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# From Factors content to Trade in value-added

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# Factors content

The concept of Factors content comes from the Heckscher-Ohlin model.

This model is rooted on neoclassical supply-side theory.

This model shows the consequences of moving from autarky to international trade between two countries (later among several countries)

# HO Basic Assumptions

There are:

2 products

2 factors

2 countries

The original HO model is also mentioned as the

**2x2x2 model**

# Basic Assumptions

## About production functions

- 1) The production functions for goods X and Y exhibit constant return to scale
- 2) These functions are the same in both countries
- 3) One product is *capital-intensive* and the other product is *labor-intensive*

# Basic Assumptions

## About factors

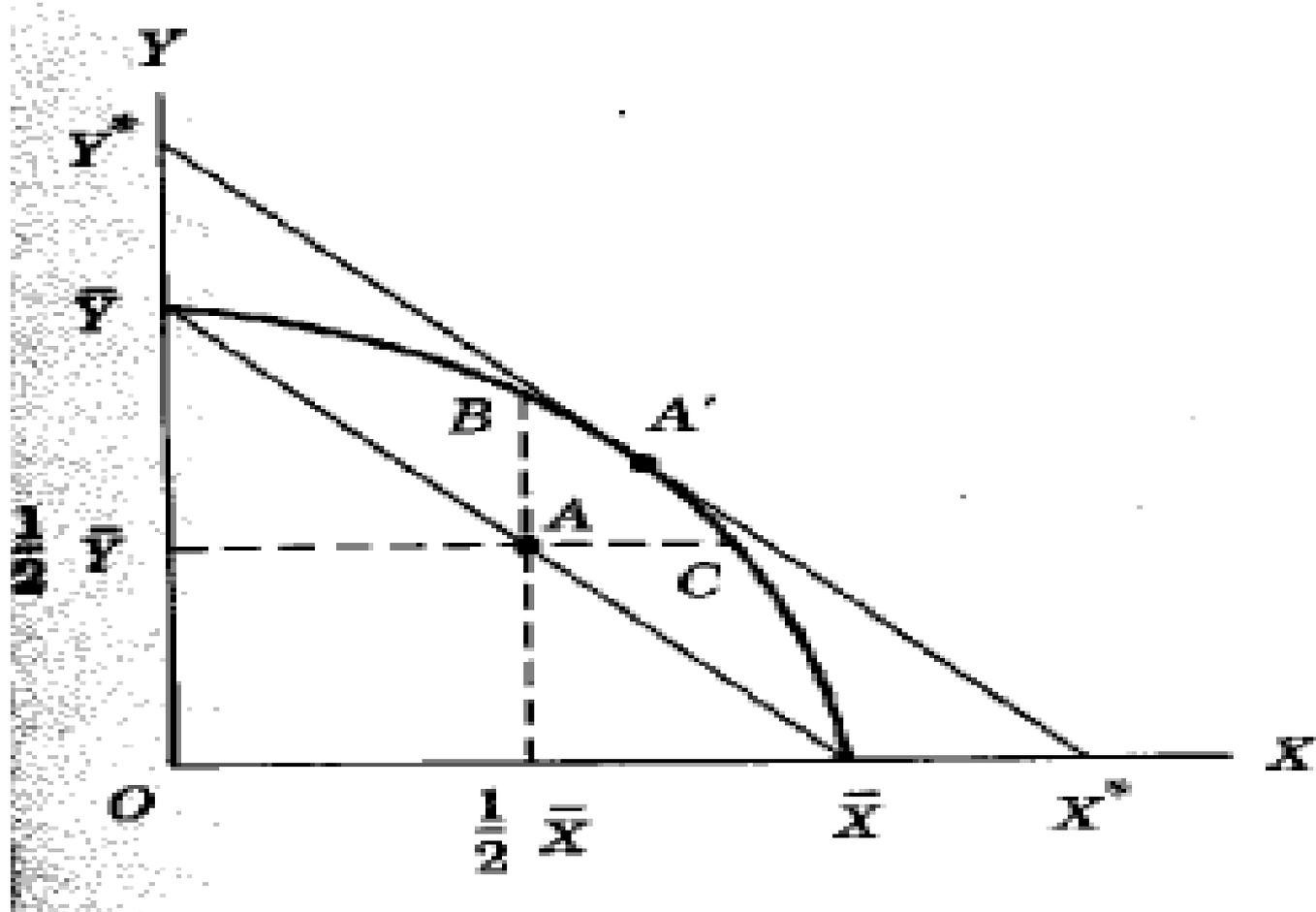
- 1) There are two factors: ***labor*** and ***capital***
- 2) They are homogeneous and perfectly mobile between industries within each country
- 3) Labor and capital are perfectly immobile between countries
- 4) No market distortions: factors are fully employed

# Basic Methodology Assumptions

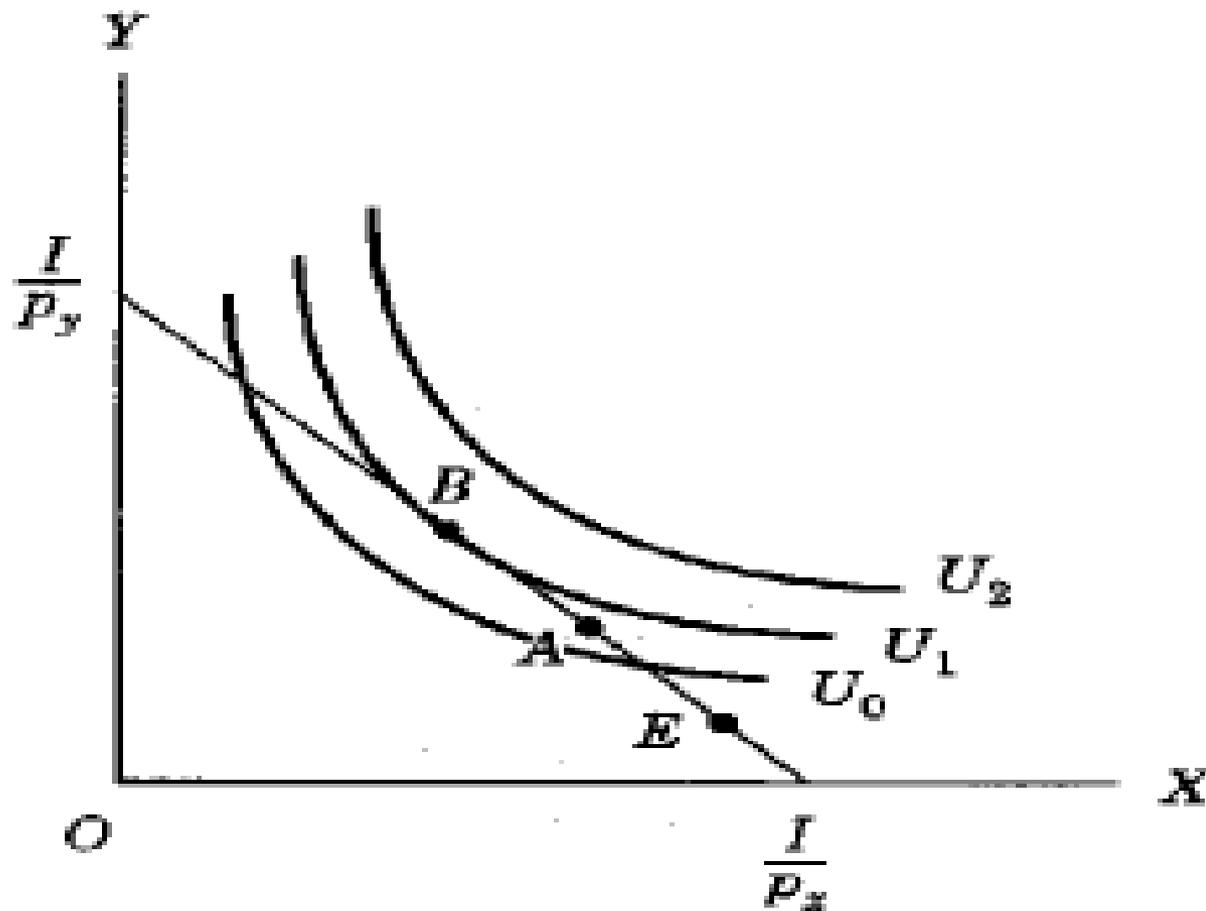
## About preferences

1) In both countries, preferences are taken to be identical and homogeneous

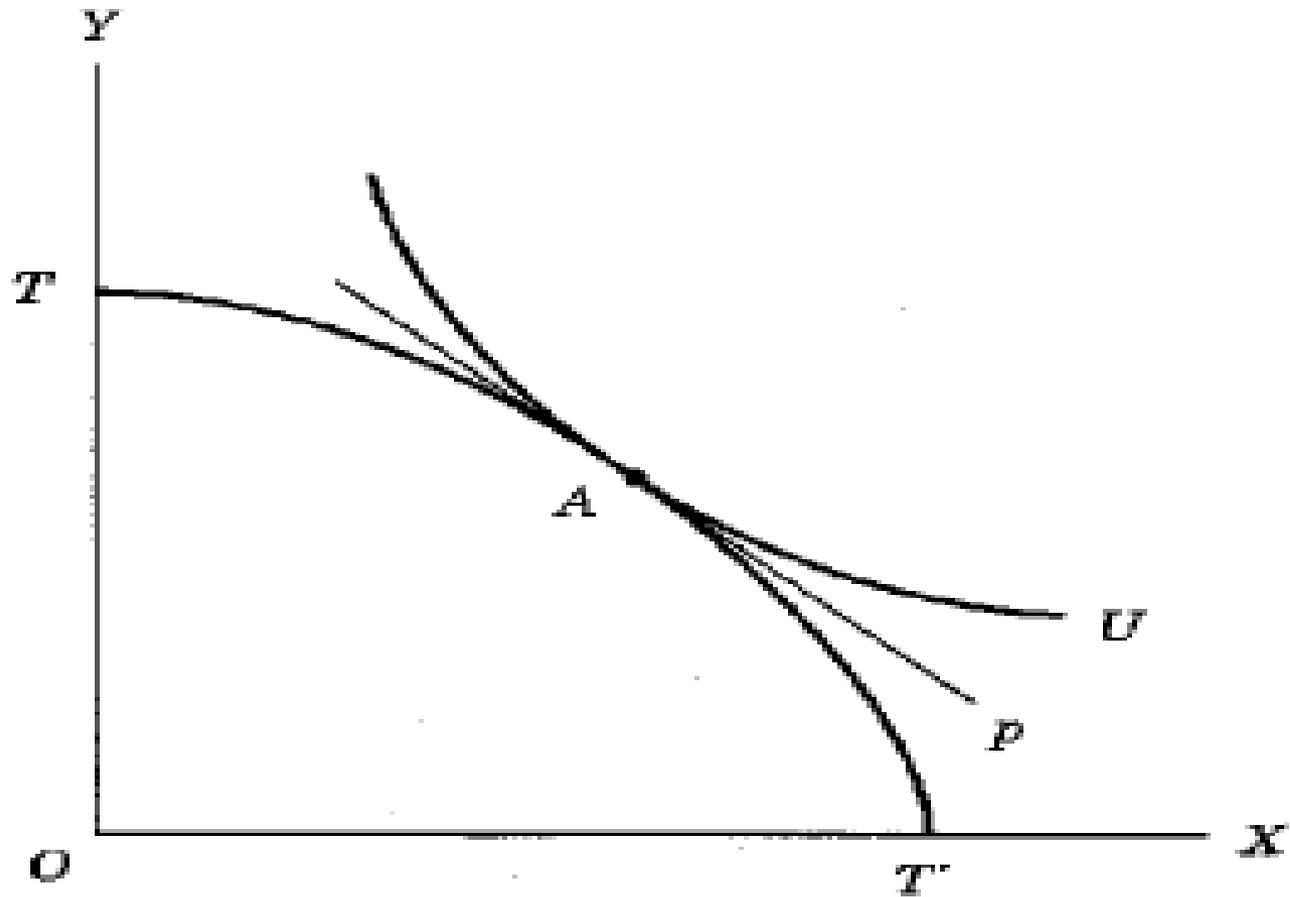
# The production «possibility frontier»



# Preferences

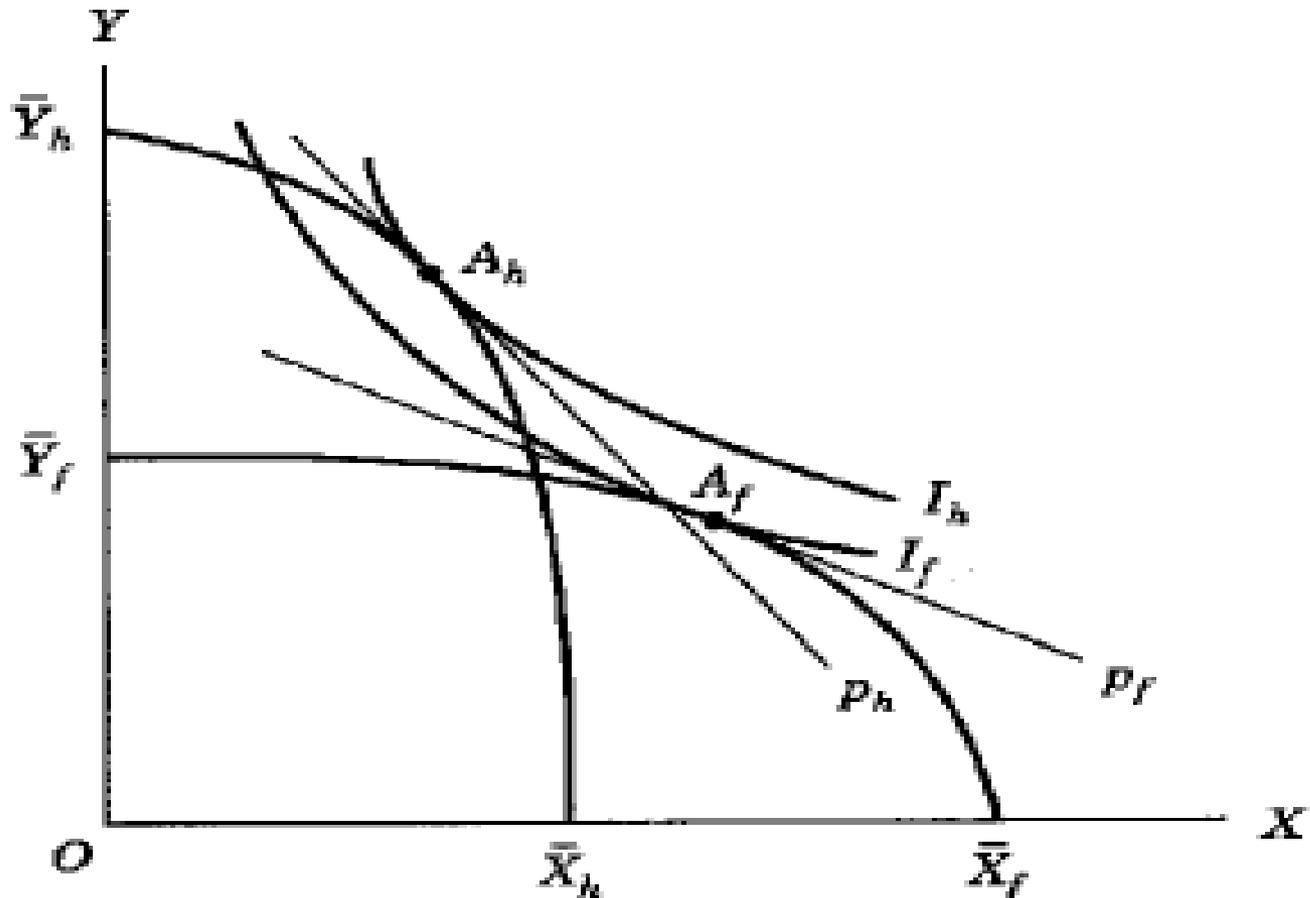


# The equilibrium in a closed economy



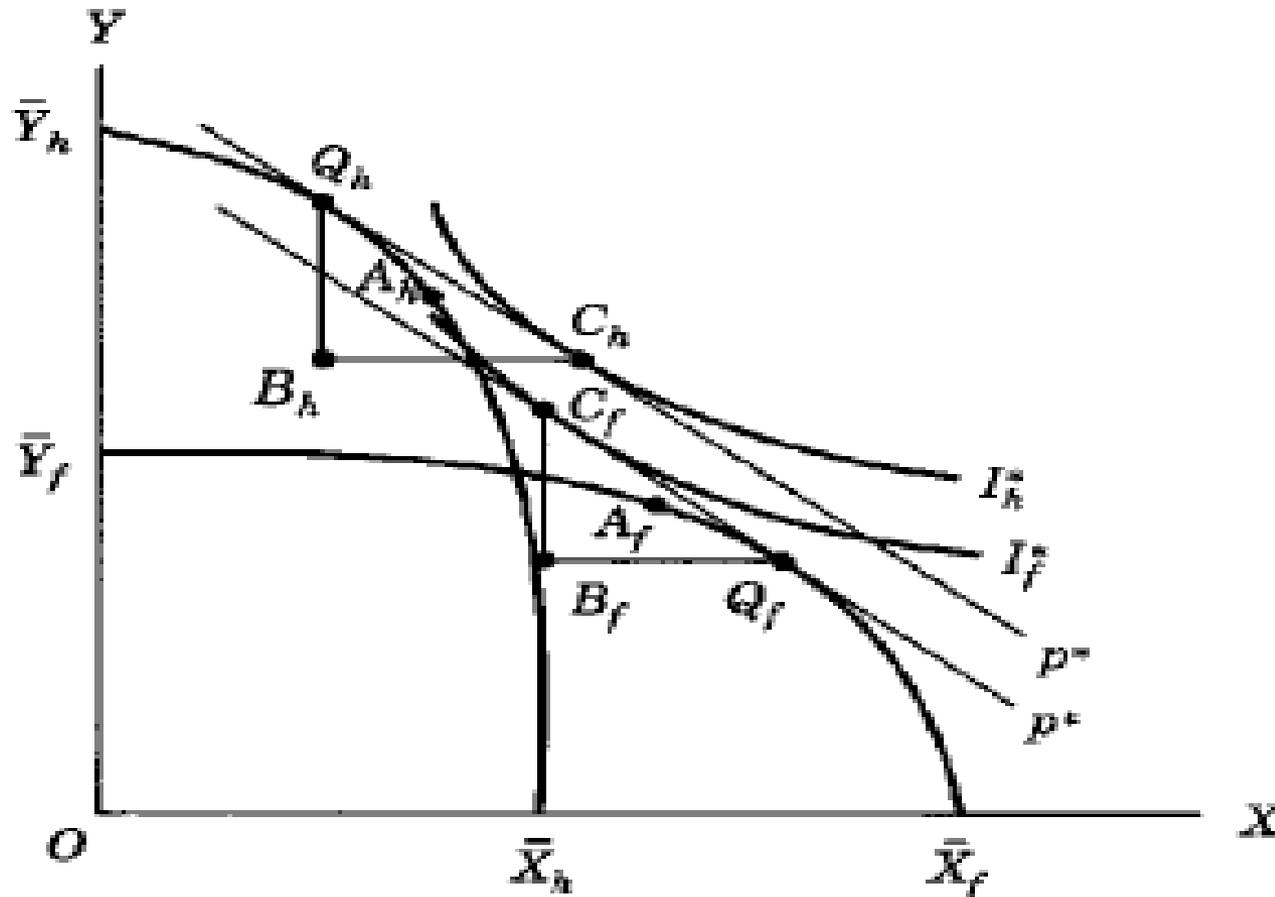
# The effect of endowment differences

## No trade – The autarky equilibrium



# The international trade equilibrium

The trade balance condition is satisfied



# The comparative advantages

- The David Ricardo theory is then proved within the neoclassical paradigm.
- Labor and capital (not only labor) are the immobile factors
- Products are mobile and labor and capital are their Factors content
- Factors content becomes mobile by means of mobile products

# Developments of the HO model

Edward Leamer (1995) gave an elegant version of the HO general equilibrium model based on a set of assumptions.

He wrote that with equal number of goods and factors, the production side of the model can be summarized by system of equations such as

$$q = A^{-1}v \quad \text{and} \quad w = A'^{-1}p$$

# Developments of the HO model

These two equations are revealing the basic foundations of HO model

a)  $q = A^{-1}v$  states that the relationship between factors and outputs are connected by a one-to-one mapping (*Leamer calls  $A$  the input-output matrix*)

b)  $w = A'^{-1}p$  “*is the inverted form of the zero-profit conditions equating product price ( $p$ ) to production costs ( $A'w$ )*”

# Generalizations of HO model

- The model under the above  $2 \times 2 \times 2$  specification was inadequate to look for any evidence from the available statistical data (outputs and trade on commodities)
- The most famous extension of the HO model is due to Vanek. This is why the HO model is also mentioned as HOV model in the field of empirical researches

# After the Development ...the Evidence.

About the evidence .....

Leamer undertook the problem to look for empirical evidence:

- A) selecting the level of commodity aggregation
- B) measuring time series of output per worker
- C) detecting resource supplies
- D) computing correlations etc. etc. etc.

# Commodity aggregation in HO framework (example from Leamer)

- 1) Petroleum
- 2) Raw materials
- 3) Forest products
- 4) Tropical agriculture
- 5) Animal products
- 6) Cereals, etc.
- 7) Labor intensive
- 8) Capital intensive
- 9) Machinery
- 10) Chemicals

# Factors endowment in HO framework (example from Leamer)

- 1) Capital
- 2) Labor professional
- 3) Literate labor
- 4) Illiterate labor
- 5) Tropical land
- 6) Arid land
- 7) Mesothermal land
- 8) Microthermal land
- 9) Minerals
- 10) Coal output
- 11) Crude oil outputs

# The evidence

from Bowen, Leamer, Sveikauskas (1987) Abstract

*The Heckscher-Ohlin-Vanek model predicts relationships among industry input requirements, country source supplies, and international trade in commodities. These relationships are tested using data on twelve resources, and the trade of twenty-seven countries in 1967. The Heckscher-Ohlin propositions that trade reveals gross and relative factor abundance are not supported by these data. The Heckscher-Ohlin-Vanek equations are also rejected in favour of weaker models that allow technological differences and measurement errors.*

# The evidence

Davis and Weinstein (2003) in "The Factor Content of Trade" complain that:

*"understanding how to incorporate traded intermediates into factor content studies remains an important area for future research"*

# Products and Factors endowment

As shown before (Leamer) the set of equations

$$q = A^{-1}v$$

define the relationship between factors and outputs where  $q$  is a vector of products and  $v$  a vector of factors.

$A$  is just the converter of factors into products as well as products into factors ( $v = Aq$ ).

# Where to find traded intermediates

Eventually, researchers studying the relationship between factors endowment and trade 'discovered' input-output tables.

Matrix  $A$  changed its role: no longer a converter.

# Factor content legacy

- Trefler and Zhu (2010) and Dietzenbacher and Los (2010 and 2012) tackle the problem of a correct factors content definition within input-output tables.
- In the input-output table, factors are hidden behind value-added flows
- Now Factors content in trade has been substituted by Trade in value-added

# Warning!!!

- the sectoral value added is expected to be divided between labor and capital ..... but
- labor can be seen behind wages, but it is hard to see capital supporting all the rest of value added
- relevant component of the operating surplus are dependent on the 'market power' (Cervantes, Fujii (2014)) and on the economic cycle (Grassini (2012))
- Furthermore, social securities, provisions, indirect taxes and subsidies on production and wages are variables strongly influenced by economic policies

From the OECD-WTO project

**TRADE IN VALUE-ADDED: CONCEPTS,  
METHODOLOGIES AND CHALLENGES  
(JOINT OECD-WTO NOTE)**

MARCH 2012

# The definition of value added share

Given  $v$ , vector of value added by industry, and  $V$ , vector of value added shares by industry, the relationship

$$v = \hat{V} x$$

(where  $\hat{V}$  is a diagonal matrix with the value added shares along the main diagonal) is the yardstick relationship which links value added to any final demand components

# The international input-output table

the OECD-WTO task (Koopman et al (2012))

$$\begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_G \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} & \dots & A_{1G} \\ A_{21} & A_{22} & \dots & A_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ A_{G1} & A_{G2} & \dots & A_{GG} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_G \end{bmatrix} + \begin{bmatrix} Y_{11} + Y_{12} & \dots & + Y_{1G} \\ Y_{21} + Y_{22} & \dots & + Y_{2G} \\ \vdots & & \\ Y_{G1} + Y_{G2} & \dots & + Y_{GG} \end{bmatrix}$$

The matrices of intermediate coefficients

$A_{ij}$  is the import matrix of country  $i$  from country  $j$

$A_{ii}$  is the domestic intermediate of country  $i$

# The Leontief equation from the International input-output table

$$\begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_G \end{bmatrix} = \begin{bmatrix} B_{11} & B_{12} & \dots & B_{1G} \\ B_{21} & B_{22} & \dots & B_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ B_{G1} & B_{G2} & \dots & B_{GG} \end{bmatrix} \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_G \end{bmatrix}$$

$$X = BY$$

# The value added shares matrix

- The  $(N \times G) \times (N \times G)$  diagonal matrix of value added shares

$$V = \begin{bmatrix} \hat{V}_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \hat{V}_G \end{bmatrix}$$

From Leontievia multipliers.....  
..... to value added content

$$VB = \begin{bmatrix} \hat{V}_1 & \dots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \dots & \hat{V}_G \end{bmatrix} \begin{bmatrix} B_{11} & B_{12} & \dots & B_{1G} \\ B_{21} & B_{22} & \dots & B_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ B_{G1} & B_{G2} & \dots & B_{GG} \end{bmatrix}$$

..... and after that.....

.....here is the value added content

$$VB = \begin{bmatrix} \hat{V}_1 B_{11} & \hat{V}_1 B_{12} & \dots & \hat{V}_1 B_{1G} \\ \hat{V}_2 B_{21} & \hat{V}_2 B_{22} & \dots & \hat{V}_2 B_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ \hat{V}_G B_{G1} & \hat{V}_G B_{G2} & \dots & \hat{V}_G B_{GG} \end{bmatrix}$$

.....decompositions down the hill....

From Koopman *et al* (2012):

*After defining value-added trade in term of final demand, let us show next how a country's gross exports can be decomposed into its various value-added components and how its double counted portion can be measured.*

# 1. Concluding remarks

The shift from 'factors content' to 'trade in value-added' is characterized not only by the choice of the data set. More important is the difference between the methodology supporting the researches concerning the 'factors content' in the wake of the Vanek prediction with respect to those regarding the 'trade in value-added' shown in the OECD-WTO note.

## 2. Concluding remarks

Getting predictions from a theoretical model (the HOV model), collecting data to test such predictions, defining alternative hypotheses, working in the framework of the statistical inference, looking for correlations, detecting explanatory variables, sentencing the theory 'true' or 'false', rejecting a model in favour of other models and so on, is a methodology at present totally ignored by the research programme described in the OECD-WTO note.

### 3. Concluding remarks

The 'trade in value-added' methodology is strictly related to linear algebra manipulation of input-output tables. The researcher in this field acts believing that the input-output table may help reveal new accounting identities.

Furthermore, the researcher intentionally ignores the difference between the concept of 'factors content' and the sectoral value-added defined in any input-output table.

# The Trade in value-added Researchers' *last request*

From Koopman (2012):

*We have shown how the decomposition results could be used to re-compute revealed comparative advantages index at country/sector level and believe there are many other applications that may affect our understanding of the pattern of global trade if we could improve the value-added trade and domestic content estimates at the sector levels.*

# The last call

*This will need joint efforts by statistical agencies and academic communities across the world.*

The positive answer in .....

**TRADE IN VALUE-ADDED:  
CONCEPTS, METHODOLOGIES AND CHALLENGES  
(JOINT OECD-WTO NOTE)**

Mar 2012

Country coverage of OECD Input-Output Database (as of March 2012)

OECD	mid-90s	early-00s	mid-00s	Non-OECD	mid-90s	early-00s	mid-00s
Australia	1994/95	1998/99	2004/05	Argentina	1997	-	-
Austria	1995	2000	2005	Brazil	1995	2000	2005
Belgium	1995	2000	2005	China	1995	2000	2005
Canada	1995	2000	2005	Chinese Taipei	1996	2001	2006
Chile	1996	-	2003	Cyprus	1995	2000	2005
Czech Republic	1995	2000	2005	India	1993/94	1998/99	2006/07
Denmark	1995	2000	2005	Indonesia	1995	2000	2005
Estonia	1997	2000	2005	Latvia	-	-	2004
Finland	1995	2000	2005	Lithuania	-	-	2005
France	1995	2000	2005	Malaysia	-	2000	-
Germany	1995	2000	2005	Malta	-	2000	2004
Greece	1995	2000	2005	Romania	-	2000	2005
Hungary	1998	2000	2005	Russian Federation	1995	2000	-
Iceland	-	-	-	Singapore*	1995	2000	2005
Ireland	1998	2000	2005	South Africa	1993	2000	2005
Israel	1995	-	2004	Thailand	-	-	2005
Italy	1995	2000	2005	Viet Nam	-	2000	-
Japan	1995	2000	2005	EU27	-	-	2005
Korea	-	2000	2005				
Luxembourg	1995	2000	2005				
Mexico	-	-	2003				
Netherlands	1995	2000	2005				
New Zealand	1995/96	2002/03	-				
Norway	1995	2000	2005				
Poland	1995	2000	2005				
Portugal	1995	2000	2005				
Slovak Republic	1995	2000	2005				
Slovenia	1996	2000	2005				
Spain	1995	2000	2005				
Sweden	1995	2000	2005				
Switzerland	-	2001	2006				
Turkey	1996	1998	2002				
United Kingdom	1995	2000	2005				
United States	1995	2000	2005				

\*: not published - internal use only

Available year, -: not available

# Derived statistics (from the NOTE)

The I-O tables show transactions between domestic industries but as a complement to these tables are supplementary tables which break down total imports by user (industry and category of final demand). Some countries provide these import tables in conjunction with their I-O tables but in some cases they are derived by the OECD Secretariat.

# “efforts for creative statistics”

(from the NOTE)

Central to the construction of an international input-output database is the estimation of trade flows between countries. Indeed, these trade flows in intermediate goods and services are the glue which tie together the individual input-output matrices derived from national accounts.

# Some doubts?

(from a FOOTNOTE of the NOTE)

Global Forum “Measuring Global Trade — Do we have the right numbers?” 2-4 February 2011, jointly organised by the United Nations Statistics Division (UNSD), the Statistical Office of the European Communities (Eurostat) with the World Trade Organization (WTO) and the United Nations Conference on Trade and Development (UNCTAD).

***Thank you for your attention!***