a standard normal distribution, since the VECM is a stationary system with super consistent estimators, implying a faster than normal convergence to the true parameter values, remedying the problem of few degrees of freedom somewhat. (Lütkepohl 2005, p. 293-296) The exogenous variable used in VECM-model is what we refer to as the yield spread, the spread between the given NRI measure and the short Fed rate. A positive yield spread is interpreted as an expansionary phase as the Fed rate is below the natural interest rate, indicating that credit is cheaper than it would have been if the NRI had been applied. According to Austrian theory, an expansionary phase would lead to a credit-induced boom followed by a bust. The negative yield spread is consequently referred to as a contractionary phase.

The results are grouped after NRI measure, where the results for expansionary phase are presented first. We present the results for the contemporaneous yield spread's effect on output, as well as the effect of past (lagged) values of the yield spread as well as the changes between these different periods. The estimated coefficients are presented in tables found in each NRI subsection.

4.2.1 10 Year Yield Natural Interest Rate Measure

During expansionary phases, as we can see in *Table 4.4*, the contemporaneous effect of the yield spread on output is somewhat mixed; half of the sectors being affected in a negative way. Agriculture, Mining and Durable goods are the sectors most negatively affected, while Construction, Nondurable goods and Finance are most positively affected. With a one-year lag of the yield spread, Mining is still showing a large negative impact, but here most other sectors are positively impacted with statistical significance. The sectors most positively impacted are Durable and Nondurable goods, Construction and Agriculture. The service oriented sectors are all affected positively. However, there are signs of a distinction between the service oriented sectors and the production oriented sectors; the latter experience larger upswings the year following an expansion. Here, all production oriented sectors except Mining experience a positive change compared to the contemporaneous effect, which also hold for all service oriented sectors.

With a two year lag the results are somewhat more mixed. All sectors except Wholesale and Agriculture are affected negatively, with Durable goods, Retail and Transport being the most extreme cases. It is not possible to make any distinction between service and production oriented sectors. Compared to the one year lagged effect, all service oriented industries experience a negative change, i.e. the effect is less two year after the expansion than one year after, and in most cases it is negative. For the production industries the same hold for all sectors except Agriculture and Mining, whose effects with a two year lag increase as compared to a lag of one year.

Table 4.4. VECM With 10 Year Natural Interest Rate Measure

Series	α_1	α_2	$\xi_t < 0$	$\xi_{t-1} < 0$	$\xi_{t-2} < 0$	$\xi_t > 0$	$\xi_{t-1} > 0$	$\xi_{t-2} > 0$
Agriculture	-0.067	-	0.113	-1.602	-0.072	-4.957	3.047	3.120
	(-0.228)	-	(0.065)	(-0.881)	(-0.039)	(-3.180)	(1.768)	(1.766)
Construction	-3.185	0.702	-1.076	1.502	0.173	0.398	2.804	-0.533
	(-3.411)	(2.663)	(-1.735)	(2.317)	(0.265)	(0.747)	(4.506)	(-0.796)
Durable Goods	-1.929	-	-3.108	3.035	-0.298	-0.446	2.293	-1.918
	(-3.666)	-	(-3.770)	(3.128)	(-0.290)	(-0.573)	(2.833)	(-2.224)
Finance	-0.222	0.046	0.090	0.298	-0.327	0.469	0.839	-0.021
	(-2.369)	(4.605)	(0.302)	(0.951)	(-1.036)	(1.850)	(3.000)	(-0.065)
Mining	-1.539	-	-3.552	-1.503	5.175	-3.033	-3.262	-0.137
	(-3.365)	-	(-2.417)	(-0.901)	(3.476)	(-2.330)	(-2.180)	(0.100)
Nondurable Goods	-0.234	-	-1.187	1.282	-0.045	0.418	1.642	-1.056
	(-2.065)	-	(-2.244)	(2.317)	(-0.083)	(0.918)	(3.407)	(-1.836)
Retail	-0.007	-	-0.363	1.235	-0.334	0.367	1.207	-1.814
	(-2.060)	-	(-0.916)	(2.967)	(-0.802)	(1.043)	(3.004)	(-4.971)
Services	0.645	-	-0.608	0.793	-0.512	0.377	0.852	-0.597
	(3.736)	-	(-1.766)	(2.193)	(-1.480)	(1.239)	(2.438)	(-1.972)
Transports	-0.261	-	-0.626	1.408	0.453	0.275	0.899	-1.499
	(-2.649)	-	(-1.546)	(3.178)	(0.973)	(0.718)	(2.245)	(-3.871)
Wholesale	0.115	-	-1.233	1.368	-0.137	-0.224	1.101	0.241
	(2.511)	-	(-2.033)	(2.007)	(-0.212)	(-0.408)	(1.833)	(0.363)

Note: α_i denote the cointegration coefficients for the equation with output as dependent variable. If no α_2 is reported, information criteria suggested use of 1 vector. ξ_t indicate contemporaneous yield spread, ξ_{t-i} indicate yield spread with i lags. $\xi_i < 0$ indicate negative yield spread and $\xi_i > 0$ indicate positive yield spread.
Values given in parentheses are test statistics for $H_0 : \gamma_i = 0$.

During contractionary phases the contemporaneous effects are similar to those during the expansionary phases described above, which is somewhat surprising. Most sectors experience a negative effect, with Finance and Agriculture being positively impacted. The industries affected most negatively are Mining and Durable goods. With a one year lag, all sectors except Agriculture and Mining are positively impacted, with Durable goods being the most extreme case. All sectors except Agriculture experience increases in the effect when comparing the one year lag with the contemporaneous value. With a two year lag, all sectors except Mining experience relatively modest downswings, off which however services, Retail and Finance are most negatively affected. All sectors except Mining and Agriculture show decreasing effects after a lag of two year as compared to after a lag of one year.

Significant for all three lag-windows, in both expansionary and contractionary phases, are that production oriented sectors tend to be more dramatically affected than service oriented industries. By looking at the average absolute effect, we see that the producing sectors experience effects due to monetary expansion that always are larger than the service sectors.

4.2.2 Austrian Natural Rate of Interest Measure

During expansionary phases, as we can see in *Table 4.5*, the contemporaneous effect of the yield spread on output is dominated by negative values for all industries with the exception of Agriculture. Construction and Durable goods, both production industries, are those with the by far largest negative effect. With a one year lag of the yield spread the effects of the expansionary monetary policy are instead dominated by positive values, Mining this time being the only industry that is impacted negatively. The other four production industries are those with the largest positive effects, however Durable and Nondurable goods are the only ones with significant coefficients. These two industries are together with Construction those that have had the largest change in impact over the two periods; closely followed by the Transport industry. This could be interpreted as if the monetary expansion has had a positive impact on output in all industries except for Agriculture and Mining.

With a two year lag the effects are mixed; all production industries except Construction are affected positively, while Wholesale is the only service industry still positively impacted from the monetary policy two years earlier. Construction is the only industry with a significant coefficient. Overall, the only industries that have seen a positive change in the yield spread's effect on output are Agriculture, Wholesale and Mining; note however that the two production industries were the only ones negatively affected in the previous period. Together with Mining, the Construction and Durable goods manufacturing industries are those with the largest change.

Table 4.5. VECM Austrian Natural Interest Rate Measure

Series	α_1	α_2	$\xi_t < 0$	$\xi_{t-1} < 0$	$\xi_{t-2} < 0$	$\xi_t > 0$	$\xi_{t-1} > 0$	$\xi_{t-2} > 0$
Agriculture	0.139	-	-4.906	0.941	5.510	1.000	0.582	0.786
	(3.489)	-	(-1.815)	(0.318)	(2.081)	(1.116)	(0.602)	(0.962)
Construction	-3.981	1.016	1.236	4.143	1.960	-1.391	0.368	-0.967
	(-2.787)	(2.558)	(1.189)	(3.474)	(1.501)	(-3.363)	(0.945)	(-2.634)
Durable Goods	-1.189	-	-0.407	4.023	-0.429	-1.215	1.425	0.312
	(-2.196)	-	(-0.315)	(3.054)	(-0.324)	(-2.830)	(3.026)	(0.701)
Finance	-0.236	0.041	0.741	1.254	-1.211	-0.172	0.145	-0.157
	(-2.070)	(3.927)	(1.478)	(2.300)	(-2.442)	(-1.002)	(0.843)	(-0.960)
Mining	-0.411	-	-3.755	-4.143	3.011	-0.433	-0.661	1.676
	(-2.280)	-	(-1.386)	(-1.394)	(1.046)	(-0.515)	(-0.745)	(2.133)
Nondurable Goods	-0.601	-	-0.534	2.476	-0.707	-0.128	0.614	0.342
	(-2.123)	-	(-0.683)	(3.200)	(-0.865)	(-0.537)	(2.226)	(1.269)
Retail	-0.511	-	0.886	2.595	-0.638	-0.070	0.319	-0.364
	(-2.953)	-	(1.228)	(3.600)	(-0.836)	(-0.296)	(1.314)	(-1.674)
Services	0.688	-	0.292	0.910	-0.689	-0.076	0.179	-0.115
	(2.561)	-	(0.464)	(1.364)	(-1.150)	(-0.383)	(0.804)	(-0.594)
Transports	-0.162	-	1.330	1.400	-0.553	-0.363	0.352	-0.010
	(-2.774)	-	(1.972)	(2.005)	(-0.847)	(-1.749)	(1.622)	(-0.039)
Wholesale	-0.083	-	0.171	2.416	0.585	-0.283	0.297	0.518
	(-3.041)	-	(0.185)	(2.618)	(0.581)	(-1.040)	(1.012)	(1.803)

Note: α_i denote the cointegration coefficients for the equation with output as dependent variable. If no α_2 is reported, information criteria suggested use of 1 vector. ξ_t indicate contemporaneous yield spread, ξ_{t-i} indicate yield spread with i lags. $\xi_i < 0$ indicate negative yield spread and $\xi_i > 0$ indicate positive yield spread. Values given in parentheses are test statistics for $H_0 : \gamma_i = 0$.

In the contractive phases, the contemporaneous effect on all production industries, except for Construction, is negative; indicating that the yield spread has had a negative impact on the industries' output. Agriculture and Mining stand out with the largest negative impacts, Construction and Transport the largest positive; the latter being the only industry with a significant coefficient. The effect of the one year lagged yield spread have a negative effect only on Mining and all other industries except services and Agriculture have significant coefficients. When looking at the change of the effect results are unexpected; the four industries with the largest positive effect increases are production industries where Mining is the only one with a decrease. For the results of the effect from the yield spread two years earlier, three out of the four industries positively effected are production industries; Agriculture, Mining and Construction as well as the service industry Wholesale.

The changes in the effect between the first and the second lag are dominated by large movements, that are primarily negative. Agriculture and Mining are the only industries with positive changes. When considering the absolute changes it's evident that also Durable and Nondurable goods together with Retail are among the five largest movers. Finance which had a significant positive effect from the one year lagged yield spread has reverted to a statistically significant negative effect of the same magnitude.

Further, a pattern is visible when considering the magnitude of the coefficients throughout all lag windows; the mean absolute values of the producing industries are always larger than the corresponding values for the service industries. It can also be observed that the mean of the coefficients for the expansionary phases are much smaller than the corresponding values for contractionary phases; this implies that the effect of the yield spread appears to be smaller when it is positive. It should however be noted that only a quarter of all coefficients are significant.

4.2.3 Real GDP Growth as Natural Rate of Interest Measure

As we can se in *Table 4.6*, the contemporaneous effects of a positive yield spread on the output of the industries are largely positive, with Finance the only industry showing a small negative effect. It's predominately producing industries that show the largest positive impacts from the expansionary yield spread; four out of the five most positively affected industries belong to this group, Durable Goods, Nondurable Goods, Mining and Construction along with Wholesale which is the only service industry of the five. The overall positive coefficients indicate that the yield spread has increased the output in all industries except for Finance, with significant values for Durable goods, Construction, Wholesale, Nondurable goods and Transport.

The effect of the previous year's positive yield spread on current output is instead largely negative; only Durable goods and Construction are positively effected, the former with a statistically significant coefficient. The Mining industry is now the industry most negatively impacted by the lagged yield spread, followed in order by Wholesale, Transport, Services and Retail; all service industries having significant coefficients. When considering the change in effect from the contemporaneous to the one-year lagged positive yield spread it is evident that all series have been negatively effected; Mining the most followed by Wholesale and Transport. The two latter are together with Durable goods also those that have statistically significant coefficients in both periods.

The impact of the yield spread from two years ago on the current output is mixed; four industries are negatively impacted and when excluding Agriculture in the negative end and Durable goods in the opposite end the magnitude of the coefficients are relatively modest. When looking at the relative size of the effects compared to that of the one-year lagged yield spread, eight industries have had positive changes with Agriculture and Construction the only ones with a negative change. Durable goods is the only industry that had effects that were found to be significant in this and the previous period, but the industry's positive change was small and close to negligible.

Table 4.6. VECM With Real GDP Growth Natural Interest Rate Measure

Series	α_1	α_2	$\xi_t < 0$	$\xi_{t-1} < 0$	$\xi_{t-2} < 0$	$\xi_t > 0$	$\xi_{t-1} > 0$	$\xi_{t-2} > 0$
Agriculture	0.529	-	-0.281	1.579	0.730	0.674	-0.182	-1.819
	(2.359)	-	(-0.369)	(1.701)	(0.909)	(0.626)	(-0.171)	(-1.662)
Construction	-0.314	-0.069	0.768	0.759	-0.874	1.531	0.085	-0.057
	(-1.700)	(-3.303)	(2.801)	(1.650)	(-2.434)	(3.344)	(0.160)	(-0.120)
Durable Goods	0.545	-	0.326	1.138	0.088	3.152	1.880	1.978
	(3.514)	-	(0.936)	(2.253)	(0.208)	(4.473)	(2.045)	(2.472)
Finance	-0.371	0.042	0.437	-0.174	-0.127	-0.208	-0.231	0.222
	(-4.960)	(2.983)	(3.986)	(-1.088)	(-1.127)	(-1.071)	(-1.285)	(1.280)
Mining	-0.611	-	-2.008	0.769	-0.365	1.863	-1.282	0.027
	(-2.660)	-	(-3.401)	(0.849)	(-0.505)	(1.618)	(-1.156)	(0.027)
Nondurable Goods	0.034	-	0.501	0.029	-0.255	1.246	-0.200	-0.195
	(3.082)	-	(2.796)	(0.101)	(-1.552)	(4.440)	(-0.540)	(-0.784)
Retail	-0.337	-	0.771	-0.277	-0.199	0.189	-0.431	0.025
	(-3.893)	-	(5.487)	(-1.204)	(-1.220)	(0.837)	(-1.997)	(0.113)
Services	0.458	-	0.271	-0.020	-0.294	0.182	-0.531	0.274
	(4.321)	-	(2.196)	(-0.111)	(-2.453)	(0.912)	(-2.549)	(1.419)
Transports	-0.072	-	0.616	-0.219	-0.183	0.936	-0.562	0.182
	(-2.186)	-	(4.176)	(-0.960)	(-0.889)	(3.098)	(-1.970)	(0.656)
Wholesale	0.027	-	0.448	0.100	-0.170	1.323	-0.984	-0.657
	(2.737)	-	(2.042)	(0.354)	(-0.865)	(3.812)	(-2.658)	(-1.807)

Note: α_i denote the cointegration coefficients for the equation with output as dependent variable. If no α_2 is reported, information criteria suggested use of 1 vector. ξ_t indicate contemporaneous yield spread, ξ_{t-i} indicate yield spread with i lags. $\xi_i < 0$ indicate negative yield spread and $\xi_i > 0$ indicate positive yield spread. Values given in parentheses are test statistics for $H_0 : \gamma_i = 0$.

Also the effect of the contemporaneous negative interest rate gap on the output is largely positive; only Mining and Agriculture have a coefficient indicating a decrease, Mining significantly so. The positive effect for the other industries, of which all except Durable goods are significant, are however relatively modest and there is no tendency for any clustering of the two industry groups. For the effect of the one-period lagged value of the yield spread the results are different. All service industries except for Wholesale are negatively effected, although modestly so. Agriculture and Durable Goods however enjoy comparatively large positive effects, in magnitude followed by Mining and Construction. Wholesale and Nondurable goods, the two remaining industries that are positively effected, have very small coefficients. This implies that producing industries in large are positively effected by a relative increase in the interest rate contra the natural rate in the previous year, a finding that is somewhat unexpected. This finding is also partly strengthened when looking at the difference in the effect compared to the effect of the contemporaneous yield spread; the three industries that had an increase in the positive effect are Mining, Agriculture and Durable goods, all producing industries.

The results of the second lag on output is in parts the inverse to that of the contemporaneous yield spread. Only two industries, Agriculture and Durable goods, enjoy a positive effect on their output while the rest are negative. The composition between the two groups of industries are mixed and Construction that have the largest effect has a significant coefficient, as has services. Only when the changes from the previous lagged value of the yield spread is considered does a clear pattern emerge; all the producing industries are grouped together with the largest negative changes.

Looking at the average absolute magnitude of the two industry groups it is evident that the producing industries are impacted to a larger extent by the interest rate gap than the service industries in all cases.

4.3 Model Validation

To ensure high reliability we perform a battery of diagnostic tests, based on the suggestions in Lütkepohl (2005, ch. 8.4). Joint tests for normality and autocorrelation in the VECM residuals ensure that a sufficient number of lags are included in the model and that the general setup is suitable. *Table 8.6* in Appendix B show p-values to Joint Multivariate Normality tests, with null hypothesis of normaility. It can be noted that in 13 of the 30 different cases, the null hypothesis is rejected, with no distinction between the different NRI measures. A standard remedy is to include more lags in the VAR model, however due to short time series and the risk of losing too many degrees of freedom, this is not a feasible solution. We however note that, given a suitable choice of model parametrization, the Maximum Likelihood method should give satisfying estimates even though the residuals do not exactly follow a multivariate normal distribution, known as quasi Maximum Likelihood (see e.g. Lütkepohl 2005, p. 297 or Hamilton 1994, p. 430-431).

More importantly, the joint portmanteau tests for autocorrelation in the residuals show only 3 cases out of 30 with dependence left; Mining, Nondurable Goods and Transports, all with the Real GDP growth NRI. The p-values to the test with null hypothesis of no autocorrelation are found in *Table 8.7* in Appendix B. We conclude that the models are properly fitted, with some caution to the Real GDP growth NRI measure.

4.4 Impulse Response Analysis

To be able to visualize the effects caused by divergences of the policy set rate from the natural rate of interest, impulse response (IR) functions are presented. These are functions of time, where a one standard deviation impulse shock in the yield spread is traced out through the system of variables, thus showing how output is affected over time. For a VAR containing stationary variables only, the impulse response function is calculated as the system's Moving Average representation. Since VECM's contain stationary components only, the IR function is calculated in the same way as for stationary VAR models. (Lütkepohl 2005, p. 263)

For standard impulse response analysis, where a shock to one of the variables is traced through the cointegration model, the analysis is dependent on contemporaneous orthogonal residual terms between the different equations in the VECM. This because if correlation do exist between the different residual series, a shock to one variable is likely associated with shocks to the other variables as well, and the whole purpose of the analysis breaks down. In this case however, the main interest lies in what effects are caused by a shock in the yield spread. Since this variable is assumed to be exogenous, a shock is not expected to be accompanied by shocks to the other variables. The impulse response functions are calculated using MATLAB, where a shock of one unit in the yield spread is transferred through the entire VECM system. Note that in the graphs the shock occur in year 2. For a more detailed description of impulse response analysis, see e.g. Lütkepohl (2005).

In this section we will discuss graphs for four different sectors, two production oriented and two service oriented, which point for or against results implied by ABCT. To highlight the differences in results between the different measures, IR graphs for all NRI measures for this set of sectors are presented. All impulse response graphs are included in Appendix A, both for negative and positive shocks. *Figure 4.2* and *Figure 4.3* on p. 28-29show the IR functions that are discussed below.

As was evident from the coefficients of the exogenous part of the VECM the results vary depending on the NRI estimate. As we in the IR analysis shock the system that is based on these coefficients, we also expect the resulting graphs to show differences between the NRI measures. As the results are sensitive to which equation of the VECM model that is shocked first, we have selected to shock the capital series and transmit the shock via labour to output.

The IR analysis for Construction based on the 10 Year NRI the positive shock to capital initially decrease output 0.5 in the first year. It then rebounds to 2 the next year and peaks at 2.5 the year after that after which it decreases in the following year. For the Austrian NRI the movement is similar during the first year, but peaks at 2 and then sharply reverts to -4 and shoots up to 4 in the last year. It's worth noting however, that the effect of the shock after this many years has a large standard deviation and that any interpretation of this spike should be made with caution. For the Real GDP growth NRI the shock immediately increases the output to 1.5 in the first year, then decreases gradually over two years to 0.5 to then increase somewhat. From a theoretical point of view it is expected that production oriented sectors experience relatively large booms followed by relatively large busts during late parts of the expansion. It is difficult to distinguish when a late period of the expansion occur, and thus when the bust is expected to take place. With that said, all three NRIs affect output strongly positive during the first 2-3 years after the shock take place, after which the effect on output reverse. For the 10 Year and Real GDP NRIs, the effect stays positive, indicating a slowdown rather than a bust. With the Austrian NRI there is a very large spike in the 5th year, which somewhat distorts this analysis. However, the uncertainty this many year after the shock is probably very high, why this spike can be overlooked.

The initial effect of a shock to the 10 Year NRI on Nondurable goods is negative, down to approximately -0.7, followed by a rebound to zero and then a large decrease to -1.45 in year 3, where it levels out. The results for the Austrian NRI is different, although it too sees an initial decrease. But this decrease is only -0.15, and the rebound goes well above zero to 0.65 in the following year and then peaks at 0.7 in the third year. For the Real GDP growth NRI the initial effect on output is positive with a value of 1.2, then decreases to 0.8 during the following t two years after which it largely levels out. We can expect that the impact on output is positive during the first years after the shock occur, after which the effect reverse. The IR functions for the Austrian NRI and the Real GDP Growth NRI hint at this behaviour, however for the 10 Year NRI the effect is negative during all years except during year 2, where the effect is close to zero. This is opposite to what is expected, and show the large difference between results from the different measures.

When shocking the 10 Year NRI the initial effect on Retail output is negative, but small; it only decreases to -0.1. The positive effect in the following year is larger in value, moving up to 0.7 and is then followed by a large negative move down to -0.6 after which it decreases to -1 over the last two years. With the Austrian NRI the pattern is similar; the initial move is the same, as is the following positive effect but the magnitude for the latter is smaller. Also the following large negative effect is similar, although the effect increases strongly in the 5th year. With the Real GDP Growth NRI the function is similar, with a positive effect during year one, followed by negative effect during later years and a sharp positive spike in year 5, which might be somewhat overlooked based on the same reasons as for Construction. For all measures these results hint at a boom in the first years after the shock, which is followed by a bust in later years.

For Wholesale and the 10 Year NRI the initial effect of the positive shock is -1.45. Although it rebounds to -1 in the following year, the effect is reversed back to -1.4 and then levels out around that value. For the Austrian NRI the effect of the shock is different, increasing to 1.2 over the first three years then leveling out at around 1. The pattern is almost identical for the Real GDP growth NRI but with much greater magnitudes, peaking at 2.5 and then leveling out at around 2. The results for the Austrian and Real GDP Growth NRIs hint at booms in the first years following the shock, followed by slowdowns rather than busts in later periods. The IR function of the 10 Year NRI is opposite of what is expected, with negative impact during all years.

Although not necessarily evident from the presented results, the effects of the shock are typically larger for the production oriented industries than for the service oriented industries. It could be argued that this is down to a difference of the magnitude of the original series. However, by visually examining *Figure 7.1*, it is evident that the normalization constant would be roughly the same for all sectors. A result of ABCT is that early stage sectors are affected to a higher degree by a low interest rate than late stage sectors, which is also what the IR functions imply.

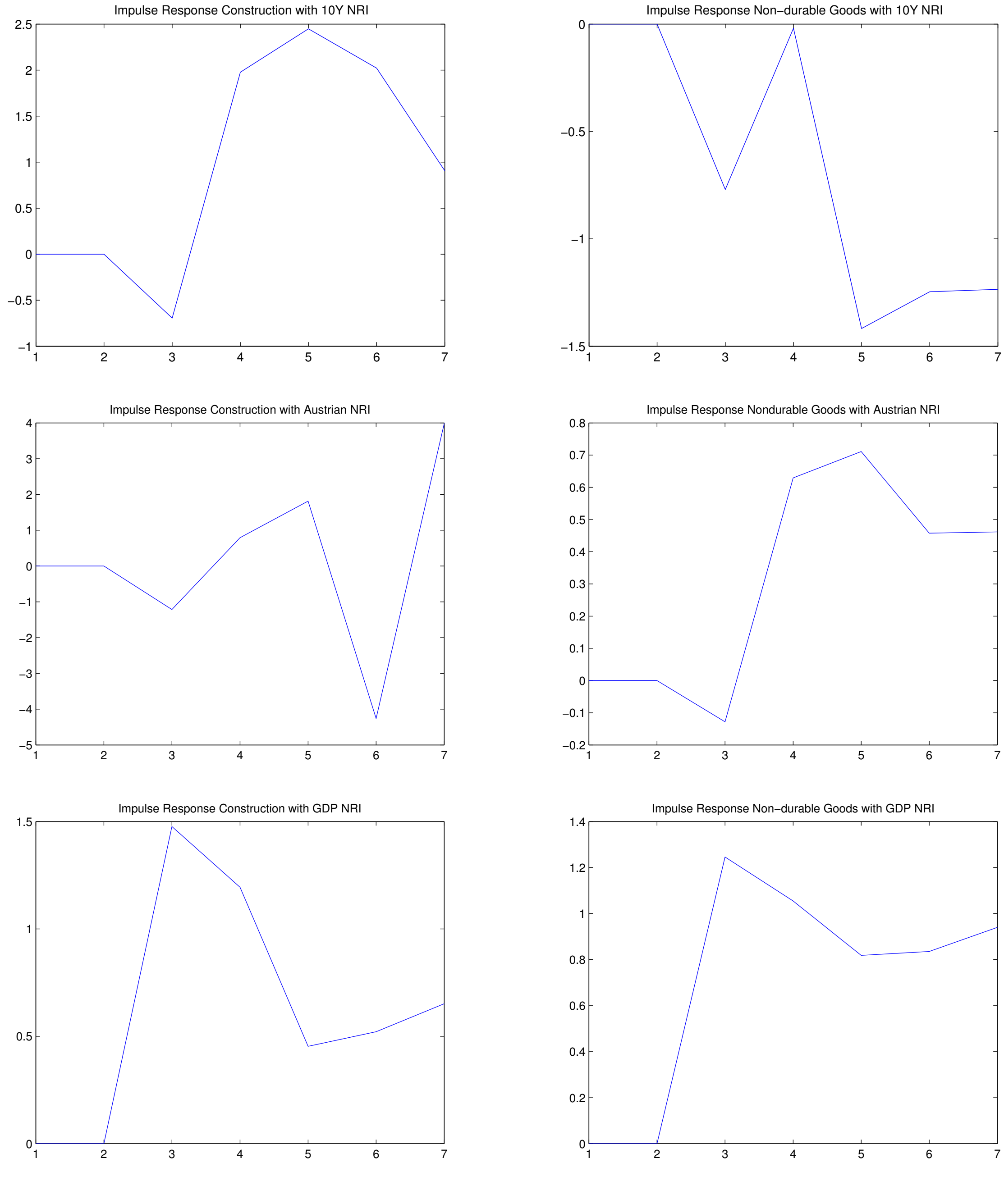

Figure 4.2. Impulse response functions, production oriented sectors, positive shock.

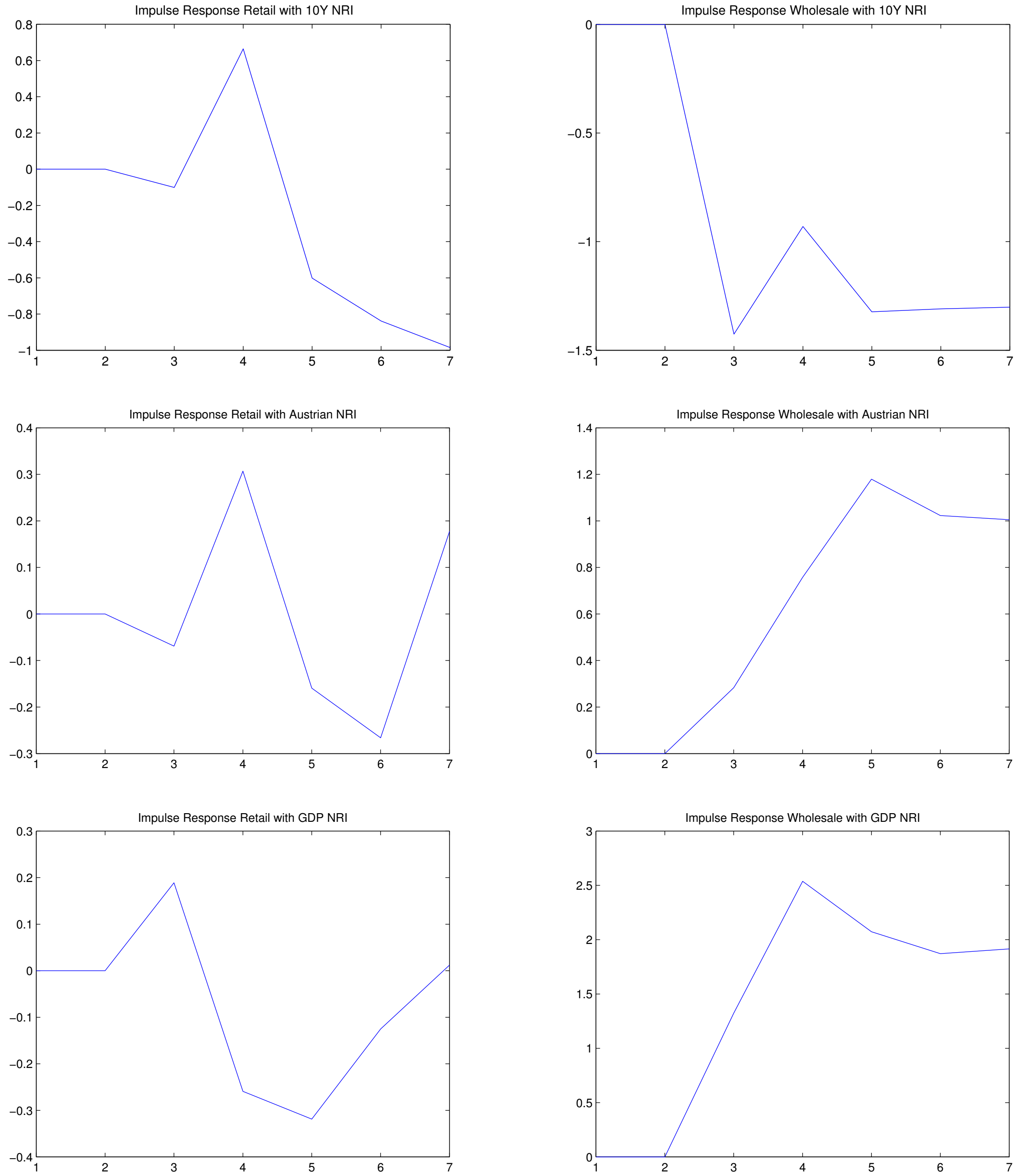

Figure 4.3. Impulse response functions, service oriented sectors, positive shock.

4.5 Connections Between NRI Measures

As is evident, there are differences between the estimated coefficients for the different NRI measures. This is in line with findings of Carilli & Dempster (2008). In total, the NRI measures of real GDP growth and that of the 10 year bonds share the direction (sign) of 41 of 60 coefficients, evenly spread between expansionary and contractionary phases. This is similar to the connection between the results of 10 year bonds and the Austrian NRI, although here only 21 coefficients share the same direction. The numbers for the Austrian and real GDP growth NRI are 28 coefficients with the same direction, however here only eight are found in the expansionary phases. Altogether the three NRI measures share the same direction of coefficients at 16 times.

As mentioned in sections 4.3.1-4.3.3, there seems to be differences in what magnitude production and service oriented sectors are affected by the yield spread. To control for this effect Monte Carlo based permutation tests (see e.g. Sköld 2005) were conducted in MATLAB, based on a null hypothesis of equal distributions for the coefficients for production and service oriented sectors. *Table 4.7* below show observed and 5% critical values to the permutation tests. We can conclude that in 9 out of 18 instances the effect is significant. It should however be noted that many coefficients are insignificant.

Table 4.7. Test Statistics and Critical Values to Permutation Tests

Measure	$\xi_t < 0$	$\xi_{t-1} < 0$	$\xi_{t-2} < 0$	$\xi_t > 0$	$\xi_{t-1} > 0$	$\xi_{t-2} > 0$
Austrian NRI	2.357	1.43	1.588	0.641	0.472	0.584
	(2.225)	(1.590)	(1.692)	(0.620)	(0.380)	(0.584)
10 Year NRI	1.223	0.764	0.800	1.508	1.63	0.518
	(1.421)	(0.727)	(1.139)	(1.508)	(1.196)	(1.189)
Real GDP Growth NRI	0.268	0.697	0.267	1.126	0.178	0.523
	(0.492)	(0.580)	(0.301)	(1.042)	(0.682)	(0.825)

Note: Given values are observed test statistics and, in parentheses, critical values, to H_0: Distribution of coefficients for production sectors and service sectors are equal. H_1: Distribution of coefficients differ.

5 Conclusions

To draw conclusions based on the empirical findings presented in the previous chapter is difficult. First, as noted by Carilli & Dempster (2008), the analysis is sensitive to the estimated natural interest rate used which is clear from our empirical findings. Secondly, with relatively few significant coefficients in the estimated VECM-model across the three different NRI's, the possibilities to draw conclusions are severely limited. With that said, there are empirical findings pointing both for and against what is suggested by Austrian theory.

A priori, we would expect to have positive contemporary coefficients during expansionary phases for both early and late stages of production, with late stages being affected to a lower magnitude. Here the Real GDP growth NRI give only one non-negative coefficient, while the 10 year and the Austrian NRIs both have mostly positive coefficients. Earlier research has suggested that the effect increases during late periods of the expansionary phase. Generally, this is true for the Real GDP growth and the 10 year NRIs, but with the Austrian NRI the effect seem to be the reverse; coefficients for all ten industries has decreased as compared to the contemporaneous coefficient.

We would expect the effect of expansionary interest rate policies to be negative towards later periods of the expansion. In this study that translates into negative coefficients for lags of two years. For the Real GDP growth NRI half of the sectors have positive and half have negative coefficients, with no distinction between production and service oriented sectors. However, coefficients for all sectors except Agriculture, Mining and Wholesale have decreased as compared to the one year lag coefficient. For the 10 year NRI all sectors except Agriculture and Wholesale have negative coefficients, whereas with the Austrian NRI Agriculture, Construction, Nondurable Goods and Wholesale have negative coefficients.

Although a lag of two years could be too few to measure large lag effects, impulse response (IR) functions can lend some support for or against what is expected over longer time horizons. As these results also vary and are inconsistent for different industries and NRIs they lend little support to what is proposed by Austrian Business Cycle Theory.

Although the purpose of this study is to measure if and how a lowering of the short interest rate below the natural interest rate affect sector-specific output we have also presented results for periods where the opposite is true; termed contractive phases. For the contemporary effect of such periods the 10 year NRI have eight industries with negative values, where the production industries generally have greater values. The corresponding results for the Real GDP growth NRI is that only production oriented industries have negative coefficients, whereas the results for the Austrian NRI is one of no distinction between the two groups of industries.

With a one-year lag the results for the contractionary phase with the Real GDP growth and 10 year NRIs are similar, with nine industries sharing the same direction and similar relative magnitudes. Producing industries generally have larger coefficients, but many are also positive indicating an increase in output. For the Austrian NRI a distinction is clear for the two groups of industries; producing oriented industries have large positive effects and service oriented industries have small, negative effects. Also the results for a lag of two years see similarities between the Real GDP growth and 10 year NRIs; seven sectors having the same direction but few are similar in magnitude. For the Austrian NRI eight are negative, all with small values

As is evident from our results an expansionary policy seem to have a greater impact on the production oriented sectors compared to the service oriented sectors, which to some extent lend support to the propositions of ABCT. When looking at the direction (sign) of the coefficients the results however vary as what is proposed by ABCT; industries in either group sometimes move in the opposite directions to what is expected. This is also confirmed by the impulse response analysis. Thus the support of the theory is inconsistent, at best.

Due to the sometimes contradictory results and the low number of significant coefficients we conclude that we do not find enough evidence to support that a lowering of the short term interest rate below the natural interest rate affect sector-specific output as proposed by the Austrian Business Cycle Theory.

Given the scarcity of previous studies and the results of this study we would propose further research on the subject. Such research would benefit from at least two related modifications as compared to our study; higher frequency series and longer samples. This would allow to capture short-term impacts of the yield spread as well as allow for studies into the long-run effects past the two years included in this thesis. As concluded, the choice of NRI measure has a significant impact on the result. Thus, further research into which NRI measure that best capture the behaviour of the true unobservable NRI is of importance and interest. Research that would take into account such modifications, if they are possible, would allow a better platform and possibly produce significant results from which better conclusions could be drawn.

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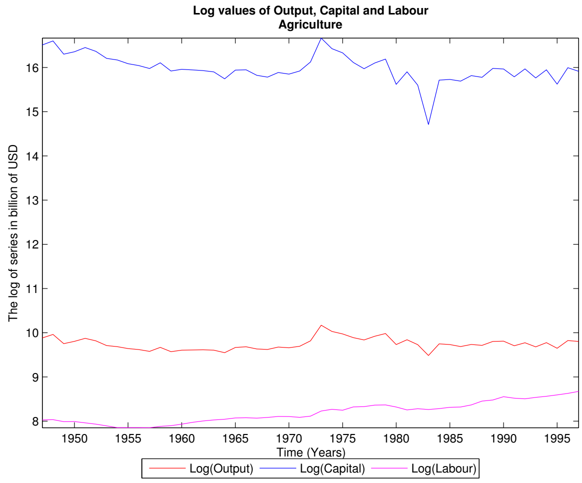
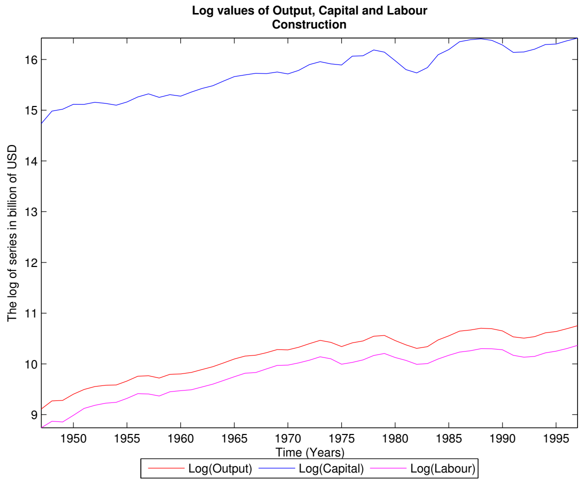
7 Appendix A: Graphs

7.1 Data Series


Log values of Output, Capital and Labour
Agriculture
The log of series in billion of USD
Time (Years)
8 9 10 11 12 13 14 15 16
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995
Log(Output) Log(Capital) Log(Labour)


Log values of Output, Capital and Labour
Construction
The log of series in billion of USD
Time (Years)
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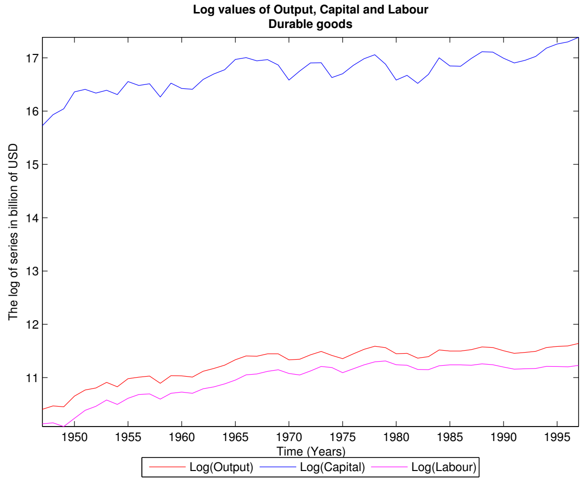
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995
Log(Output) Log(Capital) Log(Labour)


Log values of Output, Capital and Labour
Durable goods
The log of series in billion of USD
Time (Years)
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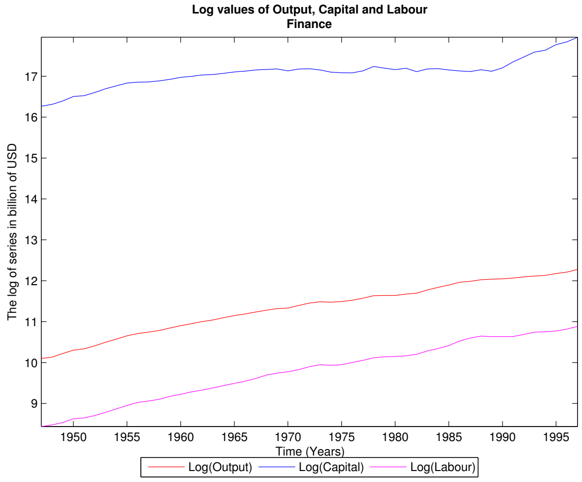
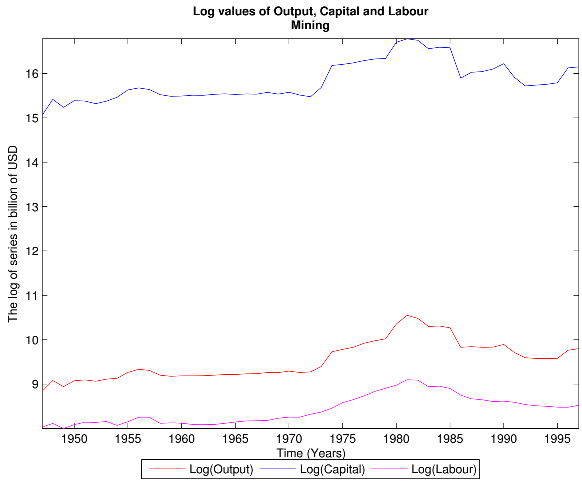
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995
Log(Output) Log(Capital) Log(Labour)


Log values of Output, Capital and Labour
Finance
The log of series in billion of USD
Time (Years)
9 10 11 12 13 14 15 16 17
1950 1955 1960 1965 1970 1975 1980 1985 1990 1995
Log(Output) Log(Capital) Log(Labour)


Log values of Output, Capital and Labour
Mining
The log of series in billion of USD
Time (Years)
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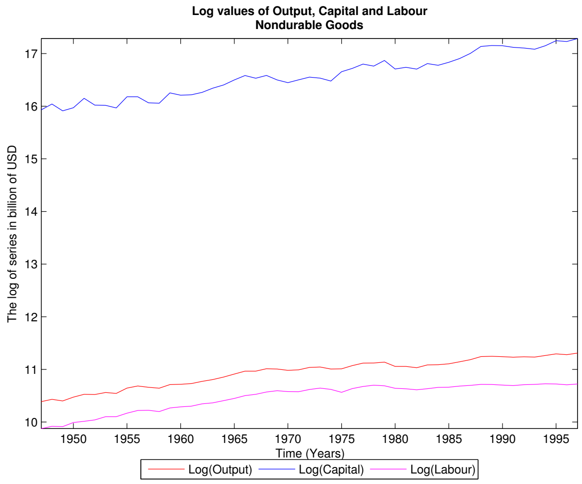
Log(Output) Log(Capital) Log(Labour)


Log values of Output, Capital and Labour
Nondurable Goods
The log of series in billion of USD
Time (Years)
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Log(Output) Log(Capital) Log(Labour)

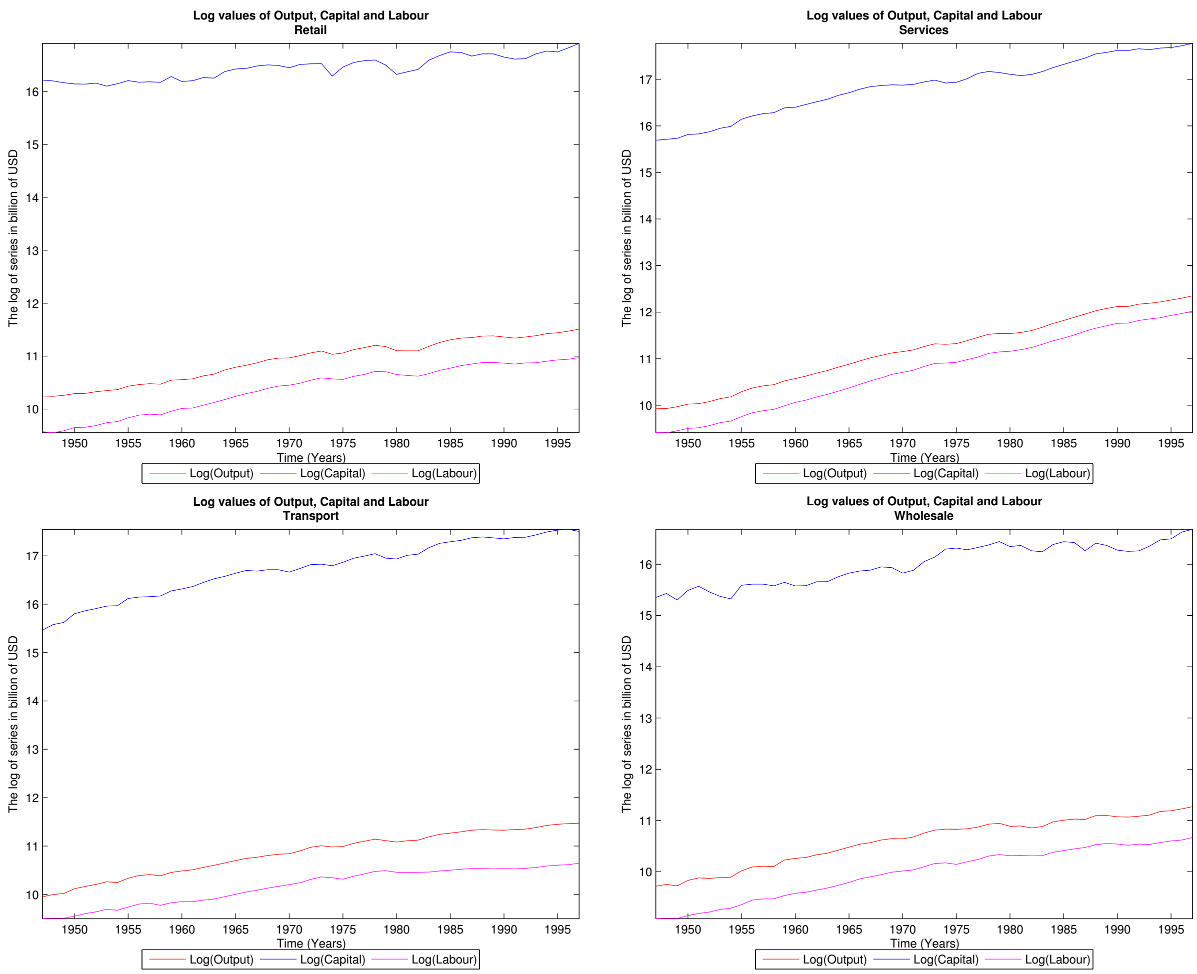
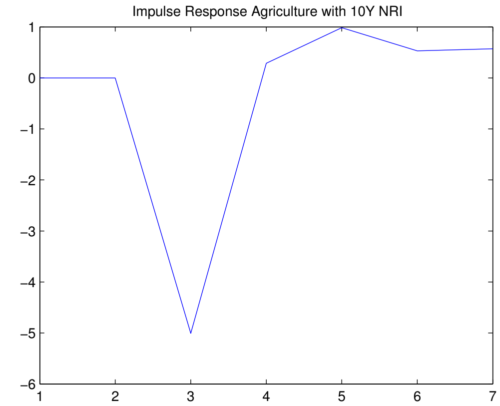


Figure 7.1 Graphs of Data Series

7.2 Impulse Response Graphs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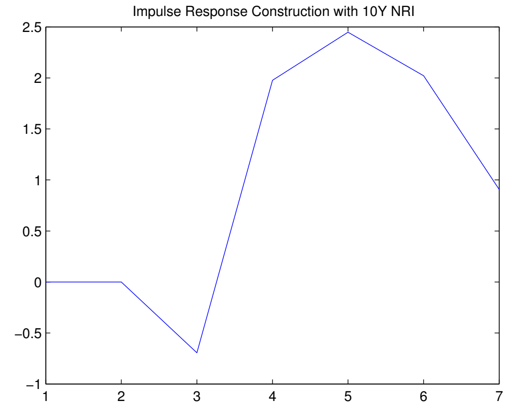
1 2 3 4 5 6 7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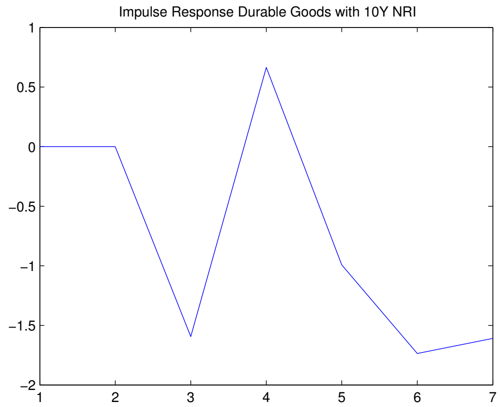
1 2 3 4 5 6 7


Impulse Response Durable Goods with 10Y NRI
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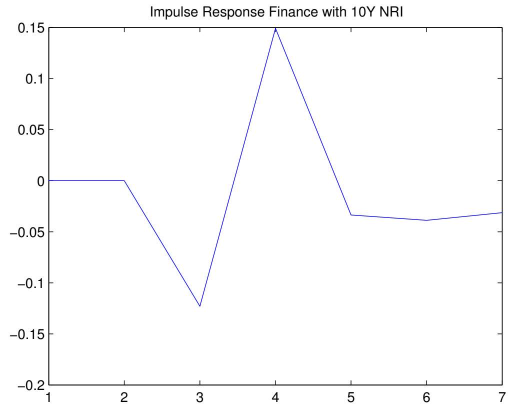
1 2 3 4 5 6 7


Impulse Response Finance with 10Y NRI
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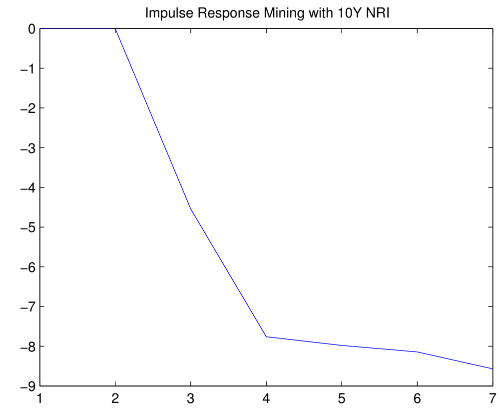
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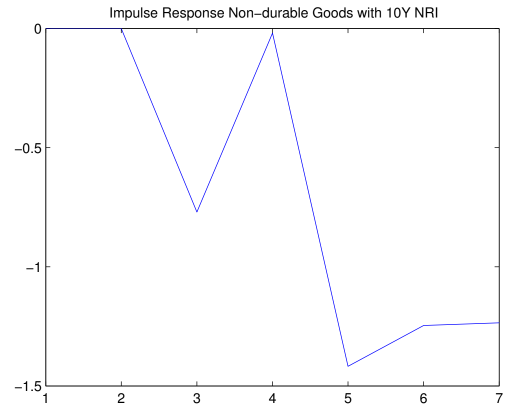
1 2 3 4 5 6 7


Impulse Response Non−durable Goods with 10Y NRI
0 −0.5 −1 −1.5
1 2 3 4 5 6 7

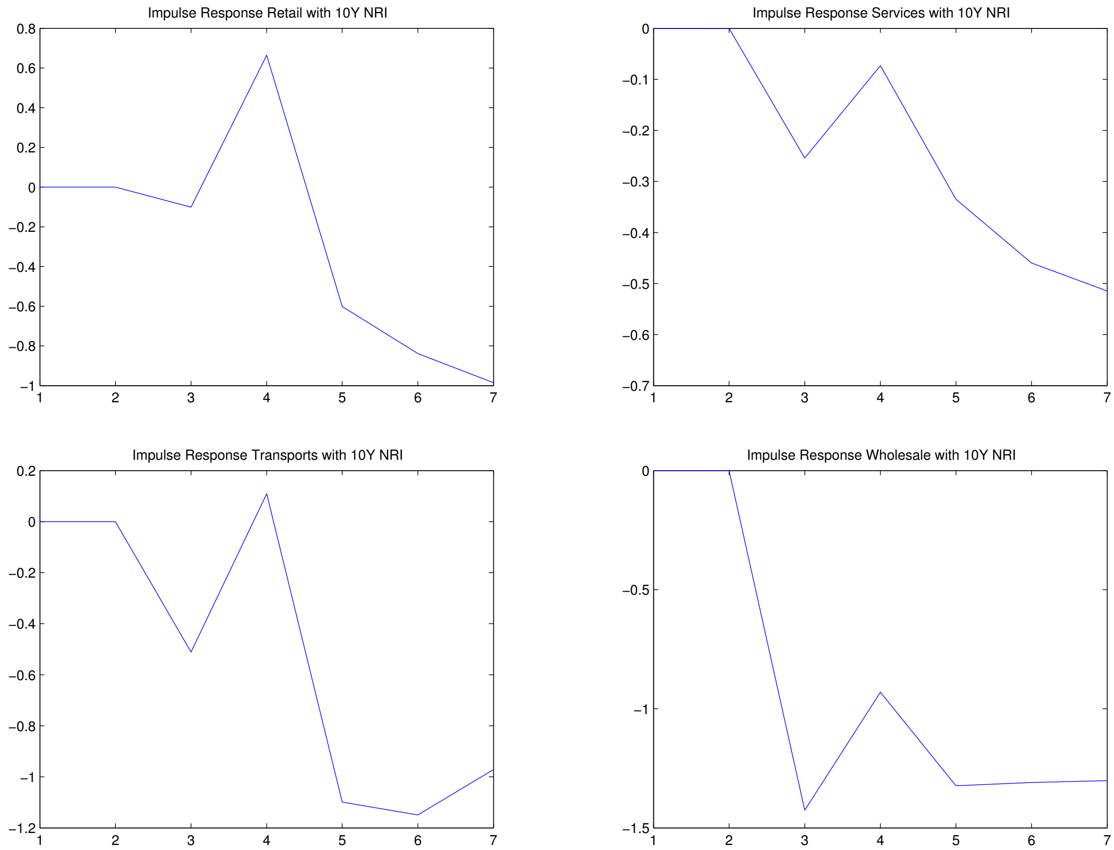
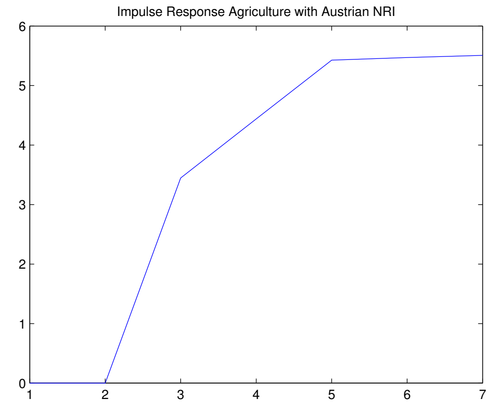
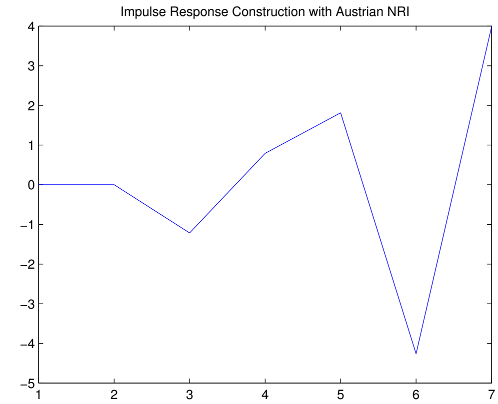
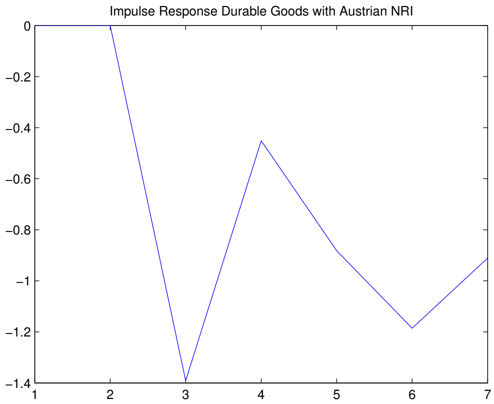
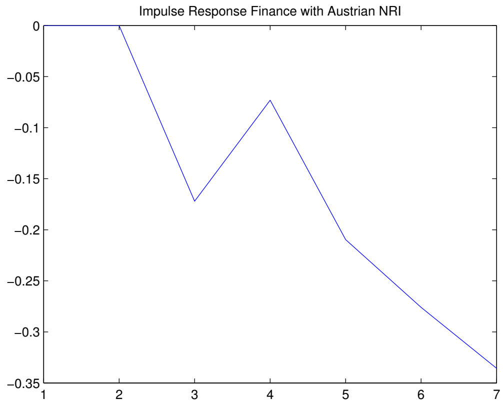


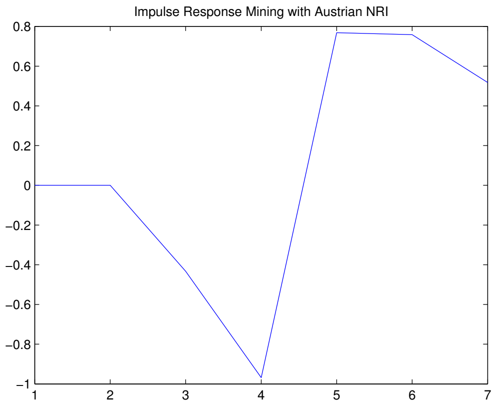
Figure 7.2. Impulse response graphs. 10 Year yield NRI, positive shock.

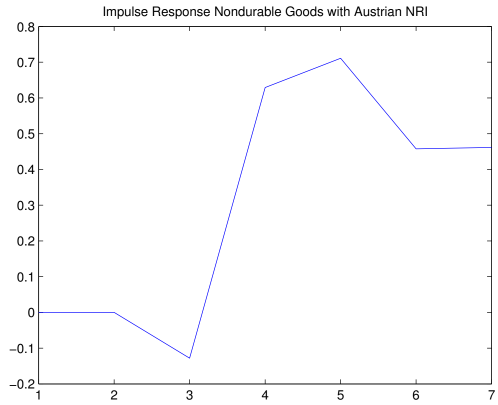

Impulse Response Agriculture with Austrian NRI
0
1
2
3
4
5
6
1
2
3
4
5
6
7


Impulse Response Construction with Austrian NRI
−5
−4
−3
−2
−1
0
1
2
3
4
1
2
3
4
5
6
7


Impulse Response Durable Goods with Austrian NRI
−1.4
−1.2
−1
−0.8
−0.6
−0.4
−0.2
0
1
2
3
4
5
6
7


Impulse Response Finance with Austrian NRI
−0.35
−0.3
−0.25
−0.2
−0.15
−0.1
−0.05
0
1
2
3
4
5
6
7


Impulse Response Mining with Austrian NRI
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1
2
3
4
5
6
7


Impulse Response Nondurable Goods with Austrian NRI
−0.2
−0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
1
2
3
4
5
6
7

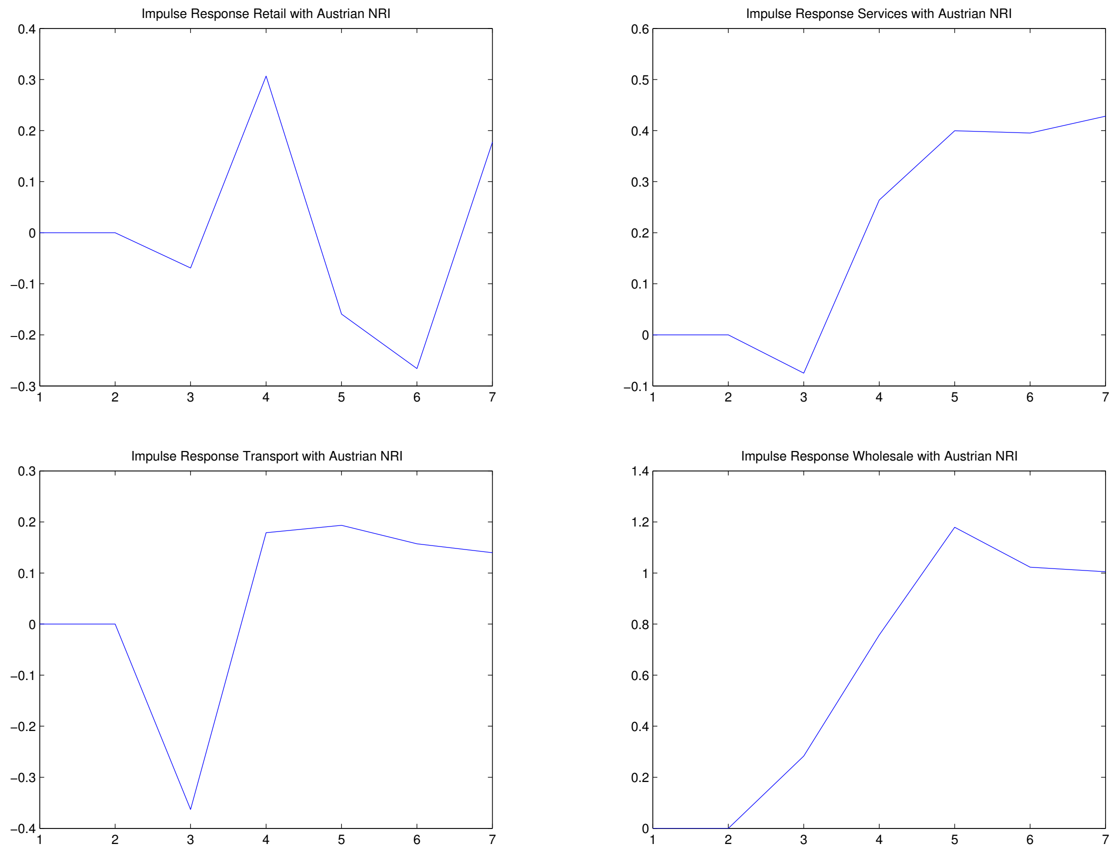
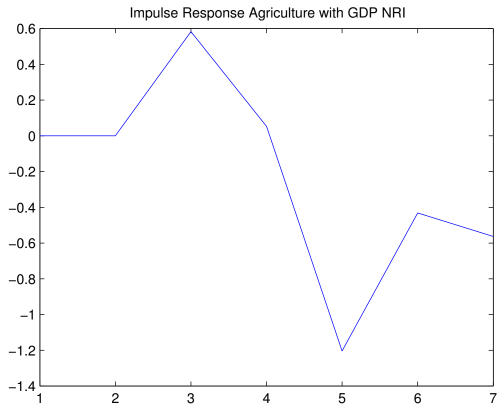
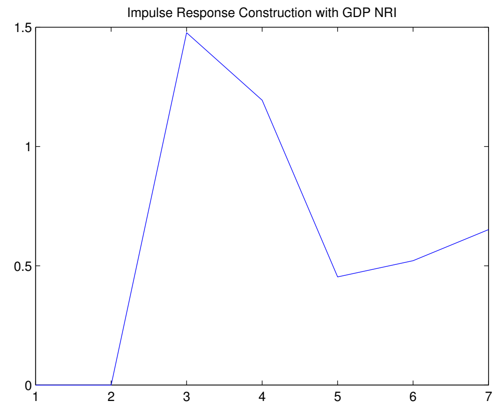
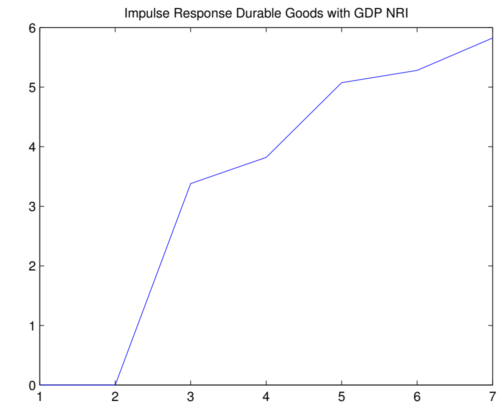
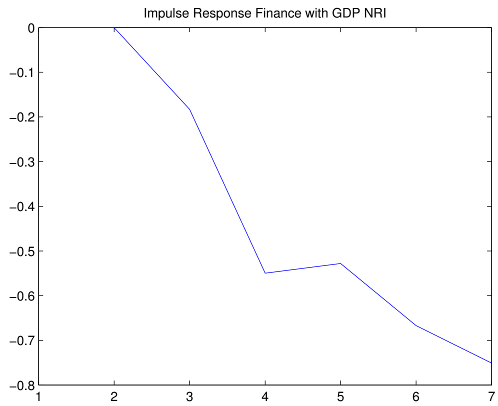


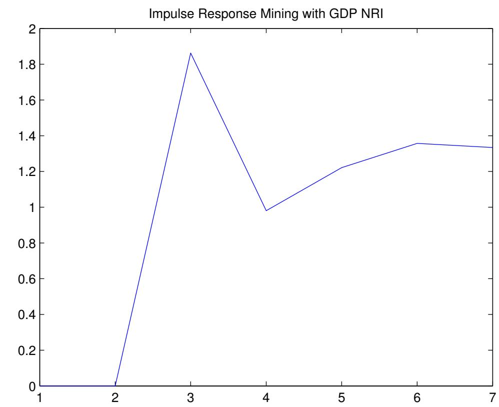
Figure 7.3. Impulse response graphs. Austrian NRI, positive shock.

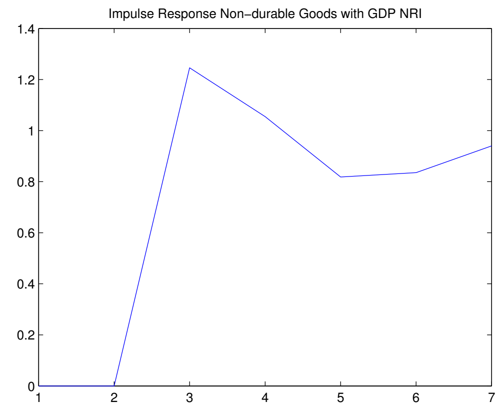

Impulse Response Agriculture with GDP NRI
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
−1.2
−1.4
1 2 3 4 5 6 7


Impulse Response Construction with GDP NRI
1.5
1
0.5
0
1 2 3 4 5 6 7


Impulse Response Durable Goods with GDP NRI
6
5
4
3
2
1
0
1 2 3 4 5 6 7


Impulse Response Finance with GDP NRI
0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
−0.7
−0.8
1 2 3 4 5 6 7


Impulse Response Mining with GDP NRI
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7


Impulse Response Non−durable Goods with GDP NRI
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7

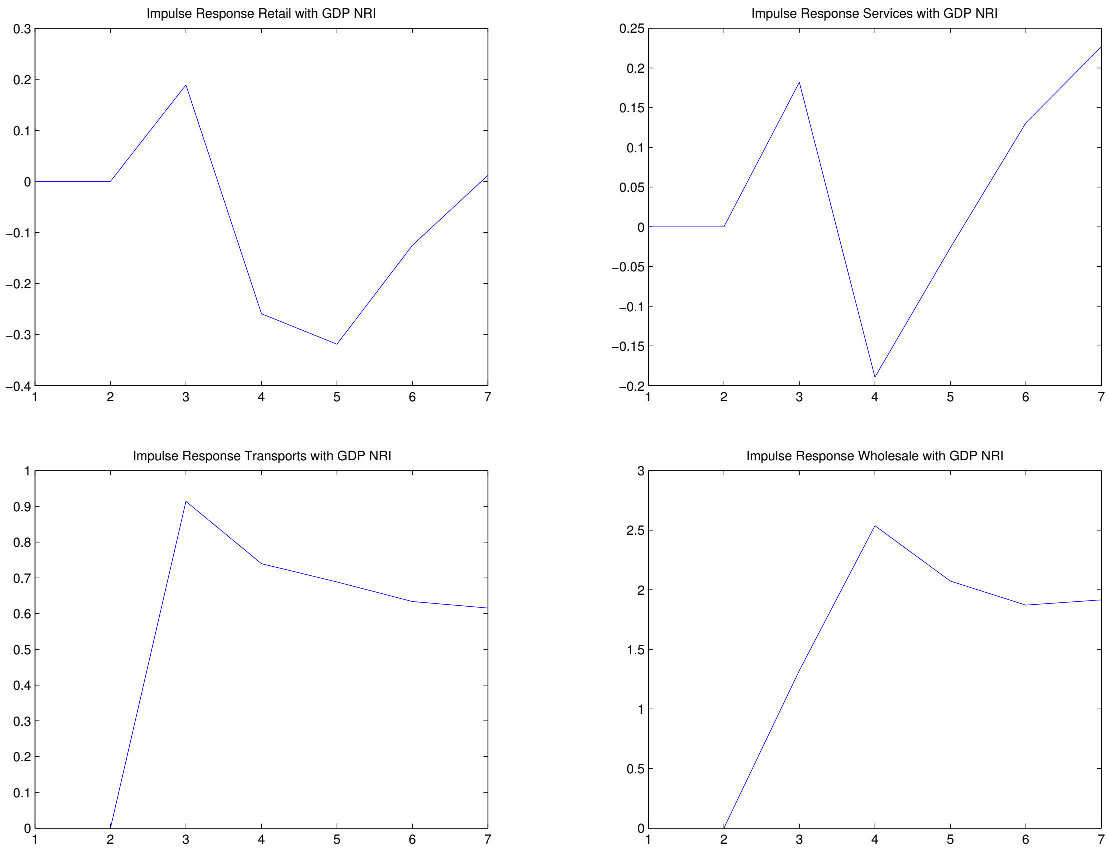
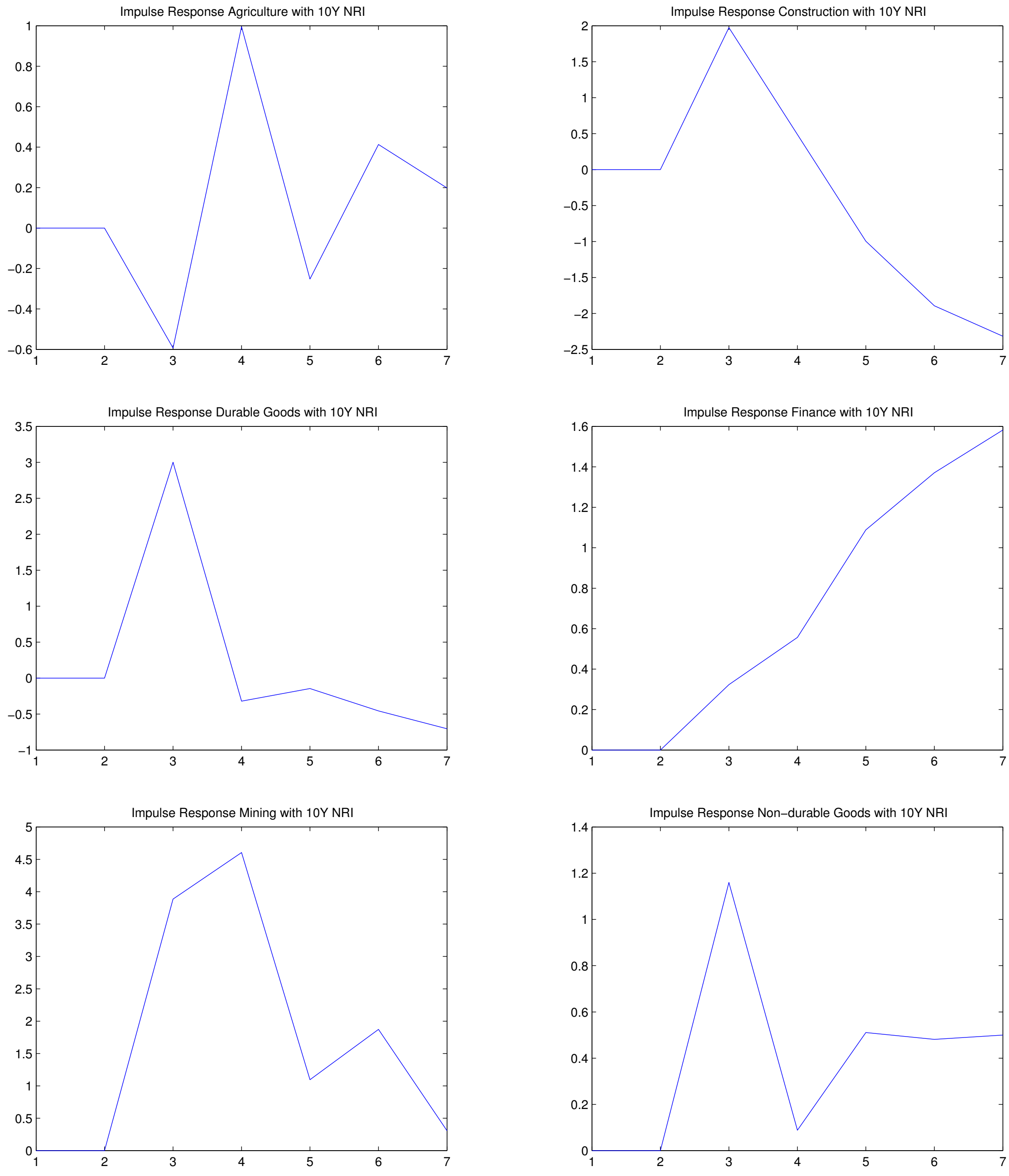


Figure 7.4. Impulse response graphs. Real GDP growth NRI, positive shock.


Impulse Response Agriculture with 10Y NRI
Impulse Response Construction with 10Y NRI
Impulse Response Durable Goods with 10Y NRI
Impulse Response Finance with 10Y NRI
Impulse Response Mining with 10Y NRI
Impulse Response Non−durable Goods with 10Y NRI

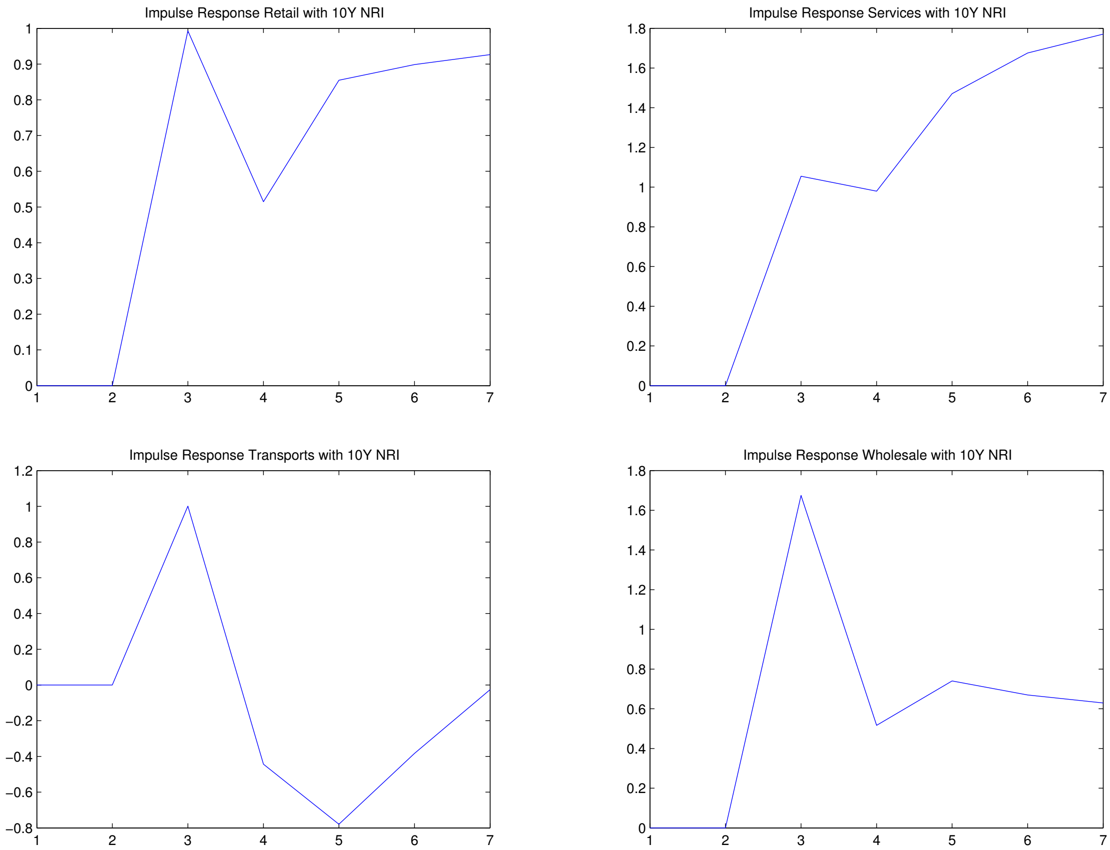
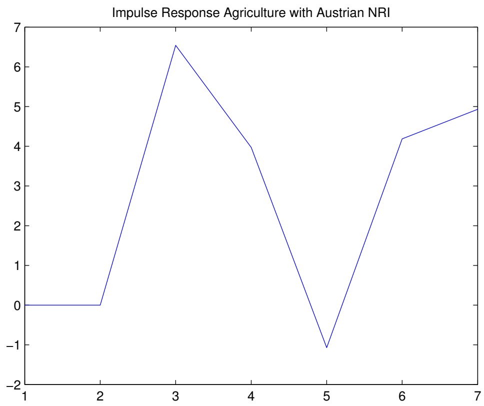
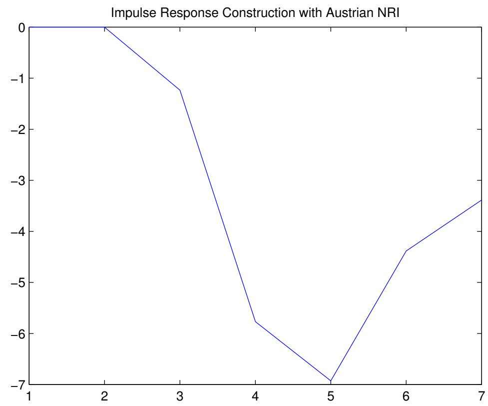
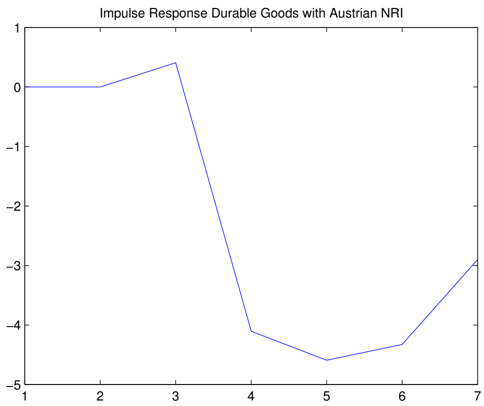
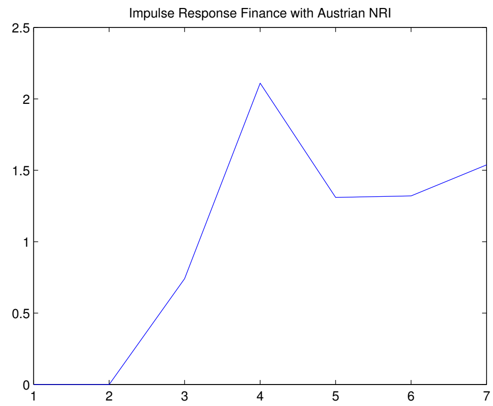


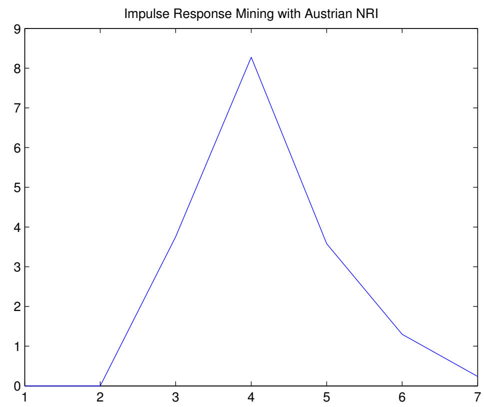
Figure 7.5. Impulse response graphs. 10 Year yield NRI, negative shock.

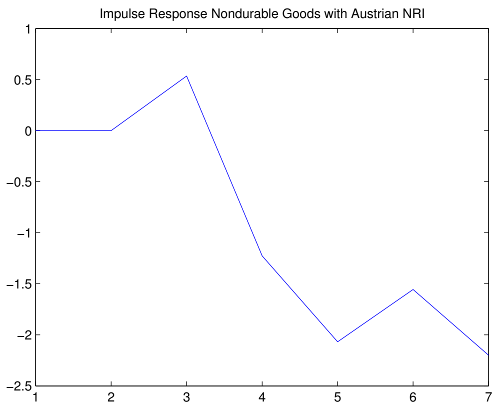

Impulse Response Agriculture with Austrian NRI
7
6
5
4
3
2
1
0
−1
−2
1
2
3
4
5
6
7


Impulse Response Construction with Austrian NRI
0
−1
−2
−3
−4
−5
−6
−7
1
2
3
4
5
6
7


Impulse Response Durable Goods with Austrian NRI
1
0
−1
−2
−3
−4
−5
1
2
3
4
5
6
7


Impulse Response Finance with Austrian NRI
2.5
2
1.5
1
0.5
0
1
2
3
4
5
6
7


Impulse Response Mining with Austrian NRI
9
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
7


Impulse Response Nondurable Goods with Austrian NRI
1
0.5
0
−0.5
−1
−1.5
−2
−2.5
1
2
3
4
5
6
7

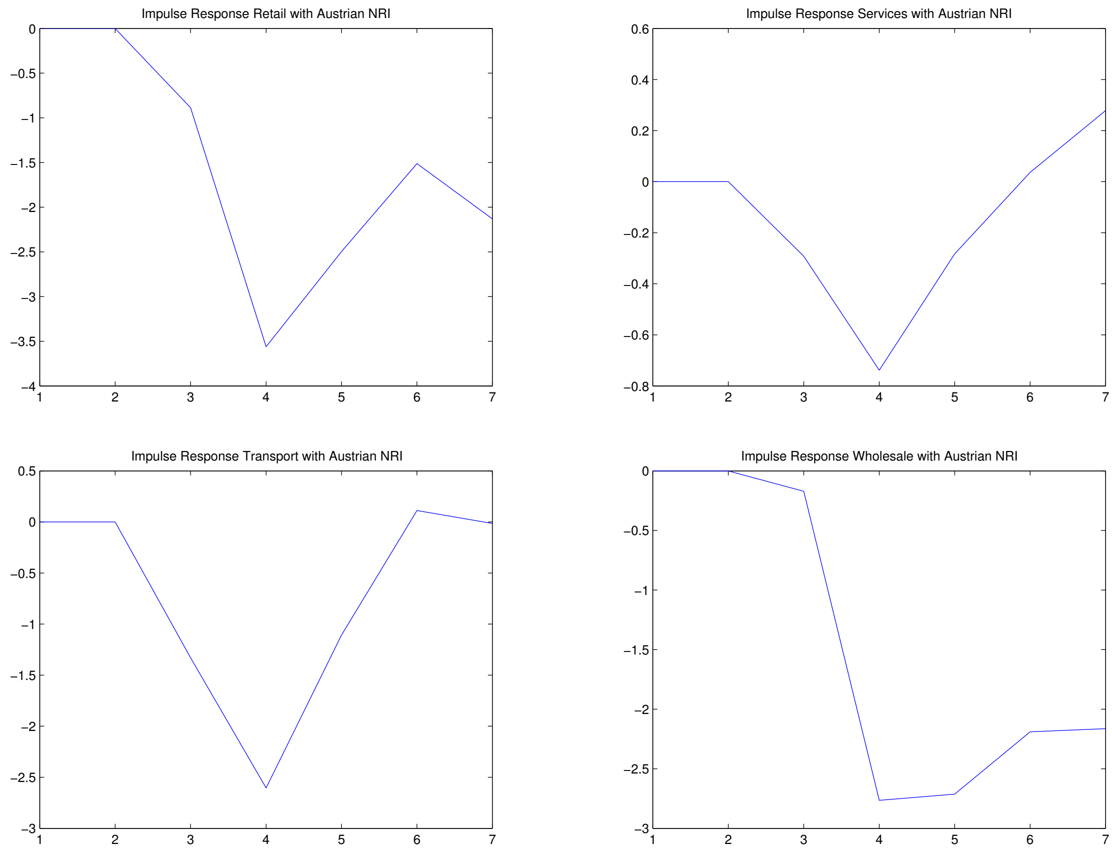
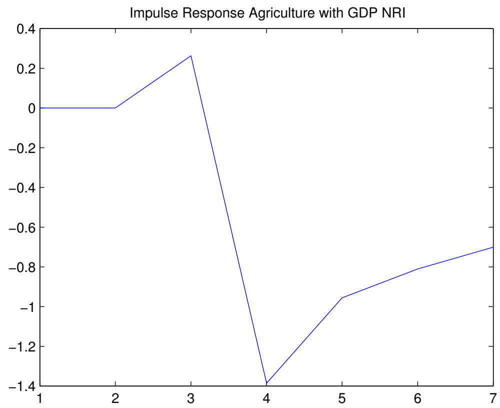
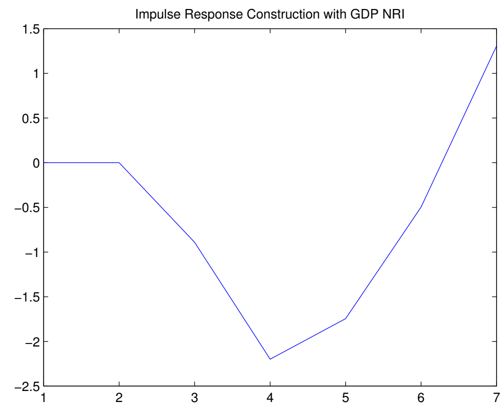
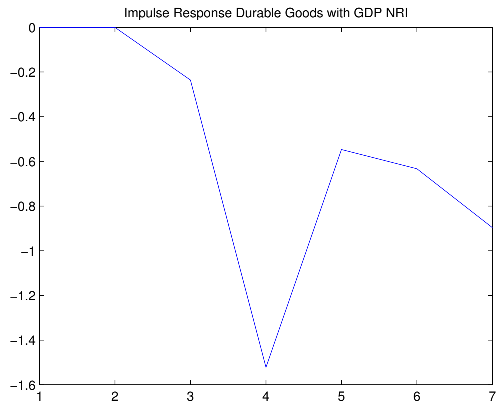
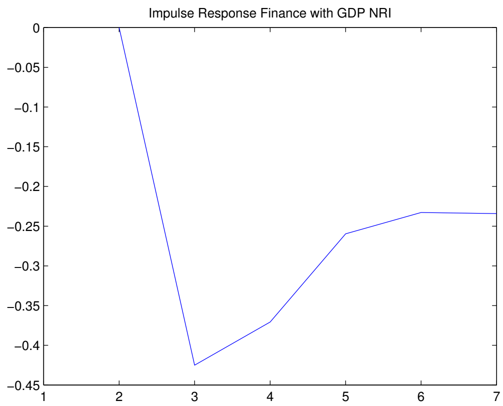


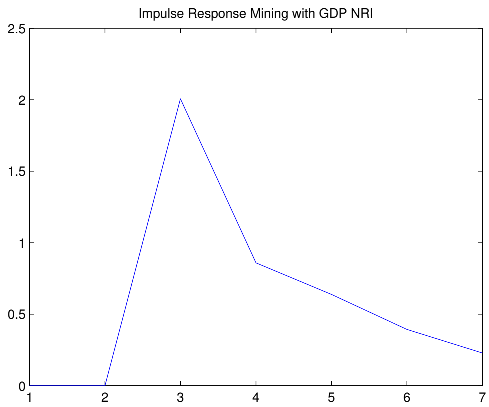
Figure 7.6. Impulse response graphs. Austrian NRI, negative shock.

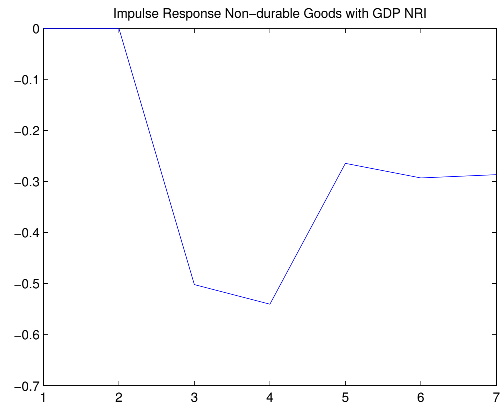

Impulse Response Agriculture with GDP NRI
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
−1.2
−1.4
1 2 3 4 5 6 7


Impulse Response Construction with GDP NRI
1.5
1
0.5
0
−0.5
−1
−1.5
−2
−2.5
1 2 3 4 5 6 7


Impulse Response Durable Goods with GDP NRI
0
−0.2
−0.4
−0.6
−0.8
−1
−1.2
−1.4
−1.6
1 2 3 4 5 6 7


Impulse Response Finance with GDP NRI
0
−0.05
−0.1
−0.15
−0.2
−0.25
−0.3
−0.35
−0.4
−0.45
1 2 3 4 5 6 7


Impulse Response Mining with GDP NRI
2.5
2
1.5
1
0.5
0
1 2 3 4 5 6 7


Impulse Response Non−durable Goods with GDP NRI
0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
−0.7
1 2 3 4 5 6 7

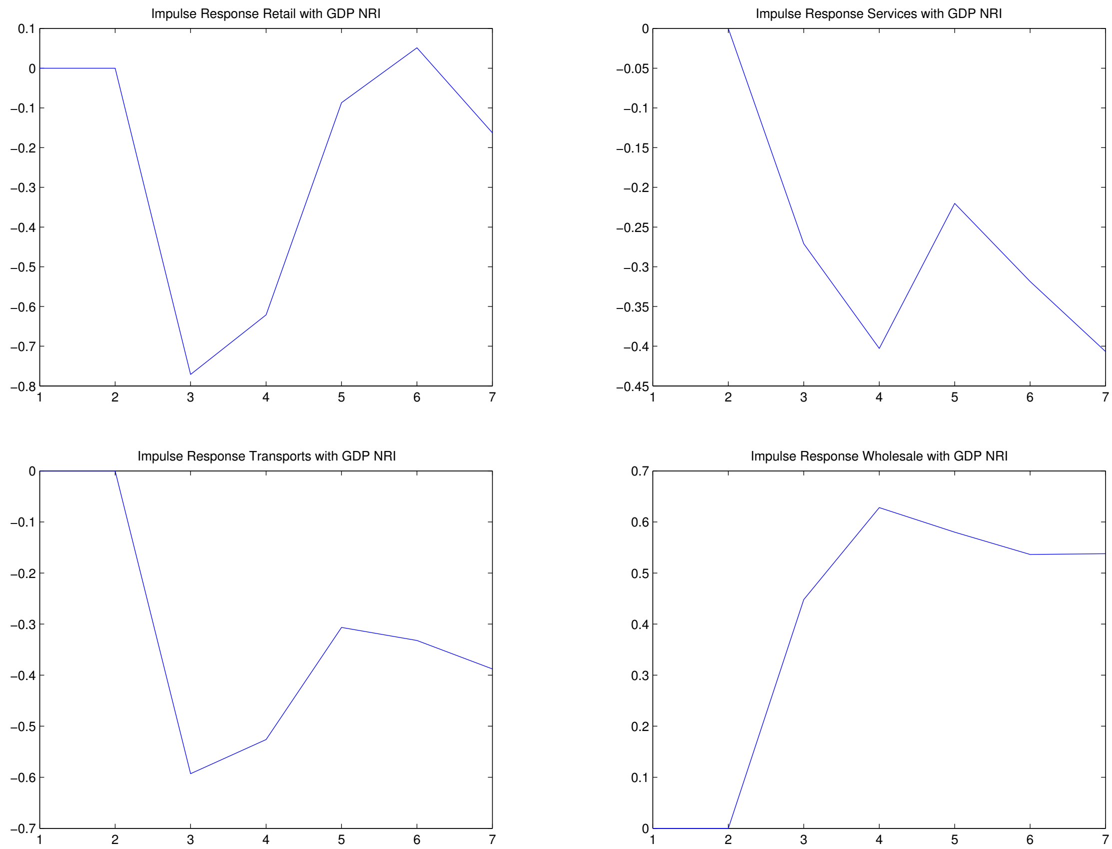


Figure 7.7. Impulse response graphs. Real GDP growth NRI, negative shock.

8 Appendix B: Tables

Table 8.1. Cobb-Douglas Regression

	Coefficient			Adjusted R^2
Series	Capital	Labour	Sum	
Agriculture	0.371	0.323	0.694	0.763
Construction	0.267	0.728	0.995	0.999
Durable Goods	0.250	0.728	0.978	0.999
Finance	0.118	0.803	0.921	0.998
Mining	0.543	0.631	1.174	0.993
Nondurable Goods	0.277	0.618	0.895	0.998
Retail	0.294	0.759	1.053	0.999
Services	0.246	0.732	0.978	0.999
Transports	0.427	0.562	0.989	0.999
Wholesale	0.080	0.874	0.954	0.994

Note: Given coefficients are from regression model $Output = \alpha + \beta_1 log(Capital) + \beta_2 log(Labour)$.

Table 8.2. Granger Causality Tests. Fed Rate - NRI Measure

Series	Austrian NRI	10 Year NRI	Real GDP Growth NRI
	0.902	0.225	0.913

Note: Given values are p-values to Granger causality test with
H_0: Fed rate do not Granger cause NRI measure.

Table 8.3. Granger Causality Tests, VECM Model - NRI Measure

Sector	Capital	Labour	Output
	Austrian NRI		
Agriculture	0.570	0.425	0.694
Construction	0.063	0.075	0.171
Durable Goods	0.030	0.308	0.137
Finance	0.691	0.497	0.631
Mining	0.198	0.634	0.263
Nondurable Goods	0.847	0.175	0.755
Retail	0.014	0.157	0.040
Services	0.700	0.496	0.788
Transports	0.039	0.457	0.097
Wholesale	0.869	0.874	0.749
	Real GDP growth NRI		
Agriculture	0.094	0.191	0.244
Construction	0.584	0.674	0.798
Durable Goods	0.686	0.415	0.531
Finance	0.496	0.583	0.712
Mining	0.937	0.656	0.914
Nondurable Goods	0.460	0.089	0.341
Retail	0.128	0.179	0.055
Services	0.484	0.921	0.719
Transports	0.001	0.719	0.123
Wholesale	0.721	0.919	0.650
	10 Year NRI		
Agriculture	0.941	0.792	0.989
Construction	0.254	0.951	0.781
Durable Goods	0.798	0.842	0.964
Finance	0.263	0.937	0.165
Mining	0.570	0.799	0.661
Nondurable Goods	0.448	0.728	0.453
Retail	0.981	0.765	0.992
Services	0.844	0.640	0.586
Transports	0.579	0.972	0.764
Wholesale	0.482	0.623	0.561

Note: Tests are conducted on residuals from VECM run without exogenous NRI measure. Given values are p-values to test with H_0: VECM does not Granger cause the NRI measure.

Table 8.4. Optimal Lag Structure

Series	AIC	SIC	HQIC
Agriculture	2	1	1
Construction	2	1	2
Durable Goods	2	1	2
Finance	2	2	2
Mining	2	1	2
Nondurable Goods	1	1	1
Retail	2	1	2
Services	2	1	2
Transports	2	1	2
Wholesale	1	1	1

Table 8.5. Cointegration Test Results

Series	λ_{max}	Trace
Agriculture	0	1
Construction	2	2
Durable Goods	2	2
Finance	2	1
Mining	1	1
Nondurable Goods	2	2
Retail	1	2
Services	1	0
Transports	1	1
Wholesale	1	1

Table 8.6. Joint Multivariate Normality test

Series	Real GDP growth NRI	10 Year NRI	Austrian NRI
Agriculture	0.000	0.015	0.000
Construction	0.930	0.220	0.234
Durable Goods	0.726	0.653	0.104
Finance	0.916	0.560	0.983
Mining	0.001	0.006	0.118
Nondurable Goods	0.000	0.004	0.000
Retail	0.868	0.892	0.975
Services	0.000	0.914	0.439
Transports	0.004	0.114	0.000
Wholesale	0.000	0.001	0.000

Note: Given values are p-values to joint null hypothesis of normality.

Table 8.7. VECM Residual Autocorrelation test

Series	Real GDP growth NRI	10 Year NRI	Austrian NRI
Agriculture	0.947	0.762	0.687
Construction	0.110	0.610	0.635
Durable Goods	0.222	0.143	0.249
Finance	0.677	0.434	0.236
Mining	0.013	0.086	0.268
Nondurable Goods	0.047	0.733	0.848
Retail	0.372	0.371	0.932
Services	0.254	0.192	0.280
Transports	0.026	0.142	0.368
Wholesale	0.932	0.976	0.954

Note: Given values are p-values to joint portmanteau test, including 6 lags, with null hypothesis of no autocorrelation.

Table 8.8. VECM results: Agriculture with 10 Year NRI measure

Cointegrating Eq:	CointEq1		
$\log(Output_{t-1})$	1.000000		
$\log(Capital_{t-1})$	-0.380622		
	[-7.00791]		
$\log(Labour_{t-1})$	-0.316649		
	[-4.19382]		
Constant	-1.069733		
Error Correction:	$\Delta\log(Output_t)$	$\Delta\log(Capital_t)$	$\Delta\log(Labour_t)$
CointEq1	-0.067423	0.677288	-0.008838
	[-0.22791]	[0.92687]	[-0.08063]
$\Delta\log(Output_{t-1})$	-0.488428	-1.001210	0.049606
	[-1.02363]	[-0.84947]	[0.28057]
$\Delta\log(Capital_{t-1})$	0.012657	-0.106827	0.019165
	[0.07088]	[-0.24219]	[0.28965]
$\Delta\log(Labour_{t-1})$	0.017182	0.034259	0.171572
	[0.03653]	[0.02949]	[0.98442]
δ	0.015467	0.038702	0.002607
	[0.52389]	[0.53070]	[0.23834]
$\xi_t < 0$	0.113040	-0.067740	-0.393177
	[0.06510]	[-0.01579]	[-0.61110]
$\xi_{t-1} < 0$	-1.601862	-1.265562	0.543666
	[-0.88110]	[-0.28181]	[0.80705]
$\xi_{t-2} < 0$	-0.071897	-0.345699	0.686136
	[-0.03897]	[-0.07585]	[1.00358]
$\xi_t > 0$	-4.957064	-7.646255	-0.550736
	[-3.18027]	[-1.98596]	[-0.95357]
$\xi_{t-1} > 0$	3.047222	4.928768	0.808948
	[1.76773]	[1.15753]	[1.26649]
$\xi_{t-2} > 0$	3.119999	11.56381	-0.504951
	[1.76592]	[2.64971]	[-0.77132]
Adj. R-squared	0.288804	0.255298	0.034115
Akaike AIC	-1.679428	0.129110	-3.665027
Schwarz SC	-1.254734	0.553804	-3.240333

Table 8.9. VECM results: Construction with 10 Year NRI measure

Cointegrating Eq:	CointEq1	CointEq2	
$\log(Output_{t-1})$	1.000000	0.000000	
$\log(Capital_{t-1})$	0.000000	1.000000	
$\log(Labour_{t-1})$	-1.008050	-1.088891	
	[-59.2931]	[-18.9050]	
Constant	-0.282487	-5.035007	
	[-1.68964]	[-8.88926]	
Error Correction:	$\Delta\log(Output_t)$	$\Delta\log(Capital_t)$	$\Delta\log(Labour_t)$
CointEq1	-3.184729	-1.565615	-3.715811
	[-3.41124]	[-1.00061]	[-4.60848]
CointEq2	0.701885	-0.003596	0.947796
	[2.66256]	[-0.00814]	[4.16306]
$\Delta\log(Output_{t-1})$	5.060180	5.745285	4.900645
	[2.45173]	[1.66096]	[2.74931]
$\Delta\log(Output_{t-2})$	3.082501	3.766176	2.899319
	[1.42377]	[1.03796]	[1.55059]
$\Delta\log(Capital_{t-1})$	-1.165604	-1.181285	-1.177354
	[-2.02764]	[-1.22613]	[-2.37143]
$\Delta\log(Capital_{t-2})$	-0.538643	-0.522511	-0.570327
	[-0.90535]	[-0.52403]	[-1.10995]
$\Delta\log(Labour_{t-1})$	-3.615644	-4.191765	-3.450350
	[-2.46603]	[-1.70589]	[-2.72483]
$\Delta\log(Labour_{t-2})$	-2.558917	-3.136255	-2.394676
	[-1.66661]	[-1.21880]	[-1.80588]
$\xi_t < 0$	-1.075780	-0.153113	-1.445318
	[-1.73507]	[-0.14735]	[-2.69912]
$\xi_{t-1} < 0$	1.501917	2.742927	1.091084
	[2.31748]	[2.52538]	[1.94936]
$\xi_{t-2} < 0$	0.173205	-0.091285	0.258652
	[0.26474]	[-0.08325]	[0.45776]
$\xi_t > 0$	0.398034	1.701919	-0.040606
	[0.74713]	[1.90615]	[-0.08825]
$\xi_{t-1} > 0$	2.804162	3.198310	2.703516
	[4.50555]	[3.06625]	[5.02965]
$\xi_{t-2} > 0$	-0.533075	-1.468057	-0.252043
	[-0.79583]	[-1.30772]	[-0.43568]
Adj. R-squared	0.632492	0.502112	0.706210
Akaike AIC	-3.626888	-2.594141	-3.920071
Schwarz SC	-3.081121	-2.048374	-3.374304

Table 8.10. VECM results: Durable goods with 10 Year NRI measure

Cointegrating Eq:	CointEq1		
$\log(Output_{t-1})$	1.000000		
$\log(Capital_{t-1})$	-0.288207		
	[-12.9846]		
$\log(Labour_{t-1})$	-0.642300		
	[-28.0897]		
Constant	0.590031		
Error Correction:	$\Delta\log(Output_t)$	$\Delta\log(Capital_t)$	$\Delta\log(Labour_t)$
CointEq1	-1.928654	-1.494850	-1.995198
	[-3.66574]	[-1.25910]	[-4.48448]
$\Delta\log(Output_{t-1})$	-0.741570	0.344367	-0.775806
	[-0.47433]	[0.09761]	[-0.58682]
$\Delta\log(Output_{t-2})$	-0.332814	0.851135	-0.476119
	[-0.22161]	[0.25116]	[-0.37491]
$\Delta\log(Capital_{t-1})$	0.249433	-0.017552	0.263497
	[0.72595]	[-0.02264]	[0.90687]
$\Delta\log(Capital_{t-2})$	0.148185	-0.086202	0.160680
	[0.41658]	[-0.10739]	[0.53416]
$\Delta\log(Labour_{t-1})$	0.181301	-1.151119	0.424161
	[0.15355]	[-0.43204]	[0.42481]
$\Delta\log(Labour_{t-2})$	0.070991	-0.913722	0.198388
	[0.06277]	[-0.35803]	[0.20743]
δ	0.035750	0.037973	0.036107
	[2.13530]	[1.00511]	[2.55031]
$\xi_t < 0$	-3.108063	-5.160745	-2.412266
	[-3.76999]	[-2.77406]	[-3.46014]
$\xi_{t-1} < 0$	3.034703	6.497385	1.984371
	[3.12811]	[2.96797]	[2.41885]
$\xi_{t-2} < 0$	-0.297833	0.366449	-0.790408
	[-0.29006]	[0.15815]	[-0.91029]
$\xi_t > 0$	-0.446176	1.141888	-0.966634
	[-0.57294]	[0.64980]	[-1.46786]
$\xi_{t-1} > 0$	2.292964	4.748641	1.858853
	[2.83310]	[2.60009]	[2.71599]
$\xi_{t-2} > 0$	-1.917720	-4.768883	-1.310624
	[-2.22427]	[-2.45116]	[-1.79762]
Adj. R-squared	0.605801	0.520161	0.610045
Akaike AIC	-3.085904	-1.458226	-3.421249
Schwarz SC	-2.540137	-0.912459	-2.875482

Table 8.11. VECM results: Finance with 10 Year NRI measure

Cointegrating Eq:	CointEq1	CointEq2	
$\log(Output_{t-1})$	1.000000	0.000000	
$\log(Capital_{t-1})$	0.000000	1.000000	
$\log(Labour_{t-1})$	-0.826440	-0.429421	
	[-49.2614]	[-2.95876]	
Constant	-3.263647	-11.91231	
	[-17.9691]	[-7.58141]	
Error Correction:	**$\Delta\log(Output_t)$**	**$\Delta\log(Capital_t)$**	**$\Delta\log(Labour_t)$**
CointEq1	-0.222027	-0.723586	0.103255
	[-2.36940]	[-3.16766]	[0.98312]
CointEq2	0.046422	0.094143	0.027699
	[4.60484]	[3.83080]	[2.45139]
$\Delta\log(Output_{t-1})$	0.716166	-0.207354	1.036996
	[3.35432]	[-0.39840]	[4.33344]
$\Delta\log(Output_{t-2})$	0.011426	0.530152	-0.245333
	[0.04384]	[0.83440]	[-0.83981]
$\Delta\log(Capital_{t-1})$	-0.254381	-0.082115	-0.296740
	[-3.16342]	[-0.41890]	[-3.29241]
$\Delta\log(Capital_{t-2})$	-0.004355	-0.039119	0.112207
	[-0.05592]	[-0.20607]	[1.28555]
$\Delta\log(Labour_{t-1})$	-0.224345	-0.670869	-0.015143
	[-1.29863]	[-1.59302]	[-0.07821]
$\Delta\log(Labour_{t-2})$	-0.198007	-0.833110	-0.094701
	[-1.13952]	[-1.96679]	[-0.48625]
$\xi_t < 0$	0.089818	0.504214	0.499523
	[0.30261]	[0.69686]	[1.50155]
$\xi_{t-1} < 0$	0.297808	0.857966	0.501917
	[0.95079]	[1.12365]	[1.42970]
$\xi_{t-2} < 0$	-0.326817	0.399827	-0.641554
	[-1.03643]	[0.52014]	[-1.81525]
$\xi_t > 0$	0.468821	0.441953	0.569174
	[1.84997]	[0.71540]	[2.00387]
$\xi_{t-1} > 0$	0.839481	1.850327	0.535693
	[2.99571]	[2.70864]	[1.70557]
$\xi_{t-2} > 0$	-0.021477	0.767213	-0.283128
	[-0.06539]	[0.95827]	[-0.76914]
Adj. R-squared	0.532538	0.478813	0.591573
Akaike AIC	-5.208540	-3.426407	-4.980426
Schwarz SC	-4.662773	-2.880640	-4.434659

Table 8.12. VECM results: Mining with 10 Year NRI measure

Cointegrating Eq:	CointEq1		
$\log(Output_{t-1})$	1.000000		
$\log(Capital_{t-1})$	-0.614004		
	[-10.3126]		
$\log(Labour_{t-1})$	-0.517207		
	[-6.50294]		
Constant	4.538107		
	[13.7991]		
Error Correction:	**$\Delta\log(Output_t)$**	**$\Delta\log(Capital_t)$**	**$\Delta\log(Labour_t)$**
CointEq1	-1.538599	-1.351420	-0.824942
	[-3.36533]	[-1.96748]	[-3.15644]
$\Delta\log(Output_{t-1})$	0.752846	0.219494	0.686587
	[1.18623]	[0.23020]	[1.89247]
$\Delta\log(Capital_{t-1})$	-0.502809	-0.320785	-0.360350
	[-1.36302]	[-0.57880]	[-1.70881]
$\Delta\log(Labour_{t-1})$	-0.972426	-0.835645	-0.468640
	[-2.05886]	[-1.17763]	[-1.73573]
$\xi_t < 0$	-3.551757	-5.331161	-2.578237
	[-2.41686]	[-2.41461]	[-3.06904]
$\xi_{t-1} < 0$	-1.503481	-2.719079	0.885832
	[-0.90132]	[-1.08497]	[0.92897]
$\xi_{t-2} < 0$	5.174876	7.868337	1.498466
	[3.47625]	[3.51812]	[1.76088]
$\xi_t > 0$	-3.032664	-3.595798	-0.827386
	[-2.32994]	[-1.83879]	[-1.11199]
$\xi_{t-1} > 0$	-3.262106	-5.586220	-0.862649
	[-2.17906]	[-2.48374]	[-1.00804]
$\xi_{t-2} > 0$	-0.136813	0.382270	-0.709332
	[-0.09967]	[0.18537]	[-0.90401]
Adj. R-squared	0.451614	0.369804	0.416795
Akaike AIC	-1.836509	-1.022391	-2.954975
Schwarz SC	-1.450423	-0.636305	-2.568889

Table 8.13. VECM results: Nondurable goods with 10 Year NRI measure

Cointegrating Eq:	CointEq1		
log($Output_{t-1}$)	1.000000		
log($Capital_{t-1}$)	-0.270108		
	[-2.86852]		
log($Labour_{t-1}$)	-0.625876		
	[-4.19997]		
Error Correction:	Δlog($Output_t$)	Δlog($Capital_t$)	Δlog($Labour_t$)
CointEq1	-0.234293	-0.145297	-0.271598
	[-2.06490]	[-0.47230]	[-2.93393]
Δlog($Output_{t-1}$)	0.049565	0.573060	-0.136747
	[0.07301]	[0.31134]	[-0.24689]
Δlog($Capital_{t-1}$)	-0.095264	-0.462463	0.030532
	[-0.53414]	[-0.95637]	[0.20982]
Δlog($Labour_{t-1}$)	0.096007	-0.224271	0.245830
	[0.20125]	[-0.17339]	[0.63161]
$\xi_t < 0$	-1.187264	-2.457861	-0.937863
	[-2.24375]	[-1.71319]	[-2.17244]
$\xi_{t-1} < 0$	1.281832	3.061077	1.071164
	[2.31697]	[2.04073]	[2.37316]
$\xi_{t-2} < 0$	-0.044655	0.953218	-0.722734
	[-0.08279]	[0.65182]	[-1.64239]
$\xi_t > 0$	0.418029	1.016971	0.118784
	[0.91801]	[0.82371]	[0.31973]
$\xi_{t-1} > 0$	1.641948	1.315345	1.633810
	[3.40726]	[1.00672]	[4.15556]
$\xi_{t-2} > 0$	-1.056357	-3.066299	-0.302739
	[-1.83645]	[-1.96610]	[-0.64509]
Adj. R-squared	0.294743	0.123527	0.361706
Akaike AIC	-4.055912	-2.061056	-4.462924
Schwarz SC	-3.669826	-1.674970	-4.076838

Table 8.14. VECM results: Retail with 10 Year NRI measure

Cointegrating Eq:	CointEq1		
log($Output_{t-1}$)	1.000000		
log($Capital_{t-1}$)	-2.257220		
	[-4.90483]		
log($Labour_{t-1}$)	2.390806		
	[3.22554]		
Error Correction:	Δlog($Output_t$)	Δlog($Capital_t$)	Δlog($Labour_t$)
CointEq1	-0.006528	0.003881	-0.011008
	[-2.06046]	[0.47606]	[-4.64976]
Δlog($Output_{t-1}$)	0.940904	0.621610	1.082073
	[1.17652]	[0.30205]	[1.81076]
Δlog($Capital_{t-1}$)	-0.134865	-0.231944	-0.126860
	[-0.67295]	[-0.44976]	[-0.84716]
Δlog($Labour_{t-1}$)	-0.408340	-0.206034	-0.522619
	[-0.68520]	[-0.13435]	[-1.17363]
$\xi_t < 0$	-0.362542	-0.296762	-0.474650
	[-0.91590]	[-0.29134]	[-1.60477]
$\xi_{t-1} < 0$	1.234502	1.938916	0.941233
	[2.96744]	[1.81116]	[3.02788]
$\xi_{t-2} < 0$	-0.334037	-0.454807	-0.200059
	[-0.80185]	[-0.42426]	[-0.64270]
$\xi_t > 0$	0.367383	1.849346	0.042468
	[1.04342]	[2.04111]	[0.16142]
$\xi_{t-1} > 0$	1.207265	2.163082	0.935380
	[3.00368]	[2.09137]	[3.11451]
$\xi_{t-2} > 0$	-1.814188	-4.242205	-1.069897
	[-4.97092]	[-4.51704]	[-3.92327]
Adj. R-squared	0.464324	0.340413	0.616755
Akaike AIC	-4.470549	-2.580164	-5.053342
Schwarz SC	-4.084463	-2.194078	-4.667257

Table 8.15. VECM results: Services with 10 Year NRI measure

Cointegrating Eq:	CointEq1		
$\log(Output_{t-1})$	1.000000		
$\log(Capital_{t-1})$	-0.144012		
	[-28.8527]		
$\log(Labour_{t-1})$	-0.809279		
	[-101.115]		
Error Correction:	$\Delta\log(Output_t)$	$\Delta\log(Capital_t)$	$\Delta\log(Labour_t)$
CointEq1	0.644930	0.535754	0.759568
	[3.73579]	[1.83652]	[4.94552]
$\Delta\log(Output_{t-1})$	2.828928	4.036572	2.202222
	[2.53766]	[2.14282]	[2.22049]
$\Delta\log(Capital_{t-1})$	-0.717715	-1.035487	-0.556228
	[-2.10711]	[-1.79904]	[-1.83554]
$\Delta\log(Labour_{t-1})$	-1.783392	-2.544614	-1.398551
	[-2.27425]	[-1.92033]	[-2.00469]
$\xi_t < 0$	-0.608293	-0.559175	-0.669342
	[-1.76638]	[-0.96091]	[-2.18472]
$\xi_{t-1} < 0$	0.792546	1.099564	0.585123
	[2.19315]	[1.80063]	[1.81998]
$\xi_{t-2} < 0$	-0.511592	-0.936351	-0.338637
	[-1.47959]	[-1.60258]	[-1.10085]
$\xi_t > 0$	0.377151	1.286425	0.101668
	[1.23868]	[2.50029]	[0.37532]
$\xi_{t-1} > 0$	0.852095	1.232187	0.713502
	[2.43754]	[2.08594]	[2.29422]
$\xi_{t-2} > 0$	-0.596933	-0.600888	-0.492561
	[-1.97231]	[-1.16538]	[-1.81446]
Adj. R-squared	0.351030	0.336491	0.337484
Akaike AIC	-4.854542	-3.805307	-5.088374
Schwarz SC	-4.468456	-3.419221	-4.702288

Table 8.16. VECM results: Transport with 10 Year NRI measure

Cointegrating Eq:	CointEq1		
$\log(Output_{t-1})$	1.000000		
$\log(Capital_{t-1})$	-0.192270		
	[-2.23170]		
$\log(Labour_{t-1})$	-0.810437		
	[-5.92308]		
Constant	0.602779		
	[2.18142]		
Error Correction:	$\Delta\log(Output_t)$	$\Delta\log(Capital_t)$	$\Delta\log(Labour_t)$
CointEq1	-0.260655	-0.678855	-0.030182
	[-2.64897]	[-4.66090]	[-0.32609]
$\Delta\log(Output_{t-1})$	0.062340	1.099213	-1.196415
	[0.06955]	[0.82845]	[-1.41892]
$\Delta\log(Output_{t-2})$	1.023122	2.175381	0.459547
	[1.15617]	[1.66078]	[0.55208]
$\Delta\log(Capital_{t-1})$	0.184868	-0.271165	0.733456
	[0.50470]	[-0.50013]	[2.12871]
$\Delta\log(Capital_{t-2})$	-0.348148	-0.683074	-0.221944
	[-0.99451]	[-1.31825]	[-0.67401]
$\Delta\log(Labour_{t-1})$	-0.047933	-1.239426	0.998324
	[-0.08379]	[-1.46376]	[1.85530]
$\Delta\log(Labour_{t-2})$	-0.484931	-1.250295	-0.029113
	[-0.86744]	[-1.51096]	[-0.05536]
$\xi_t < 0$	-0.625879	-0.270881	-0.964725
	[-1.54561]	[-0.45193]	[-2.53273]
$\xi_{t-1} < 0$	1.407700	1.760585	1.373216
	[3.17762]	[2.68492]	[3.29538]
$\xi_{t-2} < 0$	0.453216	1.501319	-0.285982
	[0.97332]	[2.17824]	[-0.65293]
$\xi_t > 0$	0.274932	0.297851	0.124343
	[0.71840]	[0.52580]	[0.34541]
$\xi_{t-1} > 0$	0.898745	1.039519	0.946346
	[2.24467]	[1.75401]	[2.51270]
$\xi_{t-2} > 0$	-1.498715	-2.256502	-0.907233
	[-3.87126]	[-3.93778]	[-2.49131]
Adj. R-squared	0.334660	0.512067	0.332321
Akaike AIC	-4.418104	-3.633763	-4.540483
Schwarz SC	-3.911320	-3.126979	-4.033700

Table 8.17. VECM results: Wholesale with 10 Year NRI measure

Cointegrating Eq:	CointEq1		
$\log(Output_{t-1})$	1.000000		
$\log(Capital_{t-1})$	-0.012348		
	[-0.22878]		
$\log(Labour_{t-1})$	-1.007905		
	[-11.6156]		
Error Correction:	$\Delta\log(Output_t)$	$\Delta\log(Capital_t)$	$\Delta\log(Labour_t)$
CointEq1	0.115314	0.039452	0.121970
	[2.51133]	[0.32492]	[4.77536]
$\Delta\log(Output_{t-1})$	0.232714	-0.215794	0.235902
	[0.54814]	[-0.19222]	[0.99891]
$\Delta\log(Capital_{t-1})$	-0.084900	-0.015328	-0.035793
	[-0.67234]	[-0.04591]	[-0.50959]
$\Delta\log(Labour_{t-1})$	-0.299923	0.045187	-0.187582
	[-0.71846]	[0.04093]	[-0.80782]
$\xi_t < 0$	-1.233426	-1.269280	-1.106371
	[-2.03276]	[-0.79107]	[-3.27797]
$\xi_{t-1} < 0$	1.366707	2.579839	0.618952
	[2.00699]	[1.43268]	[1.63402]
$\xi_{t-2} < 0$	-0.136615	0.385730	-0.144256
	[-0.21187]	[0.22622]	[-0.40219]
$\xi_t > 0$	-0.223932	-1.772294	-0.222749
	[-0.40777]	[-1.22045]	[-0.72920]
$\xi_{t-1} > 0$	1.100514	0.847360	1.237375
	[1.83314]	[0.53377]	[3.70538]
$\xi_{t-2} > 0$	0.240753	0.449247	0.179171
	[0.36286]	[0.25606]	[0.48547]
Adj. R-squared	0.171111	-0.075991	0.474531
Akaike AIC	-3.668533	-1.723706	-4.841611
Schwarz SC	-3.282448	-1.337620	-4.455525

Table 8.18. VECM results: Agriculture with Austrian NRI measure

Cointegrating Eq:	CointEq1		
log(Output$_{t-1}$)	1.000000		
log(Capital$_{t-1}$)	-2.023436		
	[-4.98846]		
log(Labour$_{t-1}$)	0.611239		
	[0.80213]		
Constant	17.57997		
Error Correction:	**Δlog(Output$_t$)**	**Δlog(Capital$_t$)**	**Δlog(Labour$_t$)**
CointEq1	0.138693	0.321140	0.025645
	[3.48850]	[3.74529]	[1.91414]
Δlog(Output$_{t-1}$)	-0.044777	0.614857	-0.027161
	[-0.11079]	[0.70538]	[-0.19942]
Δlog(Capital$_{t-1}$)	-0.006654	-0.364989	0.045572
	[-0.04187]	[-1.06488]	[0.85095]
Δlog(Labour$_{t-1}$)	-0.082753	-0.740034	0.184147
	[-0.16142]	[-0.66930]	[1.06591]
δ	-0.085864	-0.123348	0.012500
	[-1.56885]	[-1.04497]	[0.67774]
$\xi_t < 0$	-4.906018	-10.96776	0.897564
	[-1.81489]	[-1.88124]	[0.98532]
$\xi_{t-1} < 0$	0.940592	3.228458	-0.358674
	[0.31773]	[0.50565]	[-0.35954]
$\xi_{t-2} < 0$	5.509714	20.28707	1.629704
	[2.08057]	[3.55204]	[1.82622]
$\xi_t > 0$	0.999514	2.705416	-0.298453
	[1.11587]	[1.40044]	[-0.98876]
$\xi_{t-1} > 0$	0.582078	0.634385	0.179799
	[0.60155]	[0.30398]	[0.55140]
$\xi_{t-2} > 0$	0.785680	0.592385	0.202954
	[0.96191]	[0.33628]	[0.73736]
Adj. R-squared	0.269773	0.417089	0.179752
Akaike AIC	-1.653021	-0.115840	-3.828466
Schwarz SC	-1.228327	0.308855	-3.403771

Table 8.19. VECM results: Construction with Austrian NRI measure

Cointegrating Eq:	CointEq1	CointEq2	
log(Output$_{t-1}$)	1.000000	0.000000	
log(Capital$_{t-1}$)	0.000000	1.000000	
log(Labour$_{t-1}$)	-0.815490	-0.425463	
	[-11.2675]	[-1.65866]	
Constant	-2.435736	-12.49419	
	[-3.20285]	[-4.63556]	
Error Correction:	**Δlog(Output$_t$)**	**Δlog(Capital$_t$)**	**Δlog(Labour$_t$)**
CointEq1	-3.981116	0.043852	-5.394450
	[-2.78749]	[0.01949]	[-4.22752]
CointEq2	1.015802	-0.198524	1.443686
	[2.55783]	[-0.31739]	[4.06878]
Δlog(Output$_{t-1}$)	2.596300	0.922993	3.346653
	[1.19047]	[0.26871]	[1.71753]
Δlog(Output$_{t-2}$)	-0.125519	-1.230564	0.377131
	[-0.05660]	[-0.35234]	[0.19035]
Δlog(Capital$_{t-1}$)	-0.539103	-0.063850	-0.740667
	[-0.89540]	[-0.06733]	[-1.37688]
Δlog(Capital$_{t-2}$)	0.176031	0.492445	0.031987
	[0.28718]	[0.51008]	[0.05841]
Δlog(Labour$_{t-1}$)	-1.898378	-0.908881	-2.341536
	[-1.22630]	[-0.37277]	[-1.69295]
Δlog(Labour$_{t-2}$)	-0.267539	0.532540	-0.635029
	[-0.16965]	[0.21441]	[-0.45071]
$\xi_t < 0$	1.235699	4.262114	0.128377
	[1.18925]	[2.60441]	[0.13829]
$\xi_{t-1} < 0$	4.143138	6.763272	3.203368
	[3.47367]	[3.60031]	[3.00605]
$\xi_{t-2} < 0$	1.959748	3.599642	1.309809
	[1.50118]	[1.75072]	[1.12298]
$\xi_t > 0$	-1.390533	-1.275490	-1.429423
	[-3.36289]	[-1.95854]	[-3.86922]
$\xi_{t-1} > 0$	0.368135	0.072736	0.529447
	[0.94508]	[0.11856]	[1.52129]
$\xi_{t-2} > 0$	-0.967070	-1.465355	-0.836275
	[-2.63390]	[-2.53400]	[-2.54930]
Adj. R-squared	0.577194	0.494125	0.638274
Akaike AIC	-3.486720	-2.578227	-3.712051
Schwarz SC	-2.940953	-2.032461	-3.166284

Table 8.20. VECM results: Durable Goods with Austrian NRI measure

Cointegrating Eq:	CointEq1		
log($Output_{t-1}$)	1.000000		
log($Capital_{t-1}$)	-0.294749		
	[-12.2929]		
log($Labour_{t-1}$)	-0.622744		
	[-20.5266]		
Constant	0.484883		
Error Correction:	Δlog($Output_t$)	Δlog($Capital_t$)	Δlog($Labour_t$)
CointEq1	-1.189327	-0.592120	-1.203418
	[-2.19637]	[-0.47407]	[-2.53796]
Δlog($Output_{t-1}$)	-0.082141	2.911104	-0.782623
	[-0.05307]	[0.81549]	[-0.57749]
Δlog($Output_{t-2}$)	2.773028	8.022221	1.462154
	[1.78088]	[2.23360]	[1.07235]
Δlog($Capital_{t-1}$)	0.106169	-0.546714	0.268185
	[0.30124]	[-0.67251]	[0.86897]
Δlog($Capital_{t-2}$)	-0.536967	-1.727524	-0.243808
	[-1.47138]	[-2.05225]	[-0.76294]
Δlog($Labour_{t-1}$)	-0.604618	-3.796728	0.234411
	[-0.51128]	[-1.39193]	[0.22637]
Δlog($Labour_{t-2}$)	-2.445364	-6.593624	-1.402653
	[-2.05829]	[-2.40613]	[-1.34827]
δ	0.028119	0.054640	0.013441
	[1.18448]	[0.99785]	[0.64657]
$\xi_t < 0$	-0.407429	0.838228	-0.907565
	[-0.31465]	[0.28065]	[-0.80041]
$\xi_{t-1} < 0$	4.022582	9.914435	2.580317
	[3.05356]	[3.26287]	[2.23686]
$\xi_{t-2} < 0$	-0.429114	-1.043028	-0.680169
	[-0.32395]	[-0.34137]	[-0.58639]
$\xi_t > 0$	-1.214922	-1.826764	-0.930753
	[-2.83016]	[-1.84491]	[-2.47606]
$\xi_{t-1} > 0$	1.425239	2.510030	1.208867
	[3.02603]	[2.31044]	[2.93108]
$\xi_{t-2} > 0$	0.312179	0.180513	0.293760
	[0.70124]	[0.17579]	[0.75356]
Adj. R-squared	0.626099	0.524462	0.603387
Akaike AIC	-3.138767	-1.467229	-3.404319
Schwarz SC	-2.593000	-0.921462	-2.858552

Table 8.21. VECM results: Finance with Austrian NRI measure

Cointegrating Eq:	CointEq1	CointEq2	
log($Output_{t-1}$)	1.000000	0.000000	
log($Capital_{t-1}$)	0.000000	1.000000	
log($Labour_{t-1}$)	-0.889201	-0.958285	
	[-38.4456]	[-3.26104]	
Constant	-2.540409	-6.126967	
	[-9.87130]	[-1.87384]	
Error Correction:	Δlog($Output_t$)	Δlog($Capital_t$)	Δlog($Labour_t$)
CointEq1	-0.235958	-0.754981	0.121428
	[-2.06989]	[-2.85385]	[0.88909]
CointEq2	0.040512	0.061326	0.023880
	[3.92685]	[2.56150]	[1.93205]
Δlog($Output_{t-1}$)	0.710024	-0.068870	0.647704
	[3.02045]	[-0.12624]	[2.29979]
Δlog($Capital_{t-1}$)	-0.114998	0.348602	-0.054979
	[-1.77467]	[2.31815]	[-0.70817]
Δlog($Labour_{t-1}$)	-0.294568	-0.385476	-0.062832
	[-1.65786]	[-0.93485]	[-0.29516]
$\xi_t < 0$	0.740745	1.046437	1.273131
	[1.47799]	[0.89970]	[2.12025]
$\xi_{t-1} < 0$	1.253577	1.838690	1.152869
	[2.29903]	[1.45306]	[1.76477]
$\xi_{t-2} < 0$	-1.211268	-4.179096	-0.771978
	[-2.44219]	[-3.63082]	[-1.29914]
$\xi_t > 0$	-0.172447	-0.071554	-0.241904
	[-1.00155]	[-0.17907]	[-1.17267]
$\xi_{t-1} > 0$	0.145381	0.279562	0.075188
	[0.84304]	[0.69856]	[0.36392]
$\xi_{t-2} > 0$	-0.156583	0.347774	-0.406097
	[-0.96043]	[0.91918]	[-2.07906]
Adj. R-squared	0.425241	0.387440	0.384485
Akaike AIC	-4.993889	-3.310158	-4.632443
Schwarz SC	-4.569194	-2.885464	-4.207749

Table 8.22. VECM results: Mining with Austrian NRI measure

Cointegrating Eq:	CointEq1		
log($Output_{t-1}$)	1.000000		
log($Capital_{t-1}$)	0.188921		
	[1.02184]		
log($Labour_{t-1}$)	-1.481427		
	[-4.33103]		
Error Correction:	Δlog($Output_t$)	Δlog($Capital_t$)	Δlog($Labour_t$)
CointEq1	-0.411088	-0.633148	0.041004
	[-2.28049]	[-2.47769]	[0.39851]
Δlog($Output_{t-1}$)	0.556011	0.124813	0.866844
	[0.72879]	[0.11541]	[1.99057]
Δlog($Capital_{t-1}$)	-0.152369	0.111463	-0.420907
	[-0.34252]	[0.17675]	[-1.65764]
Δlog($Labour_{t-1}$)	-0.291854	-0.275427	-0.220751
	[-0.61732]	[-0.41096]	[-0.81803]
$\xi_t < 0$	-3.755336	-2.787530	-1.496662
	[-1.38576]	[-0.72562]	[-0.96757]
$\xi_{t-1} < 0$	-4.142803	-8.477399	1.080543
	[-1.39421]	[-2.01254]	[0.63708]
$\xi_{t-2} < 0$	3.011243	4.438596	2.483841
	[1.04595]	[1.08758]	[1.51150]
$\xi_t > 0$	-0.433026	-1.001158	-0.133943
	[-0.51537]	[-0.84054]	[-0.27928]
$\xi_{t-1} > 0$	-0.660531	-0.615728	-0.517013
	[-0.74531]	[-0.49010]	[-1.02204]
$\xi_{t-2} > 0$	1.675888	2.406678	0.792094
	[2.13262]	[2.16041]	[1.76589]
Adj. R-squared	0.235348	0.217676	0.189218
Akaike AIC	-1.504067	-0.806153	-2.625514
Schwarz SC	-1.117982	-0.420067	-2.239428

Table 8.23. VECM results: Nondurable Goods with Austrian NRI measure

Cointegrating Eq:	CointEq1		
log($Output_{t-1}$)	1.000000		
log($Capital_{t-1}$)	-0.346188		
	[-12.3346]		
log($Labour_{t-1}$)	-0.496497		
	[-11.2449]		
Error Correction:	Δlog($Output_t$)	Δlog($Capital_t$)	Δlog($Labour_t$)
CointEq1	-0.600720	-0.332455	-0.598276
	[-2.12317]	[-0.40372]	[-3.17753]
Δlog($Output_{t-1}$)	1.010991	1.504191	0.910493
	[1.48914]	[0.76124]	[2.01530]
Δlog($Output_{t-2}$)	-0.252483	-0.076472	-0.373348
	[-0.37692]	[-0.03922]	[-0.83754]
Δlog($Capital_{t-1}$)	-0.234961	-0.492228	-0.186687
	[-1.29274]	[-0.93049]	[-1.54349]
Δlog($Capital_{t-2}$)	0.092772	-0.100490	0.159777
	[0.53758]	[-0.20007]	[1.39127]
Δlog($Labour_{t-1}$)	-1.049420	-1.591505	-0.939337
	[-2.01873]	[-1.05188]	[-2.71535]
Δlog($Labour_{t-2}$)	-0.141417	-0.528066	-0.048638
	[-0.28083]	[-0.36029]	[-0.14514]
$\xi_t < 0$	-0.533793	-3.734835	0.526284
	[-0.68311]	[-1.64218]	[1.01208]
$\xi_{t-1} < 0$	2.476054	4.550252	1.474705
	[3.19977]	[2.02034]	[2.86378]
$\xi_{t-2} < 0$	-0.706852	-0.902339	-0.200482
	[-0.86489]	[-0.37934]	[-0.36862]
$\xi_t > 0$	-0.128040	0.014537	-0.260601
	[-0.53695]	[0.02095]	[-1.64224]
$\xi_{t-1} > 0$	0.613754	0.985991	0.684195
	[2.22642]	[1.22890]	[3.72965]
$\xi_{t-2} > 0$	0.341508	0.230985	0.380515
	[1.26889]	[0.29487]	[2.12456]
Adj. R-squared	0.235348	0.217676	0.189218
Akaike AIC	-1.504067	-0.806153	-2.625514
Schwarz SC	-1.117982	-0.420067	-2.239428

Table 8.24. VECM results: Retail with Austrian NRI measure

Cointegrating Eq:	CointEq1		
$\log(Output_{t-1})$	1.000000		
$\log(Capital_{t-1})$	-0.158780		
	[-8.18917]		
$\log(Labour_{t-1})$	-0.807857		
	[-27.5356]		
Error Correction:	$\Delta\log(Output_t)$	$\Delta\log(Capital_t)$	$\Delta\log(Labour_t)$
CointEq1	-0.511178	-1.029104	-0.283593
	[-2.95255]	[-2.15580]	[-2.11476]
$\Delta\log(Output_{t-1})$	0.113469	-0.815109	0.528803
	[0.13044]	[-0.33985]	[0.78484]
$\Delta\log(Capital_{t-1})$	0.149321	0.339790	0.056568
	[0.71291]	[0.58837]	[0.34868]
$\Delta\log(Labour_{t-1})$	-0.262710	-0.223007	-0.401930
	[-0.40613]	[-0.12503]	[-0.80218]
$\xi_t < 0$	0.885640	1.971744	0.528251
	[1.22819]	[0.99170]	[0.94577]
$\xi_{t-1} < 0$	2.594590	4.780947	1.810625
	[3.59777]	[2.40438]	[3.24139]
$\xi_{t-2} < 0$	-0.637981	-1.030131	-0.514682
	[-0.83616]	[-0.48966]	[-0.87088]
$\xi_t > 0$	-0.069001	0.251053	-0.099553
	[-0.29607]	[0.39069]	[-0.55149]
$\xi_{t-1} > 0$	0.318649	0.218037	0.285891
	[1.31398]	[0.32608]	[1.52200]
$\xi_{t-2} > 0$	-0.364124	-1.222217	0.031857
	[-1.67392]	[-2.03778]	[0.18907]
Adj. R-squared	0.422467	0.183577	0.556005
Akaike AIC	-4.395312	-2.366844	-4.906204
Schwarz SC	-4.009226	-1.980759	-4.520118

Table 8.25. VECM results: Services with Austrian NRI measure

Cointegrating Eq:	CointEq1		
$\log(Output_{t-1})$	1.000000		
$\log(Capital_{t-1})$	-0.137008		
	[-12.7525]		
$\log(Labour_{t-1})$	-0.820546		
	[-52.2173]		
Error Correction:	$\Delta\log(Output_t)$	$\Delta\log(Capital_t)$	$\Delta\log(Labour_t)$
CointEq1	0.688404	0.572443	0.822760
	[2.56083]	[1.26326]	[3.59041]
$\Delta\log(Output_{t-1})$	3.156439	4.358418	2.356537
	[2.30730]	[1.88998]	[2.02076]
$\Delta\log(Capital_{t-1})$	-0.774200	-0.966229	-0.593858
	[-1.90662]	[-1.41160]	[-1.71564]
$\Delta\log(Labour_{t-1})$	-2.138512	-3.151665	-1.566399
	[-2.22185]	[-1.94252]	[-1.90914]
$\xi_t < 0$	0.291923	1.013098	0.260560
	[0.46418]	[0.95564]	[0.48603]
$\xi_{t-1} < 0$	0.909628	0.993657	0.768314
	[1.36413]	[0.88400]	[1.35165]
$\xi_{t-2} < 0$	-0.688584	-0.485727	-0.643927
	[-1.14954]	[-0.48104]	[-1.26106]
$\xi_t > 0$	-0.075715	0.209167	-0.223233
	[-0.38286]	[0.62744]	[-1.32418]
$\xi_{t-1} > 0$	0.179408	0.166464	0.139719
	[0.80356]	[0.44230]	[0.73412]
$\xi_{t-2} > 0$	-0.114586	-0.253682	-0.010225
	[-0.59410]	[-0.78026]	[-0.06219]
Adj. R-squared	0.112281	0.096815	0.167983
Akaike AIC	-4.541273	-3.496922	-4.860566
Schwarz SC	-4.155188	-3.110836	-4.474480

Table 8.26. VECM results: Transport with Austrian NRI measure

Cointegrating Eq:	CointEq1		
log($Output_{t-1}$)	1.000000		
log($Capital_{t-1}$)	-0.502627		
	[-3.34327]		
log($Labour_{t-1}$)	-0.268796		
	[-1.08988]		
Error Correction:	Δlog($Output_t$)	Δlog($Capital_t$)	Δlog($Labour_t$)
CointEq1	-0.162385	-0.146050	-0.135783
	[-2.77452]	[-1.49551]	[-2.38372]
Δlog($Output_{t-1}$)	0.149952	1.277791	-0.914648
	[0.16777]	[0.85677]	[-1.05143]
Δlog($Output_{t-2}$)	-0.701716	-0.388100	-0.749496
	[-0.89067]	[-0.29522]	[-0.97744]
Δlog($Capital_{t-1}$)	0.034295	-0.384633	0.485977
	[0.09574]	[-0.64349]	[1.39390]
Δlog($Capital_{t-2}$)	0.243727	0.260211	0.167660
	[0.79202]	[0.50676]	[0.55979]
Δlog($Labour_{t-1}$)	-0.470723	-1.970940	0.603727
	[-0.82917]	[-2.08065]	[1.09267]
Δlog($Labour_{t-2}$)	0.200703	-0.035847	0.341875
	[0.40314]	[-0.04315]	[0.70557]
$\xi_t < 0$	1.329881	1.831147	0.750093
	[1.97215]	[1.62741]	[1.14291]
$\xi_{t-1} < 0$	1.400381	1.370928	1.165876
	[2.00531]	[1.17651]	[1.71536]
$\xi_{t-2} < 0$	-0.552941	-1.908935	0.499103
	[-0.84652]	[-1.75145]	[0.78509]
$\xi_t > 0$	-0.363287	-0.229494	-0.496104
	[-1.74911]	[-0.66219]	[-2.45420]
$\xi_{t-1} > 0$	0.352498	0.309558	0.595273
	[1.62160]	[0.85345]	[2.81366]
$\xi_{t-2} > 0$	-0.009512	0.541597	-0.316142
	[-0.03895]	[1.32931]	[-1.33032]
Adj. R-squared	0.401887	0.442592	0.357432
Akaike AIC	-4.524623	-3.500644	-4.578819
Schwarz SC	-4.017839	-2.993860	-4.072036

Table 8.27. VECM results: Transport with Austrian NRI measure

Cointegrating Eq:	CointEq1		
log($Output_{t-1}$)	1.000000		
log($Capital_{t-1}$)	0.066684		
	[0.28035]		
log($Labour_{t-1}$)	-1.203328		
	[-3.27635]		
Error Correction:	Δlog($Output_t$)	Δlog($Capital_t$)	Δlog($Labour_t$)
CointEq1	-0.082512	-0.162812	-0.052287
	[-3.04092]	[-2.31848]	[-2.85950]
Δlog($Output_{t-1}$)	0.289550	-0.640435	0.398374
	[0.77227]	[-0.66001]	[1.57669]
Δlog($Capital_{t-1}$)	-0.091533	0.131789	-0.081338
	[-0.81728]	[0.45468]	[-1.07769]
Δlog($Labour_{t-1}$)	-0.515772	-0.287865	-0.299340
	[-1.42591]	[-0.30751]	[-1.22803]
$\xi_t < 0$	0.170755	-0.287502	-0.271222
	[0.18529]	[-0.12054]	[-0.43673]
$\xi_{t-1} < 0$	2.416261	5.471679	1.288680
	[2.61780]	[2.29057]	[2.07180]
$\xi_{t-2} < 0$	0.584825	2.762309	0.524547
	[0.58080]	[1.05999]	[0.77303]
$\xi_t > 0$	-0.283181	-0.331723	-0.204993
	[-1.03976]	[-0.47063]	[-1.11692]
$\xi_{t-1} > 0$	0.297152	-0.182399	0.296136
	[1.01153]	[-0.23991]	[1.49589]
$\xi_{t-2} > 0$	0.517798	0.917190	0.358505
	(0.28717)	(0.74320)	(0.19352)
Adj. R-squared	0.229943	0.042484	0.283505
Akaike AIC	-3.742155	-1.840360	-4.531532
Schwarz SC	-3.356070	-1.454274	-4.145446

Table 8.28. VECM results: Agriculture with Real GDP Growth NRI measure

Cointegrating Eq:	CointEq1		
log($Output_{t-1}$)	1.000000		
log($Capital_{t-1}$)	-0.618528		
	[-8.33957]		
log($Labour_{t-1}$)	-0.193024		
	[-1.91934]		
Constant	1.719010		
Error Correction:	Δlog($Output_t$)	Δlog($Capital_t$)	Δlog($Labour_t$)
CointEq1	0.529011	1.677511	0.036246
	[2.35865]	[3.35325]	[0.52114]
Δlog($Output_{t-1}$)	-0.334790	-0.405734	0.085224
	[-0.77441]	[-0.42077]	[0.63571]
Δlog($Capital_{t-1}$)	0.023577	-0.104558	0.005751
	[0.13945]	[-0.27725]	[0.10969]
Δlog($Labour_{t-1}$)	-0.480399	-1.421762	0.046370
	[-0.91001]	[-1.20746]	[0.28325]
δ	0.075554	0.184607	0.035547
	[2.12838]	[2.33153]	[3.22912]
$\xi_t < 0$	-0.280558	-0.545249	0.168682
	[-0.36944]	[-0.32190]	[0.71628]
$\xi_{t-1} < 0$	1.578736	3.769706	0.421519
	[1.70142]	[1.82142]	[1.46492]
$\xi_{t-2} < 0$	0.729946	2.273153	-0.182514
	[0.90902]	[1.26915]	[-0.73295]
$\xi_t > 0$	0.674222	1.341684	0.016801
	[0.62553]	[0.55808]	[0.05027]
$\xi_{t-1} > 0$	-0.181804	0.240585	-0.830284
	[-0.17059]	[0.10121]	[-2.51227]
$\xi_{t-2} > 0$	-1.818523	-3.277864	-0.488618
	[-1.66209]	[-1.34316]	[-1.44013]
Adj. R-squared	0.214876	0.329666	0.253176
Akaike AIC	-1.580535	0.023903	-3.922242
Schwarz SC	-1.155840	0.448597	-3.497548

Table 8.29. VECM results: Construction with Real GDP Growth NRI measure

Cointegrating Eq:	CointEq1	CointEq2	
log($Output_{t-1}$)	1.000000	0.000000	
log($Capital_{t-1}$)	0.000000	1.000000	
log($Labour_{t-1}$)	-1.030294	-1.665991	
	[-307.363]	[-56.5375]	
Error Correction:	Δlog($Output_t$)	Δlog($Capital_t$)	Δlog($Labour_t$)
CointEq1	-0.314235	-0.822461	-0.111269
	[-1.70022]	[-3.23414]	[-0.60633]
CointEq2	-0.068575	-0.110978	-0.052494
	[-3.30344]	[-3.88534]	[-2.54677]
Δlog($Output_{t-1}$)	3.094294	4.232794	2.716254
	[1.44917]	[1.44071]	[1.28119]
Δlog($Output_{t-2}$)	2.215531	3.817601	1.742132
	[1.01465]	[1.27064]	[0.80354]
Δlog($Capital_{t-1}$)	-0.771414	-0.939191	-0.716845
	[-1.30032]	[-1.15056]	[-1.21695]
Δlog($Capital_{t-2}$)	-0.329822	-0.511224	-0.303813
	[-0.55036]	[-0.61997]	[-0.51057]
Δlog($Labour_{t-1}$)	-2.033474	-2.964607	-1.698385
	[-1.30797]	[-1.38586]	[-1.10022]
Δlog($Labour_{t-2}$)	-1.686357	-3.101882	-1.248333
	[-1.07658]	[-1.43918]	[-0.80263]
$\xi_t < 0$	0.767904	1.659973	0.466609
	[2.80137]	[4.40106]	[1.71436]
$\xi_{t-1} < 0$	0.758500	0.370016	0.897057
	[1.65016]	[0.58504]	[1.96551]
$\xi_{t-2} < 0$	-0.874331	-1.262283	-0.739660
	[-2.43430]	[-2.55415]	[-2.07403]
$\xi_t > 0$	1.530656	1.247802	1.640957
	[3.34439]	[1.98142]	[3.61095]
$\xi_{t-1} > 0$	0.085221	-0.210293	0.157218
	[0.16045]	[-0.28775]	[0.29811]
$\xi_{t-2} > 0$	-0.057450	0.998228	-0.472928
	[-0.12006]	[1.51618]	[-0.99543]
Adj. R-squared	0.641089	0.672243	0.620760
Akaike AIC	-3.650559	-3.012245	-3.664767
Schwarz SC	-3.104793	-2.466478	-3.119000

Table 8.30. VECM results: Durable Goods with Real GDP Growth NRI measure

Cointegrating Eq:	CointEq1		
$\log(Output_{t-1})$	1.000000		
$\log(Capital_{t-1})$	-0.585194		
	[-5.14539]		
$\log(Labour_{t-1})$	-0.105028		
	[-0.65932]		
Constant	-0.334603		
Error Correction:	$\Delta\log(Output_t)$	$\Delta\log(Capital_t)$	$\Delta\log(Labour_t)$
CointEq1	0.545463	1.357255	0.325048
	[3.51449]	[3.88671]	[2.37688]
$\Delta\log(Output_{t-1})$	-1.039499	3.894376	-2.353955
	[-0.64984]	[1.08203]	[-1.67009]
$\Delta\log(Output_{t-2})$	-1.454899	1.037191	-2.218266
	[-1.03703]	[0.32858]	[-1.79446]
$\Delta\log(Capital_{t-1})$	0.384685	-0.750155	0.682312
	[1.02946]	[-0.89224]	[2.07229]
$\Delta\log(Capital_{t-2})$	0.416940	-0.189917	0.601815
	[1.23322]	[-0.24966]	[2.02019]
$\Delta\log(Labour_{t-1})$	-0.049498	-4.260453	1.083093
	[-0.04084]	[-1.56223]	[1.01413]
$\Delta\log(Labour_{t-2})$	0.718245	-1.529278	1.426276
	[0.68027]	[-0.64375]	[1.53312]
δ	0.040711	0.088428	0.024914
	[2.90550]	[2.80494]	[2.01795]
$\xi_t < 0$	0.326023	2.058159	-0.141890
	[0.93606]	[2.62637]	[-0.46235]
$\xi_{t-1} < 0$	1.138033	1.407000	1.113252
	[2.25261]	[1.23780]	[2.50085]
$\xi_{t-2} < 0$	0.088128	0.140081	-0.021464
	[0.20766]	[0.14670]	[-0.05740]
$\xi_t > 0$	3.151808	5.591357	2.370461
	[4.47347]	[3.52717]	[3.81839]
$\xi_{t-1} > 0$	1.879526	1.710924	2.241013
	[2.04501]	[0.82738]	[2.76730]
$\xi_{t-2} > 0$	1.977723	4.475654	1.206689
	[2.47190]	[2.48626]	[1.71169]
Adj. R-squared	0.700250	0.637257	0.678064
Akaike AIC	-3.359812	-1.737981	-3.612926
Schwarz SC	-2.814045	-1.192214	-3.067159

Table 8.31. VECM results: Finance with Real GDP Growth NRI measure

Cointegrating Eq:	CointEq1	CointEq2	
$\log(Output_{t-1})$	1.000000	0.000000	
$\log(Capital_{t-1})$	0.000000	1.000000	
$\log(Labour_{t-1})$	-0.866646	-0.786722	
	[-30.3533]	[-4.05167]	
Constant	-3.040373	-10.14037	
	[-10.4637]	[-5.13172]	
Error Correction:	$\Delta\log(Output_t)$	$\Delta\log(Capital_t)$	$\Delta\log(Labour_t)$
CointEq1	-0.370953	-0.540884	-0.178112
	[-4.95971]	[-2.87853]	[-2.02436]
CointEq2	0.042392	0.001987	0.014420
	[2.98322]	[0.05565]	[0.86263]
$\Delta\log(Output_{t-1})$	0.626990	-0.380187	0.866244
	[3.04744]	[-0.73553]	[3.57909]
$\Delta\log(Capital_{t-1})$	-0.167930	0.193620	-0.152603
	[-2.76716]	[1.26995]	[-2.13760]
$\Delta\log(Labour_{t-1})$	-0.109275	-0.533974	0.100520
	[-0.65380]	[-1.27166]	[0.51125]
$\xi_t < 0$	0.437420	0.695216	0.617194
	[3.98642]	[2.52194]	[4.78150]
$\xi_{t-1} < 0$	-0.173873	0.162533	-0.442547
	[-1.08845]	[0.40499]	[-2.35501]
$\xi_{t-2} < 0$	-0.126842	-0.003749	-0.004974
	[-1.12742]	[-0.01326]	[-0.03758]
$\xi_t > 0$	-0.207618	0.264923	-0.376275
	[-1.07054]	[0.54373]	[-1.64930]
$\xi_{t-1} > 0$	-0.231185	-0.237182	-0.356836
	[-1.28490]	[-0.52471]	[-1.68592]
$\xi_{t-2} > 0$	0.221515	0.312445	0.220706
	[1.28008]	[0.71869]	[1.08420]
Adj. R-squared	0.540951	0.426641	0.526061
Akaike AIC	-5.218682	-3.376292	-4.893824
Schwarz SC	-4.793988	-2.951597	-4.469129

Table 8.32. VECM results: Mining with Real GDP Growth NRI measure

Cointegrating Eq:	CointEq1		
$\log(Output_{t-1})$	1.000000		
$\log(Capital_{t-1})$	-0.040921		
	[-0.29836]		
$\log(Labour_{t-1})$	-1.048070		
	[-4.03786]		
Error Correction:	$\Delta\log(Output_t)$	$\Delta\log(Capital_t)$	$\Delta\log(Labour_t)$
CointEq1	-0.611032	-0.887414	-0.076840
	[-2.65991]	[-2.64609]	[-0.57938]
$\Delta\log(Output_{t-1})$	0.194880	-0.179767	0.426941
	[0.27638]	[-0.17463]	[1.04876]
$\Delta\log(Capital_{t-1})$	0.036493	0.229812	-0.141463
	[0.08961]	[0.38653]	[-0.60166]
$\Delta\log(Labour_{t-1})$	-0.084767	-0.114329	0.120071
	[-0.16842]	[-0.15560]	[0.41322]
$\xi_t < 0$	-2.007845	-2.820281	-0.510018
	[-3.40083]	[-3.27207]	[-1.49628]
$\xi_{t-1} < 0$	0.769252	0.981381	0.623061
	[0.84853]	[0.74150]	[1.19042]
$\xi_{t-2} < 0$	-0.364621	-0.467880	-0.253446
	[-0.50481]	[-0.44371]	[-0.60778]
$\xi_t > 0$	1.862824	1.881220	1.903825
	[1.61756]	[1.11893]	[2.86344]
$\xi_{t-1} > 0$	-1.282218	-1.456190	-1.130782
	[-1.15612]	[-0.89936]	[-1.76601]
$\xi_{t-2} > 0$	0.026568	0.137970	-0.200936
	[0.02712]	[0.09646]	[-0.35525]
Adj. R-squared	0.288115	0.227526	0.227772
Akaike AIC	-1.575571	-0.818824	-2.674234
Schwarz SC	-1.189486	-0.432738	-2.288148

Table 8.33. VECM results: Nondurable Goods with Real GDP Growth NRI measure

Cointegrating Eq:	CointEq1		
$\log(Output_{t-1})$	1.000000		
$\log(Capital_{t-1})$	-2.062889		
	[-4.12514]		
$\log(Labour_{t-1})$	2.271373		
	[2.86362]		
Error Correction:	$\Delta\log(Output_t)$	$\Delta\log(Capital_t)$	$\Delta\log(Labour_t)$
CointEq1	0.034093	0.083735	0.025460
	[3.08228]	[2.84602]	[3.12856]
$\Delta\log(Output_{t-1})$	0.161755	1.139747	-0.122937
	[0.27756]	[0.73524]	[-0.28672]
$\Delta\log(Capital_{t-1})$	0.007267	-0.351606	0.120640
	[0.04475]	[-0.81404]	[1.00981]
$\Delta\log(Labour_{t-1})$	-0.156694	-1.061795	0.017061
	[-0.32905]	[-0.83827]	[0.04870]
$\xi_t < 0$	0.500949	1.138689	0.229884
	[2.79598]	[2.38933]	[1.74396]
$\xi_{t-1} < 0$	0.028512	-0.649334	0.412490
	[0.10146]	[-0.86872]	[1.99518]
$\xi_{t-2} < 0$	-0.254986	0.085665	-0.402458
	[-1.55239]	[0.19607]	[-3.33037]
$\xi_t > 0$	1.245926	2.439702	1.036023
	[4.43950]	[3.26820]	[5.01762]
$\xi_{t-1} > 0$	-0.199559	0.221342	-0.342922
	[-0.53971]	[0.22505]	[-1.26058]
$\xi_{t-2} > 0$	-0.195214	-2.110420	0.369985
	[-0.78417]	[-3.18711]	[2.02008]
Adj. R-squared	0.480366	0.378453	0.617563
Akaike AIC	-4.361350	-2.404750	-4.975159
Schwarz SC	-3.975264	-2.018664	-4.589073

Table 8.34. VECM results: Retailwith Real GDP Growth NRI measure

Cointegrating Eq:	CointEq1		
$\log(Output_{t-1})$	1.000000		
$\log(Capital_{t-1})$	-0.179904		
	[-6.55555]		
$\log(Labour_{t-1})$	-0.776413		
	[-18.0089]		
Error Correction:	$\Delta\log(Output_t)$	$\Delta\log(Capital_t)$	$\Delta\log(Labour_t)$
CointEq1	-0.337587	-0.352411	-0.318346
	[-3.89255]	[-1.50965]	[-4.60991]
$\Delta\log(Output_{t-1})$	1.122618	0.938760	1.385647
	[1.55312]	[0.48251]	[2.40752]
$\Delta\log(Capital_{t-1})$	-0.180615	-0.409483	-0.165573
	[-0.97154]	[-0.81831]	[-1.11850]
$\Delta\log(Labour_{t-1})$	-0.772514	-0.778409	-0.898802
	[-1.43258]	[-0.53629]	[-2.09325]
$\xi_t < 0$	0.770579	1.832904	0.506279
	[5.48675]	[4.84859]	[4.52722]
$\xi_{t-1} < 0$	-0.276738	-0.782063	-0.197210
	[-1.20353]	[-1.26359]	[-1.07711]
$\xi_{t-2} < 0$	-0.198894	-0.752518	0.010583
	[-1.21987]	[-1.71470]	[0.08152]
$\xi_t > 0$	0.188919	-0.005473	0.325711
	[0.83664]	[-0.00900]	[1.81150]
$\xi_{t-1} > 0$	-0.430811	-0.771256	-0.277865
	[-1.99707]	[-1.32826]	[-1.61765]
$\xi_{t-2} > 0$	0.025318	-0.069183	0.038000
	[0.11314]	[-0.11486]	[0.21327]
Adj. R-squared	0.577856	0.431290	0.657035
Akaike AIC	-4.708732	-2.728407	-5.164388
Schwarz SC	-4.322647	-2.342322	-4.778302

Table 8.35. VECM results: Services with Real GDP Growth NRI measure

Cointegrating Eq:	CointEq1		
log($Output_{t-1}$)	1.000000		
log($Capital_{t-1}$)	-0.125985		
	[-11.6219]		
log($Labour_{t-1}$)	-0.835299		
	[-50.3762]		
Error Correction:	Δlog($Output_t$)	Δlog($Capital_t$)	Δlog($Labour_t$)
CointEq1	0.457633	0.306469	0.535319
	[4.32148]	[1.87192]	[5.31214]
Δlog($Output_{t-1}$)	1.247365	1.540395	1.103960
	[1.10865]	[0.88556]	[1.03108]
Δlog($Capital_{t-1}$)	-0.108918	-0.070676	-0.118138
	[-0.30203]	[-0.12677]	[-0.34426]
Δlog($Labour_{t-1}$)	-0.900745	-1.093600	-0.786198
	[-1.16638]	[-0.91597]	[-1.06982]
$\xi_t < 0$	0.271067	0.628789	0.159957
	[2.19591]	[3.29480]	[1.36170]
$\xi_{t-1} < 0$	-0.019786	-0.180475	0.025971
	[-0.11140]	[-0.65724]	[0.15366]
$\xi_{t-2} < 0$	-0.294476	-0.363563	-0.232250
	[-2.45342]	[-1.95924]	[-2.03338]
$\xi_t > 0$	0.182259	0.657484	0.032702
	[0.91157]	[2.12703]	[0.17188]
$\xi_{t-1} > 0$	-0.531089	-0.819848	-0.442233
	[-2.54940]	[-2.54560]	[-2.23082]
$\xi_{t-2} > 0$	0.273851	0.608889	0.134889
	[1.41895]	[2.04068]	[0.73446]
Adj. R-squared	0.432580	0.514401	0.337255
Akaike AIC	-4.988829	-4.117466	-5.088028
Schwarz SC	-4.602743	-3.731380	-4.701942

Table 8.36. VECM results: Transport with Real GDP Growth NRI measure

Cointegrating Eq:	CointEq1		
log($Output_{t-1}$)	1.000000		
log($Capital_{t-1}$)	0.545191		
	[1.15639]		
log($Labour_{t-1}$)	-2.001679		
	[-2.55286]		
Error Correction:	Δlog($Output_t$)	Δlog($Capital_t$)	Δlog($Labour_t$)
CointEq1	-0.072159	-0.151136	-0.034477
	[-2.18563]	[-2.64736]	[-0.95113]
Δlog($Output_{t-1}$)	-0.707769	-0.290642	-1.384329
	[-0.90819]	[-0.21568]	[-1.61790]
Δlog($Output_{t-2}$)	0.259649	0.863574	-0.224236
	[0.34606]	[0.66562]	[-0.27221]
Δlog($Capital_{t-1}$)	0.388661	0.195499	0.681245
	[1.23694]	[0.35982]	[1.97473]
Δlog($Capital_{t-2}$)	-0.182619	-0.349995	-0.050942
	[-0.58169]	[-0.64472]	[-0.14779]
Δlog($Labour_{t-1}$)	0.660362	-0.118916	1.250902
	[1.21878]	[-0.12692]	[2.10277]
Δlog($Labour_{t-2}$)	-0.237266	-0.807781	0.275193
	[-0.45971]	[-0.90511]	[0.48563]
$\xi_t < 0$	0.615779	0.977774	0.333197
	[4.17633]	[3.83505]	[2.05824]
$\xi_{t-1} < 0$	-0.218817	-0.497856	0.135427
	[-0.96029]	[-1.26354]	[0.54132]
$\xi_{t-2} < 0$	-0.182719	-0.005588	-0.310536
	[-0.88901]	[-0.01572]	[-1.37613]
$\xi_t > 0$	0.935898	1.194966	0.821975
	[3.09786]	[2.28744]	[2.47809]
$\xi_{t-1} > 0$	-0.561723	-0.516255	-0.489038
	[-1.96990]	[-1.04700]	[-1.56203]
$\xi_{t-2} > 0$	0.181994	0.247829	0.017339
	[0.65633]	[0.51686]	[0.05695]
Adj. R-squared	0.542055	0.541678	0.373914
Akaike AIC	-4.791654	-3.696370	-4.604804
Schwarz SC	-4.284871	-3.189586	-4.098020

Table 8.37. VECM results: Wholesale with Real GDP Growth NRI measure

Cointegrating Eq:	CointEq1		
$\log(Output_{t-1})$	1.000000		
$\log(Capital_{t-1})$	0.454455		
	[0.97664]		
$\log(Labour_{t-1})$	-1.661979		
	[-2.25963]		
Error Correction:	$\Delta\log(Output_t)$	$\Delta\log(Capital_t)$	$\Delta\log(Labour_t)$
CointEq1	0.027398	0.012467	0.025641
	[2.73695]	[0.48115]	[3.48788]
$\Delta\log(Output_{t-1})$	0.096307	-0.403083	0.122611
	[0.25049]	[-0.40504]	[0.43426]
$\Delta\log(Capital_{t-1})$	-0.019401	0.192013	-0.004452
	[-0.18892]	[0.72236]	[-0.05904]
$\Delta\log(Labour_{t-1})$	0.243702	1.145113	0.124137
	[0.61550]	[1.11736]	[0.42694]
$\xi_t < 0$	0.447848	0.622240	0.147283
	[2.04190]	[1.09606]	[0.91442]
$\xi_{t-1} < 0$	0.100278	0.077623	0.357578
	[0.35416]	[0.10591]	[1.71970]
$\xi_{t-2} < 0$	-0.170172	-0.284863	-0.262267
	[-0.86462]	[-0.55917]	[-1.81455]
$\xi_t > 0$	1.323309	3.389426	0.455628
	[3.81225]	[3.77241]	[1.78739]
$\xi_{t-1} > 0$	-0.983900	-2.781672	-0.408527
	[-2.65843]	[-2.90371]	[-1.50308]
$\xi_{t-2} > 0$	-0.656646	-1.364725	-0.145662
	[-1.80562]	[-1.44982]	[-0.54542]
Adj. R-squared	0.394531	0.246941	0.331000
Akaike AIC	-3.982617	-2.080560	-4.600119
Schwarz SC	-3.596532	-1.694474	-4.214033