UNDERSTANDING THE WORLD WOOL MARKET: TRADE, PRODUCTIVITY AND GROWER INCOMES

PART IV: MODEL DATA AND PARAMETERS*

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CHAPTER 4

MODEL DATA AND PARAMETERS

4.1 Preamble

This chapter has three broad aims:

(i) to describe the sources and methods used to construct the WOOLGEM database;

(ii) to summarise the resulting database to aid in the interpretation of simulation results; and

(iii) to describe the sources and rationale underlying the parameters used to calibrate the behavioural equations in the WOOLGEM model.

4.2 Data sources

WOOLGEM is a comparative-static general equilibrium model of the world economy with a detailed representation of the world wool market. Thus, to calibrate the theory of WOOLGEM we require a database that captures the movement of raw wool through a number of processing stages to the production and consumption of wool garments, as well as trade in all the raw, intermediate and final commodities between regions of the world. We also require a comprehensive representation of the nonwool economy, i.e., a representation of the economy as a complete system of interdependent components – industries, households, investors, governments, importers and exporters (Dixon et al. 1992). Finally, we require a database that accurately captures the relative importance of (i) each of these interdependent components, and (ii) the wool and nonwool economies in each region of the world.

In constructing such a database we can take advantage of an existing, widely-used, and well-known database of the world economy, GTAP, which is specified in $US for 1997

(Dimaranan and McDougall 2002). The database is comprehensive, in the sense defined above, in its representation of the world economy. We thus use the GTAP database as the starting point for the construction of the WOOLGEM database. As such, the nature of the resulting WOOLGEM database will be heavily influenced by the structure of the GTAP database; to aid in describing our GTAP derivative database we present a simplified representation of the GTAP data in tables 4.1 and 4.2.

Table 4.1 A simplified representation of the GTAP input-output table for a single region

	Industry usage (IU) (j=1,…,J)	Household consumption (HC)	Investment (I)	Government consumption (GC)	Margin exports (ME)	Nonmargin exports (NME)	Total sales (TS) [row sum]
Domestic commodity (i=1,…,K)	$\begin{pmatrix} IU_{11} & \cdots & IU_{1j} \\ \vdots & \ddots & \vdots \\ IU_{i1} & \cdots & IU_{ij} \end{pmatrix}$	HC_1 $\vdots$ HC_i	I_1 $\vdots$ I_i	GC_1 $\vdots$ GC_i	ME_1 $\vdots$ ME_i	NME_1 $\vdots$ NME_i	TS_1 $\vdots$ TS_i
Imported commodity (k=1,…,K)	$\begin{pmatrix} IU_{11} & \cdots & IU_{1j} \\ \vdots & \ddots & \vdots \\ IU_{k1} & \cdots & IU_{kj} \end{pmatrix}$	HC_1 $\vdots$ HC_k	I_1 $\vdots$ I_k	GC_1 $\vdots$ GC_k			M_1 $\vdots$ M_k
Land (L)	$L_1 \quad \cdots \quad L_j$						
Labour (N)	$N_1 \quad \cdots \quad N_j$						
Capital (K)	$K_1 \quad \cdots \quad K_j$						
TOTAL COSTS (TC) [column sum]	$TC_1 \quad \cdots \quad TC_j$						

Table 4.1 presents a simplified representation of the structure of the input-output table for a single region in the GTAP database. The structure partitions sales of the K domestically-produced commodities into sales to industries (IU), households (HC), investment (I), government (GC), margin exports (ME), and nonmargin exports (NME). Summing across all sales categories for each of the domestically-produced commodities gives total sales by i, $TS_i = IU_i + HC_i + I_i + GC_i + ME_i + NME_i$. Summing across total sales

of each of the K domestically-produced commodities, $\sum_i TS_i$, gives total sales of domestically-produced commodities for a given region, or gross output. Sales of the K imported commodities are categorised similarly to domestically-produced goods except for exports. Summing across all sales categories for each of the imported commodities gives total sales by k, $M_k = IU_k + HC_k + I_k + GC_k$. Summing across total sales of each of the K imported commodities, $\sum_k M_k$, gives total imports for a given region.

Table 4.2 A simplified representation of the GTAP bilateral trade data for a single region

	Destination regions (s=1,…,R)	Source regions (r=1,…,R)	Total sales (TS) [row sum]
Margin exports (ME) (i=1,…,K)	$\begin{pmatrix} ME_{11} & \cdots & ME_{1s} \\ \vdots & \ddots & \vdots \\ ME_{i1} & \cdots & ME_{is} \end{pmatrix}$		ME_1 $\vdots$ ME_i
Nonmargin exports (NME) (i=1,…,K)	$\begin{pmatrix} NME_{11} & \cdots & NME_{1s} \\ \vdots & \ddots & \vdots \\ NME_{i1} & \cdots & NME_{is} \end{pmatrix}$		NME_1 $\vdots$ NME_i
Imported commodity (k=1,…,K)		$\begin{pmatrix} M_{11} & \cdots & M_{1r} \\ \vdots & \ddots & \vdots \\ M_{k1} & \cdots & M_{kr} \end{pmatrix}$	M_1 $\vdots$ M_k

Table 4.2 presents a simplified representation of the structure of the bilateral trade data for single region in the GTAP database. Here, the total sales of each of the imported commodities, M_k, are categorised as originating across the R source regions: thus the column vector M_k represents the K import composites summed over the R source regions, $\sum_r M_{kr}$. On the supply side, the margin and nonmargin exports of each of the domestically-produced goods, ME_i and NME_i, are categorised as being sold to the R destination regions.

Returning to table 4.1, costs for each of the J industries in a region are categorised into intermediate usage of the K domestically-produced goods, IU_{ij}, intermediate usage of the K imported composites, IU_{kj}, and land, labour and capital usage, L_j, N_j and K_j. Summing across all cost categories for each industry gives total costs by industry, TC_j. Summing total costs across all industries gives total costs for the region, $\sum_j TC_j$, or gross output. Consistency between commodity sales and industry costs requires $TS_i = TS_j$, $(i = j)$.[1]

Tables 4.1 and 4.2 are simplified representations of the GTAP database as almost all value flows listed in these tables have concomitant taxes. Thus, the full structure of the database is much more complex than that represented in tables 4.1 and 4.2. Using the GTAP database as our starting point, we can create highly disaggregated raw wool, wool textiles and wool garments commodities and industries by disaggregating the relevant commodities and industries. A detailed explanation of how this is done is the content of the following section and the Appendix.

In order to disaggregate the relevant GTAP commodities and industries we require some idea of the structure of individual raw wool, wool textile and wool garment commodities and industries in each of the more aggregated GTAP commodities and industries. Information of this kind is available from WOOLMOD, an existing model of the world wool market which treats raw wool, wool textile and wool garments as heterogeneous commodities (Verikios 2004).[2] This model divides the world wool market

[1] The GTAP database assumes a one-to-one mapping between industries and commodities, i.e., there are no multiproduct industries or multi-industry products.

[2] Raw wool is defined by Connolly (1992, p. ix) as comprising greasy wool, scoured wool, carbonised wool, wool tops, and noils. We adopt this definition in this paper. We define wool textiles as comprising of wool yarns and fabrics. We define wool garments as comprising woollen and worsted garments.

into nine geographical regions and production in each region amongst eight broad industrial sectors, each representing a different stage of the wool market. The industrial sectors cover the full spectrum of activities from greasy wool production to retail garment production. By applying the highly disaggregated commodity and industry data in WOOLMOD to the more aggregated commodity and industry data in GTAP, we can derive a database that: (i) captures the movement of raw wool through a number of processing stages to the production and consumption of wool garments, as well as trade in all the raw, intermediate, and final wool commodities between regions of the world; and (ii) represents the nonwool economy as a complete system of interdependent components comprising industries, households, investors, governments, importers, and exporters.

To aid in explaining the creation of the WOOLGEM database, we briefly describe the structure of the WOOLMOD database. Tables 4.3 and 4.4 present simplified representations of the input-output table and bilateral trade data for a given region in WOOLMOD. It is obvious from table 4.3 that WOOLMOD is a partial-equilibrium model; it contains no data on investment, government consumption, or margin exports. Further, whilst the list of *K* domestically-produced commodities used by industries includes nonwool commodities, such as synthetics and a composite nonwool input, households only consume sheep meat and wool garments. And the *K* imported commodities only include raw wool, wool textiles, and wool garments, i.e., sheep meat, synthetic textiles and the composite nonwool input are nontraded.

Table 4.3 A simplified representation of the WOOLMOD input-output table for a single region

	Industry usage (IU) (j=1,…,J)	Household consumption (HC)	Nonmargin exports (NME)	Total sales (TS) [row sum]
Domestic commodity (i=1,…,K)	$\begin{pmatrix} IU_{11} & \cdots & IU_{1j} \\ \vdots & \ddots & \vdots \\ IU_{i1} & \cdots & IU_{ij} \end{pmatrix}$	$HC_1 \vdots HC_i$	$NME_1 \vdots NME_i$	$TS_1 \vdots TS_i$
Imported commodity (k=1,…,K)	$\begin{pmatrix} IU_{11} & \cdots & IU_{1j} \\ \vdots & \ddots & \vdots \\ IU_{k1} & \cdots & IU_{kj} \end{pmatrix}$	$HC_1 \vdots HC_k$		$M_1 \vdots M_k$
Land (L)	$L_1 \ldots\ldots L_j$			
Labour (N)	$N_1 \ldots\ldots N_j$			
Capital (K)	$K_1 \ldots\ldots K_j$			
TOTAL COSTS (TC) [column sum]	$TC_1 \ldots\ldots TC_j$			

Table 4.4 A simplified representation of the WOOLMOD bilateral trade data for a single region

	Destination regions (s=1,…,R)	Source regions (r=1,…,R)	Total sales (TS) [row sum]
Nonmargin exports (NME) (i=1,…,K)	$\begin{pmatrix} NME_{11} & \cdots & NME_{1s} \\ \vdots & \ddots & \vdots \\ NME_{i1} & \cdots & NME_{is} \end{pmatrix}$		$NME_1 \vdots NME_i$
Imported commodity (k=1,…,K)		$\begin{pmatrix} M_{11} & \cdots & M_{1r} \\ \vdots & \ddots & \vdots \\ M_{k1} & \cdots & M_{kr} \end{pmatrix}$	$M_1 \vdots M_k$

On the supply side, the list of J industries only includes industries producing sheep meat, raw wool, wool textiles, and wool garments; the production of synthetic textiles and the composite nonwool input are not defined. But like the GTAP database, all trade is defined on a bilateral basis. Note that tables 4.3 and 4.4 are only slightly simplified representations of the WOOLMOD database, as only taxes on bilateral imports have been omitted. Thus, relative the GTAP database, the WOOLMOD database contains a very sparse treatment of distortions faced by economic agents.

4.3 Constructing the WOOLGEM database

This section describes the general procedure applied to create the WOOLGEM database: the Appendix contains a more detailed explanation of this procedure.

4.3.1 The general procedureEquation Section 4

The GTAP database provides us with flows representing economic behaviour in a given region for a given year. Let G_i be a given GTAP flow for the *i*-th commodity (i=1,…,A). Imagine that one of the A commodities is an aggregated wool commodity representing all forms of raw wool, i.e., $G_i \quad (i = Wool)$. The WOOLMOD database also provides us with flows representing economic behaviour in a given region for a given year. Let W_k be a given WOOLMOD flow for the *k*-th commodity (k=1,…,B). Imagine that B is a set of disaggregated raw wool commodities. Using W_k to calculate the appropriate shares, we can disaggregate G_i, $(i = Wool)$, to obtain D_k, a flow representing economic behaviour over the set B, as follows;

$$D_k = G_i \frac{W_k}{\sum_{k=1}^{B} W_k}, \; k = 1,...,B \; ; \; i = Wool \; . \qquad (4.1)$$

Formula (4.1) is the general method applied to create the WOOLGEM database. By adding regional subscripts to (4.1) we move closer to the actual method. (4.1) is also appropriate for disaggregating flows relating household consumption, investment, government consumption, total exports, and total imports. By adding industry subscripts to (4.1) we obtain a formula for disaggregating intermediate and factor usage by industries. By adding source region and destination region subscripts we obtain a formula for disaggregating bilateral trade flows. This method allows us to maintain the basic numerical structure of the GTAP database, as our *a priori* judgement is that this numerical structure is an accurate representation of the interdependent components, and the wool and nonwool economy, in each region of the world.[3]

Applying the basic technique of (4.1) requires judgements to be made regarding the mapping of commodities and industries from G_i to W_k, that is, from the GTAP database to the WOOLMOD database. This commodity mapping is presented in table 4.5. We can see that for certain commodities the mapping is not direct, for instance, the GTAP commodity *Bovine cattle, sheep and goats, horses* maps to the WOOLMOD commodity *Sheep meat* but includes more than this. In cases such as these assumptions are made about the proportion of *Sheep meat* in *Bovine cattle, sheep and goats, horses*. These assumptions are explained in the Appendix.

As WOOLMOD contains multiproduct industries the industry mapping between the WOOLMOD and GTAP databases will differ from that presented in table 4.5. Thus, for completeness, table 4.6 presents this industry mapping. Similar to the commodity mapping, the industry mapping is not direct, for instance, two GTAP industries *Bovine cattle, sheep and goats, horses* and *Wool, silk-worm cocoons* map to the WOOLMOD industry *Sheep*. In this case, assumptions are made about the proportion of *Bovine cattle, sheep and goats, horses* and *Wool, silk-worm cocoons* which relates to output by the *Sheep* industry. These assumptions are also outlined in the Appendix.

[3] The Center for Global Trade Analysis, the producers of the GTAP database, place considerable effort into ensuring the numerical structure of the macroeconomic and trade data is representative of the world economy (see Dimaranan and McDougall 2002, Chapters 15.B and 18.A).

Table 4.5 Commodity mapping between the GTAP and WOOLMOD databases

GTAP commodity	WOOLMOD commodity
Bovine cattle, sheep and goats, horses	Sheep meat
Wool, silk-worm cocoons	Greasy wool <20 microns, <56 millimetres
Wool, silk-worm cocoons	Greasy wool 20-23 microns, <56 millimetres
Wool, silk-worm cocoons	Greasy wool >23 microns, <56 millimetres
Wool, silk-worm cocoons	Greasy wool <20 microns , 56-65 millimetres
Wool, silk-worm cocoons	Greasy wool 20-23 microns, 56-65 millimetres
Wool, silk-worm cocoons	Greasy wool >23 microns, 56-65 millimetres
Wool, silk-worm cocoons	Greasy wool <20 microns, >65 millimetres
Wool, silk-worm cocoons	Greasy wool 20-23 microns, >65 millimetres
Wool, silk-worm cocoons	Greasy wool >23 microns, >65 millimetres
Wool, silk-worm cocoons	Scoured wool <20 microns, <56 millimetres
Wool, silk-worm cocoons	Scoured wool 20-23 microns, <56 millimetres
Wool, silk-worm cocoons	Scoured wool >23 microns, <56 millimetres
Wool, silk-worm cocoons	Scoured wool <20 microns , 56-65 millimetres
Wool, silk-worm cocoons	Scoured wool 20-23 microns, 56-65 millimetres
Wool, silk-worm cocoons	Scoured wool >23 microns, 56-65 millimetres
Wool, silk-worm cocoons	Scoured wool <20 microns, >65 millimetres
Wool, silk-worm cocoons	Scoured wool 20-23 microns, >65 millimetres
Wool, silk-worm cocoons	Scoured wool >23 microns, >65 millimetres
Wool, silk-worm cocoons	Carbonised wool <20 microns, <56 millimetres
Wool, silk-worm cocoons	Carbonised wool 20-23 microns, <56 millimetres
Wool, silk-worm cocoons	Carbonised wool >23 microns, <56 millimetres
Wool, silk-worm cocoons	Worsted top <20 microns , 56-65 millimetres
Wool, silk-worm cocoons	Worsted top 20-23 microns, 56-65 millimetres
Wool, silk-worm cocoons	Worsted top >23 microns, 56-65 millimetres
Wool, silk-worm cocoons	Worsted top <20 microns, >65 millimetres
Wool, silk-worm cocoons	Worsted top 20-23 microns, >65 millimetres
Wool, silk-worm cocoons	Worsted top >23 microns, >65 millimetres
Wool, silk-worm cocoons	Noil <20 microns, >56 millimetres
Wool, silk-worm cocoons	Noil 20-23 microns, >56 millimetres
Wool, silk-worm cocoons	Noil >23 microns, >56 millimetres
Textiles	Worsted blend yarn
Textiles	Worsted pure lightweight yarn
Textiles	Worsted pure heavyweight yarn
Textiles	Woollen blend yarn
Textiles	Woollen pure yarn
Textiles	Worsted blend woven fabric
Textiles	Worsted pure lightweight woven fabric
Textiles	Worsted pure heavyweight woven fabric
Textiles	Worsted knitted fabric
Textiles	Woollen blend woven fabric
Textiles	Woollen pure woven fabric
Textiles	Synthetics
Wearing apparel	Men’s worsted blend woven wholesale garments
Wearing apparel	Women’s worsted blend woven wholesale garments
Wearing apparel	Men’s worsted pure woven wholesale garments
Wearing apparel	Women’s worsted pure woven wholesale garments
Wearing apparel	Men’s worsted knitted wholesale garments
Wearing apparel	Women’s worsted knitted wholesale garments
Wearing apparel	Men’s woollen blend woven wholesale garments
Wearing apparel	Women’s woollen blend woven wholesale garments
Wearing apparel	Men’s woollen pure woven wholesale garments
Wearing apparel	Women’s woollen pure woven wholesale garments
Wearing apparel	Woollen knitted blend wholesale garments
Wearing apparel	Woollen knitted pure wholesale garments
Other commodities	Other inputs

Note: WOOLMOD also contains 14 retail wool garments commodities. The data on these commodities are not used in creating the WOOLGEM data.

Table 4.6 Industry mapping between the GTAP and WOOLMOD databases

GTAP industry	WOOLMOD industry
Bovine cattle, sheep and goats, horses	Sheep
Wool, silk-worm cocoons	Sheep
Wool, silk-worm cocoons	Scoured wool <20 microns, <56 millimetres
Wool, silk-worm cocoons	Scoured wool 20-23 microns, <56 millimetres
Wool, silk-worm cocoons	Scoured wool >23 microns, <56 millimetres
Wool, silk-worm cocoons	Scoured wool <20 microns , 56-65 millimetres
Wool, silk-worm cocoons	Scoured wool 20-23 microns, 56-65 millimetres
Wool, silk-worm cocoons	Scoured wool >23 microns, 56-65 millimetres
Wool, silk-worm cocoons	Scoured wool <20 microns, >65 millimetres
Wool, silk-worm cocoons	Scoured wool 20-23 microns, >65 millimetres
Wool, silk-worm cocoons	Scoured wool >23 microns, >65 millimetres
Wool, silk-worm cocoons	Carbonised wool <20 microns, <56 millimetres
Wool, silk-worm cocoons	Carbonised wool 20-23 microns, <56 millimetres
Wool, silk-worm cocoons	Carbonised wool >23 microns, <56 millimetres
Wool, silk-worm cocoons	Worsted top <20 microns , 56-65 millimetres
Wool, silk-worm cocoons	Worsted top 20-23 microns, 56-65 millimetres
Wool, silk-worm cocoons	Worsted top >23 microns, 56-65 millimetres
Wool, silk-worm cocoons	Worsted top <20 microns, >65 millimetres
Wool, silk-worm cocoons	Worsted top 20-23 microns, >65 millimetres
Wool, silk-worm cocoons	Worsted top >23 microns, >65 millimetres
Textiles	Worsted blend yarn
Textiles	Worsted pure lightweight yarn
Textiles	Worsted pure heavyweight yarn
Textiles	Woollen blend yarn
Textiles	Woollen pure yarn
Textiles	Worsted blend woven fabric
Textiles	Worsted pure lightweight woven fabric
Textiles	Worsted pure heavyweight woven fabric
Textiles	Worsted knitted fabric
Textiles	Woollen blend woven fabric
Textiles	Woollen pure woven fabric
Textiles	Synthetic textiles
Wearing apparel	Men's worsted blend woven wholesale garments
Wearing apparel	Women's worsted blend woven wholesale garments
Wearing apparel	Men's worsted pure woven wholesale garments
Wearing apparel	Women's worsted pure woven wholesale garments
Wearing apparel	Men's worsted knitted wholesale garments
Wearing apparel	Women's worsted knitted wholesale garments
Wearing apparel	Men's woollen blend woven wholesale garments
Wearing apparel	Women's woollen blend woven wholesale garments
Wearing apparel	Men's woollen pure woven wholesale garments
Wearing apparel	Women's woollen pure woven wholesale garments
Wearing apparel	Woollen knitted blend wholesale garments
Wearing apparel	Woollen knitted pure wholesale garments
Other industries	not applicable

Note: WOOLMOD also contains 14 retail wool garments industries. The data on these industries are not used in creating the WOOLGEM data.

The regional aggregation of the WOOLGEM database is constrained by the regional aggregation of the WOOLMOD database, which comprises nine regions of the world. Before splitting the GTAP database we aggregate across regions such that there is a one-to-one relationship with the WOOLMOD database for all regions. The resulting regional aggregation in WOOLGEM is presented in table 4.7.

Table 4.7 Regions in the WOOLGEM database

1. France
2. Germany
3. Italy
4. United Kingdom (UK)
5. United States of America (USA)
6. Japan
7. China
8. Australia
10. Rest of the world (ROW)

4.3.2 Additional data

Once the GTAP database has been split using the procedure described above, and in the Appendix, two forms of additional tax data are applied to the database:

(i) import tariffs on raw wool, wool textiles and wool garments; and

(ii) income tax rates.

4.3.2.1 Import tariffs

Import duties on raw wool, wool textiles and wool garments for 1997 are taken from TWC (2003) and applied to the WOOLGEM database. These duties replace the existing duties on the aggregated wool commodities in the GTAP database. However, neither the regional nor the commodity aggregation of the tariff data map exactly to the regional and commodity aggregation in the WOOLGEM database. Thus, it is necessary to make certain judgements when applying the tariff data to the database. These judgements are summarised in table 4.8. The TWC wool tariff data are *ad valorem* for all regions except the USA, which applies *ad valorem* as well as specific duty rates on imports. Total *ad valorem* duty rates are calculated for the USA by combining *ad valorem* and specific duty rates. Specific duty rates are specified in cents per kilogram. These are converted to *ad valorem* equivalents by assuming that the initial price (*P*) for all commodities is unity, thus quantities (*Q*) are calculated as values (*V*) divided by the initial price, i.e., $Q=V/P=V/1=V$. The specific duty rates are then applied to the value flows in the WOOLGEM database. The converted specific duty rates are then added to the *ad valorem* rates to give total *ad valorem* duty rates for USA imports.

Table 4.8 Mapping between TWC (2003) import tariffs and the WOOLGEM database

Regional mapping	
WOOLGEM region	TWC region
France	European Union
Germany	European Union
Italy	European Union
UK	European Union
USA	USA
Japan	Japan
China	China
Australia	Australia
ROW	Simple average of Korea and India
Commodity mapping	
Broad WOOLGEM commodity	TWC commodity
Greasy wool	Greasy wool
Scoured wool	Greasy wool
Carbonised wool	Wool top
Worsted tops	Wool top
Noils	Wool top
Wool yarns	Worsted yarns
Wool fabrics	Worsted fabrics
Men's wool garments	Simple average of men's suits & trousers
Women's wool garments	Simple average of men's jackets & trousers
Wool knitted garments	Simple average of jumpers & jerseys

4.3.2.2 Income tax rates

While the GTAP database contains a wide range of indirect tax data, it contains no direct tax data. This is remedied by using income tax rates from data applied in Verikios and Hanslow (1999), the calculation of which is described in Hanslow et al. (1999), Appendix E. These tax rates reflect labour and nonlabour income taxes in 1995 for all regions except Germany, 1993; Italy, 1994; and Japan, 1993.

4.4 Data summary

Here we present summary of the model database from a macroeconomic and a number of microeconomic perspectives.

4.4.1 Macroeconomic data

In this section we provide a breakdown of regional net output, or GDP, in the WOOLGEM database from two perspectives, the expenditure side and the income side. GDP from the expenditure side is the sum of household consumption, investment, government expenditure, change in stocks, exports minus imports. The first three expenditure items are valued at purchaser's prices, the fourth at supply (or basic) prices, while the last two items are valued at f.o.b. and c.i.f. prices. GDP from the income side is composed of land, labour, capital income, plus indirect tax revenue. Factor income is calculated as inclusive of direct taxes. Table 4.9 presents regional GDP from these two perspectives.

Table 4.9 Breakdown of regional GDP from two perspectives

	Expenditure on GDP						
	Household consumption (% of GDP)	Investment (% of GDP)	Government consumption (% of GDP)	Change in stocks (% of GDP)	Exports (% of GDP)	Imports (% of GDP)	**Total**
France	60.7	17.4	19.6	0.0	25.6	-23.3	**100**
Germ	58.4	20.2	19.8	0.0	26.9	-25.5	**100**
Italy	63.5	16.9	16.8	0.2	25.3	-22.7	**100**
UK	65.8	17.1	18.8	0.0	26.1	-27.7	**100**
USA	70.2	17.0	14.6	0.0	10.7	-12.5	**100**
Japan	59.5	28.7	9.7	0.0	12.0	-9.9	**100**
China	48.7	36.3	11.9	0.0	28.6	-25.5	**100**
Aust	63.7	19.6	17.0	0.0	18.7	-19.0	**100**
ROW	56.1	29.0	15.3	0.0	33.3	-33.6	**100**

	Income from GDP					GDP	
	Land (% of GDP)	Labour (% of GDP)	Capital (% of GDP)	Indirect taxes (% of GDP)	**Total**	(US$ million)	(% of world GDP)
France	0.9	42.4	43.2	13.4	**100**	1,371,798	4.7
Germ	0.5	49.6	39.5	10.4	**100**	2,058,859	7.0
Italy	1.1	41.0	49.1	8.8	**100**	1,098,153	3.8
UK	1.1	58.6	33.3	7.0	**100**	1,288,203	4.4
USA	0.8	59.6	36.2	3.3	**100**	8,235,511	28.1
Japan	0.3	51.4	33.9	14.3	**100**	4,267,870	14.6
China	6.1	45.2	30.8	17.9	**100**	928,861	3.2
Aust	2.0	47.7	40.4	9.9	**100**	409,219	1.4
ROW	3.7	46.0	40.5	9.8	**100**	9,612,592	32.8

As expected, the USA is the largest single economy in the database representing around 28 per cent of world GDP, followed by Japan (15 per cent) and Germany (7 per cent). The composite Rest of world (ROW) region makes up around one-third of world GDP. All developed economies except Japan have high (household and government) consumption shares representing low savings rates. The only separate developing economy, China, has the lowest consumption share of all regions and, consequently, the highest savings rate. On the income side, land rentals are highest in China and the ROW at 6 and 4 per cent. Australia's status as a large, developed, agricultural exporter is reflected in its high land rental share (2 per cent), relative to other developed regions. Labour and capital shares do not vary in any systematic way between the developing and developed regions, nor do indirect tax shares.

4.4.2 Commodity and sectoral data

In this section we present a breakdown of commodity sales and industry costs data for the world as a whole: see tables 4.10 and 4.11. The data are aggregated across broad commodities and industries in order to provide an overall picture of the numerical structure of the database.

Table 4.10 Sales shares by broad commodity, World

	Intermediate usage	Household consumption	Investment	Government consumption	Change in stocks	Exports	**Total**
Sheep meat	82.0	13.3	1.1	0.1	0.4	3.0	**100**
Greasy wool	61.8	0	0	0	3.4	34.9	**100**
Scoured wool	79.3	0	0	0	0	20.8	**100**
Carbon wool	68.7	0	0	0	-0.2	31.4	**100**
Worsted tops	45.9	0	0	0	0.8	53.3	**100**
Noils	39.9	0	0	0	3.0	57.1	**100**
Wool yarns	66.6	0	0	0	-0.7	34.1	**100**
Wool fabrics	69.3	0	0	0	0	30.7	**100**
Wool garms	24.8	51.6	0.4	0.6	0	22.6	**100**
Synth textiles	60.4	12.8	0.7	0.3	0	25.8	**100**
Other goods	41.0	28.4	10.9	7.9	0	11.8	**100**
Average	*41.1*	*28.4*	*10.8*	*7.8*	*0*	*11.5*	***100***

Table 4.11 Costs shares by broad industry, World

	Wool intermediate usage	Nonwool intermediate usage	Land	Labour	Capital	Indirect taxes	**Total**
Sheep	0	55.6	13.2	24.6	20.7	-14.1	**100**
Scoured wool	91.1	2.2	0	5.2	2.6	-1.1	**100**
Carbon wool	84.6	4.3	0	8.4	3.9	-1.2	**100**
Worsted tops	75.5	8.2	0	11.8	5.2	-0.7	**100**
Wool yarns	53.2	21.5	0	14.8	8.7	1.8	**100**
Wool fabrics	43.5	27.2	0	16.7	10.6	1.9	**100**
Wool garms	22.9	42.6	0	20.3	12.1	2.0	**100**
Other indus	0.1	48.7	1.0	27.6	20.6	2.0	**100**
Average	*0.2*	*48.7*	*1.0*	*27.6*	*20.6*	*2.0*	***100***

The sales shares show the unique nature of the WOOLGEM database in its depiction of the production of greasy wool and its transformation into wool garments through five separate processing stages, the six relevant stages being:

1. *Wool growing,* producing greasy wool from nonwool inputs;
2. *Scouring,* producing scoured wool from greasy wool;
3. *Carding and combing,* producing carbonised wool, worsted tops and noils from scoured wool;
4. *Spinning,* producing wool yarns from synthetic textiles, carbonised wool, worsted tops and noils;
5. *Weaving,* producing wool fabrics from wool yarns; and
6. *Garment making,* producing wool garments from wool yarns and fabrics.

The sales summary shows that commodities produced in the first five stages are not used in final consumption, by either households or governments; rather, they are used exclusively as intermediate inputs in the production of other wool commodities or exported. Only wool garments (produced in the final stage) are used for final consumption. In contrast, all nonwool commodities (sheep meat, synthetic textiles, and other goods) are used as intermediate inputs and in final consumption. However, sheep meat and synthetic textiles are primarily used as intermediate inputs whereas around half of other goods are used for final consumption and investment.

The costs summary builds on the interesting numerical picture alluded to above regarding the six stages depicting the production of greasy wool and its transformation into wool garments. These stages begin with the production of greasy wool (and sheep meat) by the sheep industry, which uses only nonwool intermediate inputs and factors of production. The five processing stages begin with production of scoured wool and progress through to the production of wool garments. Notice the large share (around 90 per cent) that wool intermediate inputs make up in the production of scoured wool, but also notice the steady reduction in this share as we move to successive processing stages such that it falls to around 23 per cent in garment making. The pattern of nonwool intermediate input usage in these five processing stages is the opposite of that observed for wool intermediate inputs; the share is low initially at around 2 per cent (for the production of scoured wool) but eventually rises to around 43 per cent (for the production of wool garments). The large share of nonwool inputs in downstream processing industries partly reflects more elaborate transformation of the raw product, thus requiring nonwool inputs such as electricity and dyes, and partly reflects the increasing importance of margins, particularly for wool garments, which are consumed by households. These margins include financial and insurance services, transport, and wholesaling and retailing activities.

We also note the share of indirect taxes in total costs as we move from primary industries, like sheep, to secondary industries, such as the five processing stages identified above, to tertiary industries, which comprise a large proportion of the other industries composite. The sheep industry receives a significant tax subsidy (14 per cent), while early-stage processors (scoured wool, carbonised wool, and worsted tops) receive small subsidies (around 1 per cent), and later-stage processors (yarns, fabric and garments) and other industries are slightly taxed at around 2 per cent.

4.4.3 Input-output data

Table 4.12 presents the input-output shares, for the world as a whole, by broad inputs and industry. This allows us to glean the intra-industry linkages in the database. The most obvious feature of the aggregated input-output tables are their diagonal nature for the wool processing industries, reflecting a linear hierarchy where outputs from downstream processing industries are not used as inputs by upstream processing industries. This conforms to the 'Austrian' view of production where there is a linear hierarchy, to be contrasted with the 'Leontief' view of production where there are 'whirlpools' of production and general interdependence between all industries via direct or indirect intermediate input usage (Blaug 1978, p. 544; Dorfman et al. 1987, p. 205). The Leontief view of production is reflected in the nonwool processing industries, sheep and other industries, which use each other's outputs as intermediate inputs.

Table 4.12 Input-output shares, World

BROAD INPUTS	BROAD INDUSTRIES							
	Sheep	Scoured wool	Carbon wool	Worsted tops	Wool yarns	Wool fabrics	Wool garments	Other industries
Sheep meat	0	0	0	0	0	0	0	0.1
Greasy wool	0	90.1	0	0	0	0	0	0
Scoured wool	0	0	83.9	75.0	0	0	0	0
Carbon wool	0	0	0	0	26.8	0	0	0
Worsted tops	0	0	0	0	14.7	0	0	0
Noils	0	0	0	0	12.6	0	0	0
Wool yarns	0	0	0	0	0	44.3	2.6	0
Wool fabrics	0	0	0	0	0	0	20.8	0
Wool garms	0	0	0	0	0	0	0	0.1
Synth textiles	0	0	0	0	2.5	0	0	0.6
Other goods	55.0	2.2	4.3	8.2	19.5	28.0	43.7	49.4
Value added	45.0	7.7	11.8	16.8	23.9	27.8	33.0	49.9
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Factor usage in the five wool processing stages follows the same pattern as nonwool intermediate input usage, rising to around one-third of total costs (for wool garments) from an initial share of around 8 per cent (for scoured wool). This pattern is intuitive given that we expect value added, as a share total costs, to rise as we move from the production of slightly transformed goods, such as scoured wool, to more highly transformed goods, such as garments (see AWIL 2005, pp. 45–6).

4.4.4 Make data

The database contains both multiproduct industries and multi-industry products. Table 4.13 presents the make shares by broad commodities and industries for the world as a whole. The multiproduct industries include the sheep industry, the worsted tops industries and the composite other industries in each region. We note that, for the world as a whole, sheep meat production predominates over greasy wool production for the sheep industry. Although not reported, this reflects the situation for the sheep industry in all regions except Australia, where greasy wool is the dominant output of the sheep industry. Production by the worsted tops industries is dominated by worsted top production, with noils production comprising around 10 per cent for total output. The other industries composite almost exclusively produces other goods, with synthetic textiles comprising less than 1 per cent of its production. The only multi-industry products in our database are noils. But this is not apparent in table 4.13 due to the level of aggregation at which the data are presented.

Table 4.13 Make shares, World

BROAD OUTPUTS	BROAD INDUSTRIES Sheep	Scoured wool	Carbon wool	Worsted tops	Wool yarns	Wool fabrics	Wool garms	Other indust	*All indust*
Sheep meat	88.85	0	0	0	0	0	0	0	*0.08*
Greasy wool	11.15	0	0	0	0	0	0	0	*0.01*
Scoured wool	0	100.00	0	0	0	0	0	0	*0.01*
Carbon wool	0	0	100.00	0	0	0	0	0	*0.01*
Worsted tops	0	0	0	90.35	0	0	0	0	*0.01*
Noils	0	0	0	9.65	0	0	0	0	*0.00*
Wool yarns	0	0	0	0	100.00	0	0	0	*0.02*
Wool fabrics	0	0	0	0	0	100.00	0	0	*0.04*
Wool garms	0	0	0	0	0	0	100.00	0.00	*0.24*
Synth textiles	0	0	0	0	0	0	0	0.68	*0.68*
Other goods	0	0	0	0	0	0	0	99.32	*98.90*
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	***100.00***

The global averages presented in the final column of table 4.13 indicate the relatively small share of total output which sheep meat and wool commodities comprise. In fact, the production of synthetic textiles is larger than the production of sheep meat and wool commodities combined. Within this subset of commodities, the output of wool garments dominates reflecting their high-value nature.

Table 4.14 presents regional output shares by broad industry. As expected, sheep industry output is largest in Australia at around half of one per cent; this is nearly four times as large as the next largest regional sheep industry, i.e., the ROW at 0.12 per cent. The early stage wool-processing industries (scouring, carbonising, and worsted tops) are also more important in total output in Australia than in any other region, at around one-third of one per cent. The late stage wool-processing industries (wool yarns, fabrics and garments) are most important in the economies of Italy (around 1.3 per cent) and China (0.52 per cent).

Table 4.14 Output shares, by broad industry, and region

	Sheep	Scoured wool	Carbon wool	Worsted tops	Wool yarns	Wool fabrics	Wool garms	Other indust	**Total**
France	0.10	0.00	0.00	0.02	0.02	0.01	0.09	99.76	**100**
Germ	0.03	0.01	0.00	0.01	0.05	0.04	0.14	99.73	**100**
Italy	0.10	0.01	0.01	0.01	0.19	0.32	0.81	98.55	**100**
UK	0.08	0.00	0.00	0.00	0.02	0.00	0.06	99.83	**100**
USA	0.10	0.00	0.00	0.00	0.01	0.03	0.15	99.70	**100**
Japan	0.01	0.01	0.00	0.00	0.02	0.06	0.37	99.53	**100**
China	0.05	0.03	0.02	0.01	0.06	0.06	0.40	99.36	**100**
Aust	0.47	0.18	0.07	0.07	0.01	0.02	0.11	99.06	**100**
ROW	0.12	0.01	0.00	0.01	0.01	0.03	0.24	99.58	**100**
Average	*0.09*	*0.01*	*0.01*	*0.01*	*0.02*	*0.04*	*0.24*	*99.58*	***100***

4.4.5 Tax data

The WOOLGEM database contains many forms of indirect tax instruments and two forms of direct taxes. Direct taxes are split into taxes on labour and nonlabour factors. Indirect taxes include:

- commodity-specific taxes on domestic and imported intermediate inputs to current production and investment;
- factor-specific taxes on factor usage by firms;
- industry-specific taxes on output by firms;
- commodity-specific taxes on domestic and imported household and government consumption;
- commodity- and destination-specific taxes on exports; and
- commodity- and source-specific taxes on imports.

Table 4.15 reports regional income tax rates in the WOOLGEM database. Note the wide variations in labour and nonlabour income tax rates. In most developed regions nonlabour tax rates are significantly lower than labour tax rates. The two separate Asian countries in our database, Japan and China, have the lowest overall income tax rates at 9.3 and 1.7 per cent, respectively. The highest overall tax rates are levied by the continental European regions: France, 29 per cent; Germany, 42 per cent; and Italy, 29 per cent.

Table 4.15 Factor income tax rates

	Land	Labour	Capital	*All factors*
France	3.7	56.2	3.7	*29.4*
Germany	57.3	30.5	57.3	*42.4*
Italy	5.4	57.4	5.4	*28.8*
UK	10.1	25.4	10.1	*19.7*
USA	7.9	28.4	7.9	*20.5*
Japan	9.2	9.4	9.2	*9.3*
China	3.0	0.7	3.0	*1.7*
Australia	10.9	20.8	10.9	*16.2*
Rest of the world	8.2	18.8	8.2	*13.6*

Tables 4.16–4.24 present regional averages for all indirect taxes by broad commodity or industry. Although taxes on domestic and imported intermediate inputs are generally low or zero in all regions, it is worth noting that small subsidies apply to the use of sheep meat and wool commodities in most regions. This reflects domestic agricultural support in these regions.

Table 4.16 Taxes on domestic intermediate inputs, by broad commodity and region (per cent)

	France	Germ	Italy	UK	USA	Japan	China	Aust	ROW
Sheep meat	0	0	0	-1.6	-0.6	-0.7	0	0	0
Greasy wool	0	0	0	0	-1.8	0	0	-3.3	0
Scoured wool	0	0	0	0	-1.8	0	0	-3.3	0
Carbon wool	0	0	0	0	0	0	0	0	0
Worsted tops	0	0	0	0	0	0	0	0	0
Noils	0	0	0	0	0	0	0	0	0
Wool yarns	0	0	0	0	0	0	0	0	0
Wool fabrics	0	0	0	0	0	0	0	0	0
Wool garms	0	0	0	-0.1	0	0	0	0	0
Synth textiles	0	0	0	-0.1	0	0	0	0	0
Other goods	2.3	1.3	2.8	2.2	-0.1	1.1	0	0.5	0.9

Table 4.17 Taxes on imported intermediate inputs, by broad commodity and region (per cent)

	France	Germ	Italy	UK	USA	Japan	China	Aust	ROW
Sheep meat	-0.6	-3.9	-0.5	-1.0	-0.6	-2.7	0	-0.1	-0.1
Greasy wool	0	0	0	0	-1.8	0	0	0	0
Scoured wool	0	0	0	0	-1.8	0	0	0	0
Carbon wool	0	0	0	0	0	0	0	0	0
Worsted tops	0	0	0	0	0	0	0	0	0
Noils	0	0	0	0	0	0	0	0	0
Wool yarns	0	0	0	0	0	0	0	0	0
Wool fabrics	0	0	0	0	0	0	0	0	0
Wool garms	0	0	0	0	0	0	0	0	0
Synth textiles	0	0	0	0	0	0	0	0	0
Other goods	2.0	4.1	1.3	1.5	0	2.6	0	0.3	0.3

Table 4.18 Taxes on factor usage firms, by broad industry and region (per cent)

	France	Germ	Italy	UK	USA	Japan	China	Aust	ROW
LAND									
Sheep	0	0	0	0	-97.6	0	0	-13.6	-1.4
Scoured wool	0	0	0	0	0	0	0	0	0
Carbon wool	0	0	0	0	0	0	0	0	0
Worsted tops	0	0	0	0	0	0	0	0	0
Wool yarns	0	0	0	0	0	0	0	0	0
Wool fabrics	0	0	0	0	0	0	0	0	0
Wool garms	0	0	0	0	0	0	0	0	0
Other indus	-65.0	-46.4	-61.9	-38.2	-25.5	-4.4	0	-2.3	-5.3
LABOUR									
Sheep	0	0	0	0	0	0	0	0	0
Scoured wool	0	0	0	0	0	0	0	0	0
Carbon wool	0	0	0	0	0	0	0	0	0
Worsted tops	0	0	0	0	0	0	0	0	0
Wool yarns	0	0	0	0	0	0	0	0	0
Wool fabrics	0	0	0	0	0	0	0	0	0
Wool garms	0	0	0	0	0	0	0	0	0
Other indus	0	0	0	0	0	0	0	0	0
CAPITAL									
Sheep	-19.9	-15.1	-15.1	-23.0	-92.2	-4.2	0	-1.6	-7.8
Scoured wool	0	0	0	0	-92.9	0	0	-1.4	-0.3
Carbon wool	0	0	0	0	-92.9	0	0	-1.4	-0.3
Worsted tops	0	0	0	0	-92.9	0	0	-1.4	-0.3
Wool yarns	0	0	0	0	0	0	0	0	0
Wool fabrics	0	0	0	0	0	0	0	0	0
Wool garms	0	0	0	0	0	0	0	0	0
Other indus	-0.8	-0.2	-0.4	-1.9	0	0	0	0	-0.2

Table 4.19 Taxes on output by firms, by broad industry and region (per cent)

	France	Germ	Italy	UK	USA	Japan	China	Aust	ROW
Sheep	-0.1	0.3	-0.1	-0.1	-1.0	-0.1	1.8	-2.4	0.7
Scoured wool	0.1	0	0.1	0	0	0	0	-0.2	0.2
Carbon wool	0.1	0	0.1	0	0	0	0	-0.2	0.2
Worsted tops	0.1	0	0.1	0	0	0	0	-0.2	0.2
Wool yarns	1.8	0	0.8	1.2	0	5.2	5.7	1.6	0.8
Wool fabrics	1.8	0	0.8	1.2	0	5.2	5.7	1.6	0.8
Wool garms	1.4	0	1.0	1.1	0	3.9	4.6	1.5	1.3
Other indus	2.1	0.3	-0.2	2.2	0	5.4	5.3	2.6	1.6

Table 4.20 Taxes on inputs to investment, by source and region (per cent)

	France	Germ	Italy	UK	USA	Japan	China	Aust	ROW
Domes goods	11.9	6.6	6.5	0	0	3.0	0	1.9	2.2
Import goods	11.6	6.6	6.5	0	0	3.4	0	7.2	4.3

Table 4.21 Taxes on inputs to household consumption, by source, broad commodity, and region (per cent)

	France	Germ	Italy	UK	USA	Japan	China	Aust	ROW
					DOMESTIC GOODS				
Sheep meat	7.8	0	7.3	0	5.0	0	0	1.7	1.1
Wool garms	7.8	9.3	7.3	0	5.0	6.8	0	0.1	5.4
Synth textiles	7.8	9.3	7.3	0	5.0	6.5	0	2.2	3.4
Other goods	11.4	12.4	11.0	2.7	5.0	4.4	0	5.5	5.3
					IMPORTED GOODS				
Sheep meat	7.8	0	7.3	0	5.0	0	0	0.5	2.6
Wool garms	7.8	9.3	7.3	0	5.0	6.4	0	0.1	7.0
Synth textiles	7.8	9.3	7.3	0	5.0	6.3	0	1.6	4.2
Other goods	26.7	20.0	21.3	0.7	5.0	4.4	0	13.7	9.8

Table 4.22 Taxes on inputs to government consumption, by source, broad commodity, and region (per cent)

	France	Germ	Italy	UK	USA	Japan	China	Aust	ROW
					DOMESTIC GOODS				
Sheep meat	0	0	0	0	0	0	0	0	0
Wool garms	0	0	0	0	0	0	0	0	0.7
Synth textiles	0	0	0	0	0	0	0	0	0.9
Other goods	0	0	0	0	0	0	0	0	0.4
					IMPORTED GOODS				
Sheep meat	0	0	0	0	0	0	0	0	0
Wool garms	0	0	0	0	0	0	0	0	0.1
Synth textiles	0	0	0	0	0	0	0	0	0.2
Other goods	0	0	0	0	0	0	0	0	0.3

Table 4.23 Average taxes on exports, by broad commodity, and region (per cent)

	France	Germ	Italy	UK	USA	Japan	China	Aust	ROW	**World**
					WOOL PRODUCTS					
Greasy wool	0	0	0	0	0	3.5	0	9.4	1.6	**6.8**
Scoured wool	0	0	0	0	0	3.5	0	9.4	0.9	**5.5**
Carbon wool	0	0	0	0	0	3.5	0	9.4	0.6	**5.7**
Worsted tops	0	0	0	0	0	3.5	0	9.4	0.5	**2.2**
Noils	0	0	0	0	0	3.5	0	9.4	0.8	**3.9**
Wool yarns	0	0	0	0	0	0	2.7	0	0.6	**0.4**
Wool fabrics	0	0	0	0	0	3.2	5.3	0	0.6	**0.3**
Wool garms	0	0	0	0	0	3.2	13.0	0.1	3.2	**3.3**
Average	*0*	*0*	*0*	*0*	*0*	*3.2*	*11.3*	*9.3*	*2.9*	***2.8***
					NONWOOL PRODUCTS					
Sheep meat	0	0	0	0	0	3.5	0	5.3	0.3	**0.7**
Synth textiles	0	0	0	0	0	3.2	3.2	0	0.9	**1.0**
Other goods	-0.3	-0.1	-0.1	-0.1	0	1.6	1.0	0.9	0.3	**0.3**
Average	*-0.3*	*-0.1*	*-0.1*	*-0.1*	*0*	*1.7*	*1.1*	*0.9*	*0.3*	***0.3***
					ALL PRODUCTS					
Average	*-0.3*	*-0.1*	*-0.1*	*-0.1*	*0*	*1.7*	*1.3*	*1.2*	*0.3*	***0.3***

Table 4.24 Average taxes on imports, by broad commodity, and region (per cent)

	France	Germ	Italy	UK	USA	Japan	China	Aust	ROW	**World**
					WOOL PRODUCTS					
Greasy wool	0	0	0	0	20.4	0	9.0	0	11.0	**5.8**
Scoured wool	0	0	0	0	20.4	0	9.0	0	11.0	**4.9**
Carbon wool	1.9	1.6	2.0	1.2	11.8	0	10.0	0	21.0	**2.3**
Worsted tops	1.9	1.6	1.4	0.9	11.8	0	10.0	0	21.0	**1.9**
Noils	1.8	1.2	1.8	1.5	11.8	0	10.0	0	21.0	**2.8**
Wool yarns	0.5	1.0	0.7	0.5	8.1	3.2	20.0	5.0	30.0	**16.0**
Wool fabrics	0.3	0.4	1.6	0.8	68.1	0	35.0	0	34.5	**25.4**
Wool garms	7.7	8.5	11.4	8.1	48.5	12.4	45.0	34.0	32.5	**28.5**
Average	*5.5*	*5.5*	*2.2*	*7.2*	*48.0*	*10.1*	*27.9*	*32.1*	*32.0*	***24.2***
					NONWOOL PRODUCTS					
Sheep meat	5.5	13.3	7.0	18.6	1.1	149.1	2.1	0.2	20.4	**16.4**
Synth textiles	4.3	5.3	5.0	5.3	8.8	8.1	25.0	13.9	10.1	**9.7**
Other goods	1.4	1.7	1.4	2.1	2.3	6.9	13.0	3.5	5.9	**4.7**
Average	*1.4*	*1.8*	*1.4*	*2.2*	*2.4*	*6.9*	*13.3*	*3.7*	*6.0*	***4.8***
					ALL PRODUCTS					
Average	*1.5*	*1.8*	*1.5*	*2.2*	*2.8*	*6.9*	*13.4*	*3.8*	*6.1*	**4.9**

In contrast to intermediate input usage, domestic agricultural support is extremely high for the use of land by firms, with subsidies of nearly 100 per cent for the sheep industry in the USA, and around 14 per cent in Australia. The Common Agricultural Policy of the European Union is reflected in the large subsidies to other industries in France (65 per cent), Germany (46 per cent), Italy (62 per cent), and the UK (38 per cent). Capital usage by agricultural industries is also subsidised but less so than for land usage: the USA is an exception with subsidies of 93 per cent for the sheep industry and other raw wool producing industries. Output taxes also reflect domestic agricultural support with most sheep and other raw wool producing industries in developed regions receiving output subsidies, in contrast to small taxes applying in China and the ROW.

Taxes on investment and consumption are generally low for all regions, although they tend to favour domestic sheep meat and wool commodities at the expense of imported sheep meat and wool commodities. This is particularly so for the continental European regions, France, Germany and Italy.

Taxes on exports are, in general, low for all regions. However, in four regions (Japan, China, Australia and the ROW) taxes on exports of wool products are generally much higher than taxes on exports of nonwool products. For China and the ROW this partly reflects export tax equivalents of quotas in place as part of the Agreement on Textiles and Clothing.

Taxes on total imports (4.9 per cent) are much higher than taxes on total exports for all regions (0.3 per cent). China has the highest overall tax on imports at around 13 per cent. For most regions taxes on imports of wool products are much higher than for nonwool products; the highest averages for imports of wool products are in the USA (48 per cent), China (28 per cent), Australia and the ROW (32 per cent). Import taxes are lower for raw wool commodities compared to highly processed wool commodities and finished garments. For instance, the average tariff rate on greasy wool (5.8 per cent) is only one-quarter of the rate on wool garments (24.5 per cent).

4.4.6 Trade data

Tables 4.25–4.26 present regional export and import shares by broad commodity. Unsurprisingly, Australia is the largest exporter of greasy, scoured and carbonised wool. Exports of worsted tops and noils are dominated by the ROW, Australia and France. Wool yarn and fabric exports are dominated by Germany and Italy, whereas wool garment exports are dominated by Italy, China and the ROW. Synthetic textile exports are dominated by the ROW and China.

Table 4.25 F.o.b. export shares, by broad commodity, and region (per cent)

	France	Germ	Italy	UK	USA	Japan	China	Aust	ROW	**Total**
Sheep meat	21.7	6.7	0.9	3.9	10.8	0.2	0.4	10.3	45.1	**100**
Greas wool	0	0	0	0	0	0	2.0	68.5	29.5	**100**
Scour wool	0	0	0	1.8	0.1	0	6.1	56.5	35.5	**100**
Carb wool	3.2	0	0	5.8	0	0	3.6	60.6	26.8	**100**
Worst tops	19.2	0.2	3.9	1.8	2.0	0.3	2.5	22.1	47.9	**100**
Noils	13.6	0.2	0.6	0.6	7.5	0	1.4	40.2	36.0	**100**
Wool yarns	9.7	41.8	18.3	9.1	0	0	11.2	0	9.9	**100**
Wool fabrc	2.3	16.8	68.7	1.1	1.6	1.9	4.0	0	3.6	**100**
Wool garms	2.6	4.5	26.7	0.6	2.3	0.7	14.8	0	47.8	**100**
Synth textls	4.1	5.3	1.3	1.7	7.4	4.1	9.0	1.1	66.1	**100**
Other goods	5.5	8.7	4.2	5.4	13.9	8.1	3.7	1.1	49.4	**100**
All goods	*5.5*	*8.7*	*4.3*	*5.3*	*13.7*	*7.9*	*3.8*	*1.1*	*49.5*	***100***

Table 4.26 C.i.f. import shares, by broad commodity, and region (per cent)

	Fran	Germ	Italy	UK	USA	Japan	China	Aust	ROW	**Total**
Sheep meat	3.8	1.5	19.3	5.8	21.0	2.9	0.1	1.3	44.3	**100**
Greas wool	1.3	12.6	8.2	3.1	9.3	24.8	27.0	0	13.8	**100**
Scour wool	30.1	9.6	15.0	2.7	11.2	6.4	4.2	0	20.7	**100**
Carb wool	1.1	45.2	48.1	0.1	2.2	0.3	2.3	0.3	0.4	**100**
Worst tops	10.9	29.0	48.7	8.6	0.5	0.2	0.5	0	1.7	**100**
Noils	5.7	11.8	69.6	0.4	10.8	0.2	0.1	1.4	0	**100**
Wool yarns	1.1	8.9	26.1	0.5	0.5	7.1	13.2	0.2	42.6	**100**
Wool fabrc	5.1	16.6	9.7	2.0	6.4	0	10.7	0	49.6	**100**
Wool garms	6.2	12.3	1.1	7.7	27.1	9.5	1.7	1.1	33.2	**100**
Synth textls	4.5	7.3	3.2	5.1	12.8	5.4	5.5	1.2	54.8	**100**
Other goods	4.9	8.1	3.8	5.5	16.0	6.6	3.6	1.2	50.2	**100**
All goods	*4.9*	*8.1*	*3.9*	*5.5*	*16.0*	*6.6*	*3.7*	*1.2*	*50.1*	***100***

The largest importers of greasy wool are the east-Asian economies of Japan and China, followed by Germany and the ROW. Scoured wool imports are dominated by France, Italy and the ROW. The continental European regions, France, Germany and Italy are the largest importers of carded and combed wool commodities (carbonised wool, worsted tops, and noils). The ROW, Germany, Italy and China are the largest importers of wool yarns and fabrics. Imports shares for wool garments are dominated by the largest consumers of garments, that is, the ROW, the USA, Germany and Japan.

4.5 Parameter settings

To parameterise WOOLGEM we use a combination of

(i) consulting the literature on estimated parameter values, and

(ii) consulting experts on the wool industry.

4.5.1 Elasticities of factor substitution

We base the CRESH elasticities of factor substitution for the sheep industry $\left(\sigma crsh_{ir}^{F}\right)$ in the European regions on Salhofer (2000).[4] The values of $\sigma crsh_{ir}^{F}$ for Japan, the USA and Australia are based on O'Donnell and Woodland (1995).[5] The values of $\sigma crsh_{ir}^{F}$ for China and the ROW are set between the values chosen for the Australian and European regions for land and labour, but greater than the values chosen for the Australian and European regions for capital. Table 4.27 presents the values of $\sigma crsh_{ir}^{F}$.

Table 4.27 CRESH elasticities of factor substitution, sheep industry

	Land	Labour	Capital	*Average*
France	0.20	0.35	0.25	*0.29*
Germany	0.20	0.35	0.25	*0.30*
Italy	0.20	0.35	0.25	*0.30*
UK	0.20	0.35	0.25	*0.27*
USA	0.60	0.10	0.40	*0.13*
Japan	0.60	0.10	0.40	*0.29*
China	0.40	0.20	0.60	*0.31*
Australia	0.60	0.10	0.40	*0.29*
ROW	0.40	0.20	0.60	*0.37*

The CES elasticities of factor substitution $\left(\sigma f_{jr}^{F}\right)$ for all wool processing industries, except garment making, in all regions except China and the ROW are based on Ramcharran (2001), and are set at 0.3.[6] Following the results in Jha et al. (1993), we set the values of σf_{jr}^{F} for the same set of industries in China and the ROW at half those used

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[4] See table 4, p. 6. The elasticity value for land is set as the simple average of mean values in columns 1 and 2; the value for labour is set as simple average of mean values in columns 1 and 3; and the value for capital is set as the simple average of mean values in columns 2 and 3.

[5] See table 2, p. 560. The elasticity value for land is set as the simple average of value in column 1, rows 1, 5 and 9; the value for labour is set as the simple average of values in column 4, rows 4 and 12; and the value for capital is set as the simple average of values in column 2, rows 2, 6 and 10.

[6] See table 1 (p. 521), column 4 (σ), final row (1993).

for all other regions (0.15). The values of σf_{jr}^{F} for the garment-making industries are assumed to be approximately twice those in other wool processing industries.

The composite other industries sector represents between 98 and 99 per cent of output in all regions (see table 4.14). Thus the values of σf_{jr}^{F} for this sector are based on the conclusions of Duffy and Papageorgiou (2000), who use a panel of 82 countries over a 28-year period to estimate a general CES (constant elasticity of substitution) aggregate production function. They find that for the entire sample of countries they can reject the Cobb-Douglas specification for the aggregate production function, i.e., $\sigma f_{r}^{F} = 1$. Further, when they divide their sample of countries into several subsamples, they find that physical capital and human capital-adjusted labour are more substitutable in the richest group of countries and are less substitutable in the poorest group of countries, than would be implied by a Cobb-Douglas specification. Specifically, they find that σf_{jr}^{F} is significantly greater than one for the richest group of countries and is significantly less than one for the poorest group of countries.

Thus, we set the values of σf_{jr}^{F} for the other industries composite at 1.5 for all developed economies, 1 for the ROW (a mixture of developed and developing economies) and 0.5 for China. Table 4.28 summarises the values of σf_{jr}^{F} by broad industry and region.

Table 4.28 CES elasticities of factor substitution, by broad industry and region

	Scoured wool	Carbon wool	Worsted tops	Wool yarns	Wool fabrics	Wool garms	Other indust	*Average*
France	0.30	0.30	0.30	0.30	0.30	0.60	1.50	*1.50*
Germ	0.30	0.30	0.30	0.30	0.30	0.60	1.50	*1.50*
Italy	0.30	0.30	0.30	0.30	0.30	0.60	1.50	*1.49*
UK	0.30	0.30	0.30	0.30	0.30	0.60	1.50	*1.50*
USA	0.30	0.30	0.30	0.30	0.30	0.60	1.50	*1.50*
Japan	0.30	0.30	0.30	0.30	0.30	0.60	1.50	*1.50*
China	0.15	0.15	0.15	0.15	0.15	0.30	0.50	*0.50*
Aust	0.30	0.30	0.30	0.30	0.30	0.60	1.50	*1.50*
ROW	0.15	0.15	0.15	0.15	0.15	0.30	1.00	*1.00*

4.5.2 Elasticities of import substitution

Following the advice of a wool industry expert,[7] the CES elasticities of substitution between imports of each type of raw wool (i.e., greasy, scoured, carbonised, top and noil) from different sources, and between imported and domestic raw wool $\left(\sigma_{ir}^{T}\right)$, are set at 20.[8] Our advice is that the high degree of disaggregation of our raw wool data implies, in turn, a high degree of substitutability between a given type of raw wool from different sources (i.e., regions), and between a given type of imported and domestic raw wool. While a CES elasticity value of 20 implies a high degree of substitution, it does not imply perfect substitution. Thus, it implies a nonzero optimal tariff and significant terms of trade effects.[9] However, our choice of values for σ_{ir}^{T} ($i \in Raw\ wool$), lies closer to the perfect substitution end of the 'no substitution – perfect substitution' continuum. Similarly, we set the value of σ_{ir}^{T} for sheep meat to 20. Thus, we are again assuming that our product classification implies that sheep meat from different regions is almost homogeneous. This is consistent with the approach taken by Tyers and Anderson (1989) in modelling seven agricultural product groups, one of which is cattle and sheep meat.

In choosing the values of σ_{ir}^{T} for imports of a given type of wool textiles (i.e., yarns and fabrics) and wool garments, we again follow the advice of a wool industry expert and

[7] Stanton, J., Department of Agriculture Western Australia, pers. comm., 31 May 2004.

[8] Note that σ_{ir}^{T} determines substitution between imports from different sources *and* between imported composites and domestically-produced goods (see Chapter 3, Sections 3.4.3, 3.6.3, 3.7.4 and 3.9.1).

[9] In fact, it implies an optimal tariff of around 5 per cent. We thank Rod Tyers for drawing our attention to this point. Nevertheless, it is worth noting that recent work by Zhang (2006) suggests that in a two-tier Armington model (such as WOOLGEM) increasing the values of σ_{ir}^{T} for all regions above a low value (such as 2) does not reduce the size of the terms of trade effect from its initial level. This suggests that in models of this type the optimal tariff is not a simple function of the values of the Armington elasticities of substitution. Note also that by choosing such high values for σ_{ir}^{T} we are rejecting the applicability of the Armington assumption at this level of commodity aggregation.

assume high values but lower than those chosen for raw wool.[10] For wool textiles we choose values 25 per cent lower than those chosen for raw wool (15), and for wool garments we choose values 25 per cent lower than those chosen for wool textiles (11.25). These values are chosen based on the advice that while our commodity disaggregation is quite high for these processed commodities, the products produced in different regions begin to take on different characteristics, such that they are slightly differentiated and a 'branding' effect occurs. These values imply a much higher degree of market power for producers of wool textiles and, particularly, wool garments, compared with producers of raw wool.

We set the values of σ_{ir}^{T} for imports of synthetic textiles at half the value assumed for individual wool textiles, i.e., 7.5, as this commodity represents a wide continuum of different forms of synthetic textiles from different regions which cannot be regarded as approaching homogeneity.

The values of σ_{ir}^{T} for imports of the other goods composite are set at 2. This value is chosen based upon the wide continuum of commodities which this composite represents; from highly substitutable agricultural and mineral commodities, homogenous and heterogeneous manufactured goods, and cross-border imports of services that are, in general, not substitutable with domestically-produced services. The nature of nonservices trade suggests a value well above zero for σ_{ir}^{T}, whereas the nature of cross-border services trade is such to suggest a value of close to zero for σ_{ir}^{T}. Given the predominance of nonservices in total imports for most countries, we choose a compromise value of 2. Table 4.29 summarises the values of σ_{ir}^{T} by broad commodity and region.

[10] Stanton, J., Department of Agriculture Western Australia, pers. comm., 31 May 2004.

Table 4.29 Elasticities of substitution between imports from different regions, and between composite imports and domestically-produced commodities, by broad commodity, and region

	France	Germ	Italy	UK	USA	Japan	China	Aust	ROW
Sheep meat	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Greasy wool	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Scoured wool	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Carbon wool	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Worsted tops	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Noils	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Wool yarns	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Wool fabrics	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Wool garms	11.25	11.25	11.25	11.25	11.25	11.25	11.25	11.25	11.25
Synth textiles	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Other goods	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

4.5.3 Elasticities of intermediate input substitution

The values of the CES elasticities of substitution between composite intermediate inputs $\left(\sigma f_{ir}^{I}\right)$ are set to zero for most industries, reflecting the assumption of fixed intermediate input technology with respect to the relative prices of intermediate inputs. The exceptions are for the wool yarns industries, where changes in the relative prices of carbonised wool, worsted tops, noils and synthetics are assumed to lead to changes in the mix of intermediate inputs. The values of σf_{ir}^{I} for carbonised wools, worsted tops and noils in the non-EU regions, and for carbonised wools and noils in the EU regions, are taken from Beare and Meshios (1990) and range from 1 to 1.9.[11] The values of σf_{ir}^{I} for worsted tops in the European regions and for synthetics in all regions are taken from Swan Consultants (1992) and set at 0.5.[12] The values of σf_{ir}^{I} are summarised in table 4.30.

[11] See table 4, p. 64.

[12] See table 5.3 (p. 17): the values for worsted tops are simple average of own-price elasticities of Crossbred and Merino; the values for synthetics are the simple average of own-price elasticities of acrylic, polyester and nylon.

Table 4.30 Elasticities of substitution between composite intermediate inputs, by broad commodity, and region

	France	Germ	Italy	UK	USA	Japan	China	Aust	ROW
Sheep meat	0	0	0	0	0	0	0	0	0
Greasy wool	0	0	0	0	0	0	0	0	0
Scoured wool	0	0	0	0	0	0	0	0	0
Carbon wool	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9
Worsted tops	0.6	0.6	0.6	0.6	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9
Noils	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9	1.0 – 1.9
Wool yarns	0	0	0	0	0	0	0	0	0
Wool fabrics	0	0	0	0	0	0	0	0	0
Wool garms	0	0	0	0	0	0	0	0	0
Synth textiles	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Other goods	0	0	0	0	0	0	0	0	0

4.5.4 Elasticities of transformation

The CRETH elasticity of transformation for the sheep industry in all regions $\left(\theta crth_{ir}\right)$ is parameterised using estimates from Whipple and Menkhaus (1989); a value of 2.83 is used for sheep meat and 1.38 for all types of greasy wool.[13] The CET elasticity of transformation $\left(\theta f_{jr}\right)$ for all other industries is only relevant for multiproduct industries, i.e., the worsted top industries and the other industries composite. Following the advice of a wool industry expert, the values of θf_{jr} for the worsted top industries are set to zero as their output mix, consisting of worsted tops and noils, is regarded as invariant to relative prices.[14] For the other industries sector, θf_{jr} is set to 2 in all regions. Thus, we are assuming that the output mix, consisting of synthetic (textiles) and other goods, is somewhat responsive to the relative prices of these two goods.

[13] Table 2, p. 133. The values used are for a 10 year time horizon, and are the own-price elasticity of supply for lamb and wool.

[14] Stanton, J., Department of Agriculture Western Australia, pers. comm., 31 May 2004.

4.5.5 Income elasticities

Most values of η_{ir}^{B}, the income elasticity of demand for broad composites, are sourced from Dimaranan and McDougall (2002) who merge income elasticities mainly from two sources: FAO (1993); and Theil et al. (1989); to form a matrix of income elasticities consisting of 11 commodity groups by 66 regions.[15] The relevant commodity groups and regions in this matrix are mapped to the broad composite goods consumed by households in WOOLGEM, as follows. The values of η_{ir}^{B} for sheep meat are taken from the *Meat and livestock group*; the values for wool garments and synthetic textiles are taken from the *Textiles and wearing apparel group*. The value for the other goods composite is determined by applying Engel's aggregation so that the normalised sum (i.e., the budget share-weighted sum) of all income elasticities equal unity. Table 4.31 presents the resulting values of η_{ir}^{B}.

Table 4.31 Income elasticities by broad commodity, and region

	France	Germ	Italy	UK	USA	Japan	China	Aust	ROW
Sheep meat	0.430	0.280	0.280	0.200	0.360	0.490	1.120	0.170	0.530
Wool garms	0.760	0.850	0.830	0.850	0.710	0.840	0.920	0.870	0.820
Synth textiles	0.760	0.850	0.830	0.850	0.710	0.840	0.920	0.870	0.820
Other goods	1.002	1.002	1.002	1.001	1.002	1.001	1.002	1.000	1.003

4.5.6 Price elasticities

The values of ε_{ijr}^{B}, the compensated own- and cross-price elasticities of demand for broad composite commodities, are calculated as follows. We assume that utility derived from each of the four composite commodities (i.e., sheep meat, wool garments, synthetic textiles, and other goods) is additive; this implies preference independence. Clements et al.

[15] See Dimaranan and McDougall (2002), table 20.4, p. 20–15.

(1995) show that assuming preference independence, in turn, implies that the compensated price elasticities can be calculated as follows;

$$\varepsilon_{ijr}^{B} = \phi_r \eta_{ir}^{B} \left(\delta_{ij} - WH_{jr} \eta_{jr}^{B} \right),\ \delta_{ij} = 1 \left(i = j \right),\ \delta_{ij} = 0 \left(i \neq j \right), \forall r \qquad (4.2)$$

where ϕ_r is the income flexibility, δ_{ij} is the Kronecker delta, and WH_{jr} is the share of good *j* in the consumer's budget. Equation (4.2) is used to calculate the own price elasticities for sheep meat, wool garments, and synthetic textiles, i.e., ε_{iir}^{B} (*i*=1,2,3). It is then assumed that all cross-price elasticities between sheep meat, wool garments, and synthetic textiles are zero due to the heterogeneous nature of these three composites, i.e., $\varepsilon_{ijr}^{B} = 0$ (*i,j*=1,2,3; $i \neq j$).

Next, we impose homogeneity (see Chapter 2, Section 2.3.7) on the first three row sums of the elasticities matrix so that $\sum_{j=1}^{4} \varepsilon_{ijr}^{B} = 0$, (*i*=1,2,3). Due to our assumption of zero values for ε_{ijr}^{B} (*i,j*=1,2,3; $i \neq j$), the homogeneity restriction implies that $\varepsilon_{ijr}^{B} = -\varepsilon_{iir}^{B}$ (*i*=1,2,3; *j*=4). In words, the cross-price elasticities of demand for sheep meat, wool garments, and synthetic textiles, with respect to the price of the other goods composite, equal the negative of the own-price elasticities for sheep meat, wool garments, and synthetic textiles.

Symmetry (see Chapter 2, Section 2.3.7) is then imposed on the cross-price elasticities of demand for other goods with respect to the prices of sheep meat, wool garments, and synthetic textiles, i.e., ε_{ijr}^{B} (*i*=4; *j*=1,2,3). Symmetry requires that $\varepsilon_{ijr}^{B} WH_{ir} = \varepsilon_{jir}^{B} WH_{jr} \left(i \neq j \right)$. Once this is done, the last unknown in the elasticities matrix, ε_{ii}^{B} (*i*=4), is calculated by imposing homogeneity on row 4. The resulting matrix of own-price elasticities is reported in table 4.32.

Table 4.32 Compensated own-price elasticities, by broad commodity, and region

	Sheep meat	Wool garments	Synthetic textiles	Other goods
France	-0.215	-0.379	-0.379	-0.003
Germ	-0.140	-0.422	-0.423	-0.005
Italy	-0.140	-0.412	-0.415	-0.004
UK	-0.100	-0.423	-0.424	-0.003
USA	-0.180	-0.354	-0.354	-0.003
Japan	-0.245	-0.418	-0.419	-0.003
China	-0.560	-0.455	-0.457	-0.009
Australia	-0.085	-0.433	-0.434	-0.004
ROW	-0.265	-0.408	-0.407	-0.007

In (4.2) above, the value of the income flexibility (ϕ_r) is taken from a number of studies supporting a value of -0.5, all of which are discussed in Clements et al. (2003, p. 14). *A priori*, we might reasonably expect the income flexibility (or the reciprocal of the income elasticity of the marginal utility of income) to vary across regions, particularly across high and low income regions; nevertheless, the studies discussed in Clements et al. (2003) find little support for such a view.

4.5.7 Marginal budget shares

In determining demand for the 12 individual wool garments (see table 4.5), we partition this set into three blocks; men's wool garments (5 goods), women's wool garments (5 goods), and knitted wool garments (2 goods) – see Chapter 3, Sections 3.7.2 and 3.7.3). This treatment requires values for the marginal budget shares (ΘH_{ir}). Given that ratio of the marginal budget share and the actual budget share represents the income elasticity for each good, $\left(\frac{\Theta H_{ir}}{WH_{ir}}\right) = \eta_{jr}^{B}$, ($i$ =1,…,K, j =1,…,4), we can use the known values of WH_{ir} (taken from the database) and assumed values of η_{jr}^{B} (taken from the literature) to calculate the marginal budget shares as $\Theta H_{ir} = \eta_{jr}^{B} WH_{ir}$.

We have labelled ΘH_{ir} as a parameter, implying it is invariant over the course of a simulation. It is a point of debate whether ΘH_{ir} should be treated as a constant for all values of income and prices, or vary systematically; for details, see Clements and Selvanathan 1994, pp. 98, 100). We decide to treat ΘH_{ir} as a variable coefficient, allowing it to vary as income and prices vary.

Appendix Creating the WOOLGEM database: a detailed exposition

Section 4.3.1 describes the general procedure applied in constructing the WOOLGEM database. The general procedure is one of applying particular shares to more aggregated data flows in order to create highly disaggregated data flows. This appendix essentially consists of presenting the shares applied for this disaggregation, and the source of these shares. It also describes some extra procedures applied to achieve certain desirable constraints on the database.

A.1 Commodity disaggregation

We begin our disaggregation procedure with the matrix of bilateral exports at basic prices, i.e., before the application of export taxes, taken from the GTAP database. Before splitting this trade matrix we remove all the nonzero values of intraregional trade for individual regions, that is, all regions except the ROW. We then apply shares to split the aggregated commodities; table A.1 summarises these shares and their sources.

Table A.1 Shares applied in disaggregating commodity data, by broad commodity

GTAP commodity	Shares applied[a]	Source[a]	WOOLGEM commodity[b]
1. Cattle, sheep and goats, horses	0.25 0.75	best guess	Sheep meat Other goods
2. Wool	Vary by region	WOOLMOD	Greasy wool (9) Scoured wool (9) Carbonised wool (3) Worsted tops (6) Noils (3)
3. Textiles	0.125/vary by region 0.125/vary by region 0.5 0.25	best guess/WOOLMOD best guess/WOOLMOD	Wool yarns (5) Wool fabrics (6) Synthetic textiles Other goods
4. Wearing apparel	0.25/vary by region 0.75	best guess/WOOLMOD	Wool garments (14) Other goods
5. Other goods	1.0		Other goods

[a] Wool yarns, fabrics and garments are first disaggregated into broad commodity groups using best guesses, and then into individual commodities using shares from WOOLMOD. [b] Figures in brackets represent the number of individual commodities in each broad group.

Once bilateral exports at basic values have been disaggregated, export taxes from GTAP are applied to give bilateral exports at f.o.b. values. The mapping of export taxes from GTAP commodities to WOOLGEM commodities is equivalent to the mapping that appears in table A.1. Following this, international transport margins from GTAP are applied to bilateral exports at f.o.b. values to give bilateral imports at c.i.f. values. Before applying international transport margins, any margins which are initially zero are reset so that (for a given export from a given region) they equal the average for all destination regions. Nonzero margins are not adjusted.

Bilateral imports at basic (ex-duty) values are calculated by applying import tariff rates to bilateral imports at c.i.f. values. For wool commodities, tariffs are applied from TWC (2003) as listed in table 4.8. For all other commodities bilateral tariff rates are taken from GTAP and are mapped to WOOLGEM commodities in the same way as export taxes.

Once bilateral imports at basic (or ex-duty) values have been determined, they are aggregated across source regions and are then allocated across users, i.e., households, capital creators, government, and industries: table A.2 summarises how this is done. Once aggregate imports at basic values have been allocated across users, taxes on imported household and government consumption are applied to give imported household and government consumption at purchasers' values.

Table A.2 Shares applied in allocating aggregate imports and domestic sales across users, by broad commodity

Broad commodity[a]	Shares applied			Source
	Households	Industries/capital creators	Government	
Sheep meat	Vary by region	Vary by region	Vary by region	GTAP
Greasy wools (9)	0	1.0	0	WOOLMOD
Scoured wools (9)	0	1.0	0	WOOLMOD
Carbonised wools (3)	0	1.0	0	WOOLMOD
Worsted tops (6)	0	1.0	0	WOOLMOD
Noils (3)	0	1.0	0	WOOLMOD
Wool yarns (5)	0	1.0	0	WOOLMOD
Wool fabrics (6)	0	1.0	0	WOOLMOD
Wool garments (14)	Vary by region	Vary by region	Vary by region	GTAP
Synthetic textiles	Vary by region	Vary by region	Vary by region	GTAP/best guess
Other goods	Vary by region	Vary by region	Vary by region	GTAP

[a] Figures in brackets represent the number of individual commodities in each broad group.

Total domestic sales at basic values (before the application of any indirect taxes) is initially disaggregated in the same way as bilateral exports at basic values, see table A.1. Once this is done, total domestic sales must be distributed across four users; households, capital creators, government, and industries: table A.2 summarises how this is done. Once disaggregated, taxes on domestic household and government consumption are applied to give domestic household and government consumption at purchasers' values.

A.2 Industry disaggregation

As WOOLGEM contains multiproduct industries, the industry disaggregation differs slightly from the commodity disaggregation. Once total intermediate inputs at basic values, domestic and foreign, have been disaggregated, they must be distributed across individual industries. Table A.3 summarises how this is done. Once total intermediate inputs at basic values have been distributed across individual industries, taxes on firms' usage of intermediate inputs, domestic and imported, are added to give intermediate inputs at purchasers' values. Table A.3 also indicates how factor usage by firms, at basic values, is allocated amongst the WOOLGEM industries. Once factor usage by firms at basic values has been disaggregated, taxes on firms' usage of factors are added to give factor usage at purchasers' values.

Table A.3 Shares applied in allocating intermediate inputs and factor usage amongst industries, by broad commodity and industry

GTAP industry	Shares applied[a]	Source[a]	WOOLGEM industry[b]
1. Cattle, sheep	0.25	best guess	Sheep
and goats, horses	0.75		Other goods
2. Wool	1-*(WI/TI)*[c]/vary by region	GTAP/WOOLMOD	Sheep
	(WI/TI)[c]/vary by region	GTAP/WOOLMOD	Scoured wool (9) Carbonised wool (3) Worsted tops (6)
3. Textiles	0.125/vary by region	best guess/WOOLMOD	Wool yarns (5)
	0.125/vary by region	best guess/WOOLMOD	Wool fabrics (6)
	0.75		Other goods
4. Wearing apparel	0.25/vary by region	best guess/WOOLMOD	Wool garments (14)
	0.75		Other goods
5. Other goods	1.0		Other goods

[a] Processed wool, wool yarn, wool fabric and wool garment industries are first disaggregated into broad industry groups using best guesses, and then into individual commodities using shares from WOOLMOD. [b] Figures in brackets represent the number of individual industries in each broad group. [c] *WI* is wool (intermediate) inputs, *TI* is total (intermediate) inputs; 1-*(WI/TI)* is taken as an indication of the share of 'Wool' representing greasy wool production, whereas *(WI/TI)* is taken as an indication of the share of 'Wool' representing processing of greasy wool.

A.3 Balancing the data

Once all commodities and industries have been disaggregated, and all taxes applied, we have a database where industry costs do not match industry sales; this is a product of the different assumptions used to disaggregate commodities and industries. Thus, we adjust our data so that basic balancing conditions apply. We choose to do this via simulation in a way which is somewhat analogous to the technique of Malcolm (1998). We choose this unconventional technique as we find that the traditional RAS method severely distorts the pattern of factor, wool and nonwool intermediate input shares in industry costs, such that the desirable broad patterns apparent in table 4.11 are unattainable.

Our simulation technique requires that we at least begin with a database which balances. This is done by assigning all initial differences in industry costs and sales as output taxes. Once assigned, these output taxes are then successively shocked till they approximate the desired output tax rates taken from the GTAP database. Once these tax rates are approximated, the database is further shocked to achieve the broad patterns of factor, wool and nonwool intermediate input shares apparent in table 4.11. At the end of this iterative procedure, trade balance to GDP ratios and investment to GDP ratios are adjusted in a similar fashion to broadly match the initial values of such shares in the GTAP database. Small differences between target output taxes and actual output taxes are assigned to changes in stocks.

The advantage in applying a simulation technique in this process is that we are able to adjust factor shares, say, in one industry while holding factor shares in n–1 industries constant. We choose the other goods/industries composite as the residual (n-th) good/industry in these simulations. The model used in the simulations is one that incorporates all the database structure described in tables 4.1 and 4.2. The properties of the model are summarised in table A.4.

Table A.4 Model behaviour and closure for adjusting data

	Value added/intermediate inputs	Domestic/import substitution	Household/government consumption
Broad industries			
Sheep	Cobb-Douglas		
Scoured wool	Cobb-Douglas		
Carbonised wool	Cobb-Douglas		
Worsted tops	Cobb-Douglas		
Wool textiles	Cobb-Douglas		
Wool fabrics	Cobb-Douglas		
Wool garments	Cobb-Douglas		
Other industries	CES; $\sigma = 2$		
Broad commodities			
Sheep meat		CES; $\sigma = 2$	Cobb-Douglas
Greasy wool		CES; $\sigma = 2$	Cobb-Douglas
Scoured wool		CES; $\sigma = 2$	Cobb-Douglas
Carbonised wool		CES; $\sigma = 2$	Cobb-Douglas
Worsted tops		CES; $\sigma = 2$	Cobb-Douglas
Noils		CES; $\sigma = 2$	Cobb-Douglas
Wool textiles		CES; $\sigma = 2$	Cobb-Douglas
Wool fabrics		CES; $\sigma = 2$	Cobb-Douglas
Wool garments		CES; $\sigma = 2$	Cobb-Douglas
Synthetic textiles		CES; $\sigma = 2$	CES; $\sigma = 2$
Other goods		CES; $\sigma = 2$	CES; $\sigma = 2$
Macro environment			
	Fixed regional investment shares	Fixed trade balance to GDP ratio	

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