Eesti Pank
Bank of Estonia

Liquidity and Productivity Shocks: A Look at Sectoral Firm Creation

Lenno Uusküla

Working Paper Series
5/2008

The Working Paper is available on the Eesti Pank web site at:
www.bankofestonia.info/pub/en/dokumendid/publikatsioonid/seeriad/uuringud/

For information about subscription call: +372 6680 998; Fax: +372 6680 954
e-mail: publications@epbe.ee

ISBN 978-9949-404-71-1
ISSN 1406-7161

Liquidity and Productivity Shocks: A Look at Sectoral Firm Creation

Lenno Uusküla*

Abstract

Only a few papers consider the sectoral effects of aggregate shocks. But do the shocks have homogeneous effects across sectors? This paper looks at the impact of liquidity and neutral productivity shocks on the creation of firms across 8 sectors in Estonia. I show that the sectoral heterogeneity in the reaction is low for liquidity shocks and high for technology shocks. An increase in liquidity leads to a uniform growth in the creation of firms across sectors with the exception of the financial sector. An increase in the labor productivity shock the entry of firms permanently in sectors that are traditionally considered to be producing tradables, such as transport or manufacturing. The increase in the creation of firms is short and close to zero in the long run in the non-tradable sectors, such as retail and whole sale, real estate, and hotels and restaurants.

JEL Code: E32, C32

Keywords: VAR, liquidity shocks, technology shocks, firm entry

Author's e-mail address: lenno.uuskyla@epbe.ee

*The author would like to thank the Estonian Enterprises Register and Mailis Mölder for providing the data, Aurelijus Dabušinskas, Karsten Staehr and Martti Randveer for fruitful discussions, and the seminar participants at Eesti Pank for their comments. Part of the paper was written when the author was visiting Eesti Pank.

Non-technical summary

The creation of new firms is strongly correlated with the business cycle. When business conditions are good, more firms are created and when the times are worse, fewer firms are started. The creation of firms is also a forward-looking measure of business opportunities because registration of a firm takes usually place months before the new firm is fully operative. Therefore understanding the creation of firms aids the analysis of economic fluctuations. It also allows one to understand the economy from a new angle where traditional measures might not be informative. For example profits or output per firm in a panel of existing firms do not necessarily increase after a productivity shock if the entry of new firms in the sector is strong. New firms might even increase competition to the extent that sales and profits in the existing firms can fall.

I look at the effects of productivity and liquidity shocks on the number of firm created in Estonia. I concentrate on these two shocks because they explain more than half of the variation in the aggregate output. Although by definition the macroeconomic shocks are aggregate, they do not necessarily have equal effects on all sectors. By looking at the sectoral composition of the creation of firms, we can learn whether the shocks have homogeneous effects.

In this paper I show that a positive liquidity shock increases firm entry in almost all sectors of the economy. The only exception is the financial sector itself, where the creation of firms decreases. On the contrary, a positive productivity shock raises the creation of firms permanently in the sectors that are traditionally considered to be tradable goods producers, such as manufacturing, transport and logistics. The increase is short-lived in retail and wholesale, hotels and restaurants, and real estate: that is, in sectors that are producing non-tradables.

In addition, I show that a positive liquidity shock leads to an economic boom — an increase in the Gross Domestic Product (GDP), employment, productivity and inflation. A technology shock increases productivity and GDP in the short and long runs. There is no permanent effect on employment, but at the time of the shock, employment falls. All these results are similar to the previously estimated effects of monetary and technology shocks for the US and Europe. In sharp contrast with the findings for other countries, the GDP deflator increases after a technology shock. For example in the US an increase in productivity leads to a drop in the inflation, consistent with the supply-side interpretation of the shock. Estonia however faced two permanent demand shocks — the Russian crisis in August 1998 and joining the European Union in May 2004. Both events had large and persistent effects on the composition and volume of Estonian exports, which in turn resulted in permanent changes in productivity. Therefore it is possible that a productivity shock in Estonia,

unlike that for other countries, has a partial demand-side interpretation.

All results in this paper are obtained by using a structural vector autoregression (SVAR) approach. The VAR includes 5 variables: labor productivity, a GDP deflator, employment, a firm creation measure and the interest rate. The creation of firms in each sector is included in the system one at a time. I use long-run restrictions to identify the productivity shock and short run restrictions to identify the liquidity shock. Only productivity shocks are allowed to have permanent effect on labor productivity. The liquidity shock is identified using recursive identification scheme — all variables in this VAR can have a contemporaneous effect on the interest rate, but not the other way around.

The results regarding firm creation are comparable to the previous studies done for the US. For example Uusküla (2007b) and Bergin and Corsetti (2008) show that an expansionary monetary shock leads to an increase in the creation of firms using a similar short-run identification scheme. Lewis (2006) uses sign restrictions in order to identify a monetary shock and finds that a monetary shock has an impact on the net entry of firms only with a significant lag. She also identifies a supply shock in the economy and finds that it is related to an increased level of net entry.

Contents

1. Introduction

Standard macroeconomic literature looks at aggregate economic shocks. But how do these shocks spill out across the sectors of the economy? In this paper I concentrate on the effects of liquidity and technology shocks on the creation of firms across 8 sectors in Estonia. As the creation of firms reflects expectations about profit opportunities, it is a good measure of the effects of the shocks on the sector. I show that, compared to permanent technology shocks, liquidity shocks lead to a considerably more homogeneous changes in the creation of new firms across sectors. Therefore it is also more likely that the impact of liquidity shocks is economy-wide, whereas the impact of productivity shock varies across sectors.

I estimate a 5-dimensional vector autoregressive (VAR) model. The variables included are labor productivity, the Gross Domestic Product (GDP) deflator, employment, the creation of firms, and the interest rate. I identify the neutral technology shock by using long-run restrictions. Only neutral technology shocks can lead to a change in labor productivity. A liquidity shock measures changes in the availability of credit, and it is identified using a short-run recursive restriction scheme as is done for the monetary shocks in VAR literature.

A positive liquidity shock, a drop in the interest rate by one percentage point, leads to a 6% increase in the creation of new firms at the aggregate level. The effect is statistically significant at the 68% confidence level for the first five years after the shock. The modal increase at the sectoral level is around 4%. The creation of firms is still 2–4% higher than the initial value after five years. The entry of firms decreases only in the financial sector itself. A positive liquidity shock also leads to an increase in GDP, employment, productivity and inflation, as found for the monetary shock in the literature.

A positive neutral technology shock rises contemporaneously the aggregate entry of firms by almost 6%. After 3 quarters it converges to a level which is not statistically significantly different from zero. However the effects of the shock vary significantly across the sectors. The shock leads to a lasting 5–8% statistically significant increase in the creation of firms in the sectors that are traditionally considered tradable, such as transport and logistics, and manufacturing. The increase in the firm creation is also high in the financial and construction sectors. The effect is around 5% at the time of the shock, but close to zero afterwards in the sectors which produce non-tradables, such as retail and wholesale, hotels, restaurants, and real estate. This variation can explain why the increase in the firm creation at the aggregate level is statistically insignificant. In addition a positive productivity shock increases GDP, leads to an initial drop in employment, and results in a small increase in prices.

In the literature, a neutral technology shock has a clear supply-side interpretation. This is supported by the finding that the price index falls after the shock. However, in this paper I find that the impulse response of the GDP deflator is non-decreasing. Therefore the supply-side interpretation is debatable for the Estonian data. The period of estimation includes several demand shocks which have had permanent effects, such as the Russian crisis, after which Estonian firms reduced exports to Russia permanently, and joining the European Union (EU), which in turn facilitated exports to the other EU countries. These shocks had a stronger impact on some sectors than others. The shock is still defined as an increase in productivity, but with the additional interpretation that the roots can also be in the demand side of the economy.

The results are robust to various changes in the model set-up. For example the qualitative aspects do not depend upon the inclusion of the relative price of investment goods relative to the consumption in the system and identification of the investment specific technology shock. In addition the results are not contingent on making interest rates fully exogenous, using 2, 3 or 4 lags, dropping four quarters of data from the beginning and the end, placing the entry before and after the interest rate, etc.

The results of the liquidity shock can be compared to the results of the monetary shocks in the U.S. for the U.S. economy. Uusküla (2007b) shows that an expansionary monetary shock leads to an increase in firm creation. The results are obtained using an 11-dimensional VAR of quarterly data and also identifies the shock with the short run restrictions. Bergin and Corsetti (2008) estimate a 6 dimensional VAR of monthly data and get a significant reaction of the creation of firms to a monetary shock when they use the non-borrowed reserves to the total reserves ratio to measure the monetary conditions, but not when they use the Federal Funds Rate.

A recent study using Estonian firm-level data by Masso et al. (2004) shows that the productivity increase has worked through the creation and destruction of businesses. This paper complements that claim, by showing that technology shocks lead to firm entry. For the U.S., Lewis (2006) shows that supply shocks lead to an increase in the net entry at the business cycle frequency by using a sign restriction based identification in VAR.

The rest of the paper is structured as follows. In next section I explain the identification of structural shocks. The third section describes the data. I present the main results in section four, starting with the impulse response functions and continuing with the variance decomposition. The fifth section includes robustness analysis and the sixth section concludes.

2. Identification of structural shocks

In this section I explain the identification of neutral technology and liquidity shocks in the VAR framework. The reduced form VAR is given by:

$$y_t = b_0 + \sum_{i=1}^{p} b_i y_{t-i} + u_t, \tag{1}$$

where, y_t is the set of endogenous variables, b_0 is the vector of constants, b_i is matrix of coefficients indexed with the number of the lag, p is the number of lags used in the model, and u_t is the error term.

The benchmark VAR contains 5 variables: log changes in labor productivity, a GDP deflator, employment, the number of firm created, and the level of the interest rate. Labor productivity is included in order to identify a productivity shock. The interest rate of kroon loans is used as a measure for the availability of liquidity. Although many loan contracts in Estonia are denominated in euros, the kroon interest rate shows the availability of loans and reflects the currency and the economy specific risks. The GDP deflator and employment are used to reduce omitted variable bias. Employment allows to calculate the GDP and the GDP deflator helps to understand the properties of the shock. The details of the data are presented in Table 5 in the Appendix.

Similar VARs estimated for the U.S. economy contain a higher number of variables. For example Altig et al. (2005) estimate a 10-variable VAR including the relative price of investment, labor productivity, a GDP deflator, hours, consumption, investment and several other variables. Uuskula (2007b) estimates an 11-dimensional VAR adding to the previous list a firm turnover measure. Ravn and Simonelli (2007) estimate a 12-dimensional VAR augmenting the system with government expenditures and labor market measures. The short sample period available for Estonia strongly restricts inclusion of more variables.

The reduced form VAR cannot be used to infer about structural shocks. Therefore I rewrite the VAR in the following structural form:

$$A_0 y_t = B_0 + \sum_{i=1}^{p} B_i y_{t-i} + \epsilon_t \tag{2}$$

where, B_i-s are matrices of the structural coefficients, related to b_i-s as the follows: $b_i = A_0^{-1} B_i$, ϵ_t are the structural shocks, and the variance-covariance matrix ($\Sigma_\epsilon = E(\epsilon_t' \epsilon_t)$ is assumed to be diagonal and related to the reduced form shock variance-covariance matrix ($\Sigma_u = E(u_t' u_t)$) by the formula $\Sigma_u = A_0^{-1\prime} \Sigma_\epsilon A_0^{-1}$.

I assume that only a neutral technology shock can have a permanent impact on labor productivity. The explanatory variables for the estimated equation on labor productivity are the lags of labor productivity itself and the lagged values of all other variables in differences. The use of differenced data implements zero long-run restrictions (for detailed discussion see Shapiro and Watson (1988)). The contemporaneous value of the interest rate is excluded from the set of explanatory variables because of the identification of the monetary shock. The productivity equation cannot be estimated with the ordinary least squares technique because the contemporaneous value of productivity might be correlated with the residual term. Therefore I estimate the equation using the instrumental variable (IV) technique. The instruments are the lagged values of the explanatory variables.

Campbell (1998) claims that technology shocks are important for generating variance in plant entry and exit dynamics, which is related to the creation of new firms. Several authors consider technology shocks to be the key shocks for business cycle dynamics, including Kydland and Prescott (1982), Altig et al. (2005), Ravn and Simonelli (2007), etc. The long-run restrictions in identifying neutral technology shocks have been adopted by many authors: see Gali (1999), Altig et al. (2005), Fisher (2006) and Ravn and Simonelli (2007) for example.

I adopt the recursive approach to identify the liquidity shock. The interest rate (R_t) is set by the financial markets. It is contemporaneously influenced by the variables in the set Ω. The orthogonal shock is defined as the residual (ζ_t) in setting $R_t = F(\Omega) + \zeta_t$. The recursive identification scheme is often used for the US economy with the interpretation of the monetary policy shock. Estonia only has a limited degree of monetary independence and the shock is not a measure of its monetary stance. The market interest rate reflects more generally the liquidity in the financial markets and does not have a traditional policy interpretation. The shock reflects the international monetary stance, the Estonian kroon risk premium, the mark-up on loans, and other similar factors.

In order to obtain identification, I impose short-run restrictions. All the variables placed before the interest rate can have contemporaneous effects on the interest rate, but are assumed not to be affected contemporaneously by the interest rate. I assume that the firm turnover variables enter into the set Ω, therefore it is not contemporaneously influenced by the interest rate. In the estimation, the recursiveness assumption implies that the interest rate equation is estimated with explanatory variables which include all the contemporaneous values and lags of the variables placed before it.

For the U.S., several authors have used the recursive assumption in order to identify monetary policy shock, some recent examples are: Altig et al. (2005), Ravn and Simonelli (2007), Boivin et al. (2007). For an overview of the identification schemes and main results see Christiano et al. (1998).

After identifying the technology shock (estimating the equation of labor productivity), I proceed the estimation of the equations in the following order: a GDP deflator, employment, firm creation, and the interest rate. I include the lags of all the variables and the contemporaneous values of the previous variables. All equations are estimated using IV technique. In addition to the lagged values of the variables, I exploit all the estimated residuals as additional instruments.

3. Description of the data

The data are for the period from 1995Q2 to 2006Q2. I start the period in 1995 because by this time major reforms were finished and the macroeconomic situation stable. The macroeconomic data is from the Statistics Estonia and the financial data from the Bank of Estonia. For detailed description, see Table 5 in the Appendix. I use employment because the number of hours worked is not available at quarterly frequency for the whole period.

The creation of firms' statistics is from the Estonian Business Registry. The quarterly number of new firms is based on the date of registration. It includes the firms that are created by the law firms to sell as 'on the shelf' products. Therefore not all firms will start operating at the time of creation. As a result, the data on firm creation reflects the expectations about future economic conditions. The manufacturing sector also includes agriculture, fishing, hunting, forestry, mining etc. Logistics also includes transportation and communication. A further division into sectors makes the number of entry volatile as the number of firms created decreases. For a detailed description, including the EMTAC codes, see Table 5 in the Appendix. I use the X12 filter to remove seasonal component from the series.

I test the stationarity of the data using the (augmented) Dickey-Fuller test. The results in Table 6 in the Appendix show that labor productivity, the GDP deflator and firm creation[1] are stationary in first differences independently of the number of lags used in the regression. The stationarity of employment and the interest rate in the differences is rejected at the 5% confidence level for models with a high number of lags. Because of the low power of the (augmented) Dickey-Fuller test and given that according to the theory the series should be stationary, for the benchmark results, I use the variables in levels.

[1]From the economic point of view the correct measure for creation of firms is entry rate. Entry rate should be stationary and could be used in levels. Unfortunately this series is not available because of the changes in the firm registry laws.

The stationarity results of the creation of firms by sectors are presented in Table 7 in the Appendix. The variables are all stationary in differences when zero or one lags are used at traditional confidence levels. The weakest are the results for the retail and whole-sale sectors, which show that the series are not stationary when two or three lags are included, but are stationary with four lags included at the 10% confidence level.

4. Results

The benchmark VAR has 3 lags and includes intercepts in all of the estimated equations. I present the 68% confidence intervals equal to one standard deviation, based on 5000 bootstrap replications centered around the point estimates.

4.1. Impulse response functions of the liquidity shock

Figure 1 presents the impulse response functions to a positive shock in liquidity: a one-time drop in the interest rate by 1 percentage point, lasting for five quarters. The impulse response function of the creation of firms has a hump-shaped form. The maximum, about a 6% increase, is reached after 10 quarters and the effect is statistically significantly different from zero for more than 20 quarters.

In addition, the liquidity shock leads to a hump-shaped increase in employment, productivity, output and the GDP deflator. However the effect on the GDP deflator is statistically insignificant. I find no evidence of the price puzzle, as is often recorded in the literature for monetary shocks.

Figure 2 shows the impacts of the positive liquidity shock on the 8 sectors in the economy, where each of the sectors is plugged into the system in turn instead the total creation of firms one-by-one. The sectors are manufacturing, construction, retail and whole-sales, hotels and restaurants, transport and logistics, financial services, real estate, and others.

The sectoral effects of the shock, with two exceptions, are very similar to the dynamics of the aggregate entry. The impact is uniform and the sectoral heterogeneity is small. The shock leads to an increase in the number of created firms in most of the sectors by around 4% after one year, and 2–4% after five years. The effects are the strongest and most persistent for the retail and whole-sale sectors. This can be explained at least in part by the stationarity properties of this data series. The number of new firms does not increase only in the financial sector. A decrease in the domestic interest rate can result in a lower mark-up and consequently a lower income of the financial companies.

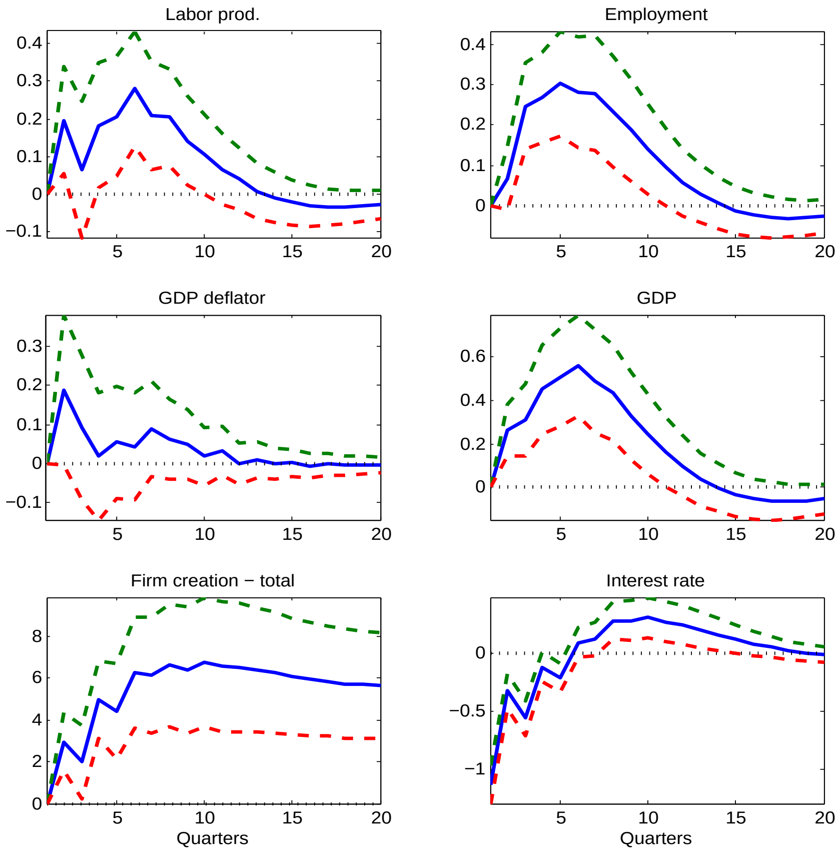

Figure 1: Impulse response functions to a expansionary standard deviation shock in liquidity

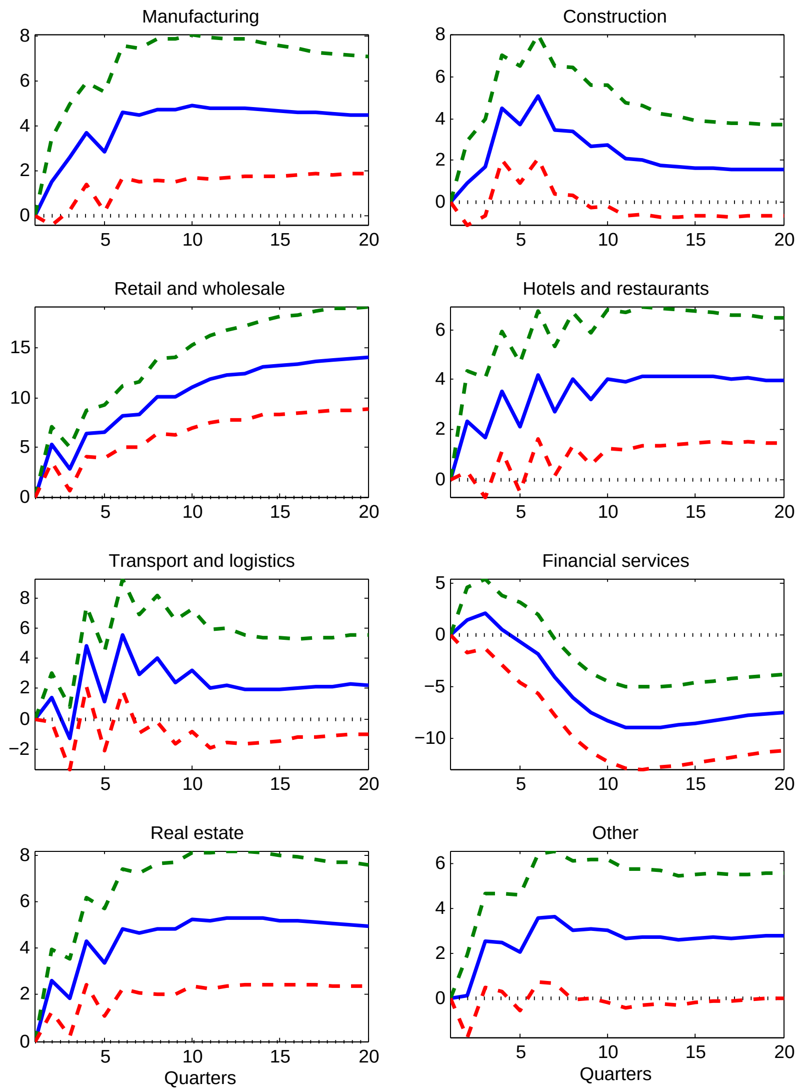

Figure 2: Impulse response functions to a expansionary standard deviation shock in liquidity

Therefore it is not unreasonable that a positive liquidity shock can lead to a drop in the creation of firms in the financial sector.

In a 3-dimensional VAR model, Uusküla (2007a) also finds that a contractionary liquidity shock leads to a drop in the number of created firms in Estonia. The effect of liquidity on the total number of new firms can also be compared to the results on the monetary shock in the U.S. Uusküla (2007b) shows that an expansionary monetary policy leads to an increase in the firm creation. Using monthly data and the ratio of non-borrowed reserves to total reserves, Bergin and Corsetti (2008) show that an expansionary monetary shock leads to a higher creation of firms. In addition the other economic variables are similar to the findings for the U.S. and the Euro area countries. There the shock also leads to a hump-shaped increase in employment and output.

4.2. Impulse response functions of the neutral technology shock

The positive neutral technology shock is defined as a long-run increase in labor productivity of about 1.5%. The impulse response functions are presented in Figure 3. The shock leads to an increase in the creation of new firms by 6% and the effect is statistically significant for four quarters. The mean effect after 20 quarters is around 4%, but it is statistically significant at the 68% confidence level. Therefore at the aggregate level the impact of the technology shock is small and uncertain.

The increase in productivity lowers employment at the time of impact, and has a zero effect from the third quarter onwards. A drop in employment decreases the initial rise in the GDP, which reaches the highest level of 1.5% after 10 quarters. In addition, a technology shock leads to a small drop in the interest rate and volatile, but more probably increasing than decreasing GDP deflator.

The sectoral response to the change in labor productivity is presented in Figure 4. The magnitude of the reactions and their statistical significance varies reflecting sizable differences across sectors. Therefore a macroeconomic shock has a heterogeneous impact on the economy.

The effect is the strongest in the financial sector, where growth is around 20%. Firm creation in the manufacturing, construction and logistics sectors increased by 5–8%, which is higher than the rise in aggregate firm creation. The shock has the smallest impact on the retail and whole-sale sectors, which face an initial 4% increase, but after one year, the impulse response functions of the creation of new firms is very close to zero or even negative.

The sectors where the increase is the strongest are mainly tradable in the

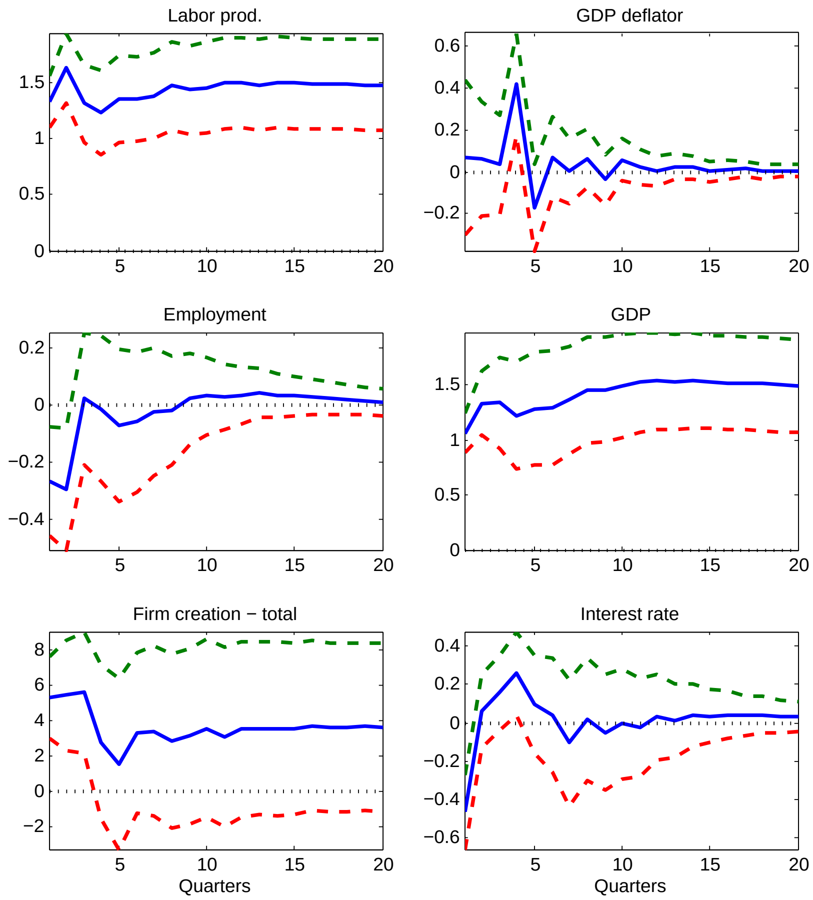

Figure 3: Impulse response functions to a positive standard deviation shock in labor productivity

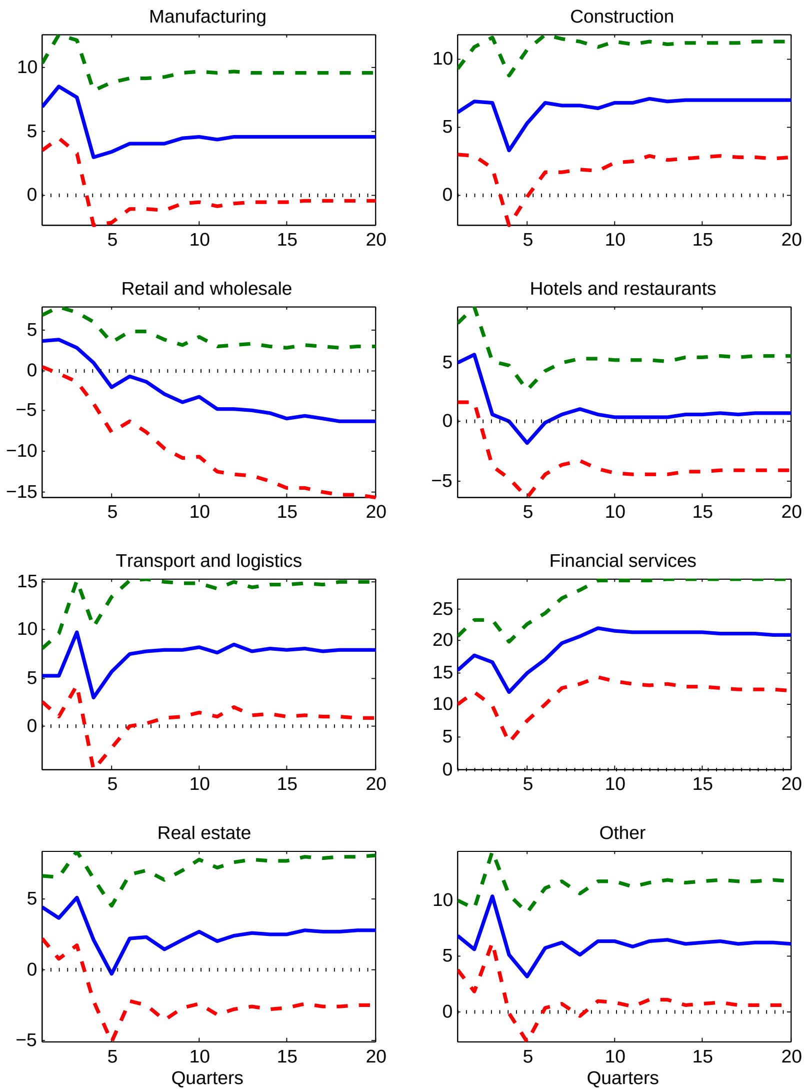

Figure 4: Impulse response functions to a positive standard deviation shock in labor productivity

nature: for example, manufacturing and logistics. The increase in the creation of firms in the sectors that are a priori producing non-tradables, such as retail and whole-sales, real estate is much smaller. The two outliers are financial services and construction. Although the financial sector is often analyzed as a non-tradable sector, it offers liquidity for entrepreneurs in the other sectors. It also has a role in amplifying business cycles (see Bernanke et al. (1996) for example), In this case the productivity shock amplified by the financial sector, which consequently mean that the macroeconomic shocks influence financial markets stronger.

Traditionally technology shocks have a clear supply-side explanation, which is supported by the fact that the GDP deflator drops after the shock (for example, see Gali (1999), Ravn and Simonelli (2007) or Altig et al. (2005)). However, here the GDP deflator does not drop.

The data period under study is marked by two important and persistent demand shocks — the Russian crisis starting in August 1998 and Estonia joining the European Union in May 2004. The Russian crisis lead to a drop in the Estonian exports to Russia. Membership to the European Union eased exports to the other EU countries. Both of these demand-driven economic events had bigger effects on some sectors than on the others and generated lasting changes in aggregate productivity. Therefore the supply-side interpretation can be complemented with permanent demand shocks.

The distinction between the tradable and non-tradable sectors points towards a possible manifestation of the Harrod-Balassa-Samuelson hypothesis. An increase in tradable sector productivity raises the cost of production of non-tradables and results in domestic inflation. The increase in tradable productivity should generate inflation only in the longer run. Here, inflation increases within a one-year horizon. Moreover it is during the time when the effect of productivity on entry into the non-tradables sector is still positive.

From a panel of Estonian firms, Masso et al. (2004) find that the technological improvement works through the creation of new firms. The result of this paper complements this result by finding that technological improvement leads to firm creation at business cycle frequencies. In addition, I show that the business cycle effect is not homogeneous across sectors leading to a redistribution and restructuring of the economy.

4.3. Variance decompositions

The variance decomposition results show that the two identified shocks are important for the Estonian economy. They capture more than half of the variance of the macroeconomic variables at the business cycle frequency. The shocks also describe an important share of variance in the creation of new firms.

The liquidity shock explains 6–18% of the forecast error variance decomposition (FEVD) of the total creation of new firms for a period of one to five years (see Table 1). The shock explains the high share of variance in the retail and whole-sale and in the real estate sectors and the lowest share in the logistics sector.

Table 1: Variance decomposition for the liquidity shock, in percents

	FEVD at indicated quarters					Business
	0	4	8	12	20	cycle freq.
Total	0.00	6.35	13.02	16.22	18.01	36.89
Agriculture	0.00	2.35	5.16	7.00	8.35	22.21
Construction	0.00	2.48	4.95	4.66	3.76	27.02
Retail and wholesale	0.00	9.20	16.45	21.15	25.45	18.21
Hotels and restaurants	0.00	2.45	5.00	6.58	8.52	29.64
Logistics	0.00	2.29	3.01	2.67	2.14	34.76
Financial	0.00	0.26	1.39	4.72	6.69	9.60
Real estate	0.00	5.40	9.22	11.32	12.82	49.38
Others	0.00	1.49	2.89	3.17	3.21	34.05

Note: FEVD stands for the forecast error variance decomposition presented at the moment of impact and 4, 8, 12 and 20 quarters after. The business cycle is calculated using the Hodrick-Prescott filtered trend with the smoothing parameter $\lambda = 1600$. The share of variance is calculated dividing the counterfactual data variance around the trend with the respective variance in the data.

The neutral technology shock explains about 21% of the variance in the new firms upon the time of impact, but with a diminishing share down to 8% at the five year horizon (see Table 2). It describes a relatively higher share of variance in the financial sector, followed by construction, manufacturing and logistics sectors.

The in-sample decomposition of the variance at the business cycle frequency is presented in the last columns of Tables 1 and 2. The business cycle frequency is defined as the variance around the Hodrick-Prescott filter trend with the smoothing parameter $\lambda = 1600$. I obtain the counterfactual data by adding the identified monetary shock to the data. Then, from the generated time-series I remove the trend and calculate standard deviations. The share of the variance explained by the shock is the fraction of the counterfactual data standard deviation to the respective data moment. Although asymptotically the variance decompositions should add to 100% for all the shocks, in limited samples this is not true and the sum of variances can exceed 100%. At the business cycle frequency, the liquidity shock describes 37% of the variance in the total number of firms created (see last column in Table 1). The highest share of variance is described in the real estate and logistics sectors, and the lowest share in the financial services sector.

Table 2: Variance decomposition for the neutral technology shock, in percents

	FEVD at indicated quarters					Business
	0	4	8	12	20	cycle freq.
Total	21.12	16.36	9.44	7.98	7.83	40.56
Agriculture	17.53	19.63	13.62	12.38	11.62	38.92
Construction	12.82	14.70	17.38	20.77	25.35	31.73
Retail and wholesale	7.31	4.51	2.40	2.98	4.31	19.29
Hotels and restaurants	8.95	6.83	4.78	3.37	2.25	37.00
Logistics	14.07	13.79	13.48	15.68	17.08	42.12
Financial	30.32	39.71	49.92	55.17	57.69	31.30
Real estate	17.08	11.73	6.42	5.16	4.65	50.24
Others	19.58	24.88	17.73	17.71	17.54	52.98

Note: FEVD stands for the forecast error variance decomposition presented at the moment of impact and 4, 8, 12 and 20 quarters after. The business cycle is calculated using the Hodrick-Prescott filtered trend with the smoothing parameter $\lambda = 1600$. The share of variance is calculated dividing the counterfactual data variance around the trend with the respective variance in the data.

The neutral technology shock explains more than 40% of the variance at the business cycle frequency. It also explains the high share of variance in the financial sector and very little in the retail and whole-sales, as well as the hotels and restaurants sector (see the last column in Table 2).

The two shocks together explain an important part of the creation of new firms, which constitutes more than quarter in the forecast error variance decomposition for the period up to five years and more than half of the variance decomposition at the business cycle frequency. This gives confidence that these two shocks capture an important share of the variance in the creation of new firms.

The liquidity shock describes more than half of the variance in the interest rate in the short-run (up to two years), and the effect decreases over time (see Table 3). The shock is also important in describing employment and output, but does not influence productivity and inflation. At the business cycle frequency, the liquidity shock describes more than half of the variance in the interest rate (see Table 3). It also explains more than one third of the variance in employment. In addition, tt explains almost 15% of the variance in output and almost 13% of the variance in inflation.

Table 3: Variance decomposition for the liquidity shock, in percents

	FEVD at indicated quarters					Business cycle
	0	4	8	12	20	frequency
Productivity	0.00	1.17	1.65	1.29	0.77	5.18
Inflation	0.00	1.32	1.70	1.73	1.73	12.70
Employment	0.00	10.36	14.86	15.37	15.40	25.62
Output	0.00	5.42	6.77	5.48	3.41	14.33
New firms	0.00	7.46	14.12	16.35	18.21	36.90
Interest rate	82.67	64.62	38.06	34.91	34.20	56.16

Note: FEVD stands for the forecast error variance decomposition presented at the moment of impact and 4, 8, 12 and 20 quarters after. The business cycle is calculated using the Hodrick-Prescott filtered trend with the smoothing parameter $\lambda = 1600$. The share of variance is calculated dividing the counterfactual data variance around the trend with the respective variance in the data.

The neutral technology shock describes more than 90% of the variance in labor productivity and at least 65% of the variance in output at the 5 year horizon (see Table 4). The technology shocks are also important in describing the interest rate and employment in the short-run (up to two years), but has little explanatory power over inflation. The neutral technology shock explains 81% of the variance in productivity, 54% of output, and 34% in employment over the business cycle.

Table 4: Variance decomposition for the neutral technology shock, in percents

	FEVD at indicated quarters					Business cycle
	0	4	8	12	20	frequency
Productivity	94.51	92.10	93.17	94.80	96.87	81.03
Inflation	0.13	5.74	5.72	5.78	5.81	17.72
Employment	16.25	7.57	5.41	5.28	5.39	33.74
Output	91.41	66.63	69.90	76.27	85.25	53.78
New firms	21.46	13.34	9.34	8.35	8.06	41.00
Interest rate	14.46	12.03	6.74	5.57	5.35	23.90

Note: FEVD stands for the forecast error variance decomposition presented at the moment of impact and 4, 8, 12 and 20 quarters after. The business cycle is calculated using the Hodrick-Prescott filtered trend with the smoothing parameter $\lambda = 1600$. The share of variance is calculated dividing the counterfactual data variance around the trend with the respective variance in the data.

The results show that the neutral productivity shock explains movements in labor productivity and does poorly in describing inflation. Similar studies for the US and Europe have found that productivity shocks describe the variance in labor productivity less and the variance in inflation more. This supports the hypothesis based on the impulse response functions that the identified shock also includes permanent demand shocks that influence productivity.

5. Robustness analysis

In this section I show that the results are robust to various changes in the model set-up, given the limitations of the variables and sample available. Recently, Fisher (2006) showed that the technology shock might be mis-specified when the investment specific technology shock is not identified. I add an equation to the system — the price of investment good relative to the GDP deflator. I base the identification of the investment specific technology shock on the assumption that only the investment specific technology shocks can have a long-run impact on the relative price of the investment good. Therefore I estimate the equation including the lags of the relative price of investment and all other variables in the first differences, which as done before for the technology shock, implements the long-run restriction. I estimate the equation by using the IV technique. For the identification of the neutral technology shock, I also assume that investment specific technology can have a permanent effect on labor productivity. Consequently relative price of investment in the labor productivity equation is not differenced, but all the other variables are used in first differences.

When an investment specific technology shock is identified in addition to the neutral technology shock, an increase in labor productivity leads to a permanent increase in the number of created firms. Similar to the benchmark results the shock results in a short-run drop in employment and interest rate. The effect of the shock on the GDP deflator is now negative, but statistically significant only for the second quarter after the shock. The real estate, hotels and restaurants, and retail and whole-sales sectors have an initial positive reaction, but after two years, the number of firms decreases. On the contrary, the effect on the manufacturing, logistics, construction and financial sectors is always positive, but has a lower statistical significance than in the benchmark results. A positive liquidity shock — a drop in the interest rate by 1 percentage point leads to an increase in the creation of new firms by about 3%, lasting for 15 quarters. The shock leads to stronger and longer lasting effects on employment and output. The GDP deflator increases, becoming statistically significant after 4 quarters.

Estonia is a small open economy with a very limited independence of monetary policy. Therefore the interest rate is determined to a large extent by exogenous factors. In order to check if that has an effect on the results, I make the interest rate fully exogenous: it is only explained by its own lags, all the coefficients of other variables of interest rate are set to zero. After the liquidity shock, interest rate does not converge back to zero within the next 20 quarters. At the disaggregated level, all sectors have a positive effect with the exception of the financial sector, for which the impact is negative, as before. However, the impulse response functions of the number of firms do not exhibit convergence back to zero within 20 quarters horizon. After the technology shock, the interest rate remains zero by construction, but the other variables have similar impulse responses as before.

I carry out several additional robustness checks. I estimate the model with two and four lags instead. I drop four quarters from the beginning and from the end of the sample. I re-estimate the model assuming difference-stationarity of employment and the interest rate. I also add money velocity to the system as a last variable after the interest rate.

In general, these changes make the impact of the neutral technology shock on the creation of firms stronger, leading to permanent effects of productivity on the number of entry. At the sectoral level, differences between the sectors remain significant: the tradeables have stronger reaction than the non-tradable ones. For example, when four lags are used in the VAR, all the impacts are statistically significant after a 5-years period, but manufacturing and logistics have impacts which are almost twice the size of those for retail and wholesales, and hotels and restaurants. Dropping the first or last four quarters from the sample strengthens the patterns described in the section of results. For the other robustness checks, the impulse response functions of the liquidity shock are similar to the benchmark.

In a similar way to the robustness of the impulse response functions, there is also an quantitative uncertainty about the variance decomposition of the shocks. The described variance of the creation of firms due to liquidity shock drops to 2%, but can also exceed 50%. The lower bound for the technology shocks is also very close to zero.

6. Conclusions

This paper gives new evidence about the transmission of monetary and technology shocks in Estonia. Based on the sectoral data about firm creation, I show that a liquidity shock has a homogeneous impact on the economy. Conversely, the effects vary significantly for a neutral productivity shock. These shocks together explain about half of the variance in the creation of new firms. Although there is uncertainty about the size of the impacts of the shocks, the qualitative results are robust to various changes. The paper also contributes to the literature on explaining firm creation by using high-quality registry data. I also argue that the interpretation of a permanent neutral technology shock does not necessarily have a direct supply side interpretation, but can also include permanent demand shocks.

References

Altig, D., Christiano, L. J., Eichenbaum, M., and Linde, J., 2005. Firm-specific capital, nominal rigidities and the business cycle. NBER Working Paper, No. 11034.

Bergin, P. and Corsetti, G., 2008. Towards a theory of firm entry and stabilization policy. Journal of Monetary Economics

Bernanke, B., Gertler, M., Gilchrist, S., 1996. The Financial Accelerator and the Flight to Quality. The Review of Economics and Statistics, No. 78(1).

Boivin, J., Giannoni, M., and Mihov, I., 2007. Sticky prices and monetary policy: Evidence from disaggregated u.s. data. NBER Working Paper, No. 12824.

Campbell, J. R., 1998. Entry, exit, embodied technology, and business cycles. Review of Economic Dynamics, No. 1(2).

Christiano, L. J., Eichenbaum, M., and Evans, C., 1998. Monetary policy shocks: What have we learned and to what end? NBER Working Papers, No. 6400.

Fisher, J. D. M., 2006. The dynamic effects of neutral and investment-specific technology shocks. Journal of Political Economy, No. 114(3).

Gali, J., 1999. Technology, employment and the business cycle: Do technology shocks explain aggregate fluctuations? American Economic Review, No. 89(1).

Kydland, F. and Prescott, E., 1982. Time to build and aggregate fluctuations. Econometrica, No. 50(6).

Lewis, V., 2006. Macroeconomic fluctuations and firm entry: theory and evidence. National Bank of Belgium, Working Paper Research, No. 103.

Masso, J., Eamets, R., and Philips, K., 2004. Firm demographics and productivity dynamics in Estonia. University of Tartu, Department of Economics Working Paper, No. 25.

Ravn, M. and Simonelli, S., 2007. Labor market dynamics and the business cycle: Structural evidence for the United States. Scandinavian Journal of Economics.

Shapiro, M. and Watson, M., 1988. NBER Macroeconomics Annual 1988, Chapter Sources of Business Cycle Fluctuations, MIT Press.

Uusküla, L., 2007a. Firm entry and liquidity. Bank of Estonia Working Paper Series, No. 6.

Uusküla, L., 2007b. Limited Participation or Sticky Prices? New Evidence from the Firm Entry and Failures. Mimeo, EUI.

Appendix

Table 5: Detailed description of variables

Variable	Description	Source
Employment	Log of number of employed people, ages 15-69	Statistics Estonia
Real GDP	Log of GDP at year 2000 prices	Statistics Estonia
Nominal GDP	Log of GDP at current prices	Statistics Estonia
GDP deflator	Difference between nominal and real GDP	
Labor productivity	Difference between real GDP and employment	
Real investment	Log of investment at year 2000 prices	Statistics Estonia
Nominal investments	Log of investment at current prices	Statistics Estonia
Price of investment	Log of nominal to real investment	
Relative price of investment	Log of investment price minus log of GDP deflator	
Interest rate	Interest rate on Estonian kroon loans	Bank of Estonia
Money	Log of M2	Bank of Estonia
Money velocity	Money minus nominal GDP	
Creation of firms	Log of the number of firms created	Estonian Business Registry
Manufacturing	EMTAC 1–44999	Ibid.
Construction	EMTAC 45000–49999	Ibid.
Retail and whoe sales	EMTAC 50000–54999	Ibid.
Hotels and restaurants	EMTAC 55000–59999	Ibid.
Logistics	EMTAC 60000–64999	Ibid.
Financial	EMTAC 65000–69999	Ibid.
Real estate	EMTAC 70000–74999	Ibid.
Others	EMTAC 75000–	Ibid.

Table 6: Stationarity analysis of main variables

Variable	Labor product.	GDP defl.	Employment		Creation of firms	Interest rate	
Level/Diff	Diff	Diff	Level	Diff	Diff	Level	Diff
0	–7.18	–8.15	–3.06	–6.21	–8.82	–2.88	–10.72
1	–8.42	–2.60	–3.07	–4.39	–6.25	–3.00	–5.15
2	–4.24	–2.99	–3.30	–3.64	–4.17	–2.58	–4.44
3	–4.61	–3.32	–1.90	–2.95	–4.09	–2.53	–3.56
4	–3.88	–3.32	–2.03	–2.85	–3.87	–2.38	–3.16

Note: Constant is included in every regression. The asymptotic critical values are –3.43, –2.86 and –2.58 respectively for 1, 5 and 10% levels.

Table 7: Stationarity analysis of firm creation in differences by sectors

Lags	Manuf.	Constr.	Sale	Hotels	Logist.	Fin.	Real estate	Other
0	–8.92	–7.18	–6.74	–9.94	–10.35	–8.08	–9.73	–10.66
1	–6.47	–5.02	–4.01	–5.90	–5.82	–5.99	–4.67	–6.55
2	–4.63	–3.61	–1.93	–4.82	–3.60	–4.42	–2.99	–3.54
3	–4.52	–3.98	–1.96	–5.23	–4.00	–4.69	–2.99	–3.66
4	–4.76	–2.37	–2.63	–4.57	–3.80	–4.01	–3.03	–3.61

Note: Constant is included in every regression. The asymptotic critical values are –3.43, –2.86 and –2.58 respectively for 1, 5 and 10% levels.

Working Papers of Eesti Pank 2008

No 1
Jaanika Meriküll
The impact of innovation on Employment: Firm- and Industry-level Evidence from Estonia

No 2
Christian Schulz
Forecasting Economic Activity for Estonia: The Application of Dynamic Principal Components Analysis

No 3
Karsten Staehr
Estimates of Employment and Welfare Effects of Personal Labour Income Taxation in a Flat-Tax Country: The Case of Estonia

No 4
Karsten Staehr
The Maastricht Inflation Criterion and the New EU Members from Central and Eastern Europe