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DISCUSSIONPAPER

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Abstract

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Diabetes affects 10% of the adult population in Finland. This study is the first to estimate the impact of diabetes on the Finnish economy using a computable general equilibrium (CGE) model. The results show that the medical costs of treating diabetes together with the lost labour inputs of diabetic patients reduces long-run Finnish GDP by over one percent. Reduced labour supply has the greater negative effect on the economy relative to health care costs of diabetes. Furthermore, aggregate investment, household consumption and foreign trade are also negatively affected. Government consumption is higher by two percent. Industry level results indicate that labour intensive sectors are most affected. The paper goes on to examine the economic effects of three diabetes policy measures: a diabetes prevention program, a sugar tax, and combined package of prevention program and sugar tax.

Keywords: CGE analysis, diabetes, chronic diseases, health care costs, productivity costs, economic effects of prevention programs, health economics

Tiivistelmä

Kaarina Reini. Diabetes Causes Substantial Losses for the Finnish Economy [Diabeteksesta mittavat menetykset Suomen kansantaloudelle]. Terveyden ja hyvinvoinnin laitos (THL). Työpaperi 14/2013. 26 sivua. Helsinki 2013.
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Suomessa aikuisväestöstä 10 prosentilla on diabetes. Tämä on ensimmäinen tutkimus, jossa diabeteksen kansantaloudellisia vaikutuksia arvioidaan yleisen tasapainon mallilla (CGE). Tutkimuksen tulokset osoittavat, että diabetekseen liittyvät hoitokulut ja diabetespotilaiden menetetty työpanos laskevat Suomen bruttokansantuotetta pitkällä aikavälillä yli prosentin. Menetetyn työpanoksen vaikutus talouteen on suurempi kuin diabeteksen terveydenhoitokulujen. Myös kokonaisinvestoinnit, kotitalouksien kulutus ja ulkomaan kauppa vähenevät. Julkinen kulutus nousee puolestaan kahdella prosentilla. Toimialakohtaiset tulokset osoittavat työvoimavaltaisten toimialojen kärsivän eniten. Tässä tutkimuksessa selvitetään myös kolmen diabetesta ehkäisevän politiikkatoimen taloudellisia vaikutuksia. Nämä toimet ovat diabeteksen ehkäisyohjelma, sokerivero ja näiden edellisten yhdistelmä.

Avainsanat: CGE analyysi, diabetes, krooniset sairaudet, terveydenhuollon kulut, tuottavuuskustannukset, ehkäisyohjelmien taloudelliset vaikutukset, terveystaloustiede

Contents

Introduction

“Man may be the captain of his fate, but he is also the victim of his blood sugar.”
Wilfred G. Oakley (1905–68)

Health is wealth. This is evident as the public health care costs continue to rise. Recent report estimates that the public health care costs of the European Union (EU) were on average 9.0% of GDP (OECD 2012a). This share as well as health care spending as a proportion of total government spending is projected to rise in the future. In most EU countries, health care spending varies between 12% and 15% of government expenses. (Przywara, 2010).

The growing cost of public health care stems from two interconnected trends: the ageing of the population, and the parallel rise in chronic disease. At the same time, improvements in medical technologies also play a role. Among the age-related chronic diseases, diabetes is reaching epidemic proportions. The current global prevalence of diabetes among adults is estimated at 8.3% (366 million) and projected to rise to 9.9% (552 million) by 2030 (IDF, 2011). In Europe, there are 35 million adult diabetes patients and this number is projected to increase by 23% to 43 million by 2030 (IDF, 2011, OECD 2012b). In the U.S., 8.3% of the population (25.8 million) have diabetes (CDC, 2011). This percentage contains both the diagnosed (18.8 million) and an estimate of undiagnosed patients (7.0 million) across all age groups.

The costs of diabetes are significant. In 2011, the global health care costs of diabetes were estimated to be at least US$465 billion (IDF, 2011). In Europe, 89 billion euros were spent on diabetes health care costs (OECD, 2012b). In the U.S., the national economic burden of diabetes was estimated to be US$218 billion in 2007 (Dall et al., 2010). This estimate includes US$153 billion in direct medical costs, and US$65 billion in reduced productivity.

The prevalence rates and costs of diabetes are unlikely to decline in the future. Forecasts for the prevalence of diabetes may even be underestimates, if the prevalence of obesity continues to rise along with other contributing factors such as aging, urbanization, and physical inactivity.

Considering the size of the public health burden of diabetes alone, decision makers are likely to have an interest in the broader economy-wide effects of the disease. Evaluation of the net benefits of policy interventions and diabetes prevention programs are important in the context of limited health care resources. This study provides estimates of the economic impact of diabetes on Finland. Finland is an interesting case example because of high diabetes prevalence and the availability of good data (Jarvala et al., 2010).

The outline of this paper is as follows. First, the major channels through which a chronic disease like diabetes affects economic activity are presented. Second, the available data about diabetes in Finland is reviewed. Third, the analytical framework and the simulation model are introduced. Fourth, model scenarios and simulation inputs are described. The paper concludes with modeling results and a discussion of their implications.

The impact of diabetes on economic activity

Poor health, in this case via diabetes, can have macroeconomic impact via increased health expenditures, labour and productivity losses and reduced investment in human and physical capital formation. In assessing the welfare effects of diabetes, it is important to note that, if not for the disease, households would prefer not to be consumers of diabetes-related health expenditures. Therefore, there is some justification for investigating impact on consumption of non-health related goods and services. The overall macroeconomic impacts of diabetes will be the product of the aggregate effects of poor health outcomes across different economic agents, and the effects on a number of variables related to economic welfare, namely, non-health consumption possibilities, leisure time and health status. These effects are explained more below. (Ruger et al., 2006, WHO, 2009.)

Poor health may change the consumption and labour supply decisions of households. The consumption of health-related goods and services are likely to increase at the expense of other goods and services. Changes in health status may also influence labour supply. Workers who are ill may reduce their hours of work relative to their potential, and may generate further lost working hours by requiring care givers to stay at home. (WHO, 2009.)

At the firm level, the effects of poor health are likely to be felt in the form of reductions in productivity and efficiency. This can negatively affect firm's earnings in the short-run, and scale in the long-run. Productive capacity is not determined solely by employment, and hence losses from work absence or illness may be compensated to some extent. However, to do so, firms may need to maintain some excess capacity and devote a part of their operating activities to health related expenditures and benefits, thus raising costs. (WHO, 2009.)

The poor health of government employees may reduce the output of public goods and services and increase their production costs. In essence, this is identical to the situation faced by the private firm as outlined earlier. However, from the perspective of government, poor health at the population-wide level is of greater concern. For given policy settings, government may find that it must increase spending on healthcare and social security payments, even as tax revenues decrease due to falling productivity and participation. In the long run, the re-weighting of public expenditures towards health may decrease possibilities to promote both human capital formation through spending on education, and new business opportunities through spending on research and development. Such changes in the composition of public spending may reduce future consumption possibilities. (WHO, 2009.)

The channels via which poor health, and in this example diabetes, have economic impacts are summarized in the following diagram.

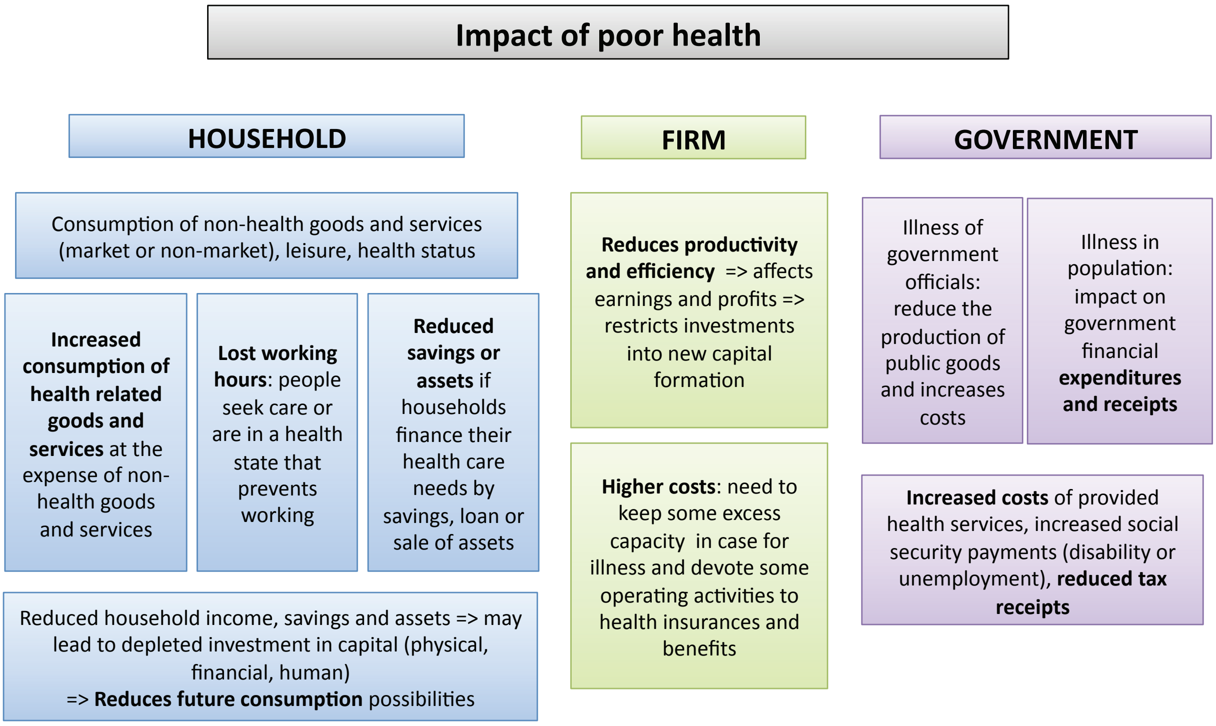

Figure 1. The channels for economic impact of poor health. Diagram is based on the WHO guide (WHO 2009).

Diabetes in Finland

The Finnish prevalence of diabetes is 10%

Finland is small country with a population of about 5.4 million. Its health care sector is challenged by the significant prevalence of diabetes together with its increasing incidence rates (Figure 2.). There were nearly a quarter of a million non-insulin dependent diabetic patients in 2007 (Sund and Koski, 2009). However, the Finnish Diabetes Association estimates that the actual number of patients is likely to be even higher, as 200,000 people have type 2 diabetes without knowing it (FDA, 2010). Diabetes thus affects approximately 10% of the adult population in Finland. The costs of diabetes have been estimated to constitute about 10-15% of the total costs of Finnish health care (DEHKO, 2009). Of these costs, about two thirds are due to expenditures related to long term diabetes complications.

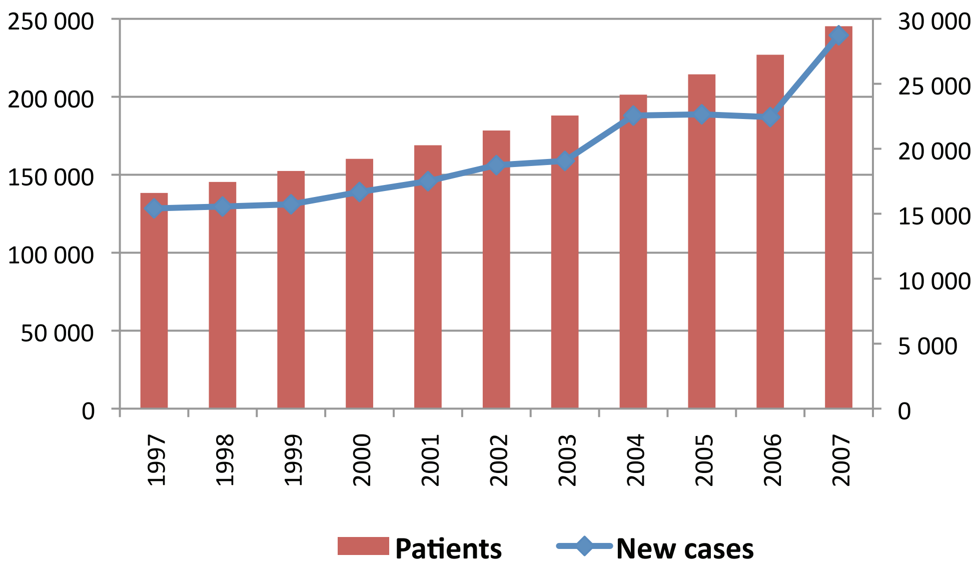

Figure 2. The number of non-insulin dependent diabetes patients (left axis) in Finland and the number of new cases (right axis) (Sund and Koski, 2009).

A unique diabetes prevention program

Finland was the first country to initiate an extensive national programme against type 2 diabetes -DEHKO (Development Programme for the Prevention and Care of Diabetes) - launched in 2000 (FDA, 2010). The programme consists of three parts: the primary prevention of type 2 diabetes, the development of diabetes care, and support for self-care of people with diabetes. The program's primary aim is to reduce the expensive complications of diabetes, such as retinopathy, neuropathy and nephropathy.

Under the DEHKO programme, a special project, FIN-D2D, was trialled over 2003-2008 for the prevention of type 2 diabetes (FDA, 2010). The measures of the FIN-D2D project are based on scientific studies that have demonstrated lifestyle interventions that reduce the risk of diabetes (Tuomilehto et al., 2001, Lindström et al., 2003). The Finnish three year study showed that intensive diet and exercise counselling can reduce the risk of diabetes by 58% compared to a control group (Tuomilehto et al., 2001).

Finnish researchers have also performed follow-up studies demonstrating that the type 2 diabetes prevention programmes have also worked in “real life” conditions (Absetz et al., 2007, Absetz et al., 2009).

The aim of FIN-D2D is to test the feasibility of a diabetes prevention programme on a larger scale (FDA, 2010). The project was implemented in five hospital districts which together cover 1.5 million Finns, or nearly 30 % of the total population. The project also includes the evaluation of the effectiveness and cost-effectiveness of the prevention program. Currently, a follow-up project to FIN-D2D is in progress. It supports the goal of establishing a type 2 diabetes prevention programme as a permanent health care measure throughout Finland.

The costs of diabetes in Finland (CoDiF) in 1998-2007 have been studied as part of DEHKO (DEHKO, 2009). The CoDiF study estimated that in 2007, health care costs of diabetic patients were 1.3 billion euros, of which 832.6 million were additional costs due to diabetes (Jarvala et al., 2010). Diabetes care consumed nearly 9 percent of the total health care budget. During the ten year study period, health care costs of diabetic patients increased annually on average by 6.2%. The number of diabetic patients grew annually on average by 4.7%. For the year 2007, CoDiF estimated the productivity costs to be 1.33 billion euro of which 962 million euro was due to premature retirement and 317 million euro was due to early deaths. The total cost of sick leave was estimated to be 55 million euro in 2007.

Finland has been a world leader in its systematic approach to addressing type 2 diabetes. From this perspective, Finland is an interesting case to study the economy-wide impact of diabetes. Detailed data about the diabetes health care costs together with information about the number of patients by age and gender is available (FDA, 2010). Furthermore, the type 2 diabetes prevention programmes have been trialled in Finland and thus the estimates about the success rates of prevention programme are valid for the Finnish population (Tuomilehto et al., 2001, Lindström et al., 2003, Absetz et al., 2007, Absetz et al., 2009). The Finnish example could provide other countries with both a clinically and economically tested framework for reducing the costs of diabetes.

A CGE assessment of the economy wide impact of diabetes and its prevention

The model used in this application is a static CGE model of the Finnish economy based on theory of the ORANI-G model. With a static CGE model the changes in the economy can be analysed either for a short-run or long-run time period. As the model itself is atemporal, the time dimension is created by certain assumptions in the closure of the model. In the short-run, capital stocks are assumed to be unaffected by the economic shock under investigations. In the long-run, capital stocks are allowed to adjust to economic shocks, with rates of return held exogenous. The ORANI-G model, its underlying principles and the model's database structure are well documented (Dixon et al., 1982, Horridge, 2003, ORANI-G, 2013). At present, the ORANI model has been adapted for over 20 countries (ORANI-G, 2013).

In the CGE model used in this application, the system of equations contains theory describing the behaviour of the various agents described in Figure 3 (Horridge, 2003). The industries face a nested production technology. Constant elasticity of substitution (CES) functions describe substitution possibilities between domestic and imported intermediates, and between different types of primary factor. At the top nest, composite intermediates and a primary factor composite are combined according to industry-specific Leontief (fixed proportions) functions. Separability assumptions also govern the composition of industry output. In choosing between inputs, industries are assumed to behave in cost-minimising way. Constant elasticity of transformation (CET) functions are employed to transform industry-specific activity into commodity-specific outputs destined for the local and export markets. In deciding on the nature of their product transformation across commodities and markets, industries are assumed to behave in a revenue-maximising way. In general, commodity markets are assumed to clear and to be competitive. Imported and domestic commodities are treated as imperfect substitutes using the CES assumption of Armington.

Investors are assumed to minimize the cost of producing new units of industry-specific capital. Decisions on the quantity of new capital to construct in each industry are based on expected rates of return. A single representative household is assumed to maximise a Klein-Rubin utility function subject to a budget constraint. Commodity-specific government demands can either be assumed to be exogenous or determined via an indexing relationship with private consumption. Commodity-specific export volumes are inversely related to foreign-currency prices.

The database of the model represents the Finnish economy for the year 2007. It was compiled from national supply and use tables, information on investment by industry, and data on employment and wages by occupation and industry. The main data source was the national statistical office Statistics Finland. The database has 71 industries and commodities and 11 different occupation groups. Household expenditure elasticities were adapted from the GTAP database. GEMPACK software package was used to solve the model and analyze the results (Pearson, 1988, GEMPACK, 2013).

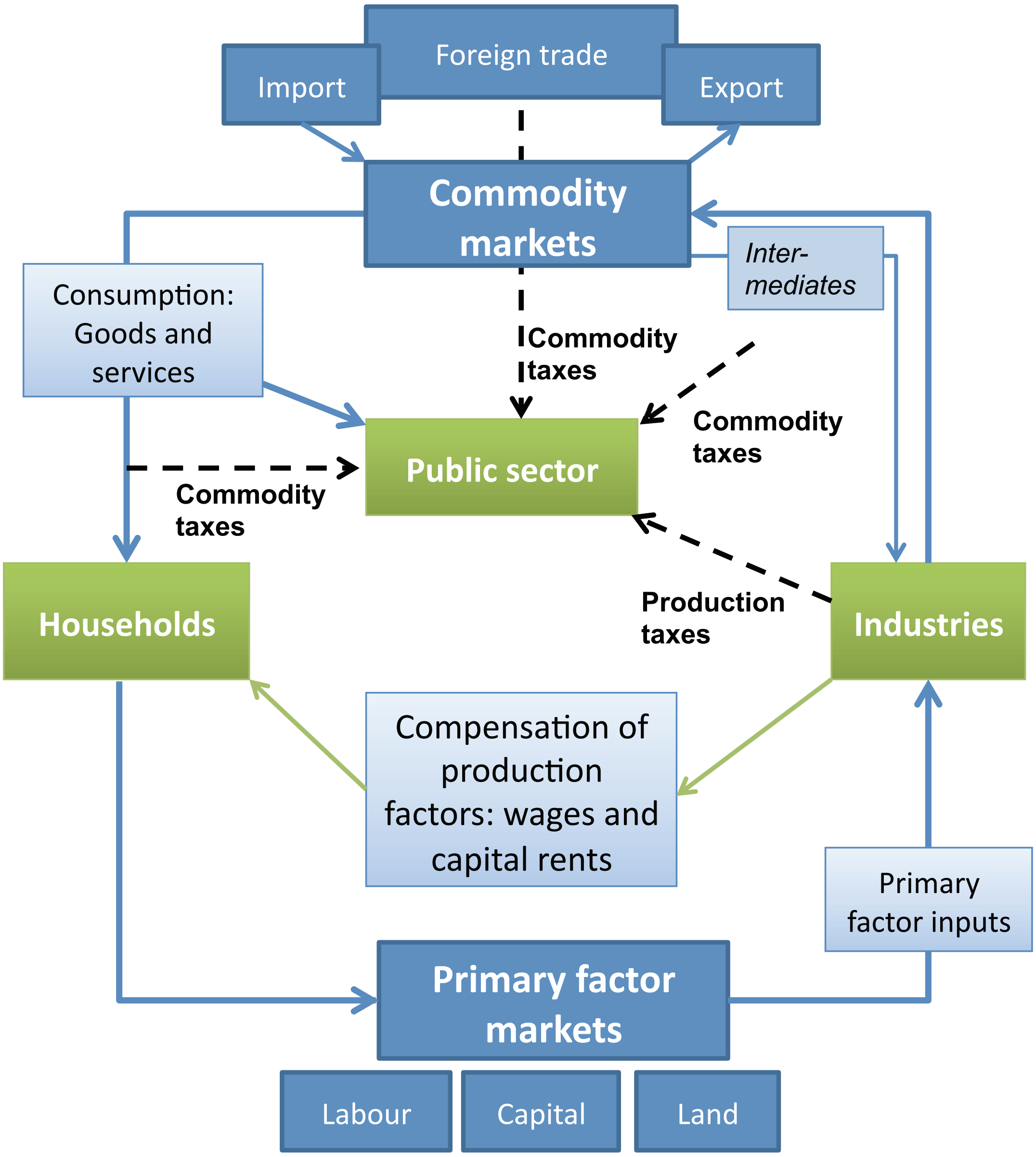

Figure 3. Schematic presentation of the economic circulation in a CGE model.

Scenarios and simulation design

Five different scenarios are examined (Table 1). The first scenario is based on the detailed diabetes cost analysis of year 2007. In the other scenarios, the effects of alternative future developments are simulated. In year 2007 and "no action" simulations, both the health care and labour supply shock are run simultaneously. Results are shown for both shocks independently as well as the total effect. In the other simulations, the effects of different policy measures are examined. Namely, approximately five years following the intervention, how the policies have affected diabetes health care costs and what are the economic effects of this compared to a "no action" counterfactual. The three policy scenarios examine the effects of diabetes prevention program, sugar tax and both measures together.

The data that have been used as an input to the model simulations are summarized in the table below. Jarvala and collegues have published a detailed study on the development of diabetes health care costs for a 10 year period, 1998-2007 (Jarvala et al., 2010). This data is used to simulate the effects of the year 2007 situation and a "no action" scenario. For the policy measures, the data from other published studies of the Finnish DEHKO program (Tuomilehto et al., 2001, Lindström et al., 2003) are used. Kotakorpi and collegues (2011) provided estimates of the effect of a sugar tax on diabetes costs.

Table 1. The simulation scenarios.

Scenarios / year	Assumptions	Reference
Situation in 2007	Health care costs of diabetes as of year 2007. Only additional costs due to diabetes taken into account.	Jarvala *et al.* 2010
No action /+ 5 years	Health care costs of diabetes continue to rise on average 6.2% annually as during 1998-2007. Costs of early retirement continue to rise on average 4.1% as during 1998-2007.	Jarvala *et al.* 2010
Prevention program /+ 5 years	Lifestyle counseling program reduces diabetes risk by 58%.	Tuomilehto *et al.* 2001, Lindström *et al.* 2003
Sugar tax /+ 5 years	Sugar tax reduces the health care costs of diabetes by 6% in the long run.	Kotakorpi *et al.* 2011
Prevention program and sugar tax / + 5 years	Diabetes risk reduced by 58% and diabetes health care costs by 6%.	Tuomilehto *et al.* 2001, Lindström *et al.* 2003, Kotakorpi *et al.* 2011

The simulation shocks are presented in the following table (Table 2). They have been calculated as a percentage of the total public health care costs and the value of total labour inputs. Only the costs of early retirement are regarded as productivity losses caused by diabetes. This is studied by changing the employment in the simulations. The health care costs of diabetes are simulated by changing the government demand for the health care commodity. In the year 2007 situation and "no action" scenario, the shocks are introduced so as to show what the economy would look like without diabetes, that is, the health care shocks are set as negative shocks and the employment shocks are set as positive shocks (Table 2). The results are then recalculated to show the loss to the Finnish economy caused by diabetes. In the policy scenario simulations only the health care consumption is changed. The health care shocks are calculated as difference to the year 2007 situation and the shocks are positive as the health care consumption is increasing over time (Table 3).

Table 2. The shocks of the year 2007 situation and "no action" scenario: The effect of diabetes to health care consumption and labour supply.

Scenarios / year	Diabetes costs, million euro		Simulation shocks, %	
Comparison of year 2007 and after 5 years	Health care	Early retirement	Public health care expenditures	Labour supply
Situation in 2007	833	658	- 9.97 %	0.77 %
No action /+ 5 years	1125	833	-13.47 %	0.94 %

Table 3. The shocks of the policy simulations: The effect of various policy measures to diabetes health care costs.

Scenarios / year	Diabetes costs, million euro		Simulation shocks, %
Policy simulations	Health care	Difference to year 2007	Public health care expenditures
Prevention program /+ 5 years	947	114	1.4%
Sugar tax /+ 5 years	1057	224	2.7 %
Prevention program and sugar tax /+ 5 years	890	57	0.7%
No action /+ 5 years	1125	292	3.5%

Closure

The closure of the model determines which variables are resolved by the model (the endogenous variables) and which are given by the user (the exogenous variables). In these simulations, a standard long run closure was used. The study time period (five years following an intervention) is assumed to be long enough that investors have sufficient time to adjust capital stocks, and workers have sufficient time to change wage bargains to leave the unemployment rate unchanged from its counterfactual value. The latter assumption is implemented by determining aggregate employment exogenously and the real wage endogenously. The productivity loss caused by diabetes is simulated by shocking the level of employment. This approach assumes that it would be difficult to find replacement workers from among those outside the labour force or unemployed.

On the expenditure side of GDP, government demand is otherwise fixed except that the level of health care spending is allowed to change. The ratio of the balance of trade to GDP is also exogenous. This determining net exports, and with government demand exogenous, private consumption spending is required to be endogenous. Industry-specific investment (and with it, economy-wide aggregate investment) is determined endogenously via an indexing relationship with industry-specific capital stocks.

The nominal exchange rate is set as the numeraire. This is consistent with the European Central Bank controlling monetary policy in the Euro area. Movements in Finland's real exchange rate are manifested through changes in the domestic Finnish price level

Results

Table 4 presents the simulation results for the effects of diabetes in 2007. The simulation results indicate that reduced labour supply has the greater negative effect on the economy relative to health care costs. The diabetes situation in 2007 provides a good reference point for analyzing the simulation results of the other scenarios. All results are reported as percentage change and summarized in the following tables (Table 4 and 5).

The diabetes burden reduces Finnish GDP by over one percent, relative to what it would otherwise have been in the absence of diabetes. Most of the loss, at nearly 0.8 percent, arises from reduced labour supply. The effect of elevated health care costs on real GDP is less than half of the impact of reduced labour supply. Household consumption is lower by over two percent. In the case of consumption, the effects of both shocks (at approximately -1 percent) are quite similar. Government consumption increases by more than two percent relative to what it would otherwise have been. This reflects the increase in health care costs, with other components of government consumption spending held unchanged from what they would otherwise have been.

Table 4. The simulation results of the year 2007 situation. All results are reported as %-change.

Variable		%-change	million euro
Labour supply / SHOCK		0.77	658
Public health care costs / SHOCK		-9.97	833
Results as %-change	**Total effect**	**HC cost**	**Labour supply**
Real GDP from expenditure side	-1.08	-0.30	-0.78
Aggregate real investments	-1.33	-0.55	-0.78
Aggregate capital stock	-1.35	-0.54	-0.81
Real household consumption	-2.11	-1.13	-0.98
Aggregate real government demands	2.20	2.20	0.00
Exports	-1.29	-0.50	-0.79
Imports	-1.03	-0.42	-0.61
Average nominal wage	0.87	0.34	0.53
Average real wage	0.48	0.19	0.30
Consumer price index	0.39	0.15	0.24

The reduction in labour inputs increases the marginal product of labour and results in an increase in the average real wage. In accordance with this, the results show that the nominal wage increases (0.87%) more than the consumer prices (0.39%). Technological change affecting primary factors was held exogenous in these simulations. With employment lower, and with sectoral rates of return on capital exogenous, the long run aggregate capital stock also falls relative to what it would otherwise have been. This is manifested as a reduction in the aggregate capital stock and economy-wide investment.

With real government expenditure determined exogenously, the labour supply shock on its own does not affect government consumption. As it is not realistic to assume that foreign countries will be willing to finance additional spending on health, the ratio of the balance of trade to GDP is fixed in the simulations. This means that if GDP goes down, as it does with the labour supply shock alone, both import and export volumes fall by a similar amount. In the case of the expansion in health care spending, with the balance of trade/GDP ratio exogenous, the increased health care costs are effectively financed by a reduction in private consumption spending. This explains why in the "HC cost" column the health care shock has a negative effect on household consumption.

The "No action" scenario describes how the effects deepen compared with year 2007 if diabetes health care costs and labour force impacts develop at the estimated rates published by Jarvala and colleagues (2010). Over a five year period, the GDP loss is nearly 0.3 percent greater. Household consumption experiences a significant loss, at -2.7 percent relative to what it would otherwise have been. Government consumption increases 0.8 percent. Both imports and exports shrink by approximately 0.3 percent more. The average real wage and consumer prices rise by between 0.1 – 0.14 percent more. In general, the relative effects of both shocks across different macro variables stay nearly the same.

Table 5. The simulation results of the "no action" scenario. All results are reported as %-change.

Variable	%-change		million euro	
Labour supply / SHOCK	0.94		804	
Public health care costs / SHOCK	-13.47		1125	
Results as %-change	**Total effect**	**Diff. to 2007**	**HC cost**	**Labour supply**
Real GDP from expenditure side	-1.36	-0.28	-0.40	-0.95
Aggregate real investments	-1.69	-0.36	-0.74	-0.95
Aggregate capital stock	-1.72	-0.37	-0.73	-0.99
Real household consumption	-2.71	-0.60	-1.52	-1.19
Aggregate real government demands	3.00	0.80	3.00	0.00
Exports	-1.63	-0.34	-0.67	-0.96
Imports	-1.30	-0.27	-0.55	-0.75
Average nominal wage	1.11	0.24	0.45	0.66
Average real wage	0.62	0.14	0.26	0.36
Consumer price index	0.49	0.10	0.20	0.29

Problems for labour intensive sectors

The sectoral results indicate that industries with high labour inputs are likely to be the most affected. Both the labour and health care shocks cause difficulties for the labour intensive industries. In the case of the labour input shocks, this follows directly from the fact that sectors that are labour intensive will experience a relative rise in input costs as wages increase. In the case of the rise in health care spending, the mechanism is the relative labour intensity of the health care sector – as this sector expands, it takes labour resources from other sectors.

The health care sector expands both in terms of production and employment as the public demand for the health care commodity is increased. Both employment and production are increased by over 7 percent in the health care sector (scenario: year 2007). The least affected industries are those that offer their products mostly to government and public use. Administration and defence, education, and the social services sectors suffer only about 0.3 – 0.5 percent drop in production and employment. In the other less affected sectors capital is an important production factor.

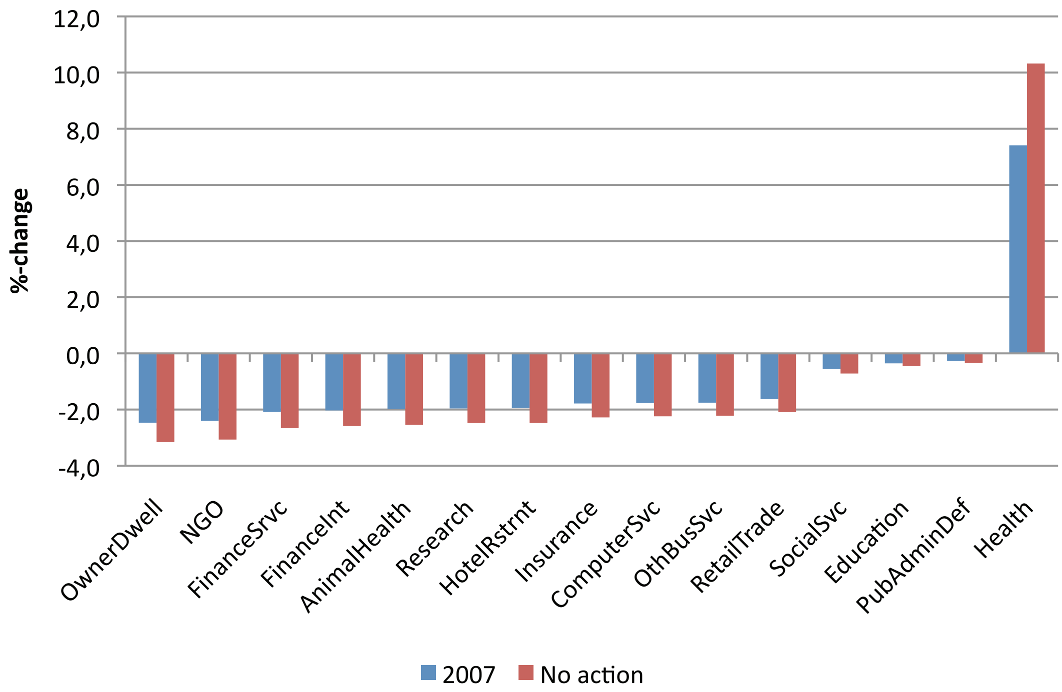

Figure 4. Effects of health and labour shocks to the production of industries. Year 2007 situation and "no action" scenario comparison[1]. Results are reported as %-change.

The labour intensive service industries are the ones mostly affected. Both the labour and health care shocks have nearly equal negative effects. The retail trade sector is an exception as it suffers more from the health care shock. This is due to lower private consumption. Similarly, the other service industries are also affected by the lower household consumption. The assumption regarding government demand, namely that only health care consumption is changed, also partly explains why the administration and defense, education and social services sectors only experience mild contractions. The drop in the production of ownership of dwellings sector reflects the overall fall in real private consumption spending.

The figures (Figure 4 and 5) show the industry level results for production and employment for the year 2007 situation and the "no action" scenario. In these graphs, the impacts of both the health care and labour shocks are added together. In the appendix, the figures for the industry level results show the individual and cumulative effects of both shocks (from Figure 6 to Figure 9). The results of the industries with greatest and smallest losses are selected in addition to the health care sector.

[1] Abbreviations: OwnerDwell: Ownership of dwellings, actual and imputed rents, NGO: Membership organisation services n.e.c., FinanceSrvc: Services auxiliary to financial intermediation, FinanceInt: Financial intermediation services (except insurance and pension), AnimalHealth: Animal health services, HotelRstrnt: Hotel and restaurant services, Research: Research and development services, Insurance: Insurance and pension funding services, ComputerSvc: Computer and related services, OthBusSvc: Other business services, RetailTrade: Retail trade services, SocialSvc: Social work services, Education: Education services, PubAdminDef: Public administration and defence services (+ compulsory social security), Health: Health services.

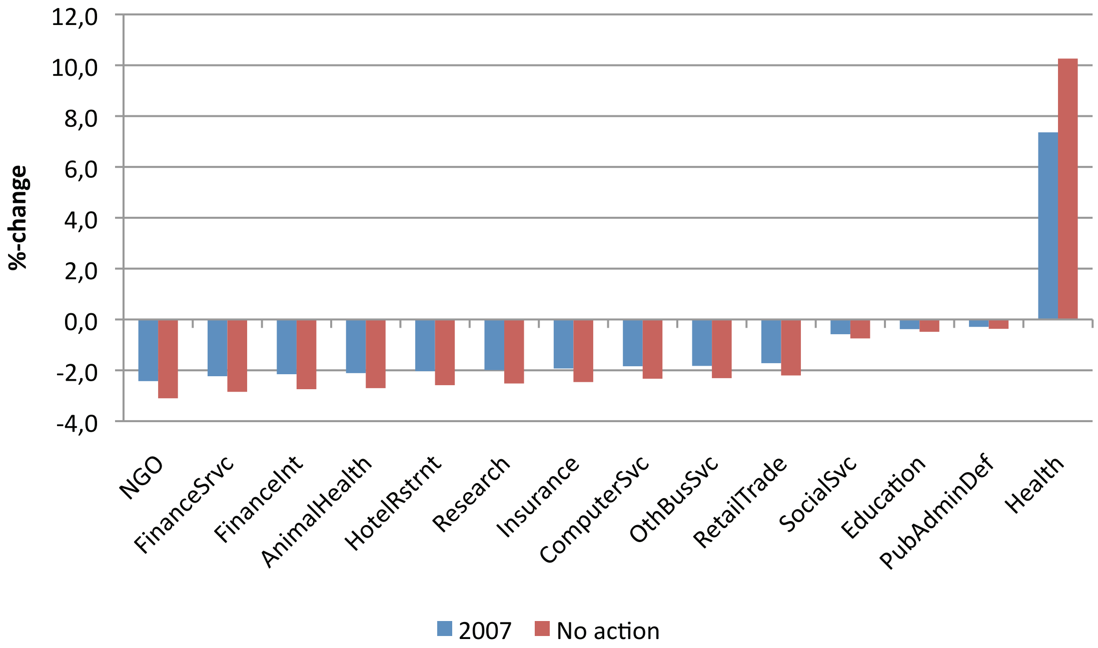

Figure 5. Total effect of health and labour shocks to the employment of industries. Year 2007 situation and "no action" scenario comparison. Results are reported as %-change.

Policy scenarios: The gain from preventive measures against the diabetic epidemic

Next, the effects of policy measures against diabetes are examined. The three scenarios studied are: diabetes prevention program, sugar tax and these two measures combined. The settings and assumptions in the simulations are similar to those applied in the year 2007 situation and "no action" scenario. However, in the three policy simulations, only government health care demand is shocked. This reflects the current lack of estimates of the effect these preventive measures may have on labour supply.

The following table summarizes the results and shows the effects of the policy measures on macro variables. Results are compared with the "no action" scenario to pinpoint what is the net benefit of the preventive measures. All results are reported as percentage changes relative to where the economy would otherwise have been.

Table 6. The economic effects of policy measures compared with "no action" scenario. All results are reported as %-change.

Variable	Prevention program (PP)	Sugar tax	PP + tax	No action	Impact of policy	
					Min	Max
Shock to health care expenditure	1.4%	2.7%	0.7%	3.50 %		
Results as %-change						
Real GDP from expenditure side	-0.04	-0.08	-0.02	-0.11	0.02	0.09
Aggregate real investments	-0.08	-0.15	-0.04	-0.20	0.04	0.16
Real household consumption	-0.16	-0.31	-0.08	-0.41	0.09	0.33
Aggregate real government demands	0.30	0.58	0.15	0.76	-0.17	-0.61
Exports	-0.07	-0.14	-0.04	-0.18	0.04	0.14
Imports	-0.06	-0.11	-0.03	-0.15	0.03	0.12
Average real wage	0.03	0.05	0.01	0.07	-0.02	-0.05
Consumer price index	0.02	0.04	0.01	0.05	-0.01	-0.04

The biggest positive effect is obtained with a simultaneous sugar tax and prevention program policy. The gain in terms of GDP is maximally 0.09 percent. At best investments are 0.16 percent higher and household consumption is 0.33 percent higher when compared with the "no action" scenario. Government consumption is reduced by 0.61 percent. Foreign trade is positively affected as imports and exports rise by over 0.1 percent. There is a slight decrease in the average real wage and consumer prices, reflecting the lower pressure on the labour-intensive health sector. At the industry level the effect is greatest to the service sector similarly as the year 2007 and "no action" scenario simulations already showed.

Discussion and conclusions

This study is the first to estimate the impact of diabetes on the Finnish economy. The simulations are based on a detailed diabetes health care cost study (Jarvala et al., 2010). The results show that reduced labour supply has a greater negative effect on the economy than the diabetes health care costs. The known health care costs and associated lost labour inputs of diabetic patients (year 2007) reduces Finnish GDP by over one percent in the long run. Also investment, household consumption and foreign trade are negatively affected. Government consumption rises by approximately two percent. Average real wage rises almost by half percent and consumer prices nearly 0.4 percent. The industry level results indicate that the labour intensive sectors are the most affected.

This study also examines the economic effects of three policy measures against diabetes. The scenarios are: diabetes prevention program, sugar tax and these two measures combined. The biggest economic benefit is obtained with simultaneous sugar tax and prevention program policy. The gain from these preventive measures is 0.09 percent in terms of GDP. Investment is 0.16 percent higher and household consumption is 0.33 percent higher when compared with a no policy situation. Government consumption is reduced by over half a percent. At the industry level, largest impacts are experienced by the service sector. In these prevention program simulations, only the effect of increased health care demand was studied. This was due to the lack of estimates of what these preventive measures might have on labour supply.

The diabetes prevention programs have shown that they can prevent or at least delay the on-set of diabetes (Lindström et al., 2003, Tuomilehto et al., 2001). The results of this study can be utilized when assessing the net economic benefit of such prevention programs. The prevention programs involve costs that must be financed and therefore careful analysis of total benefits are required. There is evidence that some preventive interventions will actually increase the medical costs rather than save money (Goetzel et al., 2005, Russell, 2009, Goetzel, 2009).

These results can also support the public decision making. The Finnish population is ageing. Statistics Finland estimates that the working age population will decrease from over 65 percent to under 60 percent by year 2030 (Ruotsalainen, 2013). Aging increases pressure on public services and potentially raises the health care bill, while simultaneously reducing labour supply. There is currently intensive public discussion about how to prolong Finnish working careers. Longer working careers are also one goal of the current Finnish government as well as to renovate the social and health care services systems (Finnish Government, 2011).

There are several interesting questions still open. In this study, the costs of the prevention programmes are not included in the simulations. In a further study they could be included in a dynamic model setting. In dynamic simulations the costs of the prevention programme and diabetes health care costs could be studied simultaneously. Furthermore, the results would show the adjustment path of the economy in addition to the effects on macro variables. A labour supply model could be integrated with the CGE model, which would provide more options on how to study the impact of diabetes on labour markets. In a Australian study, three different simulation models were linked to examine the influence of type 2 diabetes on employment and the impact of diabetes prevention on labour supply and aggregate economic indicators (Brown et al., 2009, Brown et al., 2007).

The dynamic model approach would also enable the examination of various policy measures in a more detailed manner. Finland is already collecting candy tax from confectionary, soft drinks and ice-cream. Currently, there are discussions to broaden this to a general sugar tax. According to a Finnish study the demand for sweets is quite elastic and therefore taxation can influence their consumption (Kotakorpi et al., 2011). CGE models suit well the examination of various tax policies as they also reveal the industry level effects in addition to the aggregate economic indicators.

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Appendix

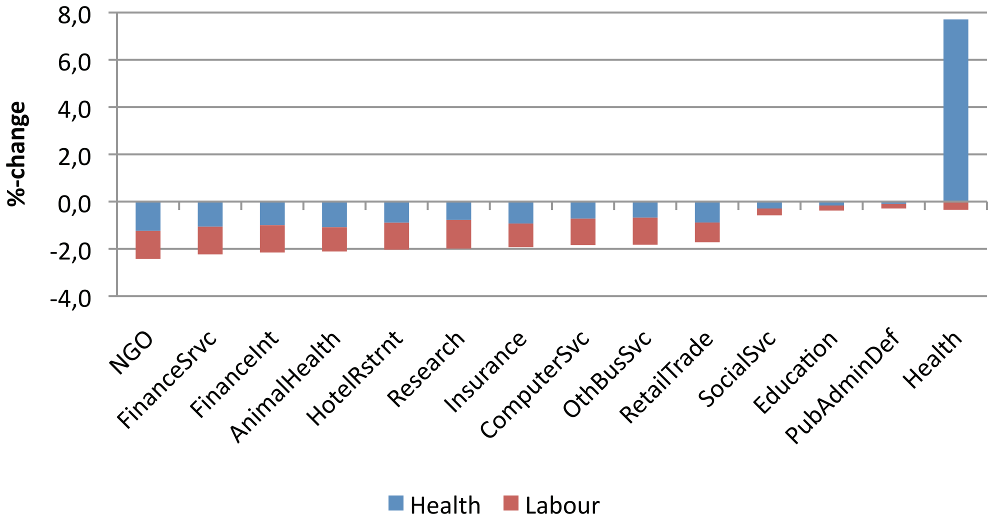

Figure 6. Effects of health and labour shocks to the employment of industries scenario: year 2007[2]. Results are reported as %-change.

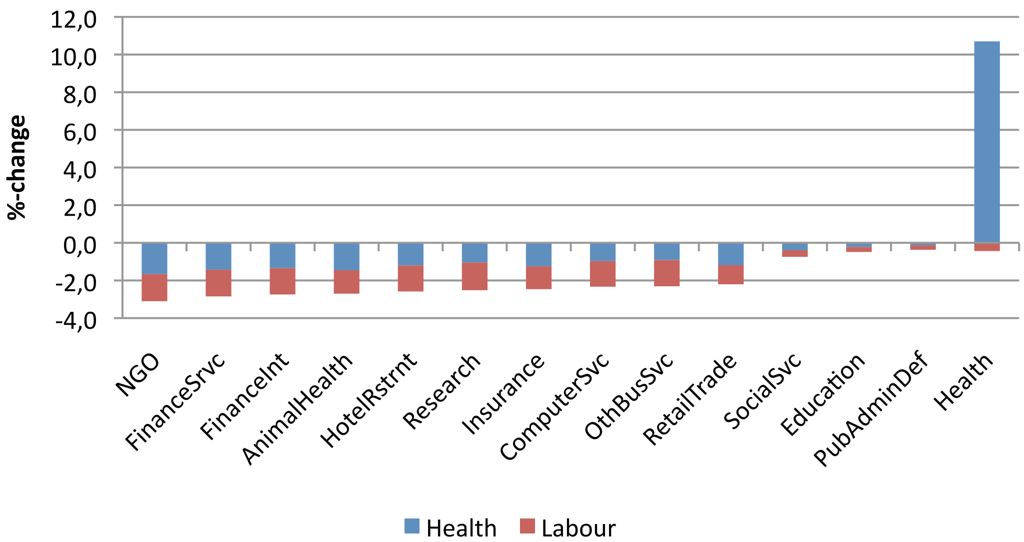

Figure 7. Effects of health and labour shocks to the employment of industries scenario: no action. Results are reported as %-change.

[2] Abbreviations: OwnerDwell: Ownership of dwellings, actual and imputed rents, NGO: Membership organisation services n.e.c., FinanceSrvc: Services auxiliary to financial intermediation, FinanceInt: Financial intermediation services (except insurance and pension), AnimalHealth: Animal health services, HotelRstrnt: Hotel and restaurant services, Research: Research and development services, Insurance: Insurance and pension funding services, ComputerSvc: Computer and related services, OthBusSvc: Other business services, RetailTrade: Retail trade services, SocialSvc: Social work services, Education: Education services, PubAdminDef: Public administration and defence services (+ compulsory social security), Health: Health services.

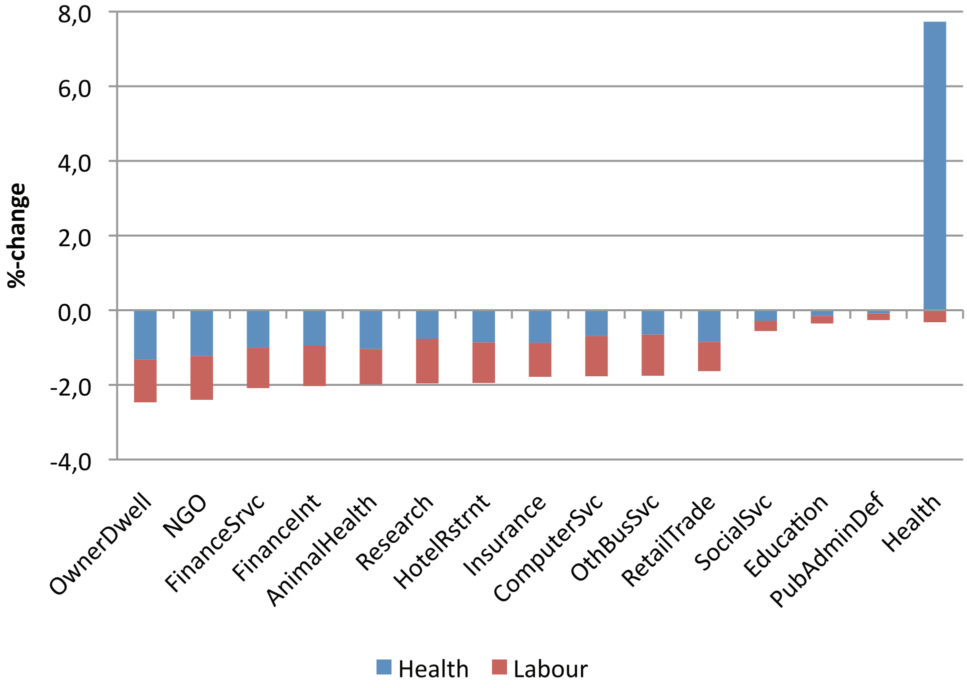

Figure 8. Effects of health and labour shocks to the production of industries scenario: year 2007. Results are reported as %-change.

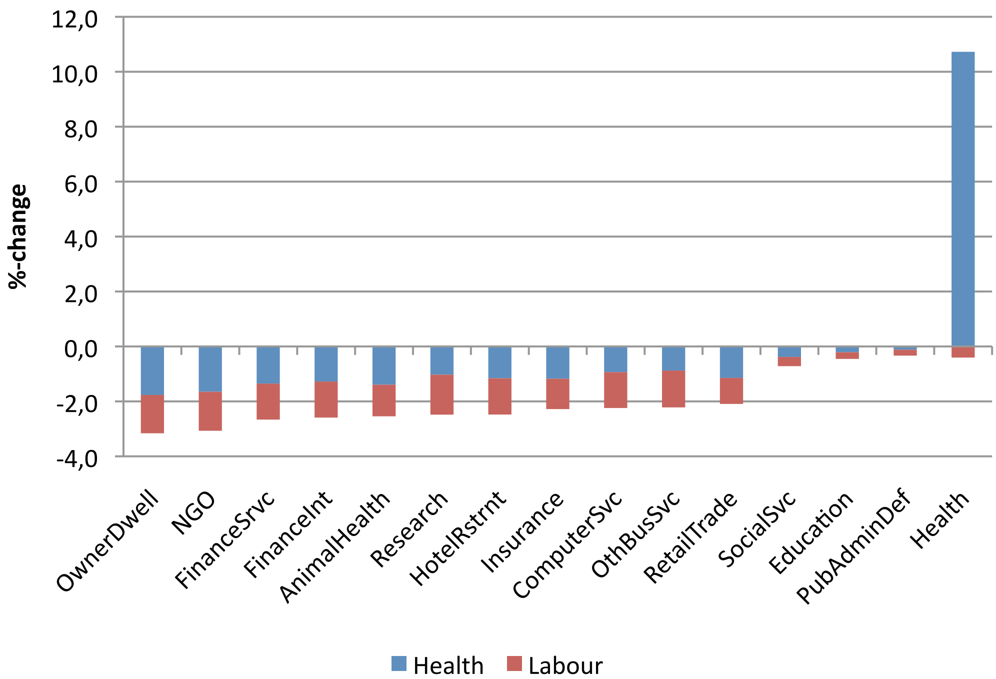

Figure 9. Effects of health and labour shocks to the production of industries scenario: no action. Results are reported as %-change.