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CONTRIBUTION OF INTERNATIONAL STUDENTS AND EMPLOYMENT TO ESTONIAN ECONOMIC STRUCTURE: AN ANALYSIS OF HYPOTHETICAL EXPENDITURE SHOCK ON RESEARCH AND EDUCATION

Master's Thesis

Supervisor: Kadri Ukrainski

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I have written this master's thesis independently. All viewpoints of other authors, literary sources and data from elsewhere used for writing this paper have been referenced.

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Abstract

The interest for international education and employment abroad has been increasing and their impact has become more important over the years. This report attempts to study a hypothetical shock of an increase of expenditure on foreign students and employment to economic structure. The VIO (Dynamic Variable Input-Output) model is utilized. It is different from the traditional method Leontief's matrix since the input substitution is available so that output of each industry can be influenced. The goal is to show the impact of increasing the expenditure in education and research sectors for the years 2000, 2005 and 2010. As a result, the efficiency of expenditure shock is larger to education sector than to research sector and real estate activity, accommodation and food service activities, aggregated manufacturing, wholesale and retail trade show higher sensitivity to expenditure shock than other industries.

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1. Introduction

The globalization helps students to have more chances to study in higher education abroad and the impacts of international education and research expenditure to economies become more substantial.

The general number of students in the world who have enrolled at higher education institutes has been increasing over the years. As there has been increasing interest in higher education and mobility possibility, students also have considered studying in other countries' HEIs (Higher Education Institution). Münch and Hoch (2013), present that the number of international students enrolled at HEIs has increased 5 times during the last 40 years. They estimate significant impacts on the economic structure by international students and foreign employment. The more channels of impact on expenditure for international students and foreign employment result in substantial impacts to economic structure in a country. As the number of international students and employees increase, the impact becomes stronger. Since the number of international students and foreign employment increases, there should be higher economic impact by various sources of expenditure because they spend money in other countries. (e.g. tuition fee, living cost and labor cost for foreign students and employment.)

Another impact of international students is fulfilling job vacancies. According to DBEDT (2015) in Hawaii 4,922 jobs were occupied by international students. The number of international students is 4,886 for short-term jobs and 5,218 for long-term jobs in 2015. And the estimation by the impact of foreign students' employment is 205.1 million dollars. Oxford Economics (2007) measure the employment of foreign students. According to the estimation, there is 25,000 pounds per foreign employee by productivity. Foreign students are engaged in 21,000 jobs out of 77,000 which are occupied by students in higher education in the UK. According to NRB (2013) in New Zealand, the number of international students occupying direct jobs is over 13,600. If we sum the direct, indirect, induced jobs, then the number of international students' employment, in total, is 28,170 which are around a half of all the higher educated students. Kunin (2012) shows that international education provides employees for 70,240 jobs and it is 5.7% of overall employment (1,217,800 people were employed in Canada in 2010). Bone (2006) tells that when it comes to employments in HEIs, there are 280,146 FTE (Full Time Employment) jobs which is equivalent to 1.2 % of total

employment in UK.

In Estonia, the number of international students has increased over the years. As a result of the effort to have more foreign students in Estonia, the number of international students has increased around 186% during 10 years from 2005 to 2014 (Statistics Estonia : ES309). They are mostly from EU but also from other countries such as the US and third countries such as Russia, China, Turkey and Georgia. The foreign employment has also increased. According to the data from Statistics Estonia, the number of jobs occupied by foreign people has increased and the rate of part-time job among them is 6% in average (Eurostat) which means the demand for foreign people on full time jobs is increasing and the recruits might be international students since Estonia lacks of qualified labor. About the investment in education, OECD (2012) report shows that expenditure on the education sector has increased from the year 2000. It is marked that Estonia has the third highest educational expenditure among OECD countries. When it comes to the source of expenditure for education sector, Estonian education system largely relies on public funds. 94% of the funds are from public sector which is over the average of the OECD (84%). There are only three countries that have higher education fund reliance on public sectors: Finland, Sweden and Portugal. It can be interpreted that the Estonian education cost is susceptible to the changes of the policy of the public organizations.

The given report studies the simulation about the impact of expenditure shock on education and research. The simulation model is based on the Input-output table. It can be assumed that increased expenditure can be considered as one instrument of economic policy. Through the input-output data from Statistics Estonia, it can be showed how Estonian economic structure reacts to positive expenditure shock on foreign employment and international students in education and research sectors. In conclusion, the main focus of this report is to show the elasticity of output variation as a reaction to expenditure shock in each industry. The report simulates the modified model based on Leontief's matrix, the VIO model and interprets the results by comparing the estimated outputs in industries.

2. Literature review

Many researchers have studied the impacts of international students in countries. In table 1, it shows an overview of a part of international students' impact in literature review.

There are case studies which estimate the impact through various channels and compare different effects of local students and foreign students from the EU and from elsewhere. Münch and Hoch (2013) measure financial and economic effects of international students' mobility in various dimensions of German economy. The report's target group consists of international students, who are from Netherlands, Austria, Poland, Switzerland and Spain studying for a higher education degree, such as Bachelor's and Master's degrees. Kelly et al (2014) present the key economic effects of HEIs and their contributions to the economy of the UK from 2011 to 2012. It also measures knock-on effect[1]s of the UK and the non-UK students. Valentinem and Onslow-Cole (2015) note changes of international students' contributions to the UK economy because of the government's immigration policy, and impact of their activities during and after their studies. And it compares the employment between EU and non-EU students. Since students from the non-EU countries require working permit and extra support, there are less students seeking for jobs or staying after they graduate. Vickers and Bekhradnia (2007) analyze international students' economic cost and benefit. They compare students from the EU and the non-EU countries. It is not measured exactly but they predict there are more EU students remaining than those of non-EU.

Shumilova et al (2012) have researched the number of international students working in Finland after they graduated from Finnish HEIs. The report shows in detail the skills and working experiences of the international students required for employment in Finland. They survey the opinions of graduates and employees. In that way, they analyze the factors related to the foreign employment and the factors needed to increase employability of the international students in Finland.

[1] Knock-on effect is generally recognized as comprising two types of economic interaction: (Kelly et al (2014), chapter 4 University expenditure and it's knock-on impact on the economy)

- Indirect effects: universities purchase goods and services from other sectors in order to support their own activity, thereby stimulating activity within those industries. The supplying industries also buy from other suppliers in order to fulfill university orders, and those suppliers in turn buy, so that there is a rippling-out effect.
- Induced effects: universities pay wages and salaries to employees, who in turn spend this income on consumer goods and services. This creates wage income for employees in other sectors, who also spend their income and so on, creating a ripple effect throughout the economy as a whole.

Table 1 overview of literature review related to international students' impact

	Channel	Effect	Country	Year	Author
Financial and economic effects	Cost and benefit effect of cross-border students mobility	Host country's benefit is significant from students' mobility in terms of value creation.	Germany, Netherlands, Austria, Poland, Switzerland and Spain	2010, 2011	Claudia and Markus (2013)
The number of employment by international students	Expenditure and job creation by non-UK students	7.37 billion pounds and 62,380 FTE (Full-time-Employment)	UK	2011, 2012	Kelly et al (2014)
	The number of International students in UK labor market	Around 5,000 international students enter the labor market (12% of 43,000 graduating students in 2014), International students account for approximately 70,000 jobs in London and 12 % of international students remain	UK	2014	Valentinem and Onslow-Cole (2015)
	Job seeking students from EU and non-EU	6,595 EU students seek employment and assume that there are similar number of students from non-EU	UK	2004, 2005	Vickers and Bekhradnia (2007)
Employability of international students	International graduates of 2009-10 (N=363)	253 - employed 67-undertaking further study 31-taking care of family 12-doing internship 14-being in another situation	Finland	2009, 2010	Shumilova et al(2012)

Government expenditure' on education and research sectors has increased the efficiency of education services and it results in higher output. However, that does not always have positive results. Daghbashyan (2011) analyzes cost efficiency of the HEI in Sweden to find factors by using pooled and panel data. It shows different efficiency levels of impact of HEIs with respect to the specific indicators of the university, staff and students characteristics. And the factors, which influence the cost efficiency, show different economic efficiency. Especially the specific indicators of the university present ambiguous or insignificant results from the models. Aghion et al (2009) study an exogenous shock to investment in education

and research type-education (professional and doctoral programs) how it affects to productivity growth in US. There is a positive externality from research type-education and four-year college-type education (including master degree programs) such as increasing patenting of inventions. EMSI (2014) estimates the impact of the public community colleges of the US to the national economy, and the returns of the investments in education for different groups, such as students, society and taxpayers. Furthermore, it analyzes the effects of community colleges' performance with respect to the amount of investment over years. The results show significant impact of the investment in colleges and the impact is always beneficial to the rates of return. The returns are always exceeding the costs and alternative investment opportunities when taking into account the employment factor. According to Psacharopoulos and Patrinos (2004), they follow human capital theories and calculate returns to investment in education sector. It presents the patterns of returns based on the comparison between private and public education. In the pattern, private (competitive) sectors are taken into account more than public (non-competitive) sectors.

Over the years, the Input-Output model has been used in empirical economic analysis. Valdkhani (2003) utilizes the Input-Output model for high employment industries in Australia. By measuring the magnitude of the employment elasticity sector wise, they show the key industries in terms of direct and indirect contribution to total employment. Tiganescu et al (2010) use the Input-output analysis to build educational model. They sum two types of models: production flows of input-output model and demographic flows of allocation model. As a result of the calculation, the education model shows that the effects of human inputs are involved with demographic system and the effects of economic inputs are involved in productive system. Kim, Lee (2011) analyze the impact of cost reduction in education and research to Korean economic structure with the VIO model. The VIO model is established by transforming the general Input-output model. By modifying the traditional Leontief model, the model calculates the rate of change of the education cost reduction in education and research sectors. It is observed that there is a growing effect of the cost reduction in the economic structure from 1980 to 1990 in Korea. During that time periods, the number of students changes is from 170.1 to 389.8 college students per 10,000 people. Those changes might be one of reasons for higher sensitivity to cost reduction in education and reduction sector. Liew (2003) uses the VIO model to study input equilibrium price changes with respect to output, income, and employment. With two groups (with wage rate change and without

wage rate change), the test shows that substitution effect of input price is significant for each time lag. Thus it is proven that use of price-sensitive multipliers is an efficient method to measure the impact of government spending.

The previous reports handle related impacts of international students and employment on economies and present the returns of investments in education and research sectors. For example, EMS (2012) collects general information about international students in Estonia. It notes that international students replace the decreasing number of local students in universities and they help to enhance the quality of education level and internationalization. However, they do not show sensitivity of the output with respect to the increased expenditure in education and research sectors. Since education and research investment can be an efficient policy in terms of output, it would be informative to measure the changes by expenditure shock. Also, it could be effective to have more international students and more foreign employment in Estonia. Furthermore, we can observe which industries can get more benefits from expenditure shock. The bigger number of students is not directly connected to the larger number of employment, however, that guarantees higher possibility for students to find a job and thus increases the number of employment. The positive effects of both factors can contribute to a higher elasticity of industry output.

3. Methodology

The changes of government expenditure in education and research sectors through price variations are evaluated in this paper with Input-output model. The input-output model analysis is an analytical method developed by Wassily Leontief.[2]However, it cannot analyze the effects of price or cost variations to certain industry. Thus, this study starts from the VIO model that was designed to back up the limit of the Leontief's model.[3] In the study, there are two variables added separately to the original form and employment variable is changed to incorporate foreign values. The modified equation by the author is becoming the following:

$$p_j x_j = \sum_{i=1}^{n} p_i x_{ij} + w_j L_j + r_j R_j + e_j E_j \qquad (1)$$

$$j = 1 \qquad p_1 x_1 = p_1 x_{11} + p_2 x_{21} + \cdots + p_n x_{n1} + w_1 L_1 + r_1 R_1 + e_1 E_1$$

$$j = 2 \qquad p_2 x_2 = p_1 x_{12} + p_2 x_{22} + \cdots + p_n x_{n2} + w_2 L_2 + r_2 R_2 + e_2 E_2$$

$$\vdots \qquad\qquad \vdots$$

$$j = n \qquad p_n x_n = p_1 x_{1n} + p_2 x_{2n} + \cdots + p_n x_{nn} + w_n L_n + r_n R_n + e_n L_n$$

- $p_i x_{ij}$ is the output from a product at basic level according to the product Input-output table.
- w_j is labor cost of the j-th industry,
- L_j is the number of foreign employees in the j-th industry,
- r_j is the labor cost of foreign researchers (both in profit and nonprofit industries) in the j-th industry,
- R_j is the number of foreign researchers (both in profit and nonprofit industries) in the j-th industry,
- e_j is the expenditure of international students in the j-th industry,
- E_j is the number of international students in the j-th industry.

The model consists of production side and consumption side. From the equation above, production and profit equations are derived for the profit maximization process. The production equation is formulated by transforming a Cobb-Douglas' production function into log-linear type:

$$\ln x_j = \alpha_{0j} + \sum_i \alpha_{ij} \ln x_{ij} + \sum_g \beta_{gj} \ln L_{gj} + \sum_k \gamma_{kj} \ln R_{kj} + \sum_m \delta_{mj} \ln E_{mj} \qquad (2)$$

[2] Wassily W. Leontief (1936) for more details
[3] Kim, HeonGoo, Lee, Namchul(2012) for more details

where x_j is the output of the sector j, x_{ij} is intermediate product of the sector i for the production in the sector j and R_{kj}, E_{mj}, L_{gj} are intermediate mediums of the education and research with foreign values and labor cost of sectors purchased by sector j. The profit function is,

$$p_j x_j = \sum_i p_i x_{ij} + \sum_g w_{gj} L_{gj} + \sum_k r_{kj} R_{kj} + \sum_m e_{mj} E_{mj}, \quad (3)$$

where the equation follows an assumption of zero profit, p_j is the industrial price of sector j, p_i is the industrial price of sector i and w_{gj}, r_{kj}, e_{mj} are expenditure on the education, research sectors and labor cost spent in sector j(g, k, m). The Lagrangian function of profit maximization with respect to a production function gives

$$\text{Max } \pi = \sum_j \left(p_j x_j - \sum_i p_i x_{ij} - \sum_g w_{gj} L_{gj} - \sum_k r_{kj} R_{kj} - \sum_m e_{mj} E_{mj} \right) +$$
$$\sum_j \lambda(\ln x_j - \alpha_{0j} - \sum_i \alpha_{ij} \ln x_{ij} - \sum_g \beta_{gj} \ln L_{gj} - \sum_k \gamma_{kj} \ln R_{kj} - \sum_m \delta_{mj} \ln E_{mj}), \quad (4)$$

This equation is assumed to be CES, therefore, it follows homogeneity condition.[4] The assumption is one of the conditions of Cobb-Douglas' production function. Through first-order condition of the Lagrangian equation for optimization process, we find out optimal values and they are below,

$$x_{ij} = \alpha_{ij} {}^{p_j x_j}/_{p_i}, L_{gj} = \beta_{gj} {}^{p_j x_j}/_{w_{gj}}, R_{kj} = \gamma_{kj} {}^{p_j x_j}/_{r_{kj}}, E_{mj} = \delta_{mj} {}^{p_j x_j}/_{e_{mj}}. \quad (5)$$

When we substitute x_{ij}, L_{gj}, R_{kj} and E_{mj} into the production function, we can define the price frontier equation,

$$\ln x_j = \alpha_{0j} + \sum_i \alpha_{ij} \ln x_{ij} + \sum_g \beta_{gj} \ln L_{gj} + \sum_k \gamma_{kj} \ln R_{kj} + \sum_m \delta_{mj} \ln E_{mj}$$
$$\vdots$$
$$\ln p = (I - A')^{-1} \left[\sum_g \beta_g \ln w_g + \sum_k \gamma_k \ln r_k + \sum_m \delta_m \ln e_j \right], \quad (6)$$

the price of industry j-m is affected, when the education (e_m) and the research (r_k)

[4] $Q = A\alpha^a \beta^b \gamma^c \delta^d$
$= A(t\alpha)^a (t\beta)^b (t\gamma)^c (t\delta)^d = A\alpha^a \beta^b \gamma^c \delta^d t^{a+b+c+d} = Qt$
where $a + b + c + d = 1$, when Q is CES,

expenditures change with the condition that the sectors' prices and labor costs remain constant. Changes of the costs influence the values of education and research input, which are considered as exogenous factors. In this study, we estimate the possible change of the output for three time periods by comparing the rate of changes (dx/x).[5]

In consumption side, the calculation follows the same process in other research[6] The one difference this study has is to use national income as $Y = \sum_j \sum_g w_{gj} L_{gj} + \sum_j \sum_k r_{kj} R_{kj} + \sum_j \sum_m e_{mj} E_{mj}$. Thus, the optimal level of consumption c_i is,

$$c_i = \frac{\tau_i E}{p_i} = \tau_i \theta(\sum_g \beta_g \sum_j p_j x_j + \sum_k \gamma_k \sum_j p_j x_j + \sum_m \delta_m \sum_j p_j x_j)/p_i \quad (7)$$

Next, we formulate the Input-output equation with the production side and the consumption side. When we substitute the values into the Leontief's input-output function with extra value c_i, we get

$$x_i = \sum_j x_{ij} + c_i + f_i$$

$$= \sum_j \alpha_{ij} \left(\frac{p_j}{p_i}\right) x_j + c_i + f_i$$

$$= \sum_j \alpha_{ij} \left(\frac{p_j}{p_i}\right) x_j + \frac{\tau_i \theta \left(\sum_g \beta_g \sum_j p_j x_j + \sum_k \gamma_k \sum_j p_j x_j + \sum_m \delta_m \sum_j p_j x_j\right)}{p_i} + f_i \quad (8)$$

We can change it to a matrix form, the technology coefficient matrix $A(\alpha_{ij})$ can be denoted as Λ:

$$\Lambda = \begin{bmatrix} \alpha_{11} + \theta\tau_1\beta_1\gamma_1\delta_1 & \cdots & \alpha_{1n} + \theta\tau_1\beta_n\gamma_n\delta_n \\ \vdots & \ddots & \vdots \\ \alpha_{n1} + \theta\tau_n\beta_1\gamma_1\delta_1 & \cdots & \alpha_{nn} + \theta\tau_n\beta_n\gamma_n\delta_n \end{bmatrix}.$$

Thus, the accounting balance equation will become

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[5] $x = (I - \hat{p}^{-1}A\hat{p}^{-1})^{-1}F = \hat{p}^{-1}(I - A)^{-1}\hat{p}F$,

when we have total differentiation,

$d\hat{p}x + \hat{p}dx - \left(A(d\hat{p}x + \hat{p}ddx)\right) = d\hat{p}f + \hat{p}df$,

$dx = \hat{p}^{-1}(I - A)^{-1}(d\hat{p}f - \hat{p}df) - \hat{p}^{-1}d\hat{p}x$

$= \hat{p}^{-1}(I - A)^{-1}\hat{p}(\hat{p}^{-1}d\hat{p}f + df)^{-1} - \hat{p}^{-1}d\hat{p}x$

$= \hat{p}^{-1}(I - A)^{-1}\hat{p}\left(\hat{f}dlnp + df\right) - \hat{x}dlnp$

$= [\hat{p}^{-1}\left(I - A\right)^{-1}\hat{p}\hat{f} - \hat{x}]dlnp + \hat{p}^{-1}(I - A)^{-1}\hat{p}df$

$= [\hat{p}^{-1}\left(I - A\right)^{-1}\hat{p}\hat{f} - \hat{x}](I - A')^{-1}\left[\sum_g \beta_g lnw_g + \sum_k \gamma_k lnr_k + \sum_m \delta_m lne_{mj}\right] + \hat{p}^{-1}(I - A)^{-1}\hat{p}df$

[6] Kim and Lee (2012), the calculation is from (3.11) to (3.14) in 2.VIO model, consumption side.

$$x = \hat{p}^{-1}\,\Lambda\hat{p}x + f, \tag{9}$$

where $\hat{p}$ is a n-dimensional diagonal matrix of p_j. We can also express the equation in a form,

$$x = \hat{p}^{-1}(I - \Lambda)^{-1}\hat{p}f. \tag{10}$$

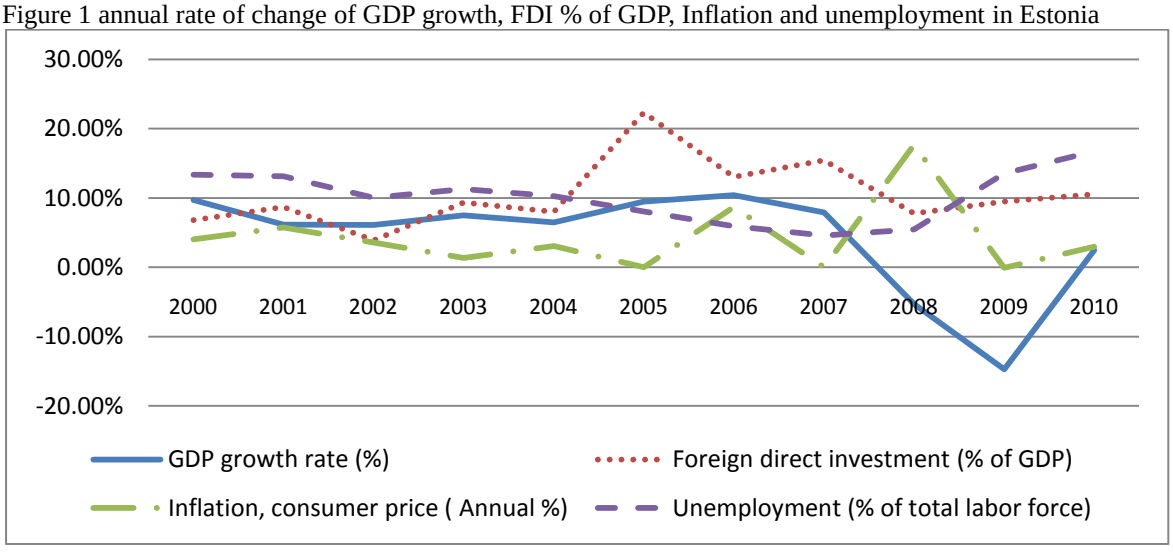
The equation above shows that price p affects the output x, which is not seeable in the Leontief's model. Therefore, the VIO model can be better than a traditional Input-output model and is very useful method for additional estimations.

4. Data

In the methodology, we derived a modified model from the traditional Leontief's model. Also it was proven that the changes of input prices in other variables influence the prices in other industries. To measure the rate of change of output by expenditure shock, we need background information about Estonian economic status, such as employment and unemployment with tertiary education, the number of students with higher education degrees, the size of the whole population and Estonian government expenditure over the years. The input-output tables for 2000, 2005 and 2010 are the main database for the study. Furthermore, the data is used for the VIO model and it shows the simulation of output changes through variation of input price in education and research sectors. The rates of change of the outputs in each sector with foreign values are derived by summing the production and consumption equations in the VIO model. Thus we can observe which industry has higher sensitivity to expenditure shock

In the study, there are some missing data, which can affect the unexpected result. But they are either removed or replaced by the estimation. Input-output data are from 2000, 2005 and 2010, since this data is available in Statistics Estonia. In addition, since 2008 there was an economic crisis in Europe and Estonia is still recovering from it as we can see from figure 1. Mačys (2012) shows that economic values such as GDP, FDI, unemployment rate and national budget deficit get severe negative values because of the economic crisis in 2008.

Figure 1 annual rate of change of GDP growth, FDI % of GDP, Inflation and unemployment in Estonia



Source: International Monetary Fund, International Financial Statistics and data files

Economy suffered the most in 2009 and 2010 was the second worst year during the 6 years of

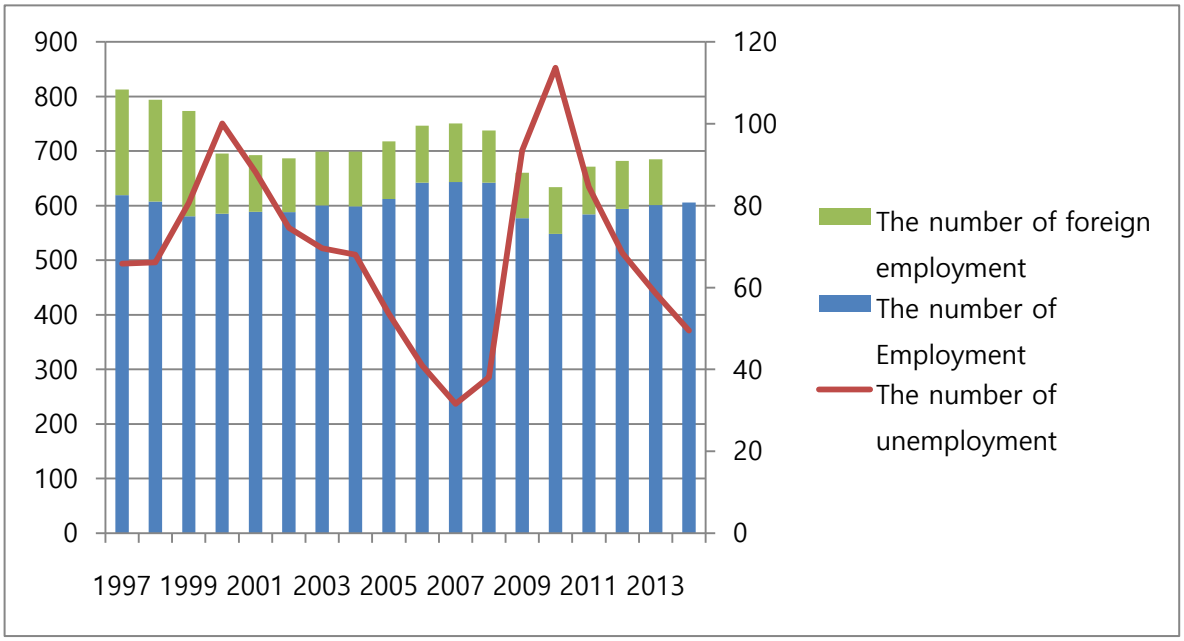
crisis. Krugman (2012) states that Estonia had severe recession from 2008 and they did not recover until 2012.

According to methodology, since the model handles data only from 2000, 2005 and 2010 without taking into account the effect by economic crisis, the impact of economic crisis can be a bias to the result. Especially the impact of expenditure shock might be weaker in 2010. Among industries, there can be less elasticity in service sectors because service sectors in tertiary industry are susceptible to a change of economic situation. Therefore, the economic crisis indicators might offset the positive impact of foreign students and employment.

5. Employment, students enrolled and expenditure dynamics in Estonia from 1997 to 2014

Here is general Estonian information related to students, employment and expenditure. In common, there are decreasing phases after 2000 and 2008 because of economic recessions. As we can see from methodology part, we use the number of foreign students and employment as an input and expenditure as an input price in the modified equation. Data below give an idea about how they have changed from 1997 to 2014. Moreover, we take into account those for an interpretation of simulation about expenditure shock to economic structure. Thus, this part helps to understand the state of students, employment and expenditure in Estonia and what factors the simulation model use for.

Figure 2 the number of total employment, foreign employment (left scale) and unemployment (right scale) in Estonia (unit: thousand)

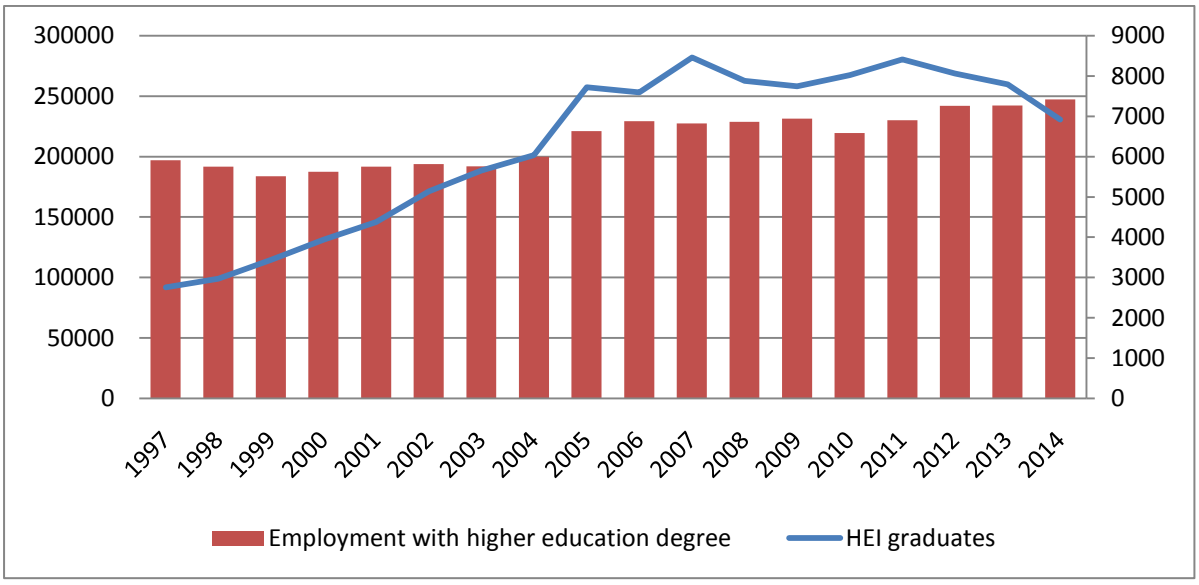


Source: Eurostat, Statistics Estonia: NAL0011: Employment by domestic concept

From figure 2, there are the numbers of foreign employment, total employment and unemployment. The number of total employment is 600,000 in average from 1997 to 2014. Among them, 81.81% of employed people have had tertiary education. About foreign employment in Estonia, before 2000, it shows the higher number of foreign employment than other years. It is because there was ambiguity between Russians living in Estonia as foreigners and Estonian citizens. The majority of them are former case and they play a role to increase the number of foreign employment. Puur (2000) states that foreign-origin labor force

increased rapidly in 1990s. The majority of their employment sectors were electricity, gas, steam and air conditioning supply and mining and quarrying. That was a result from the Soviet development strategy for Estonia. They are second generation of immigrants from Soviet era but nationalities of those immigrants became clear by the new legislations. Thus, there is sudden decline on 2000. But, there only have been little fluctuation and stayed in average 96500 from 2000. Afterward, there were 2 economic recessions in the world: Euro zone crisis in 2000 and automotive industry crisis causing global financial downturn. We can see that there were sudden changes during the two periods and the number of employment decreased. Schleicher (2012) reports that Estonian unemployment rate was a lot higher than OECD average level in the beginning of 2000s but it converged to the average over the years. Second economic crisis stroke the world financial state and Estonia was one of the highly impacted countries. Especially unemployment rate was far over the average in OECD. Comparing the number of unemployment in 2010 with the one in 2014 recent year, it has declined to almost half of the number (113,628 to 49,515)

Figure 3 the number of employment with higher education degree (left) and HEIs graduates (right scale) in Estonia

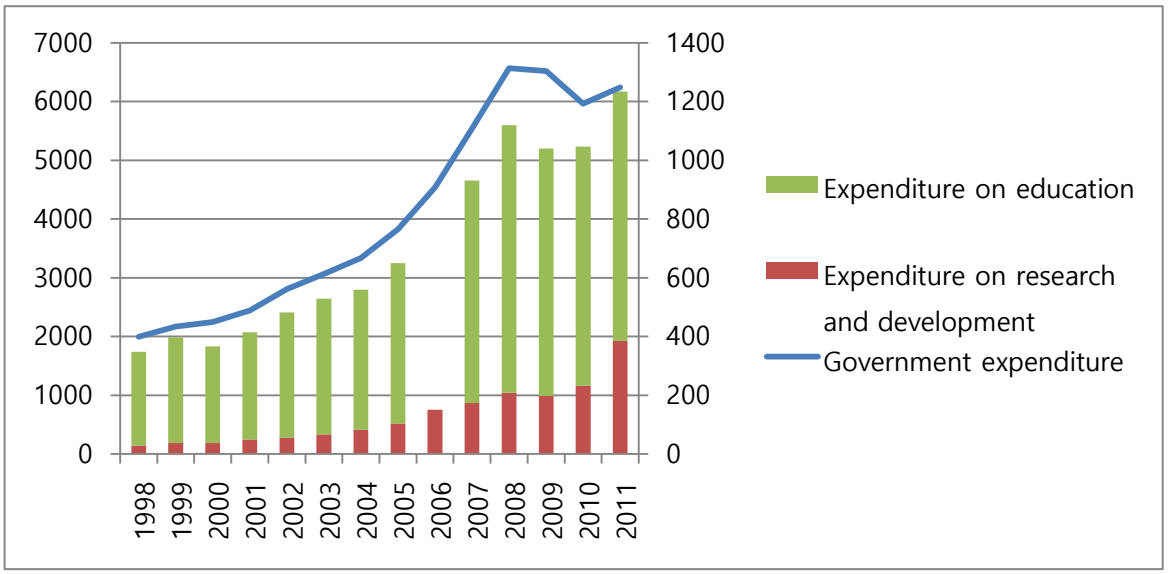


Source: Eurostat, Statistics Estonia: ESG09: Graduates by level of education and year, ML111: Labour status of population aged 15-74 by Educational level

From figure 3, the number of students graduated and employment increased together from 2000 to 2007. But they show different trends from 2008. The number of employment with higher education degree has been increasing until 2009 and it decreased shortly due to the impact of the economic crisis in 2010. Afterward, it started increasing again. The number of

students graduated from HEIs has been increasing almost three times from 1997 to 2011 and it strated decreasing after that period. However, before 2011, there are decreased number of students in 2006 and 2008. The ratio of international students out of whole number of students is 1 - 2 % during 2000s which is far less than ratio 20% in average in other countries such as US, UK and Australia according to Okk (2015)

Figure 4 total government expenditure (left scale) and education, research expenditure (right scale) in Estonia (unit: million euros)

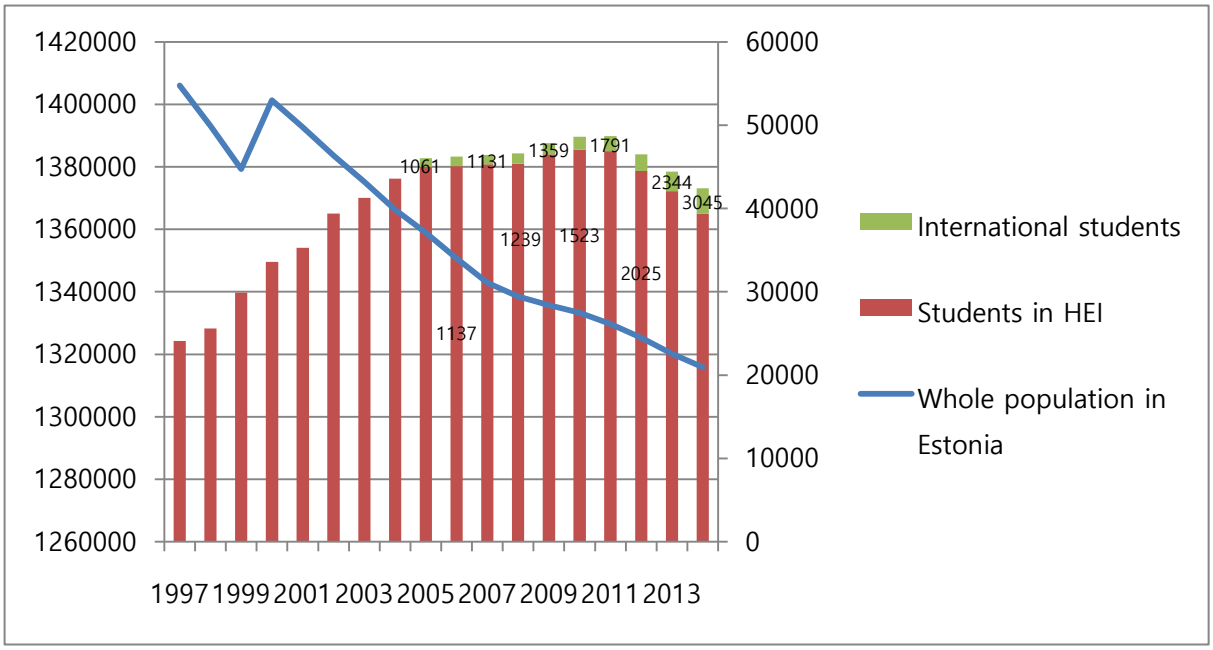


Source: Eurostat, Statistics Estonia: RD052: Research and development expenditures and their financing by, World bank: World development indicators.

The amount of total government expenditure has increased from 1998 except when there was the economic crisis on 2010. Also, government expenditure on education and research and development have increased. There is relatively more expenditure on education than R&D sector from 1998. However, when comparing growing effects between education and research sectors, we can observe that both sectors have higher growing effect, especially from 2010 to 2011. Schleicher (2012) presents in the OECD report, expenditure on education has been increasing significantly in Estonia from 2000. It is marked that expenditure level is a little higher than OECD average. However, Okk (2015) reports Estonia do not have good state in research sector since there are too many centers of excellence. For instance, about smart specialization clusters, Estonia have five or ten such clusters for cooperative economic research activities. Moreover, according to Okk (2015), internal audit conducted by the ministry of education and research shows that those sectors undergo financial deficit for sustainability to manage. This impact is relevant to the model in this study. Since the model takes into account the labor cost and the number of researchers as variables, decreased

financial asset can be connected to the less labor cost and researchers employed. Therefore, the elasticity of expenditure shock to research sector might become weaker.

Figure 5 the total number of students, international students (right side) and population (left side) in Estonia



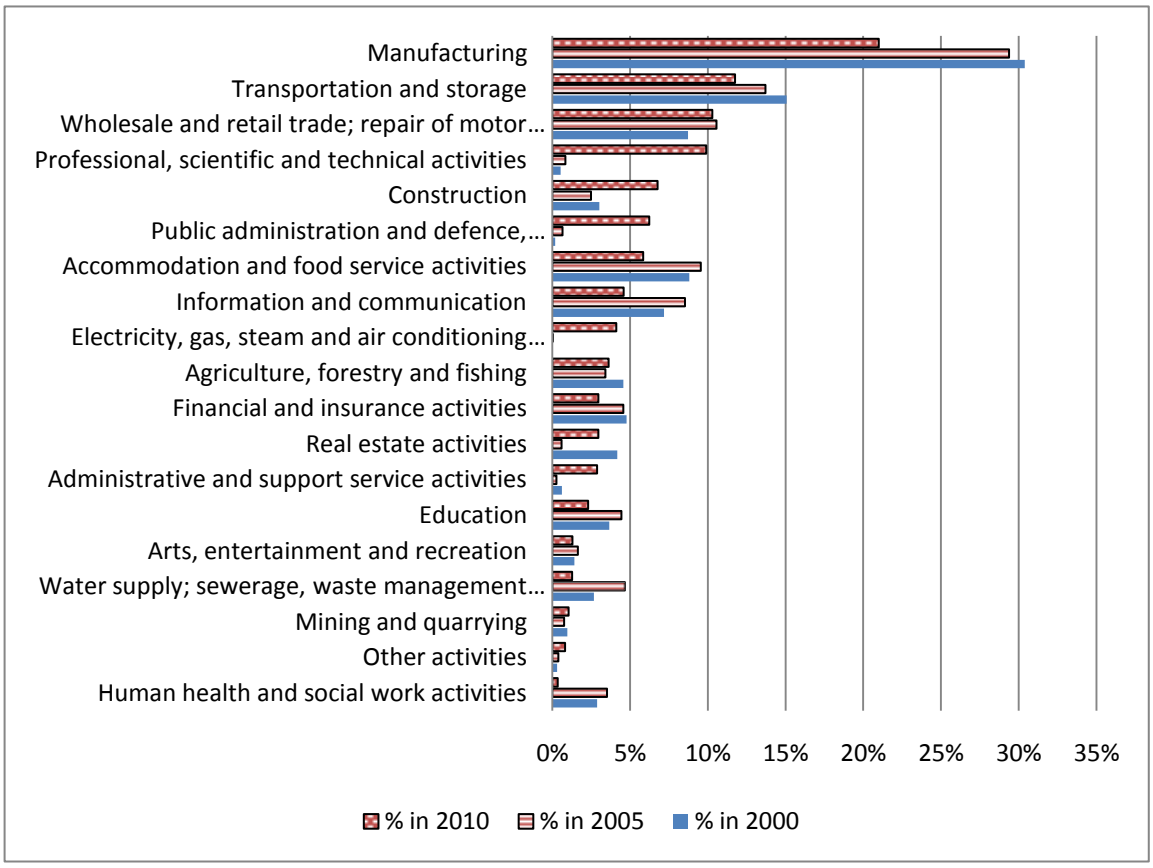
Source: Statistics Estonia: ESG03: Enrolment in formal education by type and level of education, ES309: Students in Estonia by country, territory, year and country of, PO021: Population by sex, year and age group

Figure 5 shows that total population is decreasing phase in Estonia. Ainsaar and Maripuu (2008) present that population of Estonia has decreased from 1990. According to various forecasts, decreasing trend will have remained in spite of longer life expectancy. However, one positive fact is that Estonia is one of the countries which has higher immigration rate in Europe. Also the interest for higher education is increasing. Schleicher (2012) present from the OECD report, tertiary attainment in Estonia is high: 35% of 25-64 years old and 31% for the OECD average. From figure 5, we can observe that population of Estonia has been decreasing but it increased once from 1999 to 2000. In contrast, the number of student had increased but from 2011, it started to decrease. When it comes to the number of international students, Statistic Estonia offers the data from 2005 onward and it has been increasing with 10% average rate but it is especially faster in 2014 (30%). The ratio of international students in Estonia accounts for 2% in 2005 and up to 8 % in 2014.

6. The Input-output estimates without expenditure shock in 2000, 2005 and 2010

This part presents the results of the estimation without expenditure shock for the years 2000, 2005 and 2010. It explains the input-output table without the expenditure shock to the education and research sectors. We can observe how much the industrial output originally contribute to the economy and how the outputs of industries change. Later, we compare the original Input-output data to the result from the simulation of expenditure shock to education and research sectors. Thus, we can study the relationship between output improvement and elasticity to expenditure shock.

Figure 6 each industry's ratio of contribution to total output

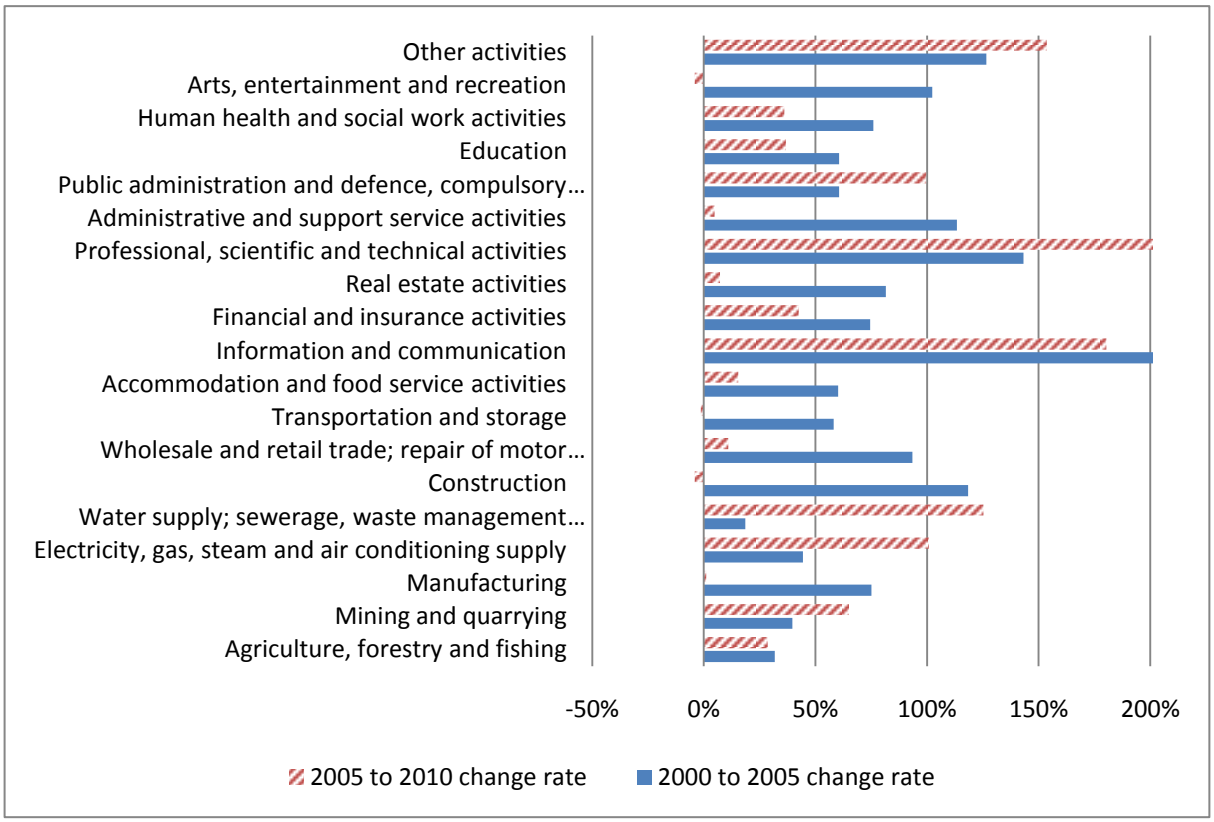


Source: author's calculation based on Statistics Estonia: NAT0004 symmetric product by product input-output table at basic

Figure 6, aggregated manufacturing sector takes the most shares in Estonian total output for three time periods since the sector includes entire outputs from all kinds of manufacturing industries. However, during three time periods, the ratio of output in manufacturing sector decreased which means the majority of manufacturing industries' outputs became smaller. There are expanding industries such as professional, scientific and technical activities,

administrative and support service activities and public administration and defense, compulsory social security sectors in 2010. In other word, there is a trend transition from the secondary to tertiary industries as we can expect how the world changes. More detailed result from the input-output table, contrary to aggregated manufacturing industries, some industries such as public administration and defense, compulsory social security, administrative and support service activities and electricity, gas, steam, air conditioning supply sectors have had more shares for three time periods. Generally there is no big change to the ratio of industries in Estonian economy. Remarkable changes are in professional, scientific and technical activities, electricity, gas, steam, air conditioning supply and public administration and defense, compulsory social security but mining and quarrying sector is not so important industry anymore and it went down to the lowest share industry in 2010. About education and research sectors (professional, scientific and technical activities), education sector does not show the big fluctuation and research sector show few output during 2000 and 2005 but there is outstanding improvement in 2010.

Figure 7 changing rate of output in each industry for three time periods



Source: author's calculation based on Statistics Estonia: NAT0004 symmetric product by product input-output table at basic

Also we can observe how much output changes in industries for three time periods. Figure 7 shows the output changes from 2000 to 2005 to 2010. All sectors' outputs increased from 2000 to 2005 but some of industries' (arts, entertainment and recreation, transportation and storage and construction sectors) outputs decreased from 2005 to 2010. Professional, scientific and technical activities sector shows an outstanding increasing rate. And information and communication sector highly increase continuously from 2000 to 2005 to 2010. Jauhiainen (2011) reports Estonian economy has caught up with OECD countries' industrial development over the years. The share of labor intensive industries (the primary industries) decreases since there is enhancement on R&D sector such as high-technology in industries. Thus the share of labor increases in sectors which are related to industries required advanced skills. Total rates of output changes at basic price have increased but there is higher rate of change from 2000 to 2005 than the one from 2005 to 2010.

7. Expenditure shock to education and research sectors

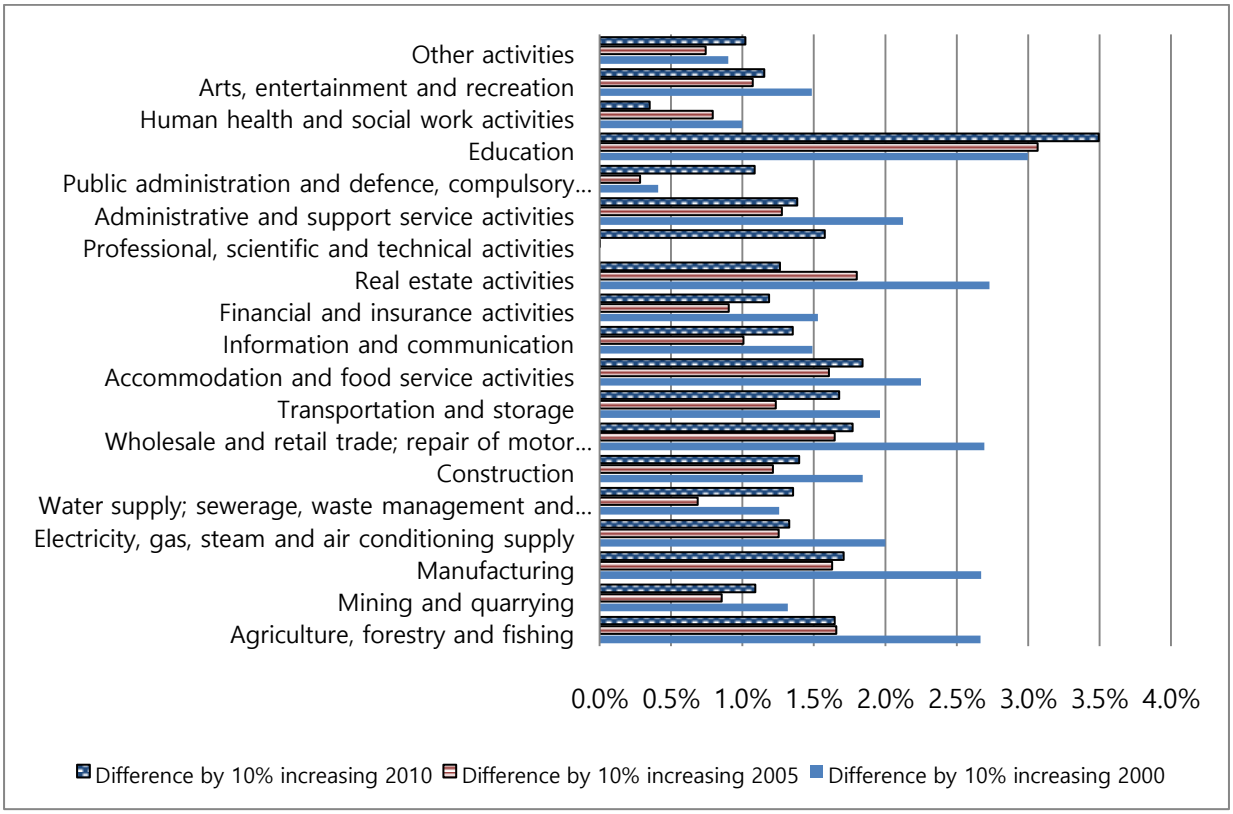
Here are results from the simulation. We can observe how industries react to expenditure shock on education and research sectors. The simulation is based on the equation (8) : Expenditure shock to education and research sectors

$$\sum_j \alpha_{ij} \left(\frac{p_j}{p_i}\right) x_j + \frac{\tau_i \theta \left(\sum_g \beta_g \sum_j p_j x_j + \sum_k \gamma_k \sum_j p_j x_j + \sum_m \delta_m \sum_j p_j x_j\right)}{p_i} + f_i,$$

- α_{ij} is input coefficient of domestic output.
- τ_i is share of how much it is spent in sector i from consumption expenditure.
- θ is aggregate household consumption out of labor incomes.
- p_i is CPI (assume that 2015 has the index 100).

We have the optimal output derived from profit maximization function from the production and utility maximization function from consumer's behavior. By summation of both sides, we can find a connection between price and output. To know the economic structure variation by expenditure shock to education and research sectors, we can give a shock on price of inputs related to education and research industries.

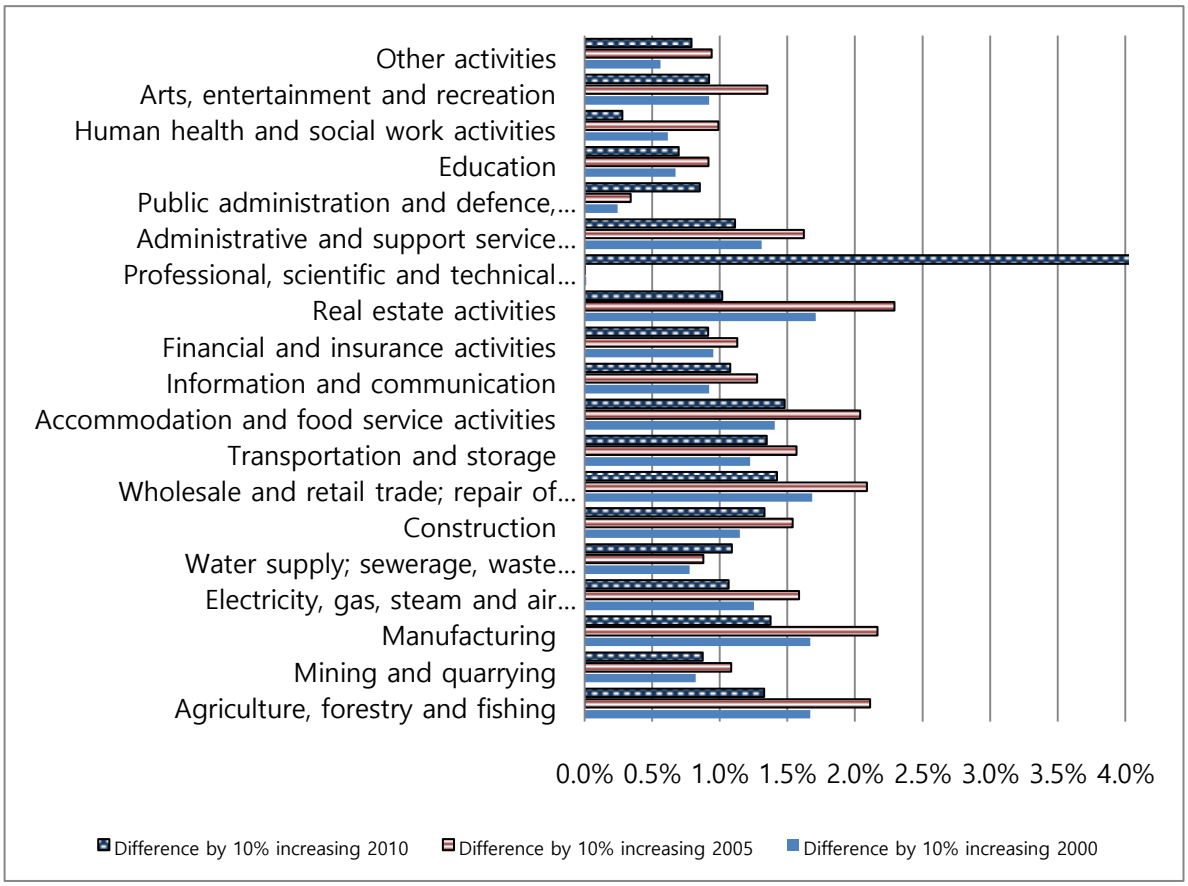
Figure 8 output variations by 10% increased expenditure on education sector



Source: author's calculation

When we add 10 % extra expenditure on education sector, we can see the output changes in each sector from figure 8. In average, each industry has around 1% to 1.5% of changes but in 2000, industries have more than 2%. About total changes for three time periods, the change in 2000 has the highest variation except education, professional, scientific and technical activities and public administration and defense, compulsory social security sectors. Between 2005 and 2010, we can observe that there are generally more sensitive industries in 2010 than the ones in 2005 but few industries in 2005 have higher changing rates. For example there are agriculture, forestry and fishing, real estate activities, human health and social work activities sectors. Education sector naturally shows the highest increasing rate and about research sector, there is only remarkable change in 2010. But on 2000, 2005, we can see that research sector is not likely to be responded by Education expenditure support. Among 3 periods, for education and research sectors, in 2010, there is the most change in total by 3.495%, 3.067% in 2005 and 2.999% in 2005 in education sectors and 1,577% in 2010, 0.0017% in 2005 and 0.0001% in 2000 in research sector.

Figure 9 output variations by 10% increased expenditure on research sector



Source: author's calculation

For the case of expenditure shock to research sector, the outputs show relatively different trend as we can see from figure 9. Contrary to the case of expenditure shock to education cost, it has the highest variation in 2005. However, research sector in 2010 has the higher changes same as the rate of change in the education case. Research sector itself also reasonably is changed the most by extra research expenditure only for 8.3712% in 2010. Other time periods have almost no sensitivity to the increased research cost: 0.011% rate of change in 2000 and 0,002% in 2005. In average, they fluctuate near 1 % line. More than half of industries have variation rate over 2% line in 2005. Comparing output change rate between 2000 and 2010, they have similar rates of change in each industry. For the case of professional, scientific and technical activities and public administration and defense, compulsory social security sectors, there are relatively higher changes in 2010 than the ones in 2005. On the contrary to the trend, there are higher variations to real estate activities, administrative and support service activities sectors in 2005 than in 2010.

Table 2 yearly elasticity of expenditure shock on education sector

Sector	2000	2005	2010
Agriculture, forestry and fishing	0.00267	0.00166	0.00165
Mining and quarrying	0.00132	0.00085	0.00109
Manufacturing	0.00267	0.00163	0.00171
Electricity, gas, steam and air conditioning supply	0.00200	0.00125	0.00133
Water supply; sewerage, waste management and remediation activities	0.00126	0.00069	0.00136
Construction	0.00184	0.00121	0.00140
Wholesale and retail trade; repair of motor vehicles and motorcycles	0.00269	0.00165	0.00177
Transportation and storage	0.00196	0.00123	0.00168
Accommodation and food service activities	0.00225	0.00161	0.00184
Information and communication	0.00149	0.00101	0.00135
Financial and insurance activities	0.00153	0.00090	0.00119
Real estate activities	0.00273	0.00180	0.00126
Professional, scientific and technical activities	0.00000	0.00000	0.00158
Administrative and support service activities	0.00212	0.00128	0.00138
Public administration and defense, compulsory social security	0.00041	0.00028	0.00109
Education	0.00300	0.00307	0.00349
Human health and social work activities	0.00100	0.00079	0.00035
Arts, entertainment and recreation	0.00149	0.00107	0.00115

Other activities	0.00090	0.00074	0.00102
Total	0.00267	0.00166	0.00165

Source: author's calculation

Through the output elasticity in 2000, 2005 and 2010 from table 2 and 3, we can find out the changes in each sectors resulting from expenditure shock to education and research separately. Thus, we can interpret the elasticity as the sensitivity of the industrial structure to the expenditure shock. The changes in output of all sectors are derived from domestic industrial input, foreign research and education input price changes. As we can see from figure 7 that education and research sectors are not the industries themselves generating high outcomes and that fact remain same with extra foreign values. Following industries show the higher elasticity to expenditure shock on education sector: education, real estate activities, wholesale and retail trade; repair of motor vehicles and motorcycles, manufacturing and transportation and storage. For the case of increased research expenditure, professional, scientific and technical activities, real estate activities, accommodation and food service activities, aggregated manufacturing and transportation and storage are sensitive to the expenditure shock during 2000 and 2005. But in 2010, they show different result compared to other years. For example, professional, scientific and technical activities, transportation and storage, and construction are highly responded to expenditure shock. These trends can be interpreted as the fact which industries are elastic to education and research expenditure. In total, real estate activities, wholesale and retail trade, manufacturing and accommodation and food service activities industries show overall sensitive to expenditure shock to education and research sectors.

Table 3 yearly elasticity of expenditure shock on research sector

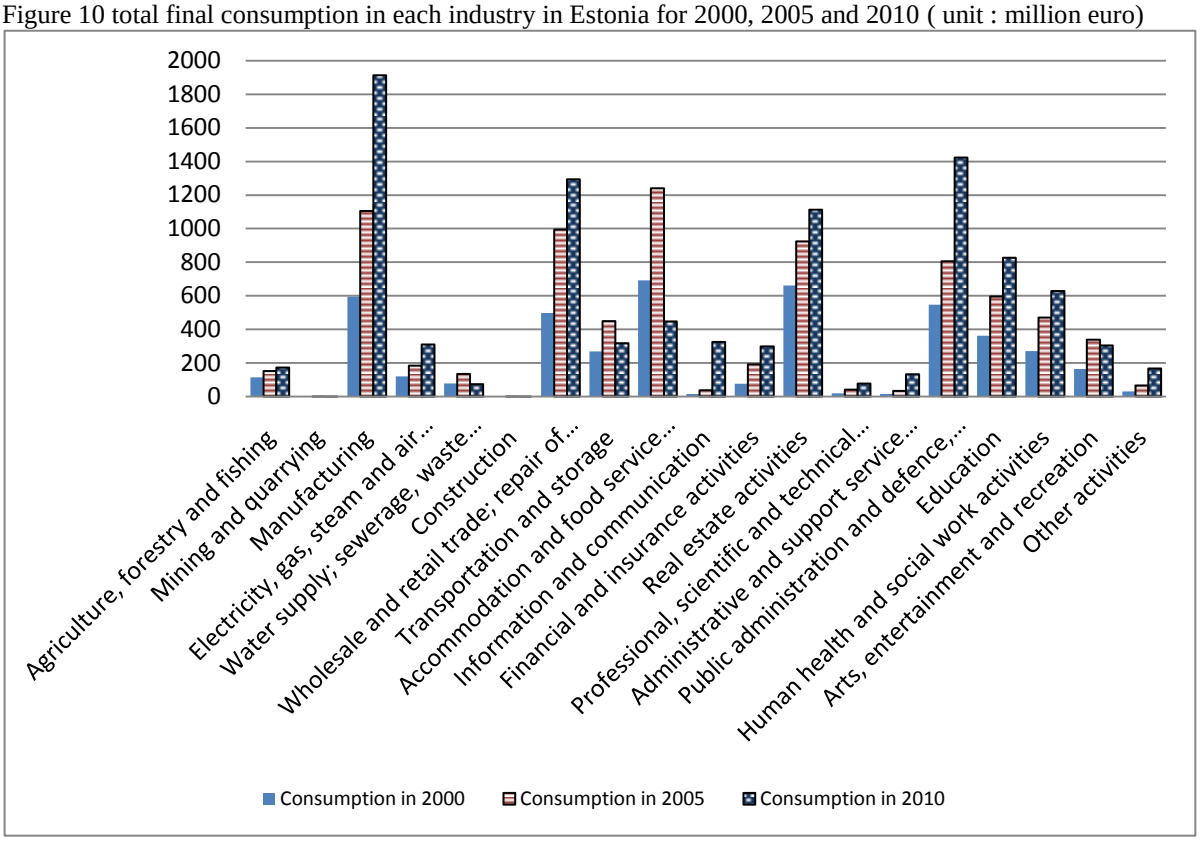
Sector	2000	2005	2010
Agriculture, forestry and fishing	0.00167	0.00211	0.00133
Mining and quarrying	0.00082	0.00108	0.00088
Manufacturing	0.00167	0.00217	0.00138
Electricity, gas, steam and air conditioning supply	0.00125	0.00159	0.00107
Water supply; sewerage, waste management and remediation activities	0.00078	0.00088	0.00109
Construction	0.00115	0.00154	0.00133
Wholesale and retail trade; repair of motor vehicles and motorcycles	0.00168	0.00209	0.00142
Transportation and storage	0.00123	0.00157	0.00135
Accommodation and food service activities	0.00141	0.00204	0.00148

Information and communication	0.00092	0.00128	0.00108
Financial and insurance activities	0.00095	0.00113	0.00091
Real estate activities	0.00171	0.00229	0.00102
Professional, scientific and technical activities	0.00001	0.00000	0.00837
Administrative and support service activities	0.00131	0.00162	0.00111
Public administration and defense, compulsory social security	0.00024	0.00034	0.00085
Education	0.00067	0.00092	0.00070
Human health and social work activities	0.00061	0.00099	0.00028
Arts, entertainment and recreation	0.00092	0.00135	0.00092
Other activities	0.00056	0.00094	0.00079
Total	0.00167	0.00211	0.00133

Source: author's calculation

Comparing to the original output in figure 6, we can observe that some sectors do not generate great output in the state without expenditure shock but it shows higher elasticity to expenditure shock. For example, there are public administration and defense, compulsory social security, administrative and support service activities, professional, scientific and technical activities, construction, water supply; sewerage, waste management and remediation activities, electricity, gas, steam and air conditioning supply, mining and quarrying and agriculture, forestry and fishing sectors. When we check industries which are highly sensitive to expenditure shock, we can predict that there is another channel that gives an impact to the output. According to methodology, we can observe that there is a consumption value in the model. Since consumption part gets also affected by expenditure shock, some industries in the result show greater elasticity to expenditure shock more than the expectation. For example, there are industries: real estate activities, wholesale and retail trade, manufacturing and agriculture, forestry and fishing. Products in those sectors are highly consumed as we can see figure 10. It shows the final consumption by all subjects. For example they include household, NPISH (Households and non-profit institution serving households) and government. In conclusion, consumption is another channel to give an impact to the output by expenditure shock. And then, we can explain that why there are some industries showing higher rate of elasticity such as real estate activities, wholesale and retail trade, manufacturing and agriculture, forestry and fishing.

Figure 10 total final consumption in each industry in Estonia for 2000, 2005 and 2010 (unit : million euro)



Source: Statistics Estonia: NAT0004 symmetric product by product input-output table at basic

To observe how the industrial elasticity changed between 2000 and 2010, we can compare the changing rates of elasticity during 2000 and 2010. Figure 11, 12 show the changes separately with respect to expenditure shock to education and research sectors. We can see that the most of industries show decreased elasticity by education cost variation but there are relatively more industries with increased elasticity by research cost variation. In other word, the growth rate of sensitivity of output in Estonian economic structure with foreign values to increased education and research cost has decreased. The exceptions for that trend are education, public administration and defense, compulsory social security and professional, scientific and technical activities sectors. Those sectors' outputs have positive response to increased education cost. For the case of research, 10 industries have increased the elasticity of variation on research cost such as other activities, public administration and defense, compulsory social security, professional, scientific and technical activities, information and communication, accommodation and food service activities, transportation and storage, construction, water supply, sewerage, waste management and remediation activities and mining and quarrying. In conclusion, there shows remarkable change rates of elasticity in public administration and defense, compulsory social security, research sectors by both

education and research expenditure. We can expect better performance by expenditure shock to education and research sectors from those industries in 2010

Figure 11 changes of elasticity to 10 % increased expenditure on education sector from 2000 to 2010

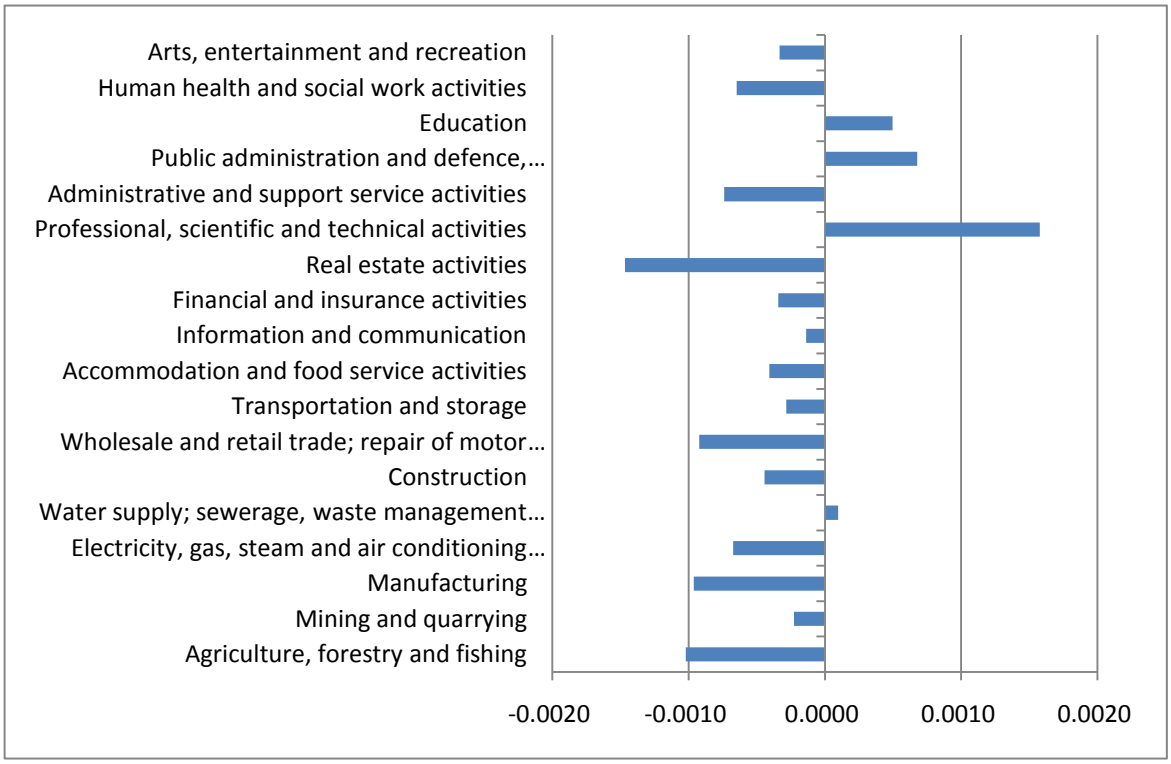
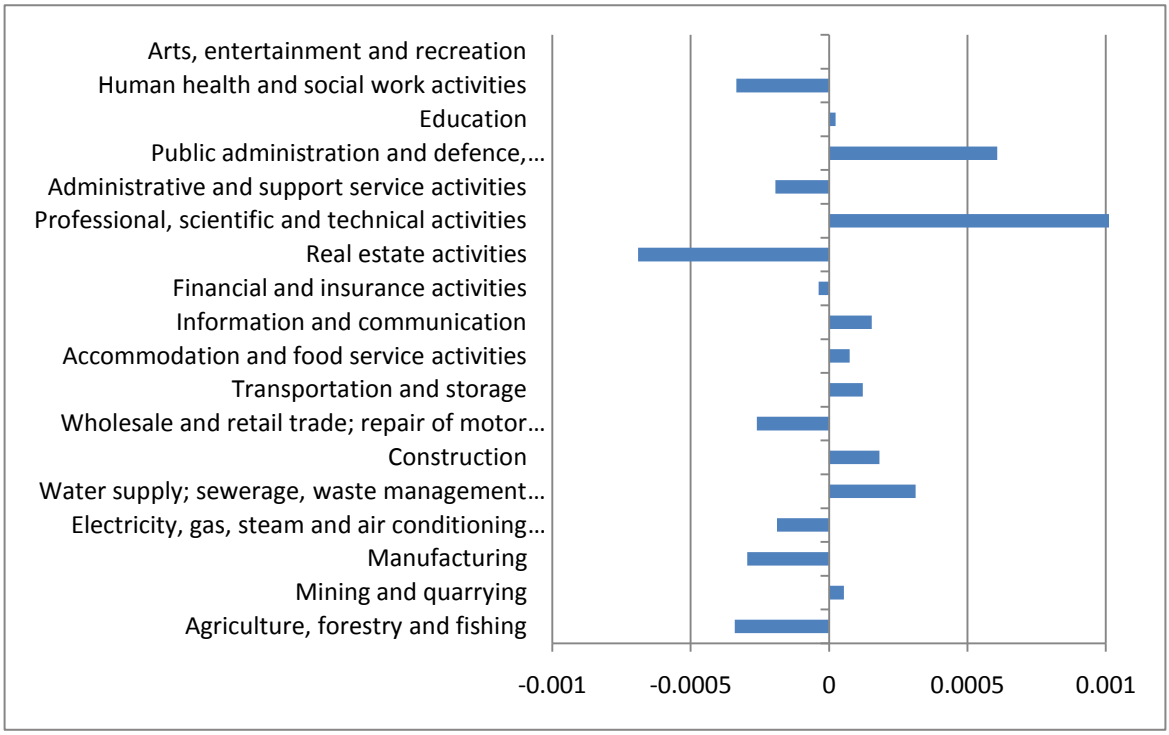


Figure 12 changes of elasticity to 10 % increased expenditure on research sector from 2000 to 2010



Source: author's calculation

Table 4 outputs and ratios of primary, secondary and tertiary industries by 10% increased education and research expenditure.

	Industry	Output	Ratio	Education	Ratio	Research	Ratio
2000	Primary Industry	820,277	1,1013%	842,117	1,1028%	833,939	1,1024%
	Secondary Industry	44012,8	59,0911%	45181,1	59,1674%	44743,5	59,1449%
	Tertiary Industry	29649,9	39,8076%	30338,3	39,7298%	30073,2	39,7527%
	Total	74483	1	76361,5	1	75650,6	1
2005	Primary Industry	930,153	0,6369%	945,531	0,6374%	949,753	0,6374%
	Secondary Industry	87024,1	59,5921%	88434,5	59,6174%	88899,5	59,6589%
	Tertiary Industry	58078,8	39,7710%	58956,6	39,7451%	59163,7	39,7037%
	Total	146033	1	148337	1	149013	1
2010	Primary Industry	1744,11	0,8637%	1772,8	0,8634%	1767,25	0,8611%
	Secondary Industry	128889	63,8252%	131074	63,8373%	130648	63,6578%
	Tertiary Industry	71307,4	35,3111%	72478,2	35,2993%	72819,5	35,4811%
	Total	201941	1	205325	1	205235	1

Source: author's calculation

When we look through the structure change according to the ratios of industries from 2000 to 2010 in Estonia, the basic frame of economic structure has not changed. Secondary industry accounts for more than half share of economy and tertiary, primary industry are following. Over the years, total amount of optimal output has increased but ratios of tertiary industry in each year, it slightly decreased from 2000 to 2005, 39.81% to 39.77% but decreased more in 2010, 35.231%. When we compare the optimal output in response to 10% increased expenditure on education and research sectors, all levels of industries accompany with better condition by increased education and research service. Comparing the economic structure trend, it has stayed the same that secondary industries take the most share from total output. In terms of change of ratio, in 2000, primary and secondary industries increase by the 10% more expenditure on education but tertiary industries decreases. By the investment on research sector, the structure changes are the same as by changes from the investment on education. In 2005, the primary and secondary industries increases and tertiary industry decreases by education sector. For the case of increased expenditure on research sector, it shows the same impact as the ones by education cost. In 2010, secondary industry only shows the increasing ratio as a result of increased education cost and primary, tertiary industries

decrease. We can interpret the education and research service contribute to primary and secondary industries more than contribution to tertiary industry which means Estonia had a higher necessity to adopt development of education and research in primary and secondary industries in 2000. In 2005, still the impact of education and research cost contribute more to secondary industry as it is observed that the ratio of secondary industry keeps increasing by expenditure shock to education and research costs. In 2010, it shows similar impact to economic structure by education cost change in other years but it changes differently and ratio of tertiary industry increases by research cost as it is expected that importance of tertiary industry gets greater. Kilvits (2014) presents that the state of manufacturing industries became stronger in Estonia after the economic crisis since there exists less number of inefficient enterprises and lower wrong investment. As a result, there are higher technological level, better organization of work, higher value added and productivity and enhanced value chain system. Therefore, the importance of secondary and tertiary industry becomes stronger.

In total, the expenditure shock to education and research sectors show the impact to economic structure differently. Also, each year has different sensitivity to expenditure shock. What we can observe is that the contribution of tertiary industry gets greater as well as the sensitivity of tertiary industry becomes higher to investment. Moreover, research sector is closely related to the tertiary industry over the years as we can check the results from figure 12 and table 4. The impact to tertiary industry by the expenditure shock to research sector has increased and it shows the higher improvement in 2010. Furthermore, the elasticity to expenditure shock increased when comparing between 2000 and 2010. The most of those industries showing positive rate of change of elasticity are included in tertiary industry. Therefore, the policy investing more on research sector can be a good strategy for the better performance from tertiary industry since we can observe the structural change of economy that the tertiary industry becomes more important.

8. Conclusion

This report presents the economic structure with extra variables such as output from foreign research and international education variables. We analyze the sensitivity of changes by increased expenditure in education and research sectors for three time years, 2000, 2005 and 2010. The variables consist of foreign people having higher education degrees. Based on the input-output table, variations in the economic structure are calculated by changes of input price. By using the VIO model, the study covers the weakness of traditional analysis of Leontief's matrix. Thus it is implied that the change of input price is not an independent factor but can influence on input prices in other industries.

Since it is observed that the number of international students and foreign employment with tertiary education degrees has been increasing, there is an expectation that the impacts of economic structure by expenditure shock in education and research sectors can be greater. Sensitivities of the impact of expenditure shock generally show similar trend in 2000, 2005 and 2010. There is the highest elasticity responding to increased expenditure in education sector in 2000 and about increased expenditure on research sector, is the highest in 2005. When comparing the elasticity in total between education and research sectors to expenditure shock, it shows higher elasticity to education sector than research sector. The industries showing higher sensitivity to expenditure shock are real estate activity in 2000, 2005 and accommodation and food service in 2010. On average, following 4 industries show higher sensitivity by expenditure shock to both education and research sectors: real estate activity, accommodation and food service activities, aggregated manufacturing and wholesale and retail trade. Those seem to be not industries directly related to education and research services. However, according to the model, it can be interpreted that a higher consumption level considered as one of reasons why they show the higher elasticity to expenditure shock since it is shown that consumptions are higher in those industries. For the case of growth rate of elasticity from 2000 to 2010, public administration and defense, compulsory social security and research sectors become more elastic.

The large number of students and foreign employment does not guarantee the economic growth but there is higher possibility for economic development with certain level of students and adequate amount of expenditure. According to Okk(2015), the ratio of international students in well-known universities is 15 to 25% international students and the case of foreign academic staff is 10 to 20%. Comparing the situation of Estonia to those, it is far less

than the average ratio. Okk (2015) also compare the cost for education and research sector in 2014/2015. There are 700 million Euros in University of Helsinki, 630 million euros in 2013 in Stockholm Karolinska Institute and Aalto University is 400 million euros. Combined budget of all Estonian Higher Education and Research institutions is 395 million Euros. There lacks of expenditure comparing to education and research institutions near Estonia.

The world's economic structure is changing. The main industrial structure moves from primary industry to secondary and tertiary industries. Following the trend, we also can observe that there shows a similar trend in Estonia. Moreover, international students and employees' mobility gets higher and the ratio of foreign population increases. It is shown that there has been a remarkable change of the number of international student and employment in Estonia. Their contributions to Estonian economy become greater and they can be considered one of factors to change the economic structure. Therefore, based on the result from the simulation, increasing the government expenditure on education and research sectors is able to change the economic structure toward more secondary and tertiary industries.

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CONTRIBUTION OF INTERNATIONAL STUDENTS AND EMPLOYMENT TO ESTONIAN ECONOMIC STRUCTURE: AN ANALYSIS OF HYPOTHETICAL EXPENDITURE SHOCK ON RESEARCH AND EDUCATION

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