The use of multi-country multi sector CGE and a technical description of MIRAGRODEP/MIRAGE

Antoine Bouet and David Laborde
IFPRI, 12/15/2012

Introductory remarks

- **Structure of the presentation**
- A. Introductory remarks
- B. Why using a multi-country CGE?
- C. Model Closure and Numeraire
- D. Trade Policy issues
- E. A case study
- F. Main features of MIRAGE
- G. Technical description of the standard framework
- H. Specificities
- I. Recent extensions

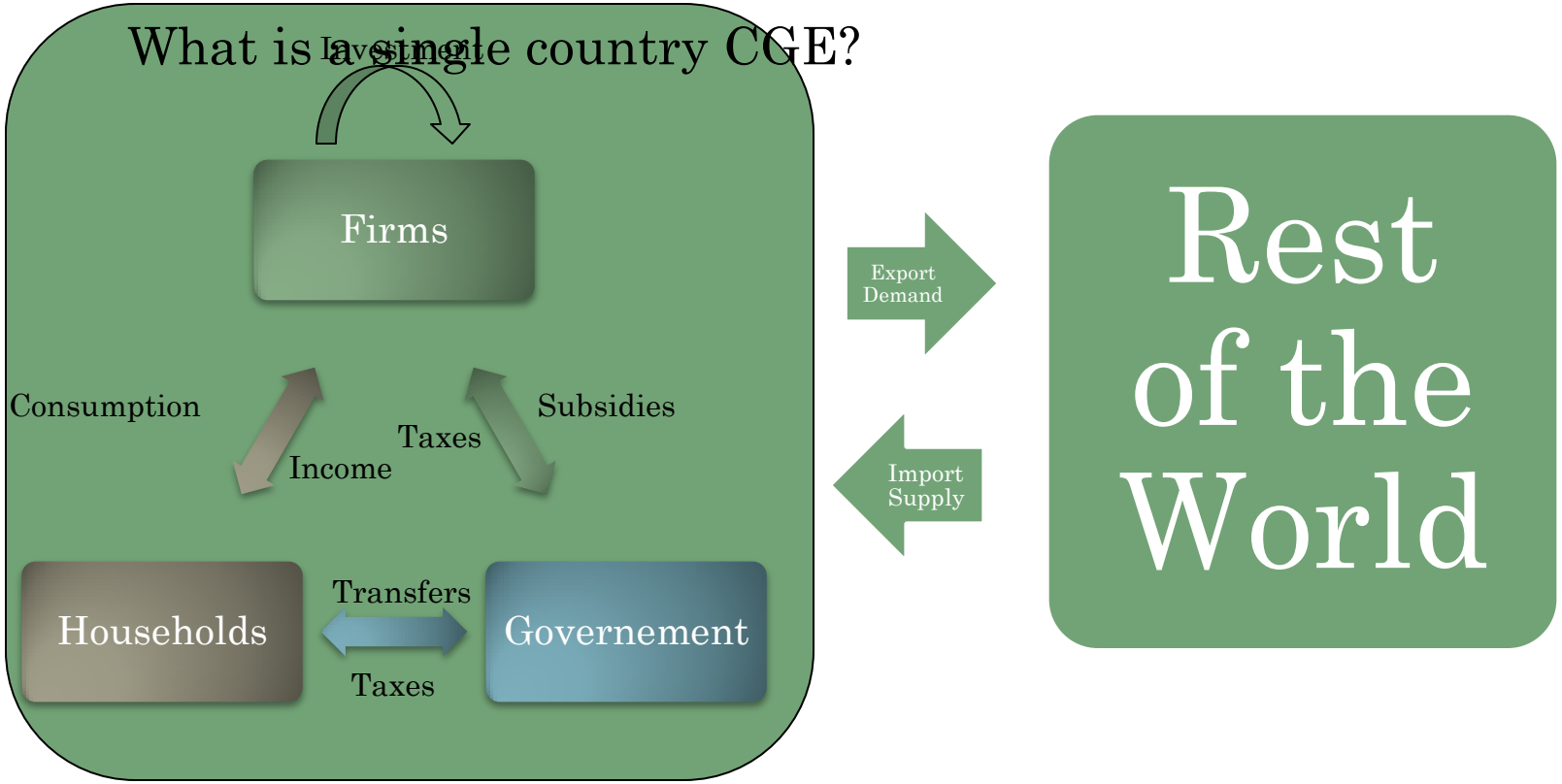
INTRODUCTORY REMARKS

- ***MIRAGRODEP:***
  - FROM "MIRAGE" AND"AGRODEP"
- ***Derived from***: MIRAGE = MODELLING INTERNATIONAL RELATIONS UNDER APPLIED GENERAL EQUILIBRIUM
- ***Model type***: Multi country, multi sector dynamic CGE
- ***Participating modelers***: Hedi Bchir, Antoine Bouet, Yvan Decreux, Jean Foure, Christophe Gouel, David Laborde, Cristina Mitaritonna, Priscilla Ramos, Hugo Valin

Introductory remarks

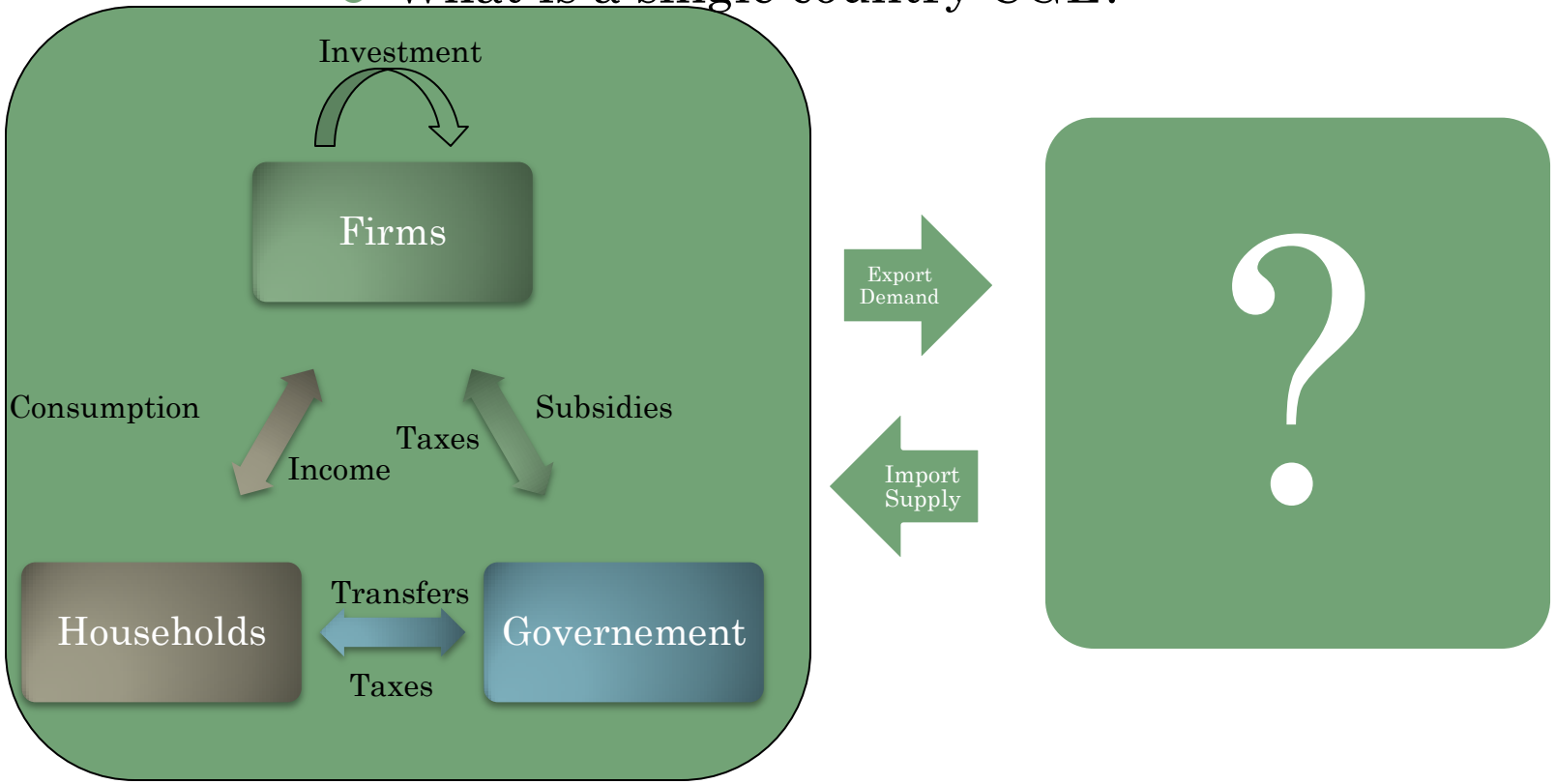
- MIRAGE
  - A computable general equilibrium model
    - Interdependence of market equilibria
    - Example: the product market and the factor market
    - Real income effects are taken into account
    - Walras's law
  - Multi-region, multi-sector
  - Initially devoted to trade policy analysis
    - Multilateral agreements/Regional Agreements/Preferenti Agreements
    - Export taxes, trade facilitation, ..
  - New topics: biofuels/poverty

Why using a multi-country CGE?



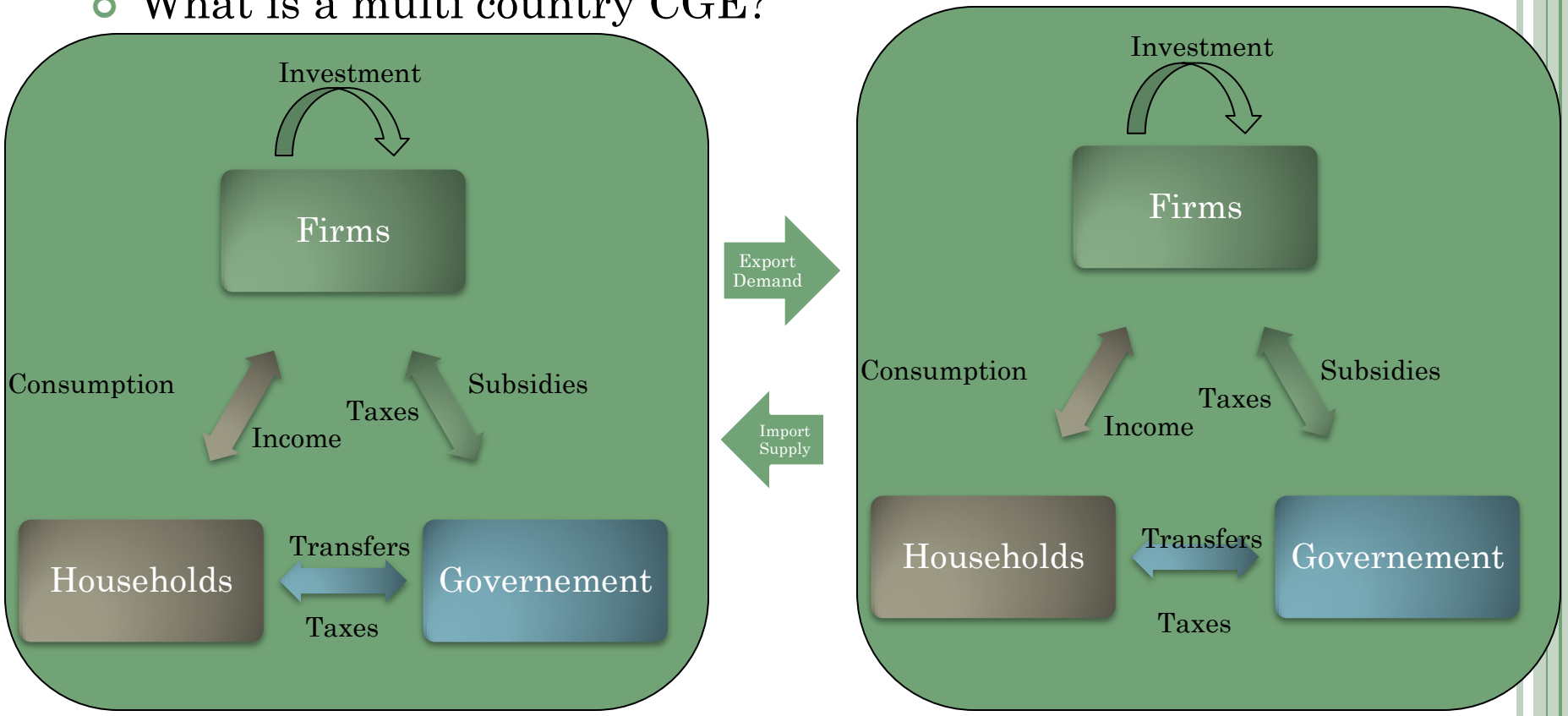
WHY USING A MULTI-COUNTRY CGE?

- What is a single country CGE?



WHY USING A MULTI-COUNTRY CGE?

- What is a multi country CGE?



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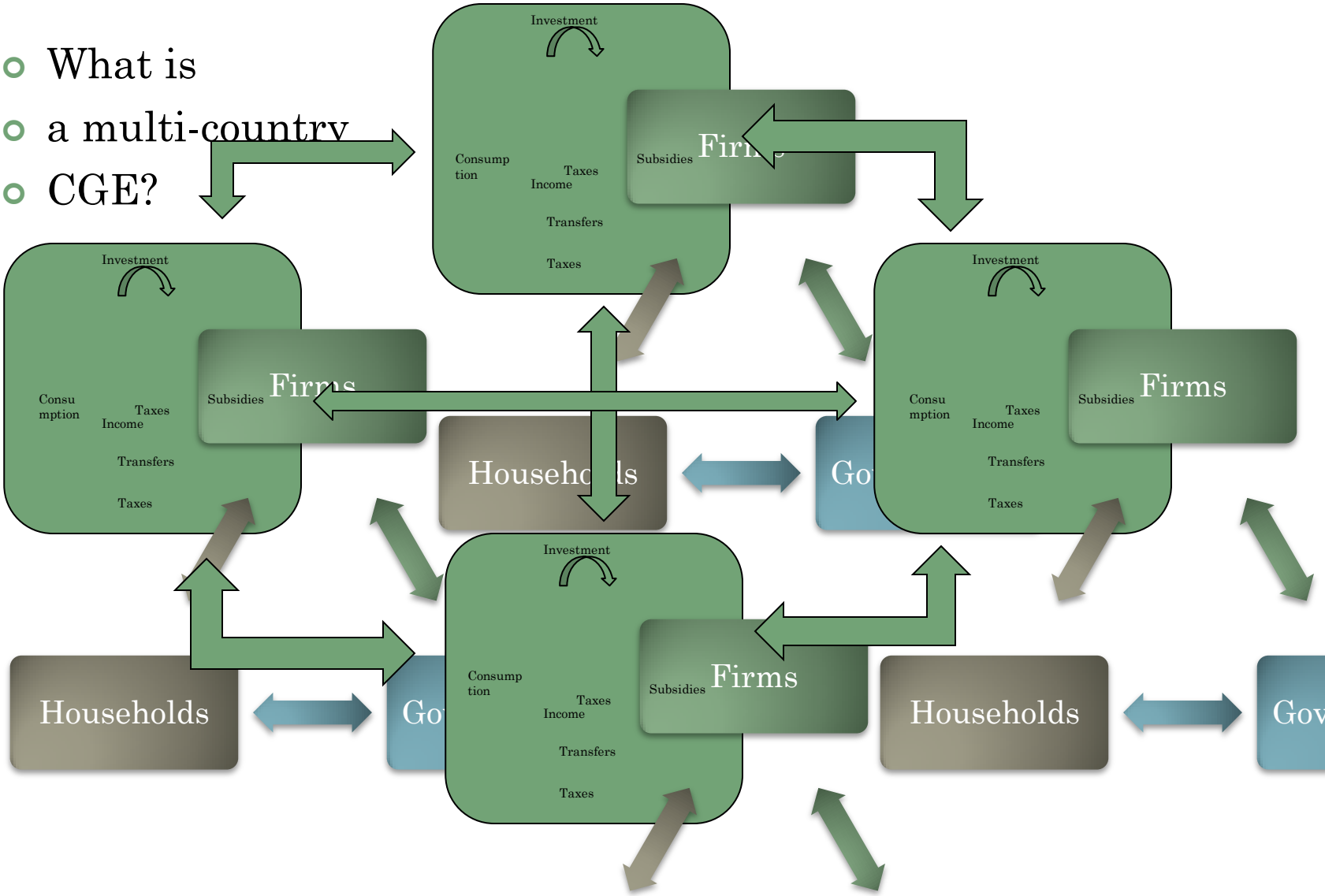
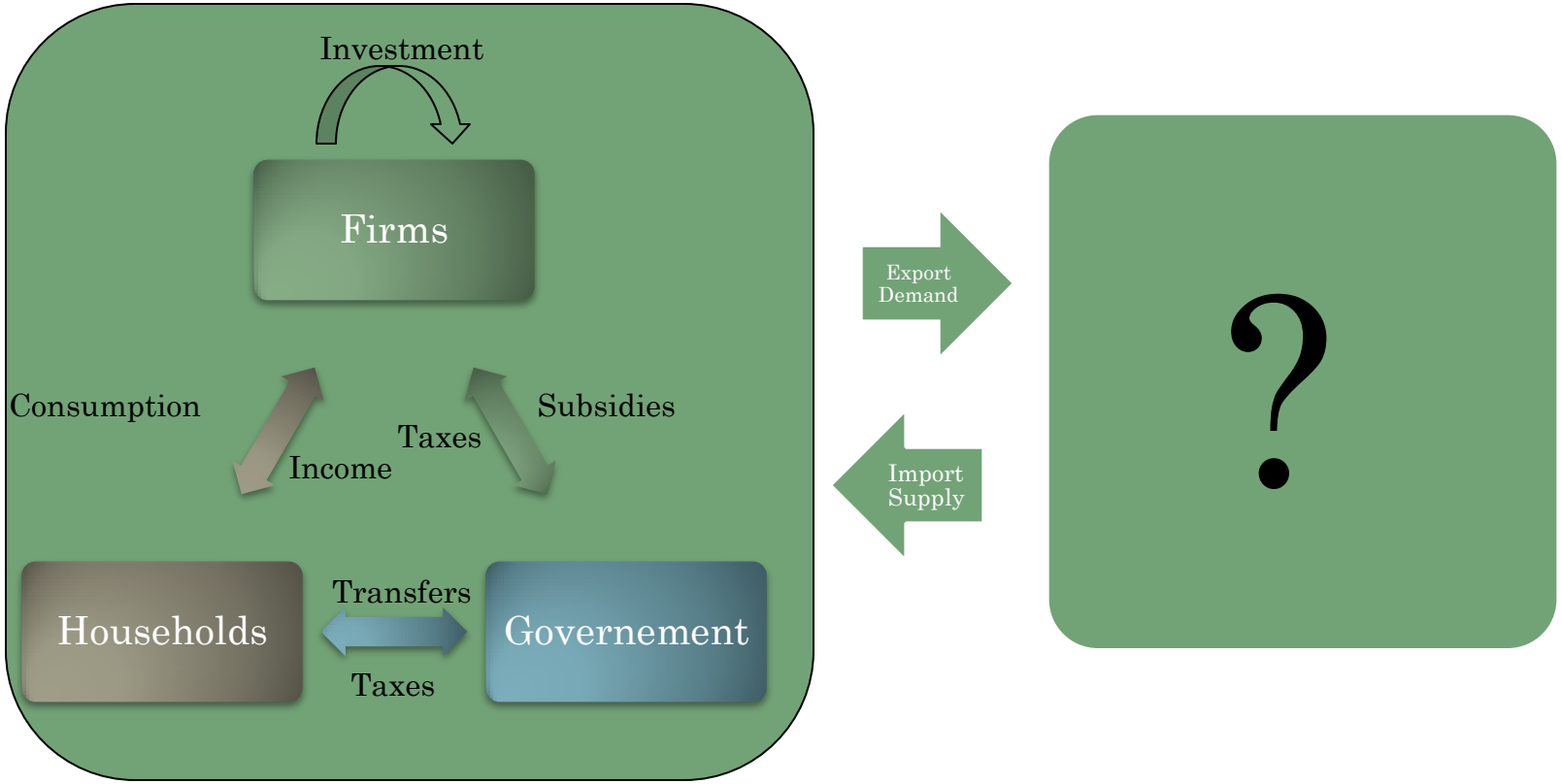
WHY USING A MULTI-COUNTRY CGE?

- What is
- a multi-country
- CGE?



WHY USING A MULTI-COUNTRY CGE?

- What happens in case of a shock? (unilateral lib'n e.g.)



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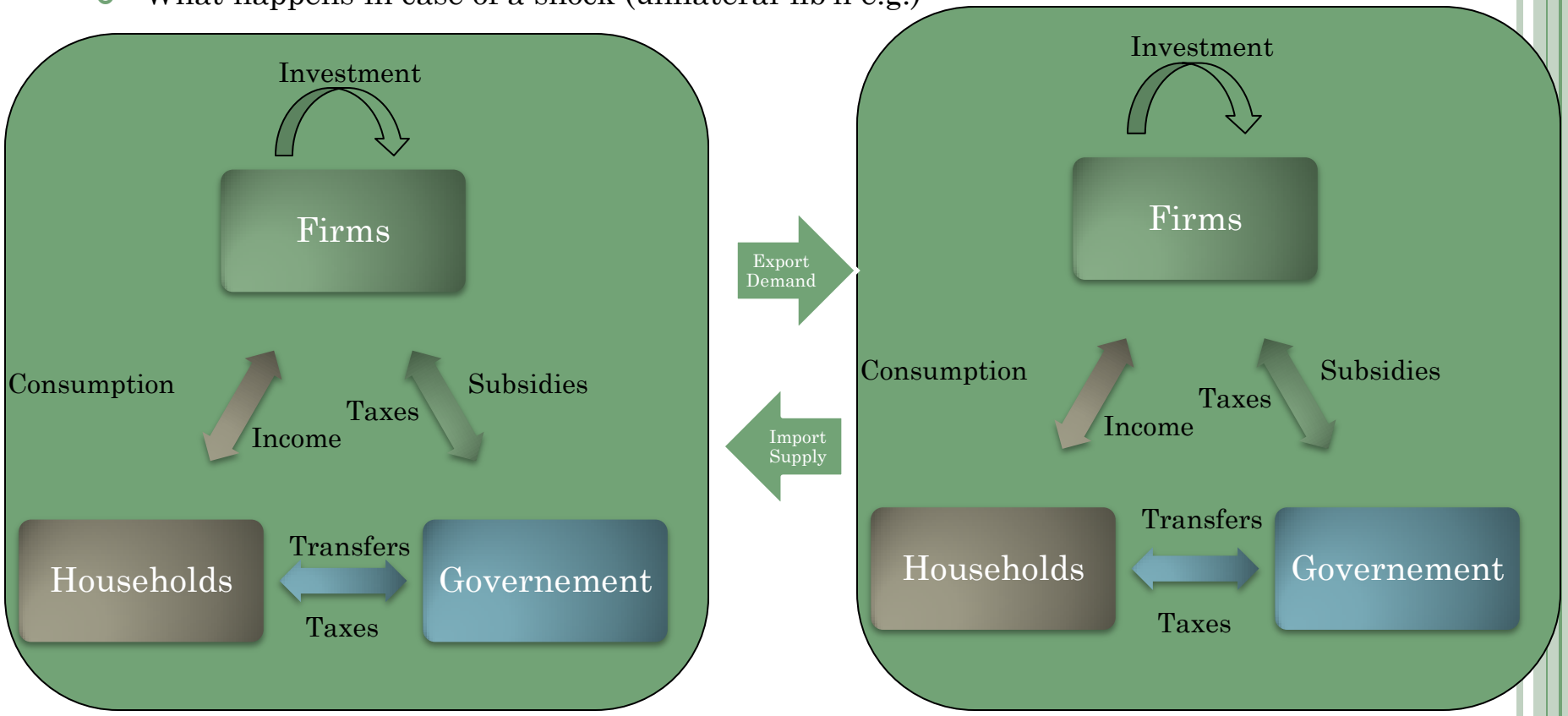
WHY USING A MULTI-COUNTRY CGE?

- What happens in case of a shock (unilateral lib'n e.g.)



WHY USING A MULTI-COUNTRY CGE?

- Multi-Country multi-sector CGE allows a detailed and consistent representation of the rest of the world…
- … which is no more a Black Box
- It captures international economic linkages through the international trade of goods and services.
- It captures impact of domestic reform on foreign countries and feedback impact on domestic economy.
- It captures a multilateral liberalization reform or a regional agreement reform

WHY USING A MULTI-COUNTRY CGE?

- It gives information not only on:
  - Production(i,"xxx"),
  - Exports(i,"xxx"),
  - Imports(i,"xxx"),
  - Final Consumption(i,"xxx"), ….
- It also gives information on
  - Production(i,r),
  - Exports(i,r),
  - Imports(i,r),
  - Final Consumption(i,r), ….
- And Exports(i,r,s), imports(i,r,s), …

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WHY USING A MULTI-COUNTRY CGE?

- The cost of adopting a multi-country CGE: increased complexity.
  - Let us suppose 24 sectors (and 24 regions).
  - Single country:
    - 24 export equations and 24 import equations = 48 equations.
  - Multi country:
  - 24*23*24=13,248 export equations and 13,248 import equations = 26,496 equations !!
- The number of equations increases exponentially with the number of countries and sectors.
  - Problem concerning the calculation time
  - Problem concerning the number of parameters to calibrate
  - Problems concerning the behavioral parameters

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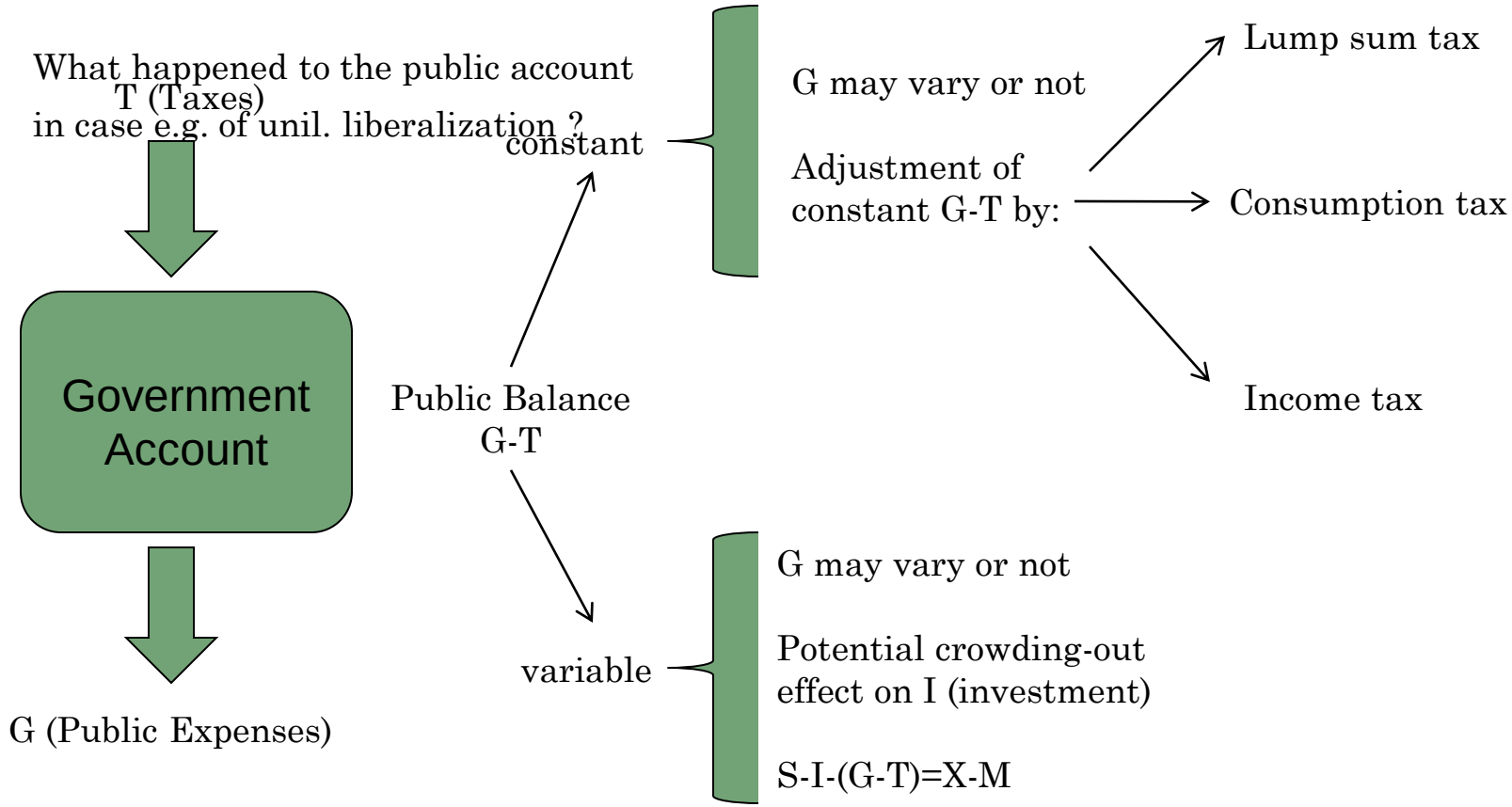
Model Closure and Numeraire

- A multi-country CGE is a set of mathematical relations describing prod'n, cons'n, exports, imports, investment, …
- Two important issues
  - Closures: the modeler has to clearly understand the consequences of the closures he selected
  - Numeraire
- Three closures
  - Government balance
  - Investment-Savings
  - External balance

Public Closure

- What happened to the public account
- in case e.g. of unil. liberalization ?



Public Closure

- Comments:
  - Lump-sum tax:
    - Fixed amount of tax, whatever the characteristics of taxed entity
    - Regressive tax: the lower the income is, the higher the percentage of income applicable to the tax
    - Minimizes loss of economic efficiency
  - Consumption tax:
    - Popular tax
    - Tax on spending on goods and services: VAT, sales tax, excise tax
    - Unfair in the sense that it taxes more people who spend a larger share of income
    - May distort the allocation of productive resources if it concerns some goods
    - May distort the allocation of income between consumption and savings
    - Consumption taxes do not tax savings and therefore do not restrict investment

Public Closure

- Comments:
  - Income tax:
    - Tax levied on the income of individuals or businesses
    - Income tax may be progressive, proportional or regressive
    - If progressive, income tax reduces absolute and relative income inequality
    - It reduces consumption and savings… and therefore it impacts investment
  - Crowding-out effect:
    - Crowding-out effect of fiscal policy happens when expansionary fiscal policy (rising public deficit) causes interest rates to rise

Investment-Savings relation

- The I-S closure concerns the economic relationship between Investment and Savings

I-S

Neo-classical closure
S determines I
Savings-driven closure

$\Delta Y \rightarrow \Delta S = s.\Delta Y \rightarrow \Delta I$

Keynesian closure
I determines S
Investment-driven closure

$\Delta I \rightarrow \Delta Y \rightarrow \Delta S$

Investment-Savings relation

- Comments
  - MIRAGE/MIRAGRODEP is based on neo-classical closure
  - In a Keynesian framework, thanks to the multiplying effect of private investment (or of public deficit), more investment will cause more income and therefore more savings… no financing concern.
  - In a Neo-classical framework, this is only thanks to more income and therefore more savings that more investment may be allowed.
    - Gives birth to a potential crowding-out effect of fiscal policy
    - With variable current account and inflows of capital, crowding-out effect may be avoided

External Closure

- What are the options in terms of adjustment of each economy within its relations with the rest of the world?

- Two main options:
  - - External balance is constant and exchange rate is flexible
  - - External balance is flexible and exchange rate is constant

External Closure

- Exchange rate is constant: adjustment by variation in Central Bank Foreign Exchange Reserves
- It implies variation in monetary stocks and therefore in prices…

- Balance of payments

Credit	Debit
Exports G.&S.	Imports G.&S.
Current Account	
Long term Capital inflows	Long term Capital outflows
Short term Capital inflows	Short term Capital outflows
Var in Central Bank Foreign Exchange Assets	

External Closure

- Exchange rate is flexible: no variation in Central Bank Foreign Exchange Reserves
- Since we do not model Capital inflows/outflows, we suppose that current account is constant.

- Balance of payments

Credit	Debit
Exports G.&S.	Imports G.&S.
Current Account	
Long term Capital inflows	Long term Capital outflows
Short term Capital inflows	Short term Capital outflows

External Closure

- **Problem**

- Adjustment of the exchange rate in order to maintain current account constant is in real terms
- It means that it is not e (nominal exchange rate) which adjusts, but eP*/P (real exchange rate).
  - Either e is adjusting
  - Or P* and P
  - Or both.
- In MIRAGE we do not model the nominal exchange rate since it is more determined by financial flows than by real flows.
- Therefore the only adjustment is through P and P*

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NUMERAIRE

- Why do we need a numeraire in a CGE?

- Walras's law means interdependence between markets in a Walrassian economy.

- If there are n markets,
- and if n-1 markets are in equilibrium…
- the n^{th} market is also in equilibrium.

- In a CGE described by N equations and N endogenous variables, one equation is not independent.
- We used to: create a new variable which is added to the dependent equation (this equation becomes independent) / choose a numeraire: price fixed to 1; it remains constant all along the modeling.
- This changes nominal prices, not relative prices.

NUMERAIRE

- A simple CGE to illustrate the Walras's law
- Simple economy with one good, two primary factors, labour and capital, a Cobb-Douglass technology, no relations with abroad.

$$Y = A0.KD^{\alpha}.LD^{1-\alpha}$$

$$W.LD = (1-\alpha).P.Y$$

$$R.KD = \alpha.P.Y$$

$$INC = W.LS + R.KS$$

$$P.C = INC$$

$$Y = C$$

$$LD = LS$$

$$KD = KS$$

NUMERAIRE

- A CGE with 8 equations and 8 variables
- One equation is not independent!

$$P.Y = P.C = INC = \alpha.P.Y + (1-\alpha).P.Y$$

$$So: \quad R.KD + W.LD = INC$$

$$Since: \; LD = LS, it\ ensures\ that: KD = KS$$

$$So: KD = KS\ is\ implied\ by\ other\ equations$$

- This is due to Walras's law.

  Write: KD=KS + Leon

  Leon is a new variable, initialized at 0

  So 9 variables, 8 equations: introduce a numeraire, P

  Since KD=KS is implied by other equations, leon will remain at 0

NUMERAIRE

- We add a new variable called Leon which is initialized at 0.
- Leon is added to an equation which is not independent.
- We choose a numeraire: price of the good/ everything is expressed in this good. This price is fixed at 1.
- We check that Leon remains at 0.

NUMERAIRE

- Impact of an increase by 10% of the labor supply with three different numeraires

Results	P numeraire	Results	W numeraire	Results	RK numeraire
	Rate of var		Rate of var		Rate of var
Y	6.90%	Y	6.90%	Y	6.90%
KD	0.00%	KD	0.00%	KD	0.00%
LD	10.00%	LD	10.00%	LD	10.00%
W	-2.82%	W	0.00%	W	-9.09%
RK	6.90%	RK	10.00%	RK	0.00%
INC	6.90%	INC	10.00%	INC	0.00%
CONS	6.90%	CONS	6.90%	CONS	6.90%
Leon	-	Leon	-	Leon	-
P	0.00%	P	2.90%	P	-6.45%

Numeraire

- What is the right numeraire?
  - Select a price which will not change very much
  - Good option: an aggregate price

- In MIRAGE/MIRAGRODEP, the price of utility of the first country

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TRADE POLICY ISSUES

- Impact of import duties on domestic producers and domestic consumers
- Impact of export taxes on domestic producers and domestic consumers
- Impact of foreign liberalization on domestic producers and domestic consumers
- Impact of liberalization on productive factors' remuneration with perfect mobility
- Impact of liberalization on productive factors' remuneration with perfect mobility and specific factors
- Impact of multilateral liberalization/regional agreements

TRADE POLICY ISSUES

Impact of import duties on domestic producers and domestic consumers

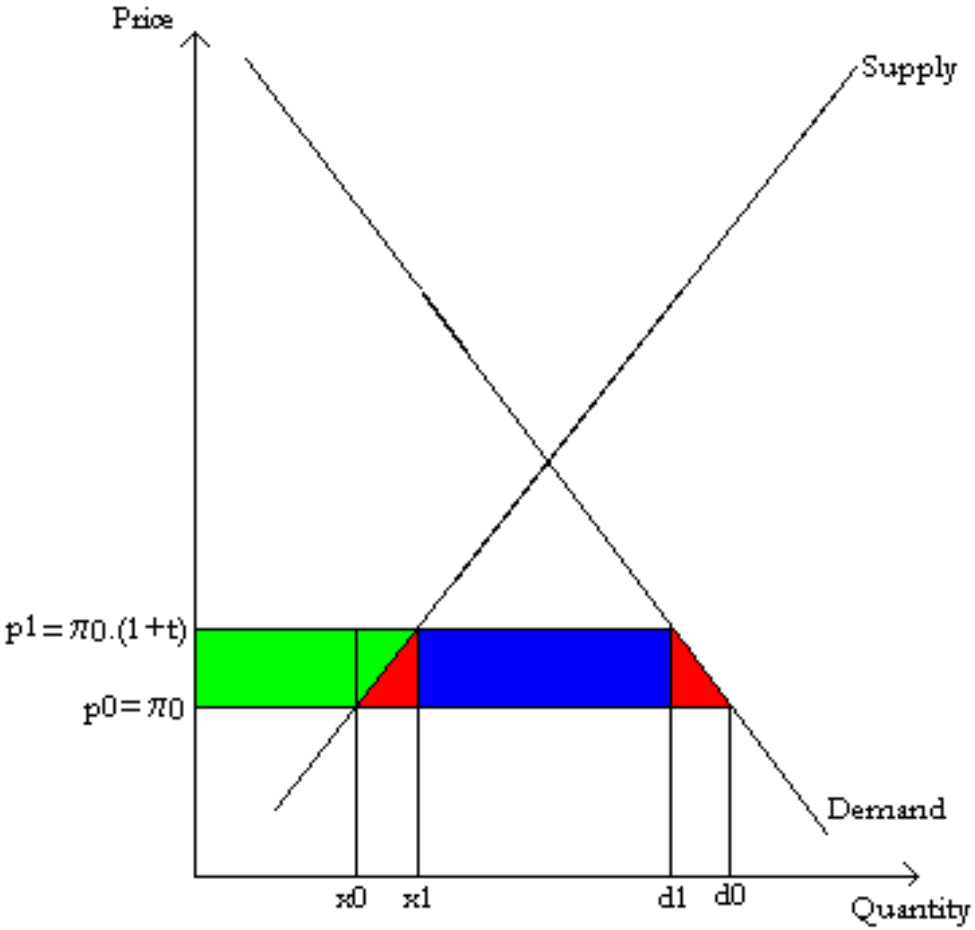
Partial equilibrium analysis for a small country

World price remains constant.

Analysis is conducted 'other things being equal'.

Impact of tariff on consumers' purchasing power, factor market, public account is not taken into account

TRADE POLICY ISSUES: IMPORT DUTY



Small Country

Impact of an import tariff

TRADE POLICY ISSUES : IMPORT DUTY

Impact of an import duty in a small country

1 – Protective impact: domestic supply is increased.

2 – Consumption effect: domestic consumption is decreased.

3 – Impact on public revenues: they increase

4 – Impact on imports: they decrease.

5 – Impact on income distribution: from domestic consumers to domestic producers and government..

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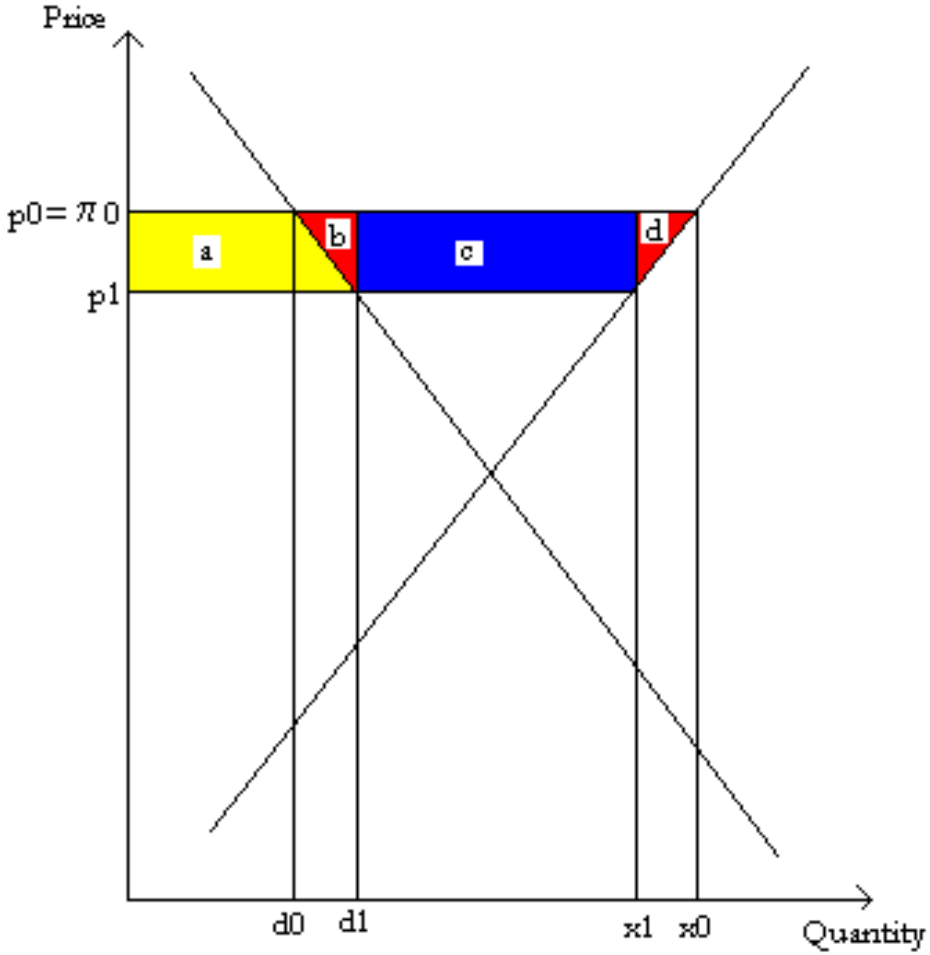
TRADE POLICY ISSUES: EXPORT TAX



Small Country
Impact of an export tax

Trade policy issues: export tax

- Impact of an export tax:
  - Domestic price is decreased.
  - May be good for food security issue
  - Decrease of producers' surplus
  - Increase of consumers' surplus.
  - Public revenues.
  - Deadweight loss

TRADE POLICY ISSUES : IMPORT DUTY

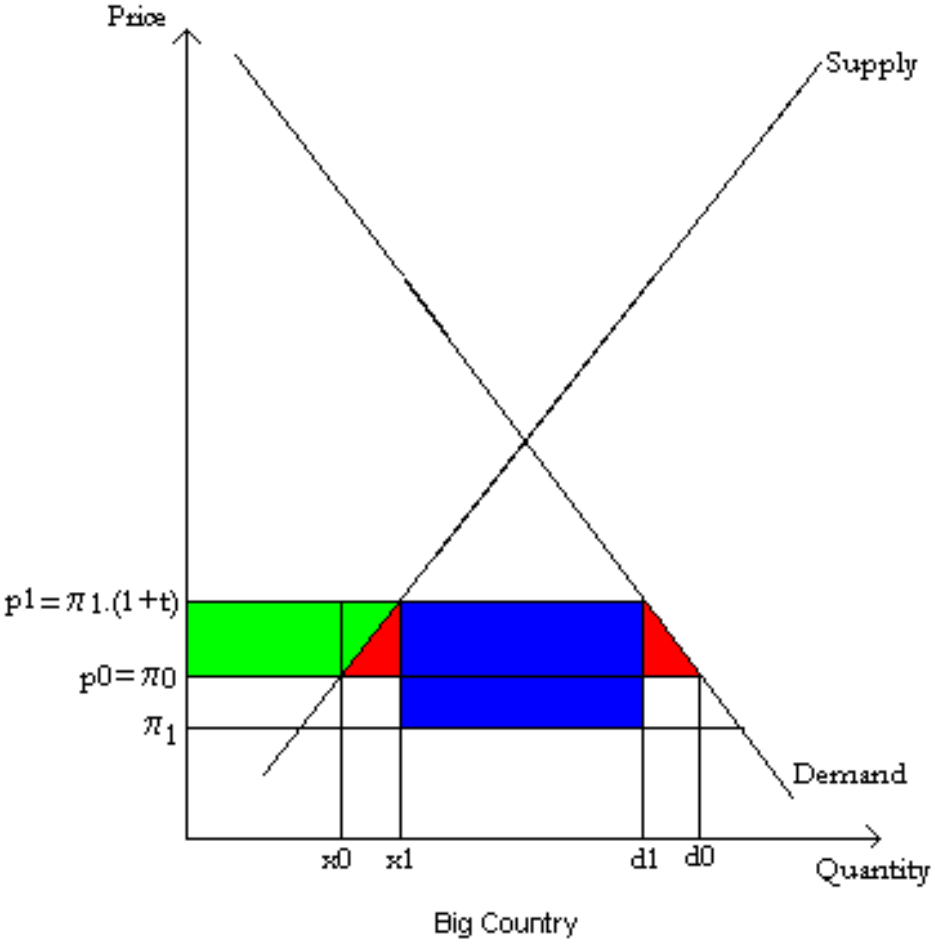
Tariff in case of a large country: the optimum tariff

Consider a large country imposing a tariff on its imports:

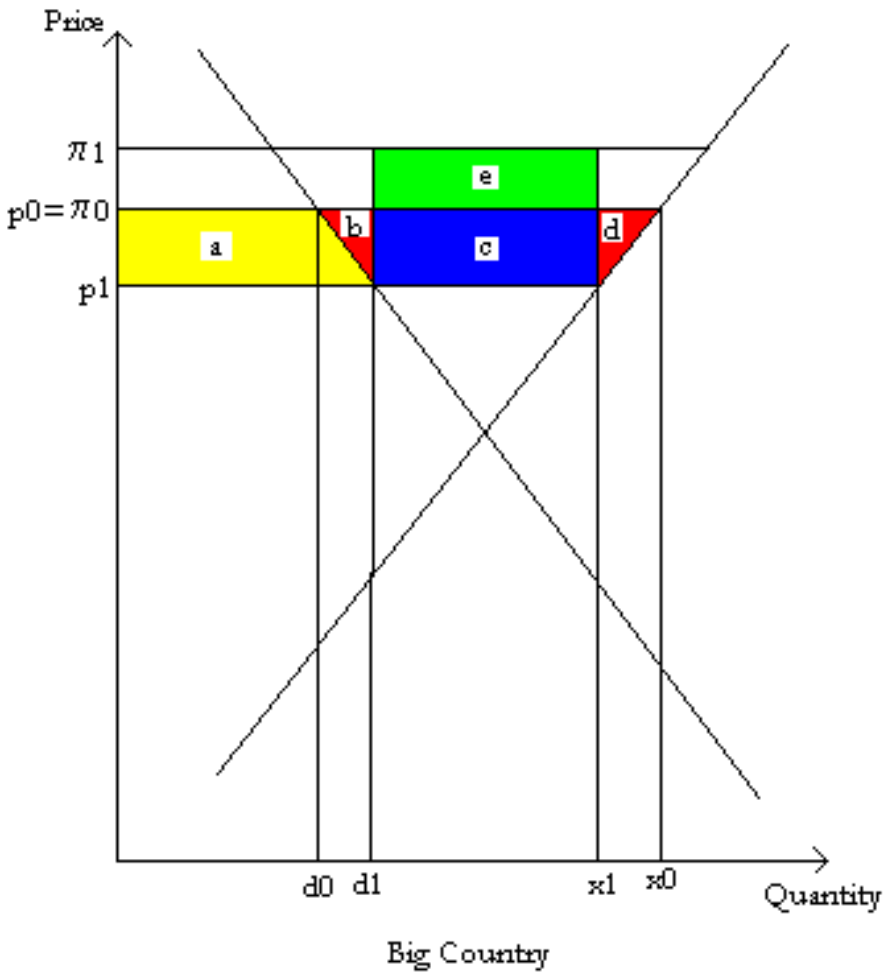
- reduction in domestic demand
- reduction in imports and world demand
- world price is decreased
- an import tariff improves the terms of trade of a large country.

In case of a large country exporting a commodity, an export tax decreases local supply and world supply and increases world price.

TRADE POLICY ISSUES : IMPORT DUTY



TRADE POLICY ISSUES: EXPORT TAX



TRADE POLICY ISSUES: EXPORT TAX

- (i) Terms of trade justification.
  - By restricting its exports a country which supplies a significant share of the world market in a commodity can raise its world price. This implies an increase of the world price of the commodity that it exports, which means an improvement of its terms of trade.
- (ii) Food security and net domestic consumers (final consumption price);
  - Piermartini provides the example of the Indonesian Government imposing export taxes on palm oil products, including crude and palm cooking oil in 1994, as it considers cooking oil as an "essential" commodity.
  - This objective has often been used during the food crisis of 2006-2008 by governments to justify the implementation of export taxes and other forms of export restrictions.
- (iii) Intermediate consumption price:
  - Export taxes on primary commodities (especially unprocessed) work as an indirect subsidy to higher value-added manufacturing or processing industries.
  - For example, in Indonesia an export tax on lumber has implied a development of the domestic wood processing industry, which has been judged as excessive for environmental reasons since it favored the depletion of forests (World Bank, 1998).
  - In 1988, Pakistan imposed an export tax on raw cotton, in order to stimulate the development of the yarn cotton industry.

TRADE POLICY ISSUES: EXPORT TAX

- (iv) Public receipts:
  - export taxes provide revenues to developing countries with a poor tax administration.
- (v) Income redistribution:
  - like import tariffs, export taxes are measures that imply a redistribution of income, at the detrimental of domestic producers of the commodity taxed and at the benefits of domestic consumers and public revenues.
- (vi) Stabilization of domestic prices :
  - In order to stabilize domestic price for export producers, some developing countries use variable tax rates.
  - Piermartini provides the example of Papua New Guinea which established an export tax/subsidy rate for cocoa, coffee, copra and palm oil equal to one half the difference between the reference price – calculated as the average of the world price in the previous 10 years – and the actual price for the year.

Trade policy issues

- Trade policy and income distribution (Stolper-Samuelson)
  - Consider a country with two sectors, agriculture and industry, and two productive factors, capital and labor;
  - Agriculture is intensive in labor (sector point of view)
  - Industry is intensive in capital (sector point of view)
  - This country is abundant in capital (international point of view)
  - Trade liberalization increases the relative price of industry and the real remuneration of capital and it lowers real remuneration of labor
  - Protection increases the relative price of agriculture and the real remuneration of labor and it lowers real remuneration of capital

TRADE POLICY ISSUES

- Trade policy and income distribution (Ricardo Viner)
  - Consider a country with two sectors, agriculture and industry, and three productive factors, capital, land and labor;
  - Land is specific to agriculture
  - Capital is specific to industry
  - Labor is mobile
  - This country is abundant in capital
  - Trade liberalization increases very much remuneration of capital and lowers very much real remuneration of land while labor can move from agriculture to industry
  - Land is very much demanding of protectionism

Trade policy issues

- Different options for trade liberalization
  - Multilateral liberalization
    - Most efficient way to liberalize
    - Multilateral deals are difficult to negotiate
    - Doha Round:
      - What is the real value of trade lib'n for each member?
      - Erosion of preferences
      - Deterioration of Terms of Trade in case of NFICs
  - Regional Agreements
    - May be the origin of trade creation
    - … but also trade diversion (Viner 1950)
    - Easier to negotiate

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A CASE STUDY

- Doha Round=1st Development Round
- Potential implications for LDCs of the proposed actions under the DDA have not been thoroughly examined
- Concerns for LDCs
  - Will they gain in market access?
  - Risk of eroded preferences
  - Increasing world agricultural and food prices
- Examination of LDCs' trade structure and access to foreign markets
- Evaluate the impact of DDA

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A CASE STUDY

Table 6.1: *Average duty faced on exports by groups of countries ranked by income in 2004 (level and decomposition, in percent).*

	Average duty faced by exporters	Apparent margin	Composition effect	Nominal margin
High-income countries	3.7	0.0	−1.6	1.6
Middle-income countries	3.7	0.0	−1.7	1.6
LDCs	3.2	0.5	−4.0	4.6

The nominal margin is defined by the difference between the MFN applied rate and the preferential rate at the HS6 level on a bilateral basis. The apparent margin is the difference between the average protection faced by the world and the average protection faced by the zone. The composition effect is defined as the difference between the apparent and the nominal margins.

Source: MAcMap-HS6v2.1 and authors' calculation. Trade-weighted 2004 data, updated for changes in main GSP programmes until 2008 with full implementations of current WTO commitments. Only WTO trade relationships, excluding intra-EU, are covered. Preferential margins related to TRQs are included. Full utilisation of preferences is assumed.

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A CASE STUDY

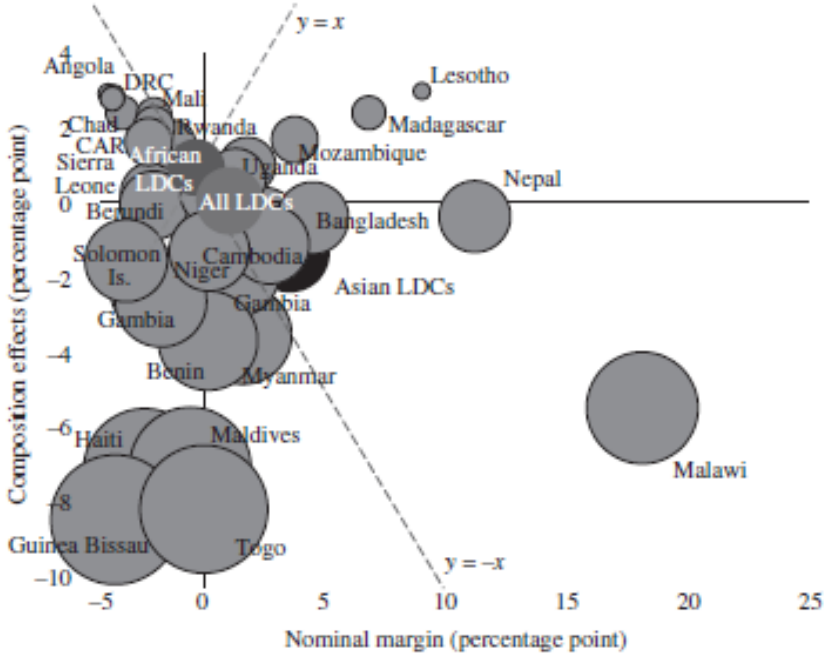

Figure 6.1: *Average duty faced on exports by WTO LDCs: decomposition of preferential margins structure.*

The nominal margin is defined by the difference between the MFN applied rate and the preferential rate at the HS6 level on a bilateral basis. The composition effect is defined as the difference between the apparent and the nominal margins. A negative composition effect indicate an adverse market specialisation. The size of the bubble displays the average tariff faced by the country. Trade-weighted 2004 data, updated for changes in main GSP programmes until 2008 with full implementations of current WTO commitments. Only WTO trade relationships, excluding intra-EU, are covered. Preferential margins related to TRQs are included. Full utilisation of preferences is assumed.

Source: MAcMap-HS6v2.1 and authors' calculations.

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A CASE STUDY

Table 6.2: *Concentration of LDC exports and tariffs paid by LDCs (in percent).*

(a) LDC export concentration

	Top 0.5% of products	Top 1% of products	Top 3% of products	Top 5% of products	Top 10% of products
High-income countries	65.8	75.4	89.0	93.4	96.9
Australia	80.8	85.9	93.2	96.2	99.0
Canada	71.9	82.6	93.9	96.7	99.0
EU	65.5	76.8	89.1	93.0	96.6
Iceland	78.3	87.9	97.8	99.9	100.0
Japan	86.3	91.4	96.7	98.3	99.5
New Zealand	91.3	94.1	97.9	99.0	99.9
Norway	80.3	88.2	96.3	98.3	99.8
Switzerland	89.4	94.0	97.8	98.8	99.7
USA	76.7	85.4	96.1	98.1	99.4
Selected middle-income countries	85.9	90.0	94.7	96.5	98.4
Brazil	91.3	95.3	98.9	99.7	100.0
China	96.8	98.0	99.3	99.7	99.9
India	71.5	79.4	90.1	94.1	97.5
Korea	93.8	95.6	98.2	99.0	99.8
Mexico	60.3	74.3	90.9	96.0	99.3
Turkey	83.6	91.0	97.6	99.2	100.0

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A CASE STUDY

Table 6.2: *Continued.*

(b) Tariff revenue on LDC exports

	Top 0.5% of products	Top 1% of products	Top 3% of products	Top 5% of products	Top 10% of products
High-income countries	71.9	83.8	97.3	99.2	99.9
Australia	63.5	79.7	97.5	99.8	100.0
Canada	100.0	100.0	100.0	100.0	100.0
EU	94.4	97.4	99.5	99.9	100.0
Iceland	83.1	91.7	99.3	100.0	100.0
Japan	97.4	99.3	100.0	100.0	100.0
New Zealand	100.0	100.0	100.0	100.0	100.0
Norway	87.9	95.8	100.0	100.0	100.0
Switzerland	98.9	99.8	100.0	100.0	100.0
USA	70.1	84.1	98.4	99.7	100.0
Selected middle-income countries	77.8	84.1	92.7	95.4	98.0
Brazil	79.5	87.1	96.8	99.3	100.0
China	87.1	91.4	96.6	98.3	99.6
India	79.4	88.4	96.2	98.0	99.4
Korea	97.3	98.2	99.2	99.6	99.9
Mexico	65.8	78.0	92.8	97.1	99.5
Turkey	88.4	94.1	98.9	99.8	100.0

Source: MAcMap-HS6v2.1 and authors' calculation. Theoretical tariff revenue is computed as the product of actual trade times the applied preferential tariff.

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A CASE STUDY

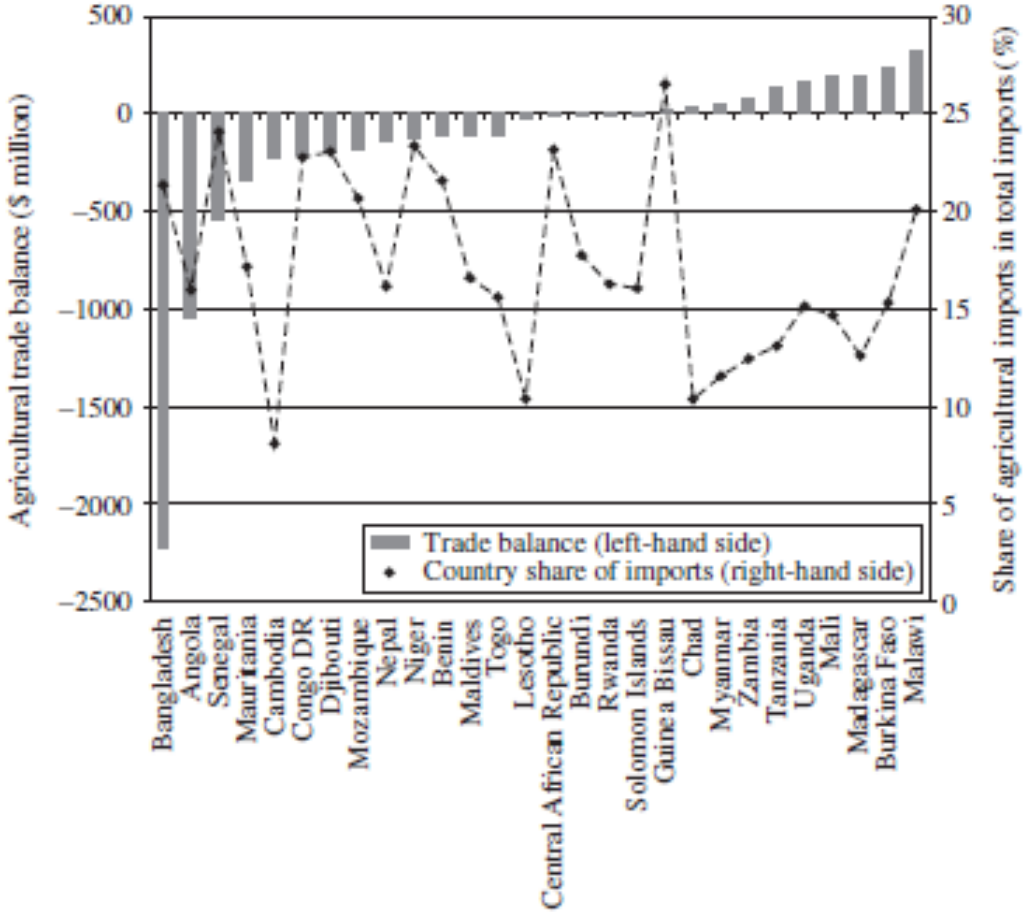

Figure 6.2: *Net agricultural trade balance for LDCs, 2002–4 average ($ billion). Source: MAcMap-HS6v2.1 and authors' calculation.*

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A CASE STUDY

- Implementation of the last version of the DDA modalities at the most detailed level of the protection database: 5,113 products, 170 importing countries and 208 exporting countries

- Use of MIRAGE to evaluate the impact of this trade reform on LDCs' exports and real income.

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A CASE STUDY

Table 6.4: *Average faced protection by zone: WTO trade relations (in percent).*

	Applied tariff			Nominal preferential margin		
	Baseline	Central scenario	Cut rate	Baseline	Central scenario	Cut rate
All WTO members	3.7	2.9	−21	1.7	1.1	−35
High-income countries						
WTO members	3.7	3.0	−19	1.6	1.1	−32
Asia	4.6	3.6	−21	0.4	0.2	−56
Europe	3.9	3.3	−17	1.2	0.7	−39
North Africa	2.4	1.9	−19	3.4	2.5	−27
Latin America and the Caribbean	5.5	5.2	−6	0.8	0.6	−22
Developing countries (non-LDCs)						
WTO members	3.7	2.8	−24	1.6	1.0	−38
Africa	3.2	2.8	−12	3.0	1.8	−41
Asia	3.9	2.9	−25	1.0	0.6	−39
Europe	1.4	1.0	−24	4.8	2.8	−41
North Africa	0.5	0.4	−17	3.4	1.7	−49
Latin America and the Caribbean	5.0	3.9	−22	3.2	2.3	−28
LDCs						
WTO members	3.2	2.3	−27	4.6	2.6	−43
Africa	2.3	2.2	−4	3.4	2.3	−33
Asia	4.6	2.5	−46	6.7	3.2	−53
Latin America and the Caribbean	10.4	4.0	−61	1.5	0.6	−63

Source: MAcMap-HS6v2.1 and authors' calculation. Trade-weighted 2004 data, updated for changes in main GSP programmes until 2008 with full implementations of current WTO commitments. Only WTO trade relationships, excluding intra-EU, are covered. Preferential margins related to TRQs are included. Full utilisation of preferences is assumed.

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A CASE STUDY

Table 6.5: *Impact of the central scenario on bilateral exports upon value (until 2025, scenario/baseline, in percent).*

	Exporter								
	LDCs: Asia	LDCs: Bangladesh	LDCs: Central South Africa	LDCs: East Africa	LDCs: Malawi	LDCs: Senegal	Central Africa (mix)	West Africa (mix)	Rest of sub-Saharan Africa (non-LDCs)
LDCs: Asia	−0.1	−1.2	−1.2	−1.2	0.2	−2.0	−1.4	−2.6	−0.9
LDCs: Bangladesh	−0.2	0.0	−1.0	−1.0	0.6	−1.7	−1.7	−1.9	−1.1
LDCs: Central South Africa	1.0	1.0	−0.0	0.2	3.0	−0.6	−0.3	−1.7	0.1
LDCs: East Africa	0.7	0.7	−0.3	−0.2	2.1	−0.9	−0.4	−1.8	−0.0
LDCs: Malawi	−0.9	−0.9	−2.1	−0.9	0.0	−2.8	−2.1	−3.7	−1.8
LDCs: Senegal	1.5	1.6	0.3	0.9	3.0	0.0	−0.2	−0.1	0.8
Central Africa (mix)	0.9	1.1	3.1	2.0	2.8	−0.8	−0.2	−1.6	1.1
West Africa (mix)	2.2	2.1	0.9	1.1	0.8	0.4	0.5	0.1	1.4
Rest of sub-Saharan Africa (non-LDCs)	0.6	0.1	−0.9	−0.1	1.9	−1.4	−0.7	−1.5	−1.0
ANZCERTA	4.1	−4.0	0.1	0.9	7.3	−0.5	−0.3	−0.7	2.2
ASEAN	−0.8	15.4	1.4	1.7	3.8	5.1	1.9	4.4	3.9
Brazil	4.8	3.5	1.8	2.2	7.9	0.6	0.8	3.4	1.4
Canada	−19.4	−21.2	−1.3	−0.6	1.5	−1.7	−1.1	−0.3	2.2
China	2.4	10.3	−0.1	0.5	1.5	1.0	0.3	0.1	2.9
EFTA	3.2	−0.7	0.0	−1.2	−27.6	11.7	−1.3	−5.7	−1.2
EU (27)	−5.5	−5.9	−2.6	−2.5	−7.7	−2.0	−1.4	2.0	−0.6

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Table 6.5: *Continued.*

	Exporter								
	LDCs: Asia	LDCs: Bangladesh	LDCs: Central South Africa	LDCs: East Africa	LDCs: Malawi	LDCs: Senegal	Central Africa (mix)	West Africa (mix)	Rest of sub-Saharan Africa (non-LDCs)
India	1.2	−0.4	5.2	2.1	2.0	2.5	3.0	2.0	5.0
Japan	−12.8	−4.9	1.4	1.0	0.6	−0.7	2.2	−2.4	3.0
Republic of Korea	−1.0	−3.4	1.0	0.6	3.0	4.8	1.2	−1.0	1.8
MENA	−1.3	8.9	19.4	−4.7	−0.4	7.8	43.5	23.3	0.1
Mexico	42.8	52.4	−0.8	3.9	3.8	6.5	−1.1	0.2	2.1
Oil exporters (non−LDCs)	0.3	−0.1	−0.5	0.0	1.9	−1.0	−0.6	−1.2	−0.1
Rest of East Asia	3.6	5.8	−1.2	2.6	5.5	3.4	−0.8	3.5	2.6
Rest of Latin Latin America	1.1	1.8	−0.8	0.7	2.2	−0.3	−0.6	−1.4	0.3
Rest of South Asia	2.4	4.3	1.5	3.5	3.5	1.9	2.9	2.7	2.3
Rest of the world	0.9	1.3	0.0	0.9	2.3	−0.3	−0.2	−0.4	0.9
South Africa	4.3	14.0	−1.2	−0.9	−3.1	−3.9	−5.1	−0.5	−5.5
Turkey	−3.0	−5.6	−1.0	1.2	1.4	−1.0	0.0	0.9	6.2
USA	10.0	7.7	−1.0	−1.7	44.8	−1.2	−1.0	−2.6	−0.9

'ANZCERTA' stands for Australia New Zealand Closer Economic Relations Trade Agreement. 'ASEAN' stands for Association of Southeast Asian Nations.
Source: authors' calculation using the MIRAGE model.

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A CASE STUDY

Table 6.6: *Impact of the central scenario on sectoral exports and output in volume (2025, scenario/baseline, in percent).*

(a) Impact on sectoral exports

Sector	High-income countries	Low-income countries	LDCs	LDCs: Asia	LDCs: Bangladesh	LDCs: Central South Africa	LDCs: East Africa	LDCs: Malawi	LDCs: Senegal	Central Africa (mix)	West Africa (mix)	Rest of sub-Saharan Africa (non-LDCs)
Agro-food	3.9	7.5	−1.0	−6.8	0.2	−1.4	−1.1	−2.5	−0.1	0.0	3.0	1.9
Industry	4.1	2.5	−0.8	−1.6	−2.5	−0.2	−0.4	−0.8	0.8	−0.1	−1.0	−1.4

(b) Impact on sectoral output in volume

Sector	LDCs: Asia	LDCs: Bangladesh	LDCs: Central South Africa	LDCs: East Africa	LDCs: Malawi	LDCs: Senegal	Central Africa (mix)	West Africa (mix)	Rest of sub-Saharan Africa (non-LDCs)
Agro-food	−0.8	0.0	0.0	−0.2	−0.8	0.2	0.0	0.2	0.3
Industry	−0.7	−0.5	−0.1	0.0	1.0	0.3	−0.1	−0.9	−0.6

Source: authors' calculation using the MIRAGE model.

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Table 6.7: *Impact of the central scenario on macroeconomic variables (2025, scenario/baseline, in percent).*

Sector	Real income	Exports (volume)	Terms of trade	Unskilled real wages
High-income countries	0.13	3.12	—	—
Low-income countries	0.12	2.46	—	—
LDCs	−0.09	−0.49	—	—
LDCs: Asia	−0.66	−0.82	−0.35	−0.64
LDCs: Bangladesh	−0.14	−1.54	−0.38	−0.17
LDCs: Central and South Africa	−0.11	−0.16	−0.17	−0.01
LDCs: East Africa	−0.03	−0.32	−0.05	−0.02
LDCs: Malawi	−0.24	−1.12	−0.34	−0.18
LDCs: Senegal	0.07	0.03	0.04	0.32
West Africa (mix)	−0.08	−0.01	0.09	0.01
Central Africa (mix)	0.13	0.66	−0.09	−0.23
Rest of sub-Saharan Africa (non-LDCs)	0.02	−0.10	0.04	0.12

Source: authors' calculation using the MIRAGE model.

Main features of MIRAGE

- ***Solution type***
  - Static or Dynamic recursive
- ***Time frame***
  - Standard: 2004-2025,
  - Climate Change 2004-2049 (Δ5)
- ***Equilibrium type***
  - Market general equilibrium
- ***Computing Framework***:
  - GAMS/CONOPT
  - with Excel interface

Main features of MIRAGE

- Databases used
  - GTAP7 for trade and SAMs
  - The GTAP Data Base is a fully documented, publicly available global data base which contains complete bilateral trade information, transport and protection linkages among 113 regions for all 57 GTAP commodities for 2004.
  - https://www.gtap.agecon.purdue.edu/databases/v7/default.asp

  - MAcMAP-HS6 or TASTE
  - MAcMap-HS6v2 is a comprehensive database providing detailed protection data at the 6 digit level of the harmonized system (HS6), i.e. more than 5000 products, for the year 2004.
  - It includes ad valorem equivalents on MFN tariffs for 169 importing countries, as well as bilateral applied protection, together with preferential provisions for 220 partners.
  - Specific and compound tariffs and tariff rate quotasdata are also provided, at the same level of detail.
    http://www.cepii.fr/anglaisgraph/workpap/summaries/2009/wp2009-22.htm

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Main features of MIRAGE

- A few distinctive features
  - Perfect/imperfect competition
    - Perfect competition: price=Marginal cost
    - Imperfect competition (Chamberlin monopolistic competition):
      - Short Term: Lerner Index=Inverse of price-elasticity of demand
      - Medium term: Price = Average Cost
  - Product differentiation
    - Vertical differentiation (by quality): products coming from the North vs. from the South
    - Horizontal differentiation (by variety) if imperfect competition
  - Several modeling of factor markets
    - Perfect/Imperfect mobility of unskilled labor; option: Lewis assumption on duality
    - Perfect/Imperfect mobility of land
    - Capital:
      - Static version: perfect mobility
      - Dynamic version: “putty-clay” hypothesis with new capital mobile while installed capital immobile.

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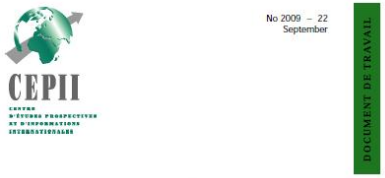
MAIN FEATURES OF MIRAGE

- Documents available on the internet network:
- www.ifpri.org
- www.cepii.org



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Main features of MIRAGE

- Demand function
  - CES-LES utility function
  - Income elasticities differ from 1
  - Two series of parameter to calibrate: share + minimal consumptions
  - Option: Cobb Douglas
- Recursive dynamics
  - No expectation of value of variables in future periods
  - Value of variable X at the end of period t is the initial value of variable X at the beginning of period t+1
- Modeling of FDI
  - Imperfect capital mobility across country
  - Investment sharing across countries and sectors depends on sectoral rate of return of capital and present capital stock

Main features of MIRAGE

- Imperfect competition (Krugman, 1979; Smith and Venables, 1988):
  - Each firm produces a unique variety
  - Marginal cost of prod'n is constant at given factor prices
  - Prod'n requires each year a fixed cost
  - Cournot-Nash hypothesis
  - No Ford effect
- Vertical differentiation: quality
  - Not only subjective differentiation (horizontal; Krugman, Lancaster…)
  - But also objective differentiation (vertical; Falvey 1981; Das and Donnefeld 1987)

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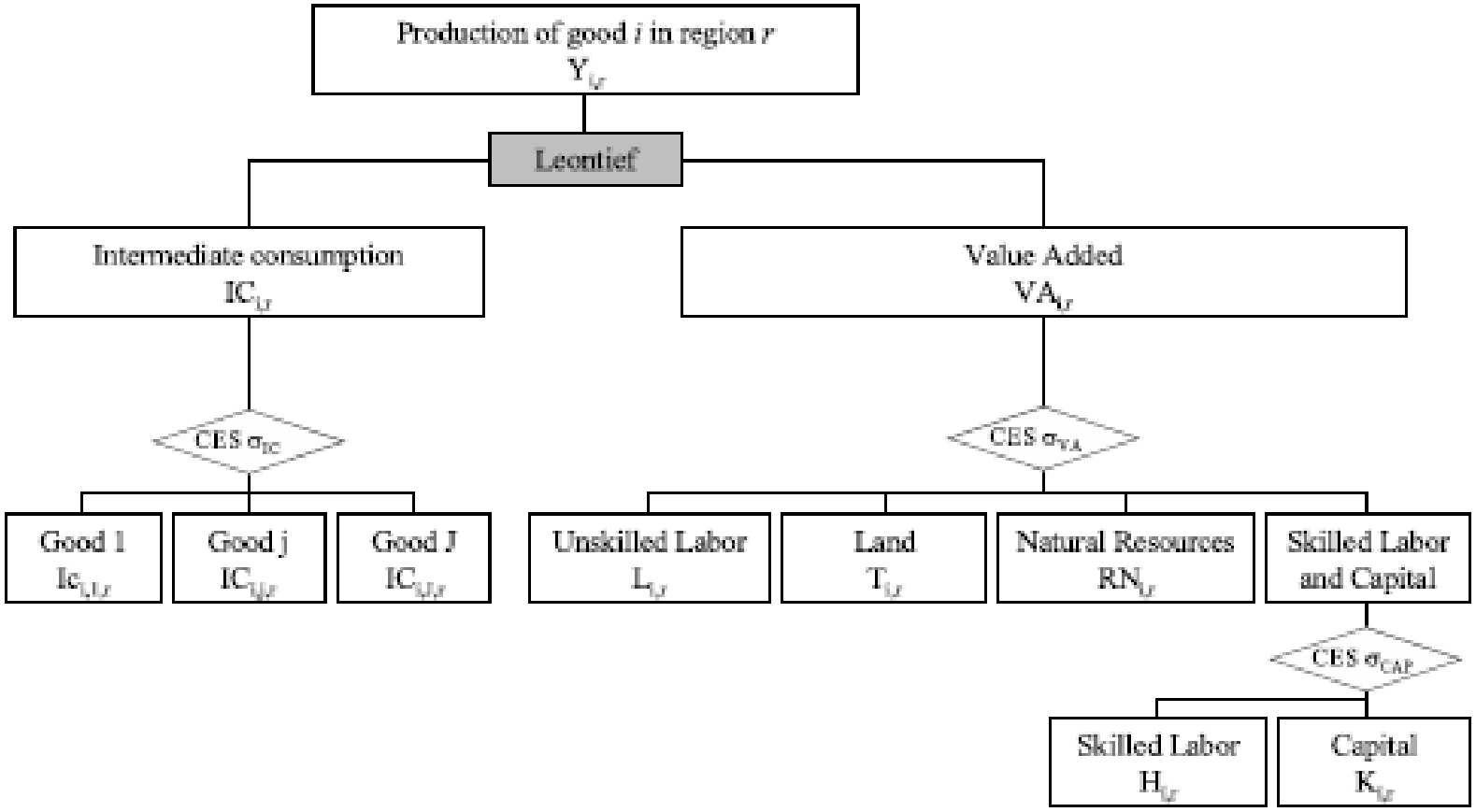
MAIN FEATURES OF MIRAGE

Supply

Structure of sector's *i* production function



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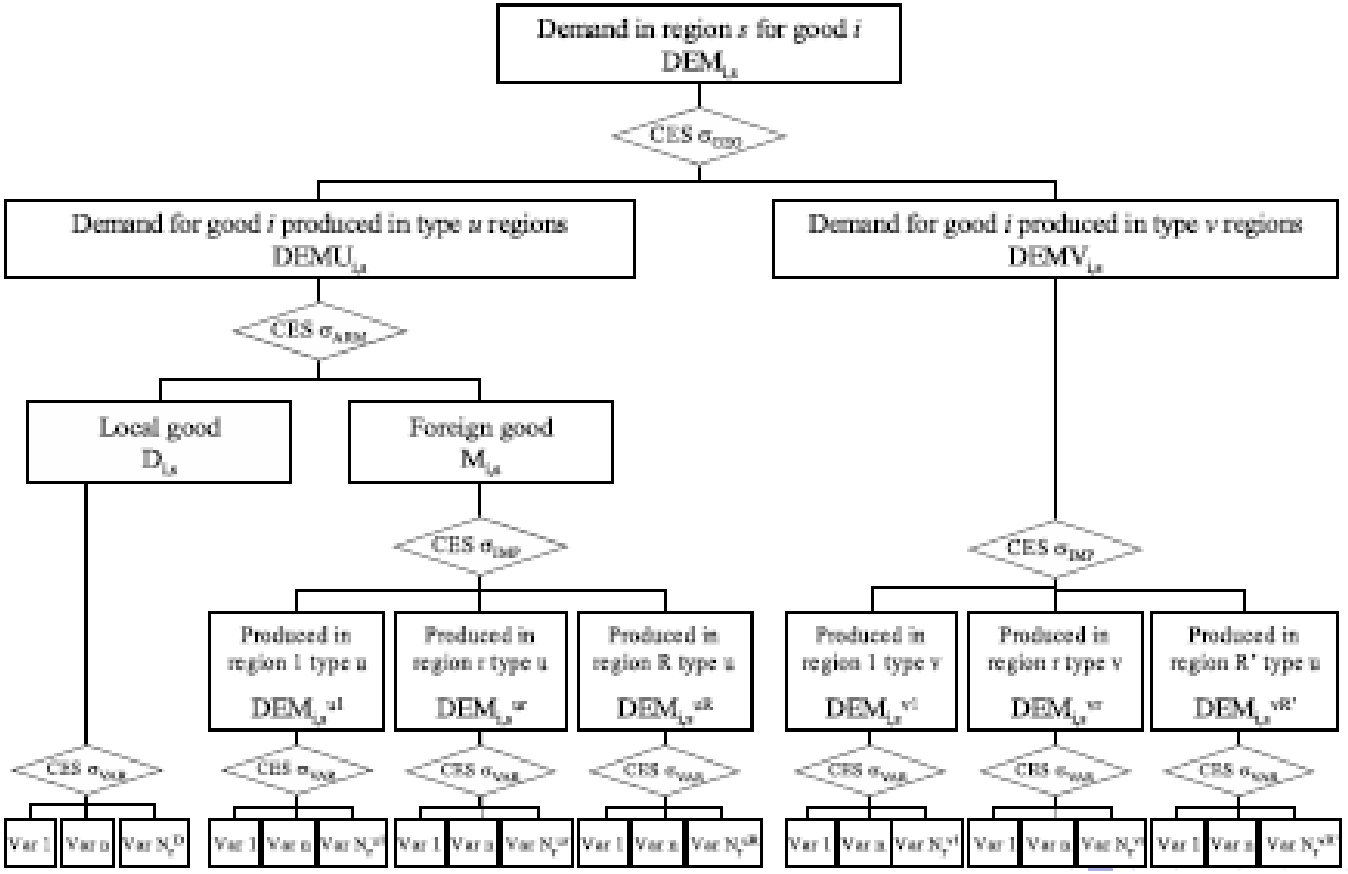
MAIN FEATURES OF MIRAGE

Demand

Demand nesting for good *i*



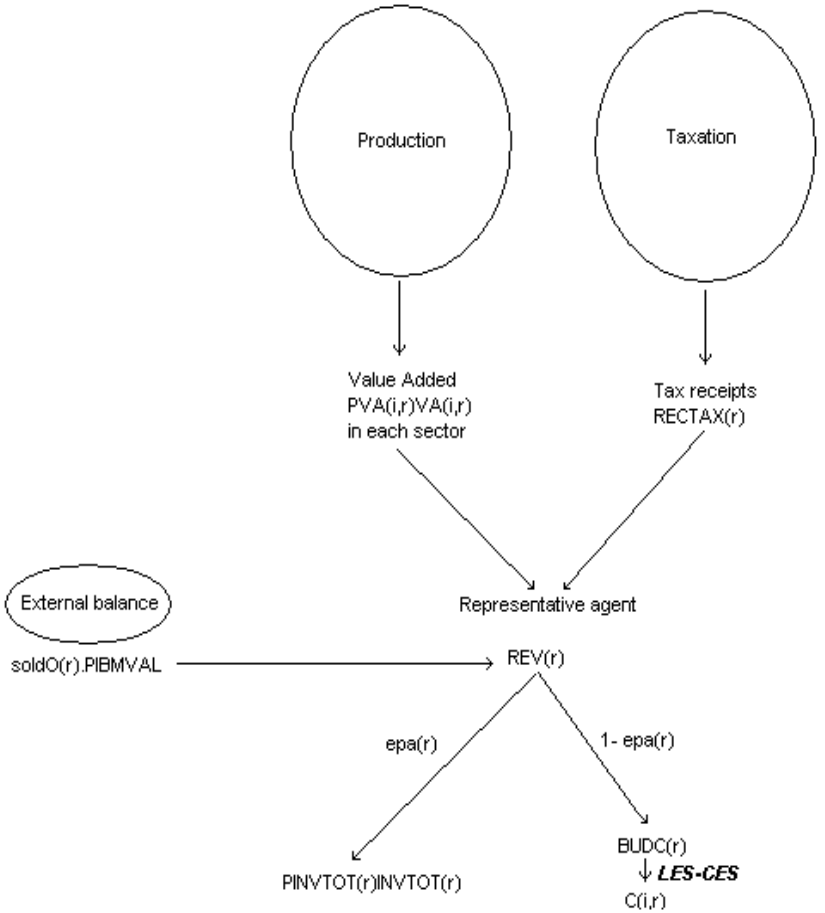
Main features of MIRAGE

- In MIRAGE, **1) MIRAGE actuel**
  we define
  REV=BUDC + INV
  with BUDC = final consumption (private and public)
  and INV total investement (private and public).
- So we calibrate the external balance in % of World GDP (PIBMVAL)
  SOLD = [(Sum of Value Added in all sectors)
  +RECTAX - REV]/PIBMVAL
- With RECTAX=total public revenues
- Therefore
- REV+PIBMVAL*SOLD=(Sum of Value Added in all sectors) +RECTAX
  This is revenue from all factors and taxes

  Saving rate is thus:
  epa=1-BUDC/REV
- This implies:
  BUDC+epa REV = REV = BUDC+INV

  So
  epa REV = INV

  This looks like a closed economy equation. But in fact national savings may finance investment abroad since the macroeconomic closure is defined in % of the world GDP which is increased year after year.
- It comes from the definition of the saving rate (epa) which is not defined a the usual macroeconomic saving rate.



Main features of MIRAGE

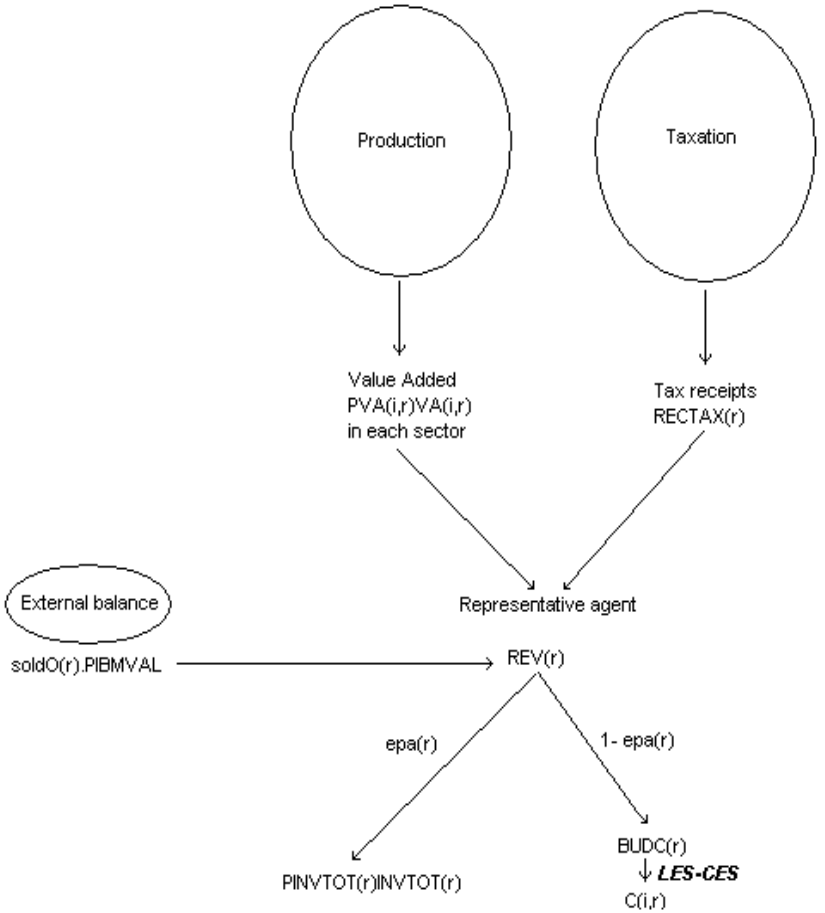
- **2) Another option**
  If we define the Macroeconomic Saving rate :

- epa=1-
  BUDC/(REV+PIBMVAL*SOLD)

- This implies:
  BUDC+epa REV =
  REV+PIBMVAL*SOLD =
  BUDC+INV+PIBMVAL*SOLD

  So
  epa REV =
  INV+PIBMVAL*SOLD

  This is in discussion right now.



TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- Standard framework
  - Static
  - Perfect competition in all sectors
  - No vertical differentiation
  - Imperfect mobility of unskilled labor between agric. vs non agric. sectors
  - Perfect mobility of land

Technical description of the standard framework

- Notations
  - i,j refer to sector
  - r,s refer to countries
  - t refers to year
  - sim refers to simulation
  - In case of trade (r,s) means that r is exporter and s importer

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- 1 Production
- 2 Demand
- 3 Factors of production
- 4 Commodities
- 5 Merchandise transportation
- 6 Income and tax receipts
- 7 Investment, capital and dynamics
- 8 Closure

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- 1 Production
- 1.1 First level of production: VA-CI (Leontieff)
- 1.2 Value added decomposition
- 1.3 Capital - Skilled labour bundle

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **First level of production: VA-CI**
- EQ_VA(i,r,t,sim)..
- Y(i,r,t,sim) =e= a_VA(i,r)*VA(i,r,t,sim)
- *Leontieff on Value Added-Output*

- EQ_CNTER(i,r,t,sim)..
- Y(i,r,t,sim) =e= a_CNTER(i,r)*CNTER(i,r,t,sim);
- *Leontieff on Intermediate Consumption-Output*

- EQ_Y(i,r,t,sim)..
- PY(i,r,t,sim)*Y(i,r,t,sim) =e= PVA(i,r,t,sim)*VA(i,r,t,sim) +PCNTER(i,r,t,sim)*CNTER(i,r,t,sim)
- *Total cost of production: PY is marginal cost*

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **1.2 Value added decomposition**
- *Value added is a CES of unskilled labor (L), Land (TE), Natural resources (RN) and a composite factor (=capital + skilled labor)*
- *It is supposed to tackle "complementarity" between capital and skilled labor and substituability between unskilled labor on one side and capital and skilled labor on the other side*
- EQ_CES_PVA(j,r,t,sim).
- PVA(j,r,t,sim)*VA(j,r,t,sim)
- =e= PL(j,r,t,sim)*L(j,r,t,sim)+PQ(j,r,t,sim)*Q(j,r,t,sim)
- +PTE(j,r,t,sim)*TE(j,r,t,sim)
- +PRN(j,r,t,sim)*RN(j,r,t,sim)

- EQ_CES_L(i,r,t,sim)..
- L(i,r,t,sim)
- =e= a_L(i,r)*VA(i,r,t,sim)*PGF(r,t,sim)**(sigma_VA(i)-1)
- *[PVA(i,r,t,sim)/PL(i,r,t,sim)]**sigma_VA(i);

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- EQ_CES_TE(i,r,t,sim)..
- Gel(i,r,t,sim)*TE(i,r,t,sim)
- =e= a_TE(i,r)*VA(i,r,t,sim)*PGF(r,t,sim)**(sigma_VA(i)-1)
- *[Gel(i,r,t,sim)*PVA(i,r,t,sim)/PTE(i,r,t,sim)]**sigma_VA(i)

- EQ_CES_RN(i,r,t,sim)..
- RN(i,r,t,sim)
- =e= a_RN(i,r)*VA(i,r,t,sim)*PGF(r,t,sim)**(sigma_VA(i)-1)
- *[PVA(i,r,t,sim)/PRN(i,r,t,sim)]**sigma_VA(i);

- EQ_CES_Q(i,r,t,sim)$CES..
- Q(i,r,t,sim)
- =e= a_Q(i,r)*VA(i,r,t,sim)*PGF(r,t,sim)**(sigma_VA(i)-1)
- *[PVA(i,r,t,sim)/PQ(i,r,t,sim)]**sigma_VA(i);

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **Capital - Skilled labour bundle**
- EQ_H(j,r,t,sim)..
- H(j,r,t,sim)
- =e= a_H(j,r)*Q(j,r,t,sim)*[PQ(j,r,t,sim)/PH(j,r,t,sim)]**sigma_CAP(j);

- EQ_KTOT(j,r,t,sim)..
- KTOT(j,r,t,sim)
- =e= a_K(j,r)*Q(j,r,t,sim)*[PQ(j,r,t,sim)/PK(j,r,t,sim)]**sigma_CAP(j);

- EQ_PQ(j,r,t,sim)..
- PQ(j,r,t,sim)*Q(j,r,t,sim)
- =e= PK(j,r,t,sim)*KTOT(j,r,t,sim)+PH(j,r,t,sim)*H(j,r,t,sim);

- *If sigma_CAP=sigma_VA(i), then it is equivalent to a value added a CES of capital, unskilled labor, skilled labor, land and natural resources, with degree of substitutability between capital and unskilled labor same as for capital and skilled labor.*

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- 2 Demand
- 2.1 Households (LES-CES)
- 2.2 Intermediary consumptions (CES)
- 2.3 Capital good demand (CES)
- 2.4 Total demand
- 2.5 Domestic - Import (Armington CES)
- 2.6 Substitution between imports (CES)

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **Households (LES-CES)**
- EQ_C(i,r,t,sim)..
- C(i,r,t,sim)=e= Pop_ag('Totpop',r,t)*{cmin(i,r)+a_C(i,r)*AUX(r,t,sim)*[P(r,t,sim)/PC(i,r,t,sim)]**sigma_C(r)};
- *CES-LES defined at the household 's level. When population is increasing, national consumption increases.*
- *With CES-LES, income-elasticities are different from 1;*
- *cmin(i,r) and a_C(i,r) are calibrated to reflect elasticities from the literature; concern in 10 years ???*

- EQ_P(r,t,sim)..
- P(r,t,sim)*AUX(r,t,sim) =e= sum{i,PC(i,r,t,sim)*[C(i,r,t,sim)/Pop_ag('Totpop',r,t) -cmin(i,r)]};
- EQ_AUX(r,t,sim)..
- BUDC(r,t,sim) =e= sum[i$CO(i,r),PC(i,r,t,sim)* C(i,r,t,sim)];
- *This is total consumption*

- EQ_PC(i,r,t,sim)$CO(i,r)..
- PC(i,r,t,sim) =e= PDEMTOT(i,r,t,sim)*(1+taxcc(i,r,t,sim));
- *Consumption price may be increased by a consumption tax taxcc*

- EQ_PI(r,t,sim)..

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **2.2 Intermediary consumptions (CES)**
- EQ_IC(i,j,r,t,sim)..

IC(i,j,r,t,sim)=e= a_IC(i,j,r)*CNTER(j,r,t,sim)

*[PCNTER(j,r,t,sim)/PIC(i,j,r,t,sim)]**sigma_IC;

Total intermediate consumption is a CES of an individual intermediate consumption

Questions: 1) is sigma_IC different from sigma_C(r)?

2) Leontieff and not CES

3) another stage in the CES : agric./industry/services or…?

- EQ_PCNTER(j,r,t,sim)..

PCNTER(j,r,t,sim)*CNTER(j,r,t,sim) =e= sum[i,PIC(i,j,r,t,sim)*IC(i,j,r,t,sim)];

- EQ_PIC(i,j,r,t,sim)..
- PIC(i,j,r,t,sim) =e= PDEMTOT(i,r,t,sim)*(1+taxicc(i,j,r,t,sim));
- *Intermediate consumption price may be increased by a intermediate consumption tax taxicc that may differ from final consumption tax taxcc*

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **2.3 Capital good demand (CES)**
- EQ_KG(i,r,t,sim)..
- KG(i,r,t,sim)=e= a_KG(i,r)*INVTOT(r,t,sim)
- *[PINVTOT(r,t,sim)/PKG(i,r,t,sim)]**sigma_KG;

- EQ_PINVTOT(r,t,sim)..
- PINVTOT(r,t,sim)*INVTOT(r,t,sim) =e= sum[i$KGO(i,r),PKG(i,r,t,sim)*KG(i,r,t,sim)];

- EQ_PKG(i,r,t,sim)$KGO(i,r)..
- PKG(i,r,t,sim)=e= PDEMTOT(i,r,t,sim)*(1+taxkgc(i,r,t,sim));

- *Again a CES on demand of capital goods… with the same remarks*

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **2.4 Total demand**
- EQ_DEMTOT(i,s,t,sim)..

DEMTOT(i,s,t,sim) =e=
C(i,s,t,sim)+sum[j,IC(i,j,s,t,sim)]+KG(i,s,t,sim);

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **2.5 Domestic - Import (Armington CES)**
- EQ_D(i,s,t,sim)..
- D(i,s,t,sim)=e= a_D(i,s)* DEMTOT(i,s,t,sim)
- *[PDEMTOT(i,s,t,sim) /PD(i,s,t,sim)]**sigma_ARM(i);

- EQ_M(i,s,t,sim)..
  M(i,s,t,sim) =e= a_M(i,s)* DEMTOT(i,s,t,sim)
  *[PDEMTOT(i,s,t,sim) /PM(i,s,t,sim)]**sigma_ARM(i);

- EQ_PDEMTOT(i,s,t,sim)..

PDEMTOT(i,s,t,sim) * DEMTOT(i,s,t,sim)

- =e= PD(i,s,t,sim)*D(i,s,t,sim) + PM(i,s,t,sim)*M(i,s,t,sim) ;
- *Armington hypothesis = product differentiation according to geographical origin*
- *Here we first make a differentiation between domestic products and foreign products, …*

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **2.6 Substitution between imports (CES)**
- EQ_DEM(i,r,s,t,sim)..

DEM(i,r,s,t,sim)

=e= a_IMP(i,r,s)*M(i,s,t,sim)

*[PM(i,s,t,sim)/PDEM(i,r,s,t,sim)]**sigma_IMP(i) ;

- EQ_PM(i,s,t,sim)..

PM(i,s,t,sim)*M(i,s,t,sim) =e= sum{r,PDEM(i,r,s,t,sim)*DEM(i,r,s,t,sim)};

... *then we make a distinction between products coming from different countries*

- *Another option is to put all products at the same level of the nesting tree: for a frenchy, there is as much substitutability between a french car and a japanese car as there is between a japanese car and a US car... : Krugman hypothesis.*

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

3 Factors of production

- 3.1 Market clearing for full allocation
- 3.2 Factor subvention and taxation
- 3.3 Unskilled dual labor market

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **3.1 Market clearing for full allocation**
- EQ_WLt(Ltype,r,t,sim)..
- Lt(Ltype,r,t,sim) =e= sum[j$Labor(j,Ltype),L(j,r,t,sim)];

- EQ_WTEbar(r,t,sim)..
- TEbar(r,t,sim) =e= sum[j,TE(j,r,t,sim)];

- EQ_WH(r,t,sim)..
- Hbar(r,t,sim) =e= sum[j,H(j,r,t,sim)];

- EQ_WKbar(r,t,sim)..
- Kbar(r,t,sim) =e= sum[j,KTOT(j,r,t,sim)];
- *One clearing condition for capital, skilled labor and land implies a unique remuneration = perfect mobility.*
- *As many clearing condition for unskilled labor as there are different types of unskilled labor defined by Ltype; generally two with agricultural activities vs. non–agricultural activities.*

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **3.2 Factor subvention and taxation**
- EQ_PTE(i,r,t,sim)..
- PTE(i,r,t,sim) =e= WTE(i,r,t,sim)-PIndC(r,t,sim)*subf('Land',i,r,t,sim);

- EQ_PL(i,r,t,sim)..
- PL(i,r,t,sim) =e= sum[Ltype$Labor(i,Ltype),WLt(Ltype,r,t,sim)]
- - PIndC(r,t,sim)*subf('UnSkLab',i,r,t,sim);

- EQ_PH(i,r,t,sim)..
- PH(i,r,t,sim) =e= WH(r,t,sim)-PIndC(r,t,sim)*subf('SkLab',i,r,t,sim);

- EQ_PK(i,r,t,sim)..
- PK(i,r,t,sim) =e= WK(i,r,t,sim)-PIndC(r,t,sim)*subf('Capital',i,r,t,sim);
- *PIndC(.) is a Consumption Price Index and is the basis of indexation for factor subsidies.*

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **3.3 Unskilled dual labor market**
- EQ_CET_Lt(Ltype,r,t,sim)$[LtO(Ltype,r)]..

Lt(Ltype,r,t,sim) =e= b_Lt(Ltype,r,sim)
Lbar(r,t,sim)[WLt(Ltype,r,t,sim)/WLbar(r,t,sim)]**sigma_L;

- EQ_CET_WLbar(r,t,sim)..

WLbar(r,t,sim)*Lbar(r,t,sim) =e=
sum[Ltype$LtO(Ltype,r),WLt(Ltype,r,t,sim)*Lt(Ltype,r,t,sim)]

CET means Constant Elasticity of Transformation. Kind of supply-side CES. Same relationship as CES except change of sign.

It means:

- there are unskilled labor people in both sector types (agr/non agr) even with different levels of remuneration;

- a change in remuneration implies a change in the allocation;

- a potential explanation is the existence of a cost for shifting activity.

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- 4 Commodities
- EQ_PY(i,r,t,sim)..
- Y(i,r,t,sim) =e= D(i,r,t,sim) +sum{s,DEM(i,r,s,t,sim)}
- *Means that price are flexible such that demand equals to supply.*
- EQ_TRADE(i,r,s,t,sim)..
- TRADE(i,r,s,t,sim) =e= DEM(i,r,s,t,sim) ;
- *Means nothing !*
- EQ_PCIF(i,r,s,t,sim)..
- PCIF(i,r,s,t,sim) =e= PY(i,r,t,sim) *[1+taxP(i,r,t,sim)]*[1+taxEXP(i,r,s,t,sim)]+[mu(i,r,s,t,sim)*PTr(i,r,s,t,sim)];
- *Means zero profit.*

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **4 Commodities**
- EQ_PDEMVAR(i,r,s,t,sim)..

PDEM(i,r,s,t,sim) =e=PCIF(i,r,s,t,sim)
*(1+DD(i,r,s,t,sim))

- *Distortion = import duty DD(.)*
- EQ_PDVAR(i,r,t,sim)..

PD(i,r,t,sim) =e= PY(i,r,t,sim) *(1+taxP(i,r,t,sim));

- *Distortion = Production tax taxP(.)*

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **In Transportation sector, first equation is**

- Y(i,r,t,sim) =e= TrSupply(i,r,t,sim)

- *This equation appears in the supply block with conditional expression ($)*

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- 5 Merchandise transportation
- 5.1 Transportation demand
- 5.2 Transportation supply
- 5.3 Transportation market clearing

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **5.1 Transportation demand**
- EQ_Tr(i,r,s,t,sim)..

Tr(i,r,s,t,sim) =e= mu(i,r,s,t,sim)*TRADE(i,r,s,t,sim);

- *Demand for transport proportional to trade*

- EQ_TrMode(Transport,i,r,s,t,sim)..

PTrMode(Transport,t,sim)*TrMode(Transport,i,r,s,t,sim) =e= a_Tr(Transport,i,r,s)*Tr(i,r,s,t,sim)*PTr(i,r,s,t,sim);

Aggregation of transport demands per mode

Transport is a set of transportation modes but very generally containing a unique element

- EQ_PTr(i,r,s,t,sim)..
- PTr(i,r,s,t,sim) =e= prod{Transport, PTrMode(Transport,t,sim)**a_Tr(Transport,i,r,s)};
- *PTrMode World Transportation Price Index*

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **5.2 Transportation supply**
- EQ_TrSupply(Transport,r,t,sim)..
- PY(Transport,r,t,sim)*(1+taxP(Transport,r,t,sim))
- *TrSupply(Transport,r,t,sim) =e= a_TrSupply(Transport,r)*

  PTrMode(Transport,t,sim)*WorldTr(Transport,t,sim);

PY(Transport,r,t,sim) is the marginal cost of transportation in country r

- EQ_WorldTr(Transport,t,sim)..

WorldTr(Transport,t,sim) =e= c_T(Transport)

*prod[r,TrSupply(Transport,r,t,sim)**a_TrSupply(Transport,r)];

Aggregation of transport supplies per mode

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **5.3 Transportation market clearing**
- EQ_PTrMode(Transport,t,sim)..

WorldTr(Transport,t,sim)=e= sum[(i,r,s),
TrMode(Transport,i,r,s,t,sim)];

- *This equation determines the World Transportation Price Index: PTrMode*

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- 6 Income and tax receipts
- 6.1 Gouvernment income
- 6.2 Total income

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **6.1 Gouvernment income**
- EQ_RECPROD(i,r,t,sim)..
- RECPROD(i,r,t,sim)
- =e= taxP(i,r,t,sim)*PY(i,r,t,sim)*Y(i,r,t,sim);
- *Revenues from production taxes (taxP may be <0)*

- EQ_RECEXP(i,r,t,sim)..
- RECEXP(i,r,t,sim)=e= PY(i,r,t,sim)*(1+taxP(i,r,t,sim))
- *sum{s,[taxEXP(i,r,s,t,sim)+taxAMF(i,r,s,t,sim)]
- *TRADE(i,r,s,t,sim)};
- *Revenues from export taxes (taxEXP may be <0)*

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- EQ_RECDD(i,s,t,sim)..
- RECDD(i,s,t,sim) =e= sum[r,DD(i,r,s,t,sim)*PCIF(i,r,s,t,sim)*TRADE(i,r,s,t,sim)];
- *Revenues from import duties*

- EQ_RECCONS(i,s,t,sim)..
- RECCONS(i,s,t,sim)=e= PDEMTOT(i,s,t,sim)*{(taxcc(i,s,t,sim)*C(i,s,t,sim))+(taxkgc(i,s,t,sim)*KG(i,s,t,sim)) +sum[j,taxicc(i,j,s,t,sim)*IC(i,j,s,t,sim)]};
- *Revenues from consumption taxes.*
- *Different taxes on final consumption, intermediate consumption, consumption of capital goods.*
- *All consumption taxes may be <0.*

- EQ_RECTAX(r,t,sim)..
- RECTAX(r,t,sim)
- =e= sum[i,RECPROD(i,r,t,sim)+RECEXP(i,r,t,sim)+RECDD(i,r,t,sim)
- +RECCONS(i,r,t,sim)];
- *Public revenues from all taxes*

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- 6.2 Total income
- EQ_REV(r,t,sim)..
  REV(r,t,sim)+[PIBMVAL(t,sim)*SOLD(r,t,sim)]
- =e= sum{i,PRN(i,r,t,sim)*RN(i,r,t,sim)
- +PTE(i,r,t,sim)*TE(i,r,t,sim)
  +H(i,r,t,sim)*PH(i,r,t,sim)+L(i,r,t,sim)*PL(i,r,t,sim)
  +(PK(i,r,t,sim)*KTOT(i,r,t,sim))}
- +RECTAX(r,t,sim);

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- EQ_BUDC(r,t,sim)..

BUDC(r,t,sim) =e= (1-epa(r))*REV(r,t,sim);

Consumption is the income which is not saved

Neoclassical hypothesis: income/ a fixed share is saved / the rest is consumed

EQ_PIBMVAL(t,sim)..

PIBMVAL(t,sim) =e=
sum[(i,r),PVA(i,r,t,sim)*VA(i,r,t,sim)];

Definition of World GDP

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

7 Investment, capital and Total Factor Productivity

EQ_B(r,t,sim)..

epa(r) * REV(r,t,sim) =e= PINVTOT(r,t,sim)*INVTOT(r,t,sim) ;

As explained earlier this equation is derived from the consumption function

A consumption function BUDC(r,t,sim) =e= (1-epa(r))[REV(r,t,sim) + PIBMVAL(t,sim)*SOLD(r,t,sim)] would imply*

*epa(r) * REV(r,t,sim) - PINVTOT(r,t,sim)*INVTOT(r,t,sim) =e= PIBMVAL(t,sim)*SOLD(r,t,sim)]*

- EQ_PGF(r,t,sim).. GDPVOL(r,t,sim)*prod[i,PC(i,r,t,sim)**pondC(i,r)] =e=
- REV(r,t,sim)+PIBMVAL(t,sim)*SOLD(r,t,sim)

This equation determines Total Factor Productivity PGF(r,t,sim)

PGF(r,t,sim) is adjusted such that in the baseline the evolution of country r's GDP is conform to long term projections (World Bank and IMF).

TECHNICAL DESCRIPTION OF THE STANDARD FRAMEWORK

- **8 Closure of the model**
- SOLD.fx(r,Temps,Simul) = SOLDO(r);
- *Current account are fixed. In fact this is the percentage relative to world GDP which is fixed.*

- Lbar.fx(r,Temps,Simul) = LbarO(r);
- Hbar.fx(r,Temps,Simul) = HbarO(r);
- Kbar.fx(r,Temps,Simul) = KbarO(r);
- RN.fx(i,s,Temps,Simul) = RNO(i,s);
- *Closure in the static version of MIRAGE*

SPECIFICITIES

- C. Specificities
  1) Cobb-Douglass in the production function
  2) CET on land allocation
  3) Specific tariff vs. Ad Valorem tariffs
  4) Vertical differentiation
  5) Dynamics
  6) Imperfect competition

SPECIFICITIES

- **1) Cobb-Douglass in the production function**
- *Constant shares in value of each factor in total value added*
- EQ_CD_PVA(i,r,t,sim)..
- Log(VA(i,r,t,sim)) =e= Log(PGF(r,t,sim))
- + a_L(i,r) * Log(L(i,r,t,sim)) + a_Q(i,r) * Log(Q(i,r,t,sim))
- + a_RN(i,r)*Log(RN(i,r,t,sim)) + a_TE(i,r)*Log(Gel(i,r,t,sim)*TE(i,r,t,sim));

- EQ_CD_L(i,r,t,sim)..
- PL(i,r,t,sim)*L(i,r,t,sim) =e= a_L(i,r)*PVA(i,r,t,sim)*VA(i,r,t,sim);

SPECIFICITIES

- EQ_CD_TE(i,r,t,sim)..
- PTE(i,r,t,sim)*TE(i,r,t,sim) =e= a_TE(i,r)*PVA(i,r,t,sim)*VA(i,r,t,sim);

- EQ_CD_RN(i,r,t,sim)..
- PRN(i,r,t,sim)*RN(i,r,t,sim) =e= a_RN(i,r)*PVA(i,r,t,sim)*VA(i,r,t,sim);

- EQ_CD_Q(i,r,t,sim)..
- PQ(i,r,t,sim)*Q(i,r,t,sim) =e= a_Q(i,r) *PVA(i,r,t,sim)*VA(i,r,t,sim);

SPECIFICITIES

- **2) CET on land allocation**
  - EQ_CET_WTE(i,r,t,sim)..

TE(i,r,t,sim) =e= b_TE(i,r)*TEbar(r,t,sim)

*(WTE(i,r,t,sim)/WTEbar(r,t,sim))**sigma_TE;

  - *Land can be reallocated to various uses, depending on remuneration attached (from example from cattle to cereals).*
  - *It implies as many land remuneration as there are agricultural sectors*
  - EQ_CET_WTEbar(r,t,sim)..

WTEbar(r,t,sim)*TEbar(r,t,sim) =e= sum(i,WTE(i,r,t,sim)*TE(i,r,t,sim));

Aggregate remuneration of land

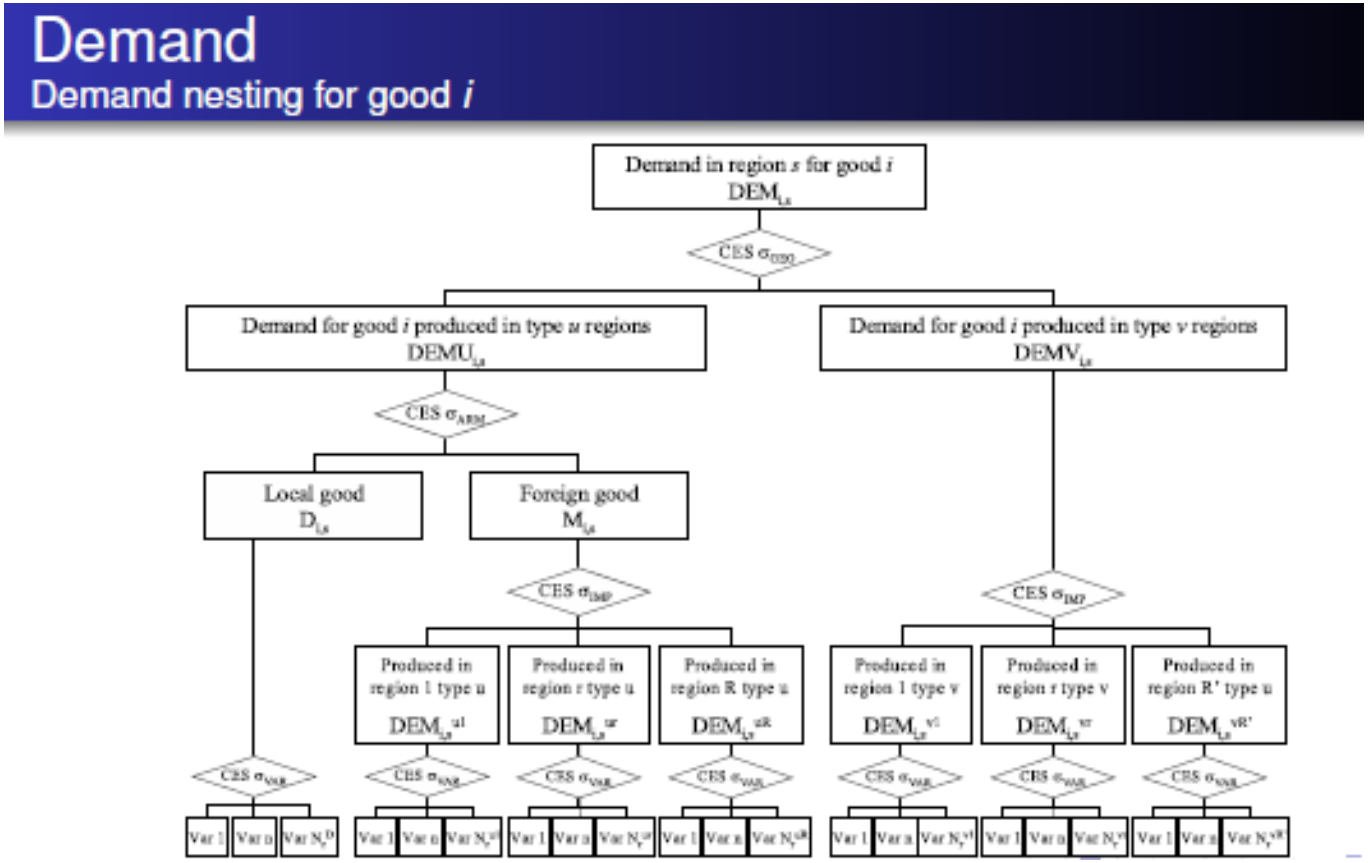
SPECIFICITIES

- **3) Specific tariff vs. Ad Valorem tariffs**
- EQ_AVEDD(i,r,s,t,sim)..

- DD(i,r,s,t,sim) =e= AdvDD(i,r,s,t,sim) + SpeDD(i,r,s,t,sim) / PCIF(i,r,s,t,sim)
- *This accounts for the variation in the protection degree of a specific tariff when world prices vary*

SPECIFICITIES

- 4) Vertical differentiation



SPECIFICITIES

- ! U = same quality region
- ! V = different quality region

- Demand of good from same region of quality
- EQ_DEMU(i,s,t,sim)..
- DEMU(i,s,t,sim) =e= a_U(i,s)*DEMTOT(i,s,t,sim)*(PDEMTOT(i,s,t,sim)/PDEMU(i,s,t,sim))**sigma_GEO(i);

- Demand of good from different region of quality
- EQ_DEMV(i,s,t,sim)$DEMVO(i,s)..
- DEMV(i,s,t,sim) =e= a_V(i,s)*DEMTOT(i,s,t,sim)*(PDEMTOT(i,s,t,sim)/PDEMV(i,s,t,sim))**sigma_GEO(i);

- EQ_PDEMTOT(i,s,t,sim)..
- PDEMTOT(i,s,t,sim)*DEMTOT(i,s,t,sim) =e= PDEMU(i,s,t,sim)*DEMU(i,s,t,sim) + (PDEMV(i,s,t,sim)*DEMV(i,s,t,sim))$DEMVO(i,s);

SPECIFICITIES

- EQ_D(i,s,t,sim)..
- D(i,s,t,sim) =e= a_D(i,s)*DEMU(i,s,t,sim)*(PDEMU(i,s,t,sim)/PD(i,s,t,sim))**sigma_ARM(i);

- EQ_M(i,s,t,sim)$MO(i,s)..
- M(i,s,t,sim) =e= a_M(i,s)*DEMU(i,s,t,sim)*(PDEMU(i,s,t,sim)/PM(i,s,t,sim))**sigma_ARM(i);

- EQ_PDEMU(i,s,t,sim)..
- PDEMU(i,s,t,sim)*DEMU(i,s,t,sim) =e= PD(i,s,t,sim)*D(i,s,t,sim)+(PM(i,s,t,sim)*M(i,s,t,sim))$MO(i,s);

SPECIFICITIES

- EQ_DEM(i,r,s,t,sim)..
- DEM(i,r,s,t,sim) =e= (a_IMP(i,r,s)*M(i,s,t,sim) *(PM(i,s,t,sim) /PDEM(i,r,s,t,sim))**sigma_IMP(i))$U(i,r,s)
- + (a_IMP(i,r,s)*DEMV(i,s,t,sim)*(PDEMV(i,s,t,sim) /PDEM(i,r,s,t,sim))**sigma_IMP(i))$V(i,r,s);

- EQ_PM(i,s,t,sim)..
- PM(i,s,t,sim)*M(i,s,t,sim) =e= sum(r$(U(i,r,s)),PDEM(i,r,s,t,sim)*DEM(i,r,s,t,sim));

SPECIFICITIES

- **5) Dynamics**

- For each variable, period t initial value is equal to period t-1 end value.
- EQ_INV(i,r,s,t,sim)..
- INV(i,r,s,t,sim)=e= B(r,t,sim)*a(i,r,s)*KTOT(i,s,t,sim)*exp(alpha*(WK(i,s,t,sim)/PINVTOT(s,t,sim)-delta(r)));
- *In many models, international financial flows result from the assumptions of perfect capital mobility across countries and sectors. This modeling is induces implausibly high cross-border capital flows.*
- *However the rate of return to capital is a natural determinant of investment sharing across sectors and countries*
- *This rate of return incorporates the influence of many FDI determinants identified in the empirical literature such as market size, growth rate or market potential (Chakrabarti, 2001).*
- *Allocating savings across sectors and regions is also a function of the initial savings allocation pattern*

- EQ_INVTOT(s,t,sim)..

INVTOT(s,t,sim) =e= sum((i,r)$INVO(i,r,s),INV(i,r,s,t,sim));

SPECIFICITIES

- EQ_K(i,r,s,Temps,sim)..

K(i,r,s,Temps,sim) =e= K_(i,r,s)*(1-delta(r)) + INV(i,r,s,Temps,sim)

Capital stock at t equal to capital stock at t-1, minus capital depreciation plus investment.

- EQ_WK(i,s,Temps,sim)..

KTOT(i,s,Temps,sim) =e= sum(r$KO(i,r,s),K(i,r,s,Temps,sim));

SPECIFICITIES

- **Land Supply**
- EQ_TEbar(r,t,sim)..

TEbar(r,t,sim) =e=
TEbarO(r)*(WTEbar(r,t,sim)/P(r,t,sim))**sigma_
Tebar(r)

Land supply increases with real remuneration of land

The evolution of total labor supply (skilled and unskilled) is exogenous.

SPECIFICITIES

- 6) Imperfect competition
  - Firms compete in a Cournot-Nash (they suppose that their decisions of production do not affect the volume of production of others).
  - No Ford effect.
  - Firms take their market power into account: their decisions can influence the sectoral or infra-sectoral price index (Cournot-Nash assumption).
  - From the absence of strategic interaction implied by the Cournot-Nash hypothesis, it follows that the mark-up is given by the Lerner formula:
- (Price-Marginal Cost)/Price=1/Perceived elasticity
- Where Perceived elasticity=$(-dQ^D/dP).(P/Q^D)$

SPECIFICITIES

- **SUPPLY SIDE**

- Fixed costs in prod'n cf(i): production involves each year a fixed cost, expressed as a fixed quantity of output.

$$NB(i,r,t,sim)*(Y(i,r,t,sim)+cf(i,r))=e= a\_VA(i,r)*VA(i,r,t,sim)$$

$$NB(i,r,t,sim)*(Y(i,r,t,sim)+cf(i,r)) =e= a\_CNTER(i,r)*CNTER(i,r,t,sim);$$

$$NB(i,r,t,sim)*PY(i,r,t,sim)*(Y(i,r,t,sim)+cf(i,r))$$

- $=e= PVA(i,r,t,sim)*VA(i,r,t,sim)+PCNTER(i,r,t,sim)*CNTER(i,r,t,sim)$

- Variable cost: $NB(i,r,t,sim)*PY(i,r,t,sim)*Y(i,r,t,sim)$ at the level of the sector
- Fixed cost: $NB(i,r,t,sim)*PY(i,r,t,sim)*cf(i,r)$ at the level of the sector

- Variable cost: $PY(i,r,t,sim)*Y(i,r,t,sim)$ at the level of the firm
- Fixed cost: $PY(i,r,t,sim)*cf(i,r)$ at the level of the firm

- Factor demand and intermediate goods demand are not modified as compared to perfect competition.

SPECIFICITIES

- EQ_PCIF(i,r,s,t,sim)$DEMO(i,r,s)..
- PCIF(i,r,s,t,sim) =e= PY(i,r,t,sim)/(1+EP(i,r,s,t,sim)) *(1+taxP(i,r,t,sim))*(1+TAXEXP(i,r,s,t,sim)+taxAMF(i,r,s,t, sim))
- <=>
- {PCIF(i,r,s,t,sim)/[(1+taxP(i,r,t,sim))*(1+TAXEXP(i,r,s,t,si m))]}/ PY(i,r,t,sim)
- =e= 1/(1+EP(i,r,s,t,sim))
- PCIF(i,r,s,t,sim)/[(1+taxP(i,r,t,sim))*(1+TAXEXP(i,r,s,t,sim))] is the price received by r's producer when selling good i on market s
- PY(i,r,t,sim) is marginal cost
- So this relation is equivalent to:
- (Price/Marginal Cost) =1/(1+EP(.))
- Where EP=$(dP/dQ^D).(Q^D/P)$
-

SPECIFICITIES

- Perceived price-elasticity of demand for sector i in region r:
  - increases with the elasticity of substitution between good i varieties produced in country r
  - Increases with the elasticity of substitution between good i baskets from region r and from other regions;
  - it is a decreasing function of the global market share of region r's producers taken together in the region s's market for good i.
- This endogenous determination of firms' mark-up allows the pro-competitive effect of trade shocks to be accounted for.

SPECIFICITIES

- Perceived elasticities (see Bchir, Decreux, Guerin and Jean, 2004; or Decreux and Valin, 2007 for justification)
- EQ_D_EP(i,s,t,sim)$(ici(i) and Oli)..
- NB(i,s,t,sim)*(EPD(i,s,t,sim)+1/sigma_VAR(i)) =e= 1/sigma_VAR(i)-1/sigma_ARM(i)
- + (1/sigma_ARM(i)-1/sigma_GEO(i))*(SDU(i,s,t,sim))$SDUO(i,s)
- + (1/sigma_GEO(i)-1/sigma_C(s))*(SDT(i,s,t,sim))$SDTO(i,s);

- EQ_U_EP(i,r,s,t,sim)$(U(i,r,s) and ici(i) and DEMO(i,r,s) and Oli)..
- NB(i,r,t,sim)*(EP(i,r,s,t,sim)+1/sigma_VAR(i)) =e= 1/sigma_VAR(i)-1/sigma_IMP(i)
- + (1/sigma_IMP(i)-1/sigma_ARM(i))*(SM(i,r,s,t,sim))$SMO(i,r,s)
- + (1/sigma_ARM(i)-1/sigma_GEO(i))*(SU(i,r,s,t,sim))$SUO(i,r,s)
- + (1/sigma_GEO(i)-1/sigma_C(r))*(ST(i,r,s,t,sim))$STO(i,r,s);

- EQ_V_EP(i,r,s,t,sim)$(V(i,r,s) and ici(i) and DEMO(i,r,s) and Oli)..
- NB(i,r,t,sim)*(EP(i,r,s,t,sim)+1/sigma_VAR(i)) =e= 1/sigma_VAR(i)-1/sigma_IMP(i)
- + (1/sigma_IMP(i)-1/sigma_GEO(i))*(SV(i,r,s,t,sim))$SVO(i,r,s)
- + (1/sigma_GEO(i)-1/sigma_C(r))*(ST(i,r,s,t,sim))$STO(i,r,s);

SPECIFICITIES

- Market shares
- EQ_SDU(i,s,t,sim)..
- SDU(i,s,t,sim)*PDEMU(i,s,t,sim)*DEMU(i,s,t,sim) =e= PD(i,s,t,sim)*D(i,s,t,sim);
- EQ_SDT(i,s,t,sim)..
- SDT(i,s,t,sim)*PDEMTOT(i,s,t,sim)*DEMTOT(i,s,t,sim) =e= PD(i,s,t,sim)*D(i,s,t,sim);
- EQ_SM(i,r,s,t,sim)..
- SM(i,r,s,t,sim)*PM(i,s,t,sim)*M(i,s,t,sim) =e= PDEM(i,r,s,t,sim)*DEM(i,r,s,t,sim);

SPECIFICITIES

- **6) Imperfect competition**
- **DEMAND SIDE**

- *** a) Imports

- EQUATIONS
- EQ_DEMVAR Demand of varieties (CES)
- EQ_PDEM Agreggate price of good from varieties
- ;

- EQ_DEMVAR(i,r,s,t,sim)$(ici(i) and DEMO(i,r,s))..
- DEM(i,r,s,t,sim) =e= DEMVAR(i,r,s,t,sim) *NB(i,r,t,sim)**(1/(1-1/sigma_VAR(i)));

- EQ_PDEM(i,r,s,t,sim)$(ici(i) and DEMO(i,r,s))..
- PDEM(i,r,s,t,sim) =e= PDEMVAR(i,r,s,t,sim)*NB(i,r,t,sim)**(1/(1-sigma_VAR(i)));

SPECIFICITIES

- ***** b) Local goods**

- EQ_DVAR(i,s,t,sim)$ici(i)..
- D(i,s,t,sim) =e= DVAR(i,s,t,sim)*NB(i,s,t,sim)**(1/(1-1/sigma_VAR(i)));

- EQ_PD(i,s,t,sim)$ici(i)..
- PD(i,s,t,sim) =e= PDVAR(i,s,t,sim)*NB(i,s,t,sim)**(1/(1-sigma_VAR(i)));

SPECIFICITIES

- **6) Imperfect competition**
- Firms income
- EQ_NB(i,r,t,sim)..
- 0=e=PY(i,r,t,sim)*(sum(s, TRADE(i,r,s,t,sim)/(1+EP(i,r,s,t,sim)))
- +
- NB(i,r,t,sim)*DVAR(i,r,t,sim)/(1+EPD(i,r,t,sim)))
- - PVA(i,r,t,sim)*VA(i,r,t,sim) - PCNTER(i,r,t,sim)*CNTER(i,r,t,sim);
- *It implies zero profit ⇔ Equation that determines NB(i,r,t,sim), the number of firms operating in sector i in country r at time t under scenario sim*

Recent extensions

- D. Recent extensions
- Just some illustrations
  - Biofuels:
    - better integration of demand for energy
    - Use of land (ILUC)
  - MIRAGE-HH
    - Taking into account the diversity of revenue sources and consumption structure to study the impact on poverty

MIRAGE - Biofuels

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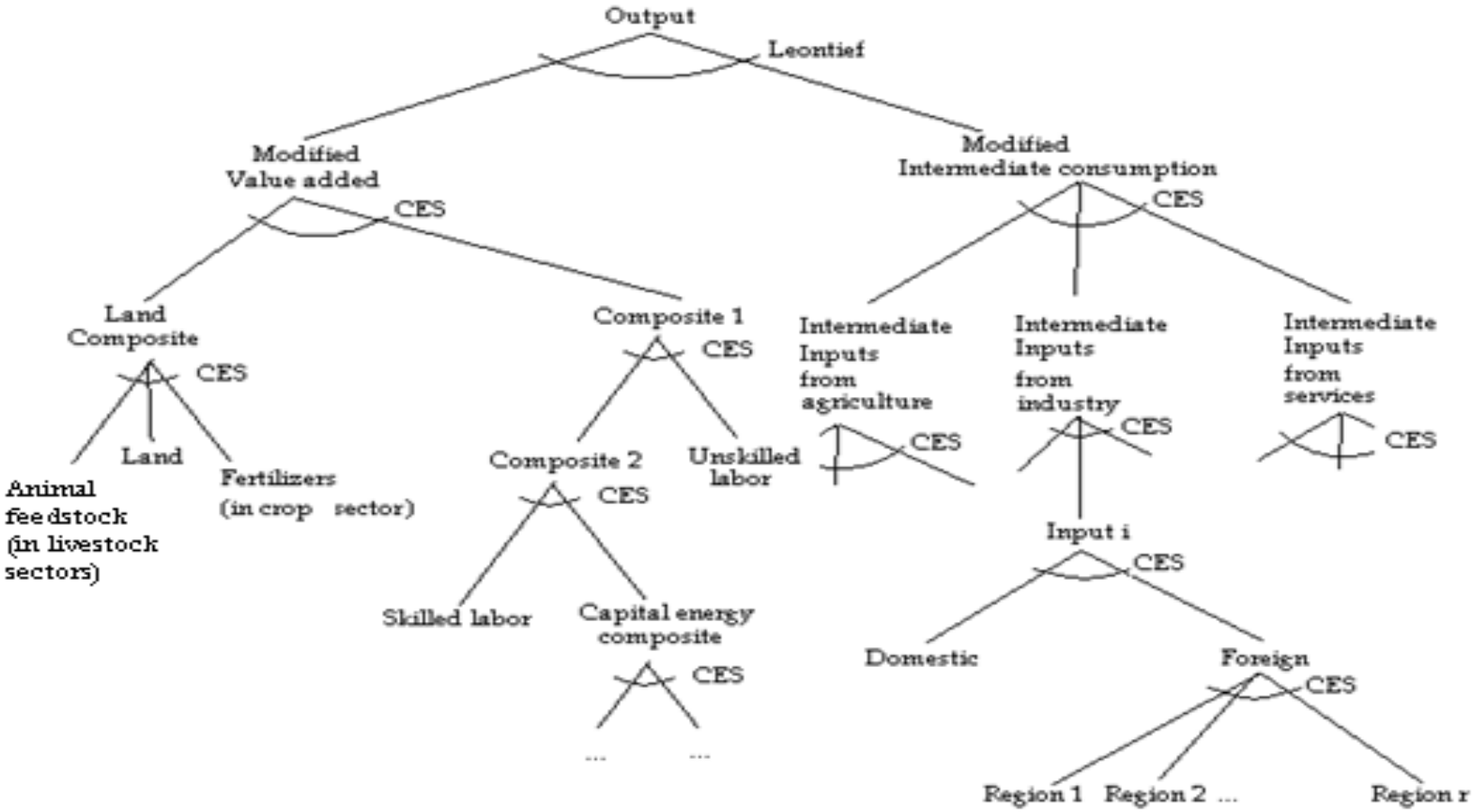
D. Recent extensions



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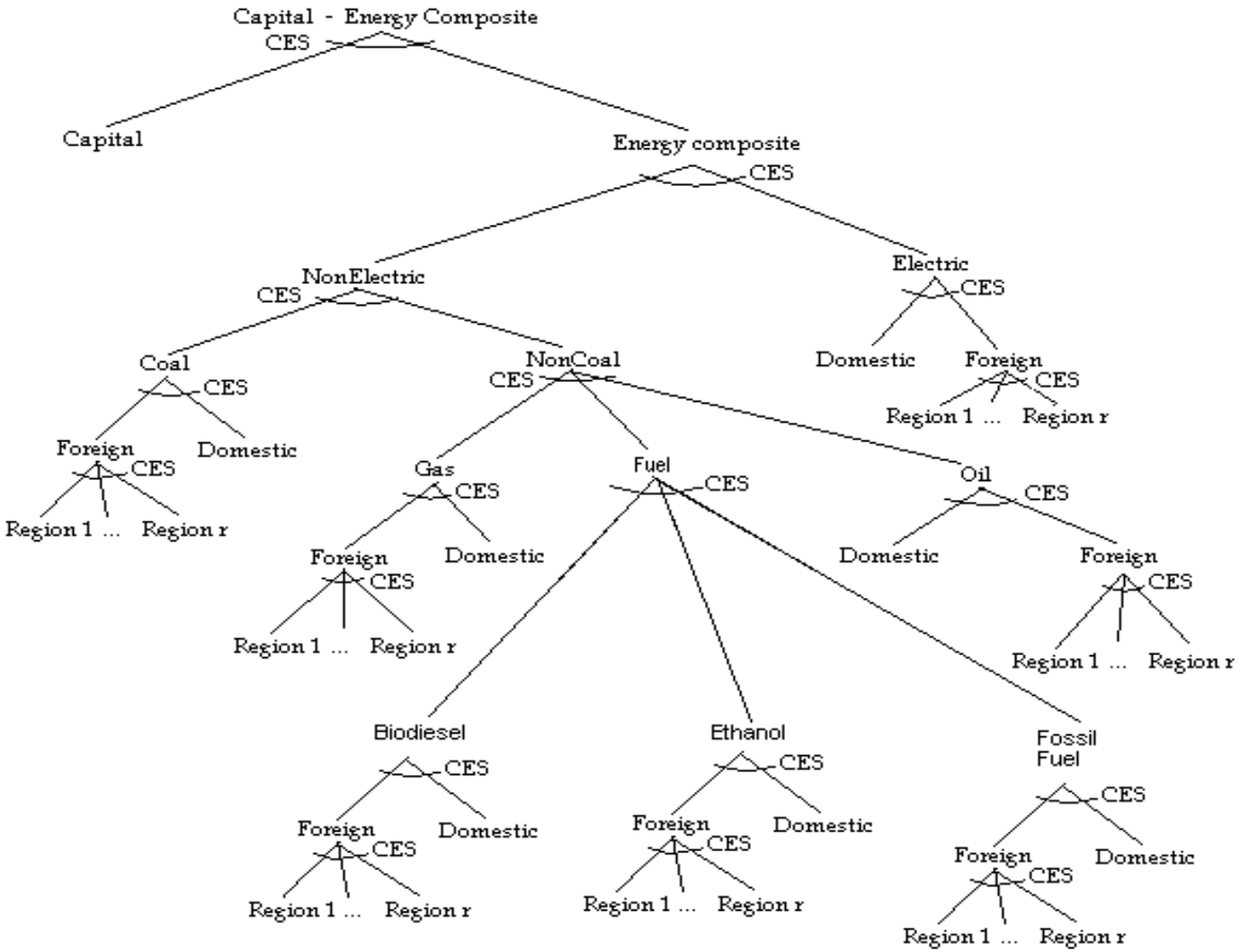
D. Recent extensions



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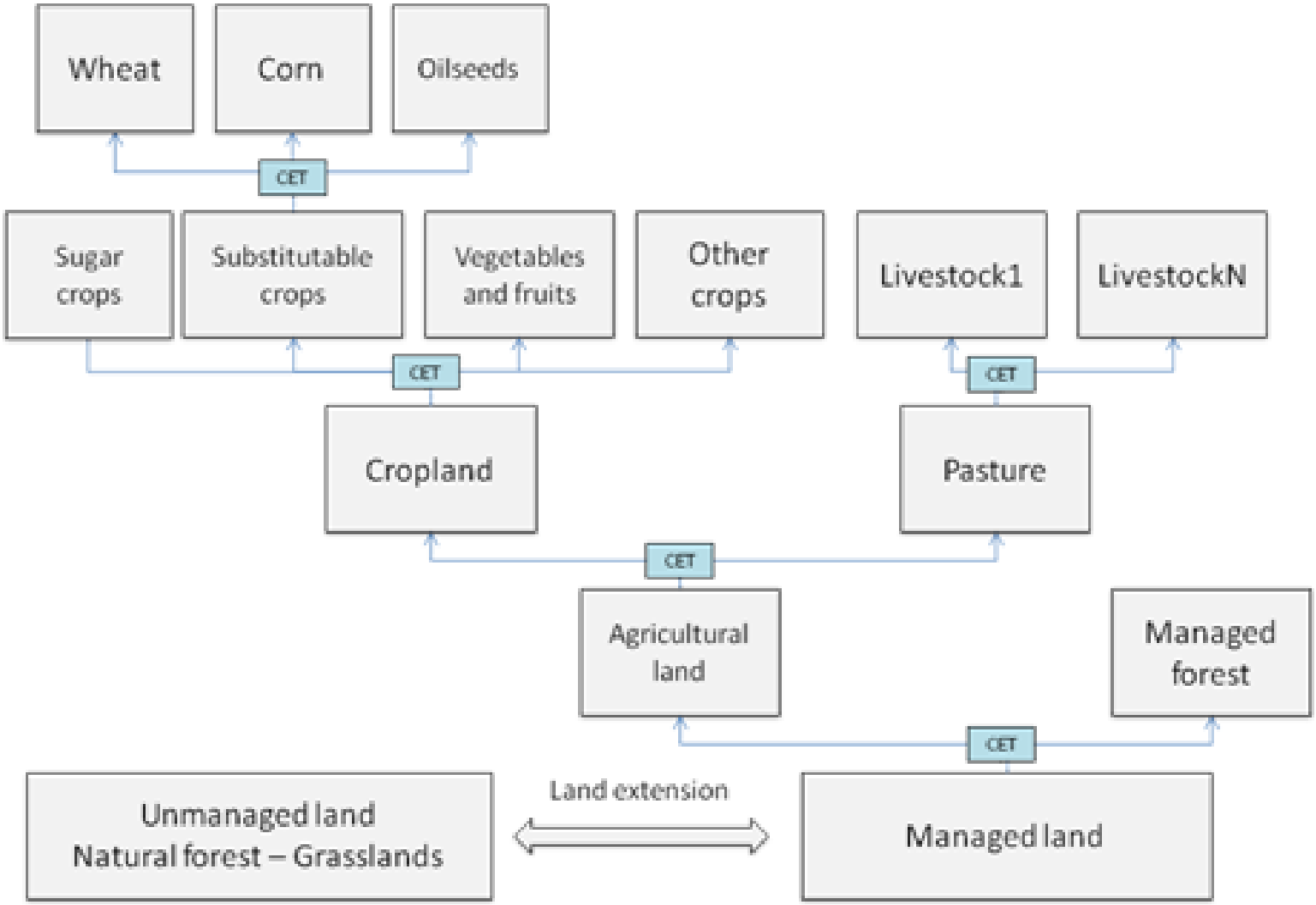
D. Recent extensions



MIRAGE - HOUSEHOLDS

MIRAGE-HH

Each private agent receives transfers from the public agent

Each private agent's income is taxed: new receipt for the pu agent

About transfers one option is that they are constant in proportion of GDP (not neutral)

- other options ? Constant in real terms ?... Different options may be proposed

- the distribution of transfers is affected ??

Savings of all private agents finance investment and public deficit

Inter-households transfers

Different closures are proposed

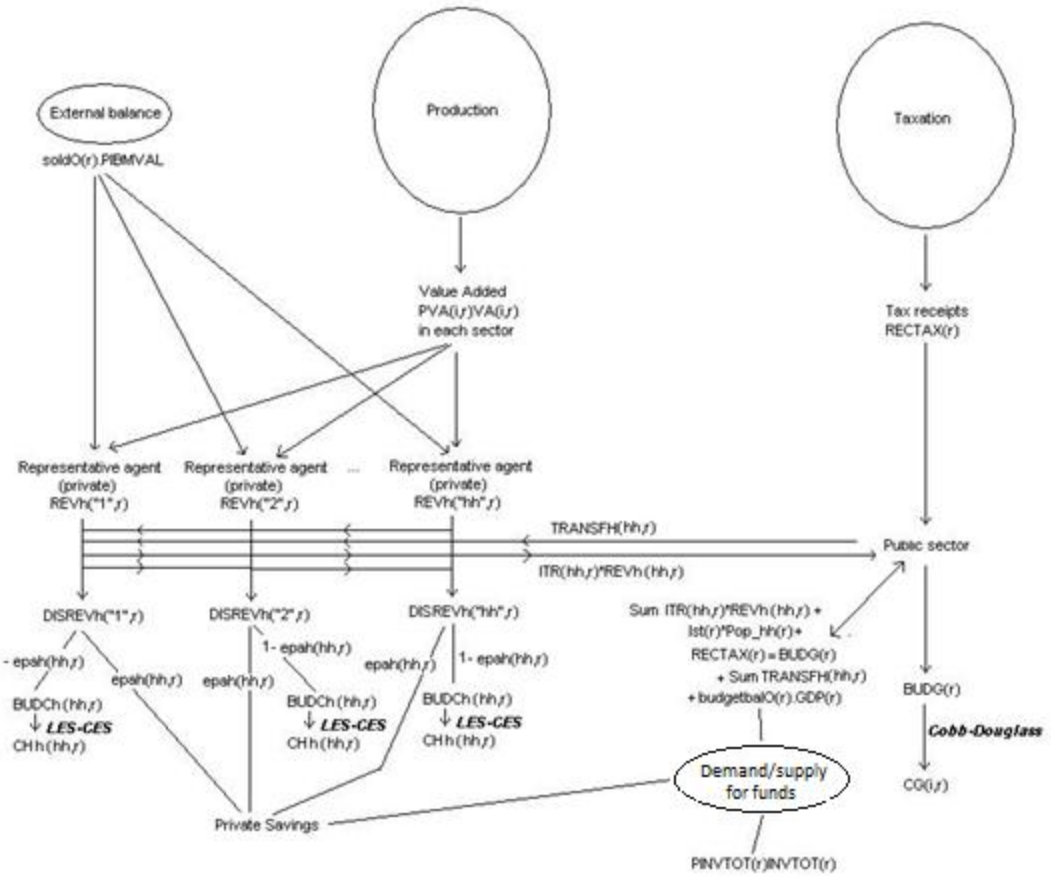
- Deficit is constant and BUDG adapts to cha in fiscal receipts (public demand is reduced by lib'n)

- Tax receipts are constant through a lump s tax on private agents

- or lump sum tax on each household (lst(r)) such that public sold is constant in terms of GDP

- Another tax is changed (consumption tax / income tax)

-- Redistribution policies



Annex

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Multilateral scenarios - DDA vs. Protectionist scenarios

Global results (in volume terms – in % in the upper part of the table – in $ billion in the lower part of the table) led by tariffs and domestic support changes – Change compared to the baseline in 2025

- From Bouet and Laborde, *World Trade Review*, 2010, 9: 319-351.

		DDA	***Up_to_Bound***	***Bound & DDA***	***Up_to_MAX***	***Max & DDA***
World exports in goods and services [(a)]		*1.90*	*-9.93*	*-5.70*	*-4.23*	*-1.19*
of which	*Agro-food*	5.47	-20.26	-13.42	-9.36	-4.52
	Industry	1.96	-9.77	-5.07	-4.36	-0.95
World Welfare		*0.09*	*-0.51*	*-0.25*	*-0.19*	*-0.04*
of which	*North*	0.07	-0.32	-0.20	-0.14	-0.08
	South	0.13	-1.00	-0.35	-0.32	0.06
World exports in goods and services [(a)]		*363*	*-1899*	*-1090*	*-808*	*-227*
of which	*Agro-food*	73	-269	-178	-124	-60
	Industry	279	-1389	-721	-621	-135
World Welfare		*59*	*-353*	*-169*	*-134*	*-26*
of which	*North*	33	-156	-100	-70	-37
	South	26	-197	-69	-64	11

Regional trade Agreements
South Asean Free Trade Agreement

Real income effect under trade liberalization scenarios, year 2020. Scenario/Baseline

	Full Trade Liberalization		SAFTA Scenario I		SAFTA Scenario II	
	Percentage change	Change in million $US	Net Income gains	Change in million $US	Net Income gains	Change in million $US
United States	0.12	1.19	0.00	0.00	0.00	0.01
European Union - 25	0.61	4.39	0.00	0.00	0.00	0.00
Japan	1.27	4.33	0.00	0.00	0.00	0.00
Rest of Developed Countries	1.77	2.65	0.00	0.00	0.00	0.00
Bangladesh	-0.77	-0.04	-0.02	0.00	-0.51	-0.02
India	1.10	0.54	0.02	0.01	0.10	0.05
Pakistan	0.49	0.04	0.09	0.01	0.17	0.01
Sri Lanka	2.35	0.04	0.19	0.00	0.92	0.01
Rest of South Asia	0.44	0.01	0.36	0.01	0.25	0.01
China	0.20	0.22	0.00	0.00	-0.01	-0.01
Indonesia	1.26	0.16	-0.01	0.00	-0.03	0.00
Korea	2.93	1.08	0.00	0.00	0.00	0.00
Malaysia	4.28	0.16	-0.02	0.00	-0.04	0.00
Singapore	1.14	0.09	0.00	0.00	-0.02	0.00
Taiwan	0.38	0.10	0.00	0.00	0.00	0.00
Thailand	2.91	0.29	-0.01	0.00	-0.03	0.00
Viet Nam	2.05	0.07	0.00	0.00	-0.01	0.00
Rest of Developing Asia	-0.17	-0.03	0.00	0.00	0.00	0.00
Iran	0.73	0.08	0.00	0.00	-0.01	0.00
Rest of Middle East	0.47	0.27	-0.01	0.00	-0.02	-0.01
Rest of the World	0.10	0.27	0.00	0.00	0.00	-0.01

- From Bouet, Corong and Thomas, 2010, IFPRI Discussion Paper, #950

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Regional trade Agreements Specific Modelling of FDI

Impact of Free Trade between Latin American countries and Asian countries – Macroeconomic variables - % Scenario/baseline - 2020

- From Bouet, Estrades, Laborde, *Journal of Policy Modelling*, 2012(34): 193-210.

Region	Region	Exports (value, no intra trade)	GDP (volume)	Terms of trade	Welfare
Andean countries	Latin America	6.4	0.20	-0.81	-0.11
Argentina	Latin America	5.5	0.49	1.17	0.67
Brazil	Latin America	8.4	0.26	0.52	0.27
Central America	Latin America	10.8	0.18	-1.26	-0.21
Chile	Latin America	4.5	0.65	1.39	1.20
Rest of Mercosur	Latin America	10.4	1.62	3.13	2.60
Venezuela	Latin America	2.3	0.02	-0.66	-0.31
ASEAN	Asia	0.6	-0.02	-0.03	-0.03
Central Asia	Asia	3.3	0.58	1.52	1.31
China	Asia	0.8	0.02	0.07	0.04
Hong Kong and Singapore	Asia	0.1	0.00	0.02	0.03
India	Asia	2.7	0.02	-0.37	-0.01
Japan	Asia	0.9	0.06	0.01	0.03
Korea	Asia	0.6	0.08	0.11	0.16
South Asia	Asia	1.0	-0.02	-0.08	-0.02

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Percentage change in Export Volume in 2020 – Scenario/Baseline

Various scenarios of Duty Free Quota Free

	Region	B_LDCsonly	C_OtherSVEs	All LICs(1)
Least Developed Countries	Bangladesh	4.16	3.46	3.38
	Ethiopia	1.35	-0.49	0.90
	Madagascar	-0.03	-2.28	-0.70
	Malawi	12.97	4.71	11.15
	Mozambique	0.39	-0.48	0.21
	Senegal	1.16	0.80	1.12
	Rest of South East Asia	2.52	2.40	2.25
	Rest of Africa	0.08	0.49	0.29
Low-income Countries	Pakistan	-0.04	-0.05	11.90
	Vietnam	-0.01	-0.06	18.00
Additional SVEs	Bolivia	-0.03	3.46	-0.02
	Paraguay	-0.04	16.95	-0.03
	Sri Lanka	-0.01	20.94	-0.27

(1) Additional scenario included all the LICs. All other developing countries are not reported here, but do not present significant variations.

From Bouet, Dienesch, Elliott and Laborde, 2012, *Journal of Globalization and Development, 2012(1).*