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This paper is from the
GTAP Annual Conference on Global Economic Analysis
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THE MONASH-MULTI-COUNTRY (MMC) MODEL AND THE INVESTMENT LIBERALISATION IN CHINA'S OIL INDUSTRY

by

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JEL classification: D58 F15 F21
Key words: China, oil industry, investment liberalisation, CGE modelling

Abstract

Computable general equilibrium models have been widely applied in analysing the effects of removing tariffs. However, not nearly as much effort has been devoted to their application on investment liberalisation that is increasingly an integral part of trade liberalisation agreements. The Monash-Multi-Country (MMC) model is developed to meet such policy needs. The MMC model is an advanced dynamic CGE model with bilateral investment flows between countries/regions modelled explicitly at an industry level. This paper describes the model structure and data of the MMC model. Its application is illustrated by a simulation of a potential investment liberalisation in China's oil industry. The MMC model has been used to analyse the effects of a bilateral free trade agreement between Australia and China.

Acronyms and Initials

CGE	Computable General Equilibrium
CoPS	Centre of Policy Studies
DFAT	Department of Foreign Affairs and Trade, Australia
FTA	Free Trade Agreement
GDP	Gross Domestic Product
GNE	Gross National Expenditure
GNP	Gross National Product
GTAP	Global Trade Analysis Project
MMC	Monash Multi-Country
MOFCOM	Ministry of Commerce, People's Republic of China
nec	not elsewhere classified
ROW	Rest Of the World
UNCTAD	United Nations Conference on Trade and Development
WTO	World Trade Organisation

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1. Introduction

The Monash-Multi-Country (MMC) model is an advanced dynamic Computable General Equilibrium (CGE) model of the Australian, Chinese and the Rest of the World (ROW) economies[1]. The MMC model contains economic linkages between industries and between economies. It can be used to analyse the effects of policy changes – such as a bilateral free trade agreement between Australia and China – on various industries and economies in the model[2]. It is a dynamic model in the sense that it captures the accumulation of physical capital, and foreign liabilities and assets over time. MMC also recognises bilateral investment flows between countries by sector and is useful in analyzing investment liberalization of a particular industry.

The MMC model was built in three stages. In the first stage, an existing comparative-static model of a single country – ORANI-G (see Horridge 2001 and Dixon et. al. 1982) – was transformed into a multi-country model by the addition of spatial-dimensions to all variables, equations and coefficients[3]. In the second stage, behavioural and accounting equations concerning international trade flows were added into MMC. In the third stage, capital supply and demand equations distinguishing capital from different sources (domestic and foreign countries/regions) were added. The dynamic mechanisms connecting expected rates of return to investment and connecting investment to capital are based on those used in the MONASH model (see Dixon and Rimmer 2002). MMC uses the GTAP database as the main source for input-output, trade and protection data (see Dimaranan and McDougall 2002 and Hertel 1997).

MMC is a system of non-linear equations. These are solved using GEMPACK, a suite of programs for implementing and solving economic models. A linear, differential version of the MMC equation system is specified in syntax similar to ordinary algebra. GEMPACK then solves the system of non-linear equations as an Initial Value problem,

[1] Version 2 of the MMC model has twelve economies: China, India, Indonesia, Thailand, Malaysia, the Philippines, Singapore, Australia, the Republic of Korea, Japan, the United States, and the Rest of the World region.

[2] The model was used in 2004 to analyse the potential benefits of an Australia-China free trade agreement for the feasibility study jointly conducted by the Australian Department of Foreign Affairs and Trade and Chinese Ministry of Commerce. It was also used in 2005 to analyse trade liberalisation scenarios for wool under an Australia-China free trade agreement for Australian Wool Innovation.

[3] This part of the work was done by Dr Mark Horridge.

using a standard method, such as Euler or midpoint. Details of the algorithms available in GEMPACK are given in Harrison and Pearson (1996).

This paper documents the model structure and database of the MMC model. Section 1 of this paper is this introduction. Section 2 provide a brief description of the core CGE structure of the MMC model (for a more detailed and technical description, see Horridge 2001; Dixon et. al. 1982). Section 3 describes the trade linkages between countries. Section 4 describes the capital market including both the dynamism and bilateral foreign investment by industry. Section 5 describes the database of the MMC model. Section 6 presents a business-as-usual scenario or baseline with which to compare any policy scenarios to be simulated. Section 7 illustrates how MMC can be used to simulate investment liberalization of a particular industry, the case of Chinese oil industry.

2. A description of the core CGE structure

The MMC model is a large system of linearised equations. The equations are mathematical representation of demand and supply conditions in goods, services and factor markets. The demand and supply equations are derived from the behaviour of various economic agents: producers, consumers, governments, exporters, importers, and investors. Such behaviour (described in more details below) determines the reaction of the economic agents to changes in relative prices and economic environment. The model assumes that all the goods, services and factor markets start from an equilibrium represented in the model database. A change in economic policy (such as a tariff reduction) or economic environment (such as a drought) leads to a new equilibrium in which demand equals to supply for all goods, services and factor markets. The model serves to calculate changes to equilibrium quantities and prices of goods, services and factors (and other economic indicators) caused by the change in economic policy or environment.

The model recognises up to 57 industries each produces a category of goods or services such as textiles, wearing apparel, and construction (Table 1). In each industry **producers** use 3 production factors (land, a combination of skilled and unskilled labour, and a combination of capital from different countries/regions) and up to 57 categories of (domestically produced and imported) goods and services as inputs to produce its output (Figure 1). In their production, producers mix material inputs and a combination of all production factors in fixed proportions. They determine the combination of production

factors according to the relative prices of the production factors. If labour becomes relatively more expensive than capital, producers substitute labour for capital. In determining their demand for material inputs and production factors, producers exhibit optimisation behaviour of minimising costs to produce a certain level of output. Once the level of a material input is determined, producers chose to buy the material input from domestic or foreign sources according to their relative prices. When tariff on textiles is reduced in China, clothing producers choose to use more imported textiles because it becomes less expensive relative to domestically produced textiles. Technological change happens when producers can produce the same level of output using less of one (or all) material input(s) or production factor(s). The output produced by each industry is sold either domestically or exported.

Consumers in the model purchase various categories of goods from different sources (imported or domestically produced). They consume a bundle of necessities and luxury goods. The luxury part of their consumption expands with their income. They exhibit optimisation behaviour in choosing their bundle of luxury consumption by maximising their utility subject to budget constraints. Consumers choose between imported and domestically produced goods according to their relative prices. When tariff on cars is reduced, consumers choose to buy more imported cars because it becomes less expensive relative to domestically produced cars.

Governments in the model collect direct and indirect taxes (including tariffs) and have budget expenditures. **Investors** minimise costs when they purchase various goods (imported and domestically produced) and services (mainly construction) for capital creation. Investors exhibit similar behaviours to producers and consumers in their purchasing choice of imported versus domestically produced goods.

3. Bilateral trade linkages

The model mechanism capturing bilateral trade linkages between economies is similar to that of the GTAP model (see Hetel 1997), except that producer's decision to supply domestic versus export market is related to the prices in domestic versus export market through a Constant Elasticity of Transformation (CET) function.

The demand for the composite[4] imports for each category of products is determined by the choice of economic agents (producers, consumers and investors). As discussed in section 2, producers, consumers and investors choose to use domestically produced and imported products according to their relative prices. Once the level of the composite imports for each category of products is determined, importers then choose which country/region to import from according to their relative prices (Figure 1). For example, if Australian wool becomes less expensive relative to wool produced in the ROW region due to a bilateral Free Trade Agreement (FTA) between China and Australia, importers in China will substitute ROW wool for Australian produced wool.

Linking the export supply and import demand is the international transport sector. The international transport sector provides transport and insurance for bilateral flows of goods between countries/regions, and, thus, adds margins between F.O.B. export prices and C.I.F. import prices. The model mechanism capturing the function of the international transport sector is based on that of the GTAP model (See Hetel 1997 for more details).

4. Capital market

The capital market dynamism allows the model to capture how the economies evolve from one year to another through accumulation of physical capital in each industry. A specific feature of MMC is that it distinguishes capital owned by residence of different countries/regions. Thus, the capital market dynamism also allows for the accounting of the accumulation of foreign assets and liabilities through ownership of capitals operating in foreign countries/regions.

4.1 Demand for capital

On the demand side, the demand for the composite capital is linked to relevant prices through a Constant Elasticity of Substitution (CES) function (Equation E_capt in Box 1). This CES function determines the substitution between the composite capital, the composite labour[5] and land/resource. The composite capital is composed of a bundle of capital owned by residents of different countries/regions. Equation *E_capt* (Box 1) allows

[4] The composite imports of a category of products are composed of a bundle of the category of products imported from different countries/regions, such as the total imports of automobile composed of automobile imported from different countries/regions.

[5] The composite labour is composed of skilled and unskilled labour.

demand for composite capital to respond to changes to relative prices, but also to other factors such as technological evolvement that affects capital/labour ratio given a set of relative prices of primary factors. When calibrate the model to a period of historical data, the variable *twistcap* (Box1) captures changes in capital/labour ratio that can not be explained by changes in relative prices.

The bundle of capital owned by different countries/regions is determined by another CES function linking demand for capital owned by a specific country/region to relevant prices (Equation *E_capts* in Box 2). A faster growth in the rental price of capital owned by one country/region relative to the effective price of composite capital leads to a slower growth in the demand for the capital owned by that country/region.

Again, Equation *E_capts* (Box 2) allows model to explain or simulate changes in the ratio of foreign versus domestic capital in a particular industry that can not be explained by changes in relative prices (see variable *twistcaps* in Box 2). One such change occurred in China's oil industry when the government sold a significant part of its shares to foreigners in 2000. The change itself was part of China's economic reform process and can not be explained only by changes in relative rental prices.

4.2 Supply of capital

On the supply side, the capital stock available at the end of the year equals to capital stock at the beginning of the year minus depreciation plus investment occurred in the current year. Investment in the current year is determined by an equation linking capital growth with expected rate of return on capital (Equation *E_x2tots* Box 3). In Equation *E_x2tots*, expected rates of return are linked to the growth of capital stocks through inverse logistic functions (Figure 2). In the current version of the MMC model, I assumed static expectation. Under static expectations, investors only take account of current rentals and asset prices when forming current expectations about rates of return (for a more detailed deduction of actual and expected rates of return, see Dixon and Maureen 2002).

Notice that there is a supply curve for capital owned by each country/region that is operating in each industry of each hosting country/region. The accounting of the accumulation of capital stock owned by different countries/regions allows foreign owned capital be counted as foreign liabilities and capital operating in foreign countries/regions

be counted as foreign assets. This allows returns on capital operating in foreign countries/regions be added into the calculation of the Gross National Product (GNP) and returns on foreign-owned capital be subtracted from GNP. The model is therefore able to calculate the welfare effects of investment liberalization more accurately.

5. Database

MMC uses the GTAP database (Dimaranan and McDougall 2002) as the main source for input-output, trade and protection data. Additional data are required for the capital market modeling, in particular, the share of bilateral capital stock by industry and the share of bilateral investment by industry. The major sources of the bilateral investment data used for the MMC model are the Australian Department of Foreign Affairs and Trade (DFAT), Chinese Ministry of Commerce (MOFCOM), China statistical yearbook, the Australian Bureau of Statistics, the World Bank, and the United Nations Conference on Trade and Development (UNCTAD). More specifically,

- Table 2 presents the total inward FDI into China from 1997 to 2001 provided by MOFCOM;
- Table 3 presents total value of inward and outward foreign investment for Australia provided by DFAT;
- Australian inward and outward foreign investment by sector is available from database provided by the Australian Bureau of Statistics;
- The 2004 *World Investment Report* published by UNCTAD provides the level and a profile of China's outward FDI; and
- The above sources are supplemented by information on specific industries, such as company annual reports in China's oil and gas industry.

Limited data is available on China's outward FDI. According to UNCTAD (2004), China's FDI outward flows increased from US$450 million in the 1980s to US$2.3 billion in the 1990s, and FDI outward stock increased from US$15.8 billion in 1995 to US$37 billion in 2003. Hong Kong and the United States accounted for more than half of approved Chinese outward FDI. The bulk of Chinese outward FDI flows to resource and property assets.

6. A business-as-usual projection

The dynamic aspect of the model enables us to analyse the effects of a policy change under a growth perspective. Under this perspective, the effects of a policy change are viewed as a change in the way the economies evolve into the future. This is achieved by producing a business-as-usual scenario from 1997 (the year of the model database) to a future year (2015 in this study). The business-as-usual scenario contains our view on what would happen to 2015 without the policy changes. It forms a bench mark with which we compare the growth path of the economies with the policy changes implemented (Figure 3).

In other words, under a dynamic perspective, the effects of a policy change depend on how the economies evolve into the future. For example, for an industry with a shrinking output, a negative policy impact on the industry means negative growth in output. However, for a rapidly expanding industry in the business-as-usual situation, a negative policy impact could merely mean a slower rate of positive growth rather than a negative growth in the level of output.

The business-as-usual scenario is obtained by simulating year-to-year changes happened from 1997 to 2015 to the three economies in the model, such as, growth of macroeconomic indicators, industry output, employment, and trade. This is made possible through the dynamic mechanisms described in Section 4.

The modelling starts from a database comprising a snapshot in 1997 of the economic structures of various economies in the model and the economic linkages between them. In the simulation of the business-as-usual scenarios, we inform the model how the Australian, Chinese and the Rest of the World (ROW) economies evolved from 1997 to 2005 using historical and forecast data. The main sources of the historical and forecast data are Access Economics (a private consulting firm located in Australia), the Australian Bureau of Statistics, the World Bank, the International Monetary Fund, Economist Intelligence Unit, the United Nation, the China National Bureau of Statistics, and the Chinese Academy of Social Sciences. More detailed industry data is used to formulate the baseline in the analysis of issues related to a specific industry. For example, data from the Australian Bureau of Agricultural and Resource Economics, Chinese Ministry of Agriculture, and Wool Mark Company can be used in the baseline simulation when the

model is used to analyse the effects of liberalising wool trade between Australia and China.

From 2005 to 2015, we use the forecast data, plus information obtained from our own simulation of history, to formulate the business-as-usual scenario. The growth rates of key economic and trade indicators in the baseline, expressed as average annual growth rates between 2005 and 2015, are presented in Tables 4. These indicators include real GDP, consumption, investment, exports and imports, and industry output. The features of the business-as-usual scenario include:

- Rapid growth in Chinese real GDP at a rate twice that of Australia's real GDP;
- Growth in trade volumes in both countries in excess of growth in real GDP; and
- Continued shifts from manufacturing to services in Australia and declining shares of agriculture and mining in Chinese real GDP.

I assume that real GDP of ROW grows at an average annual rate of 2.4 per cent between 2005 and 2015.

7. Simulating investment liberalisation in China's oil industry

There are two ways to simulate investment liberalisation using the MMC model. Investment facilitation measures, such as more transparent rules and regulations and simplified foreign investment screening procedures, can be simulated as reductions in required rates of return that encourages investment flows between countries (Figure 4).

However, such is not the case in China's petroleum industry where the government decided to partially privatise state-owned oil giants to improve their business performance (for details see Mai 2002). The policy move was to build internationally competitive oil companies. In this case, the investment liberalisation can be considered as a shift in China's preference for imported versus domestic capital. In this paper, a hypothetical simulation is formulated to demonstrate how MMC can be used to analyse investment liberalisation of this nature.

The simulation is implemented by reducing the variable *twistcaps* for Chinese up-stream and down-stream petroleum industries in Equation E_capts (Box 2) by 30 per cent annually from 2006 to 2008. One-percentage-point reduction in *twistcaps* means that the industry's technology/preference changed so that at any given ratio of the rental rates on

foreign to domestic capital, the industry would choose one-percentage-point higher foreign to domestic capital ratio (Equation E_capts).

An inflow of foreign investment brings in more advanced technology and management and, therefore, improves productivity in the liberalising countries. Productivity improvements associated with investment liberalisation have been empirically estimated using historical Chinese data (Mai et. al. 2003). In this study, I assumed that the shift in the preference for imported versus domestic capital is accompanied by two percentage point improvement in productivity annually from 2007 to 2009 (with one year lag).

Another benefit of foreign investment is bringing market and improved output design and quality. This effect can be captured by a shift in buyer's preference in favour of the liberalising country. However, this effect is not simulated in this study.

8. Effects of investment liberalisation in China's oil industry

The simulated effects of the investment liberalisation in China's oil industry are presented in Tables 5 to 7. The simulated policy change lead to an increase in the share of foreign capital in China's oil industry from 10 to 20 per cent with a total inflow of about 15 billion US dollars.

Although the inflow of foreign capital is quite significant, the inflow of capital itself does not bring much benefit in terms of both macro and industry effects (column 1 in Tables 6 and 7). This is because foreign investment accounts for a very small percentage of total gross fixed capital formation in China.

With improved productivity, however, the effects of investment liberalisation become much more dramatic (column 2 in Tables 6 and 7). The benefit of foreign capital, therefore, lies with its potential in bringing in advanced technology and improved management.

References

Dimaranan, B. V. and McDougall, R. A. (2002) *Global Trade, Assistance, and Production: The GTAP 5 Data Base*, Centre for Global Trade Analysis, Purdue University.

Dixon, P.B., Parmenter, B.R., Sutton, J., and Vincent, D.P., (1982) *ORANI: A Multisectoral Model of the Australian Economy*, North-Holland, Amsterdam.

Dixon, P.B. and M.T. Rimmer (2002), *Dynamic General Equilibrium Modelling for Forecasting and Policy: a Practical Guide and Documentation of MONASH*, North-Holland Publishing Company, Amsterdam.

Hertel, Thomas W. (editor) 1997. *Global Trade Analysis: Modeling and Applications*, New York: Cambridge University Press.

Horridge, M. (2001) 'ORANI-G: A General Equilibrium Model of the Australian Economy', Edition prepared for the Yogyakarta CGE Training Course, Centre of Policy Studies, Monash University.

Harrison,W.J. and K.R.Pearson (1996) 'Computing Solutions to Large General Equilibrium Models Using GEMPACK', *Computational Economics,* Vol 9 pp.87-127.

Mai, Y., Mark Horridge, and Frances Perkins, (2003) 'Estimating the Effects of China's accession to the World Trade Organisation', paper presented at the 6th Annual Conference on Global Economic Analysis June 12-14 2003, Scheveningen, The Hague, The Netherlands.

Mai, Y., (2002) "The Petroleum Sector After China's Entry Into the WTO" *China Perspectives, No. 41 pp.24-32.*

UNCTAD (2004) *World Investment Report 2004: The Shift Towards Services*, United Nations, New York and Geneva.

Table 1. Complete list of MMC industries*

1	paddy rice	30	wood products
2	Wheat	31	paper products, publishing
3	cereal grains nec	32	petroleum, coal products
4	vegetables,fruit,nuts	33	chemical, rubber, plastic prods
5	oil seeds	34	mineral products nec
6	sugar cane, sugar beet	35	ferrous metals
7	plant-based fibers	36	metal nec
8	crops nec	37	metal products
9	cattle,sheep,goats,horses	38	motor vehicles and parts
10	animal products nec	39	transport equiqment nec
11	raw milk	40	electronic equipment
12	wool,silk-worm cocoons	41	machinery and equipment nec
13	Forestry	42	miscellaneous manufactures
14	Fishing	43	electricity
15	Coal	44	gas manufacture, distribution
16	oil	45	water
17	Gas	46	construction
18	minerals nec	47	Trade
19	meat:cattle,sheep,goats,horse	48	transport nec
20	meat products nec	49	sea transport
21	vegetable oils and fats	50	air transport
22	dairy products	51	communication
23	processed rice	52	financial services nec
24	sugar	53	insurance
25	food products nec	54	business services nec
26	beverages and tobacco products	55	recreation and other services
27	Textiles	56	pubadmin/defence/health/educat
28	wearing apparel	57	dwellings
29	leather products		

* The industry classification reported here is identical to the classification used for version 5 of the GTAP database (see Dimaranan and McDougall, 2002). The term “nec” means not elsewhere classified.

Table 2. China: inward FDI (actual used values), 1997-2001, US$ mn

	From Australia	From the world
TOTAL	**747**	**218630**
Agriculture, forestry and fishing	**36**	**3536**
Agriculture	10	1669
Mining	**18**	**3470**
Oil and gas exploration and production	n.a.	1323
Manufacturing	**469**	**133057**
Textiles and clothing	29	8043
Chemical raw materials and products	34	9323
Medicine	21	2951
General machinery and equipments	9	4302
Special machinery and equipments	15	2329
Telecommunication equipments incl. computers	19	19923
Electricity, gas and water	**32**	**13392**
Construction	**22**	**6131**
Transportation, storage and postal services	**6**	**6772**
Computer software and services	**3**	**n.a.**
Wholesale and retail	**8**	**5575**
Hotel and restaurants	**66**	**n.a.**
Tourism hotels	50	2655
Banking	**n.a.**	**249**
Real estate	**28**	**26961**
Real estate development and management	26	23404
Hiring and business services	**20**	**5865**
Research and technology	**16**	**381**
Water, environment and public infrastructure	**10**	**n.a.**
Personal and other services	**3**	**12282**
Education	**n.a.**	**293**
Health and social welfare services	**n.a.**	**665**
Cultural, sports and entertainment services	**11**	**n.a.**

n.a. not available.
Source: MOFCOM.

Table 3. Australia: level of foreign investment at 30 June, A$ million

	China	World
Australain investment abroad		
1996-97	1014	221545
1997-98	1773	290293
1998-99	2053	313359
1999-00	1636	410484
2000-01	1870	462154
2001-02	1524	458766
2002-03	1190	461364
Foreign investment in Australia		
1996-97	1221	511700
1997-98	2345	587231
1998-99	2553	635014
1999-00	3374	736989
2000-01	3357	823187
2001-02	2929	844505
2002-03	2236	904384

Source: DFAT.

Table 4. Baseline: average annual growth rates, per cent

	Australia		China	
	1997-2015	2005-2015	1997-2015	2005-2015
Macroeconomic indicators				
Real GDP	3.6	3.3	7.2	6.7
Real Consumption	3.6	3.4	6.0	5.8
Real Investment	3.8	2.9	7.5	6.6
Export volumes	3.5	3.9	10.1	9.2
Import volumes	4.2	3.7	9.0	8.2
Output of aggregated sectors				
Agriculture	2.2	2.4	2.9	2.6
Mining	3.1	3.2	7.0	6.3
Manufacturing	2.2	2.1	8.0	7.4
Services	3.7	3.4	7.3	6.7

Source: baseline simulation.

Table 5. A simulated investment liberalization in China's petroleum industry from 2006 to 2008

	Shares of foreign capital before the simulated liberalisation	Share of foreign capital after the simulated liberalisation	Total value of the simulated increase in foreign capital in 2005 dollars
	(%)	(%)	(US$billion)
Up-stream activities	7	16	7.8
Down-stream activities	14	27	6.8
All activities	10	20	14.7

Table 6. Investment liberalization in China's petroleum industry: macroeconomic effects,

Percentage deviation from baseline in 2015, per cent

	Capital inflow only	Capital inflow plus productivity improvement
Real GDP	0.06	0.34
Capital	0.10	0.31
Labour	0.04	0.20
Productivity	0.00	0.12
Real GNP	-0.01	0.24
Real Consumption	0.00	0.26
Real depreciation	0.05	0.14
Export volumes	0.09	0.43
Import volumes	0.00	0.09

Source: policy simulation.

Table 7. Investment liberalization in China's petroleum industry: effects on industry output

Percentage deviation from baseline in 2015, per cent

	Capital inflow only	Capital inflow plus productivity improvement
Up-stream activities	0.93	6.10
Down-stream activities	0.17	1.02

Source: policy simulation.

Figure 1. The MMC Input-Output Structure

		Absorption Matrix					
		1		2	3	4	5
		Prod-ucers	Mixer	Invest-ors	House-holds	Exports	Govern-ment
	Size	← *I* →	←*C*→	← 1 →	← 1 →	←R+1→	← 1 →
Domestic output for domestic market	↑ *C* ↓	V1BAS (dom)		V2BAS (dom)	V3BAS (dom)		V5BAS (dom)
Domestic output for exports	↑ *C* ↓					VXMD	
Composite imports	↑ *R* ↓	V1BAS (imp)		V2BAS (imp)	V3BAS (imp)		V5BAS (imp)
Imports by source	↑ *R* ↓		VXWD				
Margins on imports	↑ *R*×*M* ↓		VTMFSD				
Tariffs	↑ *R* ↓		V0TARS				
Taxes on domestic products	↑ *C* ↓	V1TAX (dom)		V2TAX (dom)	V3TAX (dom)		
Taxes on exports	↑ *C* ↓					V4TAXD	
Taxes on composite imports	↑ *C* ↓	V1TAX (imp)		V2TAX (imp)	V3TAX (imp)		
Labour	↑ *O* ↓	V1LAB					
Capital	↑ R ↓	V1CAP					
Land	↑ 1 ↓	V1LND					
Other Costs	↑ 1 ↓	V1OCT					

C = Number of commodities
I = Number of industries
S = 2; domestic and imported
R = Number of country/regions
O = Number of occupations
M = Number of margins on imports

Size	Joint Production Matrix ← *I* →
↑ C ↓	MAKE

Figure 2. The shape of capital supply curves

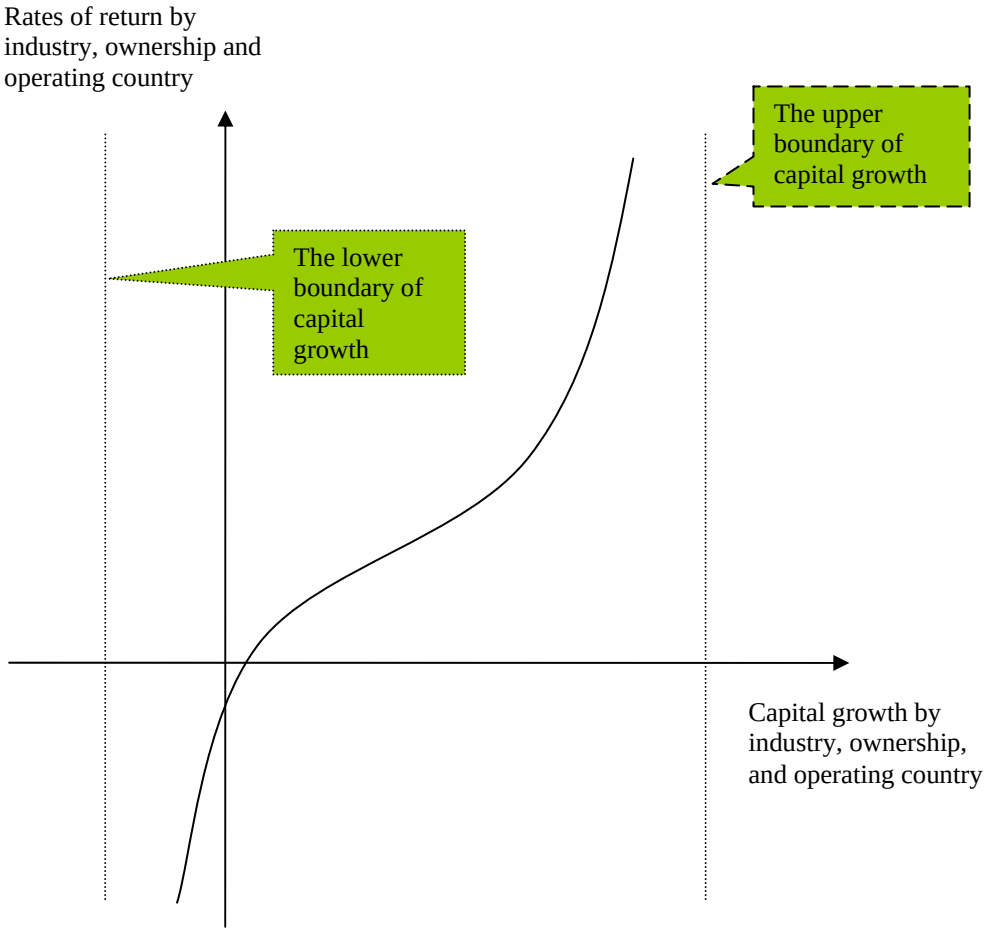


Figure 3. History, baseline forecasts and policy simulations

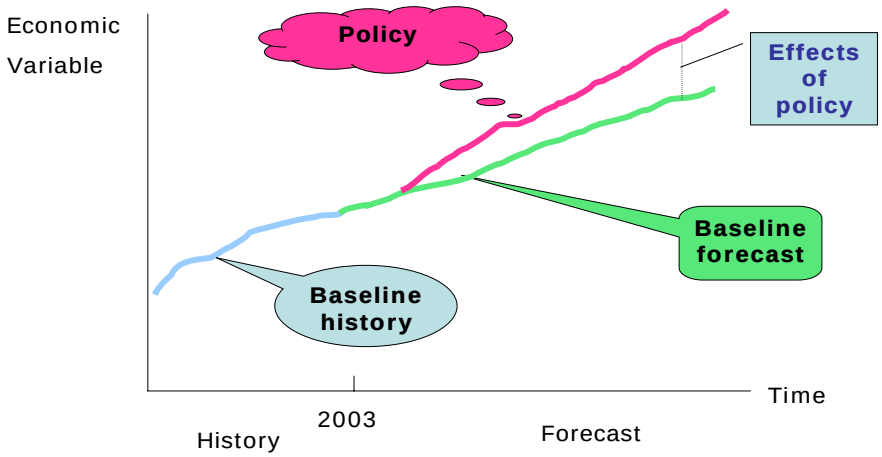
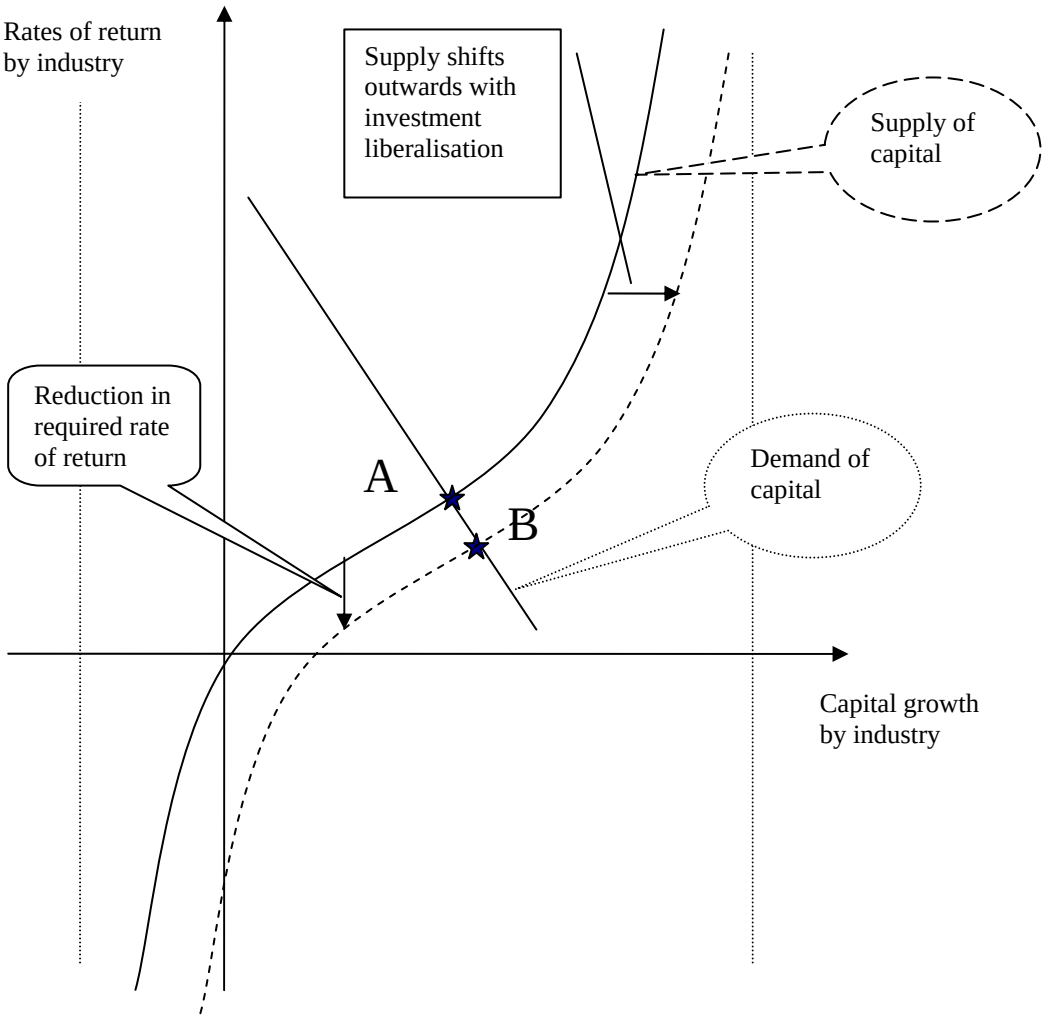
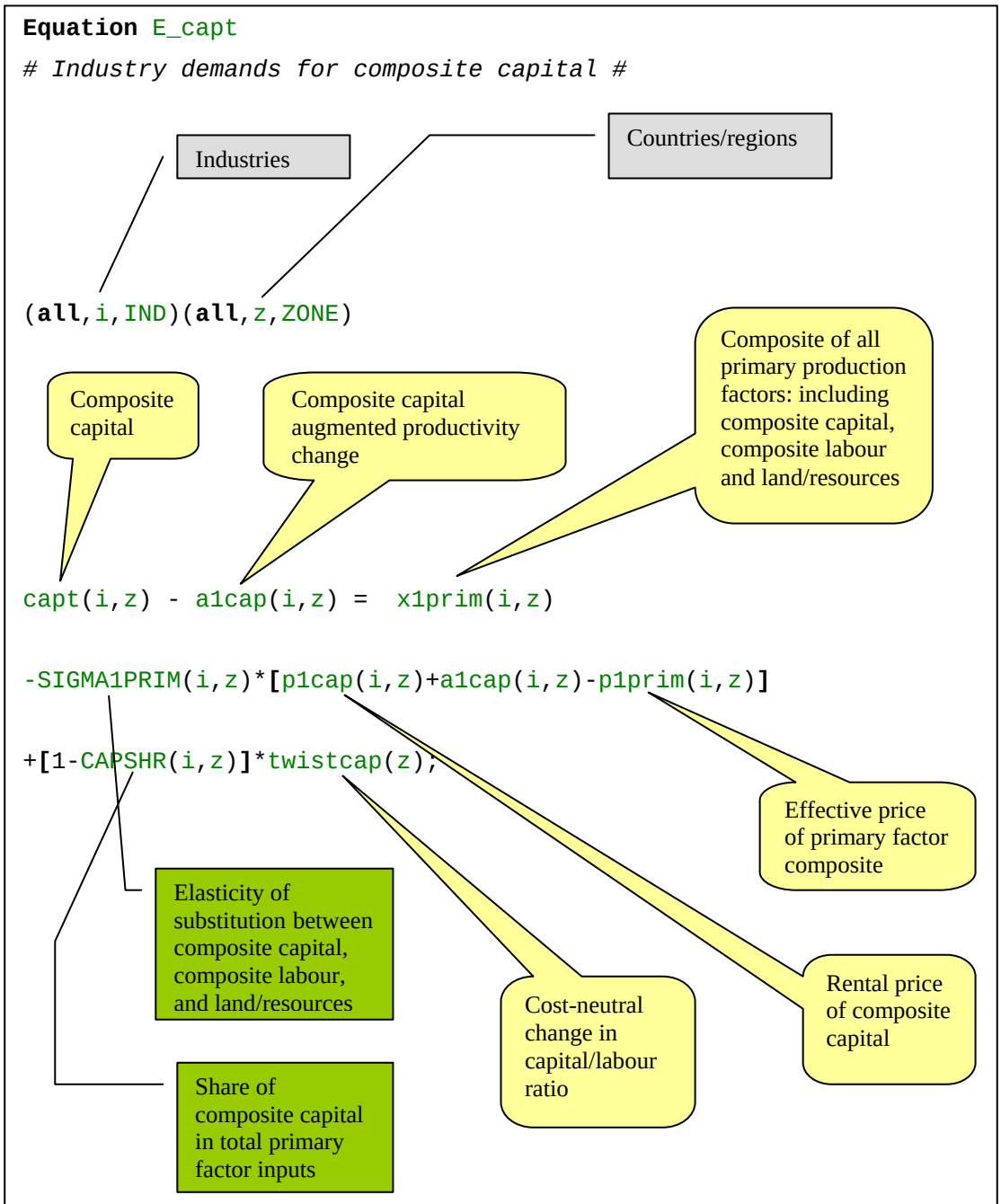


Figure 4. Simulating investment facilitation measures



Box 1. Demand for composite capital by industry

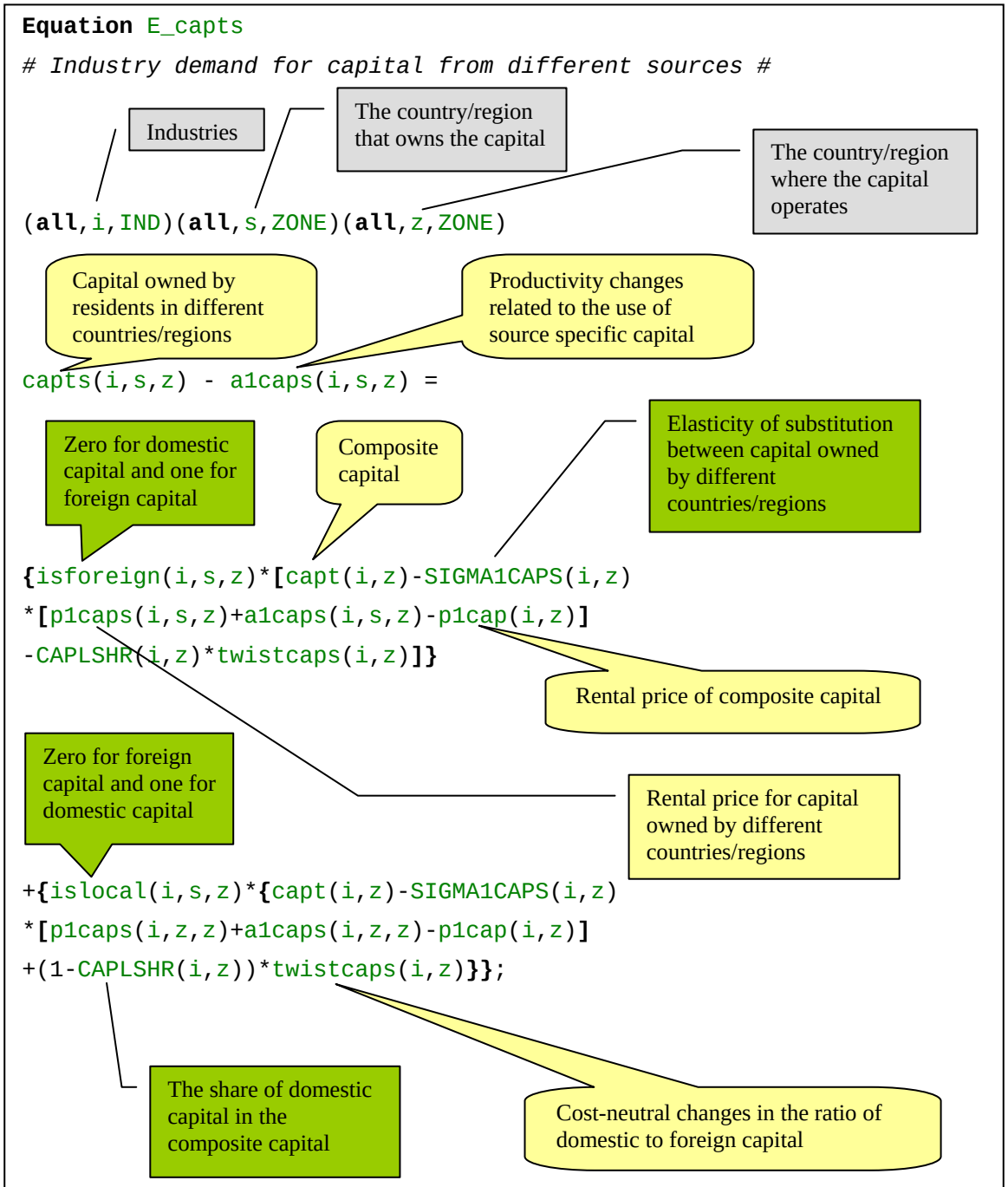


Notes:

The equation says that a faster growth in the rental price of composite capital relative to the effective price of primary factor composite leads to a slower growth in the demand for the composite capital.

The cost neutral change in capital/labour ratio captures the technological or preference changes in capital/labour ratio due to factors other than changes in relative prices.

Box 2. Demand for capital owned by different countries/regions

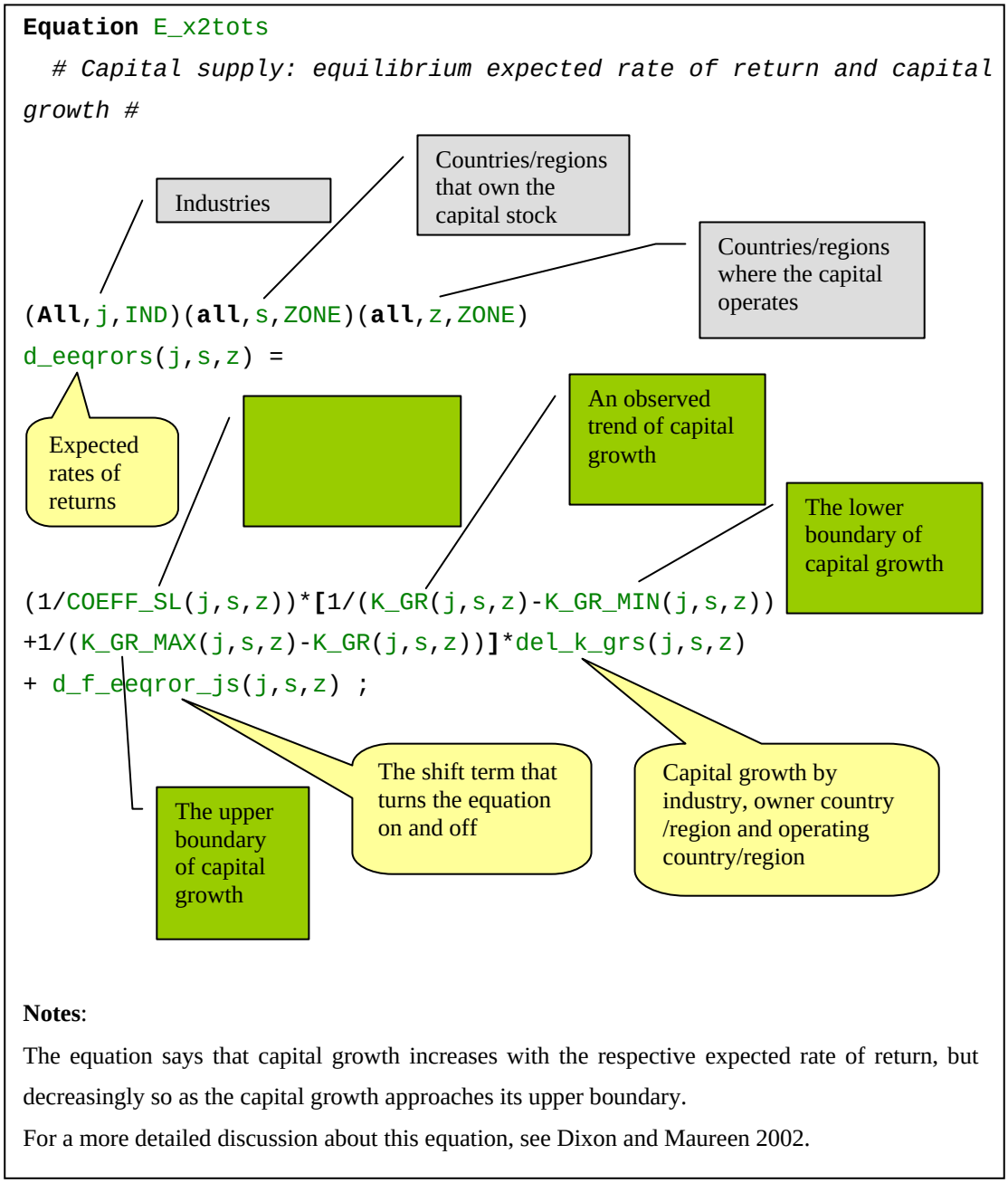


Notes:

The equation says that a faster growth in the rental price of capital owned by one country/region relative to the effective price of composite capital leads to a slower growth in the demand for the capital from that country/region.

The cost neutral change in the ratio of domestic to foreign capital captures the changes in the ratio due to factors other than changes in relative prices, such as due to technological or preference changes.

Box 3. Supply of capital by source and industry



Notes:

The equation says that capital growth increases with the respective expected rate of return, but decreasingly so as the capital growth approaches its upper boundary.

For a more detailed discussion about this equation, see Dixon and Maureen 2002.