

**ILLUSTRATIVE SUBSIDY VARIATIONS
TO ATTRACT INVESTORS
(using the EMERALD Indonesian multi-regional CGE model)**

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A b s t r a c t

Paper ini membahas dampak ekonomi dari subsidi terhadap industri yang dapat menarik minat investor pada daerah tertentu. Dengan mempergunakan EMERALD (Equilibrium Model with Economic Regional Analysis Dimensions) yang merupakan model CGE multi region untuk Indonesia, paper ini menganalisa beberapa simulasi alternatif pembiayaan subsidi industri Tekstil di Jawa Tengah.

Hasil yang diperoleh menunjukkan bahwa subsidi atas industri Tekstil dengan sumber pendanaan bukan pajak akan meningkatkan daya saing industri Tekstil diatas biaya sektor tradable secara keseluruhan. Secara riil, subsidi ini akan meningkatkan PDRB Jawa Tengah sebesar 0.21%. Jika subsidi tersebut dibiayai dari pengenaan pajak atas rumah tangga, akan meningkatkan PDRB Jawa Tengah sebesar 0.11%.

Keyword: Regional, Computable General Equilibrium, investment, subsidy

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1. BACKGROUND

1.1. Introduction

The aim of this research is to construct a bottoms-up CGE model for Indonesia that can be used for studying and analysing regional policies comprehensively. This model makes us possible to simulate regional based policies scenario to obtain the regional and national results.

This model adopts the TERM model structure for comparative static analyses. We use the new model to study the policy implications of competitive bidding between regions to attract investment. Tax concessions, for instance, are sometimes viewed as an attractive instrument to boost regional and national welfare. However, national approaches differ. For example, Australian states subsidize some investors and the Federal Government taxes them. Vietnam taxes them. The model may suggest which approach is better. Also, the long-run effects of taxing (or subsidizing) investments may differ from the short-run effects. Again, national interest may conflict with those of individual regions. The model will be used to examine some of these issues.

To construct this big multiregional model, we require data on regional supplies and demands. Moreover, the necessary inter-regional flows data showing, for example, what share of bananas eaten in Kalimantan come from Java are rarely available. To overcome these problems, innovations will be needed. In preparing and making data which used for this model, we adopt a data making process from Horridge, such as using the gravity approach to produce inter-regional data.

Three existing CGE models, each heavily influenced by the ORANI model (Dixon *et al.* 1982), provide components which may be adapted to contribute to a new multiregional model. These three models are MMRF (the Monash Multi Regional Forecasting Model), the Indonesian ORANI (INDORANI) and the default model of the Global Trade Analysis Project (GTAP).

- MMRF is a multiregional multisectoral model of Australia based on the single region ORANI model of the Australian economy (Adams, Horridge and Parmenter, 2000).
- INDORANI (Abimanyu, 2000), based on ORANI-G (Horridge 2000; see also Horridge, *et al.* 1993), is a multisectoral model of the Indonesian economy with “tops-down” approach. Both models will provide with necessary ingredients: “bottoms-up” approach and Indonesian data in constructing the new model.
- GTAP, a world trade model, includes trade links between all regions for all commodities

(Hertel and Tsigas, 1997). It is useful to follow the GTAP in attributing competition among regions in the new model.

We plan to explain the model into four sections. Section 2 contains structure of the database, graphical description of nesting and computational efficiency. Section 3 contains model equations. Section 4 contains database. Section 5 contains simulation results of subsidy variations to attract investors.

1.2. Development CGE model in Indonesia

The previous models of Indonesia have used “tops-down” approach. In a “tops-down” model, regional results merely are a decomposition of national results. By contrast, in a “bottoms-up” model each region is modeled independently. There is interaction between each regional and national agent and also among regional agents. This approach is preferable.

2. STRUCTURE OF THE DATABASE AND NESTING

2.1. Introduction

EMERALD is a bottoms-up regional CGE model which treats each region as a separate economy. This is particularly suitable for Indonesia, with its 32 diverse provinces. In a “bottoms-up” model each region is modeled independently. The “bottoms-up” method allows us to capture differences between regional economies and to model the effects of region-specific supply-side shocks. Unfortunately computational constraints have hitherto hindered the construction of CGE models with as many as 32 separate regions.

2.2. The structure of the database

Figure 2.1 shows the basic structure of the model based on each region's input-output database. The rectangles indicate matrices of flows. Core matrices (those stored on the database) are shown in bold type; other matrices may be calculated from the core matrices. The dimensions of the matrices are indicated by indices (s, c, m, etc) which correspond to the sets in Table 2.1.

EMERALD recognises three sets of regions: regions of use (d), of origin (r), and of origin of margins (p) (i.e., the origins of margins services used to deliver a commodity from (r) to (d)). In fact, the three sets are the same: they are labeled according to the context of use.

Tabel 2.1.
Main Sets of The EMERALD

Index	Set Name	Description	Typical Size
s	SRC	Domestic or imported (ROW) sources	2
c	COM	Commodities	19
m	MAR	Margin commodities	2
i	IND	Industries	19
o	OCC	Skills	9
d	DST	Regions of use (destination)	26
r	ORG	Region of origin	26
p	PRD	Region of margin production	26
f	FINDEM	Final demanders (HOU, INV, GOV, and EXP)	4
u	USER	Users = IND union FINDEM	23

EMERALD assigns three different value flows:

- basic values, or output prices for domestically-produced commodities and CIF prices for imports;
- delivered values (= basic plus margins);
- purchasers' values which equals delivered plus taxes.

As a consequence, EMERALD produces price indices which distinguish between different points of sale by commodities and regions. Each region has its own set of supply, demand and trade matrices. This allows simulations of policies that have region-specific price effects.

The matrices on the left-hand side in Figure 2.1 resemble (for each region) a conventional single-region input-output database. For example, the matrix $USE(c,s,u,d)$ at the top left shows the delivered value of demand for each good (c in COM) whether domestic or imported (s in SRC) in each destination region (DST) for each user (user, comprising the industries, IND, and 4 final demanders: households, investment, government, and exports). Some typical element of USE might show:

- $USE(\text{"Agriculture"}, \text{"dom"}, \text{"TCF"}, \text{"DIY"})$ is domestically-produced Agriculture; used by the TCF industry in region DIY.
- $USE(\text{"Mining"}, \text{"imp"}, \text{"EXP"}, \text{"DKI"})$ is the imported value of mining re-exported from a port in DKI.

As the last example shows, the data structure allows for re-export (at least in principle). All these USE values are “delivered”: they include the value of any trade or transport margins used to bring goods to the user. Notice also that the USE matrix contains no information about the regional sourcing of goods.

The TAX matrix of commodity tax revenues contains an element corresponding to each element of USE. Together with matrices of primary factor cost and production taxes, these add up to the cost of production (or value of output) of each regional industry.

In principle, each industry is capable of producing any good. The MAKE matrix at the bottom of Figure 2.1 shows the value of output of each commodity by each industry in each region d .

EMERALD recognises inventory changes in a limited way. First, changes in stocks of imports are ignored. For domestic output, stocks are unsold industry outputs, so the dimension of stocks is STOCK (i,d) rather than STOCK (c,d) .

USE (c,s,u,d) is the delivered value of commodity c from source s used by users u in region d . Delivered value means basic plus margin values. To produce USE (c,s,u,d) from the DELIVRD (c,s,r,d) , EMERALD assumes that all users of a given good (c,s) in a given region (d) have the same sourcing (r) mix. In effect, for each good (c,s) and region of use (d) there is a broker who decides for all users in d from which source region, r , supplies will be obtained. We use the Armington (1969, 1970) sourcing assumption that DELIVRD_R (c,s,d) is a CES composite (over r in ORG) of the DELIVRD (c,s,r,d) .

The DELIVRD (c,s,r,d) matrix shows the delivered value of demand of commodity c , source s , from region r to region d . For each flow there is a quantity and a price variable. For example, $p_{\text{deliverd}}(c,s,r,d)$ and $x_{\text{trad}}(c,s,r,d)$ are price and quantity variables corresponding to the matrix DELIVRD (c,s,r,d) .

Using a CES nest, the quantity of goods from different regions of r to destination d , $x_{\text{trad}}(c,s,r,d)$, is proportional to the quantity of goods summed over r , $x_{\text{trad}_r}(c,s,d)$ and to a price term powered by elasticities of substitution, SIGMADOMDOM (c) , between the source regions for each commodity c . The price term is composed of relative price, $p_{\text{deliverd}}(c,s,r,d)$ to $p_{\text{use}}(c,s,d)$. Changes in the relative prices of commodity between r induce substitution in favour of relatively cheapening goods.

Because DELIVRD (c,s,r,d) is comprised of TRADE (c,s,r,d) plus $\text{sum}\{m, \text{MAR}, \text{TRADMAR}(c,s,m,r,d)\}$, we used $x_{\text{trad}}(c,s,r,d)$ as a quantity variable for both DELIVRD (c,s,r,d) and TRADE (c,s,r,d) . The delivered prices variable, $p_{\text{deliverd}}(c,s,r,d)$, is used for

DELIVRD(c,s,r,d) and basic prices, pbasic(c,s,r) for TRADE(c,s,r,d). Note that pdelivrd(c,s,r,d) is composed of pbasic(c,s,r) and margin prices, psuppmar_p(m,r,d). For TRADMAR(c,s,m,r,d), we used a quantity variable xtradmar(c,s,m,r,d). We will discuss how these variables relate to nesting system in Section 2.3.

TRADMAR(c,s,m,r,d) shows the value of margin goods (m) which is required to facilitate trade flows. Since TRADMAR(c,s,m,r,d) has no information on where a margin flow is produced, EMERALD requires matrix SUPPMAR(m,r,d,p). It assumes that for all usage of margin goods used to transport any goods from region r to d, the same proportion of margin, m, produced in region p.

A balancing requirement for the EMERALD database is that the sum over user (u) of USE(c,s,u,d), USE_U(c,s,d), shall equal DELIVERD_R(c,s,d) which is the summation over regional sources (r) of the DELIVERD(c,s,r,d).

It remains to reconcile demand and supply for domestically-produced goods. In Figure 2.1 the connection is made by arrow linking the MAKE_I matrix with the TRADE and SUPPMAR matrices. For non-margin goods, the domestic part of the TRADE matrix must sum (over d in DST) to the corresponding element in the MAKE_I matrix of commodity supplies. For margin goods, we must take into account both the margins required SUPPMAR_RD and direct demands TRADE_D.

For many purposes it is useful to break down investment according to destination industry. The satellite matrix INVEST (subscripted c in COM, i in IND, and d in DST) serves this purpose. It allows us to distinguish the commodity composition of investment according to industry: for example, we would expect investment in agriculture to use more machinery (and less construction) than investment in dwellings.

2.3. Graphical description of demand nesting

Figure 2.2 represents the household demand sourcing of TCF in region DKI. As all users in the EMERALD have the same demand sourcing by commodities and regions, we can apply this figure for all commodities, users and regions. From the top to the bottom, there are two different nests (CES and Leontief) indicating different types of substitution in the model. They cover all mechanisms of demand sourcing of TCF and its margin from different regions to DKI. At the top, a CES nest determines domestic and imported TCF used by households in DKI. This nest corresponds to the value of flows (shown in upper case) with price, ppur_s(c,u,d) and quantity, xhou_s(c,d) variables. The dimensions of the

model correspond to the matrices in Figure 2.1. Note that these flows are purchasers values which are the sum of $USE(c,s,u,d)$ and $TAX(c,s,u,d)$ matrices. The Armington elasticity 2.6 represents a CES in choosing between imported (from other country) and domestic TCF.

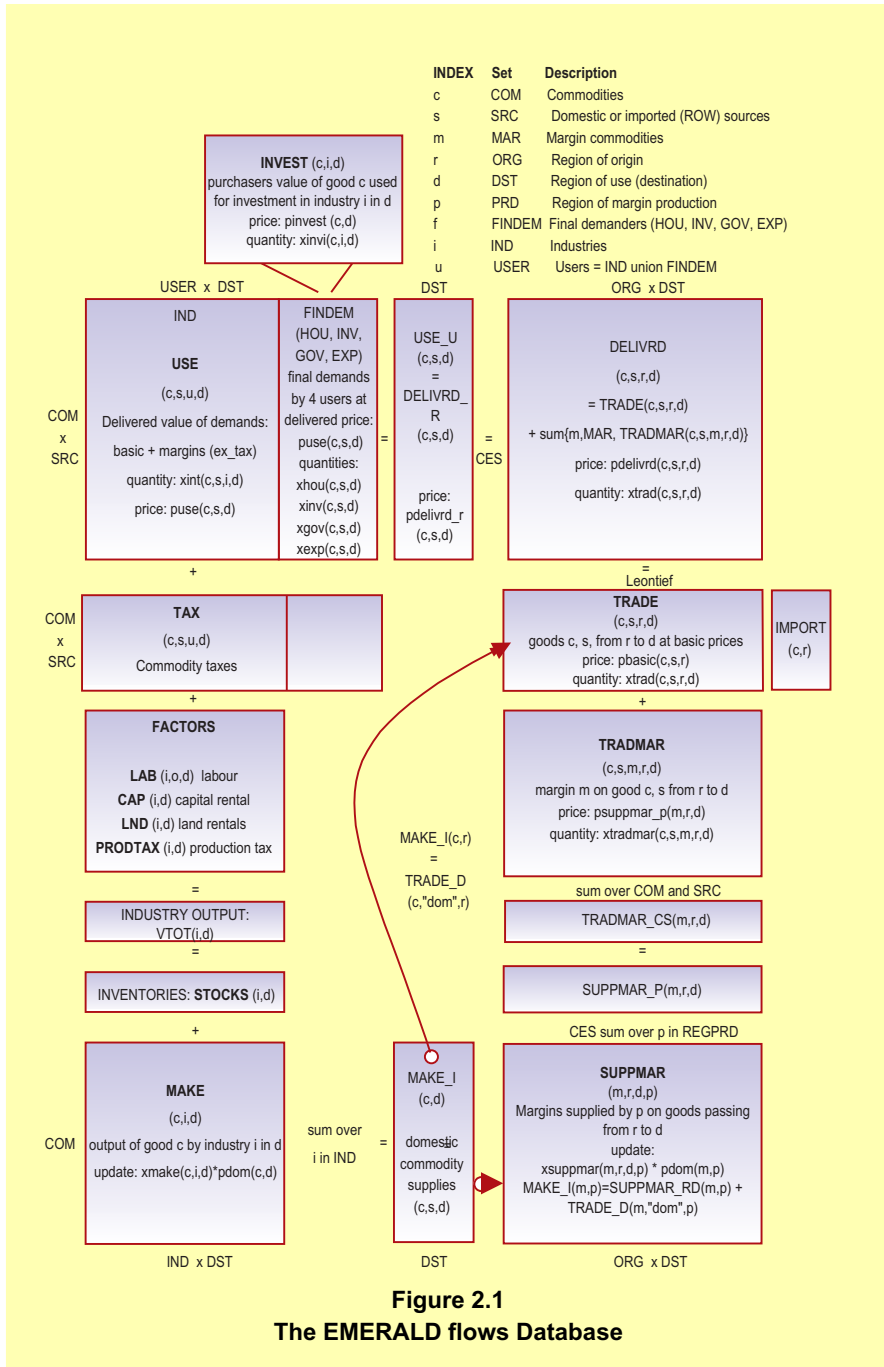


Figure 2.1
 The EMERALD flows Database

Demand for domestic TCF in DKI is summed over users to give total value $USE_U(c,s,d)$ which is measured in delivered value (basic plus margin but excluding user-specific commodity taxes). Note that this nest is not user-specific. This nest represents demand for domestic TCF in DKI supplied by all origin of TCF. The CES determines the allocations with substitution elasticities ranging from 5 (merchandise) to 0.2 (services). This CES implies that the region with lowered production costs compared to other regions will tend to increase its market share. The sourcing decision is made on the basis of delivered prices so not only basic costs affect regional market share but also margin costs. Note that variables in this nest lack a user (u) subscript. The decision is made on an all-user basis. The implication is that, in DKI, the proportion of TCF which come from JaTeng is the same for all users.

The next level indicates how a “delivered” TCF from JaTeng is a Leontief composite of basic TCF, corresponding with matrix $TRADE(c,s,r,d)$, and the various margin goods, $TRADMAR(c,s,m,r,d)$. The share of each margin in the delivered price is specific to a particular combination of origin, destination, commodity and source. For example, we should expect transport costs to form a larger share for region pairs which are far apart, or for heavy or bulky goods. The number of margin goods will depend on how aggregated is the model database. Under the Leontief specification we prevent substitution between road and trade margins.

The bottom part shows that the margin on TCF passing from JaBar to DKI could be produced in different regions. The figure shows the sourcing mechanism for the road margin. We might expect this to be drawn more or less equally from origin (JaTeng), the destination (DKI) and regions between (JaBar). There would be some scope for substitution ($s=1$), since trucking firms can relocate depots to cheaper regions. For retail margins, on the other hand, a larger share would be drawn from destination region, and scope for substitution would be less ($s=0.1$). Once again, this substitution decision takes place at an aggregated level. The assumption is that the share for example, JaBar, in providing road margin on trips from JaTeng to DKI, is the same whatever good is being transported. This corresponds to $TRADMAR_CS(m,r,d)$ which has no c and s scripts. Although not shown in Figure 2.2, a parallel system of sourcing is also modelled for imported TCF, tracing them back to port of entry instead of region of production.

2.4. Graphical description of production nesting

The EMERALD adapts production nests from ORANI. This allows each industry to

produce several commodities, using as inputs domestic and imported commodities, labour of several types, land, capital and 'other costs' which are all distinguished by region. The multi-input, multi-output production specification is kept manageable by a series of separability assumptions, illustrated by the nesting shown in Figure 2.3. For example, the assumption of input-output separability implies that the generalised production function for some industry:

$$F(\text{inputs}, \text{outputs}) = 0 \quad (1)$$

may be written as:

$$G(\text{inputs}) = X1TOT = H(\text{outputs}) \quad (2)$$

where X1TOT is an index of industry activity. Assumptions of this type reduce the number of estimated parameters required by the model. Figure 2.3 shows that the H function in (2) is derived from a CET (constant elasticity of transformation) aggregation function.

The G function is broken into a sequence of nests. At the top level, commodity composites, a primary-factor composite and production costs are combined using a Leontief production function.

Consequently, they are all demanded in direct proportion to X1TOT. Each commodity composite is a CES (constant elasticity of substitution) function of a domestic good and the imported equivalent. We adopt the Armington (1969; 1970) assumption that imports are imperfect substitutes for domestic supplies². The primary-factor composite is a CES aggregation of land, capital and composite labour. Composite labour is a CES aggregation of occupational labour types. Although all industries share this common production structure, input proportions and behavioural parameters may vary between industries.

The nested structure is mirrored in the TABLO equations—each nest requiring 2 sets of equations, determining quantity and price.

2 Armington PS (1969) The Geographic Pattern of Trade and the Effects of Price Changes, *IMF Staff Papers*, XVI, July, pp 176-199.

— (1970) Adjustment of Trade Balances: Some Experiments with a Model of Trade Among Many Countries, *IMF Staff Papers*, XVII, November, pp 488-523.

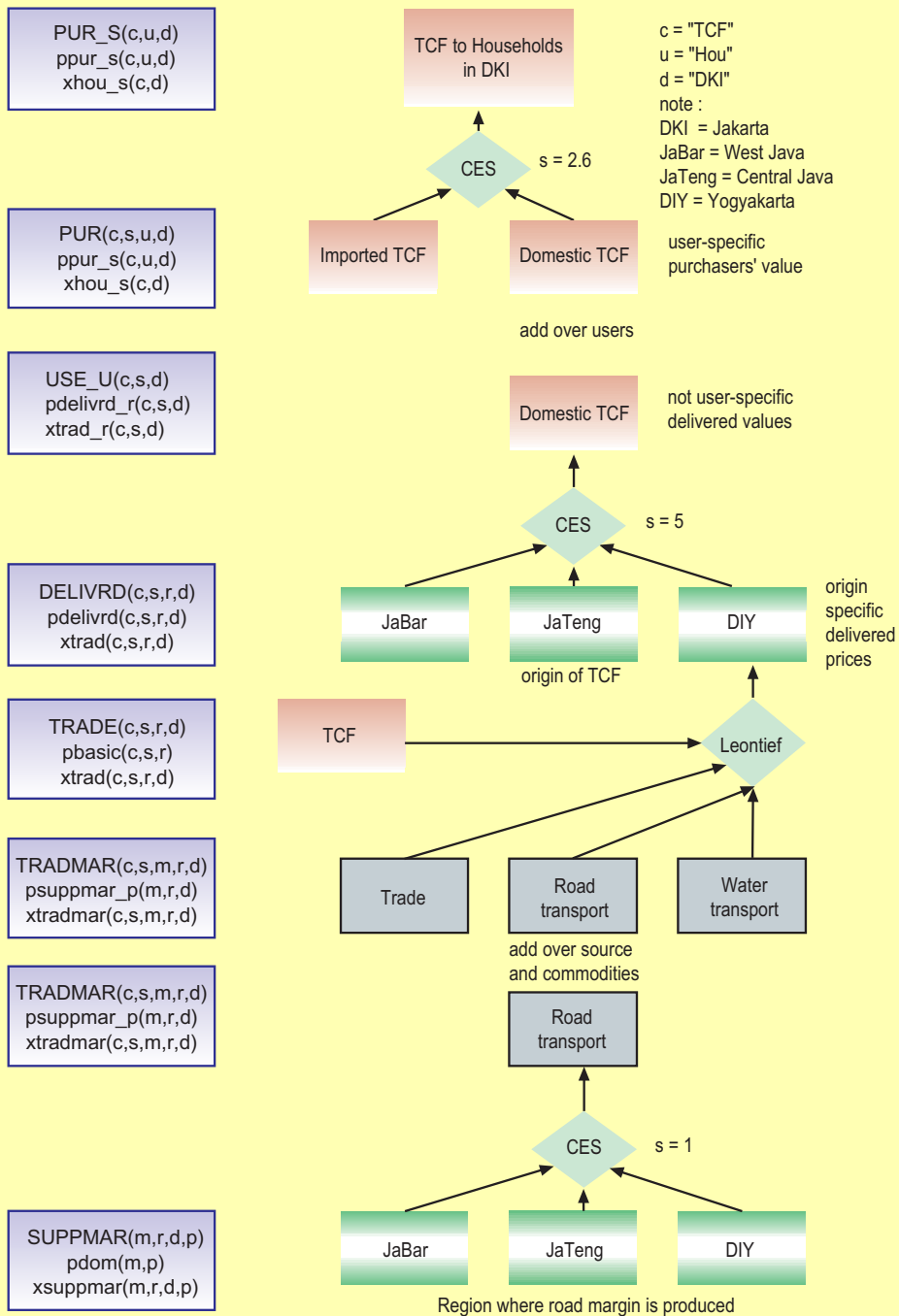


Figure 2.2
The EMERALD Demand Nesting

2.5. Computational efficiency

The EMERALD is able to handle a greater number of regions or sectors than previous multiregional models through key assumptions that compress the database and enhance computational efficiency. For example, EMERALD assumes that all users (i.e. downstream industries, households and government) in a particular region of, say, textiles clothing and footwear (TCF), source their TCF from other regions according to common proportions. By assuming this, we notice that the model needs two sub-sourcing matrices (Table 2.2): USE(c,s,u,d) and TRADE(c,s,r,d). By using the typical set sizes shown in Table 2.2, both sourcing matrices need 48412 cells. Without the common sourcing assumption 590 thousand numbers would be needed. The EMERALD becomes 12 times more efficient. This efficiency will be multiplied by the number of margin commodities if we apply

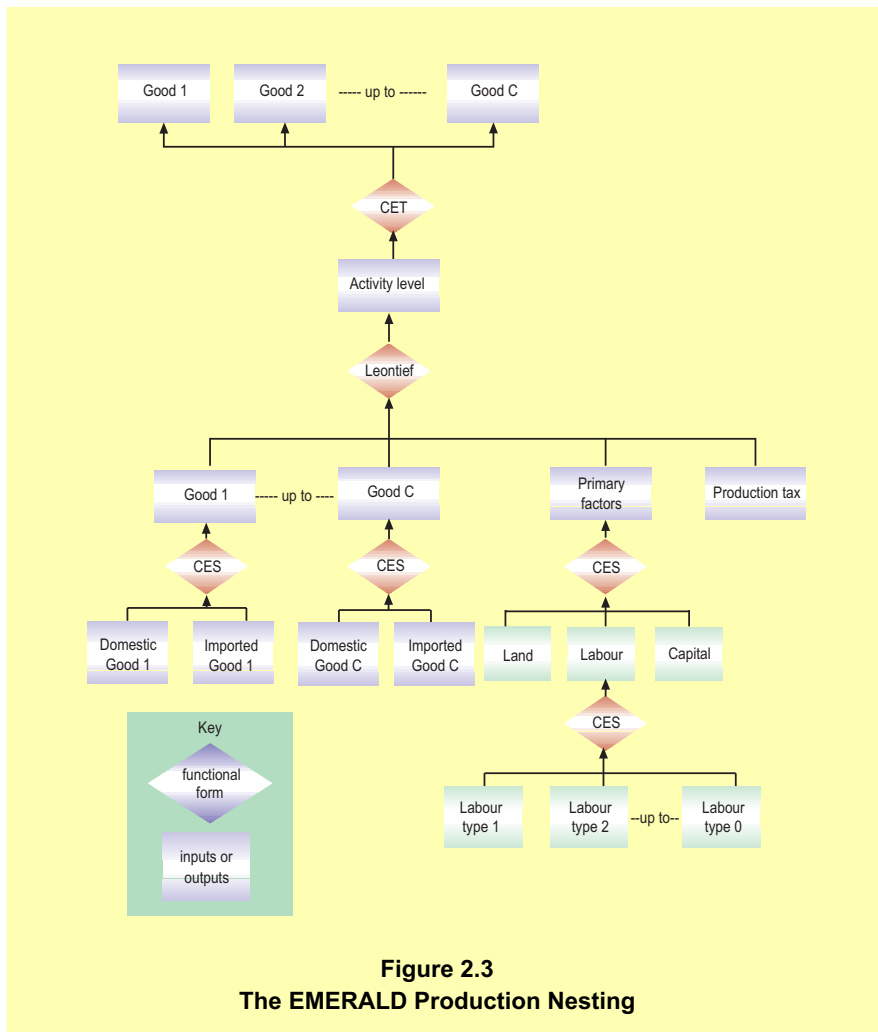


Figure 2.3
The EMERALD Production Nesting

the common assumption to the matrix of trade margin (TRADMAR(c,s,m,r,d)). In turn, this efficiency saves computation and memory in solving equations.

Tabel 2.2. Computational efficiency in EMERALD		
Sourcing Matrix in EMERALD	Dimencional Cells	Total Cells
USE (c,s,u,d)	$c(19)*s(2)*u(23)*d(26)$	22724
TRADE (c,s,r,d)	$c(19)*s(2)*r(26)*d(26)$	25688
Total		48412
Sourcing Matrix Without Common Proportions	Dimencional Cells	Total Cells
Source matrix (c,s,u,r,d)	$c(19)*s(2)*u(23)*r(26)*d(26)$	590824

2.6. *Other features*

The remaining features of EMERALD are common to most CGE models, and in particular to ORANI, from which EMERALD descends. Industry production functions are of the nested CES type: Leontief except for substitution between primary factors and between sources of goods. Exports from each region's port to the ROW face a constant elasticity of demand. The composition of household demand follows the linear expenditure system, while the composition of investment and government demands is exogenous.

3. THE CORE EQUATIONS OF THE EMERALD

3.1. *Main sets of the EMERALD*

Table 2.1 lists the main sets of the model using GEMPACK levels notation. In each excerpt, each set is expressed by one index, for example index *s* for the set 'SRC (dom, imp)'. This set has two elements: domestic (dom) and imported (imp). Another example is 'DST' expressed by index *d* which has 26 regional elements.

We can declare the relationship between two sets using a subset. The set of margin commodities (trade and transport), 'MAR', is a subset of the commodities (COM). This means that each element of set MAR is also an element of set COM. We also can define set complements such as the set NONMAR which is equal to set COM less set MAR.

The following excerpts are taken from the TABLO input file. They are written in order corresponding to sequential nests. In this section, we only show the excerpts of the core of the model.

Each excerpt begins with a list of parameters or variables indicated by a name followed by an index such as '(c)'. The expression '(c)' stands for commodities. It signifies that the variable is a vector containing one value or scalar parameter for each element of the set commodities, COM. The parameter 'SIGMADOMIMP(c)', for example, is the substitution of elasticity between domestic and imported good by commodity, c.

3.2. Industries choice between domestic and imported goods

Equation 1.1 determines the demand for domestic and imported goods used by producers in region d. Each industry minimizes cost using a CES (constant elasticity substitution) nest. Various nest equations follow the same pattern. Each nest includes a quantity and a price equation.

The intermediate demand for producers, $XINT(c,s,i,d)$, is proportional to overall composite goods demanded by industry i, $XINT_S(c,i,d)$, and to a price term powered by the substitution elasticity between domestic and imported goods, $SIGMADOMIMP(c)$. The price term is the ratio of purchasers' prices, $PPUR(c,s,i,d)$, to purchasers' prices averaged over source, $PPUR_S(c,i,d)$. Changes in relative prices of domestic and imported goods induce substitution in favour of relatively cheapening goods.

The denominator in the relative price term above is given by Equation 1.2.

Excerpt 1 of TABLO input file: !

! Industries choice between domestic and imported goods !

SIGMADOMIMP(c) Parameter substitution elasticity between dom/imp
 BXINT(c,s,i,d) Parameter constant in intermediate demands
 XINT(c,s,i,d) Intermediate demands for all-region composite
 XINT_S(c,i,d) Industry demands for domestic/imported composite
 PPUR(c,s,u,d) User (purchasers) prices, include margins and taxes
 PPUR_S(c,u,d) User prices, average over s

$$(1.1) \quad XINT(c,s,i,d)/XINT_S(c,i,d) = BXINT(c,s,i,d) * [PPUR(c,s,i,d)/PPUR_S(c,i,d)]^{*-SIGMADOMIMP(c)}$$

$$(1.2) \quad PPUR_S(c,i,d)*XINT_S(c,i,d) = \text{sum}\{s, SRC, PPUR(c,s,i,d) * XINT(c,s,i,d)\}$$

3.3. *Household choice between domestic and imported goods*

Likewise, Equation 2.1 shows that the demand for domestic and imported goods for household in region d, $XHOU(c,s,d)$, is proportional to overall household composite goods demand, $XHOU_S(c,d)$, and to a price term powered by the substitution elasticity between domestic and imported goods, $SIGMADOMIMP(c)$. The price term is the ratio of purchasers' prices, $PPUR(c,s,"hou",d)$, to the composite price index, $PPUR_S(c,"hou",d)$. Again the denominator $PPUR(c,s,"hou",d)$ is given by Equation 2.2.

! Excerpt 2 of TABLO input file: !

! Household choice between domestic and imported goods !

$BHOU(c,s,d)$ Parameter: constant in household demands

$XHOU(c,s,d)$ Household demands for all-region composite

$XHOU_S(c,d)$ Household demands for domestic/imported composite

$$(2.1) \quad XHOU(c,s,d)/XHOU_S(c,d) = BHOU(c,s,d)$$

$$*[PPUR(c,s,"HOU",d)/PPUR_S(c,"hou",d)]^{*-SIGMADOMIMP(c)}$$

$$(2.2) \quad PPUR_S(c,"hou",d)*XHOU_S(c,d) = \text{sum}\{s, SRC, PPUR(c,s,"hou",d) \\ *XHOU(c,s,d)\}$$

3.4. *Investors choice between domestic and imported goods*

Equation 3.1 follows the same pattern as previous. It shows that the demand for domestic and imported goods for investors in region d, $XINV(c,s,d)$, is proportional to overall investors' composite goods demand, $XINV_S(c,d)$, and to a price term powered by the substitution elasticity between domestic and imported goods, $SIGMADOMIMP(c)$. The price term is the ratio of investment purchasers' prices to average (over domestic and imported) prices. The denominator $PPUR(c,s,"inv",d)$ is given by Equation 3.2

! Excerpt 3 of TABLO input file: !

! Investors choice between domestic and imported goods !

$BINV(c,s,d)$ Parameter constant in investment demands

$XINV(c,s,d)$ Investment demands for all-region composite

$XINV_S(c,d)$ Investment demands for domestic/imported composite

$$(3.1) \quad XINV(c,s,d)/XINV_S(c,d) = BINV(c,s,d) \\ * [PPUR(c,s,"INV",d)/PPUR_S(c,"inv",d)]^{**} - SIGMADOMIMP(c)$$

$$(3.2) \quad PPUR_S(c,"inv",d)*XINV_S(c,d) = \text{sum}\{s, SRC, PPUR(c,s,"inv",d) \\ *XINV(c,s,d)\}$$

3.5. Labour skill nest

Excerpt 4 represents a labour skill nest to minimize labour cost. Similar with the previous, this nest is expressed by Equation 4.1 determining labour demand of industry *i* for different occupations, $XLAB(i,o,d)$. The average industry wage, $PLAB_O(i,d)$, is determined by Equation 4.2.

! Excerpt 4 of TABLO input file: !

! Labour skill nest !

$SIGMALAB(i)$ Parameter CES substitution between skill types
 $BLAB(i,o,d)$ Parameter constant in labour demand equation
 $XLAB(i,o,d)$ Labour demands
 $XLAB_O(i,d)$ Effective labour input
 $PLAB(i,o,d)$ Wage rates
 $PLAB_O(i,d)$ Price of labour composite

$$(4.1) \quad XLAB(i,o,d)/XLAB_O(i,d) = BLAB(i,o,d) \\ * [PLAB(i,o,d)/PLAB_O(i,d)]^{**} - SIGMALAB(i)$$

$$(4.2) \quad PLAB_O(i,d)*XLAB_O(i,d) = \text{sum}\{o, OCC, PLAB(i,o,d)* XLAB(i,o,d)\}$$

The $XLAB(i,o,d)$ is proportional to effective labour input, $XLAB_O(i,d)$, and to a wage term powered by elasticities of substitution between labour skill in each industry, $SIGMALAB(i)$. The wage term is ratio of wage rates, $PLAB(i,o,d)$, to price of labour composite, $PLAB_O(i,d)$. Changes in relative occupational wages induce substitution in favour of relatively cheaper skills.

3.6. Demands for primary factors

Excerpt 5 explains demands for primary factors. The effective labour, capital, and

land cost are combined using a CES nest. Ignoring the labour technological change terms, $ALAB_O(i,d)$, the effective labour demand, $XLAB_O$, is proportional to overall primary factor demands, $XPRIM(i,d)$, and to a price term powered by the elasticity of substitution between primary factors, $SIGMAPRIM(i)$. The price term is the relative price of the labour composite, $PLAB_O(i,d)$, to the price of composite factors, $PPRIM(i,d)$. Changes in the price term induce substitution in favour of relatively cheapening factors. The same rules govern for capital and land demand.

The price of factor composite, $PPRIM(i,d)$, is determined by the value of the primary factor composite equalling the sum of all component costs.

! Excerpt 5 of TABLO input file: !

! Demands for primary factors !

$SIGMAPRIM(i)$	Parameter CES substitution, primary factors
$BLAB_O(i,d)$	Parameter constant in effective labour demand
$BCAP(i,d)$	Parameter constant in capital demand equation
$BLND(i,d)$	Parameter constant in land demand equation
$ACAP(i,d)$	Capital usage technological change
$ALAB_O(i,d)$	Effective labour input technological change
$ALND(i,d)$	Land usage technological change
$XCAP(i,d)$	Capital usage
$XLND(i,d)$	Land usage
$XPRIM(i,d)$	Effective composite inputs
$PCAP(i,d)$	Rental price of capital
$PLND(i,d)$	Rental price of land
$PPRIM(i,d)$	Price of factor composite

$$(5.1) \quad XLAB_O(i,d)/[XPRIM(i,d)*ALAB_O(i,d)]=BLAB_O(i,d) \\ *[[PLAB_O(i,d)*ALAB_O(i,d)]/PPRIM(i,d)]^{**}-SIGMAPRIM(i)$$

$$(5.2) \quad XCAP(i,d)/[XPRIM(i,d)*ACAP(i,d)]=BCAP(i,d) \\ *[[PCAP(i,d)*ACAP(i,d)]/PPRIM(i,d)]^{**}-SIGMAPRIM(i)$$

$$(5.3) \quad XLND(i,d)/[XPRIM(i,d)*ALND(i,d)]=BLND(i,d) \\ *[[PLND(i,d)*ALND(i,d)]/PPRIM(i,d)]^{**}-SIGMAPRIM(i)$$

$$(5.4) \quad PPRIM(i,d)*XPRIM(i,d)=PLAB_O(i,d)*XLAB_O(i,d) \\ +PCAP(i,d)*XCAP(i,d)+PLND(i,d)*XLND(i,d)$$

3.7. Demands for aggregate primary factors and intermediate inputs

For the top nest, excerpt 6 explains how to produce output using a combination of composite primary inputs, $XPRIM(i,d)$, and composite intermediate goods, $XINT_S(c,i,d)$, with Leontief elasticity of substitution. As a consequence, the demand equations for $XPRIM(i,d)$ and $XINT_S(c,i,d)$ have a similar pattern as seen in two equations below.

Equation 6.1 explains that the industry demand for aggregate primary factor, $XPRIM(i,d)$, is proportional to total output and technological terms. Equation 6.2 explains that the demand for composite goods, $XINT_S(c,i,d)$ is also proportional to total output and technological terms. We recognise three different technological terms, $APRIM(i,d)$, $AINT_S(c,i,d)$ and $ATOT(i,d)$. Technological change implies change in input requirement per unit of output. When these technological terms reduce, the same level of output is produced using less $XPRIM(i,d)$ or $XINT_S(c,i,d)$.

The third equation, Equation 6.3 is the 'Zero Pure Profits'. Total revenue is equal to total cost of all inputs.

! Excerpt 6 of TABLO input file: !

! Demands for aggregate primary factor and intermediate inputs !

$APRIM(i,d)$ Primary inputs technological change
 $AINT_S(c,i,d)$ Intermediate composite technological change
 $ATOT(i,d)$ Industry output technological change
 $XTOT(i,d)$ Industry outputs
 $PCST(i,d)$ Production cost

$$(6.1) \quad XPRIM(i,d) = APRIM(i,d)*ATOT(i,d)*XTOT(i,d)$$

$$(6.2) \quad XINT_S(c,i,d) = AINT_S(c,i,d)*ATOT(i,d)*XTOT(i,d)$$

$$(6.3) \quad PCST(i,d)*XTOT(i,d) = \text{sum}\{c,COM,PPUR_S(c,i,d)*XINT_S(c,i,d)\}$$

$$+\text{sum}\{o, \text{OCC}, \text{PLAB}(i, o, d) * \text{XLAB}(i, o, d)\}$$

$$+\text{PCAP}(i, d) * \text{XCAP}(i, d) + \text{PLND}(i, d) * \text{XLND}(i, d)$$

3.8. *Adding production tax to firm costs*

Excerpt 7 explains how a production tax is added to the firm cost. Equation 7.1 indicates that a change in production tax revenue, $\text{PTX}(i, d)$, is determined by change in $\text{PTXRATE}(i, d)$ multiplied by the value of output, $(\text{PCST}(i, d) * \text{XTOT}(i, d))$.

Equation 7.2 sets industry output price, $\text{PTOT}(i, d)$, via the firm cost, $\text{PCST}(i)$ and the tax revenue $\text{PTX}(i, d)$.

! Excerpt 7 of TABLO input file: !

! Adding Production tax to firm costs !

$\text{PTOT}(i, d)$ Industry output prices

$\text{PTXRATE}(i, d)$ Rate of production tax

$\text{PTX}(i, d)$ Ordinary change in production tax revenue

$$(7.1) \quad \text{PTX}(i, d) = \text{PTXRATE}(i, d) * \text{PCST}(i, d) * \text{XTOT}(i, d)$$

$$(7.2) \quad \text{PTOT}(i, d) * \text{XTOT}(i, d) = \text{PCST}(i, d) * \text{XTOT}(i, d) + \text{PTX}(i, d)$$

3.9. *MAKE: multi-product industries have CET specification*

Equation 8.1 explains supplies of commodities by industries, $\text{XMAKE}(c, i, d)$, with constant elasticity transformation (CET). Ignoring the technological term, $\text{AMAKE}(c, i, d)$, output each commodity supplied by an industry, $\text{XMAKE}(c, i, d)$, is proportional to $\text{XTOT}(i, d)$ and to a price term powered by $\text{SIGMAOUT}(i)$. The price term is composed of the price of domestic good relative to average price of industry i output. Since $\text{SIGMAOUT}(i)$ is positive, this induces industries to produce more of the commodity with an increased relative prices.

Equation 8.2 equates the output value of industry $(\text{PTOT}(i, d) * \text{XTOT}(i, d))$ equals to the sum of commodities supplied by industry calculated using domestic prices, $\text{PDOM}(c, d)$.

Equation 8.3 shows that total output of commodities, $\text{XCOM}(c, d)$, is equal to the sum of commodities supplied by various industries.

Lastly, import prices, $\text{PIMP}(c, r)$, in Equation 8.4, are simply determined by foreign import prices, $\text{PFIMP}(c, r)$ multiplied by the exchange rate, PHI .

! Excerpt 8 of TABLO input file: !

! MAKE: multi-product industries have CET specification !

SIGMAOUT(i) Parameter CET transformation elasticities
 AMAKE(c,i,d) MAKE technological change
 XMAKE(c,i,d) Output of good c by industry i in d
 XCOM(c,d) Total output of commodities
 PDOM(c,r) Output prices = basic prices of domestic goods
 PFIMP(c,r) Import prices, foreign currency
 PIMP(c,r) Import prices, local currency
 PHI Exchange rate

$$(8.1) \quad XMAKE(c,i,d) = AMAKE(c,i,d) * XTOT(i,d) * \{ [PDOM(c,d)/PTOT(i,d)]^{SIGMAOUT(i)} \}$$

$$(8.2) \quad PTOT(i,d) * XTOT(i,d) = \text{sum}\{c, COM, PDOM(c,d) * XMAKE(c,i,d)\}$$

$$(8.3) \quad XCOM(c,d) = \text{sum}\{i, IND, XMAKE(c,i,d)\}$$

$$(8.4) \quad PIMP(c,r) = PFIMP(c,r) * PHI$$

3.10. Household demands

Excerpt 9 determines the allocation of household expenditure between commodity composites. This is derived from the Klein-Rubin utility function:

$$\text{Utility per household} = P \{X3_S(c) - X3SUB(c)\}^{S3LUX(c)},$$

The X3SUB and S3LUX are behavioural coefficients—the S3LUX must sum to unity. Q is the number of households. The demand equations that arise from this utility function are:

$$X3_S(c) = X3SUB(c) + S3LUX(c) * V3LUX_C / P3_S(c),$$

where:

$$V3LUX_C = V3TOT - \hat{A}X3SUB(c) * P3_S(c)$$

The name of the linear expenditure system derives from its property that expenditure on each good is a linear function of prices (P3_S) and expenditure (V3TOT). The form of the demand equations gives rise to the following interpretation. The X3SUB are said to be the

'subsistence' requirements of each good—these quantities are purchased regardless of price. $V3LUX_C$ is what remains of the consumer budget after subsistence expenditures are deducted—we call this 'luxury' or 'supernumerary' expenditure. The $S3LUX$ are the shares of this remnant allocated to each good—the marginal budget shares.

The simplicity of this scheme is that LES has no specific substitutability. Hence, LES requires only a vector of expenditure elasticities and 1 Frisch parameter for each region.

Equation 9.1, an alias, equates household prices by commodity, $PHOU(c,d)$, to the household purchasing prices, $PPUR_S(c,"hou",d)$. Household subsistence costs in d , $WSUBSIST(d)$, are defined by Equation 9.2 as total per capita subsistence expenditure spent by the number of households $NHOU(d)$. The household expenditure is composed by consumer prices, $PHOU(c,d)$, multiplied by household subsistence quantities, $XSUBSIST(c,d)$.

Equation 9.3 determines that total household demand for composite commodities, $XHOU_S(c,d)$, is proportional to marginal budget share, $MBS(c,d)$ multiplied by luxury cost. The luxury cost is household purchasing value other than subsistence cost, $(WHOUTOT(d)-WSUBSIST(d))$. Then, the nominal household expenditure, $WHOUTOT(d)$ is $PHOUTOT(d)$ multiplied by total household expenditure, $XHOUTOT(d)$.

Equation 9.4 determines that budget share, $BUDGSHR(c,d)$, is the ratio of household purchasing value to total nominal household consumption.

Equation 9.5 determines $PHOUTOT(d)$, as consumer price index, which is the sum over consumer price by commodity, $PHOU(c,d)$, multiplied by budget share, $BUDGSHR(c,d)$. Since $WHOUTOT(d)$ and $PHOUTOT(d)$ are known, total real household consumption, $XHOUTOT(d)$ and $WHOUTOT(d)$ are given by Equation 9.6 and Equation 9.7.

! Excerpt 9 of TABLO input file: !

! Household demands !

$MBS(c,d)$	Parameter marginal budget shares
$BUDGSHR(c,d)$	Average budget shares
$WHOUTOT(d)$	Total nominal household consumption
$WSUBSIST(d)$	Household subsistence costs
$XHOUTOT(d)$	Total real household consumption
$PHOUTOT(d)$	CPI

NHOU(d) Number of households

XSUBSIST(c,d) Household subsistence quantities

PHOU(c,d) Household price of composites

$$(9.1) \quad PHOU(c,d) = PPUR_S(c, "hou", d)$$

$$(9.2) \quad WSUBSIST(d) = \sum\{c, COM, PHOU(c,d) * NHOU(d) * XSUBSIST(c,d)\}$$

$$(9.3) \quad XHOU_S(c,d) * PHOU(c,d) = MBS(c,d) * [WHOUTOT(d) - WSUBSIST(d)]$$

$$(9.4) \quad BUDGSHR(c,d) = PUR_S(c, "Hou", d) / WHOUTOT(d)$$

$$(9.5) \quad PHOUTOT(d) = \sum\{c, COM, BUDGSHR(c,d) * PHOU(c,d)\}$$

$$(9.6) \quad XHOUTOT(d) = WHOUTOT(d) / PHOUTOT(d)$$

$$(9.7) \quad WHOUTOT(d) = PHOUTOT(d) * XHOUTOT(d)$$

3.11. *Investment demands and indices: conditional on industry-specific investment*

Excerpt 10 shows the equations determining investment demands and indices æ conditional on industry-specific investment. The equation determining new capital creation is derived using Leontief technology demand. Equation 10.1 explains that the amount of good c for investment industry i in d, XINVI(c,i,d) is proportional to investment by industries in d, XINVTOT(i,d), multiplied by investment technological term, AINVI(c,i,d).

Equation 10.2 defines purchaser's price of good c for investment in d, PINVEST(c,d) as investor purchasing price, PPUR_S(c, "INV", d)

Equation 10.3 determines the investment price index for industry i, in region d, PINVITOT(i,d) by making an identity between the value of investment by industry i in d as the sum over commodities used by that industry for investment in d.

Equation 10.4 explains that XINV_S(c,d) is sum over industry demands for investment goods, XINVI(c,i,d).

! Excerpt 10 of TABLO input file: !

! Investment demands and indices:conditional on industry-specific !

! investment !

AINVI(c,i,d) Investment technological change

XINVI(c,i,d) Amount of good c for investment, industry i in d

XINVITOT(i,d) Investment by industry

PINVITOT(i,d) Investment price index by industry

PINVEST(c,d) Purchaser's price of good c for investment in d

$$(10.1) \text{XINVI}(c,i,d) = \text{AINVI}(c,i,d) * \text{XINVITOT}(i,d)$$

$$(10.2) \text{PINVEST}(c,d) = \text{PPUR_S}(c, \text{"INV"}, d)$$

$$(10.3) \text{PINVITOT}(i,d) * \text{XINVITOT}(i,d) = \text{sum}\{c, \text{COM}, \text{PINVEST}(c,d) * \text{XINVI}(c,i,d)\}$$

$$(10.4) \text{XINV_S}(c,d) = \text{sum}\{i, \text{IND}, \text{XINVI}(c,i,d)\}$$

3.12. *Government, export, and inventory demands*

Excerpt 11 explains government, export, and inventory demands. As expressed by Equation 11.1, the government demand is proportional to three corresponding shifters. They shift the demand function with different dimensions: by d as FGOVTOT(d), by c and d, as FGOV_S(c,d) and by c, s, and d, as FGOV(c,s,d).

Equation 11.2 explains that demand for export goods, XEXP(c,s,d), is proportional to export-quantity shifter, FQEXP(c,s) multiplied by a price term powered by export elasticity substitution, EXP_ELAST(c). The price term is composed of purchasing export prices, PPUR(c,s,"EXP",d), relative to the ratio of export price shifter, FPEXP(c,s), and exchange rate, PHI.

Equation 11.3 defines that stocks, XSTOCKS(i,d), is proportional to XTOT(i,d) multiplied by stocks shifter, FSTOCKS(i,d).

! Excerpt 11 of TABLO input file: !

! Government, export, and inventory demands !

! Governments !

FGOVTOT(d) Government demand shifter

FGOV(c,s,d) Government demand shifter

FGOV_S(c,d) Government demand shifter

XGOV(c,s,d) Government demand

$$(11.1) \text{ XGOV}(c,s,d) = \text{FGOVTOT}(d) * \text{FGOV}(c,s,d) * \text{FGOV_S}(c,d)$$

! Exports !

EXP_ELAST(c) Export demand elasticities

FQEXP(c,s) Export quantity shift variable

FPEXP(c,s) Export price shift variable

XEXP(c,s,d) Export of all-region composite leaving port at d

$$(11.2) \text{ XEXP}(c,s,d) / \text{FQEXP}(c,s) = [\text{PPUR}(c,s, \text{"EXP"}, d) / \\ [\text{FPEXP}(c,s) / \text{PHI}]]^{**} * \text{EXP_ELAST}(c)$$

! Inventories !

FSTOCKS(i,d) Stocks shifter

XSTOCKS(i,d) Inventories

$$(11.3) \text{ XSTOCKS}(i,d) = \text{FSTOCKS}(i,d) * \text{XTOT}(i,d)$$

3.13. Add up user demands to get total regional demand for delivered goods

Excerpt 12 explains that total regional demand for delivered goods composite c, s in d, XTRAD_R(c,s,d), is an add up of user demand.

! Excerpt 12 of TABLO input file: !

! Add up user demands to get total regional demand for !

! delivered goods !

XTRAD_R(c,s,d) Total demand for regional composite c,s in d

$$(12.1) \text{ XTRAD_R}(c,s,d) = \text{sum}\{i, \text{IND}, \text{XINT}(c,s,i,d)\} + \text{XHOU}(c,s,d) \\ + \text{XINV}(c,s,d) + \text{XGOV}(c,s,d) + \text{XEXP}(c,s,d)$$

3.14. Delivering goods to regions

Excerpt 13 explains delivering goods to regions. Using the Leontief function, Equation 13.1 determines that the demand for margin, XTRADMAR(c,s,m,r,d), is a proportion of XTRAD(c,s,r,d) multiplied by margin technological term, ATRADMAR(c,s,m,r,d). This XTRADMAR(c,s,m,r,d) contains a margin flow to facilitate commodities from region r to d.

The delivered price of good c, s from r to d , $PDELIVRD(c,s,r,d)$ is determined using Equation 13.2. Since $XTRAD(c,s,r,d)$ is known, the delivered value of commodity c, s , from r to d (on the left hand side) is composed by the basic plus the margin value used.

! Excerpt 13 of TABLO input file: !

! Delivering goods to regions !

$ATRADMAR(c,s,m,r,d)$ Trade for margins technological change

$XTRAD(c,s,r,d)$ Quantity of good c,s from r to d

$XTRADMAR(c,s,m,r,d)$ Margin m on good c,s going from r to d

$PBASIC(c,s,r)$ Basic prices

$PDELIVRD(c,s,r,d)$ All-user delivered price of good c,s from r to d

$XSUPPMAR_P(m,r,d)$ Quantity of composite margin m on goods from r to d

$PSUPPMAR_P(m,r,d)$ Price of composite margin m on goods from r to d

$$(13.1) XTRADMAR(c,s,m,r,d) = ATRADMAR(c,s,m,r,d) * XTRAD(c,s,r,d)$$

$$(13.2) PDELIVRD(c,s,r,d) * XTRAD(c,s,r,d) = PBASIC(c,s,r) * XTRAD(c,s,r,d)$$

$$+ \text{sum}\{m, MAR, PSUPPMAR_P(m,r,d) * XTRADMAR(c,s,m,r,d)\}$$

3.15 Regional sourcing

For each good and destination region, an average user chooses region sourcing based on delivered (margin-paid, but ex-tax) prices and values.

Equation 14.1 explains the delivered price of regional composite good c, s , to d , $PUSE(c,s,d)$. By multiplying $PUSE(c,s,d)$ to $XTRAD_R(c,s,d)$, it converts the left hand side equation into a value. Since the value of total components on the right hand side and $XTRAD_R(c,s,d)$ are known, we can determine $PUSE(c,s,d)$.

Equation 14.2 determines the demand of good c , either domestic or imported (s) from regional source (r) to destination region (d), $XTRAD(c,s,r,d)$ by multiplying $XTRAD_R(c,s,d)$ to trading share, $STRAD(c,s,r,d)$, and by a price term. The $XTRAD_R(c,s,d)$ is the demand of good c, s to d sum over region of origins, r . The price term is composed of the ratio $PDELIVRD(c,s,r,d)$ to $PUSE(c,s,d)$ powered by constant elasticity substitution between region, $SIGMADOMDOM(c)$, to total good from original regions.

! Excerpt 14 of TABLO input file: !

! For each good and destination region, an average user chooses !

! regional sourcing !

! Based on delivered (margin-paid, but ex-tax) prices and values !

SIGMADOMDOM(c) Parameter substitution elasticity between origins

PUSE(c,s,d) Delivered price of reg composite good c,s to d

STRAD(c,s,r,d) Initial share

$$(14.1) \text{ PUSE}(c,s,d) * \text{XTRAD_R}(c,s,d) = \text{sum}\{r, \text{ORG}, \text{PDELIVRD}(c,s,r,d) * \text{XTRAD}(c,s,r,d)\}$$

$$(14.2) \text{ XTRAD}(c,s,r,d) = \text{STRAD}(c,s,r,d) * \text{XTRAD_R}(c,s,d) * [\text{PDELIVRD}(c,s,r,d) / \text{PUSE}(c,s,d)]^{** - \text{SIGMADOMDOM}(c)}$$

3.16. Where margins are produced

Equation 15.1 contains equations determining where margins are produced. It shows that the composite margin m on goods passing from r to d , $\text{XSUPPMAR_P}(m,r,d)$, is sum over commodity and source of margin m on good c, s going from r to d , $\text{XTRADMAR}(c,s,m,r,d)$.

The price of composite margin m on goods from r to d , $\text{PSUPPMAR_P}(m,r,d)$ is given by Equation 15.2.

Margin m supplied by p on goods passing from r to d , $\text{XSUPPMAR}(m,r,d,p)$ as expressed by Equation 15.3, is proportional to $\text{XSUPPMAR_P}(m,r,d)$ multiplied by a price term. The price term is a ratio $\text{PDOM}(m,p)$ to $\text{PSUPPMAR_P}(m,r,d)$ powered by substitution elasticity between margin origins, $\text{SIGMAMAR}(m)$.

Adding up total demand for margins produced in p can be expressed into two different ways, Equation 15.4 and Equation 15.5. One is a sum over d and the other is sum over r and d .

! Excerpt 15 of TABLO input file: !

! Where margins are produced !

! We need $\text{xsuppmar_p}(m,r,d)$ margins !

! What regions p shall they come from ? !

SIGMAMAR(m) Parameter substitution elast between marg origins

BSUPPMAR(m,r,d,p) Parameter:const in demand for marg m (made in p)

XSUPPMAR(m,r,d,p) Demand for marg m (made in p) on goods from r to d

XSUPPMAR_D(m,r,p) Total margins on goods from r, produced in p

XSUPPMAR_RD(m,p) Total demand for margins produced in p

$$(15.1) \text{ XSUPPMAR_P}(m,r,d) = \text{sum}\{c,\text{COM}, \text{sum}\{s,\text{SRC}, \text{XTRADMAR}(c,s,m,r,d)\}\}$$

$$(15.2) \text{ XSUPPMAR_P}(m,r,d) * \text{PSUPPMAR_P}(m,r,d) =$$

$$\text{sum}\{p,\text{PRD}, \text{XSUPPMAR}(m,r,d,p) * \text{PDOM}(m,p)\}$$

$$(15.3) \text{ XSUPPMAR}(m,r,d,p) = \text{BSUPPMAR}(m,r,d,p) * \text{XSUPPMAR_P}(m,r,d)$$

$$* [\text{PDOM}(m,p) / \text{PSUPPMAR_P}(m,r,d)]^{**} - \text{SIGMAMAR}(m)$$

! Add up total demand for margins produced in p !

$$(15.4) \text{ XSUPPMAR_D}(m,r,p) = \text{sum}\{d,\text{DST}, \text{XSUPPMAR}(m,r,d,p)\}$$

$$(15.5) \text{ XSUPPMAR_RD}(m,p) = \text{sum}\{r,\text{ORG}, \text{XSUPPMAR_D}(m,r,p)\}$$

3.17. *Total demand for commodity c made in r = supply commodity c made in r*

Equation 16.1 explains total demand for commodity c produced in r equal to supply commodity c, s produced in r.

Specifically for domestic source, TOTDEM(c,"dom",r) expressed by Equation 16.2, is equal to supply for non-margins, XCOM(c,r). Then, supply for margins, XCOM(m,p) determined by Equation 16.3, is composed of direct demands for goods produced domestically in r, TOTDEM(m,"dom",p) plus demand for margins produced in p, XSUPPMAR_RD(m,p).

Equation 16.4 shows that PBASIC(c,"dom",r) is identical to PDOM(c,r). Equation 16.5 shows that PBASIC(c,"imp",r) is identical to import price, PIMP(c,r). PPUR(c,s,u,d) is given by Equation 16.6.

Using Equation 16.7, commodity tax revenue, COMTAXREV(d), is obtained from total value of goods used by users multiplied by commodity tax rate. Where commodity tax rate is TAX(c,s,u,d)/USE(c,s,u,d) or [TUSER(c,s,i,d)-1] .

! Excerpt 16 of TABLO input file: !

! Total demand for commodity c made in r = supply commodity c !

! made in r !

TOTDEM(c,s,r) Total direct demands for goods made and landed in r

TUSER(c,s,u,d) Powers of commodity taxes

COMTAXREV(d) Commodity tax revenue

$$(16.1) \text{TOTDEM}(c,s,r) = \text{sum}\{d, \text{DST}, \text{XTRAD}(c,s,r,d)\}$$

$$(16.2) \text{XCOM}(c,r) = \text{TOTDEM}(c, \text{"dom"}, r)$$

$$(16.3) \text{XCOM}(m,p) = \text{TOTDEM}(m, \text{"dom"}, p) + \text{XSUPPMAR_RD}(m,p)$$

$$(16.4) \text{PBASIC}(c, \text{"dom"}, r) = \text{PDOM}(c,r)$$

$$(16.5) \text{PBASIC}(c, \text{"imp"}, r) = \text{PIMP}(c,r)$$

$$(16.6) \text{PPUR}(c,s,u,d) = \text{PUSE}(c,s,d) * \text{TUSER}(c,s,u,d)$$

$$(16.7) \text{COMTAXREV}(d) = \text{sum}\{c, \text{COM}, \text{sum}\{s, \text{SRC}, \\ \text{sum}\{i, \text{IND}, [\text{TUSER}(c,s,i,d)-1] * \text{PUSE}(c,s,d) * \text{XINT}(c,s,i,d)\} \\ + [\text{TUSER}(c,s, \text{"hou"}, d)-1] * \text{PUSE}(c,s,d) * \text{XHOU}(c,s,d) \\ + [\text{TUSER}(c,s, \text{"gov"}, d)-1] * \text{PUSE}(c,s,d) * \text{XGOV}(c,s,d) \\ + [\text{TUSER}(c,s, \text{"inv"}, d)-1] * \text{PUSE}(c,s,d) * \text{XINV}(c,s,d) \\ + [\text{TUSER}(c,s, \text{"exp"}, d)-1] * \text{PUSE}(c,s,d) * \text{XEXP}(c,s,d)\}\}$$

3.18. Industry-specific investment demands

Excerpt 17 describes industry specific investment demands. The gross rate of return, $\text{GRET}(i,d)$, is determined as a ratio of capital rental to price of new capital. The investment by industries, $\text{XINVITOT}(i,d)$ is capital usage, $\text{XCAP}(i,d)$, multiplied by the gross growth rate of capital, $\text{GGRO}(i,d)$. Where $\text{GGRO}(i,d)$ is determined by the DPSV (Dixon *et al.* 1982) investment rule³.

³ As explained in excerpt 31 of the Oranig03.tab, above equation comes from substituting the values 0.33 and 2.0 which correspond to the DPSV ratios $[1/G.Beta]$ and Q (= ratio, gross to net rate of return) and are typical values of these ratios. In DPSV invslack was called "omega" and was interpreted as the "economy-wide rate of return".

! Excerpt 17 of TABLO input file: !

! Industry-specific investment demands !

GRET(i,d) Gross rate of return = rental/[price of new capital]

GGRO(i,d) Gross growth rate of capital = investment/capital

FINV1(i,d) Investment shift variable

INVS LACK Investment slack variable for exogenizing national investment

$$(17.1) \text{GRET}(i,d) = \text{PCAP}(i,d) / \text{PINVITOT}(i,d)$$

$$(17.2) \text{GGRO}(i,d) = \text{XINVITOT}(i,d) / \text{XCAP}(i,d)$$

$$(17.3) \text{GGRO}(i,d) = \text{FINV1}(i,d) * \{[\text{GRET}(i,d)]^2 / \text{INVS LACK}\} * 0.33$$

The following excerpts are Excerpt 16 and Excerpt 17 but written in percentage changes version. Equation 16.1 in level version corresponds to Equation 16.1 in the percentage changes version. We can write an equation in level with several equations in percentages changes version. For example, Equation 16.7 in level version, it is written by several equations in percentage changes (from Equation 16.7 to 16.11). Note that we write variable names in lower case and value flows/coefficients in capital case. Sometimes it is necessary to state a variable in ordinary change if that variable can change from positive toward negative or reverse. We write ordinary-change variables with prefix 'del, for example ' delTAXint (c,s,i,d). This represents ordinary change in TAX for intermediate input demands.

\c AnsiText * MERGEFORMAT ! Excerpt 16 of TABLO input file: !

! Total demand for commodity c produced in r = supply commodity c !

! produced in r (in percentage changes version) !

! data flows/coefficients !

TRADE(c,s,r,d) Trade matrix (at basic prices)

TRADE_D(c,s,r) Total direct demands

SUPPMAR_RD(m,p) Total demand for margin m produced in p

TAX(c,s,u,d) Commodity taxes

! variables in percentage changes !

totdem(c,s,r) Total direct demand for goods produced(dom)

orlanded(imp)	in r
xtrad(c,s,r,d)	Quantity of good c,s from r to d
xcom(c,d)	Total output of commodities
ppur(c,s,u,d)	User (purchasers) prices, inc margins and taxes
puse(c,s,d)	Delivered price of regional composite good c,s to d
tuser(c,s,u,d)	Powers of commodity taxes

$$(16.1) \text{ (TRADE_D}(c,s,r)\text{)*totdem}(c,s,r) = \text{sum}\{d,\text{DST,TRADE}(c,s,r,d) \\ \text{*xtrad}(c,s,r,d)\}$$

$$(16.2) \text{ xcom}(c,r) = \text{totdem}(c,\text{"dom"},r)$$

$$(16.3) \text{ MAKE_I}(m,p)\text{*xcom}(m,p) = \text{TRADE_D}(m,\text{"dom"},p)\text{*totdem}(m,\text{"dom"},p) \\ + \text{SUPPMAR_RD}(m,p)\text{*xsuppmar_rd}(m,p)$$

$$(16.4) \text{ pbasic}(c,\text{"dom"},r) = \text{pdom}(c,r)$$

$$(16.5) \text{ pbasic}(c,\text{"imp"},r) = \text{pimp}(c,r)$$

$$(16.6) \text{ ppur}(c,s,u,d) = \text{puse}(c,s,d) + \text{tuser}(c,s,u,d)$$

! variables in ordinary change !

delTAXint(c,s,i,d)	intermediate commodity tax revenue
delTAXhou(c,s,d)	household commodity tax revenue
delTAXinv(c,s,d)	investment commodity tax revenue
delTAXgov(c,s,d)	government commodity tax revenue
delTAXexp(c,s,d)	export commodity tax revenue

!variables in percentage changes!

xint(c,s,i,d)	Intermediate demands for all-region composite
xhou(c,s,d)	Household demands for all-region composite
xinv(c,s,d)	Investment demands for all-region composite
xgov(c,s,d)	Government demands for all-region composite
xexp(c,s,d)	Export of all-region composite leaving port at d

$$(16.7) \text{delTAXint}(c,s,i,d) = 0.01 * \text{TAX}(c,s,i,d)$$

$$*[\text{xint}(c,s,i,d) + \text{puse}(c,s,d)] + 0.01 * \text{PUR}(c,s,i,d) * \text{tuser}(c,s,i,d)$$

$$(16.8) \text{delTAXhou}(c,s,d) = 0.01 * \text{TAX}(c,s, \text{"hou"}, d)$$

$$*[\text{xhou}(c,s,d) + \text{puse}(c,s,d)] + 0.01 * \text{PUR}(c,s, \text{"hou"}, d) * \text{tuser}(c,s, \text{"hou"}, d)$$

$$(16.9) \text{delTAXinv}(c,s,d) = 0.01 * \text{TAX}(c,s, \text{"inv"}, d) * [\text{xinv}(c,s,d) + \text{puse}(c,s,d)] +$$

$$0.01 * \text{PUR}(c,s, \text{"inv"}, d) * \text{tuser}(c,s, \text{"inv"}, d)$$

$$(16.10) \text{delTAXgov}(c,s,d) = 0.01 * \text{TAX}(c,s, \text{"gov"}, d) * [\text{xgov}(c,s,d) + \text{puse}(c,s,d)] +$$

$$0.01 * \text{PUR}(c,s, \text{"gov"}, d) * \text{tuser}(c,s, \text{"gov"}, d)$$

$$(16.11) \text{delTAXexp}(c,s,d) = 0.01 * \text{TAX}(c,s, \text{"exp"}, d) * [\text{xexp}(c,s,d) + \text{puse}(c,s,d)] +$$

$$0.01 * \text{PUR}(c,s, \text{"exp"}, d) * \text{tuser}(c,s, \text{"exp"}, d)$$

! Excerpt 17 of TABLO input file: !

! Industry-specific investment demands !

! (in percentage changes version) !

! Variables in percentage changes !

ggro(i,d) Gross growth rate of capital = Investment/capital

gret(i,d) Gross rate of return = Rental/[Price of new capital]

finv1(i,d) Investment shift variable invslack Investment slack for exogenizing
national investment

pcap(i,d) Rental price of capital

pinvitot(i,d) Investment price index by industry

xcap(i,d) Capital usage

xinvitot(i,d) Investment by industry

$$(17.1) \text{gret}(i,d) = \text{pcap}(i,d) - \text{pinvitot}(i,d)$$

$$(17.2) \text{ggro}(i,d) = \text{xinvitot}(i,d) - \text{xcap}(i,d)$$

$$(17.3) \text{ggro}(i,d) = \text{finv1}(i,d) + 0.33 * [2.0 * \text{gret}(i,d) - \text{invslack}]$$

4. DATABASE

4.1. Introduction

Regional input-output tables and trade matrices, as shown in Figure 2.1 Section 2, are not available in Indonesia. The EMERALD database is produced from very limited regional data in several steps. Key features of this strategy are:

- The process starts with a national input-output table and certain regional data. The minimum requirement for regional data is very modest: the distribution between regions of industry output and of final demand aggregates.
- The database is constructed at the most disaggregated sectoral and regional level: 97 sectors and 26 regions. This is useful when estimating missing data.

The data process is broken into 7 stages, as shown in Figure 4.1:

- A preliminary aggregation to reduce multiproduction
- Simplification of data structure
- Input usage distinguished by place of use
- Input usage distinguished by place of production
- Consolidate final format
- Aggregation into 19 sectors
- Run the model to produce diagnostic information and summary

Our exposition follows these steps.

Remainder of Section 4 omitted to meet size limit. A zip file of the complete section may be downloaded from <http://www.monash.edu.au/policy/archivep.htm>.

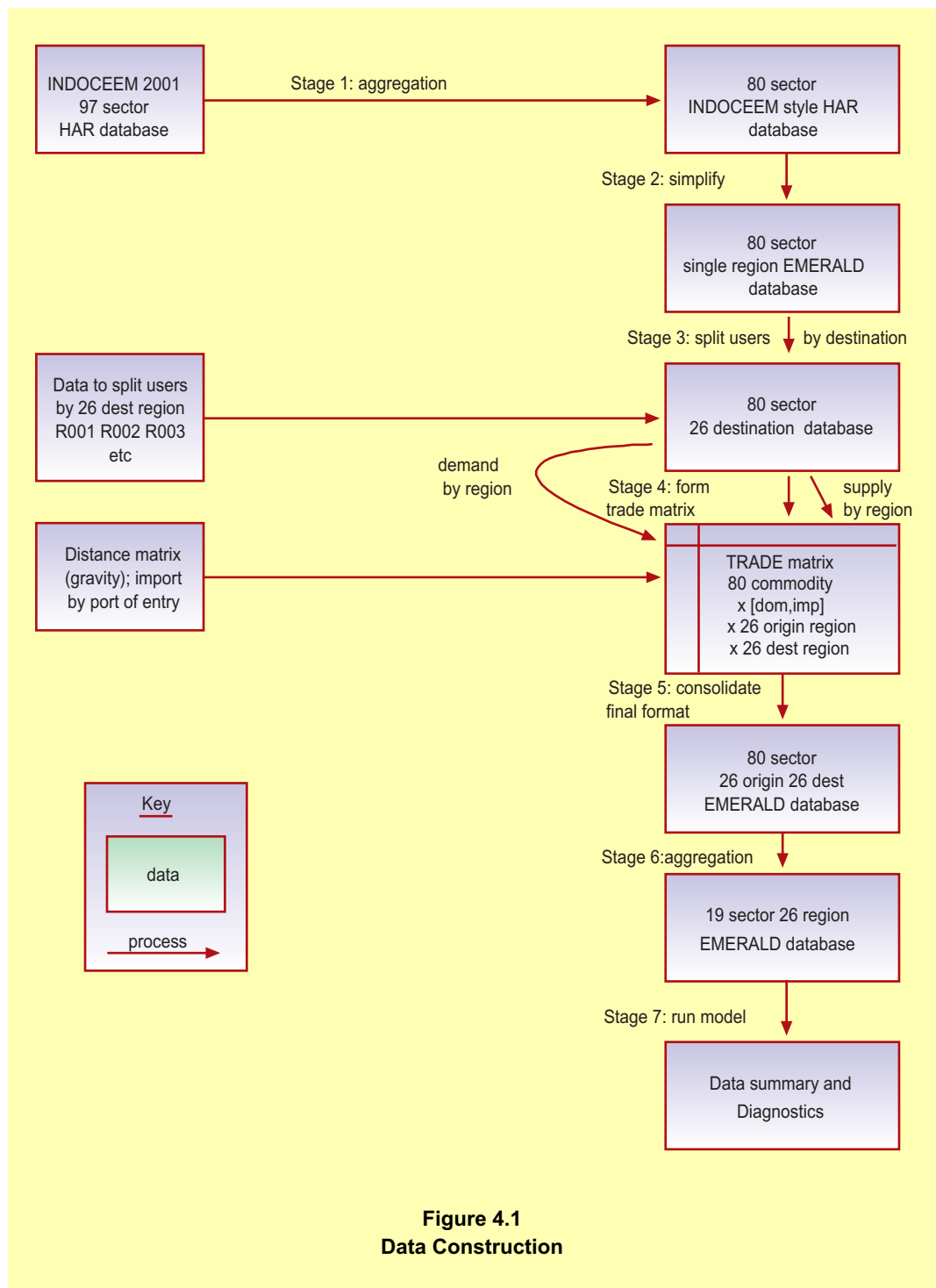


Figure 4.1
Data Construction

5. SUBSIDY VARIATIONS TO ATTRACT INVESTORS.

5.1. Introduction

This section analyses the economic effects of subsidising industry to attract investment in specific regions. As an example, we choose to subsidise Textiles, Clothing and Footwear (TCF) industry in Central Java (JaTeng) using the EMERALD (Equilibrium Model with Economic Regional AnaLysis Dimensions) multi-regional CGE Model.

We simulate several financial approaches to the TCF subsidy in JaTeng: unfunded subsidy, subsidy funded by consumer tax or by producer tax, and reduction in local government demand. Selected results are shown for the target region (JaTeng), a neighbour region (Yogyakarta) and for the nation. Also we decompose total results into different effects. For example, we split the total effect of a subsidy funded by consumers into two separate effects: the effects of the subsidy and the effects of the consumer tax.

5.2. Textile clothing and footwear in JaTeng (Central Java)

Tables 5.1 and 5.2 are examples of data generated for this model. Table 5.1 shows destinations of TCF made in JaTeng. 26% remains in JaTeng (14% used by industries and 12% by households), other regions take 51% and exports take 22%.

Local (JaTeng)				Other Regions	ROW Export	Total
Intermediate	Households	Investment	Government			
2640 14.47%	2182 11.96%	4 0.02%	8 0.04%	9356 51.28%	4055 22.23%	18245 100%

Table 5.2 shows trade inflows to JaTeng. There are three sources of TCF used in JaTeng: local (47%), other regions (45%) and import (8%).

Local Production	Other Regions	ROW Import	Total
8890 46.86%	8608 45.37%	1474 7.77%	18972 100%

5.3. Closure

We used a long-run closure for most of the experiments: within each region, labour is completely mobile between sectors. A wage differential is needed to induce labour movement between regions. The national labour supply is fixed. Rates of return (ROR) are exogenous and capital for each regional industry is in elastic supply. Foreign currency prices of imports are naturally exogenous. Population is also held constant. Other exogenous variables include changes in rate of production tax, technology, price and quantity shift variables.

On the regional expenditure side, nominal household consumption moves with nominal labour income. Real aggregate investment follows regional demands for capital. Real government consumption follows real household consumption. Export demand elasticities and export prices determine export volumes.

Most national results are no more than the sum of the corresponding regional results. However a few constraints were imposed at the national, rather than the regional, level. National employment is fixed, while real wages adjust. National real household consumption moves with real GDP. The exchange rate is fixed as numeraire. Table 5.3 shows that for exogenous variables, main macro results for both Indonesia as a whole and JaTeng, are zero. Other than unfunded subsidy, we examine three alternative ways of financing the subsidy: to shift the cost of the subsidy either to JaTeng consumers, to JaTeng industries or to reduce JaTeng government demands.

To shift the cost of the subsidy either to JaTeng consumers or to JaTeng industries, we use two slightly different closures to hold indirect tax (commodity plus production tax) revenue constant. In the first closure, rates of commodity taxes for JaTeng households adjust uniformly to finance the subsidy. In the second closure, production tax rates for JaTeng industries are raised to finance the TCF subsidy. To finance the subsidy by reduction in JaTeng government demands, we reduce government demand by a sum equal to the cost of the subsidy⁴.

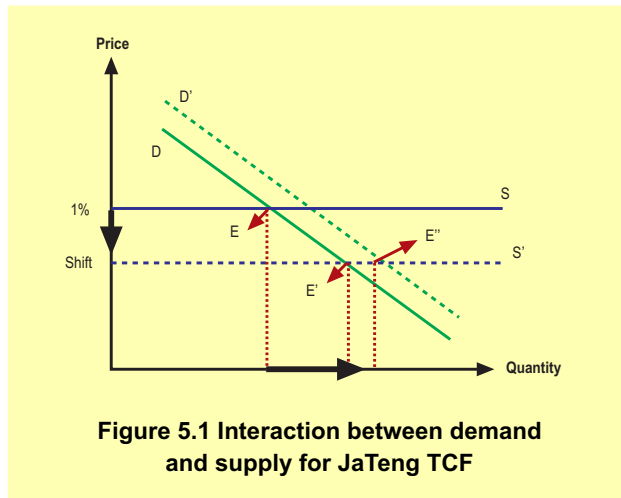
5.4. Shock

To subsidise the Textiles, Clothing and Footwear industry (TCF) in JaTeng, we shocked the model by shifting down the supply curve for TCF⁵. Since labour and capital in long run are mobile between sectors, EMERALD has very flat long run regional industry supply curves.

4 We apply variable *fgovtot2* which represents government demand shifter.

5 We shocked the model by applying *delPTXrate*("TCF","JaTeng")=-0.01. This variable has two dimensions, industry and region. The 'delPTXrate' represents an ordinary change in an ad valorem production tax rate. The negative figure "-0.01" means that we subsidise JaTeng Textiles, Clothing and Footwear industry by 1% of the value of output.

Figure 5.1 illustrates the interaction between JaTeng TCF demand and supply. The initial equilibrium is at point E. The shock moves the supply curve down from S to S'. As a result, the equilibrium moves from point E to E', which has lower price and higher quantity than initially. Because of input-output linkages, employment, wages and household income all rise. As a result, the demand curve will shift upward from D to D'. It creates a new equilibrium at point E'' which greater quantity than point E'.



5.5. Simulation results

Simulation results appear in Table 5.3 to Table 5.6—they differ according to the financial approaches to the TCF subsidy. We discuss the results in the following order: (1) unfunded subsidy, (2) subsidy paid for by consumers, (3) subsidy paid for by industries, followed by (4) subsidy funded by reduction in local government demands. Returning to the unfunded subsidy, we focus on a neighbouring region and on national results. Each table of results shows main macro variables, TCF sector variables, and sectoral outputs.

5.5.1. Unfunded subsidy

Table 5.3 shows three results columns. The first column shows results for JaTeng (Central Java), the second results for DIY (District of Yogyakarta, a neighbouring region) and the third, national results. In this section, our discussion focuses on column (1).

JaTeng TCF sector (Table 5.3, column (1))

When we subsidise JaTeng TCF by 1%, output price of TCF decreases further, by 1.1%. This is because intermediate input cost falls by 0.24% to dominate increases in other cost (capital rental by 0.034% and wages by 0.25%). Note that 26% of TCF input is TCF output.

Since domestic prices fall, not only do international exports of TCF increase by 5.5%, but also exports to other regions increase by 5.0%. Imports lose market share so that local TCF sales increase by 7%. This causes TCF output to increase by 5.96%. Consequently, demands for inputs also increase. Employment rises by 5.89% and capital rises by 6.0%.

To attract labour from other regions, wages had to rise by 0.25%. Capital rentals rose by 0.034% (the latter are indexed to the investment price index). Since wages rose more than capital rentals, TCF employment rose by less than TCF output, while capital use rose by more (MPL is positive function of K/L ratio).

Imports of TCF from other regions only increase by 1.7% mainly because the local demand shifts toward JaTeng TCF. We see from local TCF used locally increases by 7%.

JaTeng macro results (Table 5.3, column (1))

In the macro results, JaTeng real household consumption rises by 0.42% in line with nominal labour income (employment increases by 0.21% plus nominal wages by 0.25%). The 0.25% increase in nominal wages is composed of an increase in average real wage of 0.24%, plus a 0.012% increase in CPI.

Again, real government consumption grows by 0.42% to follow real household consumption. Since we assume gross growth rates of capital to be fixed, investment follows capital growth. Hence, JaTeng real investment grows by 0.22% and aggregate capital stock by 0.22%.

The export price index falls by 0.097% (due to a domestic price fall, i.e, price of GDP falls by 0.032%). So export volumes grow by 0.29%. Import volumes used grow by 0.43% because demand expands and imports lose market share. Hence, real GDP grows by 0.21%.

JaTeng sectoral output (Table 5.3, column (1))

In national or trade-exposed industries which compete with the same industries from other regions, the wage rise increases costs, leading to loss of market shares. So output and employment shrink.

However, industries less exposed to competition grow. For example, utilities grow by 0.40% and government services by 0.31%. Since local goods are produced and consumed locally, demand for local goods grows to follow absorption (which is itself driven by labour income). Since input costs to JaTeng firms rise, output prices also rise except in TCF sector.

Traded industries ranging from agriculture to manufactures shrink; machines and electronics by 0.15% and mining by 0.16%. In turn, their demands for inputs contract.

Except for TCF exports, rising input costs cause exports to shrink. For example, in agriculture domestic prices rise by 0.017% and exports shrink by 2.3%.

Jobs grow in TCF (by 5.9%) and in non-traded sectors, but shrink in trade-exposed sectors.

5.5.2. Unfunded subsidy: effect on neighbour and nation

The effects on neighbour and nation of a long-run unfunded subsidy are shown in Table 5.3, DIY (column (2)) and National (column (3)). Note that DIY is a neighbour region surrounded by JaTeng. It is interesting to observe that effects on DIY are similar to effects on JaTeng (but smaller). DIY also benefits, again led by increased TCF output. The reason is that TCF partly from JaTeng is a big input into DIY TCF—so cheaper TCF imports benefit DIY TCF also. National results are also positive, although small. One reason is that national results are no more than the sum of the corresponding regional results.

TCF sector (Table 5.3, column (2, 3))

Since 24% of TCF in DIY is from JaTeng: a fall in JaTeng TCF domestic price by 1.1% causes DIY TCF domestic prices to fall by 0.065%. As consequences, TCF output in DIY expands by 0.57%. Then the demand of inputs rises, capital by 0.58% and labour by 0.55%. To attract labour from other regions, wages had to rise by 0.077% relative to capital rentals by 0.015% (the later are indexed to investment price index).

Due to TCF price falls, TCF output, export to ROW increases by 2.78%, and exports to other regions increase by 0.75%. Import from other regions also increase by 1.6% because of demand expansion. Again, local demand for local TCF rises by 0.11%.

Column (3) shows that national output prices for TCF falls by 0.16%. As results, TCF output and exports all rise by 0.90% and by 1.42%. This sector sucks in employment from other sectors by 0.90%. Note that national employment is fixed.

Macro results (Table 5.3, column (2, 3))

In DIY, even though export prices fall by 0.031%, export volume falls by 0.046%. This indicates that domestic demand is stronger than export. We can see from a rise in GDP price index by 0.036%.

DIY also sucks in labour and capital from other regions. Aggregate employment and capital stock in DIY increase by 0.029% and 0.021%. This causes real GDP to grow by 0.023%. Since labour income rises, household expenditures and government expenditure all rise by 0.059%. Real investment grows by 0.016% to follow a growth in capital stock. Again, import volume used increases by 0.095% to follow expansion in economy activity.

Tabel 5.3.
Unfunded subsidy to TCF industry in JaTeng

Main Macro Variable	Description	(1) JaTeng	(2) DIY	(3) National
RealHou	Real Household Expenditure	0.418	0.059	0.001
RealInv	Real Investment Expenditure	0.219	0.016	0.001
RealGov	Real Government Expenditure	0.418	0.059	0.003
ExpVol	Export Volume	0.285	-0.046	0.027
Xdomexp_c	Export to other regions	0.261	0.060	-
Xdomimp_c	Import from other regions	0.378	0.058	-
ImpVolUsed	Import Volume Used	0.425	0.095	0.026
ImpsLanded	Import Volume Landed	0.332	0.130	0.026
RealGDP	Real GDP	0.206	0.023	0.001
AggEmploy	Aggregate Employment	0.208	0.029	0.000
AveRealWage	Average Real Wage	0.241	0.062	0.033
AggCapStock	Aggregate Capital Stock	0.220	0.021	0.002
GDPPPI	Price GDP	-0.032	0.036	0.000
CPI	Consumer Price Index	0.012	0.015	0.001
ExportPI	Export Price Index	-0.097	-0.031	-0.012
TCF Sector Variable	Description			
xexpsho("TCF")	Direct exports to Row	5.533	2.776	1.416
xtot("TCF")	Industry output	5.962	0.565	0.902
plab_o("TCF")	Nominal wage	0.253	0.077	-
xlab_o("TCF")	Employment	5.892	0.547	0.898
pcapsho("TCF")	Capital rentals	0.034	0.015	-
xcap("TCF")	Capital	6.008	0.578	-
pint("TCF")	Intermediate cost	-0.236	-0.120	-
pdom("TCF")	Domestic prices	-1.111	-0.065	-0.160
xdomexp("TCF")	Export to other regions	4.975	0.747	-
xdomimp("TCF")	Import from other regions	1.732	1.574	-
xdomloc("TCF")	TCF made and used locally	7.000	0.108	-

Sectoral Output	Description	(1) JaTeng	(2) DIY	(3) National
xtot("Agriculture")	Agriculture	-0.170	-0.066	-0.046
xtot("Fishing")	Fishing	-0.160	-0.059	-0.031
xtot("OilGas")	Oil and Gas	-0.023	0.000	0.001
xtot("Mining")	Mining	-0.155	-0.049	-0.013
xtot("FoodDrink")	Food and Drink	-0.349	-0.144	-0.116
xtot("TCF")	Textiles, Clothing and Footwear	5.962	0.565	0.902
xtot("WoodPaper")	Wood and Paper	-0.232	-0.155	-0.084
xtot("Chemicals")	Chemicals	-0.110	-0.014	-0.066
xtot("LNG")	Liquid Natural Gases	0.000	0.000	-0.026
xtot("BasicMetal")	Basic Metals	-0.174	0.000	-0.028
xtot("MachinElec")	Machines Electronics	-0.154	-0.063	-0.064
xtot("OtherManuf")	Other Manufactures	-0.041	-0.024	-0.027
xtot("ElecGasWater")	Electricity, Gas, and Water	0.396	0.262	0.033
xtot("Construction")	Construction	0.097	0.028	0.001
xtot("Trade")	Trade	0.065	0.048	-0.004
xtot(" HotelRest")	Hotel and Restaurant	0.335	0.075	-0.007
xtot("Transport")	Transport	0.101	0.021	-0.021
xtot("OtherServ")	Other Services	0.191	0.048	-0.026
xtot("GovSrvces")	Government Services	0.307	0.120	0.002

Long-run national effects

As comparison, Figure 5.2 shows regional real GDP results. JaTeng wins most with a growth in real GDP followed by DIY. In contrast, other regions lose slightly.

Subsidising JaTeng TCF is good for the whole nation. Table 5.3, column (3) shows that real GDP grows by 0.001%. All spending rise, for example, real household expenditure and investment by 0.001%. Since we assume national aggregate employment is fixed, a 0.002% growth in capital determines a 0.001% growth in national GDP. Ordinary change in share of real trade balance to real GDP increases by 0.002%.

Sectoral output (Table 5.3, column (2, 3))

Local industries grow in DIY such as utilities by 0.26% and government service by 0.12%. On the other hand, trade-exposed industries shrink for instance, food and drink by 0.14% and wood paper by 0.16%. It is because of substitution toward other regions product as a result from a DIY rising costs. Again, national sectoral output follows the sum of the corresponding regional results for example in column (3), food and drink shrinks by 0.12% and wood paper by 0.084%. Except TCF, growing sectors include utilities by 0.033%, construction by 0.001% and government service by 0.002%

5.5.3. Consumers pay the subsidy



Figure 5.2
Regional Real GDP Result

In this section we subsidise the TCF industry by the same amount—this time funded by a commodity tax on household purchases. Table 5.4 splits the results into three columns showing, the effects of: (1) subsidy alone, (2) consumer tax, and (3) total.

To compute column (3) we allowed consumer taxes to adjust uniformly so that total indirect tax revenue (including the subsidy cost) remained constant. The second column shows the effect of the consumer tax increase alone. The necessary change was an increase of 0.18% in the power of all taxes on household purchases. Column (1) is simply the difference between (2) and (3). Due to model non-linearity it is not quite the same as column (1) of Table 5.3.

Since the first column is nearly the same as the unfunded subsidy in the previous section, here we focus on the second and total columns.

JaTeng macro results (Table 5.4, column (2))

A tax on households has opposing effects to an industry subsidy. All demand spending in JaTeng went down, real household consumption by 0.26%, real investment by 0.082% and real government consumption by 0.26%.

On the income side of GDP, aggregate employment falls by 0.13% and aggregate capital stock by 0.082%. As a result real GDP shrinks by 0.097%. Since we assumed capital/investment ratio to be fixed, investment also falls by 0.082%.

An increase on household power tax by 0.18% causes CPI to increase by 0.19%. In turn, average real wages fall by 0.15%.

Due rising input costs, the export price index increases by 0.004% to cause a fall in export volume by 0.10%. Again, import volume shrinks by 0.16% as a result of a shrinking in production. The changes in export and import volumes hardly affect the real trade balance to real GDP.

Tabel 5.4. Subsidy Funded by Consumer Tax (JaTeng Results)				
Main Macro Variable	Description	(1) Efex of Subsidy = (3) - (2)	(2) Efex of Consumer Fax	(3) Total
RealHou	Real Household Expenditure	0.417	-0.258	0.159
RealInv	Real Investment Expenditure	0.219	-0.082	0.137
RealGov	Real Government Expenditure	0.417	-0.258	0.159
ExpVol	Export Volume	0.286	-0.102	0.184
Xdomexp_c	Export to other regions	0.261	-0.002	0.259
Xdomimp_c	Import from other regions	0.378	-0.129	0.249
ImpVolUsed	Import Volume Used	0.424	-0.158	0.266
ImpsLanded	Import Volume Landed	0.331	-0.126	0.205
RealGDP	Real GDP	0.206	-0.097	0.109
AggEmploy	Aggregate Employment	0.208	-0.129	0.079
AveRealWage	Average Real Wage	0.241	-0.149	0.092
AggCapStock	Aggregate Capital Stock	0.220	-0.082	0.138
GDPPPI	Price GDP	-0.032	0.132	0.100
CPI	Consumer Price Index	0.012	0.187	0.199
ExportPI	Export Price Index	-0.097	0.004	-0.092
TCF Sector Variables	Description			
xexpsho("TCF")	Direct exports to ROW	5.530	-0.039	5.491
xtot("TCF")	Industry output	5.958	-0.068	5.889
plab_o("TCF")	Nominal wage	0.253	0.038	0.292
xlab_o("TCF")	Employment	5.888	-0.079	5.809
pcapsho("TCF")	Capital rentals	0.034	0.003	0.038
xcap("TCF")	Capital	6.004	-0.061	5.943
pint("TCF")	Intermediate cost	-0.236	0.003	-0.233
pdom("TCF")	Domestic prices	-1.111	0.008	-1.103
xdomexp("TCF")	Export to other regions	4.973	-0.027	4.946
xdomimp("TCF")	Import from other regions	1.732	-0.068	1.664
xdomloc("TCF")	TCF made and used locally	6.994	-0.112	6.882

Sectoral Output	Description	(1) Efex of Subsidy = (3) - (2)	(2) Efex of Consumer Fax	(3) Total
xtot("Agriculture")	Agriculture	-0.170	-0.040	-0.210
xtot("Fishing")	Fishing	-0.160	-0.045	-0.205
xtot("OilGas")	Oil and Gas	-0.023	-0.005	-0.028
xtot("Mining")	Mining	-0.155	-0.033	-0.188
xtot("FoodDrink")	Food and Drink	-0.348	-0.104	-0.452
xtot("TCF")	Textiles, Clothing and Footwear	5.958	-0.068	5.889
xtot("WoodPaper")	Wood and Paper	-0.232	-0.129	-0.361
xtot("Chemicals")	Chemicals	-0.110	-0.056	-0.166
xtot("LNG")	Liquid Natural Gases	0.000	0.000	0.000
xtot("BasicMetal")	Basic Metals	-0.174	-0.046	-0.220
xtot("MachinElec")	Machines Electronics	-0.154	-0.080	-0.234
xtot("OtherManuf")	Other Manufactures	-0.041	-0.114	-0.155
xtot("ElecGasWater")	Electricity, Gas, and Water	0.396	-0.136	0.259
xtot("Construction")	Construction	0.097	-0.062	0.035
xtot("Trade")	Trade	0.065	-0.079	-0.014
xtot(" HotelRest")	Hotel and Restaurant	0.335	-0.261	0.074
xtot("Transport")	Transport	0.101	-0.100	0.001
xtot("OtherServ")	Other Services	0.191	-0.173	0.018
xtot("GovSrvces")	Government Services	0.306	-0.277	0.030

JaTeng sectoral output (Table 5.4, column (2))

The effect of the consumer tax is that both trade and non-trade-exposed sectors shrink. Sectors that are mainly used by household shrink most. For example government services output shrinks by 0.28% and hotel and restaurant by 0.26%.

JaTeng TCF sector (Table 5.4, column (2))

Focusing on Table 5.4, column (2), TCF production shrinks by 0.068% mainly due to reduced household demand. This causes demand for inputs to shrink, employment by 0.079%, capital by 0.061%.

TCF cost rises due to an increase in wages by 0.038%, capital by 0.003%, and also intermediate input by 0.003%. This causes TCF output price to rise by 0.008%. In turn, export shrinks by 0.039%. Import shrinks by 0.090% as local demand (including TCF production).

5.5.4. Subsidy funded by production tax

In this experiment, industries pay for the subsidy instead of households. Revenue

raised from production tax is used to subsidise the TCF sector. Again we split the results into three columns: effect of subsidy, effect of production tax and total effect. To ease comparison we also show in column (4), the total effect if consumers pay the subsidy (Table 5.5, column (4)). In this section we focus on the effect of the production tax (column (2)). To pay for the TCF subsidy it was necessary to impose on all sectors a production tax equal to 0.066% of input costs.

JaTeng TCF sector (Table 5.5, column (2))

A rise in TCF production tax by 0.066% of output value only causes TCF domestic prices to rise only by 0.047%. This is because regional wages fall by 0.23% to offset an increase in capital rentals (by 0.012%) and intermediate input costs (by 0.015%). As TCF output price increases, TCF output shrinks by 0.28%.

Due to a fall in output, TCF employment falls by 0.21% to depress local wage by 0.23%. Increasing JaTeng commodity prices cause investment price index also to rise. Since we fixed gross rate of return, rental price of capital also to rise by 0.012% to follow investment price index. In turn, demand of capital falls by 0.33% as a result of an increase in capital rental.

Since TCF prices rises, exports to ROW shrinks by 0.20% and exports to other regions shrinks by 0.189%. Import from other regions shrink by 0.14% because the substitution effect is not enough to counteract the contraction in demand.

JaTeng macro results (Table 5.5, column (2))

Increases in most output prices cause all demand to fall. On the expenditure side of GDP, real household and government expenditure fall by 0.41%, real investment falls by 0.30%, and export volumes fall by 0.62%. Since domestic demands fall, import volumes also contract by 0.34%. Changes in export and import volume used causes share of real trade balance to real GDP to increase by 0.001%

In spite of an increase in production tax by 0.07%, GDP price index only rises by 0.030%. It is because government price index falls by 0.053%, while other price indexes rise, CPI by 0.005%, export price index by 0.024% and investment prices index by 0.012% (recall capital rentals rise by 0.012%).

Government uses mainly government services (about 69% of government expenses). Since government services is labour intensive sector. When local wage falls, so does the output price. As consequences, government price index falls.

On the income side of GDP, aggregate employment falls by 0.20% and aggregate capital stock by 0.33%. Hence, real GDP shrinks by 0.26%.

JaTeng sectoral output (Table 5.5, column (2))

All sectors shrink to follow macro expenditure results. For example, government services falls by 0.36% to follow a fall in real government spending by 0.41%. Construction shrinks by 0.22% to follow a 0.30% fall in real investment expenditure.

Comparison with subsidy funded by consumer tax

Macro results indicate the production tax method of funding the TCF subsidy is far more damaging to the JaTeng economy than the consumer tax. Raising the production tax causes factor cost and intermediate costs to rise. As consequences, JaTeng demand weakens. Even though export price index falls, this is not enough to raise the export. Imports displace domestic products.

If producers pay for the subsidy, capital rentals rise by more than if the consumers pay the subsidy. This offsets the effect of the subsidy on aggregate capital stock and causes it and investment to fall. As a result, the real GDP shrinks when producers are taxed

Tabel 5.5.
Subsidy funded by producer tax (JaTeng results)

Main Macro Variable	Description	(1) Efex of Subsidy = (3) - (2)	(2) Efex of Consumer Fax	(3) Total	(4) col (3), Table 5.4
RealHou	Real Household Expenditure	0.417	-0.411	0.006	0.159
RealInv	Real Investment Expenditure	0.219	-0.296	-0.077	0.137
RealGov	Real Government Expenditure	0.417	-0.411	0.006	0.159
ExpVol	Export Volume	0.292	-0.618	-0.326	0.184
Xdomexp_c	Export to other regions	0.260	-0.090	0.170	0.259
Xdomimp_c	Import from other regions	0.378	-0.318	0.060	0.249
ImpVolUsed	Import Volume Used	0.425	-0.339	0.085	0.266
RealGDP	Real GDP	0.206	-0.261	-0.054	0.109
AggEmploy	Aggregate Employment	0.208	-0.201	0.007	0.079
AveRealWage	Average Real Wage	0.241	-0.236	0.004	0.092
AggCapStock	Aggregate Capital Stock	0.220	-0.329	-0.108	0.138
GDPPI	Price GDP	-0.032	0.030	-0.003	0.100
CPI	Consumer Price Index	0.012	0.005	0.017	0.199
ExportPI	Export Price Index	-0.097	0.024	-0.073	-0.092

TCF Sector Variables	Description	(1) Efex of Subsidy = (3) - (2)	(2) Efex of Consumer Fax	(3) Total	(4) col (3), Table 5.4
xexpsho("TCF")	Direct exports to ROW	5.513	-0.202	5.311	5.491
xtot("TCF")	Industry output	5.940	-0.279	5.661	5.889
plab_o("TCF")	Nominal wage	0.253	-0.232	0.021	0.292
xlab_o("TCF")	Employment	5.875	-0.207	5.668	5.809
pcapsho("TCF")	Capital rentals	0.034	0.012	0.046	0.038
xcap("TCF")	Capital	5.983	-0.328	5.655	5.943
pint("TCF")	Intermediate cost	-0.235	0.015	-0.221	-0.233
pdom("TCF")	Domestic prices	-1.111	0.047	-1.064	-1.103
xdomexp("TCF")	Export to other regions	4.961	-0.189	4.772	4.946
xdomimp("TCF")	Import from other regions	1.728	-0.144	1.584	1.664
xdomloc("TCF")	TCF made and used locally	6.969	-0.374	6.595	6.882
Sectoral output	Description				
xtot("Agriculture")	Agriculture	-0.169	-0.046	-0.215	-0.210
xtot("Fishing")	Fishing	-0.160	-0.056	-0.216	-0.205
xtot("OilGas")	Oil and Gas	-0.023	-0.067	-0.090	-0.028
xtot("Mining")	Mining	-0.155	-0.026	-0.181	-0.188
xtot("FoodDrink")	Food and Drink	-0.344	-0.391	-0.734	-0.452
xtot("TCF")	Textiles, Clothing and Footwear	5.940	-0.279	5.661	5.889
xtot("WoodPaper")	Wood and Paper	-0.230	-0.484	-0.714	-0.361
xtot("Chemicals")	Chemicals	-0.110	-0.351	-0.461	-0.166
xtot("LNG")	Liquid Natural Gases	0.000	0.000	0.000	0.000
xtot("BasicMetal")	Basic Metals	-0.174	-0.260	-0.433	-0.220
xtot("MachinElec")	Machines Electronics	-0.154	-0.319	-0.473	-0.234
xtot("OtherManuf")	Other Manufactures	-0.040	-0.340	-0.380	-0.155
xtot("ElecGasWater")	Electricity, Gas, and Water	0.395	-0.293	0.103	0.259
xtot("Construction")	Construction	0.097	-0.204	-0.107	0.035
xtot("Trade")	Trade	0.066	-0.224	-0.157	-0.014
xtot(" HotelRest")	Hotel and Restaurant	0.335	-0.430	-0.095	0.074
xtot("Transport")	Transport	0.102	-0.261	-0.159	0.001
xtot("OtherServ")	Other Services	0.191	-0.310	-0.119	0.018
xtot("GovSrvces")	Government Services	0.307	-0.363	-0.056	0.030

The subsidy funded by producer tax causes employment to rise by less than when funded by consumers.

5.5.5. Subsidy funded by reduction in local government demands

In this section our TCF subsidy is funded by a 2.19% reduction in local government demand. Table 5.6 decomposes the results into two columns: effect of subsidy and effect of government demand cut. We first discuss column (2): the effects of the government demand

cut then discuss column (3): the total effects.

Since the first column is nearly the same as the unfunded subsidy in the previous section, here we focus on the second and total columns.

JaTeng TCF sector (Table 5.6, column (2, 3))

Column (2), the effect of the government spending cut, shows that when government releases labour and capital, wages fall by 0.11% and capital rentals fall by 0.013%. Also, intermediate input cost falls by 0.012%. So, TCF output price falls by 0.025%. Then, output expands by 0.13%. In turn, export to ROW and to other regions expand by 0.14% and by 0.13%. Import from other regions only expands by 0.009% due to substitution toward local TCF (TCF produced and used locally increases by 0.13%).

Column (3), the total effect shows that TCF output grows by 6.1%. Government spending cut can be interpreted as a subsidy to TCF sector by reducing production cost. In comparison to the previous simulations, TCF domestic price under this policy falls by more, 1.14%. Consequently, TCF output, export to ROW and export to other regions all expand.

JaTeng macro results (Table 5.6, column (2))

Even though regional costs are decreasing, real household expenditure falls by 0.16%. This is because JaTeng labour income decreases [Note that aggregate employment falls by 0.084% and real wage falls by 0.092% and $0.084\% + 0.092\% \approx 0.16\%$]. In contrast, real investment grows by 0.052%, following a 0.05% growth in aggregate capital stock.

Since local prices decrease, export volumes increase by 0.44% (mainly to ROW) and import volumes fall by 0.065%. The changes in exports and imports causes the share of real trade balance in real GDP to grow by 0.016%.

Perhaps counterintuitively, the government cuts leads to a small GDP rise. This is because we follow a rule⁶ that the average real wage and a labour migration elasticity determine labour supply. If we apply an elasticity value of 3 (in this we used 1) real GDP shrinks by 0.045%.

Falling wages induce JaTeng price indexes to fall. For example the CPI falls by 0.017%, the export prices index by 0.016%, the investment price index by 0.013% and the government price index by 0.052%, and so the GDP price index falls by 0.040%.

⁶ $XLAB_IO(d) = AVEREALWAGE(d) \cdot I \cdot FLABSUP(d) \cdot LABSLACK$; where $AVEREALWAGE(d)$ =average real wage; I =labour migration elasticity; $XLAB_IO(d)$ =inter-regional labour migration or labour supply; $FLABSUP(d)$ =Labour migration shifter; $LABSLACK$ =Slack to allow aggregate employment constraint

Note that welfare cost of sacking government officers, for example teachers, are not captured by this experiment.

JaTeng macro results (Table 5.6, column (3))

Column (3), the total effect, shows that all spending (except government) expand: for example investment grows by 0.27%. JaTeng sucks in labour and capital— labour is up 0.12% and capital 0.28%. As a result, real GDP expands by 0.21%.

The export price index falls by 0.11%, but the CPI, only by 0.005%. This is because the share of JaTeng TCF for export is about as twice as much for households. This causes GDP price index to fall by 0.073%.

Since export price decreases, export volume increases by 0.73%. Again, import volume expands by 0.36% as a result from expanding in production (driven by TCF sector).

JaTeng sectoral output (Table 5.6, column (2, 3))

Column (2), the effect of government spending cut, shows that government services, hotel and restaurant, utilities and other services shrink because they released labours. On the other hand, other sectors employed more labours so they grow.

Tabel 5.6. Subsidy funded by reduction in local government demands (JaTeng results)				
Main Macro Variable	Description	(1) Efex of Subsidy = (3) - (2)	(2) Efex of gov cut	(3) Total
RealHou	Real Household Expenditure	0.416	-0.158	0.258
RealInv	Real Investment Expenditure	0.219	0.052	0.271
RealGov	Real Government Expenditure	0.408	-2.185	-1.777
ExpVol	Export Volume	0.283	0.444	0.728
Xdomexp_c	Export to other regions	0.262	0.093	0.355
Xdomimp_c	Import from other regions	0.377	-0.063	0.314
ImpVolUsed	Import Volume Used	0.424	-0.065	0.359
RealGDP	Real GDP	0.206	0.000	0.206
AggEmploy	Aggregate Employment	0.207	-0.084	0.124
AveRealWage	Average Real Wage	0.240	-0.092	0.149
AggCapStock	Aggregate Capital Stock	0.220	0.058	0.278
GDPPPI	Price GDP	-0.033	-0.040	-0.073
CPI	Consumer Price Index	0.012	-0.017	-0.005
ExportPI	Export Price Index	-0.097	-0.016	-0.113

TCF Sector Variables	Description	(1) Efex of Subsidy = (3) - (2)	(2) Efex of Consumer Fax	(3) Total
xexpsho("TCF")	Direct exports to ROW	5.546	0.144	5.690
xtot("TCF")	Industry output	5.973	0.129	6.101
plab_o("TCF")	Nominal wage	0.252	-0.108	0.144
xlab_o("TCF")	Employment	5.905	0.157	6.062
pcapsho("TCF")	Capital rentals	0.034	-0.013	0.021
xcap("TCF")	Capital	6.018	0.110	6.127
pint("TCF")	Intermediate cost	-0.236	-0.012	-0.247
pdom("TCF")	Domestic prices	-1.111	-0.025	-1.137
xdomexp("TCF")	Export to other regions	4.983	0.130	5.113
xdomimp("TCF")	Import from other regions	1.735	0.009	1.744
xdomloc("TCF")	TCF made and used locally	7.267	0.127	7.140
Sectoral Output	Description			
xtot("Agriculture")	Agriculture	-0.170	0.077	-0.093
xtot("Fishing")	Fishing	-0.160	0.070	-0.090
xtot("OilGas")	Oil and Gas	-0.023	0.020	-0.003
xtot("Mining")	Mining	-0.154	0.071	-0.083
xtot("FoodDrink")	Food and Drink	-0.351	0.153	-0.198
xtot("TCF")	Textiles, Clothing and Footwear	5.973	0.129	6.101
xtot("WoodPaper")	Wood and Paper	-0.232	0.050	-0.182
xtot("Chemicals")	Chemicals	-0.110	0.084	-0.025
xtot("LNG")	Liquid Natural Gases	0.000	0.000	0.000
xtot("BasicMetal")	Basic Metals	-0.174	0.091	-0.083
xtot("MachinElec")	Machines Electronics	-0.154	0.131	-0.022
xtot("OtherManuf")	Other Manufactures	-0.040	0.055	0.014
xtot("ElecGasWater")	Electricity, Gas, and Water	0.396	-0.064	0.331
xtot("Construction")	Construction	0.096	0.002	0.098
xtot("Trade")	Trade	0.065	0.098	0.163
xtot(" HotelRest")	Hotel and Restaurant	0.334	-0.142	0.192
xtot("Transport")	Transport	0.101	0.016	0.116
xtot("OtherServ")	Other Services	0.190	-0.107	0.083
xtot("GovSrvces")	Government Services	0.302	-1.061	-0.759

Column (3), the total effect, shows that all local sectors (except government services) grow but trade-exposed sectors (except TCF) shrink. The effect of the subsidy dominates the effect of the government cut except for government services.

5.6. Conclusion

In the long-run closure, the unfunded subsidy causes JaTeng TCF to become more

competitive at the expense of other tradeable sectors. JaTeng sucks in labour (from other regions) by 0.21% and capital by 0.22% (mainly from overseas). Real GDP grows by 0.21%. National GDP also grows by 0.001%.

A subsidy funded by a households tax also raised JaTeng GDP (by 0.11%), but by less than the unfunded subsidy. This is because the consumer tax weakens household demand. JaTeng wins the most, followed by DIY (a region surrounded by JaTeng). Other regions lose slightly because their workforce is moving to JaTeng and DIY, and because they become unattractive to investors.

Taxing industries to finance the subsidy causes capital to flee JaTeng (fall 0.12%). As a result real GDP shrinks by 0.054%. The reason is that the industry tax bears more heavily on capital, which is in elastic supply.

If the subsidy is funded by a reduction in local government demands, labour moves from government sectors to other more capital-intensive sectors especially tradeable sectors. Real government spending shrinks but other spending grows more than in the previous simulations. As a result, real GDP also grows by most, 0.206%, than the previous cases but sacking government officers is not captured by this experiment.

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