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## Welfare Effects of Trade Liberalisation in Distorted Economies A Dynamic General Equilibrium Assessment for Norway

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*Taran Fæhn and Erling Holmøy*

**Welfare Effects of Trade  
Liberalisation in Distorted  
Economies**  
A Dynamic General Equilibrium  
Assessment for Norway

**Abstract:**

A disaggregated intertemporal CGE model is used to simulate the welfare effects in Norway of the recently implemented trade reforms including the WTO agreement, the EEA treaty, the EFTA fishery agreement and an anticipated EEA resolution on shipbuilding. These reforms affect the Norwegian economy through changes in tariffs, Non Tariff Barriers (NTBs), government procurement and subsidy policy as well as shifts in world prices and demand. Reduction of such import barriers that represent real costs for the country is identified as the most important source of welfare gains, through improved terms of trade. Due to initial distortions caused by taxes and imperfect competition, changes in the resource allocation have first order effects on welfare. In particular, this explains why the simulated reduction of employment has a significant negative impact on the total welfare gain.

**Keywords:** Trade Reforms; Intertemporal CGE Model; Welfare

**JEL classification:** F12, F13, D58, D61

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## 1. Introduction

During the last seven years, most European countries have endorsed a large number of multinational agreements on trade related issues. Many studies have singled out effects of the WTO agreement, or of European integration. In our view, these agreements should rather be studied as results of a simultaneous process, in which negotiations have mutually inspired and affected each other. In this study we consider how the overall impact of the new surroundings may affect welfare in a European small, open economy, Norway. In addition to (1) the Norwegian association to the Common Market through the EEA Treaty, and (2) her participation in the WTO, we have incorporated two international agreements on governmental aid: (3) the EFTA-agreement on fishery and (4) an anticipated EEA resolution on shipbuilding. Though several commitments in the agreements are overlapping, their simultaneity in time brings about large changes the import regime, in the rules of governmental aid, and in world market conditions within relatively short time.

Fæhn and Grünfeld (1999) encompasses all the above-mentioned reforms in their study of the long run effects of trade liberalisation on the Norwegian industry structure. By employing a much richer CGE model, MSG-6<sup>1</sup>, the present paper extends the analysis in Fæhn and Grünfeld (1999), first of all by covering the welfare effects of dynamic equilibrium adjustments. Though several studies emphasise the importance of the accumulation processes set in force by the recent international trade agreements (see e.g. Haaland and Tollefsen (1994)), we investigate this aspect in a more consistent way, by modelling rational intertemporal behaviour by both households and firms. Besides endogenous determination of the capital endowment, MSG-6 also determines how labour supply is endogenously affected by trade liberalisation. The role of scale economies and imperfect competition is addressed in several studies of trade reforms (see e.g. Harris (1984), Helpman and Krugman (1985), Smith and Venables (1988) and Keuschnigg and Kohler (1996)). Nevertheless, Francios et al.(1996) find that, with a few exceptions, these aspects are left out of assessments of multilateral agreements on liberalisation. These aspects are incorporated in MSG-6, which describes producer behaviour in most manufacturing and service industries by the Large Group case of Monopolistic Competition (LGMC). An innovative part of the model structure is that the LGMC formulation incorporates productivity differentials between firms within the same industry. The commodity- and industry classification of the model has been especially designed for giving an accurate description of various trade- and

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<sup>1</sup> MSG-6 is the most recent version of the *Multi-Sectoral Growth* models developed in Statistics Norway.

industry policy measures. The model also provides a detailed description of taxes and other distortions in the Norwegian economy.

We find that the implemented policy reforms induce a welfare increase of 0.77 percent. “That may be worth having, but it is hardly a matter of life and death.” This judgement quoted from *The Economist*<sup>2</sup> applies to almost all estimates of gains from trade liberalisation. Our result fits well into those of the rest of the CGE studies on welfare gains from trade agreements, see e.g. the survey of Uruguay Round assessments in Francois et al. (1996). It may, however, turn out that the gain estimate is small because significant welfare effects counteract each other. In this paper we explore this possibility by identifying the most important sources to the welfare gain. We find that terms-of-trade improvements associated with reduced import barriers stand out as the most important contributor. In addition, our analysis emphasises welfare effects from reallocations as crucial explanations to the welfare gain. The most significant reallocation is the reduction of employment, which counteracts the terms-of-trade gain substantially because of the high effective tax on labour income. The significance of this tax wedge is clearly illustrated in a partial calculation of removing the shipbuilding subsidies. We find that welfare decreases, as time is reallocated from labour in shipbuilding to leisure rather than to employment in more efficient industries. We find that aspects of trade reforms emphasised in the theory developed in the 1980’s, i.e. rationalisation-, procompetitive-, and love-of-variety effects, are not empirically important for Norway. Nor do the possibilities for the small open economy to adjust the intertemporal consumption patterns and the composition of savings through trade in time, play any major role, contrary to the results of Keuschnigg and Kohler (1996) and Ho and Jorgenson (1994).

The paper is organised as follows. Section 2 presents a brief non-technical overview of the structure of the empirical model. In Section 3 we describe the exogenous changes associated with the trade liberalisation. Changes in world prices and a wide range of policy variables are quantified, including changes in tariffs, NTBs, subsidies, government regulations and procurement policy. Section 4 explains the determinants of the general equilibrium adjustments caused by trade liberalisation in the model, focusing on the most important reallocations in a welfare perspective. Section 5 identifies the main contributions to the simulated welfare gain. Here, we also assess the empirical importance for our welfare estimate of some effects stressed as important in related studies. Section 6 concludes.

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<sup>2</sup> *The Economist*, July 16th, 1994, pg. 73.

## 2. The Numerical Model

### 2.1. General features

MSG-6 provides a rather detailed description of Norwegian commodities and industries. The model specifies 32 private business industries, 7 government sectors and 60 commodities, of which 34 are tradables. 9 tradables are provided by imports, only. The remaining 25 are produced in exposed domestic industries, mainly in manufacturing, primary industries and offshore industries. The classification is conducted to obtain homogeneity within aggregates with respect to the actual design of trade- and industry policies, as well as to production and demand functions. The Norwegian National Accounts (NA) constitutes the main empirical data source for both calibration and estimation of behavioural and technology parameters.

The Norwegian economy is assumed to be too small to affect world prices, and the exchange rate is normalised to unity. All agents have access to international markets for financial capital, where they face an exogenous real rate of interest. Government spending, as well as the public budget surplus are exogenous. The public budget constraint is satisfied by endogenous adjustments of lumpsum transfers.

Goods and services, including those from labour and capital, are perfectly mobile across industries. Supply equals demand in all markets in all periods. One implication of this standard assumption is that we disregard the possibility of unemployment. One reason for choosing this approach is that the inclusion of short-run rigidities and frictions in addition to structural long-run effects in CGE-models, is yet at a premature stage. Another argument, put forward in e.g. Krugman (1996) and Johansen (1960), is that the Government has other policy instruments which have a far more powerful impact on unemployment than any trade policy. Thus, an accommodating macroeconomic policy will neutralise any impacts on unemployment caused by trade policy changes.

One of the characteristics of the intertemporal general equilibrium in MSG-6 is that the current account surplus in the steady state is zero, i.e. the stationary trade surplus is exactly sufficient to pay the interests on the foreign debt accumulated before the steady state is reached. As the accumulated foreign debt depends on what happens in this transition period, the steady state solution of the model is path dependent, as for the model analysed in e.g. Turnovsky (1995), ch. 12.

## 2.2. Household Behaviour

Consumption, labour supply and savings are derived from the decisions of one representative price taking household with perfect foresight, which maximises an intertemporal CES utility function over an infinite horizon subject to an intertemporal budget constraint and a time constraint effective in each period. The intertemporal budget constraint is derived from a non-ponzi game condition which prevents the total Norwegian net debt to foreigners from exploding. When Government annual net debt is assumed to follow the same exogenous time path in the pre- and post-reform scenarios, it follows from Walras' law that the transversality condition for the net foreign debt implies an intertemporal budget constraint for the household. The intertemporal elasticity of substitution is assumed to be 0.3, which is in line with other studies, see Steigum (1993). The rate of subjective time preference is fixed equal to the exogenous after-tax interest rate to obtain a steady state solution. In each period the consumer allocates an exogenous time endowment to leisure and labour according to standard consumer theory. On the margin the price of leisure equals the average wage rate received by employees net of the average marginal tax rate on labour income. The market prices of the consumption goods include VAT and other indirect taxes on private consumption. Based on microeconomic studies of labour supply in Norway, see Aaberge, Dagsvik and Strøm (1995), the elasticity of substitution between leisure and consumption has been set to 0.25. Combined with the assumption of homotheticity of the subutility function defined over consumption and leisure, and calibrated budget shares, the *partial* labour supply function is backward bending. Bye and Holmøy (1997) provides a more detailed description of the intertemporal behaviour and the labour supply decision in MSG-6. The composition of private consumption is determined in a nested separable structure of origo adjusted CES subutility functions, see Aasness and Holtmark (1995).

## 2.3. Market Structure and Producer Behaviour

MSG-6 distinguishes between the behaviour of the individual firms and the aggregate industry behaviour. Output and input in an industry can change both because of changes at the firm level and as a result of entry or exit of firms. Entry (exit) takes place in an industry if the variable after-tax profit increases (decreases) relatively to the net fixed cost associated with entry. Holmøy and Hægeland (1997) provide a detailed analysis of the production model in MSG-6. Below we summarise the features most relevant for trade policy analyses.

All firms in the private business sector are run by managers with model consistent expectations, who maximise present after tax value of the cashflow to owners. The private profitability is affected by the system of capital income taxation, the payroll tax and other taxes on input factors. In addition, various

commercial policy instruments are specified, including a detailed description of government transfers and subsidies. In order to capture the impact of these measures on the entry/exit incentives, the model distinguishes between output dependent transfers and those that are “neutral” with respect to the firm output.

The model of the entry/exit mechanism in MSG-6 differs from the standard textbook model of the Large Group Case of Monopolistic Competition (LGMC), see e.g. Helpman and Krugman (1985), by allowing productivity differentials between firms within the same industry. Klette (1994) and Klette and Mathiassen (1995, 1996) document that such differentials are substantial and persistent in Norwegian industries. In MSG-6, firms are ranked according to their total factor productivity level, with firm no. 1 being the most efficient. The heterogeneity is captured by a constant parameter indicating the average relative productivity differential between any two adjacent firms. The reward for this restrictive assumption is analytical expressions for aggregate industry variables in terms of the equilibrium for the most efficient firm and the number of active firms in the industry. Accordingly, the model does not have to describe each individual firm. The productivity heterogeneity, combined with the entry/exit mechanism, introduces a source of decreasing returns to scale at the industry level through variations in number of firms. However, this effect will be modest as long as the changes in the number of active firms are not very large.

Producers of manufactures and tradable services allocate their output between the domestic and the foreign market, which are assumed to be segregated. It is assumed costly to change the composition of these deliveries. This aspect of the technology is captured by assuming that output is a Constant-Elasticity-of-Transformation function of deliveries to the export market and deliveries to the domestic market.

As noted above, world prices of exports is exogenously determined in the world markets. Aukrust (1970) and Bowitz and Cappelen (1994) find empirical evidence supporting the (common) view that Norwegian manufacturing firms behave more like price takers on the export markets than they do domestically. In the domestic markets of manufactures and services it is therefore assumed that firms exhibit market power since the products from different firms within the same industry are regarded by Norwegian customers as close, but imperfect, substitutes. The market structure is formalised by LGMC. The demand function facing each firm in a differentiated industry is derived through decisions at several stages. For all agents on the demand side, separability assumptions imply that an industry product can be defined as a symmetric CES function of the quantities of the firm specific varieties.



The domestic demand function for the variety produced by firm no.  $i$  then takes the form  $(P_i^H/P^H)^{-\sigma} D^H$ , where  $P_i^H$  is the variety price charged in the domestic market, and  $D^H$  and  $P^H$  are the CES volume- and price indexes for the domestic demand facing the whole industry. The elasticity of substitution between the firm specific varieties,  $\sigma$ , is calibrated to be consistent with the estimated markup ratios between the output price and marginal costs in Klette (1994)<sup>3</sup>. None of the markup ratios exceed unity by more than 5 percent, which implies that the scope for love-of-variety effects on aggregate welfare is relatively small.

Turning to the demand for input factors, the separability assumptions allow all inputs to be perfectly aggregated into one index of aggregate input through a system of nested constant-returns-to-scale CES functions. Most of the elasticities of substitution have been set in accordance with estimates presented in Alfsen, Bye and Holmøy (1996, ch. 3), which are derived from sectoral time series. Most inputs are Armington composites of imperfectly substitutable imported and domestic varieties. Capital goods and intermediates are Leontief aggregates of the commodities specified in the model. Firms are assumed to be price takers in all factor markets. The production function for the firm is assumed to exhibit decreasing returns to scale. The scale elasticities range from 0.85 - 1.00. Evidence of decreasing returns to scale at the firm level is presented in Klette (1994)<sup>4</sup>. Moreover, the variable cost function of the firm is assumed to be additively separable into distinct cost functions for exports and domestic deliveries, respectively.

## 2.4. Imports

For one group of tradables, consisting of manufactures and services, imported products are considered as close but imperfect substitutes for the corresponding differentiated products supplied domestically. This Armington hypothesis implies that the import shares of these tradables depend negatively on the ratio of the import price to the price index of domestic deliveries. The initial import shares are calibrated and vary in general both between commodities and source of absorption. The elasticities of substitution have been set in accordance with the stationary time series estimates reported in Naug (1994). Commodities produced by primary industries, including *Electricity*, *Crude Oil and Natural Gas*, as well as products from *Agriculture*, *Forestry* and *Fishery*, constitute a second group of tradables, which are assumed to be regarded as homogenous by both Norwegian and foreign consumers. The domestic prices of these commodities are equal to the corresponding import prices,

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<sup>3</sup> From profit maximisation the monopolistically competitive firm sets the markup ratio,  $m$ , according to  $m = \sigma/(\sigma-1)$ , where  $\sigma$  is the elasticity of substitution between varieties of the same differentiated product.

<sup>4</sup> Compared to the estimates in Klette (1994), the scale elasticities in MSG-6 are negatively biased. This bias was accepted in order to avoid unrealistic specialisation patterns within the export oriented industries.

and the model determines *net* imports, as the residual between domestic production and domestic demand.

Barriers on imports of good  $i$  are quantified by a *protection rate* ( $PR$ ) defined as the generated gap between the price on the imported good (net of indirect taxes), and a reference price defined as the lowest possible import c.i.f. price. In MSG-6,  $PR$  is decomposed into three components: the *tariff rate* ( $t$ ), the *penetration cost rate* ( $PCR$ ) and the *quota rent* ( $QR$ ). The two latter refer to effects of two distinct groups of NTBs; those which represent an exogenous increase in the costs of penetrating the domestic border on top of the tariffs, and those which arise from quotas or prohibitive import barriers. The latter price gap component depends endogenously on the market conditions and the exogenous import volumes (which are zero in the case of prohibitive barriers). The import price of commodity  $i$ ,  $P_i^I$ , is then determined as  $P_i^I = P_i^W (1+PR_i) = P_i^W (1+t_i)(1+PCR_i)(1+QR_i)$ , where  $P_i^W$  is the exogenous world price of imports.

### **3. The content of the policy reforms**

#### **3.1. Recent agreements on trade- and industry policy**

Quantifications of the results of four recent international treaties are reported in the subsequent subsections. The EEA agreement, which was implemented from January 1994, and the WTO agreement in force from January 1995, are the two most comprehensive. Both involve considerable changes in the trade conditions for Norwegian industries. In addition, the analysis include the anticipated effects of two agreements on subsidies, an EFTA resolution concerning fishery effectuated from January 1994, and new EEA rules concerning shipbuilding, expected to apply from January 2001. The announcement of the reforms is treated as an exogenous shock in the first year of the simulation period (1992). The reforms are phased in according to the time schedules specified in the agreements. All exogenous changes have taken place within year 2005. This simulation path is compared to a path characterised by a status quo policy from 1992, before the reforms.

### 3.2. Changes in the import regime<sup>5</sup>

Already before the recent reforms, tariffs were insignificant in the Norwegian protection system. Free trade agreements on tariff elimination between Norway and the EU and EFTA countries have existed for several decades, and low tariffs were assigned to third country imports. The only exemptions applied to food, beverages, tobacco, textiles and clothes. No previous agreements have, however, placed effective restrictions on the use of NTBs. It is especially in this field the prohibitions and regulations in the EEA- and WTO treaties are expected to induce changes.

In Table1, NTBs before and after liberalisation are quantified by *ad valorem* QRs and PCRs. The pre-reform NTB regime was particularly restrictive for *Agricultural Products*, *Meat and Dairy Products*, *Other Processed Food*, and *Beverages and Tobacco*. For the two former, import quotas or prohibitive measures were dominant. This is also true after implementation of the reforms. Though the WTO treaty turns all previous quantitative barriers on food into tariff rates, they are still at prohibitive levels and function similarly to quantitative restrictions. The import volumes are estimated to increase by 14% for *Agricultural Products* and by 19% for *Meat and Dairy Products*, contributing to lower the QRs. This is due to several liberalising changes in the EEA treaty and to the WTO regulations of market access, which may not fall for any product, and must increase if imports represent less than 5% of consumption<sup>6</sup>. Lower tariffs on imports from LDC countries enable Norway to satisfy these requirements. *Other Processed Food* and *Beverages and Tobacco* were mainly protected by (non-prohibitive) tariffs, import levies and technical barriers. For the former, the WTO tariffication actually increases protection, due to a sharp increase in production costs for flour. While cereals were previously imported at world market prices by a state-owned import monopoly, they are now subject to high tariffs. Concerning *Beverages and Tobacco*, both agreements prohibit several technical barriers. They have also eliminated the import monopoly on alcoholic beverages.

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<sup>5</sup> In Fæhn (1997) and Fæhn and Grünfeld (1999) the pre-reform and post-reform estimates, respectively, are documented in further detail.

<sup>6</sup> This refers to the average consumption over the period 1986 to 1988.

**Table 1. Ad valorem PRs exclusive of tariffs, before and after liberalisation (per cent)**

Goods	Reference path	Reform path
<i>Agricultural Products</i>	40 <sup>1</sup>	36 <sup>1</sup>
<i>Meat and Dairy Products</i>	66 <sup>1</sup>	54 <sup>1</sup>
<i>Other Processed Food</i>	33	34
<i>Beverages and Tobacco</i>	42	26
<i>Textiles and Clothes</i>	1	0
<i>Manufacturing Products</i>	7	0
<i>Industrial Chemicals</i>	3	0
<i>Hardware and Machinery</i>	4	0
<i>Oil Platforms</i>	3	0

<sup>1</sup> These figures refer to the stationary part of the paths. QRs are, as mentioned, endogenously determined.

Imports of *Textiles and Clothes* from most low cost countries were previously restricted by high tariffs (17 percent on average) and *Voluntary Export Restraints* (VERs), having price effects of similar magnitude. On average, protection rates are nevertheless low<sup>7</sup>. In accordance with the WTO treaty, VERs are to be removed and tariffs reduced by 40%. The previous protection rate for *Manufacturing Products* was related to technical barriers on pharmaceutical products, as well as to evidence on collusive market sharing in the cement industry. For *Industrial Chemicals*, the rate arises from technical standards on fertilisers. *Hardware and Machinery* were sheltered by tariffs and technical standards. Finally, *Oil Platforms* were found to be significantly protected through discriminating government procurement policies. For all of these industrial products, the effects of the NTBs are treated as PCRs<sup>8</sup>. After full implementation of the international agreements, the PCRs are expected to fall to zero. Protection by means of technical standards, quantitative restrictions, discriminatory procurement policies and market regulations are then prohibited, and effective enforcement procedures introduced. Most of the NTB changes imply altered real costs of importing (e.g. when technical standards and rules of government tender procedures are harmonised) or altered quota rents collected by foreigners (e.g. when bilateral export- or import quota arrangements are eliminated). The changes in PCRs and QRs are thus modelled to affect import c.i.f. prices and will generate terms-of-trade effects.

<sup>7</sup>Weights according to country of origin are based on the estimated import pattern in case of absence of VERs (Melchior (1993)), to avoid parts of the bias in favour of imports with preferential trade conditions. As also the tariff policy favours high-cost trade partners, the average reference prices still tend to be overstated.

<sup>8</sup> Truly, barriers like VERs or market sharing arrangements have the character of quotas. But as the products restricted by these measures constitute minor parts of their respective commodity aggregates, treating the import level of the whole aggregate as exogenous, will be quite misleading.

### 3.3. New rules on governmental aid

Recent international negotiations on trade liberalisation have increasingly focused on the diverting role of subsidies. Subsidies to Norwegian industries in 1992 (see Table 2) were primarily directed towards *Agriculture, Fishery* and *Shipbuilding*. According to the WTO agreement on agriculture, support defined to distort competition is to be reduced by 20% within 2001. However, by purely redirecting subsidies, we anticipate that a prolonging of the overall subsidy rate of 1992 may be obtained (see Skjeflo et al. (1994)). The WTO agreement also restricts the use of export subsidies to agricultural and food products. The effects will be minor, since Norwegian agricultural export is relatively small. The EFTA resolution on fishery turned about 40% of the previous subsidy arrangements illegal. Finally, we have included the effects of a complete removal of subsidies to shipbuilding. This is the anticipated consequence of a prohibition carried by the EU Commission, which is likely to be implemented within the entire EEA area from January 2001. The rules on government aid to the industry sectors in the WTO and EEA treaties are not found to impose any additional restrictions on state aid.

**Table 2. Subsidies to industries in 1992**

	Net subsidies (mill. ECU)	Pre-reform net subsidy rate <sup>1</sup>	Post-reform net subsidy rate
<i>Agriculture</i>	836	26.4	26.4
<i>Fishery</i>	56	7.2	4.3
<i>Shipbuilding</i>	99	6.2	0
<i>Manuf. of Meat and Dairy Products</i>	207	4.4	4.4
<i>Printing and Publishing</i>	64	2.1	2.1
<i>Forestry</i>	9	1.9	1.9
<i>Manuf. of Other Consumption Goods</i>	69	1.8	1.8
<i>Preserving and Processing of Fish</i>	26	1.7	1.7
<i>Manuf. of Chemical and Mineral Products</i>	60	1.5	1.5

<sup>1</sup>Net subsidy rate is defined as net subsidies as percentage of gross production value in the sector

### 3.4. Changes in world market conditions

The EEA agreement, which has the effect of incorporating the relatively small EFTA countries in the inner market, is not expected to significantly affect the producer price levels of important trading partners of Norway, including EU. However, the agreement has a potential of increasing Norwegian competitiveness for fish. In 1992, EU tariffs on fish products ranged from 10 to 30 percent depending on the degree of processing. Based on Bowitz, Fæhn, Grünfeld and Moum (1997), we have calculated

a 2 percentage point reduction in EU tariffs and -NTBs in response to the EEA agreement, thus raising Norwegian export prices<sup>9</sup>.

Our estimates of the world market price changes due to the WTO implementation are based on Haaland and Tollefsen (1994). They study the effects of the WTO treaty by applying a 4-region (EU, EFTA, USA and Japan) CGE model that allows for imperfect competition. They find that most consumer prices fall by between 1.5 and 2% in the significant areas for Norwegian trade. Since removal of trade barriers is assumed to directly reduce consumer prices by 2.5 percent, their findings suggest a slight increase in international producer prices, by 0.5 - 1.0 percent. Increased primary factor prices seem to dominate the effects of lower markups and marginal costs from liberalisation. Norwegian export- and import prices are affected similarly by the rise in world prices. For the import prices, however, this is only part of the story. They are as mentioned also affected negatively by the removal of NTBs. On average, the import c.i.f. prices *fall* by 1.14 percent in the long run.

The EFTA resolution on subsidy reductions to fisheries is expected to increase marginal costs of all participants to approximately the same extent. Thus, Norwegian export deliveries remain unaffected by this reform.

To determine the development of world market prices on ships in the two scenarios with and without the subsidy prohibition of the expected EEA resolution, we have consulted Hellesjø, Mohn and Wergeland (1994), who construct a cost curve for the world shipbuilding industry<sup>10</sup>. They conclude that Japanese marginal costs determined the world market prices for ships in 1992. By combining anticipated demand and capacity developments with the cost curves of the two scenarios with and without the OECD subsidy agreement, two world market price scenarios may be deduced<sup>11</sup>. In our reference scenario without a EEA resolution, marginal costs of Japan will define the world price of ships. If the agreement comes true, the world price will increase to a level 20% beyond Japanese prices within the first 8 years; reflecting the cost level of marginal (European) suppliers. As demand growth decreases, world prices fall again to the Japanese cost level.

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<sup>9</sup> EU still has the option to employ minimum prices and anti-dumping measures on Norwegian fish products, and has proved to do so. We do not, however, regard such practice to be more comprehensive or long-lasting in presence of the EEA agreement.

<sup>10</sup> Their cost curve hinges on the assumption that ships may be regarded as a homogenous product. Several facts allow for this: The flexibility of large scale Japanese and South-Korean shipyards has shown to be high and technological diffusion to occur rather fast. Contracting is easily made in any country and the significance of transport costs easily evaded by undertaking the first transport order from the site of the yard.

<sup>11</sup> We have used an estimate of 2 percent capacity growth per year (Hellesjø et al. (1994)) and the base demand scenario of *Association of West European Shipbuilders (AWES) (1993)*. Capacity utilisation then increases until 2001 and later falls somewhat, due to a slowdown of the demand growth.

## 4. Equilibrium adjustments to the policy reforms

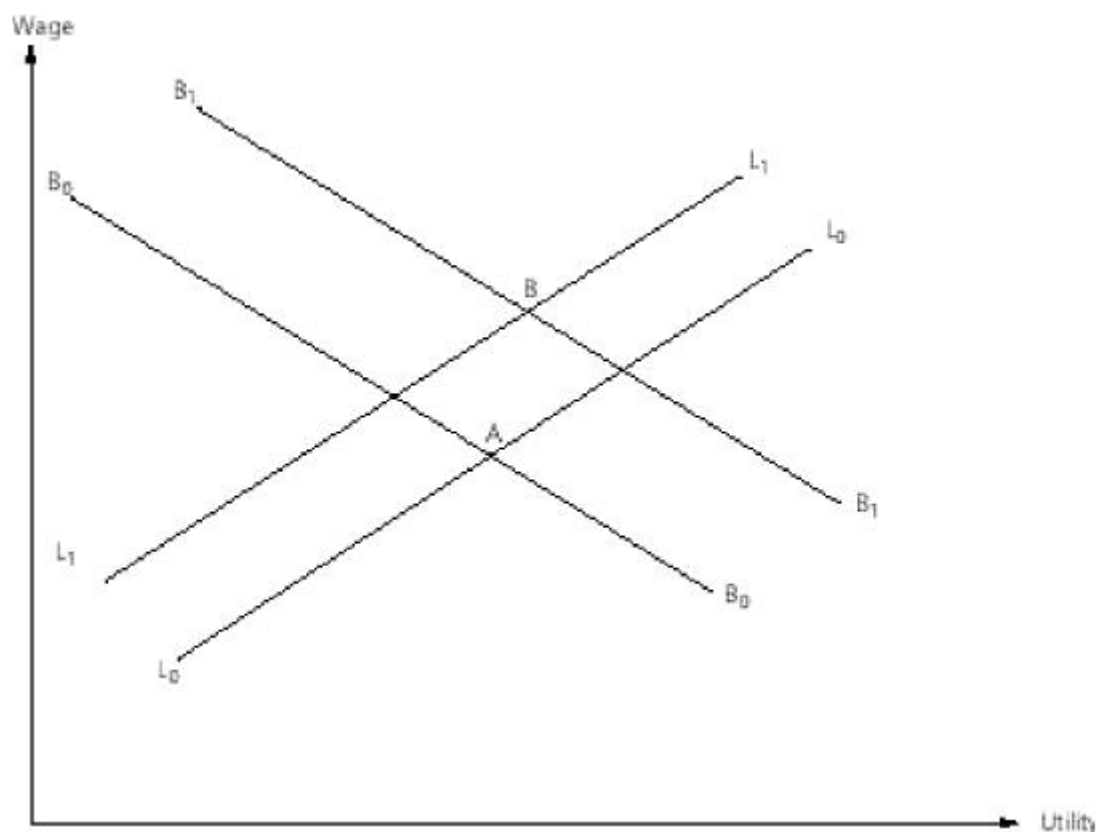
In this section we explain the key determinants of those reallocations that have the strongest impact on aggregate welfare. To this end, we employ a framework in 4.1, which is stylised, but consistent with the major macroeconomic mechanisms of the computable model, see Holmøy (1999). One of the simplifications made concerns the path dependence of the steady state solution, which strictly implies that the stationary long-run results cannot be analysed separately from the dynamic adjustments over the transition period (see Section 2). However, by linearising the dynamics, as in Turnovsky (1995, Ch. 12), the long-run effects may be analysed qualitatively by standard comparative statics.

Recursively, the analysis of the transitional dynamics follows in 4.2.

### 4.1. Steady state effects

Holmøy (1999) shows that the general equilibrium of a stylised aggregate version of MSG-6 can be represented by the intersection of the two curves LL and BB drawn in the wage-utility diagram in Figure 1.

**Figure 1. The determination of the stationary equilibrium utility level and wage rate in MSG-6.**



The meaning of these curves can be explained as follows. Let the stationary excess demand function for labour be given by  $EL(w, U, Z)$ , where  $w$  is the wage rate,  $U$  is the utility level and  $Z$  is the vector of exogenous variables. Let  $EB(w, U, Z)$  denote the stationary current account surplus. The LL-locus in Figure 1 is defined by  $EL(w, U, Z) = 0$ , and describes the wage and utility combinations which are consistent with labour market equilibrium. The BB-locus, defined by  $EB(w, U, Z) = 0$ , describes the wage and utility combinations which make the economy obey the intertemporal budget constraint in the sense that the present value of the net foreign debt does not explode. This constraint captures the path dependence of the steady state equilibrium.

In general equilibrium  $EL(w, U, Z) = EB(w, U, Z) = 0$ . The slope of the LL-locus is determined by  $(dw/dU)_{LL} = -EL_U / EL_w$ , where  $EL_U$  and  $EL_w$  are the partial derivatives of  $EL(\cdot)$  with respect to  $U$  and  $w$  respectively. Correspondingly, the slope of the BB-locus is defined by  $(dw/dU)_{BB} = -EB_U / EB_w$ . In such a large model as MSG-6 the true expressions for these partial derivatives would be extremely complex, reflecting the multitude of repercussions operating in the model. However, confining the analysis to those effects that turns out to be empirically interesting<sup>12</sup>, the partial derivatives depend on the strength of the following effects.

**$EL_U$ :**

- i) A partial increase in the utility level causes households to increase their consumption of goods and leisure. Both changes contribute to increased excess demand for labour, i.e.  $EL_U > 0$ .

**$EL_w$ :**

- i) A partial increase in the wage rate causes firms to lower labour demand relative to other factors of production.
- ii) The higher wage rate shifts the unit cost functions upwards, especially in the most labour intensive industries. For import competing- as well as exporting Norwegian producers, the international competitiveness deteriorates, causing a negative scale effect on labour demand.
- iii) Households will experience an increase in the relative price of domestic goods produced by the most labour intensive technologies, and substitute less labour intensive ones for these. More generally, resource reallocation between industries reinforce the fall in labour demand, because the labour intensive industries are hardest hit by the demand adjustments to the rise in the labour costs, a Rybczynski effect.

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<sup>12</sup>Insight in the empirical significance of various effects in MSG-6 has been gathered through systematic simulation experiments as well as analytical examination of stylised aggregate versions of the model.



iv) The real consumer wage rate rises, and households move along the fixed indifference curve substituting consumption for leisure. This substitution implies a simultaneous rise in both labour supply and induced labour demand, having opposite effects on excess demand for labour. Due to taxation of labour income and consumption, as well as import leakage, the former will unambiguously dominate.

All these effects contribute to make  $EL_w < 0$ .

**EB<sub>U</sub>:**

i) A partial increase in the utility level causes households to increase their consumption, including imports, which reduces the current account surplus, i.e.  $EB_U < 0$ .

**EB<sub>w</sub>:**

i) The loss of international competitiveness caused by a partial wage increase reduces exports and increases import shares.

ii) Households substitute consumption of goods for leisure, which raises imports.

Both effects contribute to make  $EB_w < 0$ .

It follows that  $(dw/dU)_{LL} = -EL_U/EL_w > 0$  and  $(dw/dU)_{BB} = -EB_U/EB_w < 0$ . Thus, the LL-locus consistent with the empirical properties of MSG-6 is increasing in the  $w$ - $U$  diagram, whereas the BB-locus is negatively sloped. To summarise, there is a positive relationship between the wage rate and the utility level along the LL-locus, because a partial increase in the wage rate from any point on the curve implies unemployment, whereas a partial increase in utility implies excess labour demand. Consequently, in order to restore labour market equilibrium, higher utility must be neutralised by a higher wage rate. There is a negative relationship between the same variables along the BB-locus because partial increases in both the wage rate and the utility level have negative effect on the net export value.

In Figure 1, the loci with subscript “0” denote the pre-reform situation, and the loci with subscript “1” denote the post-reform situation. Both loci shift upwards due to the reduction of import c.i.f. prices, the increase in the world prices of exports and the reduction of industry subsidies. As concerns the shift in the BB-locus, the changes in import- and export prices improve terms of trade, thereby raising exports and import shares. The reduction of industry subsidies implies higher marginal costs, which has a negative effect on exports, and reinforces the substitution of imports for domestic products. On balance, however, exports rise, and by more than the import growth. Adding these changes to the

impact of improved terms of trade yields a current account surplus as long as the wage rate and the stationary utility level are held constant. Keeping the utility level (wage rate) fixed, the wage rate (utility level) must rise in order to restore the current account balance. This corresponds to a shift upwards of the BB-locus.

Turning to the labour market, the excess demand for labour is affected by mechanisms pulling in both directions. The most significant positive effect in MSG-6 works through export growth. This is mainly due to great elasticities of the export supplies to changes in the ratios of world prices to unit cost indexes, which lie in the vicinity of 6.5. On the other hand, lower import c.i.f. prices and less non-tariff protection imply a rise in the import shares in various categories of domestic demand.

Accordingly, the import competing industries contract and reduce their labour demand. Furthermore, the price of those capital goods and intermediates which are either directly imported or produced (through the input-output structure) by means of imported products, will fall. For a given wage rate, the resulting factor substitution reinforces the reduction of labour demand. Moreover, lower import prices give rise to a substitution of household consumption of goods for leisure. As noted above, the direct expansion of labour supply dominates the indirect positive impact on labour demand. For fixed utility- and wage rate levels, the net effect of the reforms on excess labour demand is positive<sup>13</sup>, implying an upward shift in the LL-locus in Figure 1.

The result of the simultaneous shifts of the loci described above is illustrated in Figure 1. According to the simulations, the wage rate increases by 1.75 percent compared to the steady state of the reference path, while the corresponding utility increase is 0.81 percent. From the steady state effects on these two variables, one can derive all remaining long-run changes recursively. Changes in key variables are reported in Table 3. As will be explained in Section 5, one effect that has important welfare implications, is the 0.58 percent fall in employment. This reduction is most easily accounted for by examining the incentives affecting labour supply. The combination of lower import prices and higher wage rates brings about a positive substitution effect. The substitution effect is, however, dominated by a negative income effect working through higher utility.

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<sup>13</sup> This property of MSG-6 has been checked by simulations of a special version of the model, in which the closure rule has been properly revised in order to compute the LL-locus and the sensitivity of its position to changes in exogenous variables.

**Table 3. Key macroeconomic steady-state effects. Deviations in percent between the post- and the pre-reform scenarios**

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Utility	0.81
Consumption	1.00
Employment	-0.58
Price index for consumption	0.20
Wage rate	1.75
User cost of capital	0.25
Real capital	0.09
Housing capital	0.61
GDP	-0.14
Net foreign wealth	-21.37
Trade surplus	4.95
Export prices	0.50
Import prices	-1.14

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In the subsequent sections we will also discuss the welfare effect of the adjustments of the aggregate real capital stock. In the long run the capital stock is found to increase by 0.09 percent. This slight increase reflects that a negative scale effect is weakly dominated by a positive factor substitution effect in favour of capital. The latter substitution is driven by a rise in the steady state ratio of the wage rate to the user cost of capital equal to 1.50 percent. Note that the 0.67 percent rise in the aggregate capital-labour ratio reflects factor substitution both at the industry level and the Rybczynski effect of reallocation of resources from labour intensive to capital intensive industries<sup>14</sup>. Expansion of the housing capital is especially important in this respect. It follows that a measure of the macro elasticity of substitution between capital and labour is  $0.67/1.50 = 0.45$ .

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<sup>14</sup> This effect plays a significant role in MSG-6 since, as already pointed out, export supplies are rather sensitive to changes in costs.

## 4.2. Equilibrium dynamics of utility, investment and saving

The equilibrium dynamics set in force by the trade reforms is determined both by forward looking behaviour of the consumer and producers, the stock-flow dynamics associated with accumulation of real capital and foreign wealth, as well as the gradual phasing in of the reforms within the period 1995 to 2005, after having been announced in 1992.

The variation over time of the increase in utility, see Figure 2, is inversely related to the changes in the annual cost-of-living index through the intertemporal substitution. The changes in cost-of-living index can be attributed to three sources. First, the exogenous fall in import prices reduces the price of consumption both directly and indirectly through reductions in the domestic costs of production. Second, the endogenous adjustments of the wage rate affects the cost-of-living index directly through the price of leisure, and indirectly through the incidence on the prices of domestic deliveries. Third, price dynamics will affect the cost-of-living index through the incidence of changes in the user cost of capital goods. Among these sources, the wage rate adjustments turn out to have the strongest influence on the cost-of-living index.

**Figure 2. Equilibrium dynamics of utility. Percentage deviations between post- and pre-reform scenarios**



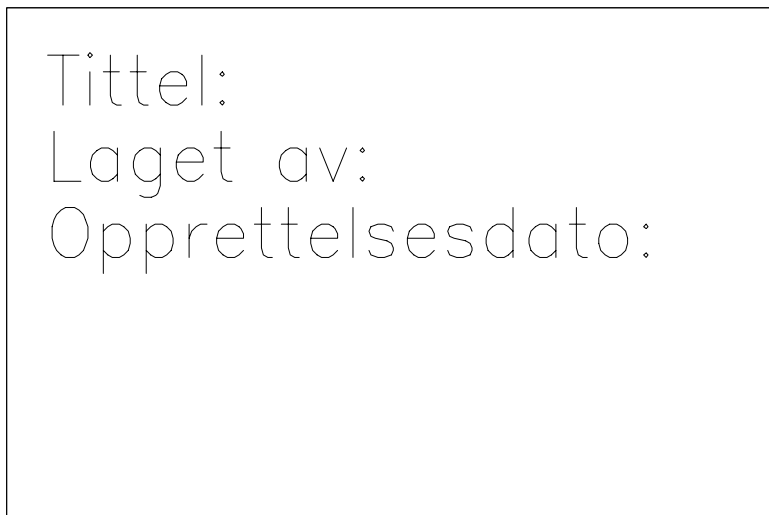
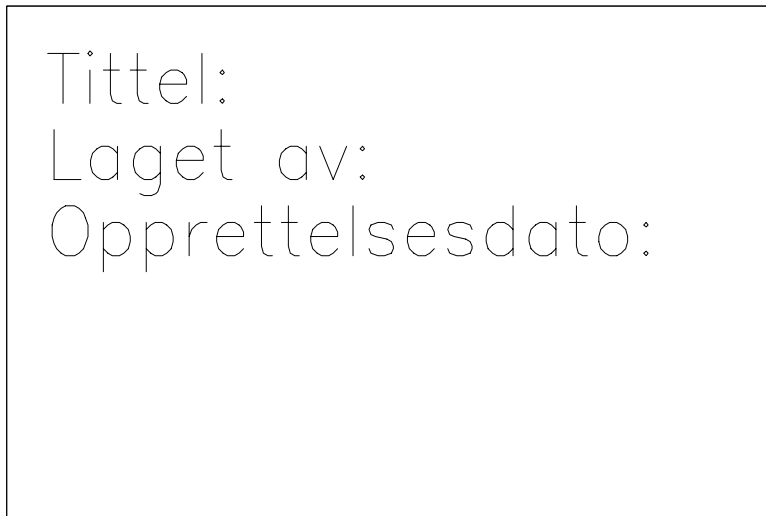
The wage rate changes can be interpreted as equilibrium adjustments to non-constant shifts in labour supply and -demand. In the years between 1997 and 2001, the post-reform growth in world prices is particularly strong, causing a sharp growth in labour demand from the relatively price elastic export-oriented industries, along with relatively slow, import price reductions. The positive substitution effects on import shares and labour supply are therefore relatively weak in these years.. The wage

rate responds to these shifts by increasing rapidly until 2001 when it peaks at a level which is 1.95 percent above the corresponding pre-reform level. From 2001 to 2005, the most substantial fall in import prices occurs and relaxes the pressure in the labour market. The wage rate stabilises at 1.75 percent above the pre-reform level. This is higher than the immediate rise of 1.47 percent, as the long-run import- and export prices are, respectively, lower and higher. Whereas the wage rate adjustments contribute to make the long-run rise in the cost-of-living index higher than the immediate increase, the incidence of gradually declining import prices works in the opposite direction. This explains why the long- and short-run effects on the cost-of-living index are approximately equal, as can be inferred from Figure 2.

Although the capital stock hardly changes in the long run, the reforms generate transitory changes in aggregate investment. Whereas investment falls in most years before 2001, investment starts growing relatively to the pre-reform path in the wake of the significant import price fall between 2001 and 2005. The gradual reduction of the import prices brings about a decline in the market prices of capital goods over time. The impact on the *user cost* of capital goods is ambiguous, however, because the expected decline in the capital goods prices implies negative expected capital gains. In the years before 2001, the cost effect of negative capital gains is sufficiently strong to bring about a reduction in aggregate investments. As this effect fades out, the increase in the user cost of capital gradually declines, and it becomes profitable to let capital accumulate up to the desired steady-state level, as shown in Figure 3.

The dynamic effects on investment are transmitted to the labour market. In particular, the sharp expansion of investment in the last years of the reform period, implies another wage peak in 2005. This effect is carried over to the cost-of living index and is reflected in Figure 2 by the non-monothonic growth in the utility change after 2001. The wage rate adjustments, combined with decreasing returns to scale in production of capital goods, imply that there is costs of aggregate capital adjustments in the model. In effect, a small part of the changes in investments is financed by crowding-out of utility. The main part of the changes in capital formation, as well as the immediate increase in consumption, is financed by issuing foreign debt (see Figure 3). Thus, the simulated results show that Norway exploits her access to the international credit market. In order to service the part of the increase in the foreign debt that cannot be financed by improved terms of trade, the trade surplus becomes positive after about 10 years. In the stationary solution it has increased by 4.91 percent.

**Figure 3. Equilibrium dynamics of real capital and net foreign wealth. Percentage deviations between post- and pre-reform scenarios**



## **5. The main sources of the welfare gain**

The simulated welfare gain, calculated in accordance with the household preferences, i.e. as the growth in present value of the utility flows reported in the previous section, equals 0.77 percent. The result is modest, but placed well within the bond of results from similar policy experiments in the CGE literature, see e.g. the survey of Francois et al. (1996) on Uruguay-Round assessments. In this section we identify the most important sources to the welfare gain. Note that besides effects on welfare from terms-of-trade changes, the reforms induce reallocations, which may affect welfare for several reasons. First, the conventional free trade argument says that reductions of price distortions caused by protective policies and subsidies reduce deadweight losses. Second, imperfections emphasised to have potential welfare implications in the trade literature of the 1980s, like imperfect competition,

externalities of increased product variety and scale economies, are built into the model. Third, the Norwegian economy, as any real economy, is riddled with numerous tax distortions, which remain after the implemented reforms. All changes in the equilibrium of markets with remaining imperfections and tax wedges will have first-order effects on welfare.

Before proceeding with a decomposition of the welfare gain, we examine how this gain is affected by the fact that the reforms are implemented gradually, not immediately. We find that if, hypothetically, the trade reforms were implemented immediately at the time of announcement, the welfare index would grow by 1.22 percent. Thus, the cost of a gradual rather than an immediate implementation of the trade reforms, is quantified to almost 40 percent of the potential welfare. We stress, however, that this is a gross measure. There may be good reasons, which are not captured by the model, for undertaking a phased reform process.

Empirically, the terms-of-trade gain turns out to be the dominating explanation of the welfare growth. The most important contribution to the terms-of-trade gain stems from national NTB removals, since external world price changes affect import- and export prices symmetrically. The overall, long-run result is an average rise in export prices of 0.50 percent and fall in import prices of 1.14 percent. As a first-order approximation the direct income effect of improved terms of trade can be measured by the increase in the present value of the net export value that follows from evaluating the *pre*-reform export- and import quantities at *post*-reform rather than *pre*-reform prices of exports and imports, respectively<sup>15</sup>. Such a calculation yields an increase in income equal to 0.70 percent of the initial welfare level, which indicates the additional import that can be afforded by Norwegians, evaluated at world prices. In a world without taxes, marginal utilities of consuming imports would be proportional to the world prices, so this figure would express the approximate welfare effect of the terms-of-trade gain, see e.g. Woodland (1982). When there are tax wedges between consumer prices and world prices, the additional imports that can be enjoyed due to the terms-of-trade gain should be evaluated at consumer prices rather than world prices. The tax wedge between world prices and consumer prices equals on average about 23 percent in Norway. A rough welfare assessment of the terms-of-trade gain thus amounts to slightly less than 0.9 percent<sup>16</sup>.

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<sup>15</sup> This can be done since units are normalised, so that the utility level in the base year equals the consumption expenditure. Thus, the marginal utility of income is normalised to unity in the base year.

<sup>16</sup> The formula underlying this assessment is derived as a separate component in the decomposition of the welfare effect described in the appendix.

It follows that the reallocations captured by the model on balance generate a welfare *loss* close to 0.1 percent of the initial welfare level. This is a net measure summarising contributions to welfare from a huge number of reallocations. In order to identify those with the most significant impact on welfare, it is useful to recall the fundamental reason why reallocations may influence welfare in a setting where lumpsum transfers are used to balance the public budget. Welfare increases (decreases) when a given resource (factor, commodity) is reallocated to a kind of use where the wedge between marginal utility and the marginal social cost is larger (smaller) than in the initial allocation. In MSG-6 such wedges are due to taxes and markups in prices set by domestic firms. The fact that distortive taxes may have distributional functions or serve as corrections of market failures, is not accounted for in the model. Given this, the absolute welfare effect from reallocation of a resource is the higher are the wedges between the prices facing different agents supplying or demanding the resource, and the more the transacted volume of the resource responds to the changes induced by the policy reform. These general guidelines combined with systematic simulations on the model, have led us to focus on the following reallocations.

The most important negative welfare contribution stems from the reduction of employment taking place in a situation with a large effective tax rate on the consumers' return to labour efforts.

The Norwegian tax system makes the social marginal utility of leisure much lower than the social marginal utility generated by labour. Thus, the reduction of employment has a negative effect on welfare. The most important elements of the tax wedge include an average marginal tax on personal labour income approximately equal to 40 percent, an effective payroll tax rate on labour costs averaging 17 percent, and net indirect taxation of consumption, including VAT, averaging 19 percent. The tax wedge made up by these three tax rates makes the ratio between the social and the private marginal rate of transformation of leisure into consumption equal to  $1.19 * 1.17 / (1 - 0.40) = 2.32$ . As a first-order approximation, the stationary utility reduction from the 0.58 percent decline in employment is estimated to 0.35 percent<sup>17</sup>. In terms of the steady state presentation in Figure 1, the isolated contribution of the tax wedge is to modify the shifts in both loci, dimensioned so that the welfare gain, as well as the wage growth, diminish.

The importance of the repercussions affecting employment can be highlighted by examining the isolated effect of removing shipbuilding support, only. If, hypothetically, this subsidy represented the only distortion, such a policy change would, of course, yield a welfare gain through improved

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<sup>17</sup> It is shown in the appendix that this estimate can be derived by the formula  $0.35 = [\text{wage cost} * (1 + \text{average consumer tax rate}) / (\text{utility value})] * (1 - 1/2.32) * \text{percentage change in labour supply}$ , where 2.32 is the wedge defined in the text.



production efficiency, since the subsidy implies that the marginal productivities of factors are lower in the shipbuilding industry than in other industries. However, simulation of such a reform on the MSG-6 model yields a slight welfare loss equal to 0.01 percent. The basic reason is that the pre-reform subsidy implies a positive shift in the aggregate labour demand. Removing the subsidy causes the real wage rate to fall in order to restore labour market equilibrium. This effect stimulates labour demand in other industries, which may improve aggregate production efficiency depending on the distortions which still remain. However, the reduction of real wages implies a negative substitution effect on labour supply, which reduce aggregate employment. In other words, only a fraction of the employment in *Shipbuilding* finds work in other industries. The major share accepts increased leisure as the optimal alternative. Due to the difference between the shadow prices of time used for leisure and labour, respectively, the average social return to the absorption of the time endowment is reduced, and this effect is the dominating one. Thus, this particular industry subsidy contributes to modify the total tax wedge between the social and the private return to employment. However, it is well known that subsidising specific industries is not the first-best policy when the basic distortion affects the labour supply incentives.

The first-order approximation made above is indicative for the welfare loss associated with a *marginal* increase in leisure at the expense of employment in an industry with *average productivity*. The approximation is however biased, as such an estimate disregards that labour productivity is affected by non-marginal changes in output and factor input in each individual industry. The labour productivity in an industry increases when all inputs are reduced proportionally, because the model assumes decreasing returns to scale at the firm level. As the scale elasticity of the production function is constant, the ratio of the marginal factor productivity to the average factor productivity equals the scale elasticity, i.e. the percentage changes in the marginal and the average factor productivities are equal. This effect is slightly reinforced in the model if firms exit from the industry. Moreover, labour productivity rises when the reduction of labour is relatively stronger than the reduction of other inputs. On average, all three effects contribute to raise labour productivity in the private sector. In the long run, total gross production falls by 0.29 percent, the number of firms in manufacturing and private service industries falls by 0.17 percent on average, the input of capital increases by 0.09 percent, whereas the input of intermediates goes down, but not as much as gross production.

Average labour productivity, measured by the GDP-labour ratio in private industries, grows by 0.65 percent in the long run. This is not, however, a result only of the variations of inputs and outputs along given production functions in each individual industry. It also results from reallocations of inputs

across industries with different shadow prices of their inputs due to sectoral differences in factor taxes, market power and industry subsidies. In accordance with the primary motivation for several of the reforms, the reductions of industry subsidies and protection trigger reallocations of labour and other input factors which, *cet. par.*, improve the aggregate production efficiency. It is, however, difficult to separate quantitatively the efficiency effect caused by such a shift in the aggregate production function for the private business sector from the efficiency effect from input changes along a fixed aggregate production function.

The broad pattern of labour flows across industries is characterised by reallocation from *Shipbuilding*, *Agriculture* and *Manufacture of Chemical and Mineral Products* to private service industries. The three first mentioned industries are all hit directly by the reforms. Employment in *Shipbuilding* goes down by 15.7 percent in the long run, mainly due to the implementation of the anticipated EEA resolution, which reduces the subsidies to this industry. In *Agriculture*, where positive remuneration to labour and capital is possible only because of massive subsidisation and transfers, employment goes down by 3.1 percent in the long run. Approximately half of the reduction of employment in *Agriculture* is due to substitution from labour to capital. The remaining reduction reflects an increase in exogenous imports and changes in domestic demand. *Manufacture of Chemical and Mineral Products* is hit by the removal of technical import barriers. Due to the growth in the household demand for services, the employment in the service industries is not much affected in the long run. This means that they increase their share of total employment. Traditional export-oriented industries (*Fishery*, *Manufacture of Pulp and Paper*, *Industrial Chemicals* and *Metals*) all increase their employment in the long run. This mirrors the aggregate macroeconomic dynamics of savings; the trade surplus rises in the long run in order to service the net foreign debt that accumulates during the first 30 years of the simulation period.

Much of the trade theory developed in the 1980s focused on the possibility that trade liberalisation might affect welfare through changes in i) the number of product varieties available to domestic demanders (love-of-variety effects), ii) the monopolistic profits earned by domestic firms (procompetitive effects), and iii) aggregate fixed costs through entry and exit of firms (rationalisation effects), see Helpman and Krugman (1985). These effects are active in simulations on MSG-6, but they turn out to be of minor importance in the present study. In this respect our results differ from the positive welfare role of such effects in related studies of trade liberalisation. Keuschnigg and Kohler (1996) emphasise the welfare contribution of love-of-variety effects, and especially their contribution through increased efficiency of intermediates and capital goods. The fact that love-of-variety effects

are greater in their study than in ours, is probably less explained by the design of the policy experiment than by the strength of different mechanisms at work. First, compared to their base case, the calibrated elasticities of substitution between varieties in the differentiated industries are large in MSG-6. The utility increase of a given rise in the number of varieties is decreasing in the substitution elasticity, and so is the “productivity” increase of differentiated intermediates and capital goods. Second, a special feature in MSG-6 is that the firms that enter or exit from the differentiated industries will be the least efficient ones, according to productivity heterogeneity. Thus, the benefit in terms of increased variety is smaller than in the symmetric LGMC model, because the marginal variety is more costly to produce than the other ones, and therefore obtains a very small budget share. Third, Keuschnigg and Kohler (1996) obtains a 1.2 percent increase in number of domestic firms, while the aggregate number of home-produced varieties changes by only -0.2 in our study. The general expansion of the economy thus drives much of the result in Keuschnigg and Kohler (1996), while the reductions in employment neutralises such effects in our model. The only significant contribution to a love-of-variety effect in our simulation occurs in *Shipbuilding*, where the number of domestic firms and varieties falls by 19 percent. This effect is estimated to constitute 0.6 percent of the initial producer value. Weighting the figure by the value share of ships in the utility index yields an insignificant negative welfare contribution. The minor changes in the number of firms also imply that the rationalisation effect is small in our study, contrary to e.g. Harris (1984). Again, the much weaker expansionary effects of trade liberalisation in the monopolistically competitive industries explain much of the difference. In the LGMC case with fixed markup factors, pro- or anticompetitive effects from trade liberalisation will resemble the welfare effects generated by existing tax wedges. The reforms will be procompetitive provided that activity increases in monopolistically competitive industries, as e.g. obtained in Keuschnigg and Kohler (1996)<sup>18</sup>. However, according to our simulation, the consumption growth does not involve an expansion of monopolistic industries. Instead, aggregate monopoly profits decrease, which implies a negative welfare effect since consumption is reduced in markets where the markup factor contributes to make the marginal utility greater than the marginal cost of production. However, this contribution to the aggregate welfare effect is small compared to other contributions since the markup factors are less than 1.05.

Let us now turn the focus from the supply side to the effects of changes in the composition of household consumption. Such changes will have positive impact on welfare if the consumption is reallocated in favour of goods with relatively high tax rates. This would show up in the simulation results as a stronger growth in consumer tax bases than in aggregate real private consumption.

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<sup>18</sup> See e.g. Hertel (1994) on this definition of the term *procompetitive effects* introduced in Markusen (1981).

However, the opposite is true in most of the simulation period; in the long run the aggregate base of indirect consumer taxes grows by 0.4 percent, whereas real private consumption<sup>19</sup> increases by 0.5 percent. This reflects that the composition of household consumption changes in favour of services on which there is no VAT. We conclude that changes in the composition of household consumption imply a negative, but very small, welfare effect.

Turning to the welfare implications of the intertemporal reallocations, changes in the time profile of the utility flow will in general have first-order effects on welfare in MSG-6, since interest income is taxed by 28 percent in Norway. However, model simulations, see e.g. Bye, Holmøy and Strøm (1999), suggest that aggregate welfare is rather insensitive to such reallocations. Moreover, in the present study, the dynamics of the changes in the utility flow generates a negative welfare effect during most of the first 10 years, while the opposite is true for the next 20 years, see Figure 2.

In their study of the effects of changes in post-war trade policy on U.S. economic growth, Ho and Jorgenson (1994) emphasise that the reduction of import prices obtained by removal of import barriers stimulates capital formation which has a positive welfare impact. This effect plays a much smaller role in our study. Throughout the entire simulation path we obtain quite modest changes in the capital stock, which in the long run stabilises at a level 0.09 percent higher than in the pre-reform scenario (see Figure 3). A part of the difference can of course be attributed to the fact that the two studies analyse different trade policy shifts in different economies. However, there is also reason to believe that the models work differently when exposed to the same exogenous changes. In particular, employment increases in the study by Ho and Jorgenson. Thus, whereas the scale effect on capital formation is negative in our study, this effect is significantly positive in Ho and Jorgenson (1994). Furthermore, the welfare effect of reallocating resources into capital formation may be different in the two models reflecting differences in price distortions in the two economies. Simulations on MSG-6 suggest that welfare is rather insensitive to changes in the aggregate capital stock. Since capital formation is mainly financed by increasing foreign debt, this result indicates a rather small difference between the social returns to saving through fixed capital formation and savings through accumulation of net foreign wealth. This property reflects the approximate neutrality in the Norwegian tax system after the tax reform in 1992 with respect to taxation of returns to real capital and interest income respectively. There is, however, one empirically important exception: Beneficial tax rules make the

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<sup>19</sup> The consumption concept used in the utility definition of MSG-6, deviates from this Private Consumption concept, on which the calculation of tax revenue is based, in two respects: First, it excludes the minimum quantities in the origo adjusted utility function, and second, it measures consumer durables by the annual service flow rather than by the investment expenditure.

social return to housing much lower than the social return to savings in other assets. Thus, a shift of investments in favour of housing capital (see Table 3) contributes to lower welfare.

## 6. Conclusions

Our intertemporal general equilibrium assessment of the recent international agreements on trade indicates an aggregate welfare gain equal to 0.77 percent, which confirms the conclusion obtained in most CGE studies that substantial gains from trade liberalisation are unlikely. We conclude that the main part of the gain can be attributed to changes in import- and export prices which improve terms of trade. Though altered world prices are partly a result of changes outside Norwegian control, the most important determinant of the terms-of-trade gain can be obtained independent of multilateral arrangements. Several domestic trade barriers represent terms-of-trade disadvantages for Norway, as they imply real costs or rents accrued by foreigners. Unilateral elimination of domestic protection thus reduces import c.i.f. prices.

We also argue that the welfare gains from improved terms of trade and from efficiency improving reallocations, cannot be absorbed without significant modifications. We identify the major negative contribution to welfare to stem from reallocation of time spending from labour to leisure. Due to existing tax distortions, the marginal social return to time spending is much lower when allocated to leisure than to labour. Our model captures intertemporal behaviour in both production and consumption. In contrast to e.g. Ho and Jorgenson (1994) and Keuschnigg and Kohler (1996), our results indicate that capital formation and growth is nearly unaffected by the reforms. Also, welfare implications of changes in the time profile of private consumption and the composition of savings are minor. Several studies conclude that accounting for imperfect competition, fixed costs and love of variety in experiments of trade liberalisation, increases welfare significantly. Our findings challenge these conclusions. We estimate the normative potential of such mechanisms to be very small in the Norwegian economy, and we find that their contribution is negative in the present study, due to a general contraction of differentiated industries.

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## Decomposition of welfare gains

In order to show how changes in prices and allocations contribute to generate welfare gains, we decompose the welfare change within a model framework which is stylised compared to MSG-6. In particular we neglect dynamic features and the input-output structure associated with production and use of intermediate inputs.

The economy consumes  $n$  goods, which may be produced by both domestic and foreign firms. In the following exposition we will index variables associated with goods by  $i$  and variables related to industries by  $j$ . Let the utility function of the representative consumer be given by

$$(1) \quad U = u(C_1, \dots, C_n, F),$$

where  $F$  is leisure and  $C_i$  is a vector  $(C_i^H, C_i^I)$  where  $C_i^H$  is consumption of the domestic variety of good  $i$  and  $C_i^I$  is consumption of the variety of good  $i$  which is imported from abroad. The consumer maximises utility as a price taker. Suppressing the arguments in the utility function, the first order conditions are

$$(2a) \quad u'_{iH} = \lambda P_i^{CH} = \lambda P_i^H \mathbf{t}_i^C, \quad i = 1, \dots, n,$$

$$(2b) \quad u'_{iI} = \lambda P_i^{CI} = \lambda P_i^{WI} \mathbf{t}_i^P \mathbf{t}_i^C, \quad i = 1, \dots, n,$$

$$(2c) \quad u'_F = \mathbf{I} P^F = \mathbf{I} w \mathbf{t}^L,$$

where  $\lambda$  is the marginal utility of expenditure,  $P_i^H$  is the producer price of domestic deliveries of good  $i$ ,  $P_i^{WI}$  is the world import price of good  $i$ , which includes the part of the protection rate that is collected by foreigners (see Section 2.4),  $\mathbf{t}_i^C = 1 + t_i^C$ , where  $t_i^C$  is the *ad valorem* consumption tax rate,  $\mathbf{t}_i^P = 1 +$  the part of the protection rate that is collected by inhabitants.  $P_i^{CH} = P_i^H \mathbf{t}_i^C$  and  $P_i^{CI} = P_i^{WI} \mathbf{t}_i^P \mathbf{t}_i^C$  is, respectively, the consumer price of domestic delivery and imports of good  $i$ .  $w$  is the pre-tax wage rate and  $\mathbf{t}^L = 1 - t^L$ , where  $t^L$  is the marginal tax rate on labour income,  $P^F$  is the consumer price of leisure. World prices of all goods are exogenously given on world markets. The economy produces  $m$  goods, which may be exported or consumed domestically. The economy is small and open, and may therefore produce other goods than it consumes.

We will consider equilibria where all firms in each industry are identical. Moreover, we will disregard endogenous entry or exit, so the number of firms in each industry is a fixed variable. This implies that the subsequent decomposition of welfare effects ignores contributions from changes in the number of varieties and firms. Let  $n_j$  be the number of firms in industry  $j$ . For each one of the identical firms in industry  $j$  deliveries to the domestic and to the export market are produced according to the technology functions

$$(3) \quad T_j(X_j^H/n_j, X_j^W/n_j, L_j/n_j) = 0,$$

where  $X_j^H$  is the delivery to the domestic market from industry  $j$ , which is the only producer of good  $i=j$ ,  $X_j^W$  is the delivery to the export market from industry and  $L_j$  is employment in industry  $j$ .  $T_j(X_j^H/n_j, X_j^W/n_j, L_j/n_j)$  obeys the standard regularity conditions. Firms maximise profits given by

$$(4) \quad \mathbf{p} = P_i^H S_j^H X_j^H/n_j + P_i^W S_j^W X_j^W/n_j - w \mathbf{t}_j^A L_j/n_j$$

subject to (3), where  $i=j$  indicates that there is a one-to-one correspondence between domestic industries and goods produce by these industries.  $\mathbf{p}$  is the profit in sector  $j$ ,  $S_j^l = 1+s_j^l$ , where  $s_j^l$  is the *ad valorem* subsidy rate per unit of delivery to market  $l = H, W$ .  $P_i^W$  is the world export price of good  $i$ .  $\mathbf{t}_j^A = 1+t_j^A$  is the pay-roll tax rate on labour input in sector  $j$ . Firms are assumed to be price takers on the export markets, whereas domestic firms participate in monopolistic competition in the domestic market. We consider the symmetric large group case of monopolistic competition where each industry consists of a large number of identical firms. The perceived demand function for domestic products facing each firm has the form  $k_i(P_{il}^H)^{-\sigma_i}$ , where  $P_{il}^H$  is the producer price charged by firm  $l$  in industry  $j=i$ ,  $-\sigma_i$  is the exogenous perceived price elasticity facing all firms in sector  $j=i$ . Firms in industry  $j$  maximise profits with respect to the producer price charged in the domestic market, export deliveries and employment. In the symmetric equilibrium all firms in industry  $j$  will set the same price of domestic deliveries  $P_j^H$ . Export deliveries and labour demand from each firm in industry  $j$  will equal  $X_j^W/n_j$  and  $L_j/n_j$  respectively in equilibrium. Suppressing the arguments in the technology function, the first order conditions for profit maximisation become

$$(5a) \quad S_j^H P_i^H / m_i = \mathbf{m} T'_{jH},$$

$$(5b) \quad S_j^W P_i^W = \mathbf{m} T'_{jW},$$

$$(5c) \quad -w \mathbf{t}_j^A = \mathbf{m} T'_{jL},$$

where  $i=j$ .  $m_i$  is the ratio of the price index of the domestic varieties of good  $i$  to the marginal cost of producing one of the symmetric domestic varieties. This ratio will include the pure mark-up due to monopolistic price setting by each firm, which is  $\sigma_i/(\sigma_i-1)$ , as well as a downward correction of the price index of the individual producer prices compared to the representative producer price due to the love-of variety effect. Since the latter correction is constant when the number of varieties is fixed, we will refer to  $m_i$  as the the mark-up factor in industry  $j=i$ .  $\mu_j/n_j$  is the Lagrange-multiplier associated with the technology constraint in (3) normalised by the number of firms.  $T'_{jH}$  is the partial derivative of  $T_j()$  wrt.  $X_i^H$ .  $T'_{jW}$  and  $T'_{jL}$  are defined analogously. For domestic deliveries product market equilibrium implies

$$(6) \quad X_j^H = C_i^H ,$$

for  $i=j$ . The resource constraint, or labour market equilibrium condition, is given by

$$(7) \quad \sum_j L_j = H - F ,$$

where  $H$  is the exogenous time endowment. Finally, the consumption possibilities are constrained by the balance-of-trade requirement

$$(8) \quad \sum_i P_i^W C_i^I = \sum_j P_i^W X_j^W ,$$

where  $j=i$  for the terms included on the left hand side of the equation. The model (1) - (8) determines  $U$ ,  $C_i^H$ ,  $C_i^I$ ,  $\lambda$ ,  $P_i^H$ ,  $P_i^{CH}$ ,  $P_i^{CI}$ ,  $P^F$ ,  $w$ ,  $X_j^H$ ,  $X_j^W$ ,  $L_j$ ,  $\mathbf{p}$ ,  $\mathbf{m}$  and  $F$  endogenously as functions of the industry specific number of firms, world prices , the time endowment, tax- and subsidy rates.

We will now calculate the welfare effect of marginal changes in one or several exogenous variables, including the world prices. We do not seek reduced form solutions for all endogenous variables. Rather we will examine how changes in exogenous as well as endogenous variables contribute to the change in welfare. Total differentiation of the utility function, and substitutions from the first order conditions in (2a,b,c) yields

$$(9) \quad dU = \sum_i u'_{iH} dC_i^H + \sum_i u'_{iI} dC_i^I + u'_F dF \\ \Rightarrow dU/\lambda = \sum_i (P_i^{CH} dC_i^H + P_i^{CI} dC_i^I) + P^F dF \\ = \sum_i (P_i^H \mathbf{t}_i^C dC_i^H + P_i^W \mathbf{t}_i^P \mathbf{t}_i^C dC_i^I) + w \mathbf{t}^L dF$$

Observe that the variables which enter this expression on their level form, i.e.  $\lambda$ , prices and tax rates, are evaluated at the initial or pre-reform equilibrium. The fact that some of the world prices or tax rates may have changed is irrelevant for the *first order effect* on welfare, which is what we calculate. Denote marginal relative change rates of a variable by lower key letters so that  $x_j^H = c_i^H = dX_j^H/X_j^H$  for  $i=j$ ,  $c_i^I = dC_i^I/C_i$ ,  $l_j = dL_j/L_j$ ,  $f = dF/F$ . Also, let  $\mathbf{q}_j^{XH} = P_j^H X_j^H / (\sum_j P_j^H X_j^H)$  denote the value share, evaluated at producer prices, of domestic deliveries from sector  $j$  in the total producer value of such deliveries, and  $\mathbf{q}_i^{CI} = P_i^{WI} C_i^I / (\sum_i P_i^{WI} C_i^I)$  be the budget share of the imports of good  $i$  in consumption. Inserting these expressions in (9) yields

$$\begin{aligned}
(9') \quad dU/\lambda &= (\sum_i P_i^H C_i^H) \sum_i \mathbf{q}_i^{XH} \mathbf{t}_i^C x_i^H + (\sum_i P_i^{WI} C_i^I) \sum_i \mathbf{q}_i^{CI} \mathbf{t}_i^P \mathbf{t}_i^C c_i^I - w \mathbf{t}^L L \\
&= (\sum_i P_i^H C_i^H) \mathbf{t}^{CH} [x^H + \text{cov}(\mathbf{t}_i^C / \mathbf{t}^{CH}, x_i^H; \mathbf{q}_i^{XH})] \\
&\quad + (\sum_i P_i^{WI} C_i^I) \mathbf{t}^{CI} [c^I + \text{cov}((\mathbf{t}_i^P \mathbf{t}_i^C / \mathbf{t}^{CI}), c_i^I; \mathbf{q}_i^{CI})] \\
&\quad - w \mathbf{t}^L L,
\end{aligned}$$

where we have introduced the weighted averages  $\mathbf{t}^{CH} = \sum_i \mathbf{q}_i^{XH} \mathbf{t}_i^C$ ,  $x^H = \sum_i \mathbf{q}_i^{XH} x_i^H$ ,  $\mathbf{t}^{CI} = \sum_i \mathbf{q}_i^{CI} \mathbf{t}_i^P \mathbf{t}_i^C$ ,  $c^I = \sum_i \mathbf{q}_i^{CI} c_i^I$ , and the weighted covariances  $\text{cov}(\mathbf{t}_i^C / \mathbf{t}^{CH}, x_i^H; \mathbf{q}_i^{XH}) = \sum_i \mathbf{q}_i^{XH} (\mathbf{t}_i^C / \mathbf{t}^{CH} - 1)(x_i^H - x^H)$ ,  $\text{cov}(\mathbf{t}_i^P \mathbf{t}_i^C, c_i^I; \mathbf{q}_i^{CI}) = \sum_i \mathbf{q}_i^{CI} (\mathbf{t}_i^P \mathbf{t}_i^C / \mathbf{t}^{CI} - 1)(c_i^I - c^I)$ .  $x^H$  is the relative change rate of the «fixed price» value of total production of domestic deliveries,  $c^I$  is the relative change rate of the «fixed price» value of total imports evaluated at world import prices. We have also utilised that  $dF = -dL = -LL$ . The covariances are positive (negative) if there is a tendency for redirecting demand from markets where the effective tax rates on consumption are relatively low (high) into markets where these effective tax rates are above (below) the corresponding average rate.

Logarithmic differentiation of the trade balance constraint (8) yields

$$(10) \quad c^I = (p^{XW} - p^{CW}) + x^W,$$

where  $p^{XW} = \sum_j \mathbf{q}_j^{XW} p_j^W$  is the relative change in the aggregate world price index for exports, or the export price index. According to the convention introduced above  $p_j^W = dP_j^W/P_j^W$ , and  $\mathbf{q}_j^{XW} = P_j^W X_j^W / (\sum_j P_j^W X_j^W)$  is the value share, evaluated at world prices of exports of good  $j$  in the total export value.  $p^{CW} = \sum_i \mathbf{q}_i^{CI} p_i^{WI}$  is the relative change in the aggregate world price index for imports.  $x^W = \sum_j \mathbf{q}_j^{XW} x_j^W$  is the relative change in the volume index for aggregate exports.  $(p^{XW} - p^{CW})$  measures the change in terms of trade for the economy as the relative change in the ratio of the aggregate world price index for exports to the aggregate world price index for imports. As long as we confine the

analysis to first-order effects, the two indexes are computed according to the Laspeyres formula, i.e. the weights are measured in the initial situation.

Differentiation of the technology functions yields  $T'_{jH} X_j^H x_j^H + T'_{jW} X_j^W x_j^W = -T'_{jL} L_j l_j$ . Using (5a - c) to eliminate the partial derivatives of the transformation function, and some trivial rearrangements yields for  $j=i$

$$(11) \quad P_j^H X_j^H x_j^H = (m_j t_j^A / S_j^H) w L_j l_j - (m_j S_j^W / S_j^H) P_j^W X_j^W x_j^W .$$

We define  $x^H = (1/\sum_j P_j^H X_j^H) \sum_j P_j^H X_j^H x_j^H$  as the volume index for aggregate domestic deliveries. From (11) this index can be expressed in terms of export deliveries and employment as follows

$$(12) \quad (\sum_j P_j^H X_j^H) x^H = wL[\sum_{j=i} \theta_j^L (m_i t_j^A / S_j^H) l_j] - (\sum_{j=i} P_i^W X_j^W) [\sum_{j=i} \mathbf{q}_j^{xw} (m_i S_j^W / S_j^H) x_j^W] ,$$

where  $\theta_j^L = wL_j/wL = L_j/L$ . Substituting (10) and (12) into (9') yields

$$(13) \quad dU/\lambda = (\sum_i P_i^W C_i^I) \mathbf{t}^{CI} (p^{xw} - p^{cw}) \\ + (\sum_{i=j} P_i^H C_i^H) \mathbf{t}^{CH} \text{cov}(\mathbf{t}_i^C / \mathbf{t}^{CH}, x_i^H; \mathbf{q}_i^{xH}) + (\sum_i P_i^W C_i^I) \mathbf{t}^{CI} \text{cov}(\mathbf{t}_i^P \mathbf{t}_i^C / \mathbf{t}^{CI}, c_i^I; \mathbf{q}_i^{CI}) \\ + \mathbf{t}^L wL[(\mathbf{t}^{CH} / \mathbf{t}^L)(\sum_{j=i} \theta_j^L m_i t_j^A / S_j^H) - 1] l + wL \mathbf{t}^{CH} \text{cov}(m_i t_j^A / S_j^H, l_j; \theta_j^L) \\ + (\sum_i P_i^W C_i^I) \mathbf{t}^{CI} [1 - (\mathbf{t}^{CH} / \mathbf{t}^{CI})(\sum_{j=i} \mathbf{q}_j^{xw} m_i S_j^W / S_j^H)] x^W \\ - \mathbf{t}^{CH} (\sum_{j=i} P_i^W X_j^W) \text{cov}(m_i S_j^W / S_j^H, x_j^W; \mathbf{q}_j^{xw}).$$

Let  $V^{CI}$ ,  $V^{CH}$  and  $V^F$  be the consumer expenditure spent on imported goods, domestic goods, and leisure respectively. We have  $V^{CI} = (\sum_i P_i^W C_i^I) \mathbf{t}^{CI}$  because  $(\sum_i P_i^W C_i^I) [\sum_i P_i^W C_i^I \mathbf{t}_i^P \mathbf{t}_i^C / (\sum_i P_i^W C_i^I)] = \sum_i P_i^W C_i^I$ .

Analogously  $V^{CH} = (\sum_{i=j} P_i^H C_i^H) \mathbf{t}^{CH}$  and  $V^F = \mathbf{t}^L wF$ . (13) can then be written

$$(13') \quad dU/\lambda = V^{CI} (p^{xw} - p^{cw}) + V^{CH} \text{cov}(\mathbf{t}_i^C / \mathbf{t}^{CH}, c_i^H; \mathbf{q}_i^{xH}) + V^{CI} \text{cov}(\mathbf{t}_i^P \mathbf{t}_i^C / \mathbf{t}^{CI}, c_i^I; \mathbf{q}_i^{CI}) \\ + V^F [1 - (\mathbf{t}^{CH} / \mathbf{t}^L)(\sum_{j=i} \theta_j^L m_i t_j^A / S_j^H)] f + wL \mathbf{t}^{CH} \text{cov}(m_i t_j^A / S_j^H, l_j; \theta_j^L) \\ + V^{CI} [1 - (\mathbf{t}^{CH} / \mathbf{t}^{CI})(\sum_{j=i} \mathbf{q}_j^{xw} m_i S_j^W / S_j^H)] x^W - V^{CI} (\mathbf{t}^{CH} / \mathbf{t}^{CI}) \text{cov}(m_i S_j^W / S_j^H, x_j^W; \mathbf{q}_j^{xw}) ,$$

where we used that  $Ff = dF = -dL = -Ll$ . In order to express the welfare effect in relative terms, we utilise that the homotheticity of utility function enables us to express the utility level as

$$U = \sum_i u'_i C_i^H + \sum_i u'_i C_i^I + u'_F F = \lambda(V^{CH} + V^{CI} + V^F) = \lambda V,$$

where  $V$  is the total consumer expenditure. The relative welfare change can now be decomposed as

$$(14) \quad dU/U = (V^{CI}/V)(p^{xw} - p^{cw}) + (V^{CH}/V)\text{cov}(\mathbf{t}_i^C/\mathbf{t}^{CH}, c_i^H; \mathbf{q}^{XH}) + (V^{CI}/V)\text{cov}(\mathbf{t}_i^P \mathbf{t}_i^C/\mathbf{t}^{CI}, c_i^I; \mathbf{q}^{CI}) \\ + (V^F/V)[1 - (\mathbf{t}^{CH}/\mathbf{t}^L)(\sum_{j=i} \theta_j^L m_j^A/S_j^H)]f + (wL\mathbf{t}^{CH}/V)\text{cov}(m_i \mathbf{t}_j^A/S_j^H, l_j; \theta_j^L) \\ + (V^{CI}/V)[1 - (\mathbf{t}^{CH}/\mathbf{t}^{CI})(\sum_{j=i} \mathbf{q}_j^{xw} m_j^W/S_j^H)]x^w - (V^{CI}/V)(\mathbf{t}^{CH}/\mathbf{t}^{CI})\text{cov}(m_i S_j^W/S_j^H, x_j^W; \mathbf{q}_j^{xw}),$$

In (14) we have separated 7 effects that contribute to the welfare effect. They have the following interpretation:

1.  $(p^{xw} - p^{cw})$  is the welfare effect due to improved terms of trade. Note that the terms-of-trade change is weighted by the share of imports in total consumption expenditure. The intuition why imports is evaluated at consumer prices is that improved terms-of-trade boosts imports, and the marginal willingness to pay for imports includes indirect taxes levied on consumption as well as costs caused by protective measures.
2. The term  $(V^{CH}/V)\text{cov}(\mathbf{t}_i^C/\mathbf{t}^{CH}, c_i^H; \mathbf{q}^{XH})$  measures the welfare gain from changes in the composition of consumption of home goods for given initial aggregate producer value of home goods. The covariance is positive if consumption on average is redirected from home goods subject to consumption taxes below the average rate to home goods associated with tax rates above the average rate. The intuition why such reallocations imply a welfare gain is that differences in marginal utilities are proportional to the corresponding differences in consumption tax rates. Note that the model in this appendix as well as our trade policy simulations on MSG-6 assumes that lump-sum transfers from the government to the household is possible. Thus the additional tax revenue generated from redirecting demand for home goods in favour of those goods that are relatively most taxed, is rebated to the household.
3. The term  $V^{CI}\text{cov}(\mathbf{t}_i^P \mathbf{t}_i^C/\mathbf{t}^{CI}, c_i^I; \mathbf{q}^{CI})$  measures the welfare gain from changes in the composition of consumption of imported goods for a given initial aggregate value of imports evaluated at world prices. This term can be interpreted analogously to the preceding one. The covariance is positive if the composition of the initial aggregate value of imports, evaluated at world prices, is reallocated from the least to the most taxed goods. In addition to ordinary consumption taxes, imported goods are also taxed through tariff rates and other protective measures. Note that the resulting protection rates include costs of penetrating the home market that are collected by inhabitants. Thus, rents are, as additional tax revenue, rebated to the household.

4.  $(V^F/V) [(1 - (\mathbf{t}^{CH}/\mathbf{t}^L)(\sum_{j=i} \theta_j^L m_i \mathbf{t}_j^A/S_j^H)] f$  measures the net welfare gain from reallocating time spending from labour efforts in production of domestic deliveries to leisure. The term  $(\mathbf{t}^{CH}/\mathbf{t}^L)(\sum_{j=i} \theta_j^L m_i \mathbf{t}_j^A/S_j^H)$  is the total average effective tax wedge between the social and the private consumption returns from an additional hour of work effort. It measures the ratio of utility gain generated by allocating a marginal unit of labour effort to the production of domestic deliveries, keeping both the sectorial labour shares and all export deliveries constant, to the utility loss generated by a marginal decrease in leisure<sup>20</sup>. When  $(\mathbf{t}^{CH}/\mathbf{t}^L)(\sum_{j=i} \theta_j^L m_i \mathbf{t}_j^A/S_j^H) > 1$ , it is socially beneficial to use an hour to undertake a proportional rise in the production of domestic deliveries instead of using it as leisure. The degree of welfare improvement is higher the higher are tax rates and markup factors, and the lower are subsidy rates of domestic deliveries.
5.  $(wL\mathbf{t}^{CH}/V)\text{cov}(m_i \mathbf{t}_j^A/S_j^H, l_j; \theta_j^L)$  measures the welfare gain from reallocating labour among production sectors, provided that variations in labour input is met by variations in domestic deliveries, whereas exports are held constant. If the covariance is positive, labour has on average moved from sectors where labour on the margin generates relatively low marginal utility of home goods, and into sectors where the opposite is true. The possibility that the marginal social return to labour in production of domestic deliveries may differ between sectors is due to sector specific markup-factors, effective tax rates on labour input and subsidy rates. In the case where  $m_i = m$  for all  $i$ , the term captures the gain in production efficiency within the home market sector from reallocation of labour.
6.  $(\mathbf{t}^{CH}/\mathbf{t}^{CI})(\sum_{j=i} \mathbf{q}_j^{xw} m_i S_j^W/S_j^H)] x^W$  measures the welfare gain from raising the openness of the economy by increasing the gross trade volumes, while keeping the composition of exports and imports constant. The term compares the gross welfare effects of two changes. First, a proportional increase in all export deliveries has a positive gross welfare effect because the economy can afford more imports. From this gross gain, the term subtracts the relative loss in utility caused by the fact that the increase in export deliveries crowds out domestic deliveries when employment is kept constant in all industries.  $m_j S_j^W/S_j^H > 1$  implies that the marginal productivity of labour in production of domestic deliveries in industry  $j$  exceeds the corresponding productivity in production of export deliveries. If  $\sum_{j=i} \mathbf{q}_j^{xw} m_i S_j^W/S_j^H > 1$ , there is on average a higher marginal productivity of labour when producing domestic deliveries rather than exports. If also  $\mathbf{t}^{CH}/\mathbf{t}^{CI} > 1$ , the initial basket of domestic deliveries are on the margin evaluated higher in terms of utility than the basket of the imported goods that are financed through exports. Thus, if  $\mathbf{t}^{CH}/\mathbf{t}^{CI} < 1$  because of e.g. protective policies, a general increase in exports and imports, which crowds out production of domestic deliveries, is

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<sup>20</sup> The term  $1 - [(\mathbf{t}^{CH}/\mathbf{t}^L)(\sum_{j=i} \theta_j^L m_i \mathbf{t}_j^A/S_j^H)]^{-1}$  can be interpreted as the effective tax rate on labour income in the hypothetical case when all labour income is spent on domestic deliveries.



welfare improving if  $\sum_{j=i} \mathbf{q}_j^{xw} m_i S_j^w / S_j^H = 1$ . The existence of markup pricing in the domestic market makes it less socially beneficial to crowd out domestic deliveries for exports. Thus, domestic market power counteracts the effect of protective policies on the net welfare change of a marginal reallocation of production from the domestic to the foreign market.

7.  $(\mathbf{t}^{CH}/\mathbf{t}^{CI})\text{cov}(m_i S_j^w / S_j^H, x_j^w; \mathbf{q}_j^{xw})$  measures the welfare effect of industry specific changes in the composition of the given initial aggregate export value, evaluated at world prices. A positive covariance reflects that the redirection of output deliveries from the domestic to the foreign market is stronger than the corresponding average redirection in sectors where the ratio of the marginal labour productivity in export production to the marginal labour productivity in production of domestic deliveries is above the corresponding average ratio.

One may argue that it is a bit artificial to distinguish between the gains from changes in the composition of consumption of domestic deliveries from reallocation of employment, since a change in  $X_j^H$  implies a change in  $L_j$  as long as  $X_j^w$  is held constant. By using (3) one can eliminate  $x_j^H$  completely from the decomposition formula. The term  $(V^{CH}/V)\text{cov}(\mathbf{t}_i^C/\mathbf{t}^{CH}, c_i^H; \mathbf{q}_i^{xH})$  can be merged with the term including the covariance  $\text{cov}(m_i \mathbf{t}_j^A / S_j^H, l_j; \theta_j^L)$ . Instead of (14) the welfare effect can be written

$$(15) \quad dU/U = (V^{CI}/V)(p^{xw} - p^{cw}) \\ + (V^{CI}/V)\text{cov}(\mathbf{t}_i^P \mathbf{t}_i^C / \mathbf{t}^{CI}, c_i^I; \mathbf{q}_i^{CI}) \\ + (V^F/V)[1 - (\sum_{j=i} \theta_j^L \mathbf{t}_i^C m_i \mathbf{t}_j^A / S_j^H) / \mathbf{t}^L] f \\ + (wL/V)\text{cov}(\mathbf{t}_i^C m_i \mathbf{t}_j^A / S_j^H, l_j; \theta_j^L) \\ + (V^{CI}/V)[1 - (\sum_{j=i} \mathbf{q}_j^{xw} \mathbf{t}_i^C m_i S_j^w / S_j^H) / \mathbf{t}^{CI}] x^w \\ - (V^{CI}/(\mathbf{t}^{CI} V))\text{cov}(\mathbf{t}_i^C m_i S_j^w / S_j^H, x_j^w; \mathbf{q}_j^{xw}).$$

In Section 5 we argue that the welfare effects identified as item 1. (terms-of-trade gain) and 4. (change in aggregate leisure) in the list above are the most significant ones in our study. The latter term can be rewritten in terms of relative changes in aggregate employment as follows:

$$(16) \quad (V^F/V)[1 - (\sum_{j=i} \theta_j^L \mathbf{t}_i^C m_i \mathbf{t}_j^A / S_j^H) / \mathbf{t}^L] f = - [(\sum_{j=i} \theta_j^L \mathbf{t}_i^C m_i \mathbf{t}_j^A / S_j^H) wL/V][1 - \mathbf{t}^L / (\sum_{j=i} \theta_j^L \mathbf{t}_i^C m_i \mathbf{t}_j^A / S_j^H)] l.$$

Ignoring the mark-up factors and subsidy rates, we have  $\sum_{j=i} \theta_j^L \mathbf{t}_i^C m_i \mathbf{t}_j^A / S_j^H = \sum_{j=i} \theta_j^L \mathbf{t}_i^C \mathbf{t}_j^A$   
 $= (\sum_{j=i} \theta_j^L \mathbf{t}_i^C)(\sum_{j=i} \theta_j^L \mathbf{t}_j^A) + \text{cov}(\mathbf{t}_i^C, \mathbf{t}_j^A; \theta_j^L)$ . If this covariance between consumption tax rates and pay-roll tax rates is small, we obtain the approximate formula referred to in footnote 17 which says that the

contribution to the welfare effect from changes in employment can be approximated by the formula -  $[(\sum_{j=i} \theta_j^L t_j^C)(\sum_{j=i} \theta_j^L t_j^A)wL/V][1 - t^L/((\sum_{j=i} \theta_j^L t_j^C)(\sum_{j=i} \theta_j^L t_j^A))]/l$ . Observe, however, that the relevant weights in the computation of the average consumption tax rate are the sectorial labour shares. Thus, only consumption taxes levied on domestic deliveries are included in this average. If this weighted average is close to the import weighted average of consumption taxes levied on imports, and if the labour shares are closely correlated with the industry shares of the producer value of aggregate domestic deliveries, then the average consumption tax rate weighted by consumption weights  $(\sum_{j=i} P_i^H X_i^H t_i^C + \sum_i P_i^{WI} C_i^I t_i^P t_i^C)/V$  is a good approximation of the correct average  $\sum_{j=i} \theta_j^L t_j^C$ .