THE EFFECTS OF LONG-RUN EMISSION TARGETS ON THE FINNISH ECONOMY

Markku Stenborg[*] and Juha Honkatukia[**]

This study evaluates the long-run effects in Finland of abatement of greenhouse gases with two applied general equilibrium models. Cutting emissions by 20 per cent would cause GDP to fall by as much as 3.4 per cent in the short run, leading to significant employment effects. In the long run, the labour market may recover, which shifts the burden of adjustment more on the capital markets. It seems likely that energy-intensive industries will contract as a consequence of climate policies. Employment may recover, if the labour markets are flexible enough in the long run. The results highlight the importance of permit prices and CDM prices for the cost of mitigation. Extending participation to flexibility mechanisms would appear very important for the Finnish economy.

1 Introduction

This study evaluates the long-run effects of abatement of greenhouse gases from the Finnish point of view. Two applied general equilibrium models of the Finnish economy are used for the evaluation: the static, energy-oriented EV model and the dynamic, speed-of-adjustment-oriented VATTAGE model. The hybrid-EV model (Forsström and Honkatukia, 2002) combines an engineering model of the energy sector and key industrial sectors to a top-down AGE model. The VATTAGE model is based on the well-known MONASH model, with adjustment dynamics in the capital and labour markets as well as in the fiscal balance (Dixon and Rimmer, 2002).

The simulation models compare the effects of mitigation to a baseline scenario without climate policies. The macroeconomic assumptions on the baseline for the Kyoto period follow the EU Stability Pact assumptions for Finland (see, e.g., Ministry of Finance, 2007). Thereafter, the economy is assumed to converge to a long-run scenario that is consistent with the Ecofin Ageing Working Group assumptions. These assumptions give more detail than the national energy and climate strategy assumptions for the demand for services, whereas the sector-level growth of the economy is covered in much more detail in the climate strategy. Overall, the economy grows by slightly more than two per cent a year on average until 2025. Growth is fastest during the last years of the current decade and begins to slow down, driven by first and foremost by the ageing of the population after 2010. Ageing is also reflected in faster-than-average growth of pension and age-related service expenditures, both public and private. General government, on the other hand, grows slower than average.

The Finnish economy is by many measures energy intensive (for example, in terms of primary energy use per unit GDP) but it is also energy efficient by others (for example, in terms of energy use per unit of output). Thus, energy intensive export industries – forestry and basic metal industries – account for around one third of the total value added, which is a much higher share than in most other OECD countries. On the other hand, most of their production is exported – Finland, with its population of 5 million people, produces paper for the needs of some 100 million people all over Europe and beyond.

[*] Ministry of Finance, Finland.

[**] Government Institute for Economic Research, Finland.

At the same time, the share of renewable energy in Finland has been around 24 to 25 per cent of primary energy use, which is also far above the OECD or EU averages. The main reason for this is in the extensive use of wood residues in forest industries. Of all renewable energy sources – including hydro power – black liquor and wood residues stemming from the forest industries account for more than 40 per cent, and together they account for more than 80 per cent of bioenergy use.

The growth of energy consumption has been forecast in the National energy and climate strategy. There, industrial production is assumed to grow at an average annual rate of 3.5 per cent until 2010. Emissions of greenhouse gases are expected to grow accordingly, unless additional measures are taken, although at a slower pace than the economy. By 2010, CO_2 emissions are expected to be close to 67 Mt. To reach the Finnish emission target (1990 levels), CO_2 emissions from fossil fuels will have to be cut by 14 per cent (while the other greenhouse gases can be cut slightly more). In the longer run, by 2025, the CO_2 emissions are expected to rise well above 70 Mt. The structure of energy use is also changing, with electricity consumption growing from 85,2 TWh to 95 TWh by 2010, and to 108 TWh by 2025.

2 The effects of emission cuts in 2025

The Finnish climate strategy contains an assessment of the effects of emission cuts in the year 2025. The underlying assumptions of this assessment differ markedly from those of the recent EU Commission communication and its impact assessments. In this section, the climate strategy cost estimates are updated using the Commission’s assumptions.

The policy simulations evaluate a case where Finnish emissions are given targets for the year 2025. This year is used because it was the reference year of the Finnish energy and climate strategy. Emissions are assumed to be cut to 1990 levels, or 10 to 30 per cent lower than the 1990 levels. In the case of a 30 per cent reduction, this would mean a cut of 47 per cent from baseline 2025 emissions. The most important difference between the current study and the climate strategy stems from assumptions concerning carbon permit prices. In the climate strategy, permit prices were assumed to reach 20 € per tonne of CO_2, whereas here, following the EU commission’s assumptions, the price is assumed to reach 44 € per tonne CO_2 at its highest. Since the permit price is driving the adjustment of the economy, it is clear that higher prices will cause larger and more costly responses from the economy.

The study uses the comparative-static EV model, which combines an engineering model of the energy sector and key industrial sectors to a top-down AGE model. The key modelling target in setting up the EV model has been to capture the essential process-level features in the Finnish energy use. The model thus relies heavily on engineering data and models about the details on fuel use, reflecting the often fuel-specific processes that are used in the production of heat and electricity as well as in process industries. The model also makes a distinction between different electricity and heat generation technologies. This is essential for the analysis of the Finnish energy sector, which contains a lot of combined heat and power generation, as well as communal district heating.

The simulations make a distinction between long-run and short-run adjustment. The model’s set up could be interpreted to reflect the time required or available for adjustment – if emissions targets kick in immediately, only the short-run adjustment channels are open. The main distinction between short and long-run adjustment stems from investment and the labour markets. In the short run, the capital stock is assumed to be fixed and wages to display rigidity. Accordingly, the short-run adjustment of the economy takes place mainly through the labour market. In the long run, however, investment adjusts and allows the capital stock to reflect given, long-run rates of return, whereas labour markets are driven by the exogenous growth of the labour force, with real wages adjusting to ensure labour market equilibrium. It is assumed that in the long run, employment returns to baseline level, though this need not be the case in reality. Structural unemployment may very well be affected by the large structural changes in the economy (if there is, say, hysteresis causing persistence of higher-than-usual unemployment). Good news is also a possibility, if, for example, exports of energy technology are boosted by emission policies (which would imply that increased living costs increase the competitiveness of relatively labour-intensive industries). However, very few studies have seriously tried to evaluate the long-run, sector-level employment implications of mitigation policies in Finland. The dynamic simulations in the following section do allow for changes in structural unemployment, but do not introduce scenarios for changes in export patterns or the like.

The comparative-static simulations can be summarised as follows:

- reduction of Finnish GHG emissions to 1990 levels as part of an EU go-it-alone commitment to 20 per cent cuts without CDM – permit prices reach 44 €/t CO_2;
- reduction of Finnish GHG emissions to 10 per cent below 1990 levels as part of an EU go-it-alone commitment to 20 per cent cuts without CDM – permit prices reach 44 €/t CO_2;
- reduction of Finnish GHG emissions to 20 per cent below 1990 levels as part of an EU go-it-alone commitment to 20 per cent cuts without CDM – permit prices reach 44 €/t CO_2;
- reduction of Finnish GHG emissions to 30 per cent below 1990 levels as part of an EU go-it-alone commitment to 30 per cent cuts without CDM – permit prices reach 77 €/t CO_2;
- reduction of Finnish GHG emissions to 20 per cent below 1990 levels as part of an EU go-it-alone commitment to 20 per cent cuts with CDM – permit prices reach 4 €/t CO_2;
- reduction of Finnish GHG emissions to 30 per cent below 1990 levels as part of an EU go-it-alone commitment to 30 per cent cuts with CDM – permit prices reach 9 €/t CO_2.

The results of the 2025 simulations are presented in Table 1, together with the Commission's estimates for all of the EU. The central result of the study is that the effects on the Finnish economy are larger than in the EU on average. The Commission communication estimates that a 20 per cent one-sided EU cut would reduce GDP by 1.4 per cent, whereas in the short run the effect on the Finnish economy would be more than three per cent, and over two per cent in the long run.

Table 1

The Effects of Mitigation Policies on GDP in Finland and in the EU

Change in GDP compared to baseline				
	–20 %	Emission target –20 %, with CDM	Emission target –30 %	Emission target –30 %, with CDM
EU average in 2020	–1.4	–0.3	–2.3	–0.9
Finland in 2025 (short-run adjustment)	–3.4	–1.5	–4.9	–2.0
Finland in 2025 (long-run adjustment)	–2.3	–0.8	–3.5	–1.1

Access to cheap CDM projects would reduce costs dramatically for the EU and for the Finnish economy, but costs in Finland would still exceed the EU average.

Cutting emissions by 20 per cent would cause GDP to fall by 3.4 per cent in the short run, leading employment to drop by three per cent. Using baseline employment growth to evaluate this effect, the fall corresponds to more than 60 000 jobs, with private consumption falling accordingly by nearly eight per cent in the short run. In the long run, however, it is assumed that employment recovers but that investment adjusts to a lower level, with the long-run GDP effect settling at 2.3 per cent. The long-run adjustment would thus see the economy become more service and labour intensive, with much of the capital-intensive industries presumably shifting production abroad.

The results highlight the importance of permit prices and CDM prices for the cost of mitigation. While burden sharing can be used to level differences in mitigation costs within EU, the effect of permit and CDM reduction prices dominate. The most extreme effects on the economy would take place with one-sided 30 per cent cuts, where permit prices are assumed to reach 77 €/t CO_2. It seems unlikely that permit prices could remain at this level for extended periods, however, since carbon capture technologies are already now estimated to be competitive at lower prices. With access to cheap CDM, the effects on the economy would be significantly lower. Low CDM prices would presumably necessitate widespread participation in these mechanisms, and thus, extending participation to these mechanisms appears crucial for the Finnish and EU economies.

3 Emission paths to 2020

In this section, we study the dynamics of long-run emission targets. The study uses VATTAGE, a dynamic AGE model based on the MONASH model (Dixon and Rimmer, 2002). The main results of this section concern the central case of 20 per cent one-sided EU emissions cuts, but the dynamics of labour and capital market adjustment are also demonstrated with examples for the Kyoto period.

The distinguishing features of the model concern its dynamics. Three intertemporal links connect consecutive periods in the model: (1) accumulation of fixed capital, (2) accumulation of financial claims and (3) lagged adjustment mechanisms notably in the labour markets and in the balancing of the public sector budgets. Together, these mechanisms result in gradual adjustment to any policy shocks to the economy.

The simulations take as given the policies required for meeting the Kyoto and long term emission targets. These consist of several parts. First, the European Emission Trading Scheme (EU ETS) has been operational for more than two years now, and forms a natural starting point for the simulations. Second, some increases in energy taxes are likely to take place already in 2007. Third, during the Kyoto period, we assume that ETS emission permit prices will gradually rise to hit 20 € per t CO_2 by 2012. And finally, by 2020, when the target is tightened to 20 per cent below 1990 GHG levels, we follow the European Commission and assume a CO_2 price of 44 € per tonne CO_2.

3.1 On the dynamics of adjustment to emission policies

The VATTAGE model assumes sluggish real wage responses to policy shocks, much in the vein of the NAIRU theory of Nickell and Layard. The model also makes it possible to allow for long-run changes in structural unemployment. This is shown in Figure 3, where only the Kyoto commitment to cut emissions to 1990 levels during 2008-12 is considered. The figure demonstrates

Figure 1

Short-run Macroeconomic Effects in Finland
(percent from 2025 baseline)

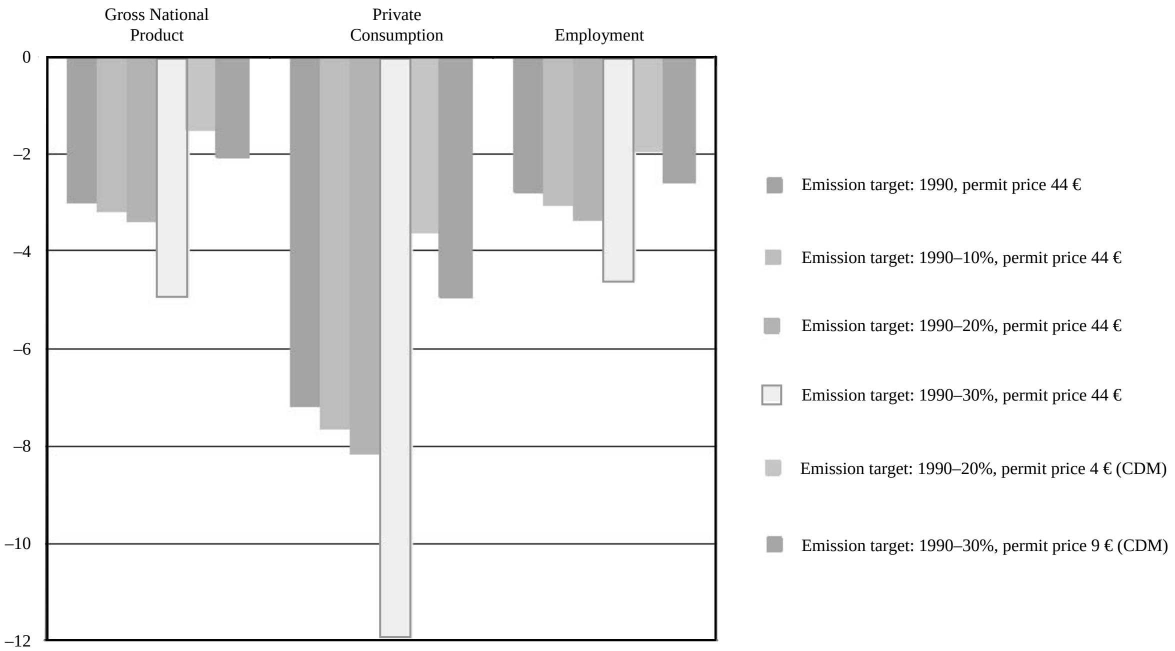


Figure 2

Long-run Macroeconomic Effects in Finland
(percent from 2025 baseline)

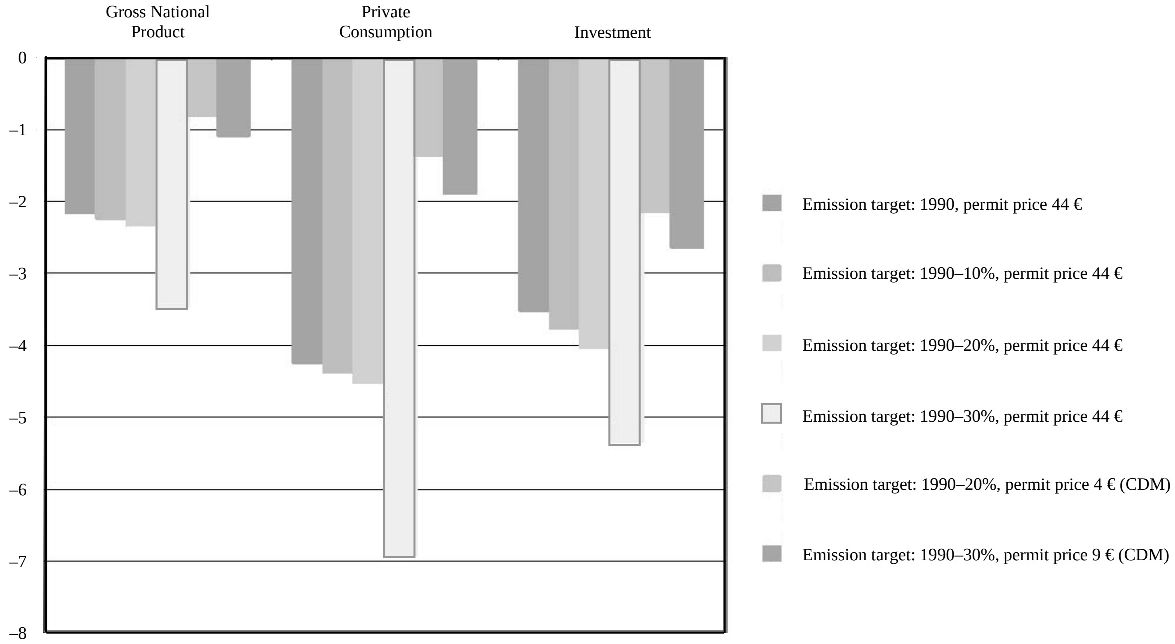


Figure 3

Employment and Real Wages with Kyoto Targets
(percentage change from baseline, cumulative)

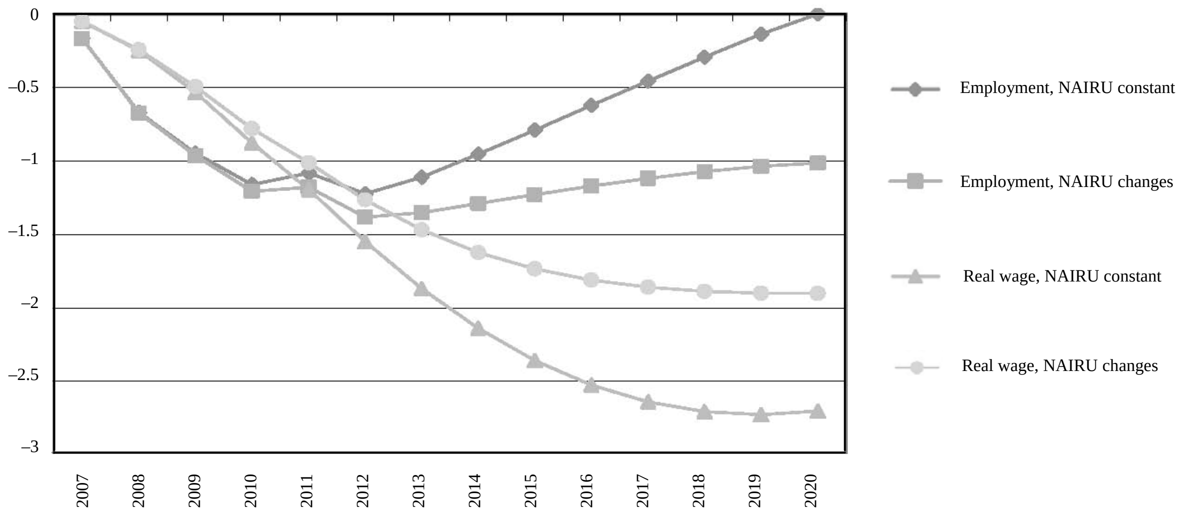
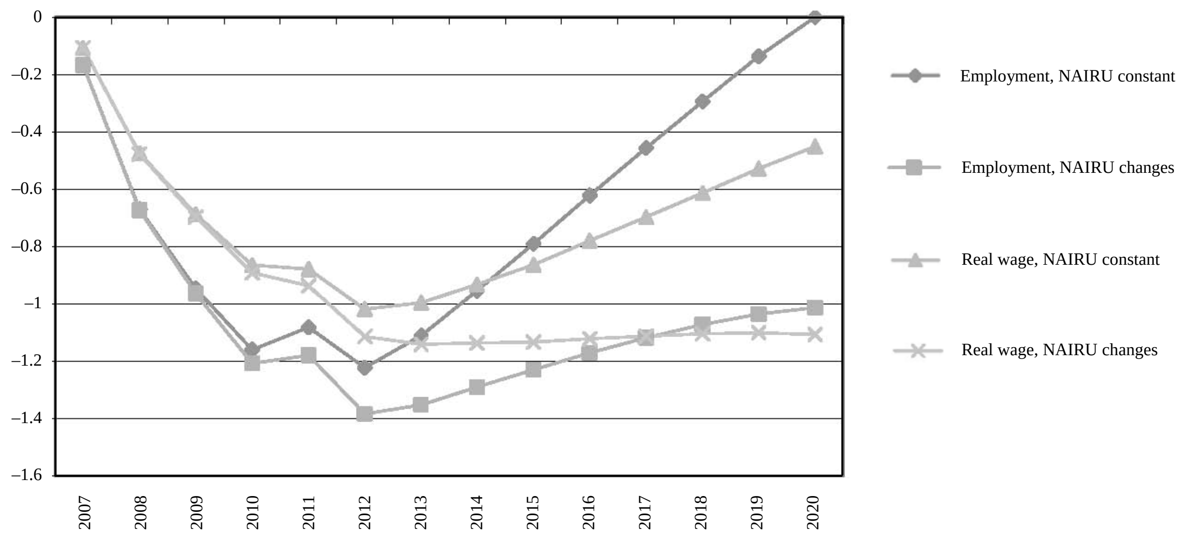


Figure 4

Employment and GDP with Kyoto Targets
(percentage change from baseline, cumulative)



how the labour market can recover to full employment by 2020 if no further restrictions take place after 2012. So far, there are few studies on the long-run dynamics of the NAIRU, but for example Alho (2002) estimates parameters for long-run shifts. If these are used in the model, structural unemployment increases along with the cost pressure caused by emission cuts. This effect is also shown in Figure 3, showing a one-percent decrease in long-run employment. Figure 4 displays a similar comparison between employment and GDP.

The model can also be used to study different abatement trajectories. In Figure 5, it is shown how early action causes the economy to plunge deeper than gradual tightening of emissions reductions. The simulation reported in the figure assumes that permit prices rise very quickly to the 44 €/t CO_2 level with early action, in contrast to the step-wise rise of permit prices with gradually-tightening targets. As a consequence, with early action, GDP drops by 2.3 per cent in the long run, with employment falling by three per cent, whereas with gradual tightening, the impacts remain much lower. But while this result gives some support to the findings of the comparative-static model, which de facto assumes high permit prices in the short run, it also reflects very different abatement targets: early abatement leads to larger, cumulative reductions than gradual tightening and thus the targets are not really comparable.

Finally, the model allows for a certain amount of flexibility on the fiscal side. It can be assumed that the government tolerates short-run imbalances when employment remains unusually low. In this way, the government can alleviate the effects of abatement. The problem with this policy is, however, that the targets will get more stringent over time. Thus, the budget imbalance may not tend to settle down but, rather, get worse over time. This is presented in Figure 6, which highlights how the government can alleviate the short-run effects of abatement with lax fiscal policies (B) compared to stricter policies insisting on budget balance (A), but not the long-run effects, as the costs of the imbalance start getting more serious over time. The ability of the government to soften the blow also depends on whether structural unemployment in rising or not.

3.2 The effects of 2020 emission targets

The main results of this report are shown in Figures 7 and 8, which study the effects of 2020 targets – 20 per cent below 1990 levels for Finland – under alternative assumptions about the labour markets. We assume a gradual tightening of targets in the EU, which pushes permit prices to the level of 44 €/t CO_2 by 2020. In Figure 7, it is assumed that structural unemployment is unaffected by policies. This means that employment would eventually return to its long-run equilibrium level after all the policy shocks to the economy have passed. However, by 2020 emission policies keep tightening and the economy is not returning to a balanced growth path. Thus, employment is about 0.7 per cent below normal in 2020 as the economy adjusts to the constantly rising price of emission permits.

In Figure 8, in contrast, structural unemployment rate is allowed to change. The change is for the worse as it is produced by rising costs and reduced competitiveness, raising structural unemployment. In contrast, a positive shock would lower the structural rate of unemployment. Under this behavioural specification, employment is almost two per cent below normal by 2020, with GDP 1.8 per cent below baseline. The figure also shows decreasing capital stocks and national saving. Clearly, climate policies will necessitate fiscal consolidation to prevent growing deficits and to ensure the ability of the economy to meet the challenges of an ageing population.

The implementation of the 2020 target would put pressure on the structure of the economy. This is illustrated in Figure 9, which shows changes in sectoral production in 2020. The figure shows the large effects on energy intensive industry and power generation. These sectors contract substantially and free up labour force for the rest of the economy. The service sectors are less affected by the rising energy prices, as is labour intensive industry. However, were the labour-intensive sectors of the economy to be able to compensate for the loss of production in the energy-intensive, export-oriented industries, they would have to become more competitive than before. The rise in energy prices, however, exerts an upward pressure on living costs, dragging real wages down, which has usually resulted in claims for compensating wage rises in the labour

Figure 5

Early Action vs. Gradually-tightening Targets
(percentage change from baseline, cumulative)

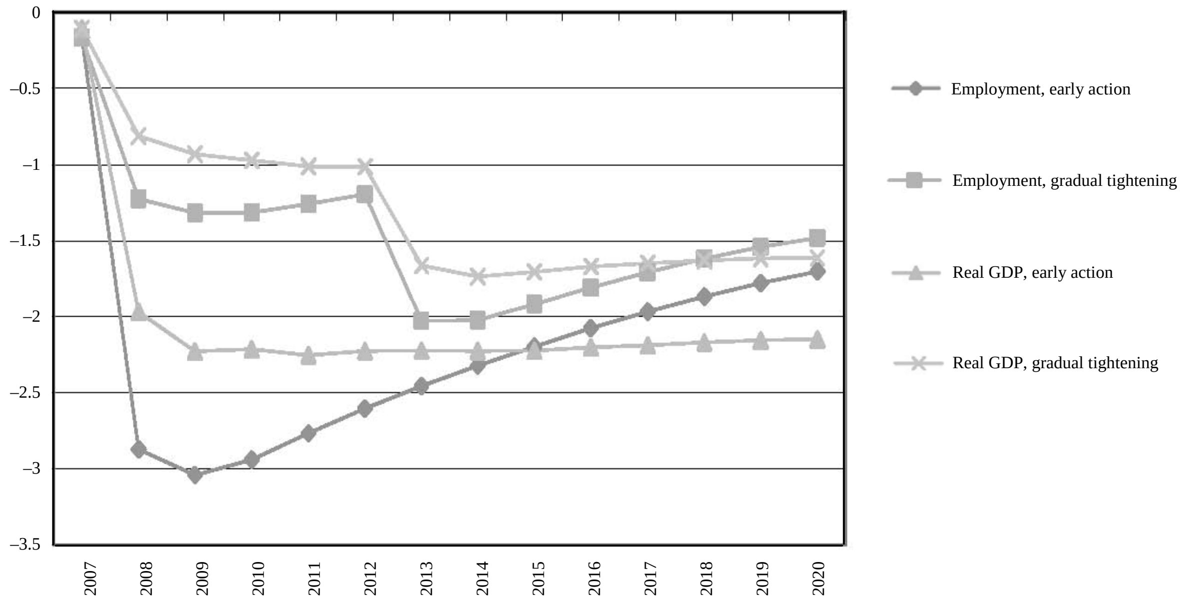


Figure 6

Fiscal Balance and Abatement
(percentage change from baseline, cumulative)

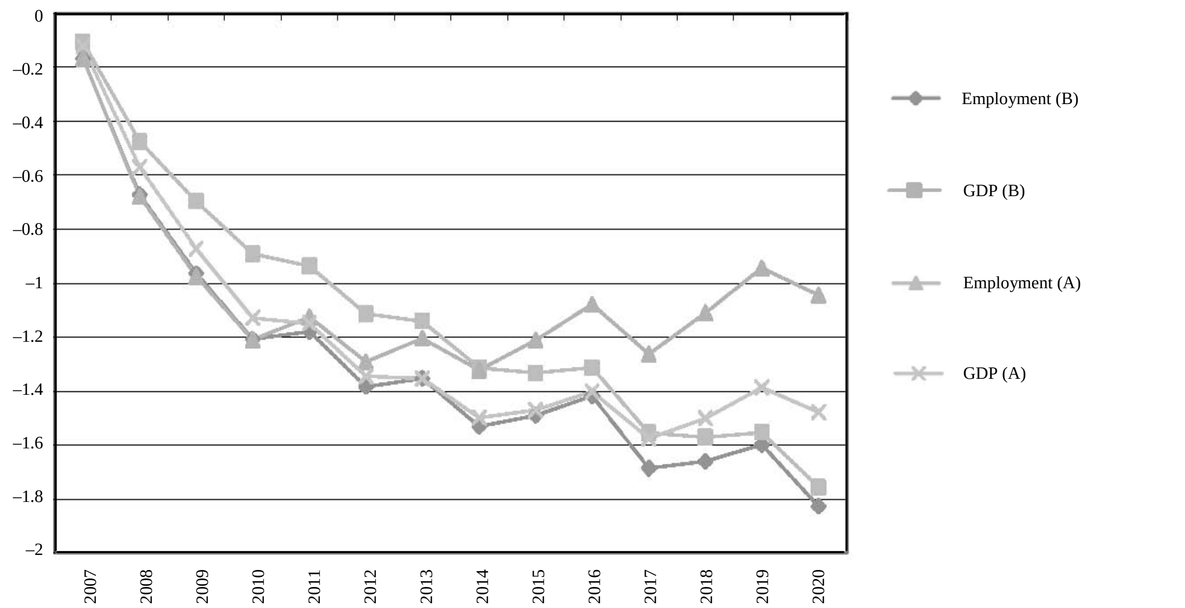


Figure 7

The Effects of Emission Reductions in 2020 with No Changes in Structural Unemployment
(percentage change from baseline, cumulative)

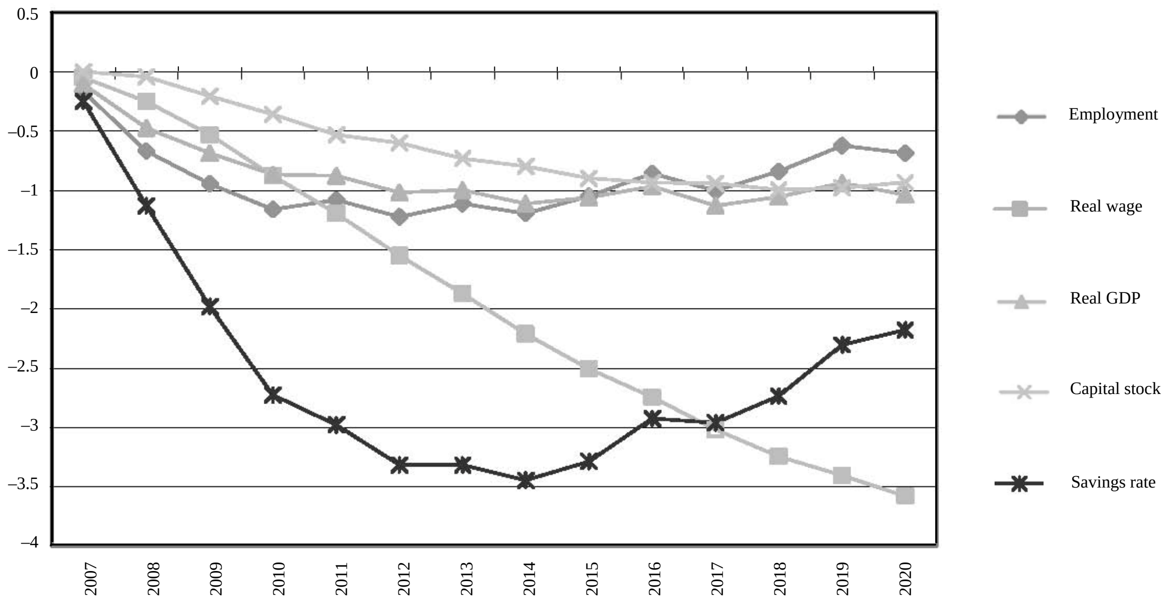


Figure 8

The Effects of Emission Reductions in 2020
Allowing for Changes in Structural Unemployment
(percentage change from baseline, cumulative)

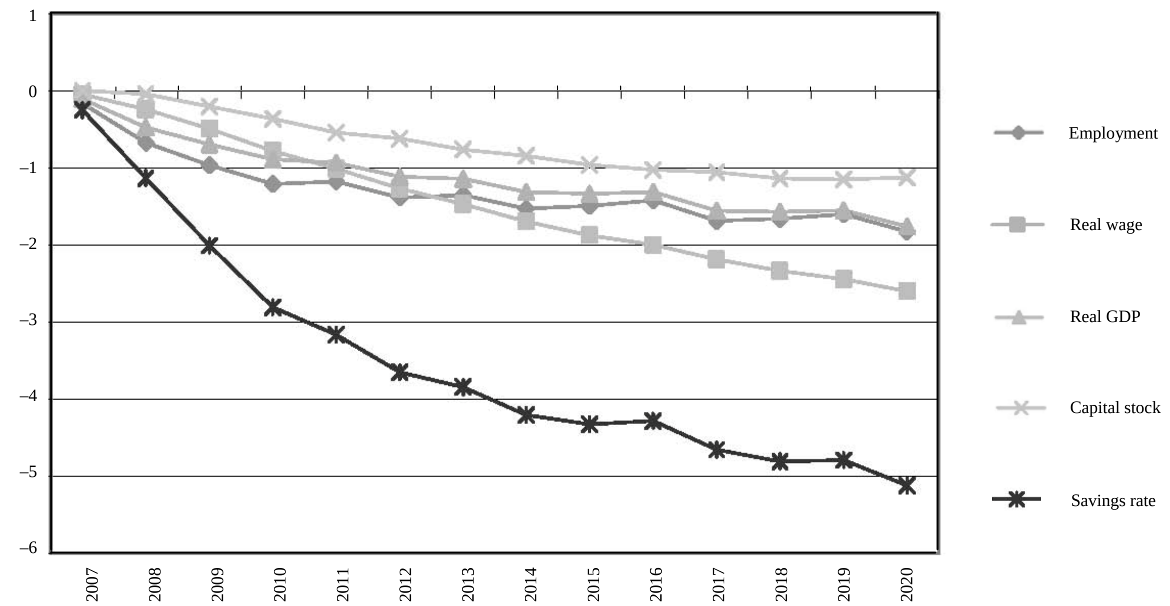
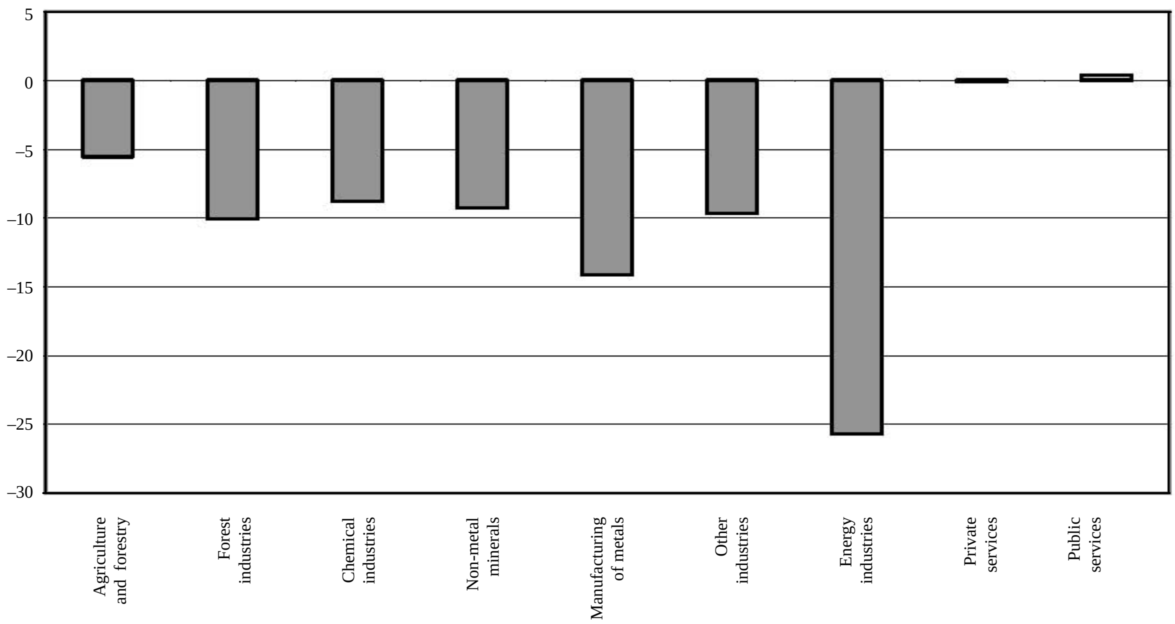


Figure 9

Sectoral Value Added in 2020 Under Climate Policies
(percentage change from baseline, cumulative)



market. There is also all likelihood that the ability of the service sectors to absorb the redundant labour force from the energy intensive sectors will depend on active labour market measures.

4 Conclusions

This study has evaluated the long-run effects in Finland of abatement of greenhouse gases with the aid of two applied general equilibrium models of the Finnish economy. According to the model simulations, cutting emissions by 20 per cent would cause GDP to fall by as much as 3.4 per cent in the short run, leading to significant employment effects. In the long run, the labour market may recover, which shifts the burden of adjustment more on the capital markets. It seems very likely that energy-intensive industries will contract as a consequence of climate policies. Employment, on the other hand may recover, if the labour markets are flexible enough in the long run.

The results highlight the importance of permit prices and CDM prices for the cost of mitigation. While burden sharing can be used to level differences in mitigation costs within the EU, the effect of permit and CDM reduction prices dominate, and thus extending participation to flexibility mechanisms to facilitate reasonable prices would appear very important for the Finnish economy.

Climate policies will have an effect on the fiscal stance of the country as well. Thus climate policies will also necessitate fiscal consolidation to prevent growing deficits and to ensure the ability of the economy to meet the challenges of an ageing population.

REFERENCES

Alho, K.E.O. (2002), “The Equilibrium Rate of Unemployment and Policies to Lower It: The Case of Finland”, Discussion Paper, No. 839, ETLA, Helsinki.

Dixon, P. and M. Rimmer (2002), *Dynamic General Equilibrium Modelling for Forecasting and Policy*, North-Holland, Amsterdam.

Forsström, J. and J. Honkatukia (2002), “EV Model: An Economic and Engineering Equilibrium Model for Finland”, in Finnish: “EV-malli; Taloudellis-tekninen tasapainomalli Suomelle”, No. C78, ETLA, Helsinki.

Hjerppe, R. and J. Honkatukia (2005), “Finland 2025. Challenges for Sustainable Development”, in Finnish: “Suomi 2025. Kestävän kasvun haasteet”; VATT Publications, No. 43, VATT; Helsinki.

Honkatukia, J., H. Kemppi and L. Kerkelä (2005), “Projections of the Economic Impacts of Climate and Energy Strategy”, in Finnish: “Arvioita ilmasto-ja energiastrategian kansantaloudellisista vaikutuksista”; VATT Research, No. 116, VATT; Helsinki.

Ministry of Finance (2007), *Stability Programme Update for Finland 2007*, available at http://www.vm.fi/vm/en/04_publications_and_documents/01_publications/02_economic_surveys/20071129Reform/vakaus-2007-e-b.pdf

Nilsson, S. and J. Honkatukia (2006), “Globalization and Economic Growth: Energy and Environmental Constraints”, in *Globalization Challenges for Europe*, report by the Secretariat of the Economic Council, Prime Minister’s Office Publications, No. 18/2006.