The Impact of Credit Booms and Economic Policy on Labour Productivity: A Sectoral Analysis[1]

Dopad úvěrového boomu a hospodářských politik na produktivitu práce: odvětvová analýza

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Abstract

Recent empirical evidence suggests that during economic booms, factors of production (especially labour) may shift into less productive and more pro-cyclical sectors of the economy, which can subsequently deepen and prolong economic slump. In this paper, we explore the effects of credit booms, monetary and fiscal policy expansions on labour productivity and labour reallocation in the Czech Republic. We model the effects jointly, as they are not mutually exclusive. To this purpose, we build a large dataset of hundreds of economic variables and estimate a FAVAR model of the Czech economy. We produce several findings: (i) a credit boom causes labour reallocation towards less productive sectors; (ii) the effects are amplified by a subsequent crisis period; (iii) monetary expansion supports the catch-up effect of the Czech economy but at the same time may boost credit activity and indirectly cause misallocations; and (iv) the most pro-cyclical sectors in terms of labour productivity in the Czech economy are Mining and quarrying, Construction and Manufacturing. These findings contribute to the debate illustrating the prolonged decline in the economy and can be further used as an information base for the better targeting of preventive and stabilising economic policy measures in the future.

Keywords

credit boom, Czech Republic, FAVAR, fiscal policy, labour productivity, labour reallocation, monetary policy

JEL Codes

E24, E52, E62, G38

Abstrakt

Nedávné studie naznačují, že v průběhu ekonomické konjunktury dochází k migraci výrobních faktorů (především práce) do méně produktivních a více pro-cyklických ekonomických odvětví. Tento jev může následně prodloužit a prohloubit hospodářský propad. V tomto příspěvku se zabýváme dopady úvěrového boomu, měnové a fiskální expanze na produktivitu a přerozdělování práce v České republice. Tyto efekty modelujeme společně, protože se vzájemně nevylučují. Za tímto účelem jsme sestavili velký dataset obsahující stovky ekonomických proměnných a odhadli FAVAR model pro

1 *The views and opinions expressed are those of the authors and do not represent the views of their institutions.*

Českou republiku. Nabízíme tato zjištění: (i) úvěrový boom způsobuje efekt přerozdělování práce směrem k méně produktivním odvětvím; (ii) tento efekt je dále prohlouben během následného krizového období; (iii) měnová expanze podporuje efekt dohánění České ekonomiky, zároveň ale může podpořit úvěrovou aktivitu a nepřímo tak způsobit efekt přerozdělování práce; a (iv) mezi nejvíce pro-cyklická odvětví v České republice, pokud jde o produktivitu práce, patří těžba a dobývání, zpracovatelský průmysl a stavebnictví. Tato zjištění přispívají k diskuzi, která se snaží zdůvodnit zdlouhavý proces ozdravování ekonomiky po poslední krizi a mohou být v budoucnu využita jako informační základna pro lepší zaměření preventivních a stabilizačních opatření hospodářských politik.

Klíčová slova
Česká republika, FAVAR, fiskální politika, měnová politika, produktivita práce, přerozdělování práce, úvěrový boom

Introduction

Research articles from the Bank of International Settlements (BIS) on financial cycles published since 2000[2] have been gradually converted into the so-called f*inancial cycle drag hypothesis*. Borio (2017) describes its form and its distinction from the s*ecular stagnation hypothesis* which became significant especially after the outbreak of the Great Recession. The *secular stagnation hypothesis*[3] explains the slow growth in a post-crisis period by insufficient demand. The *financial cycle drag hypothesis* sees the reasons to be rather on the supply side and argues that the slow growth is associated with the previous boom of a financial cycle. The expansion of the financial cycle in fact leads to an accumulation of imbalances,[4] and contraction is then connected with the elimination of the imbalances that have arisen, lengthy recession and long-term low labour productivity growth. While the *secular stagnation hypothesis* asserts that during the pre-crisis boom the economy is operating at its potential and with full employment, the *financial cycle drag hypothesis* claims that the pre-crisis boom pushes the economy over its potential and reduces labour productivity.[5] Ceccheti and Kharroubi (2015) state that a credit boom itself may lead to reduced productivity of the economy due to the misallocation of resources. Borio et al. (2015) demonstrate the negative impact of a credit boom on labour productivity on a sample of 20 developed countries over the last 40 years. According to their results, the credit boom leads to labour reallocation into sectors with a lower labour productivity growth, particularly into construction, and the decline in labour

2 *See e.g. Crockett (2000), Borio and Lowe (2002), Drehmann et al. (2012), Borio (2014).*

3 *See e.g. Summers (2014, 2016), Krugman (2014) or Eggertsson and Mehrotra (2014).*

4 *Compared to a business cycle, the duration of a financial cycle is significantly longer (Drehmann et al., 2012).*

5 *The impact of a cycle on productivity has evolved over time. Barnichon (2010), Gali and Rens (2014) and Yépez (2017) show, using US data, that while labour productivity had been rather pro-cyclical to the mid-1980s, subsequently it was rather counter-cyclical. Gilchrist and Zakrajšek (2012) demonstrate that since that time, the influence of financial variables on real economy variables has grown. Adalet McGowan et al. (2017) attribute the decline of labour productivity in this period to the existence of so-called zombie firms; therefore, to an insufficient rehabilitation recession process.*

productivity is significantly deeper if a crisis follows.[6] This is caused not only by the problems of the financial system during the financial cycle contraction but also due to the necessity of eliminating the misallocations of resources which occurred during the boom in the economy.

The final fundamental difference between the two mentioned hypotheses is their view on the concept of a natural interest rate. According to the proponents of the *secular stagnation hypothesis*, the natural interest rate is declining and may be even negative for some time to ensure full employment and the potential output of the economy being reached. Supporters of the *financial cycle drag hypothesis* claim that the natural interest rate is, given the aforementioned imbalances, significantly higher and always positive.[7] The difference between a key and natural interest rate is in fact essential from the point of view of the Austrian business cycle theory, which in simplistic terms states that this difference suppresses the information function of the cost of money. In the event a key interest rate is set lower than its natural level, massive errors occur in investment decision-making which then should lead to a decline in productivity. Gopinath et al. (2015) look at the issue of increasing misallocation of resources due to too-low interest rates in the countries of the southern wing of Europe after entering the euro area. Similarly, Dias et al. (2014) demonstrate an increase in misallocation of resources during the inflow of capital in 1996–2007, using the example of Portugal in the period before and after the introduction of the euro (entry in 1999). According to the Austrian business cycle theory, the information function of money can be suppressed not only by too-low interest rates but also by any kind of state intervention.

In this paper, we investigate the empirical link between economic policies, credit booms and labour productivity growth. We stress the importance of modelling jointly the credit boom together with the effects of monetary and fiscal policy measures, as they also may significantly influence the demand for credit and risk appetite of economic agents. To this purpose, we create a large dataset containing hundreds of economic variables and estimate a FAVAR model of the Czech economy. Central questions we aim to answer are: (i) "does labour move into less productive sectors during the credit boom period?", which is directly linked to the *financial cycle drag hypothesis* and Austrian business cycle theory and their notions about malinvestment during periods of economic boom; (ii) "does a financial crisis amplify the effect of labour reallocations?" and (iii) "do economic policies have any impact on labour productivity?" To get the whole picture, we focus on labour reallocations across economic sectors, which may be further used as an information base for the better targeting of preventive and stabilising economic policy measures in the future.

Our paper is organised as follows: Section 1 shows the decomposition procedure of labour productivity growth to uncover hidden misallocations and describe our raw data. Section 2 presents a FAVAR model of the Czech economy to measure the effects of economic policies and credit booms on labour productivity growth. Section 3 presents and further discusses our results and Section 4 concludes.

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6 Similarly, Jorda et al. (2013) state that recessions associated with a financial crisis are significantly deeper and longer.

7 The predominant view on the natural interest rate is rather that of proponents of the secular stagnation hypothesis (Bernanke, 2015).

1 Breaking down labour productivity growth into unique components[8]

We follow Borio et al. (2015) and use a simple decomposition of the aggregate labour productivity growth for the Czech Republic. The decomposition relies on information from various economic sectors and measures whether labour is reallocated towards high or low productivity sectors. The decomposition of the aggregate labour productivity growth (y/l) can be written as follows:[9]

$$1+\frac{\Delta(y/l)}{y/l}=\underbrace{\left[1+\frac{\Delta(l_S/l)}{l_S/l}\right]\cdot\left[1+\frac{\Delta(y_S/l_S)}{y_S/l_S}\cdot\alpha_S\right]}_{common\ component}+\underbrace{\mathrm{cov}\left(\frac{\Delta(l_S/l)}{l_S/l};\left(1+\frac{\Delta(y_S/l_S)}{y_S/l_S}\right)\cdot\alpha_S\right)}_{allocation\ component} \quad (1)$$

where y denotes aggregate output, l denotes aggregate employment and $\alpha_S=y_S/\bar{y}$ is the ratio of sector s output to average output across sectors. The first right-sided term in the equation is the *common component* (com) of real labour productivity growth. It is a product of the non-weighted average growth rate in employment shares per economic sector and size-weighted average growth rate of productivity across economic sectors. In other words, the common component describes the pure unweighted average of productivity growth across all industries in the economy. If, for example, we think of a hypothetical economy in which both the average employment and productivity growth are equal to zero, the common component will be of zero value as well. The second right-sided term in expression (1) is the *allocation component* $(alloc)$. As is apparent, it represents the covariance across economic sectors between the growth rate in employment shares per economic sector and size-weighted average growth rate of productivity across economic sectors. It measures the impact of labour reallocation across industries.

1.1 Sectoral data

We rely mainly on two sources of sectoral-level data: the Czech Statistical Office (CSO) and the Czech National Bank (CNB). These two databases provide information on value added and employment per sector following the SNA/ISIC rev.2 classification at the 1-digit level (a detailed description is available in the Appendix). We consider eight sectors: *Agriculture, forestry and fishing; Mining and quarrying; Manufacturing; Construction; Trade and private services; Financial and insurance activities; Public services* and *Other activities*. To be able to estimate the decomposition of the aggregate labour productivity growth as described in (1), we require the information on total value added and employment for each data point. While data on the sectoral level are available from 1996 onwards, we report our estimates starting in 2001 (in 2002 after transforming the data) due to the limitations of a large dataset that we use for the macroeconomic model estimation in the rest of the paper.

8 *We are grateful to Enisse Kharroubi for sharing his piece of code to work out the decomposition.*

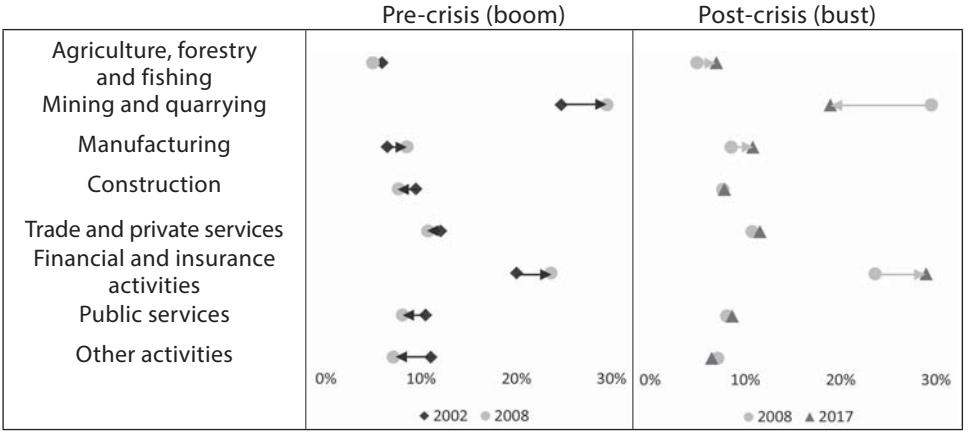
9 *Note that this is purely an identity. For the full decomposition procedure, please consult Borio et al. (2015, pp. 30-31 in the Appendix).*

Figure 1 shows the labour productivity calculated as (y/l) in annualised growth rates for three specific data points: 2002, 2008 and 2017. A few patterns emerge immediately.

Figure 1 shows that *Mining and quarrying* is not only one of the most productive sectors of the Czech economy but it is also the most pro-cyclical sector, as the growth of labour productivity during the economic boom period (+5 pp) was more than compensated by a post-crisis downturn (–11 pp). The highest increase in labour productivity during the period under review was recorded for the *Financial and insurance activities* sector, where productivity increased during both the boom (+4 pp) and the bust period (+5 pp). This is not surprising, as the Czech banking sector recorded low losses during the crisis and remained relatively stable through the entire time.

Labour productivity in the *Manufacturing* sector, which is of great importance to the Czech economy (it holds more than 27% of the total real value added by the end of 2016), is steadily increasing even though primary *Manufacturing* attracts a considerable amount of business cycle effects.[10] However, the *Manufacturing* sector in the Czech Republic is still much less productive in comparison to other countries, due to its structure which is characterised by rather lower added value. With regard to the *Construction* and *Trade and private services* sectors, labour productivity slightly declined during the economic boom. Overall, this confirms the general view of the market overheating in the pre-crisis period.

Figure 1: Labour Productivity Growth Across Economic Sectors in the Czech Republic



Source: Authors' calculations using CSO data.

Following the above-specified decomposition (1) and accounting for changes over time, say between year t and year $t+n$, we write:

$$\frac{y_{t+n}/l_{t+n}}{y_t/l_t} = (com)_{t,t+n} + (alloc)_{t,t+n} \tag{2}$$

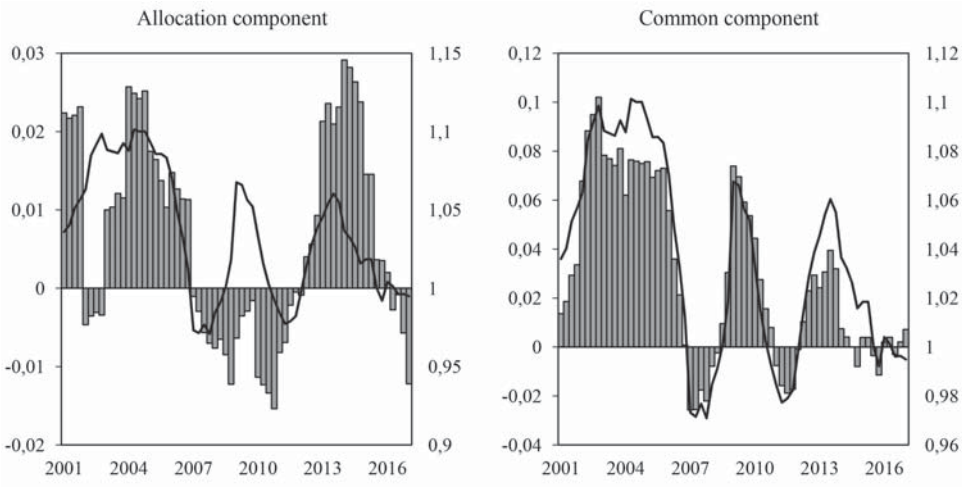
10 Note that we do not distinguish between intensive and excessive growth. Volek and Novotná (2015) have studied the importance of extensive and intensive sources of economic growth in individual sectors of the Czech economy. They confirm that the extensive factor is of negative value for all sectors of the economy (meaning that the total factor productivity rises faster than the gross value added).

which shows that the aggregate labour productivity growth is a sum of the common and allocation component. To compute various growth measures, Borio et al. (2015) suggest using rolling windows of either three or five years. The motivation for this window size is that reallocations take some time, especially between different economic sectors. We experimented with both windows, and since they yield comparatively identical results, we report the three-year wide window in the main text to avoid unnecessary loss of observations.

Figure 2 plots the common and allocation component together with the aggregate labour productivity (solid line, right-sided y-axis) evolution over the period 2001 to 2017. The common component describes the average growth rate of productivity across economic sectors but fails to capture any possible misallocations. Those are captured by the allocation component, which started to decline during the economic expansion period and remained negative until 2011, when economic recovery began. This is economically appealing and offers a new way of looking at the observed slow recovery after the crisis. The decomposition is thus useful, as it allows us to uncover possible misallocation hiding behind the aggregate labour productivity indicator.

From the first quarter of 2016, the allocation component slides into negative values again, which may point to a minor overheating of the Czech economy. This, if not addressed, may cause a new round of misallocations on the labour market.

Figure 2: Common and Allocation Components in the Czech Republic



Source: Authors' calculations using CSO sectoral-level data.

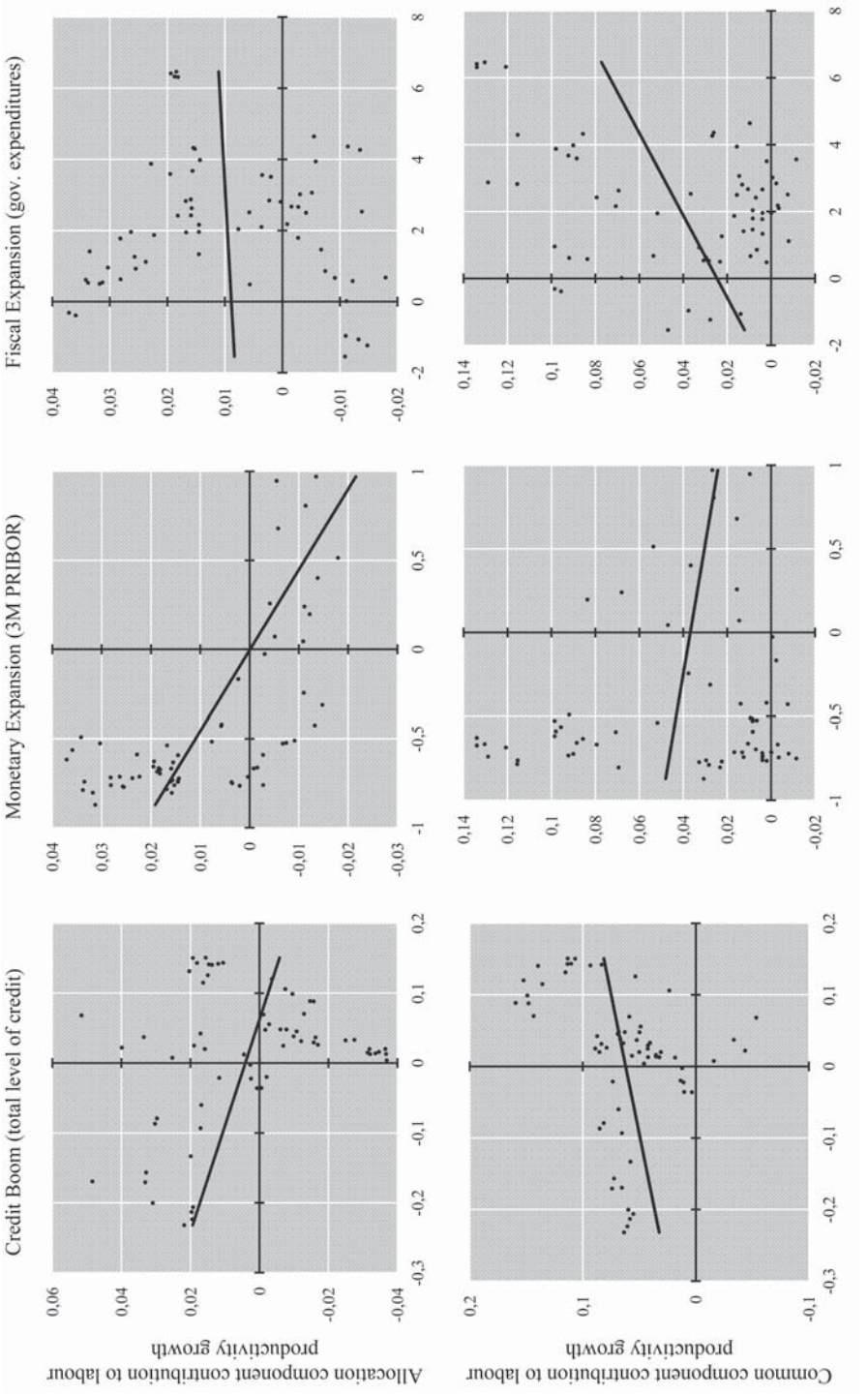
Notes: The aggregate labour productivity can be computed by simply summing the two components and adding one hundred. The data are reported in base units, not in basis points, for the sake of comparability.

1.2 A first look at the drivers of the common and allocation components

Using simple bivariate tests, we take a first look at the relationship between economic policies, credit booms and labour productivity growth. **Figure 3** plots the two labour productivity growth components against the growth in the total level of credit, three-month inter-bank rate and total government expenditures – these are our benchmark measures of credit, monetary and fiscal policy expansion. We use a three-year window for this exercise.

First, we trace a negative and statistically significant relationship between credit growth and the allocation component. By contrast, we find a positive relationship with the common component. This indicates that credit booms may cause labour misallocations and that their impact works though the allocation component. Second, similar effects are found with monetary expansion. This is expected, as monetary expansion increases the demand for credit and, if the interest rates are kept low for long enough, decreases the risk aversion of economic agents (Borio and Zhu, 2012). Third, we find a much weaker relationship between fiscal expansion and the allocation component. The relationship with the common component seems positive and statistically significant. Nevertheless, these results need to be tested if they are to survive increasingly demanding statistical tests.

Figure 3: Cross-check of Productivity Growth Components Against Credit, Monetary and Fiscal Policy Expansion



Source: Authors' calculations using CSO and CNB data.
Notes: the data are reported using three-year window growth rates. The solid line represents a simple trend line.

2 Empirical methodology

The major interest of the study is to determine the impact of credit booms and expansionary economic policies on labour productivity growth. Our goal is to uncover potential misallocations. Such analysis requires a substantial number of variables to be incorporated into the model and analysed in detail. However, the information sets utilised by, for example, the widely used VAR or single equation models are rather small to retain the degrees of freedom. This may lead to a situation in which the information set of the econometrician could be smaller than the information set of the economic agents. If this is the case, the relatively small number of variables in a small model may not be sufficient to properly identify shocks, which increases the risk of a biased estimate (see Alessi et al., 2011 for a detailed review).[11] Forni and Gambetti (2010) demonstrate that non-fundamentals can account for the well-known VAR price puzzle and the delayed overshooting puzzle.

To get around this fact, we use a factor-augmented VAR (FAVAR) model introduced in Bernanke et al. (2005). In contrast to simple VAR models, the FAVAR model includes unobserved low-dimensional factors in the autoregression, reducing the information bias. The FAVAR model uses the advantages of a data-rich environment while remaining tractable in terms of the number of parameters to be estimated. We specify an $M \times 1$ vector of macroeconomic time series Y_t and a $K \times 1$ vector of unobserved factors F_t. We assume that the joint dynamics of F_t', Y_t' is given by the following equation:

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \Phi(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + \varepsilon_t, \tag{3}$$

where $\Phi(L)$ is a lag polynomial and ε_t is an error term with a zero mean and a covariance matrix Q. Equation (3) is a standard VAR model that can be interpreted as a reduced form of a linear rational-expectations model with both observed and unobserved variables. The unobserved variables make the model impossible to estimate. Therefore, we assume that additional informational time series X_t are linked to the unobservable factors F_t and the observable factors Y_t by:

$$X_t' = \Lambda^f F_t' + \Lambda^y Y_t' + e_t', \tag{4}$$

where Λ^f and Λ^y are matrices of factor loadings and e_t' is a serially uncorrelated error term with a zero mean (innovation shock). Equation (4) captures the idea that both vectors Y_t and F_t are pervasive forces that might drive the common dynamics of X_t. This static representation of the dynamic factor model allows us to estimate the factors by principal components. Specifically, we use a two-step principal components approach, which is a nonparametric way of estimating the space spanned by the common components $C_t' = (F_t', Y_t')$ in (2). As the static factors incorporate information from a large number of

11 The standard VAR or single equation models usually take on 6 to 8 variables. If these variables are not sufficient to properly identify structural shocks, they cannot be viewed as fundamental, i.e. they cannot be recovered from the past and present values of the model variables. For example, when trying to identify a monetary policy shock in a VAR model, the shock may actually not be truly exogenous, as it may also capture instances when the central bank endogenously reacts to changing inflation expectations.

economic variables, the information set of the structural factor model is far greater than that of a standard VAR. Thus, it becomes less likely that the information set of economic agents will be superior to the information set we use.

2.1 Big data

Our vector X_t for factor extraction consists of a balanced panel of 175 quarterly time series representing the Czech economy and the rest of the world. They are drawn mainly from the Czech National Bank, Czech Statistical Office and ECB databases. The data span the 2001Q1 – 2017Q1 period (65 observations). Generally, it is not necessary to perform any ex ante categorisation of data, but we can benefit from stacking data into sub-groups in accordance with the different classes of economic variables for the sake of the clarity of our computational process. The data sub-groups and corresponding number of variables are shown in **Table 1** below.

Table 1: Sub-groups in the Dataset

Data Sub-groups	Slow/Fast-moving	Number of Variables
External environment	S	21
Real economy	S	40
Labour market	S	22
Government	S	12
Prices and price expectations	S	21
Interest rates and credits	F	39
Financial sector	F	14
Exchange rates	F	6

Note: The Appendix explains which time series form these sub-groups. Sub-groups highlighted in bold contain variables used as the sources of an identified shock. Those variables are never included in the dataset from which we extract the factors.

As is apparent from **Table 1**, the set of variables can be divided into eight logical blocks: (i) real economy variables (gross domestic product, construction production index, retail sales), (ii) labour market (employment, hours worked, wages), (iii) fiscal variables (government debt and deficit, interest payments), (iv) prices (consumer price index, industrial producer price index, house prices), (v) credit and interest rates, (vi) financial sector variables (regulatory variables, market indexes, financial cycle indicators, asset prices), (vii) exchange rates and (viii) open economy variables (real economy and financial sector development in Germany and in the Eurozone). Note that prior to the estimation, the data were transformed to assure the stationarity of the time series using natural logarithms and first differences. A more detailed description of the data is available in the Appendix.

2.2 Identification and interpretation of the factors

To estimate the FAVAR model given by Equation (3), the unobserved factors F_t need to be estimated first. Hence all factor models require an initial step prior to the estimation to determine the optimal number of factors used. Bai and Ng (2002) provide a criterion to determine the number of factors present in the macroeconomic data vector X_t. However, as shown by Tuzcuoglu and Hacioglu (2016), different time spans might offer different numbers of factors. In addition, the Bai and Ng (2002) criterion does not solve the issue of how many factors we should include in the VAR model itself.

Stock and Watson (2005) use seven factors to analyse the US economy; similarly, Bernanke et al. (2005) propose the usage of three and five factors respectively to check for the model robustness under a varying number of factors. The Bai and Ng (2002) criterion suggests using four factors, but when the test was run on a shorter sample (data until 2012Q3), the suggested number of factors changed to three. This change probably did not occur due to the sudden appearance of a new meaningful factor, but rather due to nonlinearities in the actual data. We have used various specifications with the same impulse response analysis results (we tested three to seven factors), but the model with only three latent factors showed higher explanatory power and its results are reported in the main text. In **Table 2**, we simply check the correlations of every single variable with the estimated factors. Visual inspection helps us to determine the actual interpretation of these factors. The first factor loads on real economic variables, coupled with prices. The positive correlations accumulated in the second factor correspond at most to credit and financial sector-related variables. The third factor explains external development, which is of great importance to Czech economy. The remaining fourth and fifth factors are mostly insignificant in terms of correlations, which only justifies estimating the FAVAR model with just three latent factors.

Table 2: Correlation Between Data and Estimated Factors

Data Sub-groups	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Real economy	**0.464**	0.148	-0.191	-0.070	-0.015
Labour market	0.289	0.151	0.110	-0.096	0.072
Government	0.233	-0.546	-0.108	-0.016	0.031
Prices and price expectations	**0.415**	-0.102	0.087	0.083	0.199
Interest rates and credits	-0.107	**0.313**	0.197	0.063	-0.054
Financial sector	0.006	**0.240**	0.188	0.108	-0.069
Exchange rates	-0.153	-0.031	-0.015	-0.014	0.025
External environment	0.128	0.136	**0.413**	0.210	-0.004
Factor 1	1				
Factor 2	0.068	1			
Factor 3	0.006	-0.061	1		
Factor 4	0.031	0.057	-0.056	1	
Factor 5	0.023	-0.013	-0.011	0.002	1

Note: Table shows average correlations between sub-groups of variables with five estimated factors.

The dynamics of each variable used in our sample is a linear combination of all factors, implying that the response of any underlying variable in vector X_t to shock in the transition equation (3) can be calculated using the estimated factor loadings and equation (4). Note that the factors themselves have to be uncorrelated with one another.

2.3 Identification scheme and innovations

We identify policy innovations using recursive ordering, placing unobserved factors before observed factors. The main assumption is that unobserved factors do not respond to policy innovations within one quarter. To this purpose, we divide our panel of variables into two groups: slow and fast-moving variables (as in Stock and Watson, 2002). Blocks describing the external environment, real economy, labour market, fiscal variables and prices are classed as slow-moving (in the order as in **Table 1**). A slow-moving variable is one that is largely predetermined in the current period and is assumed not to respond instantaneously to the specified shocks. Fast-moving variables are assumed to be highly sensitive to contemporaneous economic news or shocks (interest rates, credits, financial sector and exchange rates). We consider three types of shock hitting (unexpectedly) the economy: monetary and fiscal policy expansion and credit boom. In the case of a fiscal expansion, all fiscal variables are classed as fast-moving, as in Lagana and Sgro (2011). Note that the variables from which we extract the innovations are always ordered last in the covariance matrix (and treated as a factor on their own). This means that we assume each of the given innovations to affect our latent factors with a lag of one quarter.

The choice of variables from which we extract policy innovations deserve some explanation. The main policy tool of the CNB is a two-week repo rate. However, because the repo rate does not change continuously, but only as an outcome of CNB Bank Board meetings, we use the inter-bank rate (PRIBOR 3M) to proxy for the CNB's key monetary policy rate in a similar way to what is done in CNB's forecasting system. We identify an *expansionary monetary policy shock* as a decrease of the PRIBOR 3M rate. To check the robustness of our results with respect to the zero-lower bound issue and CNB's exchange rate commitment, which started in November 2013, we also estimate the model with data ending in 2012Q3.[12] Note that during this robustness exercise, we discard 20 observations, which lowers the model's explanatory power.

The main fiscal policy variables are government revenues from taxes and total government expenditures. We identify an *expansionary fiscal policy shock* as an increase in total government expenditures. As a part of our robustness exercise, we simulate a decrease in government revenues from taxes and report these results as well. It should be noted that we use a special treatment for these two variables. Building on Dungey and Fry (2009, p. 32), we use the natural logarithm form smoothed through the application of a moving average filter of the current and two lags of observations. The motivation for filtering in this manner lies in the apparent lumpiness of taxation and government expenditure. The

12 For more details on the exchange rate commitment (entry and exit), please consult the CNB website: https://www.cnb.cz/en/monetary_policy/exit_exchange_rate_commit/index.html

original data has relatively high variance in quarterly terms, which is not seasonally related but rather policy-related.

Finally, we consider the impact of a credit boom. We draw the information about *credit boom shock* from the total credit time series and the shock is identified as an increase in the absolute level of credit. We also construct a financial crisis dummy (that takes the value of one during 2008Q4-2010Q1 and zero elsewhere) to capture the financial and subsequent economic crisis structural break. The crisis dummy is included on its own and interacting with credit innovation. By including the dummy on its own, we avoid the confusion of spuriously attributing credit boom effects that belong to the crisis. By linking the dummy to the credit boom, we are able to differentiate between the states of the economy – one in which the credit boom is followed by a crisis event and other where the economy does not experience a crisis. To be able to distinguish between these two states is important, as financial crises generally undermine the ability of the economic system to correct past misallocations.

We present the effects of the identified innovations using impulse response functions (IRFs) over a time window of four years (16 quarters). The responses were normalised to entail a 1 percentage point increase in the 3M PRIBOR, government expenditures and total credit respectively. To account for any uncertainty in the factor estimation, we also calculate accurate confidence intervals as in Kilian (1998). The baseline model specification is based on Schwarz information criteria and employs the lags of explanatory variables and the factors respectively. To check for the robustness of our results, we also try estimating the FAVAR model with different lag numbers (up to four to avoid loss of observations), which yield comparatively identical results.

3 Results

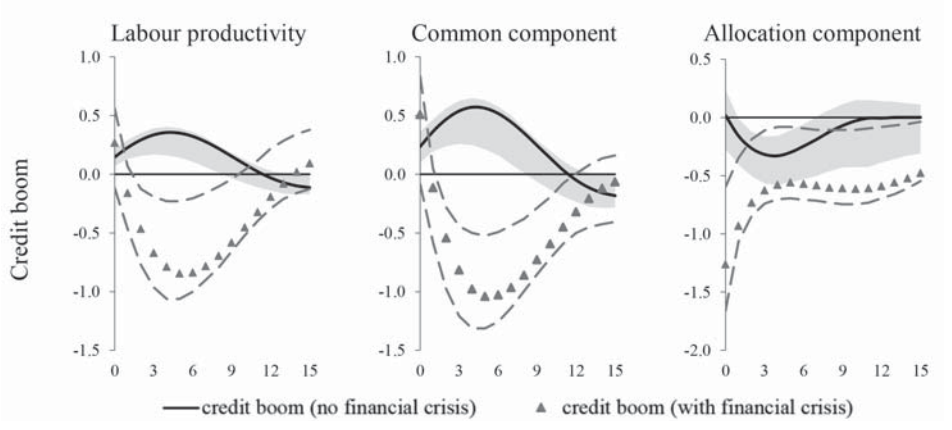
Our results largely coincide with Borio et al. (2015) regarding the impact of credit activity on labour productivity components (**Figure 4**, first row). So, following a credit boom and discarding the period of financial and economic crisis (2008Q4-2010Q1), the labour productivity increases (+0.5 pp), driven entirely by the common component. However, after introducing the structural break in the form of a financial crisis, we report the negative impact of a credit boom on labour productivity (–1 pp). In the context of our study, we are mostly interested in the downward sloping evolution path of the allocation component, both during the boom (–0.3 pp) and more vividly during the bust (–1.3 pp). This evidence shows that a credit boom causes misallocation of labour towards less productive economic sectors and that the impact is even more profound after incorporating a financial crisis period. The overall impact of increased credit activity on labour productivity may be positive during the boom period, due to the so-called catch-up effect, but this relationship always changes to negative during a bust.

Next, we look at the effects of changes in monetary policy setting on labour reallocation (**Figure 4**, second row). Unexpected monetary expansion leads to the growth of the common component (+0.4 pp) with a significant lag (2 years). This result is robust with

respect to the fact that CNB hit the zero-lower bound floor in November 2012 and entered into an exchange rate commitment in November 2013. These events did not alter our estimates in a significant manner. Overall, monetary expansion directly supports the catch-up effect of the Czech economy, because it lowers interest costs and increases real economic activity. Indirectly, however, it may increase credit activity in the economy, which is supported by the negative impact of decreased interest rates on the allocation component (–0.7 pp on average). This suggests that during monetary expansion, labour shifts towards less productive sectors.

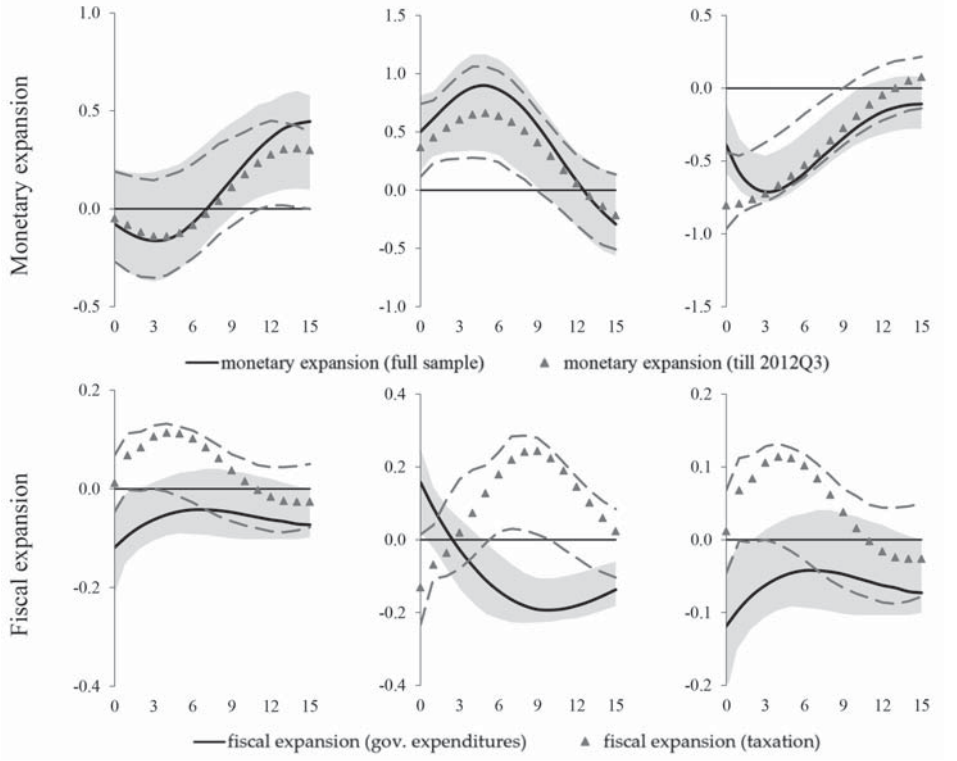
Last, we find the effect of fiscal expansion on labour productivity to be rather small in size compared to the previous shocks (**Figure 4**, third row). However, our results are hugely dependent on the way in which we model the fiscal policy shock (government expenditures vs. revenues from taxes). For instance, we find that increasing government expenditures has mostly adverse effects on both the common and allocation components. This result speaks in favour of a crowding-out effect during which the increasing government expenditures lower production value, reduce investments and thus lower productivity as well.[13] On the other hand, we find mostly positive albeit lagged effects of decreasing government revenues from taxes on the common and allocation components. This is quite intuitive, as decreasing the tax burden is in general expected to have a positive effect on productivity across economic sectors.[14] The responses to the different government shocks highlight the importance of exactly determining the fiscal policy action that is undertaken, because different spending components have different effects on labour market variables.

Figure 4: Impulse Responses of Labour Productivity to Financial and Economic Shocks – Component Breakdown



13 *Ambrisko et al. (2015) confirm the existence of a crowding-out effect in the case of an increase in government invectives in the Czech Republic.*

14 *Vartia (2008) confirms the positive effects of lowering corporate and top personal income taxes on productivity.*



Notes: Median impulse responses are reported with 90% probability bands. The y-axis measures the strength of variables' response in percentages; the x-axis is in quarters after the shock.

3.1 Credit boom

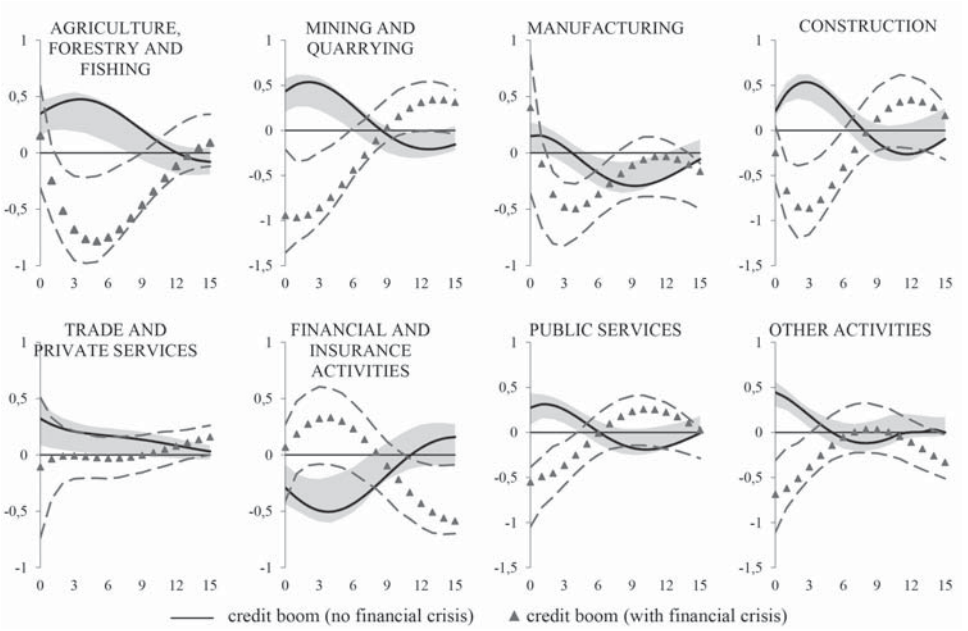
Further, we examine the propagation of the above-specified shocks within economic sectors. Note that we study the effects of shocks on the aggregate labour productivity, which is mainly described by the common component (**see Section 1.1**). This exercise should help us to identify the sectors which are the most sensitive to changes in credit activity and economic policies.

We find that a credit boom, apart from the crisis period, generally increases labour productivity across economic sectors (**Figure 5**). However, as shown in the previous section, this growth is mostly driven by the common component. This idea is supported by the fact that if we account for the crisis period and measure the impact of increased credit in terms of total value, the impact is largely negative. Above-average productivity growth during the credit boom was recorded by the *Mining and quarrying* and *Construction* sectors, due to increased real value added and decreased total employment (see **Figure 1C** in the Appendix). This is quite intuitive, as these sectors are largely dependent on credit accessibility. It comes as no surprise, however, that these sectors, along with the

Manufacturing sector, recorded the largest drop in real value added during the crisis period, and could be considered as the most pro-cyclical sectors. Our results thus suggest that the credit cycle impacts mostly sectors that are at the beginning of the production process (as coined by the Austrian school of economics).

Next, we take a closer look at the impact of credit activity on total employment (denominator in labour productivity fraction) in individual economic sectors. During this exercise, we aim to identify the sectors in which reallocations may have happened. The results are summarised in **Figure 1C** in the Appendix. The impact of credit activity on employment in individual sectors indicates that the labour reallocates towards the *Manufacturing* industry. For example, Borio et al. (2015) consider *Manufacturing* to be a relatively more productive sector in a sample of developed countries. In the Czech Republic, however, due to its specific structure, *Manufacturing* is still rather a less productive sector, despite the long-term growth in labour productivity in this sector. Credit activity also has a positive impact on employment in the productive *Financial and insurance activities*. On the other hand, the impact on employment in *Trade and private services* and *Mining and quarrying* is negative. After including the crisis period, credit expansion has an impact mainly on employment growth in *Agriculture, forestry and fishing*.

Figure 5: Impulse Responses of Labour Productivity to Credit Boom – Sector and Crisis Breakdown



Notes: Median impulse responses are reported with 90% probability bands. The y-axis measures the strength of variables' response in percentages; the x-axis is in quarters after the shock.

3.2 Monetary expansion

Monetary policy may significantly influence the demand for credit (Frait and Malovana, 2017) and it is loudly transmitted into the real economy (Borys et al., 2009). An accommodative monetary policy may stand at the very beginning of a credit boom.

The impact of monetary expansion on labour productivity varies significantly across economic sectors (**Figure 6**). This may be driven, for example, by the sectors' credit dependence (interest sensitiveness) or factor intensity (labour vs. capital intensive). Still, positive effects prevail except for the *Agriculture, forestry and fishing, Financial and insurance activities* and *Other activities* sectors. The *Agriculture, forestry and fishing* sector's response is somewhat erratic and ambiguous, as it is largely weather-driven and is also dependent on subsidies from the government. In addition, monetary expansion increases the demand for credit (see **Figure 1B**, in the Appendix) and thus demand for the services of financial and insurance companies. As is evident from the responses of real value added and total employment, the decrease in productivity is employment-driven, as its growth exceeds that for real value added (**Figure 2C**, in the Appendix).

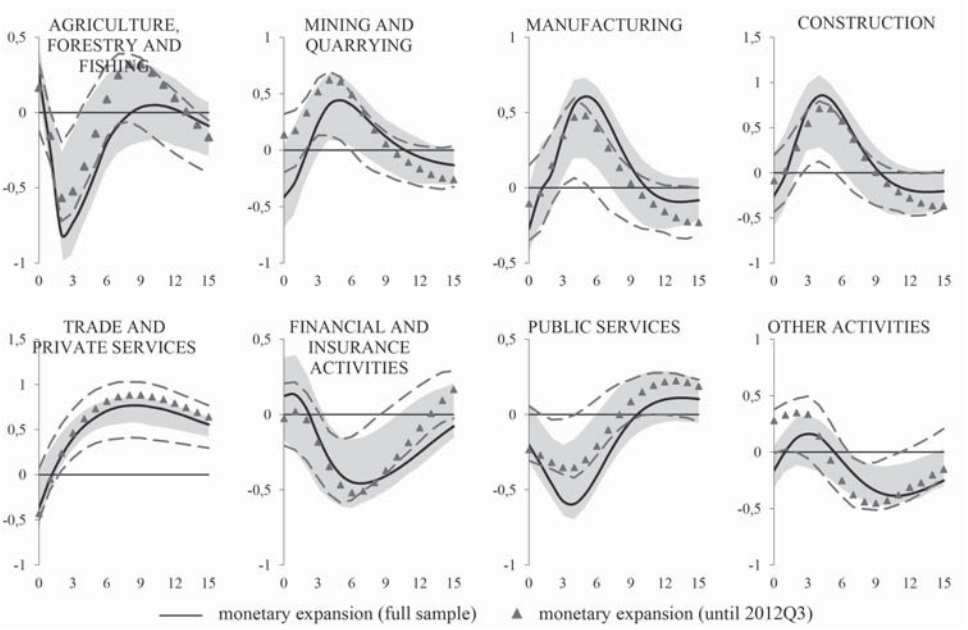
In general, lower interest rates increase firms' demand for credit and allow them to raise output and productivity. Monetary expansion thus supports the catch-up effect, especially in the *Construction, Manufacturing* and *Trade and private services* sectors, where production grows the most. This is not surprising, and this finding is rather common in the literature.[15] The significant impact of monetary expansion is also evident in the growth of credit activity in all sectors of the industry, excluding *Financial and insurance activities* and *Public services* (**Figure 1B**, in the Appendix).

The impact of monetary policy settings on employment in individual sectors (**Figure 1C**, in the Appendix) suggests that labour shifts away from *Other activities* to *Public services* and the *Manufacturing* industry. This agrees with our results obtained by simulating the credit boom in the previous section. Monetary policy also has a negative impact on the real value added of *Public services*, which may be due to the negative influence of monetary expansion on the amount of loans to this sector and by the fact that it is more dependent on government-rather than market-related decisions (see **Figure 1B**, in the Appendix).

Importantly, these documented empirical links highlight three leading sectors of the Czech economy that can both drag and prolong economic downturns as well as sustain economic expansion. These sectors are *Construction, Manufacturing* and *Trade and private services*. From a policy point of view, policy-makers should pay close attention to the development of credit and productivity in these sectors, especially during monetary contraction.

15 For example, see Bouakez et al. (2009) for a model-based study or Pellényi (2012) for Hungarian evidence.

Figure 6: Impulse Responses of Labour Productivity to Monetary Policy Expansion – Sector Breakdown



Notes: Median impulse responses are reported with 90% probability bands. The y-axis measures the strength of variables response in percentages; the x-axis is in quarters after the shock.

3.3 Fiscal expansion

Increasing government expenditures generally leads to a decrease in total labour productivity. During the first quarter after the shock, the productivity slightly increases in the *Agriculture, forestry and fishing, Manufacturing* and *Construction* sectors, only to fall one year later. This hump-like pattern in these sectors may be consistent with the presence of a crowding-out effect. The initial increase would be driven by the increased government spending while the decrease is caused by crowded-out private demand.

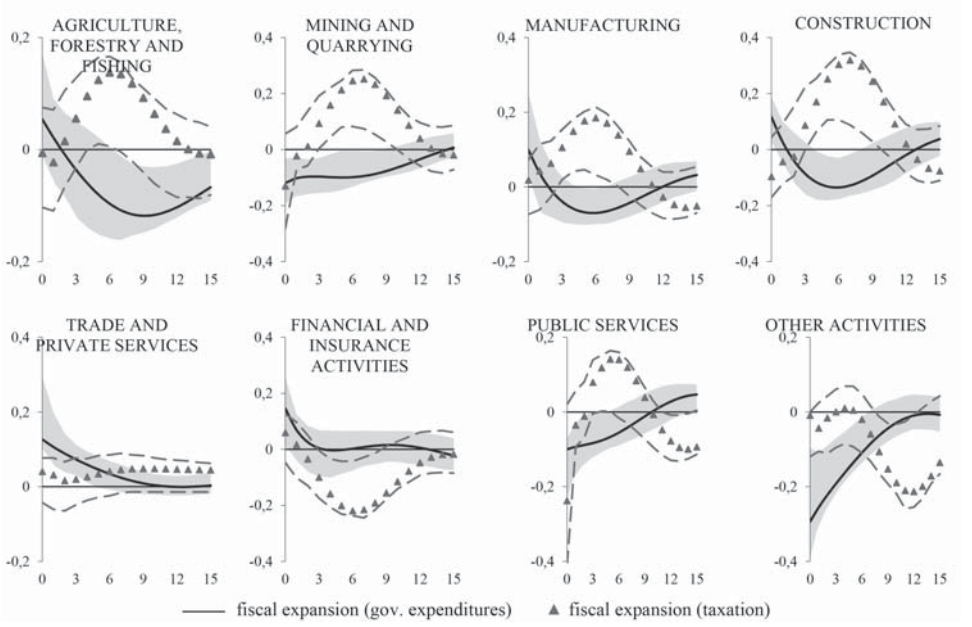
While looking at the response of total employment in individual sectors to the government spending shock, we can track down the direction of public spending. Growth in public spending has led to the highest increase in employment in the *Trade and private services* and *Public services sector*. This is because government spending is often directed to the *Public services* sector where the number of employees is growing (**Figure 3C**, in the Appendix). In addition, mandatory expenditure increases, which has a positive impact on consumption and employment in the *Trade and private services* sector.

In general, the responses to a government shock to taxation follow a hump-like pattern. A decreased tax burden for firms can make them expand employment (increase in the

demand for labour), if the adjustment cost of labour is small and shocks are perceived to be permanent. This will also depend on the extent of price rigidities.

It should also be noted that the responses to government revenue shock rather than shock to government spending resembles a shock to credit activity during the boom period. The reason is that government revenue growth is associated with the expansion of the economic and financial cycle. The highest increase in productivity is therefore evident in the tax revenue shock in the *Construction* and *Mining and quarrying* sectors, i.e. in sectors at the start of the production process. Still, we find almost zero correlation between the GDP and revenues from the taxes time series, which should render the above-mentioned risk of confusion moot.

Figure 7: Impulse Responses of Labour Productivity to Fiscal Policy Expansion – Sector Breakdown



Notes: Median impulse responses are reported with 90% probability bands. The y-axis measures the strength of variables' response in percentages; the x-axis is in quarters after the shock.

4 Conclusions

In the paper, we examine the empirical link between economic policies, credit booms and labour productivity growth using data from the Czech economy. We use a simple decomposition procedure to break down the labour productivity into two main components: the common and the allocation component. The common component is linked to actual productivity development but fails to capture any possible misallocations of labour – those are captured by the allocation component. Visual analysis and simple

bivariate tests suggest that misallocations did occur in the Czech economy and that they were fed by the credit boom prior to the crisis. To verify these results against more demanding statistical tests, we build a large FAVAR model of the Czech economy. The FAVAR model helps us to ensure that the estimated impulse responses are invariant to extensions of the information set – a deficiency that often plagues impulse response results.

Our empirical results generally coincide with those in Borio et al. (2015) regarding the impact of credit activity on individual labour productivity components. During a credit boom, credit activity contributes to labour productivity growth through the common component, but at the same time, the credit boom causes misallocation of labour towards less productive economic sectors, and thus the total labour productivity decreases due to the impact of the allocation component. The negative impact of reallocations that occur during a boom significantly increases during a crisis period, when both the common component and the allocation component contribute to the decline in labour productivity. Based on our analysis of sectoral-level data, we find that, following a credit boom, labour reallocates mainly towards the *Manufacturing* sector. However, *Manufacturing* remains among the less productive sectors (in EU-wide comparison), due to its focus on goods with lower value added. Remaining at the sectoral level, we also identify the most pro-cyclical sectors in terms of labour productivity in the Czech economy: *Mining and quarrying, Construction* and *Manufacturing*. This information may be of some value to policy-makers, who should carefully consider the effects of their measures, not only for the whole economy, but at the sectoral level as well.

Bearing in mind our results obtained from the credit boom shock, we also stress the importance of the effects of monetary and fiscal policy on labour reallocation. Again, we also perform the analysis on a sectoral level.

Monetary expansion leads to the growth of the common component and causes a drop in the allocation component. In another word, it supports the catch-up effect of the Czech economy (this was found to be true particularly for the *Construction, Manufacturing* and *Trade and private services* sectors). However, if we keep the monetary policy accommodative for long enough, it feeds the credit boom, which causes the misallocations. The impact of monetary policy on labour productivity may thus be indirect through the support of credit activity. Monetary expansion leads a the growth in credit activity in all sectors of the industry, excluding *Financial and insurance activities* and *Public services*. These results are robust with respect to the fact that CNB hit the zero-lower bound floor in November 2012 and entered into an exchange rate commitment in November 2013. In the sectoral-level analysis, we find that, apart from *Construction* and *Manufacturing*, the *Trade and private services* sector may also be important to the economy, as demand for their products depends more on consumers' borrowing.

Fiscal expansion does not appear to dampen productivity growth, if accommodated through a decrease in taxation. Such a result is economically appealing, as loosening the tax burden is generally expected to have a positive effect on factor productivity. In the case of a government spending shock, we find evidence supporting the crowding-out effect, which also lowers labour productivity, albeit mildly. In general, the effects of

fiscal policy measures on labour productivity were found to be small in size and mostly concentrated around *Trade and private services* and *Public services*.

Overall, the answer to all of our questions presented in the Introduction of this paper is a resounding yes. Our results show that credit booms dampen labour productivity growth and this effect works through labour misallocation. In addition, we show that mainly monetary policy should carefully weigh the effects of its measures, even on the sectoral level, as it may support credit activity in less productive sectors and indirectly labour misallocation. Therefore, it is possible to support the recommendations of the proponents of the *financial cycle drag hypothesis* that monetary and fiscal policy settings should systematically take into account the development of a financial cycle and thereby reduce, alongside using tools of macro-prudential economy, their negative economic impact. Borio (2017) adds that counter-cyclical economic policy settings are nowadays crucial, because productivity growth is unusually low, global debt levels are historically high and room for policy manoeuvre is remarkably narrow.

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Appendix

A. Data Description

Table 1A: NACE Aggregation

Description	**NACE, Rev. 2**
Agriculture, forestry and fishing	A
Mining and quarrying	B, D, E
Manufacturing	C
Construction	F
Trade and private services	G, H, I, J, L, M, N
Financial and insurance activities	K
Public services	O, P, Q
Sources of GDP, Other activities	R, S, T, U

Table 2A: Czech Dataset

The table shows all time-series incorporated in the analysis. Used abbreviations stands for: CSO = Czech Statistical Office, CNB – Czech National Bank database ARAD, IMF – International Monetary Fund database, ECB – European Central Bank Statistical Data Warehouse. The transformation codes (TC) are: 1 – no transformation; 2 – first difference; 4 – logarithm; 5 – first difference of logarithm. An asterisk, '', next to the transformation code number denotes a seasonally adjusted variables using CENSUS X13. S/F ranks variables as slow or fast moving in the estimation.*

Group	No.	Series description	Unit	Source	TC	S/F
Real economy	1	Industrial production index, industry total	Index 2010=100	CSO -Industry, energy	5*	S
	2	Industrial production index, mining and quarrying	Index 2010=100	CSO -Industry, energy	5*	S
	3	Industrial production index, manufacturing	Index 2010=100	CSO -Industry, energy	5*	S
	4	Industrial production index, electricity, gas, steam and air conditioning supply	Index 2010=100	CSO -Industry, energy	5*	S
	5	Sales from industrial activity, industry total	Index 2010=100	CSO -Industry, energy	5*	S
	6	Sales from industrial activity, mining and quarrying	Index 2010=100	CSO -Industry, energy	5*	S
	7	Sales from industrial activity, manufacturing	Index 2010=100	CSO -Industry, energy	5*	S
	8	Sales from industrial activity, electricity, gas, steam and air conditioning supply	Index 2010=100	CSO -Industry, energy	5*	S
	9	Direct export sales, industry total	Index 2010=100	CSO -Industry, energy	5*	S
	10	Direct export sales, mining and quarrying	Index 2010=100	CSO -Industry, energy	5*	S
	11	Direct export sales, manufacturing	Index 2010=100	CSO -Industry, energy	5*	S

Group	No.	Series description	Unit	Source	TC	S/F
Real economy	12	Domestic sales, industry total	Index 2010=100	CSO -Industry, energy	5*	S
	13	Domestic sales, mining and quarrying	Index 2010=100	CSO -Industry, energy	5*	S
	14	Domestic sales, manufacturing	Index 2010=100	CSO -Industry, energy	5*	S
	15	Domestic sales, electricity, gas, steam and air conditioning supply	Index 2010=100	CSO -Industry, energy	5*	S
	16	New industrial orders, industry total	Index 2010=100	CSO -Industry, energy	5*	S
	17	Non-domestic new orders	Index 2010=100	CSO -Industry, energy	5*	S
	18	Domestic new orders	Index 2010=100	CSO -Industry, energy	5*	S
	19	Construction production index	Index 2010=100	CSO - Construction	5*	S
	20	Construction production index, buildings	Index 2010=100	CSO - Construction	5*	S
	21	Construction production index, civil engineering works	Index 2010=100	CSO - Construction	5*	S
	22	Retail trade receipts	Index 2010=100	CNB, ARAD	5*	S
	23	Gross domestic product, market prices	Millions CZK	CSO - Gross domestic product	5*	S
	24	GDP deflator	Index 2010=100	CNB, ARAD	5*	S
	25	Final consumption expenditures, total, current prices	Millions CZK	CSO - Gross domestic product	5*	S
	26	Final consumption expenditures, households, current prices	Millions CZK	CSO - Gross domestic product	5*	S
	27	Final consumption expenditures, government, current prices	Millions CZK	CSO - Gross domestic product	5*	S
	28	Final consumption expenditures, non-profit organisations, current prices	Millions CZK	CSO - Gross domestic product	5*	S
	29	Gross capital formation, total, current prices	Millions CZK	CSO - Gross domestic product	5*	S
	30	Export, current prices	Millions CZK	CSO - Gross domestic product	5*	S
	31	Import, current prices	Millions CZK	CSO - Gross domestic product	5*	S
	32	Real gross domestic product	Millions CZK	CSO - Gross domestic product	5*	S
	33	Sources of GDP, Agriculture, forestry and fishing	Millions CZK	CSO - Gross domestic product	5*	S
	34	Sources of GDP, Mining and quarrying	Millions CZK	CSO - Gross domestic product	5*	S
	35	Sources of GDP, Manufacturing	Millions CZK	CSO - Gross domestic product	5*	S
	36	Sources of GDP, Construction	Millions CZK	CSO - Gross domestic product	5*	S
	37	Sources of GDP, Trade and private services	Millions CZK	CSO - Gross domestic product	5*	S
	38	Sources of GDP, Financial and insurance activities	Millions CZK	CSO - Gross domestic product	5*	S
	39	Sources of GDP, Public services	Millions CZK	CSO - Gross domestic product	5*	S
	40	Sources of GDP, Other activities	Millions CZK	CSO - Gross domestic product	5*	S
Labour market	41	Industry total, average number of persons employed (ANPE)	number of persons	CSO -Industry, energy	5*	S
	42	Industry total, average gross nominal wage (AGNW)	CZK per person	CSO -Industry, energy	5*	S

Group	No.	Series description	Unit	Source	TC	S/F
Labour market	43	Employees total, hours worked	thousand hours	CSO - Gross domestic product	5*	S
	44	General unemployment rate of the aged 15 to 64 years	%	CNB, ARAD	1*	S
	45	Job Vacancies	thousand	CNB, ARAD	5*	S
	46	Unplaced job seekers	thousand	CNB, ARAD	5*	S
	47	Employees, Agriculture, forestry and fishing	number of persons	CSO -Industry, energy	5*	S
	48	Employees, Mining and quarrying	number of persons	CSO -Industry, energy	5*	S
	49	Employees, Manufacturing	number of persons	CSO -Industry, energy	5*	S
	50	Employees, Construction	number of persons	CSO -Industry, energy	5*	S
	51	Employees, Trade and private services	number of persons	CSO -Industry, energy	5*	S
	52	Employees, Financial and insurance activities	number of persons	CSO -Industry, energy	5*	S
	53	Employees, Public services	number of persons	CSO -Industry, energy	5*	S
	54	Employees, Other activities	number of persons	CSO -Industry, energy	5*	S
	55	Wages and salaries, Agriculture, forestry and fishing	Millions CZK	CSO -Industry, energy	5*	S
	56	Wages and salaries, Mining and quarrying	Millions CZK	CSO -Industry, energy	5*	S
	57	Wages and salaries, Manufacturing	Millions CZK	CSO -Industry, energy	5*	S
	58	Wages and salaries, Construction	Millions CZK	CSO -Industry, energy	5*	S
	59	Wages and salaries, Trade and private services	Millions CZK	CSO -Industry, energy	5*	S
	60	Wages and salaries, Financial and insurance activities	Millions CZK	CSO -Industry, energy	5*	S
	61	Wages and salaries, Public services	Millions CZK	CSO -Industry, energy	5*	S
	62	Wages and salaries, Other activities	Millions CZK	CSO -Industry, energy	5*	S
Government	63	Government debt, total	Millions CZK	CSO - General Government	5*	S
	64	Debt securities, total	Millions CZK	CSO - General Government	5*	S
	65	Debt securities, short-term	Millions CZK	CSO - General Government	5*	S
	66	Debt securities, long-term	Millions CZK	CSO - General Government	5*	S
	67	Government loans, total	Millions CZK	CSO - General Government	5*	S
	68	Government loans, short-term	Millions CZK	CSO - General Government	5*	S
	69	Government loans, long-term	Millions CZK	CSO - General Government	5*	S
	70	Debt interests payed	Millions CZK	CSO - General Government	5*	S
	71	Government expenditures, total	Millions CZK	CSO - General Government	5*	S
	72	Government revenue, total	Millions CZK	CSO - General Government	5*	S

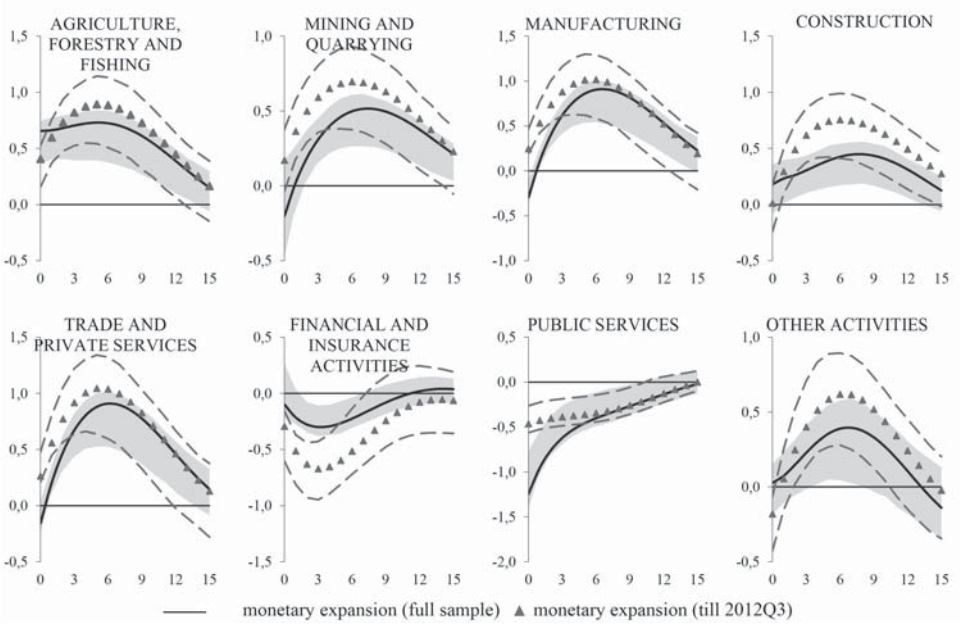
Group	No.	Series description	Unit	Source	TC	S/F
Govern-ment	73	Debt to GDP ratio	ratio	own calculation	1	S
	74	Debt service costs = interests payed in t / debt in t-1	ratio	own calculation	1	S
Prices and price expectations	75	Consumer Price Index (CPI), total	Index 2015 = 100	CNB, ARAD	5*	S
	76	CPI, food and non-alcoholic beverages	Index 2015 = 100	CSO - Prices	5*	S
	77	CPI, alcoholic beverages, tobacco	Index 2015 = 100	CSO - Prices	5*	S
	78	CPI, clothing and footwear	Index 2015 = 100	CSO - Prices	5*	S
	79	CPI, housing, water, electricity, gas and other fuels	Index 2015 = 100	CSO - Prices	5*	S
	80	CPI, furnishings, household equipment, routine maintenance of the house	Index 2015 = 100	CSO - Prices	5*	S
	81	CPI, health	Index 2015 = 100	CSO - Prices	5*	S
	82	CPI, transport	Index 2015 = 100	CSO - Prices	5*	S
	83	CPI, communications	Index 2015 = 100	CSO - Prices	5*	S
	84	CPI, recreation and culture	Index 2015 = 100	CSO - Prices	5*	S
	85	CPI, education	Index 2015 = 100	CSO - Prices	5*	S
	86	CPI, restaurants and hotels	Index 2015 = 100	CSO - Prices	5*	S
	87	CPI, miscellaneous goods and services	Index 2015 = 100	CSO - Prices	5*	S
	88	Industrial Producer Prices (IPP), total	Index 2015 = 100	CSO - Prices	5*	S
	89	IPP, mining and quarrying	Index 2015 = 100	CSO - Prices	5*	S
	90	IPP, manufacturing	Index 2015 = 100	CSO - Prices	5*	S
	91	IPP, electricity, gas, steam and air conditioning supply	Index 2015 = 100	CSO - Prices	5*	S
	92	IPP, water supply; sewerage, waste management and remediation activities	Index 2015 = 100	CSO - Prices	5*	S
	93	Market services price indices in the business sphere, total	Index 2005 = 100	CSO - Prices	5*	S
	94	Inflation expectations of non-financial corporations and companies for the 1Y horizon	%	CNB, ARAD	1*	F
	95	Financial market inflation expectations for 1Y horizon	%	CNB, ARAD	1*	F
Interest rates and credits	96	Repo rate - 2 weeks	%	CNB, ARAD	1	F
	97	PRIBOR 3M	%	CNB, ARAD	1	F
	98	PRIBOR 1Y	%	CNB, ARAD	1	F
	99	Government bond yield 2Y	%	CNB, ARAD	1	F
	100	Government bond yield 5Y	%	CNB, ARAD	1	F
	101	Government bond yield 10Y	%	CNB, ARAD	1	F
	102	Bank interest rates on CZK-denominated loans, households total	%	CNB, ARAD	1	F
	103	Bank interest rates on CZK-denominated loans, households, up to 1Y	%	CNB, ARAD	1	F
	104	Bank interest rates on CZK-denominated loans, households, up to 5Y	%	CNB, ARAD	1	F
	105	Bank interest rates on CZK-denominated loans, households, over 5Y	%	CNB, ARAD	1	F
	106	Bank interest rates on CZK-denominated loans, households consumer credit - total	%	CNB, ARAD	1	F
	107	Bank interest rates on CZK-denominated loans, households for house purchase - total	%	CNB, ARAD	1	F
	108	Bank interest rates on CZK-denominated loans, households other loans - total	%	CNB, ARAD	1	F
	109	Bank interest rates on CZK-denominated loans, non-financial corporations	%	CNB, ARAD	1	F
	110	Bank interest rates on CZK-denominated loans, non-financial corporations, up to 1Y	%	CNB, ARAD	1	F

Group	No.	Series description	Unit	Source	TC	S/F
Interest rates and credits	111	Bank interest rates on CZK-denominated loans, non-financial corporations, up to 5Y	%	CNB, ARAD	1	F
	112	Bank interest rates on CZK-denominated loans, non-financial corporations, over 5Y	%	CNB, ARAD	1	F
	113	Monetary base, monthly average	Billions CZK	CNB, ARAD	5	F
	114	Monetary aggregate M1	Millions CZK	CNB, ARAD	5	F
	115	Monetary aggregate M2	Millions CZK	CNB, ARAD	5	F
	116	Loans to residents and non-residents - MFIs	Millions CZK	CNB, ARAD	5	F
	117	Loans to non-financial corporations - MFIs	Millions CZK	CNB, ARAD	5	F
	118	Loans to financial corporations - MFIs	Millions CZK	CNB, ARAD	5	F
	119	Loans to government	Millions CZK	CNB, ARAD	5	F
	120	Loans to households	Millions CZK	CNB, ARAD	5	F
	121	Loans, short-term (up to 1Y)	Millions CZK	CNB, ARAD	5	F
	122	Loans, medium-term (up to 5Y)	Millions CZK	CNB, ARAD	5	F
	123	Loans, long-term (over 5Y)	Millions CZK	CNB, ARAD	5	F
	124	Consumption loans, total	Millions CZK	CNB, ARAD	5	F
	125	Mortgages, total	Millions CZK	CNB, ARAD	5	F
	126	Other loans, total	Millions CZK	CNB, ARAD	5	F
	127	Client loans, Agriculture, forestry and fishing	Millions CZK	CNB, ARAD	5	F
	128	Client loans, Mining and quarrying	Millions CZK	CNB, ARAD	5	F
	129	Client loans, Manufacturing	Millions CZK	CNB, ARAD	5	F
	130	Client loans, Construction	Millions CZK	CNB, ARAD	5	F
	131	Client loans, Trade and private services	Millions CZK	CNB, ARAD	5	F
	132	Client loans, Financial and insurance activities	Millions CZK	CNB, ARAD	5	F
	133	Client loans, Public services	Millions CZK	CNB, ARAD	5	F
	134	Client loans, Other activities	Millions CZK	CNB, ARAD	5	F
Financial sector	135	Capital adequancy ratio, total	%	CNB - non-public data	1*	F
	136	Leverage ratio, total	%	CNB - non-public data	1*	F
	137	Risk-weighted assets to total assets	%	CNB - non-public data	1	F
	138	Non-performing loans to total assets	%	CNB - non-public data	1	F
	139	Loans to total assets (LTA)	%	CNB - non-public data	1	F
	140	Spread, defined as the difference between 10Y gov. bonds yield and PRIBOR 3M	%	own calculation	1	F
	141	Composite indicator of sovereign stress	0-1 interval	ECB Statistical Data Warehouse	1	F
	142	Financial cycle indicator	0-1 interval	CNB - Report on Financial Stability 2016/2017	1	F
	143	Index PX	value	PSE, Prague Stock Exchange	5	F
	144	MFI total assets	Millions CZK	CNB - ARAD	5	F
	145	House price index	Index 2010 = 100	CSO - Prices	5	F
	146	Banks provisioning	value	CSO - Prices	5	F
	147	House price gap - CNB calculations	value	CNB - Report on Financial Stability 2016/2017	1	F
	148	Overvaluation of commercial property prices - CNB calculations	value	CNB - Report on Financial Stability 2016/2017	1	F

Group	No.	Series description	Unit	Source	TC	S/F
Exchange rates	149	Real effective exchange rate	Index 2015=100	CNB, ARAD	5*	F
	150	Nominal exchange rate CZK/EUR, monthly average	value	CNB, ARAD	5	F
	151	Nominal exchange rate CZK/GBP, monthly average	value	CNB, ARAD	5	F
	152	Nominal exchange rate CZK/USD, monthly average	value	CNB, ARAD	5	F
	153	Nominal exchange rate CZK/JPY, monthly average	value	CNB, ARAD	5	F
	154	Nominal effective exchange rate	Index 2015=100	CNB, ARAD	5	F
External environment	155	Government bond yield 2Y - eurozone	%	CNB, ARAD	1	F
	156	Government bond yield 5Y - eurozone	%	CNB, ARAD	1	F
	157	Government bond yield 10Y - eurozone	%	CNB, ARAD	1	F
	158	Yield spreads on risky private sector bonds	value	CNB - Report on Financial Stability 2016/2017	5	F
	159	Crude oil, Brendt, $/bbl, current Europe	USD/barel	EIA	5	F
	160	Crude oil, Brendt, $/bbl, current US	USD/barel	EIA	5	F
	161	Crude Oil Production, US fields	thousand barrels	EIA	5	F
	162	Composite indicator of systemic stress, eurozone	index 0-1	ECB Statistical Data Warehouse	1	F
	163	EURIBOR 3M	%	ECB Statistical Data Warehouse	1	F
	164	GDP, chain index volumes, Eurozone (changing composition)	Index 2010 = 100	Eurostat	5	F
	165	DAX index	value	Datastream	5	S
	166	Industrial production index, total Germany	Index 2005 = 100	Eurostat, ipp_st_m	5	S
	167	Ifo - Business Climate Index, Germany	Index 2005 = 100	CESifo	5	S
	168	All Commodity Price Index	Index 2005 = 100	IMF Primary Commodity Prices	5	S
	169	Non-Fuel Price Index	Index 2005 = 100	IMF Primary Commodity Prices	5	S
	170	Food and Beverage Price Index	Index 2005 = 100	IMF Primary Commodity Prices	5	S
	171	Industrial Inputs Price Index	Index 2005 = 100	IMF Primary Commodity Prices	5	S
	172	Agricultural Raw Materials Index	Index 2005 = 100	IMF Primary Commodity Prices	5	S
	173	Metals Price Index	Index 2005 = 100	IMF Primary Commodity Prices	5	S
	174	Fuel (Energy) Index	Index 2005 = 100	IMF Primary Commodity Prices	5	S
	175	Crude Oil (petroleum), Price index	Index 2005 = 100	IMF Primary Commodity Prices	5	S

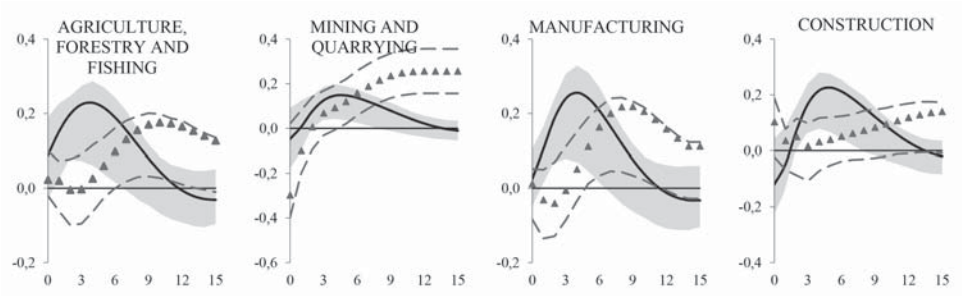
B. Impulse Responses of Client Loans

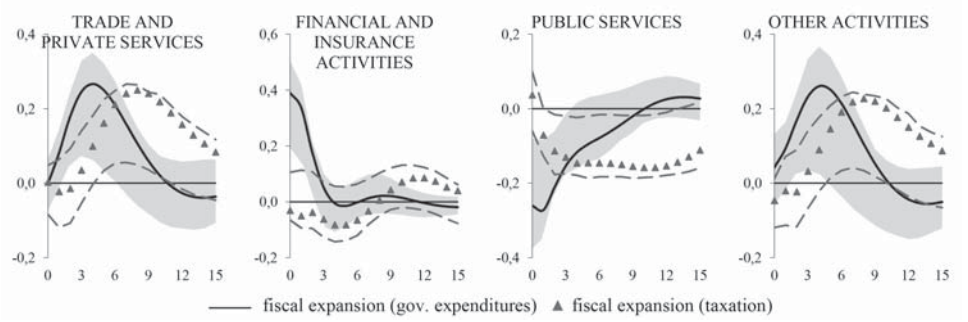
Figure 1B: Impulse Responses of Client Loans to Monetary Policy Expansion – sector breakdown



Notes: Median impulse responses are reported with 90% probability bands. The y-axis measures the strength of variables response in percentages; the x-axis is in quarters after the shock.

Figure 2B: Impulse Responses of Client Loans to Fiscal Policy Expansion – sector breakdown

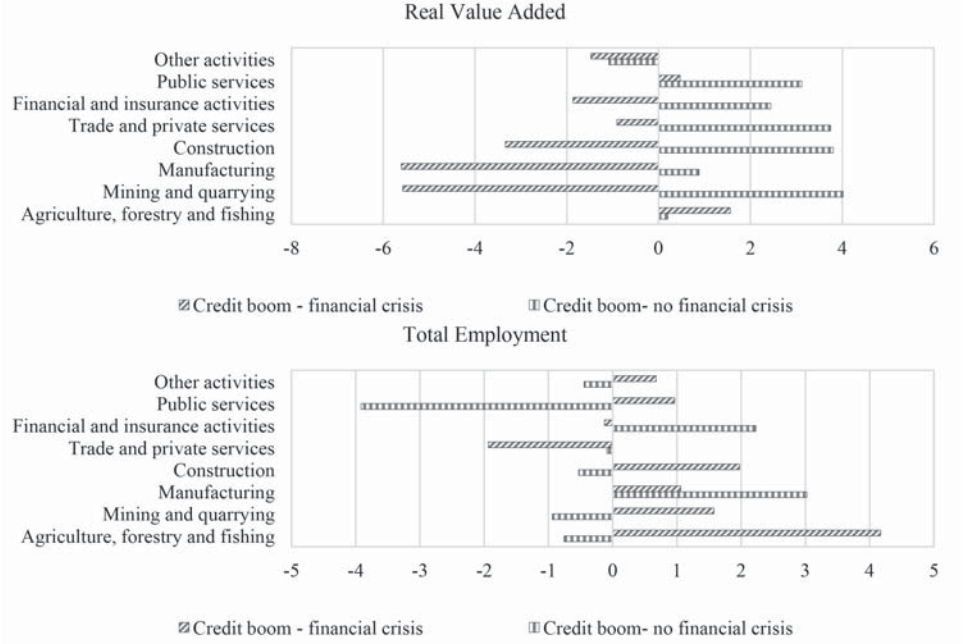




Notes: Median impulse responses are reported with 90% probability bands. The y-axis measures the strength of variables response in percentages; the x-axis is in quarters after the shock.

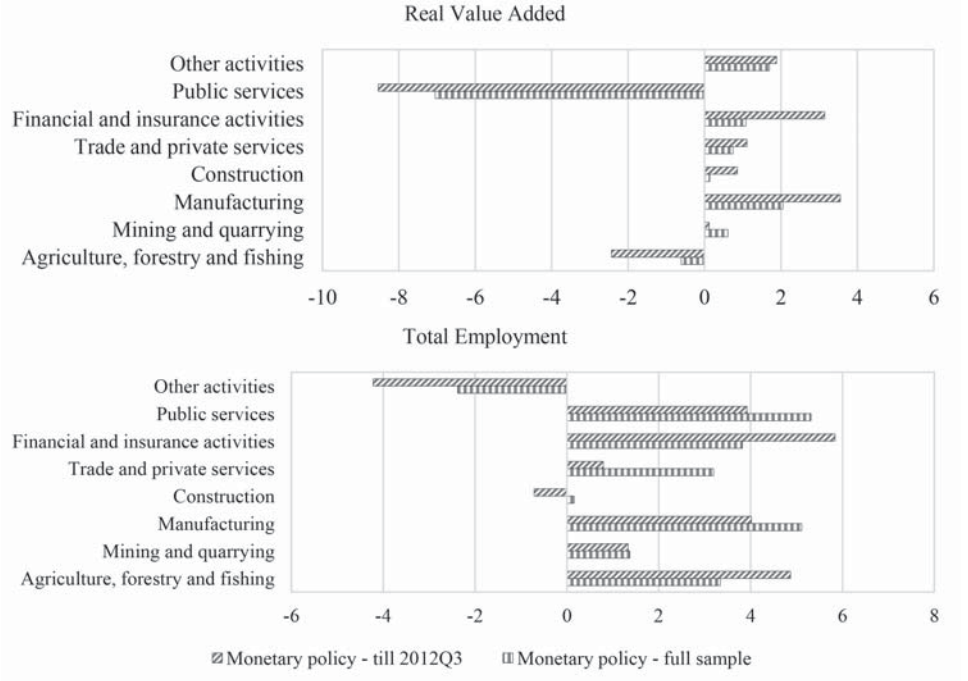
C. Impulse Responses of Real Value Added and Total Employment per Economic Sectors

Figure 1C: Accumulated Responses of Real Value Added and Total Employment to Credit Boom



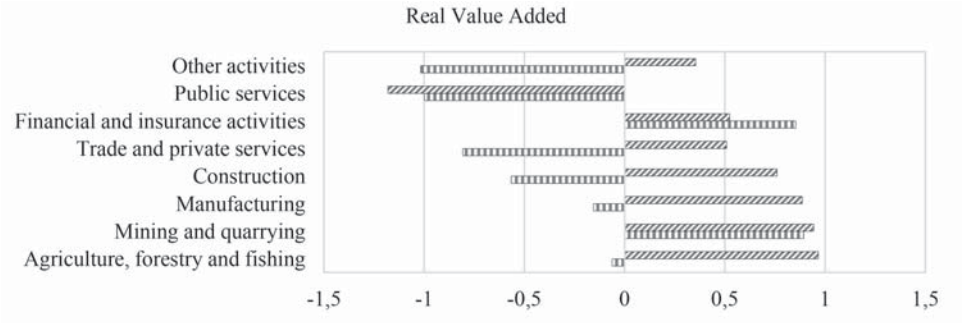
Notes: The responses were accumulated over 3-year period to account for any labour reallocations. Y-axis: economic sectors, x-axis: responses in percentage points.

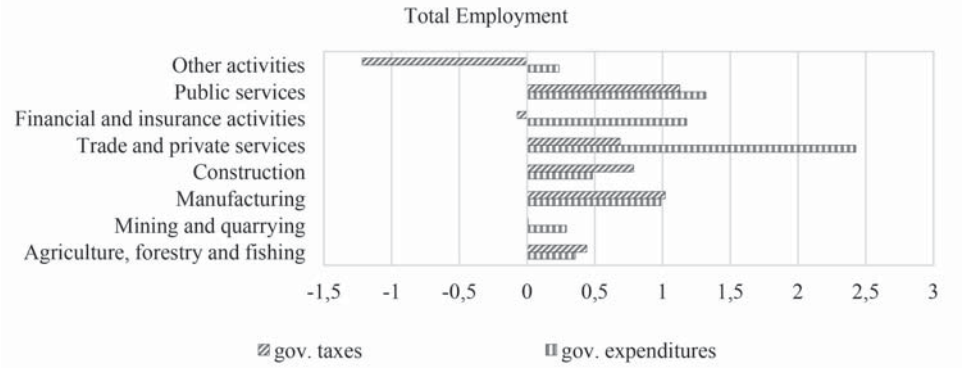
Figure 2C: Accumulated Responses of Real Value Added and Total Employment to Monetary Expansion



Notes: The responses were accumulated over 3-year period to account for any labour reallocations. Y-axis: economic sectors, x-axis: responses in percentage points.

Figure 3C: Accumulated Responses of Real Value Added and Total Employment to Fiscal Expansion





Notes: The responses were accumulated over 3-year period to account for any labour reallocations. Y-axis: economic sectors, x-axis: responses in percentage points.