7 Evaluating the Costs and Benefits of EU Trade Arrangements

In this chapter we pull together the many figures from the preceding chapters on the trade arrangements made by the EU; and we use them to estimate their welfare implications for the UK and for the EU.

We use the best estimates we have been able to find of the overall tariff-equivalent of all the EU's protective regimes (including explicit tariffs, anti-dumping procedures, and state regulations). We then use our CGE world model (described in Chapter 2) to generate estimates of changes in trade that result from these. Here our method is to obtain the weighted tariff-equivalent produced by a given protected product (say high-tech manufacturing) for the relevant one of our three traded categories (primary/basic manufacturing/complex manufacturing and services) and apply it to the model; we take the trade changes to apply entirely to the subcategory on which the protection is levied (that is, here on high-tech manufacturing). The model also gives us the implied terms of trade changes. Finally we calculate from these changes the welfare effects in the normal manner: these consist of the terms of trade gains/losses of real income, the customs union transfers effected through trade-diversion of ROW sourcing to customs union partners, and finally of the consumer surplus lost through higher internal prices.

We decided to use the usual calculations of consumer surplus, measured in equivalent income variation, but applied to the general equilibrium results of our 4-bloc world trade model (see Appendix D for an account). For this purpose we disregarded all effects of in-

creased output and income, solely counting the substitution effects of protection; the reason for this is the standard one that income effects are compensated or compensatable, whereas the substitution effects cause costs via misallocation. We did also consider a calculation using the GE model alone as the basis. This incorporates the expansion effects in the model and allows for the cost of the extra resources used; because the GE model assumes (in line with realism) a high degree of interference both in the size of the agricultural sector and in the planning process for land there are material expansion effects as a result of the policy changes examined. The resource cost of the land used in expansion does not equal the income gain because the planning process is not entirely efficient. But as opportunities for land release in attractive uses become apparent its efficiency in effect increases. We discuss these welfare estimates carefully in Appendix C. In what follows we refer to them briefly in passing; the welfare gains are quite a lot larger on this basis but we rather emphasise the measures coming out of the conventional calculations which we now go on to describe in detail.

Our calculations fall into three parts for any given trade policy change:

1. The transfer effect of customs union protection whereby one partner pays more than the world price for imports from another partner.

2. The resource misallocation effect whereby output and demand is switched between sectors – this is the usual 'triangle' of lost consumer surplus. For this we use only the substitution effects predicted by the model.

3. The terms of trade effect whereby the changes brought about by the policy change in net world supplies alters world prices. For this calculation we use the full changes predicted by the model.

We present two sets of estimates. The first considers each product trade protection regime separately. From this we may estimate the effect of withdrawing that regime alone. The second set considers the full set of regimes together. Since plainly the regimes will each affect every part of the economy, effects of all regimes together will interact, either partly cancelling or possibly reinforcing

each other. Hence in principle the second set gives the effect of withdrawing the whole set of regimes together.

We look at the net gains/losses to the UK and to the EU from two basic sets of policy changes:

1. If the UK withdraws from the EU trade arrangements in favour of unilateral free trade.

2. If the EU also moves to unilateral free trade.

We are interested in knowing whether it would pay the UK and EU for the UK to withdraw from the EU's trade arrangements; and whether it would pay the EU to liberalise its trade arrangements. In all our calculations we take the status quo, existing trade arrangements, as the benchmark.

What we will find is that it would indeed pay the EU to move to unilateral free trade in goods and services; the gain for the rest of the EU (REU) would be a substantial 2 per cent of REU GDP and for the UK an even larger 3.8 per cent of GDP. However, if we assume that because of the power of existing institutions and vested interests, the EU does not change from its existing protective set-up, then we find that the UK would still gain from withdrawing alone to unilateral free trade. The UK's gain would be a still substantial 2.5 per cent of its GDP, while the loss to the REU would be a small 0.2 per cent of its GDP. (Should the EU continue later to free trade too, then the UK would gain an extra 1.3 per cent of GDP because of resulting terms of trade effects. Hence the UK gains the same from moving to free trade whether the EU itself liberalises or not; but it also gains further if the EU liberalises.)

In these two estimates resides a dilemma for UK policy: does it stay within the EU and fight on in the hope of EU trade liberalisation from which it would derive the same benefits as from unilateral free trade and without the trauma of leaving the EU or does it leave in the expectation of the same gains but more certainly and immediately? There is also an interesting choice for the rest of the EU: does it benefit its citizens generally by going to free trade or does it accept that this is impossible because of the way that EU politics is conducted? If it assumes this impossibility, then should it welcome the departure (at rather small cost) of a UK that is fundamentally at odds with it over both the costs of

the trade arrangements and the moves to a more federal politics? We return to these policy issues in our last chapter.

We now consider each product category in turn (the details are also tabulated in Appendix A). The calculations for the model are taken from Appendix B; this explains the model and shows the key simulations of tariff-equivalent changes.

7.1 AGRICULTURE

According to Bradford (2003) whose tariff-equivalent estimates we follow for all goods trade, EU agricultural protection is on average 36 per cent. The model, as we have implemented it, prevents agricultural land from responding to price change, in line with planning and CAP restrictions on planting. Also consumer spending on food is assumed to be highly inelastic. Hence we observe no effects on the terms of trade as net trade volumes are essentially unaffected. Thus the cost of the CAP consists purely of the transfer cost to the UK which is an equal gain of course to the rest of EU. (In addition there are administrative costs; but these are considered under separate headings in Chapter 3, Other Issues.)

As UK net imports of food are some 0.8 per cent of GDP this is 0.3 per cent of UK GDP and 0.06 per cent of EU GDP.

Other studies – see Chapter 3 – mostly allow for more trade volume effects; certainly our assumption stretches plausibility as undoubtedly farming interests have had ways of achieving acreage increases which must surely be partially reversed by a 26 per cent (36/136) fall in prices. However, because agriculture is a very small part of GDP – less than 1 per cent in the UK – even adding in more volume effects does not change the size of the estimate unduly as a fraction of GDP.

7.2 BASIC MANUFACTURING

Bradford's estimate (Bradford, 2003) here is of a 16 per cent average tariff-equivalent. The spread of tariff-equivalents across products is very high (see Chapter 5). But the reason the average is only 16 per cent is that many of these products (such as textiles) have been subject to competition from cheap-labour sources for so long

that the domestic industries in the West have largely disappeared as their capital has depreciated; the vested interests pushing for protection have accordingly little power.

Here the UK is twice as big a net importer as it is of food, at 1.7 per cent of GDP. The model's estimated trade effect of the UK eliminating this tariff is that it would effectively eliminate this industry's production (14.4 per cent of GDP). There would be no terms of trade effect however, given the small size of this effect in terms of the world market. Thus UK withdrawal would save the customs union transfer effect of 0.3 per cent of GDP ($= 1.7 \times 0.16$), which is worth 0.06 per cent of GDP to the rest of EU; and also the consumer surplus burden of 1.1 per cent of GDP ($= 14.4 \times 0.16 \times 0.5$) – a total saving of 1.4 per cent.

Were the EU to liberalise, then its net exports would contract by 13.7 per cent of GDP against the current GDP share of basic manufacturing at 17.6 per cent. This is large in terms of the world market and induces a rise in world prices of basic manufactures by 4 per cent. Since both the UK and the REU would be, after liberalisation, large net importers of these, the terms of trade cost would be 0.6 per cent of GDP for the UK and 0.5 per cent of GDP for the REU. However the consumer surplus gain to the REU would be 1.1 per cent of GDP as for the UK. For the REU liberalisation would thus bring a net gain of 0.5 per cent of GDP ($= 1.1 - 0.5 - 0.06$). For the UK the gain would be less than going to free trade on its own: because of the terms of trade effect, it would fall to 0.8 per cent of GDP.

7.3 HIGH-TECH MANUFACTURING

Bradford's estimate (Bradford, 2003) of protection for high-tech manufacturing (which includes the large transport equipment industry as well as electronics, both of them areas where emerging market countries in the far east and elsewhere have made recent penetration) is a very large 58 per cent. The model estimate of the trade effect of the UK withdrawing from this protection is the effective elimination of the UK's existing modest-sized industry, currently 3.6 per cent of GDP; of course with the decline of such industries as cars and computing equipment this has already contracted greatly. The consumer surplus gain to the UK from with-

drawal would thus be 1.1 per cent of GDP ($= 3.6 \times 0.58 \times 0.5$). The UK would also gain from not paying the customs union transfer on its net imports for the REU; these net imports run at 0.8 per cent of GDP hence the transfer is 0.5 per cent (0.58×0.8). Therefore the total gain for the UK from leaving the customs union in high-tech manufactures would be 1.6 per cent of GDP. For the REU the cost would be the loss of the UK's transfer, worth 0.1 per cent of REU GDP.

For the REU high-tech manufacture output constitutes 7.9 per cent of GDP, and net exports 1.5 per cent. Plainly certain of these industries have strong comparative advantage and require no protection while others are weak and under attack from emerging market competition. This latter portion, the model indicates, would be wiped out by the elimination of the protection; we have no good figures for what this portion is but we assume it to be the existing industry minus net exports (6.3 per cent of GDP). Thus the REU would make a consumer surplus gain of 1.8 per cent of GDP ($6.3 \times 0.58 \times 0.5$). However, it would lose the 0.1 per cent customs union transfer it gets from the UK. Furthermore, the model suggests (after allowing for the capping of the output effect at 6.3 per cent of GDP) that the prices of high-tech manufactures would rise by 4.2 per cent as REU supplies were withdrawn from world markets. Since both the REU and the UK would have become net importers after liberalisation (the REU to the tune of 4.8 per cent, the UK 4.4 per cent, of GDP) the terms of trade cost would be 0.2 per cent of GDP for both the REU and the UK. Thus for the REU the total net gain of moving to free trade would be 1.5 per cent of GDP ($= 1.8 - 0.2 - 0.1$).

7.4 SERVICES

In this area our estimates of protection are particularly uncertain. The various pieces of evidence we looked at in Chapter 6 on service trade suggest that it is quite a lot higher in the REU than in the UK. This is supported by the net export figures. The UK's net exports are 3.4 per cent of GDP and 12.4 per cent of service production, suggesting that a large part of the industry must be competing on world markets and hence with no protection. The REU has a rough trade balance.

These studies, though largely qualitative, suggest that REU protection is rather high – we put it at 30 per cent which seems to be in line with these estimates. On the other hand, given its very large rate of net exports, UK prices are likely to be driven by competition to supply world markets down to world price levels; thus we assume that protection in the UK is effectively nil, We also assume in line with the studies cited in Chapter 3 that the protection is carried out by states not at the EU level; there has been very little penetration of common standards across the EU in services. In consequence the EU is assumed to have no customs union in services, with free trade inside the union; each country instead has the same barriers against all other countries including those in the REU.

Under these assumptions it is easy enough to work out the effect of the UK withdrawing from the EU protective system. Since the EU has only state-level protection and the UK is assumed to have no protection in the first place, the effect is simply nil. (Were we to have assumed that the UK had some protection in place, we would have found an additional gain from higher consumer surplus, as this protection was eliminated. However of course eliminating protection that is not due to the EU does not require withdrawal from the EU; so again we would not attribute this gain to 'withdrawal from the EU's protective system' as there is no such system in place.)

For the REU matters are different. Reducing each country's protection of 30 per cent on services would theoretically reduce output of services substantially; according to the model were the REU to do this service output (20 per cent of GDP) would fall to zero. However we must recall the assumption here that this policy is applied on its own; this is highly unlikely given that traded services are where most rich countries now think the future lies for their new industrial activity. Given this assumption however the estimate is not unreasonable, with internal prices falling by 23 per cent (30/130)on this traded activity. On this assumption, the gain in consumer surplus is 32.3 per cent of GDP ($= 20 \times 0.23 \times 0.5$). However the prices of services would rise on world markets by 6 per cent according to the model; with net imports now of 20 per cent of GDP, the REU would lose 1.2 per cent on the terms of trade, making its total gain 1.3 per cent of GDP. The UK as a net exporter would gain 0.2 per cent of GDP (3.4×0.06).

Services: Could the EU Create a Custom Union in Services using the Single Market Framework?

One might wish to consider the possibility that the EU will go on from here to extend its customs union to services, following a conceivable interpretation of the Single Mmarket agenda; in this case, the UK, as a large net exporter of services, would be better off while the EU would lose because it would have to pay the UK above world prices for imports of services.

The area of services is in flux within the EU because of the Single Market treaty. The purported aim of the EU is to create a single market across services. It has put in place many common standards across product markets (a relatively easy undertaking because these markets were already competing through free trade within the EU customs union; so all that had to be agreed were common regulations.) But in services it has faced the added problem of the lack of free trade in the EU. Thus in practice the test of the Single Market has become whether this can be done.

There are two main ways that one could think of such free trade being established. One would be simply to sweep away all state barriers and put no new barriers in their place; this would be unilateral free trade. Note that this could also be achieved by stimulating intense competition across the EU Single Market; in this case even though there might be barriers to non-EU companies they would not succeed in raising the internal price level since competition would have already driven it down to the world level. The other would be to set up a customs union as with goods: thus there would be one common barrier shielding EU producers from world producers but within that barrier free trade and competition. (Note again that as above, were the competition within the customs union to be intense, then prices could be driven by it down to the world level. This case is best thought of as equivalent to free trade; the customs union case we assume to be effective in raising internal prices by the extent of the common barrier.)

In terms of the politics of vested interests, both of these face great difficulties. Even if the common barrier were the same as the previous state barriers, national producers in less competitive regions would now face competition within the EU and would resist; yet EU consumers would get no gains if the new EU barrier were no lower. If the EU common barrier were to be reduced, consumers

would gain but the resistance from producers would become more acute and more general across the EU. But the higher the common barrier is kept the bigger the transfer from the REU to the UK which has a large net export balance in services and this balance would get larger the higher the protection the UK would now get (in place of its existing zero protection).

It is therefore hard to predict what the EU might do in services as a result of the Single Market treaty. The most reasonable assumption seems to be nothing at all; this assumption is the one we make.

Another would be that the single market in services produces strong competition, equivalent to free trade. This is so far from the present reality that it is not of too much interest as yet. We investigate this as part of our EU liberalisation scenario; we find that it is beneficial to the UK because of its effects in improving our terms of trade. It makes no difference to the gain to the UK from leaving the EU's trading arrangements, since the UK obtains terms of trade gains whether it is in or out of the EU.

We now check the plausibility of the EU setting up a exemplar customs union, whose common barrier is half way between the UK's zero and the REU's 30 per cent – that is, a 15 per cent external tariff-equivalent. In our model we find that such a customs union in services would cause a sharp rise in service supply in the UK and contraction in the EU. The terms of trade would improve for services; and the UK would gain from trade diversion and getting much higher prices paid for its services exports to the REU. Thus the UK would obtain a large gain from both the customs union transfer and the terms of trade. The overall results are shown in Table 7.1.

For the REU to transfer such sums to the UK at the expense of its own consumers (line b in Table 7.1) seems a highly unlikely development. One prediction we can therefore make with some confidence is that were the EU to decide to reduce protection on services industries it would do so by general reduction in each state's protection (line c) rather than by moving to a customs union since the latter would in addition to the effects of liberalisation in the REU also transfer large resources sums to the UK. Hence our comparisons of trade policy changes are with the status quo, not with the case where some customs union in services is negotiated prior to the changes.

Table 7.1: Gain/loss (% cent of GDP) from the EU going to a customs union in services with 15% common tariff

		UK	REU
a)	Compared with the status quo of 30% state-level protection in REU and 0% in UK	+1.9%	+0.1%
b)	Compared with EU reducing all state protection to 15% without customs union	+1.5%	−0.5%
c)	Memo item: effect of EU reducing all state protection to 15% without customs union compared with status quo	+0.4%	+0.6%

7.5 GAINS AND LOSSES FROM SEPARATE ACTS OF POLICY COMPARED WITH THE STATUS QUO

We can now use these calculations to draw up a table of gains and losses were the UK to withdraw from various parts of the EU's trade arrangements (see Table 7.2).

Table 7.2: Net gains to the UK and to the REU if the UK withdraws from status quo trade arrangements and adopts unilateral free trade (% of GDP)

	UK	REU
Agriculture	+0.3	−0.06
Basic manufacturing	+1.4	−0.06
Hi-tech manufacturing	+1.6	−0.1
Traded services	−	−
Total	+3.3	−0.22

This table is relevant to the decision of the UK to withdraw or not from individual parts of the trade treaties. We note that the

UK has a strong incentive to withdraw. For the REU the UK's withdrawal creates marginally negative effects.

We can also ask whether the UK and REU have any incentive to liberalise EU markets and move to free trade, with the UK remaining a member of these common arrangements. For this we create Table 7.3 of net gains and losses for the UK and the REU, comparing a post-liberalisation situation with the assumed benchmark.

Table 7.3: Net gains to the UK and to the REU if the EU replaces status quo trade arrangements with unilateral free trade (% of GDP)

	UK	REU	REU if UK has already gone to free trade*
Agriculture	+0.3	−0.03	–
Basic manufacturing	+0.8	+0.54	+0.6
Hi-tech manufacturing	+1.4	+1.5	+1.6
Traded services	+0.2	+1.3	+1.3
Total	+2.7	+3.3	+3.5

Note: *this is column 2 plus transfer effects (these are already eliminated by UK liberalisation)

Here we can see that there is a strong incentive on welfare grounds for the REU to liberalise.

7.6 EXAMINING POLICIES AS A GROUP

Notice however that although we have added up the effects of the various acts of policy we cannot take this addition too seriously. If we want to know what the sum total is of doing all these things together we have to re-examine the estimates under that precise assumption. In practice UK withdrawal would occur across all the areas of trade; to leave one area would probably not be negotiable.

Essentially you must 'leave or not leave'; having left, certain treaty areas might be restorable under a completely new relationship.

Furthermore EU liberalisation would no doubt similarly occur as part of a general policy across all areas. The point here is that just liberalising one area could create very large changes in economic structure as we have seen. If by contrast all areas are liberalised at once, then relative prices between major sectors would not be so badly disturbed and structural changes would be far less. Thus it so happens that most EU traded sectors are highly protected; if all protection were to be withdrawn, then the least-protected sectors of services and (less relevantly as now so small) basic manufacturing would expand by a fair amount at the expense of agriculture and high-tech manufacturing. Such a joint policy would have beneficial effects and would also be less politically sensitive than piecemeal liberalisation. Thus one might conclude that if EU liberalisation is to occur at all, it will be as a joint package.

Thus in this section we examine the above policies in total, substituting the model estimates coming from their joint implementation.

Total Gain/Loss if the UK unilaterally moves to free trade (per cent of GDP)

UK: +2.5% REU: −0.22%
Cf sum of individual policies: UK +3.3% REU −0.22%

Estimates using the full GE model including large-scale expansion effects from land liberalisation (see Appendix C): UK +29% REU −0.22%

To calculate these we have taken the model's total predictions of sectoral change with the complete package. For the UK (referred to in Appendix B as 'Exercise 1') it predicts a reduction in the size of basic manufacturing by 7 per cent of GDP, with these resources going into services/high-tech. To obtain the surplus cost we multiply this by (half of) the relative effect on post-tariff relative traded prices of basic manufactures/services, – 10 per cent. Notice that we are valuing the switch of resources at the free trade relative prices of manufacturing – that is, in terms of manufacturing as the numeraire.

For the contraction of high-tech within services/high-tech due to the withdrawal of 58 per cent high-tech protection we take the

same estimates as above, as this is the estimate from the model for the subsectoral switch effect.

The transfer costs are the same as in the disaggregated case. For UK unilateral moves there are no terms of trade effects.

We discuss in some detail in Appendix C the meaning of the full GE model simulation with full expansion effects. This simulation is carried out on two important assumptions, designed to reflect possible political realities – both of them made in all the simulations reported here with the model, including those for the individual tariff changes. We briefly alluded to them at the start of the chapter. The first is that agricultural production is maintained at existing levels whatever the changes in trade regime, by direct subsidy payments to farmers. The second is that as demand for land changes in other sectors the planning authorities release it (that is, allow its owners to sell it with the relevant use permission) at the market price. When one has the large-scale changes in tariffs all at once as in exercises 1 and 2, these assumptions permit the expanding sectors of the economy to use a large amount of additional land released onto the market by these authorities.

Plainly the gain of welfare to the UK here is dramatically larger at 29 per cent. What is going on is that with agricultural prices at home greatly lowered by the elimination of the CAP tariffs, land prices drop very substantially and this in turn is underpinned by the assumed willingness of the planning authorities to release land for industrial use, effectively in traded services and non-traded activity. These latter two sectors are therefore able to expand considerably, enriching the factors of production, including landowners, as a result of the higher factor prices paid to labour, the higher industrial usage of land (albeit at lower prices), and finally the lower consumer prices these factors pay on spending on consumption. One may legitimately have doubts about the political feasibility of this solution which is why we do not use it as our central estimate. However it does indicate that, in the presence of some planning flexibility, the central estimate we have used, based on substitution effects only, could be a significant underestimate – how much so depending naturally on the extent of such planning flexibility.

Total Gain/Loss if the UK and the REU Simultaneously Move to Free Trade (% of GDP)

UK: +3.8% REU: +2.0% REU if UK has already liberalised +2.2% Cf sum of individual policies: UK +2.7% REU +3.8% REU if UK already +4.0%

Estimates using full GE model including large-scale expansion effects from land liberalisation (see Appendix C): UK +31%, REU +12.4% (REU if UK has already liberalised +12.6%).

In this case of the EU as a whole, liberalising effectively eliminates the whole REU high-tech and traded services industry. Hence no further effect within this industry from any subsectoral output change in relative prices of high-tech versus services can be assumed; this implies no terms of trade effects either. For the UK the effects are the same as liberalising unilaterally except for the addition of terms of trade gains from the REU changes which raise the world prices of high-tech and services.

Notice that it makes a considerable difference, as one would expect from our earlier discussion, if we consider the liberalisation programmes as a whole rather than as the sum of their parts. The breakdown of the differences is shown in detail in Appendix A.

Again we should discuss the contrasting simulation of the full GE model with expansion effects under land liberalisation – we do so at some length in Appendix C. The discussion of the UK situation is no different qualitatively from above, though in this simulation the rewards are bigger due to the favourable movement in the terms of trade. For the REU, it is harder to make the same political case because it is manufacturing that is expanding owing to the fact that pre-liberalisation tariffs are much the highest in services. Planning in any case is a highly complex phenomenon in the REU, differing both across countries and across regions within countries. On the other hand, given the huge pressures to create employment under the REU conditions of generally high unemployment, the popular pressure might be greater for liberalisation. The essential point we make here is not that the full simulation should be believed but that it reminds us that the central case calculation based on substitution effects alone is a minimum which could be added to depending on the extent of land liberalisation.

APPENDIX A DETAILS OF BASIC CASE CALCULATIONS

Effects of Trade Policy Changes in Detail

Table 7.A.1: UK alone liberalises

	Agri-culture	Basic man.	Hi-tech man.	Services
UK Tariff equivalent (%)	36	16	58	0
UK net imports (% GDP)	0.8	1.7	0.8	−3.4
Gain/loss to UK (% of UK GDP)				
Transfer from UK to EU	+0.3	+0.3	+0.5	−
Consumer surplus gain	−	+1.1	+1.1	−
No terms of trade effect				
Gain/loss to REU (% of REU GDP)				
Transfer from UK to REU	−0.06	−0.06	−0.1	

Table 7.A.2: All sectors liberalised together ('Exercise 1' in Appendix B)

	Agri-culture	Basic man.	Hi-tech man.	Services
Gain/loss to UK (% of UK GDP)				
Transfer from UK to EU	+0.3	+0.3	+0.5	–
Consumer surplus gain	–	+0.3	+1.1	–
Gain/loss to REU (% of REU GDP)				
Transfer from UK to REU	−0.06	−0.06	−0.1	–

Table 7.A.3: EU as a whole liberalises

EU Tariff-equivalent (%)	36	16	58	30 (UK 0)
Gain/loss to REU (% of REU GDP)				
Transfer from UK to REU	−0.06	−0.06	−0.1	–
Consumer surplus	–	+1.1	+1.8	+2.3
Terms of trade	–	−0.5	−0.2	−1.2
Gain/loss to UK (% of UK GDP)				
Transfer from UK to EU	+0.3	+0.3	+0.5	–
Consumer surplus gain	–	+1.1	+1.1	–
Terms of trade	–	−0.6	−0.2	+0.2

Table 7.A.4: All sectors liberalised together ('Exercise 2' in Appendix B)

	Agri-culture	Basic man.	Hi-tech man.	Services
Gain/loss to REU (% of REU GDP)				
Transfer from UK to REU	−0.06	−0.06	−0.1	–
Consumer surplus	–	+3.2	–	–
Terms of trade	–	–	–	−1.0
Gain/loss to UK (% of UK GDP)				
Transfer from UK to EU	+0.3	+0.3	+0.5	–
Consumer surplus gain	–	+0.7	+1.1	–
Terms of trade	–	–	–	+0.9

APPENDIX B THE 4-BLOC WORLD COMPUTABLE GENERAL EQUILIBRIUM MODEL

The model we have used for the evaluation of general equilibrium effects of trade policy is based on one we developed for assessing the effects of globalisation on the world economy – Minford et al. (1997). This model performed well empirically in accounting for the trade trends of the 1970–1990 period; we identified a group of major causal 'shocks' during this period which between them gave a good fit to the salient features of the period – including terms of trade, production shares, sectoral trade balances, relative wage movements and employment/unemployment trends.

The model adopts the key assumptions of the Heckscher–Ohlin–Samuelson set-up. Production functions are assumed to be Cobb-Douglas and identical across countries, up to a differing productivity multiplier factor; thus factor shares are constant, enabling us to calibrate the model parsimoniously from detailed UK data that we were able to gather. There are four sectors: non-traded and three traded ones, viz. primary, basic (unskilled-labour-intensive) manufacturing and services and other (skilled-labour-intensive) manufacturing. Three immobile factors of production are identified: unskilled and skilled labour and land. Capital is mobile. All sectors are competitive and prices of traded goods of each sector are equalised across borders.

This set-up gives rise to a well-known set of equations (see below for a full listing):

1. Given world prices of traded goods, price = average costs determine the prices of immobile factors of productions.

2. These factor prices induce domestic supplies of these factors.

3. Outputs of each sector are determined by these immobile factor supplies; non-traded sector output is fixed by demand, the traded sector outputs by the supplies of immobile factors not used in the non-traded sector.

4. Demands for traded goods are set by the resulting level of total GDP.

5. World prices are set by world demand = world supply.

The world is divided into four blocs: UK, REU (rest of EU), US + rest of NAFTA, ROW (rest of world). Data for the model base run is taken from 1998, the latest generally-available information that was comprehensive at the time we started this work.

In each country we assume that for the primary sector output is politically controlled (for example, by quotas) because of the high degree of protection on agriculture and the accompanying requirement to limit the extent of output response. The supply of land is adjusted (via planning and other controls) to adjust to this and other output requirements; in other words the supply of land is demand-determined. While this assumption is crude in overriding all incentive effects on output, the reality of agricultural production is closer to this than to the uncontrolled alternative: we were unable to implement any finer assumption.

Key Model Simulations

In what follows we detail the key simulations for this model which we have used to create the cost calculations reported in the text. The model effects are broadly proportional to the size of trade policy intervention, so we generally report results for a 1 per cent tariff-equivalent (t-e) and to obtain effects for x per cent tariff-equivalents these can be multiplied by x.

There are three tables.

1. Effects of 1 per cent tariff-equivalents imposed in the UK. (Notes: in these cases terms of trade effects are negligible owing to the UK being small in the world economy; hence internal prices rise by the full extent of the t-e. Transfer effects between the UK and REU are computed separately. World manufacturing prices are the numeraire.) Full effects reported but only substitution effects used in calculations of consumer surplus (tables 7.B.1–7.B.4).

2. Effects of 1 per cent tariff-equivalents imposed in the UK and REU simultaneously (Notes: in these cases terms of trade effects are negligible owing to the UK being small in the world economy; hence internal prices rise by the full extent of the t-e. Transfer effects between the UK and REU are

computed separately. World manufacturing prices are the numeraire.) Full effects reported but only substitution effects used in calculations of consumer surplus (tables 7.B.5–7.B.8).

3. Effects of Exercise 1 (where the UK eliminates its existing tariff-equivalents) and Exercise 2 (where both the UK and REU eliminate their existing tariff-equivalents). The figures show 10 per cent of the effect (tables 7.B.9–7.B.12).

Table 7.B.1: Effects on UK of 1% tariffs in UK

TARIFFS BY UK ALONE – 1% Effects of 1% tariffs in UK (NB the tariff on each sector is imposed on its own, other tariffs are held at zero.) Sector where tariff is imposed	Basic man.	Services & hi-tech	Primary
Output (% of base GDP)			
Primary	0.00	0.00	0.00
Basic manufacturing	1.49	−1.15	−0.29
Services and high-tech manufacturing	−1.11	1.22	−0.13
Non-traded	0.64	0.39	−0.99
Factor prices (% of base)			
Unskilled labour	2.26	−0.40	−0.84
Skilled labour	−0.58	2.24	−0.63
Land	−10.48	−3.01	16.33
Factor supplies (% of base)			
Unskilled labour	0.22	−0.04	−0.08
Skilled labour	−0.28	0.26	0.02
Land	12.95	3.76	−14.62
Demand (% of base)			
Primary	0.34	0.09	−0.41
Basic manufacturing	0.09	0.03	−0.12
Services and high-tech manufacturing	1.23	0.21	−1.35
Internal prices (% of base)			
Primary	0.02	−0.01	0.99
Basic manufacturing	1.00	0.00	0.00
Services and high-tech manufacturing	0.04	0.96	−0.01
Terms of trade (% of base)			
World primary/basic manufacturing	0.02	−0.01	−0.01
World service/high-tech/basic man	0.04	−0.03	−0.01

Table 7.B.2: Effects on rest of European Union of 1% tariffs in UK

TARIFFS BY UK ALONE – 1% Effects of 1% tariffs in UK (NB the tariff on each sector is imposed on its own, other tariffs are held at zero.) Sector where tariff is imposed	Basic man.	Services & hi-tech	Primary
Output (% of base GDP)			
Primary	0.00	0.00	0.00
Basic manufacturing	−0.06	0.04	0.01
Services and high-tech manufacturing	0.05	−0.04	−0.01
Non-traded	0.00	0.00	0.00
Factor prices (% of base)			
Unskilled labour	−0.03	0.02	0.01
Skilled labour	0.09	−0.07	−0.01
Land	0.12	−0.03	−0.09
Factor supplies (% of base)			
Unskilled labour	0.00	0.00	0.00
Skilled labour	0.01	−0.01	0.00
Land	−0.11	0.01	0.09
Demand (% of base)			
Primary	0.00	0.00	0.00
Basic manufacturing	0.00	0.00	0.00
Services and high-tech manufacturing	−0.01	0.01	0.01
Internal prices (% of base)			
Primary	0.02	−0.01	−0.01
Basic manufacturing	0.00	0.00	0.00
Services and high-tech manufacturing	0.04	−0.03	−0.01
Terms of trade (% of base)			
World primary/basic manufacturing	0.02	−0.01	−0.01
World service/high-tech/basic man	0.04	−0.03	−0.01

Table 7.B.3: Effects on NAFTA of 1% tariffs in UK

TARIFFS BY UK ALONE – 1% Effects of 1% tariffs in UK (NB the tariff on each sector is imposed on its own, other tariffs are held at zero.) Sector where 1% tariff is imposed	Basic man.	Services & hi-tech	Primary
Output (% of base GDP)			
Primary	0.00	0.00	0.00
Basic manufacturing	−0.06	0.05	0.01
Services and high-tech manufacturing	0.05	−0.04	−0.01
Non-traded	0.00	−0.01	0.00
Factor prices (% of base)			
Unskilled labour	−0.03	0.02	0.01
Skilled labour	0.09	−0.07	−0.01
Land	0.12	−0.03	−0.09
Factor supplies (% of base)			
Unskilled labour	0.00	0.00	0.00
Skilled labour	0.01	−0.01	0.00
Land	−0.10	0.01	0.09
Demand (% of base)			
Primary	0.00	0.00	0.00
Basic manufacturing	0.00	0.00	0.00
Services and high-tech manufacturing	−0.01	0.00	0.01
Internal prices (% of base)			
Primary	0.02	−0.01	−0.01
Basic manufacturing	0.00	0.00	0.00
Services and high-tech manufacturing	0.04	−0.03	−0.01
Terms of trade (% of base)			
World primary/basic manufacturing	0.02	−0.01	−0.01
World service/high-tech/basic man	0.04	−0.03	−0.01

Table 7.B.4: Effects on rest of world of 1% tariffs in UK

TARIFFS BY UK ALONE – 1% Effects of 1% tariffs in UK (NB the tariff on each sector is imposed on its own, other tariffs are held at zero.) Sector where 1% tariff is imposed	Basic man.	Services & hi-tech	Primary
Output (% of base GDP)			
Primary	0.00	0.00	0.00
Basic manufacturing	−0.05	0.04	0.01
Services and high-tech manufacturing	0.05	−0.04	−0.01
Non-traded	0.00	0.00	0.00
Factor prices (% of base)			
Unskilled labour	−0.03	0.02	0.01
Skilled labour	0.09	−0.07	−0.01
Land	0.12	−0.03	−0.09
Factor supplies (% of base)			
Unskilled labour	0.00	0.00	0.00
Skilled labour	0.01	−0.01	0.00
Land	−0.11	0.02	0.09
Demand (% of base)			
Primary	−0.01	0.00	0.01
Basic manufacturing	−0.01	0.00	0.01
Services and high-tech manufacturing	0.00	0.00	0.00
Internal prices (% of base)			
Primary	0.02	−0.01	−0.01
Basic manufacturing	0.00	0.00	0.00
Services and high-tech manufacturing	0.04	−0.03	−0.01
Terms of trade (% of base)			
World primary/basic manufacturing	0.02	−0.01	−0.01
World service/high-tech/basic man	0.04	−0.03	−0.01

Table 7.B.5: Effects on UK of 1% tariffs in UK and rest of EU

CUSTOMS UNION TARIFFS BY EU+UK – 1%
Effects of 1% tariffs in UK and rest of EU. In each sector the tariff is imposed on its own, other tariffs are held at zero.

Sector where 1% tariff is imposed	Basic man.	Services & hi-tech	Primary
Output (% of base GDP)			
Primary	0.00	0.00	0.00
Basic manufacturing	1.22	−0.94	−0.24
Services and high-tech manufacturing	−0.86	1.01	−0.17
Non-traded	0.65	0.37	−0.98
Factor prices (% of base)			
Unskilled labour	2.10	−0.30	−0.79
Skilled labour	−0.15	1.87	−0.70
Land	−9.97	−3.16	15.88
Factor supplies (% of base)			
Unskilled labour	0.21	−0.03	−0.08
Skilled labour	−0.22	0.22	0.01
Land	12.40	3.84	−14.29
Demand (% of base)			
Primary	0.33	0.09	−0.40
Basic manufacturing	0.09	0.03	−0.11
Services and high-tech manufacturing	1.17	0.23	−1.31
Internal prices (% of base)			
Primary	0.10	−0.05	0.96
Basic manufacturing	1.00	0.00	0.00
Services and high-tech manufacturing	0.25	0.80	−0.04
Terms of trade (% of base)			
World primary/basic manufacturing	0.10	−0.05	−0.04
World service/high-tech/basic man	0.25	−0.20	−0.04

Table 7.B.6: Effects on rest of the European Union of 1% tariffs in UK and rest of EU

CUSTOMS UNION TARIFFS BY EU+UK – 1% Effects of 1% tariffs in UK and rest of EU. In each sector the tariff is imposed on its own, other tariffs are held at zero.			
Sector where 1% tariff is imposed	Basic man.	Services & hi-tech	Primary
Output (% of base GDP)			
Primary	0.00	0.00	0.00
Basic manufacturing	1.23	−0.93	−0.26
Services and high-tech manufacturing	−0.86	1.00	−0.15
Non-traded	0.66	0.37	−0.98
Factor prices (% of base)			
Unskilled labour	2.10	−0.30	−0.79
Skilled labour	−0.16	1.88	−0.69
Land	−9.96	−3.17	15.88
Factor supplies (% of base)			
Unskilled labour	0.21	−0.03	−0.08
Skilled labour	−0.22	0.22	0.01
Land	12.43	3.83	−14.30
Demand (% of base)			
Primary	0.33	0.07	−0.37
Basic manufacturing	0.11	0.02	−0.12
Services and high-tech manufacturing	1.20	0.23	−1.33
Internal prices (% of base)			
Primary	0.10	−0.05	0.96
Basic manufacturing	1.00	0.00	0.00
Services and high-tech manufacturing	0.25	0.80	−0.04
Terms of trade (% of base)			
World primary/basic manufacturing	0.10	−0.05	−0.04
World service/high-tech/basic man	0.25	−0.20	−0.04

Table 7.B.7: Effects on NAFTA of 1% tariffs in UK and rest of EU

CUSTOMS UNION TARIFFS BY EU+UK – 1%
Effects of 1% tariffs in UK and rest of EU. In each sector the tariff is imposed on its own, other tariffs are held at zero.

Sector where 1% tariff is imposed	Basic man.	Services & hi-tech	Primary
Output (% of base GDP)			
Primary	0.00	0.00	0.00
Basic manufacturing	−0.34	0.26	0.07
Services and high-tech manufacturing	0.31	−0.25	−0.05
Non-traded	0.01	−0.03	0.02
Factor prices (% of base)			
Unskilled labour	−0.19	0.13	0.05
Skilled labour	0.52	−0.43	−0.08
Land	0.69	−0.18	−0.47
Factor supplies (% of base)			
Unskilled labour	−0.02	0.01	0.01
Skilled labour	0.07	−0.06	−0.01
Land	−0.57	0.07	0.47
Demand (% of base)			
Primary	−0.03	0.01	0.01
Basic manufacturing	−0.01	0.00	0.01
Services and high-tech manufacturing	−0.07	0.03	0.04
Internal prices (% of base)			
Primary	0.10	−0.05	−0.04
Basic manufacturing	0.00	0.00	0.00
Services and high-tech manufacturing	0.25	−0.20	−0.04
Terms of trade (% of base)			
World primary/basic manufacturing	0.10	−0.05	−0.04
World service/high-tech/basic man	0.25	−0.20	−0.04

Table 7.B.8: Effects on rest of the world of 1% tariffs in UK and rest of EU

CUSTOMS UNION TARIFFS BY EU+UK – 1% Effects of 1% tariffs in UK and rest of EU. In each sector the tariff is imposed on its own, other tariffs are held at zero.			
Sector where 1% tariff is imposed	Basic man.	Services & hi-tech	Primary
Output (% of base GDP)			
Primary	0.00	0.00	0.00
Basic manufacturing	−0.29	0.22	0.06
Services and high-tech manufacturing	0.28	−0.22	−0.05
Non-traded	−0.02	0.00	0.02
Factor prices (% of base)			
Unskilled labour	−0.19	0.13	0.05
Skilled labour	0.52	−0.43	−0.08
Land	0.69	−0.18	−0.47
Factor supplies (% of base)			
Unskilled labour	−0.02	0.01	0.01
Skilled labour	0.07	−0.06	−0.01
Land	−0.62	0.12	0.47
Demand (% of base)			
Primary	−0.04	−0.01	0.05
Basic manufacturing	−0.04	−0.01	0.04
Services and high-tech manufacturing	−0.02	0.00	0.02
Internal prices (% of base)			
Primary	0.10	−0.05	−0.04
Basic manufacturing	0.00	0.00	0.00
Services and high-tech manufacturing	0.25	−0.20	−0.04
Terms of trade (% of base)			
World primary/basic manufacturing	0.10	−0.05	−0.04
World service/high-tech/basic man	0.25	−0.20	−0.04

Table 7.B.9: Effect on UK of removal of trade barriers

REMOVAL OF TRADE BARRIERS SIMULTANEOUSLY Exercise 1: UK withdraws from all EU trade arrangements to free trade from existing arrangements Exercise 2: Both EU and UK move to free trade on all products from existing arrangements Results for two exercises	Ex. 1	Ex. 2
Output (% of base GDP)		
Primary	0.00	0.00
Basic manufacturing	−8.06	−16.63
Services and high-tech manufacturing	19.06	26.29
Non-traded	45.49	39.30
Factor prices (% of base)		
Unskilled labour	1.41	−3.54
Skilled labour	24.84	37.58
Land	−99.01	−99.60
Factor supplies (% of base)		
Unskilled labour	0.14	−0.36
Skilled labour	2.10	3.70
Land	10932.22	3912.00
Demand (% of base)		
Primary	10.69	9.68
Basic manufacturing	3.19	2.85
Services and high-tech manufacturing	35.24	30.86
Internal prices (% of base)		
Primary	−35.91	−34.73
Basic manufacturing	−16.00	−16.00
Services and high-tech manufacturing	−7.28	−1.77
Terms of trade (% of base)		
World primary/basic manufacturing	0.13	1.79
World service/high-tech/basic man	−0.30	5.54

Note: Exercise 2 was solved at 80% of the full shock and the results shown obtained by raising the simulated responses pro rata (convergence for the model could not be obtained for 100% of the shock).

Table 7.B.10: Effect on rest of European Union of removal of trade barriers

REMOVAL OF TRADE BARRIERS SIMULTANEOUSLY Exercise 1: UK withdraws from all EU trade arrangements to free trade from existing arrangements Exercise 2: Both EU and UK move to free trade on all products from existing arrangements Results for two exercises	Ex. 1	Ex. 2
Output (% of base GDP)		
Primary	0.00	0.00
Basic manufacturing	0.31	35.35
Services and high-tech manufacturing	−0.38	−27.26
Non-traded	−0.25	15.77
Factor prices (% of base)		
Unskilled labour	0.01	13.38
Skilled labour	−0.76	−44.29
Land	2.99	−98.70
Factor supplies (% of base)		
Unskilled labour	0.00	1.28
Skilled labour	−0.08	−6.56
Land	−3.17	1187.40
Demand (% of base)		
Primary	−0.07	7.18
Basic manufacturing	−0.02	2.35
Services and high-tech manufacturing	−0.25	26.33
Internal prices (% of base)		
Primary	0.13	−34.73
Basic manufacturing	0.00	−16.00
Services and high-tech manufacturing	−0.30	−34.15
Terms of trade (% of base)		
World primary/basic manufacturing	0.13	1.79
World service/high-tech/basic man	−0.30	5.54

Note: Exercise 2 was solved at 80% of the full shock and the results shown obtained by raising the simulated responses pro rata (convergence for the model could not be obtained for 100% of the shock).

Table 7.B.11: Effect on NAFTA of removal of trade barriers

REMOVAL OF TRADE BARRIERS SIMULTANEOUSLY Exercise 1: UK withdraws from all EU trade arrangements to free trade from existing arrangements Exercise 2: Both EU and UK move to free trade on all products from existing arrangements Results for two exercises	Ex. 1	Ex. 2
Output (% of base GDP)		
Primary	0.00	0.00
Basic manufacturing	0.33	−7.30
Services and high-tech manufacturing	−0.40	6.83
Non-traded	−0.26	0.52
Factor prices (% of base)		
Unskilled labour	0.01	−3.77
Skilled labour	−0.76	11.88
Land	2.99	11.07
Factor supplies (% of base)		
Unskilled labour	0.00	−0.38
Skilled labour	−0.08	1.53
Land	−3.19	−7.65
Demand (% of base)		
Primary	−0.08	−0.47
Basic manufacturing	−0.03	−0.18
Services and high-tech manufacturing	−0.20	−1.31
Internal prices (% of base)		
Primary	0.13	1.79
Basic manufacturing	0.00	0.00
Services and high-tech manufacturing	−0.30	5.54
Terms of trade (% of base)		
World primary/basic manufacturing	0.13	1.79
World service/high-tech/basic man	−0.30	5.54

Note: Exercise 2 was solved at 80% of the full shock and the results shown obtained by raising the simulated responses pro rata (convergence for the model could not be obtained for 100% of the shock).

Table 7.B.12: Effect on rest of world of removal of trade barriers

REMOVAL OF TRADE BARRIERS SIMULTANEOUSLY Exercise 1: UK withdraws from all EU trade arrangements to free trade from existing arrangements Exercise 2: Both EU and UK move to free trade on all products from existing arrangements Results for two exercises	Ex. 1	Ex. 2
Output (% of base GDP)		
Primary	0.00	0.00
Basic manufacturing	0.26	−6.36
Services and high-tech manufacturing	−0.35	5.99
Non-traded	−0.23	0.05
Factor prices (% of base)		
Unskilled labour	0.01	−3.77
Skilled labour	−0.76	11.88
Land	2.99	11.07
Factor supplies (% of base)		
Unskilled labour	0.00	−0.38
Skilled labour	−0.08	1.53
Land	−3.10	−8.54
Demand (% of base)		
Primary	−0.24	−1.00
Basic manufacturing	−0.21	−0.87
Services and high-tech manufacturing	−0.10	−0.42
Internal prices (% of base)		
Primary	0.13	1.79
Basic manufacturing	0.00	0.00
Services and high-tech manufacturing	−0.30	5.54
Terms of trade (% of base)		
World primary/basic manufacturing	0.13	1.79
World service/high-tech/basic man	−0.30	5.54

Note: Exercise 2 was solved at 80% of the full shock and the results shown obtained by raising the simulated responses pro rata (convergence for the model could not be obtained for 100% of the shock).

APPENDIX C WELFARE CALCULATIONS USING THE GENERAL EQUILIBRIUM MODEL

So far in this chapter we have used the GE model solely to provide estimates of output substitution effects and price effects. These have been combined with (a) standard formulae for consumer surplus gains and losses (b) direct calculation of the transfers between UK and REU, to provide an overall estimate of welfare losses. Note that in principle income effects are ignored because it is assumed that they do not increase the population's welfare: thus the expansion in output of one sector other than at the expense of another is offset in value by the use of resources in that expansion.

However we can also use the full GE model to provide an estimate. In this there is a complete accounting for all incomes and resource use and we may compute the total welfare measure in income equivalent. The GE model used here makes two important constraining assumptions: (a) that agricultural output is held (by government subsidies directly to producers, financed by lump sum taxes on households) at its original level (b) that land supply is controlled via planning/zoning procedures to equal demand for it from productive sectors of the economy. Implicit in this last assumption is that private use of land is only permitted in 'job creating' use, and otherwise is 'marginal' in reservation use (perhaps for leisure or low-value agricultural, for example subsistence, use). These assumptions were made to mirror the reality of government policies around the world. Governments are notoriously reluctant to allow agricultural output to vary with market conditions. They also generally do place substantial constraints on land use; land is often not allowed to be used for maximum private gain but rather is allocated for 'job creation' (with its implicit appeal to the community in which the land is being used).

The alternative, more standard, assumptions would have been to assume land to be brought into use in response to its market price and to assume agricultural output would adjust to market forces. However, we found that the commercial policy changes considered here produced very large fluctuations in agricultural output, which appeared totally unrealistic. Indeed so great are the relative price changes introduced when the UK is assumed to

leave the EU that agricultural output is driven to zero in the free market solution (with no constraints at all). In fact there is some doubt whether one can get the model to solve at all because this is a 'corner solution' (that is, one where some relationships are frustrated by the absence of further resources to accommodate the expansion of other industries as agriculture disappears; in effect the model would like agriculture to go negative).

Plainly such a disappearance of agriculture would be unlikely to be permitted politically. One could accompany the assumption that agricultural production was somehow preserved by the assumption that a producer subsidy rate is paid to farmers sufficient to induce them to continue producing the same amount as before; however such a rate would have to be very high in order to allow farming to compete for land with the now-more-profitable service industries. Again, this falls foul of likely political reality.

Hence our adoption of our two assumptions above. What these amount to is that land is made available through the planning process in sufficient quantity to accommodate its expanding use in services, as well as its existing use in agriculture. This keeps the price of land down; as a result no ('deficiency') payments to farmers are needed to keep them producing at existing rates, at least in principle. In political terms one can think of the release of unused farming land as the 'compensation' to farmers for their lower prices; in economic terms however what is happening is that the price of 'planning land' is coming down towards the price of unused farming land.

In the chapter and main text we have used our general equilibrium results to support a conventional calculation of the trade costs – viz. one that ignores 'expansion' or 'income' effects. These are typically ignored because in general equilibrium existing resources can only support so much output; any expansion of one industry must therefore be offset by the contraction of another. The 'substitution' effect calculation done in the text calculates the increase in the efficiency of the use of resources from this substitution but obviously does not count any gain from the expansion of one industry. Similarly if resources are expanded by factor price changes, it is typically assumed that such expansion must come at the cost of extra effort or the loss of alternative uses (for land, for example, perhaps in private leisure use). Thus any expansion in overall GDP would come at an equivalent cost in resource utilisation and

should not be counted.

Following this method, our calculations in the main text use the GE model only to provide estimates of the substitution of one industry for another and additionally of the world terms of trade effect of policy changes. These are then inserted into a standard trade efficiency calculation to obtain our main estimates. It is approximately as if we were assuming in the GE model not merely that agricultural output was fixed but that total non-agricultural output was fixed too.

This approach is highly conservative in calculating the trade costs for the following reason. Under our two 'political' assumptions made above the GE model in fact permits substantial overall expansion. Because the land used in the expansion is over-priced via the planning process, the extra availability permits extra value to be generated from available UK resources. What occurs is that the planning process, by making much extra land available, permits its price to fall sharply, allowing UK households to produce much more with their labour and capital without corresponding extra cost.

How realistic is this large extra supply of land? Some might argue that Nimbyism (the 'not-in-my-back-yard' protests that stalemate the supply of planning land) makes it entirely unrealistic. However it is worth reflecting on the nature of the industrial expansion in question in the UK, where the price changes unleashed by EU exit induce a massive expansion in services and a contraction in manufacturing, with agriculture unchanged. Services expansion can generally be accommodated in an environmentally friendly manner; the basic requirements of services being office buildings and capital such as computers. One can imagine a sprouting of stylishly-structured industrial parks in the countryside which might, because of the extra jobs provided, turn out to be generally popular to planners' constituencies.

In the case of the REU liberalising as well, the above analysis does not apply as it turns out that within the REU services are more highly protected than manufacturing and that it is therefore manufacturing and non-traded that expand massively at the expense of traded services. Whether the politics of providing more land for manufacturing and non-traded is attractive within the REU planning systems is beyond our ability to predict. The population density of the REU is much lower in most countries than in

the UK. Also the unemployment rates are much higher, suggesting that there would be popular pressure for more land availability to support more jobs. However, the politics of land supply is complex and differs from country to country and even region to region. Thus there must be even more of a question mark about the practicality of the solution with expansion effects in Exercise 2 than there already is in Exercise 1.

Plainly we would not wish to put forward a calculation on this basis as a central one. However it is of some interest to take the GE model under these assumptions at face value and see what the welfare implications would be. Notice that in this case we are looking at not merely a structural transformation of British industry towards traded services but also a very large expansion in the economy, as traded services not merely expand beyond the mere substitution extent but also generate matching expansion in non-traded industries, also mostly of the service type.

The raw material of these calculations is in the attached tables. The welfare formula in general equilibrium is then the extra real spending power of UK households (= their factor incomes deflated by the consumer price index) minus the economic value of the extra input they contribute. For land this value is calculated as the extra land times the final price paid for it (once planning has released it): thus it is being assumed that planners' constituents value land at this new price once the new opportunities are presented to them (by implication the value of land to them cannot be greater than this as they have willingly given up all the extra land for only this price). For labour it is in standard manner the extra supply times the original price plus half the change in price induced by the policy changes (the latter being the 'surplus' cost).

The figures are, perhaps unsurprisingly, much larger than the cautious ones of the text:

Table 7.C.1: Welfare gains from Table 7.B.9

	UK	EU	NAFTA	ROW
UK leaves EU for unilateral free trade				
Welfare gains (% of GDP):	29.0	(−0.2)[a]	neg	neg

	UK	EU	NAFTA	ROW
Both UK and EU move to free trade				
Welfare gains (% of GDP):	31.0	12.4[b]	neg	neg

Notes:

a. As given in the main text; the spillover effects of UK departure are negligible, apart from the loss of EU customs union revenue from the UK, as calculated in main text.

b. Net of the loss of Customs Union revenue from UK as in main text.

APPENDIX D LISTING OF THE GENERAL EQUILIBRIUM 4-BLOC TRADE MODEL

1–4 Prices, UK, Rest of EU, NAFTA, Rest of World p_M, p_S, p_A, p_D

p_M, p_S, p_A, p_D, domestic prices, solve for w, h, l and p_D respectively.

$$p_M = w^{0.52234} \cdot h^{0.14366} \cdot l^{0.035} \cdot (p_M \cdot r)^{0.299} \cdot \pi_M^{-1}$$
$$p_S = w^{0.21168} \cdot h^{0.51832} \cdot l^{0.033} \cdot (p_M \cdot r)^{0.237} \cdot \pi_S^{-1}$$
$$p_A = w^{0.147} \cdot h^{0.132} \cdot l^{0.079} \cdot (p_M \cdot r)^{0.642} \cdot \pi_A^{-1}$$
$$p_D = w^{0.38024} \cdot h^{0.17576} \cdot l^{0.113} \cdot (p_M \cdot r)^{0.331} \cdot \pi_D^{-1}$$
$$\ln(w) = \left(\frac{1}{0.52234}\right) \cdot \left\{ \begin{array}{c} \ln(p_M \cdot \pi_M) - 0.14366 \cdot \ln(h) - 0.035 \cdot \\ \ln(l) - 0.299 \cdot \ln(p_M \cdot r) \end{array} \right\}$$
$$\ln(h) = \left(\frac{1}{0.51832}\right) \cdot \left\{ \begin{array}{c} \ln(p_S \cdot \pi_S) - 0.21168 \cdot \ln(w) - 0.033 \cdot \\ \ln(l) - 0.237 \cdot \ln(p_M \cdot r) \end{array} \right\}$$
$$\ln(l) = \left(\frac{1}{0.079}\right) \cdot \left\{ \begin{array}{c} \ln(p_A \cdot \pi_A) - 0.147 \cdot \ln(w) - 0.132 \cdot \ln(h) \\ -0.642 \cdot \ln(p_M \cdot r) \end{array} \right\}$$

5–7 Factor demands, UK, Rest of EU, NAFTA, Rest of World N, H, L:

$$N = w^{-1} \cdot \left(\begin{array}{c} 0.38024 \cdot p_D \cdot y_D + 0.52234 \cdot y_M \cdot p_M + 0.21168 \cdot \\ p_S \cdot y_S + 0.147 \cdot p_A \cdot y_A \end{array} \right)$$
$$H = h^{-1} \cdot \left(\begin{array}{c} 0.168 \cdot p_D \cdot y_D + 0.14366 \cdot y_M \cdot p_M + 0.51832 \cdot p_S \\ \cdot y_S + 0.132 \cdot p_A \cdot y_A \end{array} \right)$$
$$L = l^{-1} \cdot \left(\begin{array}{c} 0.113 \cdot p_D \cdot y_D + 0.035 \cdot y_M \cdot p_M + 0.033 \cdot p_S \cdot y_S \\ +0.079 \cdot p_A \cdot y_A \end{array} \right)$$
$$y_M = \left(\frac{1}{0.52234 \cdot p_M}\right) \cdot \left\{ \begin{array}{c} N \cdot w - 0.38024 \cdot p_D \cdot y_D - 0.21168 \cdot \\ p_S \cdot y_S - 0.147 \cdot p_A \cdot y_A \end{array} \right\}$$
$$y_S = \left(\frac{1}{0.51832 \cdot p_S}\right) \cdot \left\{ \begin{array}{c} H \cdot h - 0.168 \cdot p_D \cdot y_D - 0.14366 \cdot p_M \cdot \\ y_M - 0.132 \cdot p_A \cdot y_A \end{array} \right\}$$
$$yA = \left(\frac{1}{0.079 \cdot p_A}\right) \cdot \left\{ \begin{array}{c} L \cdot l - 0.113 \cdot p_D \cdot y_D - 0.035 \cdot p_M \cdot y_M \\ -0.033 \cdot p_S \cdot y_S \end{array} \right\}$$

When y^A is exogenised (as it is in these simulations), the last equation is solved for L and the exogenous values used for y^A are

from the base run, viz.:

$$y_A^{\mathrm{UK}} = 71.00$$
$$y_A^{\mathrm{EU14}} = 306.00$$
$$y_A^{\mathrm{NAFTA}} = 503.00$$
$$y_A^{\mathrm{RofW}} = 3460.00$$

8 K

$$K = 0.2 \cdot \frac{1}{(p_M \cdot r)} \cdot \left\{ \begin{array}{l} 0.331 \cdot p_D \cdot y_D + 0.299 \cdot p_M \cdot y_M \\ +0.237 \cdot p_S \cdot y_S + 0.642 \cdot p_A \cdot y_A \end{array} \right\} + 0.8 \cdot K_{t-1}$$

9–11 Factor supplies:

$$N = a_N \cdot \left(\frac{w}{b}\right)^{0.1} \cdot POP^{0.5} \cdot G^{0.5}$$
$$a_N^{\mathrm{UK}} = 0.486815$$
$$a_N^{\mathrm{EU14}} = 1.105789$$
$$a_N^{\mathrm{NAFTA}} = 1.309601$$
$$a_N^{\mathrm{RofW}} = 71.594820$$

$$H = a_H \cdot \left(\frac{h}{w}\right)^{0.1} \cdot G^{0.5}$$
$$a_H^{\mathrm{UK}} = 1.273294$$
$$a_H^{\mathrm{EU14}} = 3.789872$$
$$a_H^{\mathrm{NAFTA}} = 5.157474$$
$$a_H^{\mathrm{RofW}} = 84.815077$$

$$L = a_L \cdot \left(\frac{l}{w}\right)^{0.1} \cdot POP^{0.5}$$
$$a_L^{\mathrm{UK}} = 2.93624328$$
$$a_L^{\mathrm{EU14}} = 14.232869988$$
$$a_L^{\mathrm{NAFTA}} = 22.38231873$$
$$a_L^{\mathrm{RofW}} = 1311.358098$$

If $y^A$is exogenised (as it is in these simulations) then factor supply for L is determined by equation 7 above, as noted earlier so that:

$$L = l^{-1} \cdot \begin{pmatrix} 0.113 \cdot p_D \cdot y_D + 0.035 \cdot y_M \cdot p_M + 0.033 \cdot p_S \cdot y_S \\ +0.079 \cdot p_A \cdot y_A \end{pmatrix}$$

12 y_D

$$y_D = 0.50 \cdot E^{1.0} \cdot \left(\frac{p_D}{p_T}\right)^{-0.5}$$

13 y

$$y = y_D + y_M + y_S + y_A$$

14 E

$$E = y$$

15 C

$$C = E - \Delta K$$

16 E_T

$$E_T = E - y_D$$

17 E_M

$$E_M = E_T - E_S - E_A$$

18 E_S

$$\begin{aligned} E_S^{\mathrm{UK}} &= 0.9 \cdot E_T^{\mathrm{UK}} - 238.90 - 12.0 \cdot \left(p_S^{\mathrm{UK}} - p_T^{\mathrm{UK}}\right) \\ E_S^{\mathrm{EU14}} &= 0.9 \cdot E_T^{\mathrm{EU14}} - 1180.30 - 12.0 \cdot \left(p_S^{\mathrm{EU14}} - p_T^{\mathrm{EU14}}\right) \\ E_S^{\mathrm{NAFTA}} &= 0.9 \cdot E_T^{\mathrm{NAFTA}} - 1335.00 - 12.0 \cdot \left(p_S^{\mathrm{NAFTA}} - p_T^{\mathrm{NAFTA}}\right) \\ E_S^{\mathrm{RofW}} &= 0.212 \cdot E_T^{\mathrm{RofW}} + 1757.60 - 3.0 \cdot \left(p_S^{\mathrm{RofW}} - p_T^{\mathrm{RofW}}\right) \end{aligned}$$

19 E_A

$$\begin{aligned} E_A^{\mathrm{UK}} &= 0.05 \cdot E_T^{\mathrm{UK}} + 47.95 - 5.0 \cdot \left(p_A^{\mathrm{UK}} - p_T^{\mathrm{UK}}\right) \\ E_A^{\mathrm{EU14}} &= 0.05 \cdot E_T^{\mathrm{EU14}} + 217.65 - 5.0 \cdot \left(p_A^{\mathrm{EU14}} - p_T^{\mathrm{EU14}}\right) \\ E_A^{\mathrm{NAFTA}} &= 0.05 \cdot E_T^{\mathrm{NAFTA}} + 247.00 - 5.0 \cdot \left(p_A^{\mathrm{NAFTA}} - p_T^{\mathrm{NAFTA}}\right) \\ E_A^{\mathrm{RofW}} &= 0.413 \cdot E_T^{\mathrm{RofW}} - 1168.35 - 15.0 \cdot \left(p_A^{\mathrm{RofW}} - p_T^{\mathrm{RofW}}\right) \end{aligned}$$

20 p

$$p = p_M \cdot \left(\frac{E_M^{base}}{E^{base}}\right) + p_S \cdot \left(\frac{E_S^{base}}{E^{base}}\right) + p_A \cdot \left(\frac{E_A^{base}}{E^{base}}\right) + p_D \cdot \left(\frac{E_T^{base}}{E^{base}}\right)$$

21–23 p_M, p_S, p_A

$$\begin{aligned} p_M &= p_M^{\text{World}} \cdot (1 + T_M) \\ p_S &= p_S^{\text{World}} \cdot (1 + T_S) \\ p_A &= p_A^{\text{World}} \cdot (1 + T_A) \end{aligned}$$

24 p_T

$$p_T = p_M \cdot \left(\frac{E_M}{E_T}\right) + pS \cdot \left(\frac{E_S}{E_T}\right) + p_A \cdot \left(\frac{E_A}{E_T}\right)$$

World prices. Sums are over four blocs.
Variables without superscripts are bloc variables.
p_A^{World} is derived from the relationship :

$$\sum y_A = \sum E_A$$

The RHS is expanded using the expression for E_A in Equation 19 and the expression for p_A in Equation 27.
a_1, a_2 and a_3 are the coefficients from the RHS of the equation for E_A

$$\begin{aligned} \sum y_A &= \sum \{a_1 \cdot E_T + a_2 + a_3 \cdot (p_A - p_T)\} \\ \sum y_A &= \sum \left\{a_1 \cdot E_T + a_2 + a_3 \cdot (1 + T_A) \cdot p_A^{\text{World}} - a_3 \cdot p_T\right\} \\ \sum y_A &= \sum \{a_1 \cdot E_T + a_2 - a_3 \cdot p_T\} + p_A^{\text{World}} \cdot \sum a_3 \cdot (1 + T_A) \\ p_A^{\text{World}} &= \frac{\sum y_A - \sum \{a_1 \cdot E_T - a_2 + a_3 \cdot p_T\}}{\sum a_3 \cdot (1 + T_A)} \end{aligned}$$

p_S^{World} is derived similarly.
b_1, b_2 and b_3 are the coefficients from the RHS of the equation for Es :

$$\sum y_S = \sum E_S$$

and

$$p_S^{\text{World}} = \frac{\sum y_S - \sum \{b_1 \cdot E_T - b_2 + b_3 \cdot p_T\}}{\sum b_3 \cdot (1 + T_S)}$$

Glossary

Subscripts	
i	Sector
$_M$	Manufacturing
$_S$	Services
$_A$	Primary
$_D$	Non-traded
y	Output
Factor prices	
w	Unskilled
h	Services and high-tech
l	Land
Factor supplies	
N	Unskilled
H	Skilled
L	Land
E	Demand
p_i	Internal prices
p	GDP deflator

K	Capital
C	Consumption
r	Interest rate
π	Productivity
POP	working population
T	Tariff