GDP is a measure of output, not welfare.
Or, HOS meets the SNA

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ESCoE Conference on Economic Measurement 2019,
King's College London,
8-10 May 2019

CFM CENTRE FOR MACROECONOMICS

LSE THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

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This talk is based on

Nicholas Oulton, “GDP is a measure of output, not welfare. Or, HOS meets then SNA”.

Economic Statistics Centre of Excellence,

ESCoE DP 2019-06, March 2019.
https://www.escoe.ac.uk/download/3608

My view

- GDP can be an *indicator* of welfare, even though it is not a good *measure* of welfare.
- But we can do better: we can use the SNA to develop genuine measures of welfare.
- GDP is a measure of *output*. Output still matters a lot so we need to measure it well.

THE ISSUE TODAY

This presentation has a narrower focus:

How should exogenous changes in the **terms of trade** (the export price relative to the import price) be treated? Do they change GDP? Or both welfare and GDP? Or just welfare?

To answer this, I use two textbook models of a small open economy. I ask

- How would an economic theorist answer these question?
- Would a national income accountant, with access to all the necessary data and applying SNA 2008, agree?

The two models

Model 1

The country produces both goods which are for final consumption. Good 1 is exported, good 2 imported.

(any textbook of international trade)

Model 2

The country specialises on good 1. Good 1 is for final consumption and export, good 2 is an imported intermediate input (e.g. energy) into good 1.

(Bruno and Sachs 1985; Barsky and Kilian 2002; Blinder and Rudd 2008)

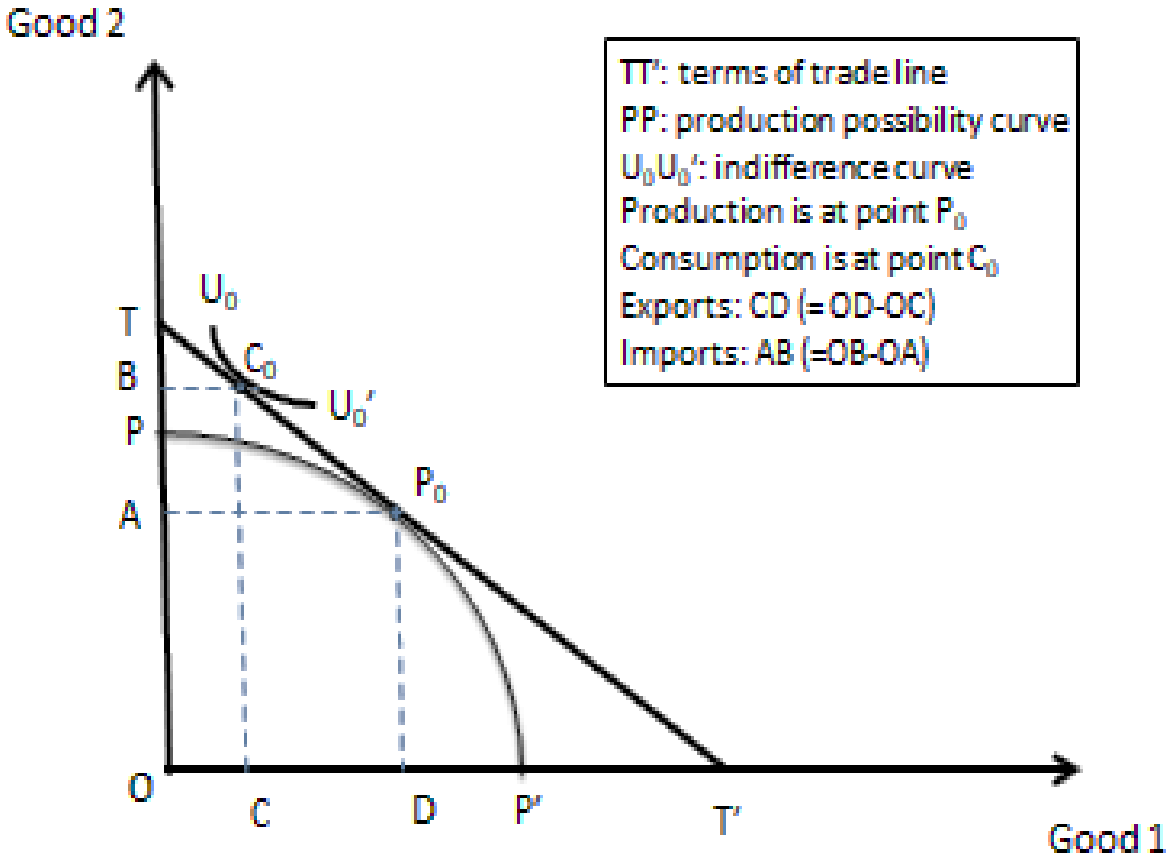
Anticipating the conclusions

- In both models, the theorist says that GDP is constant but welfare (consumption) increases.
- The national income accountant, applying SNA 2008, would (basically) agree.
- *Caveat*: the theory assumes change can be measured continuously by Divisia indices. But in practice discrete approximations must be used. So agreement of theorist and accountant is not exact.

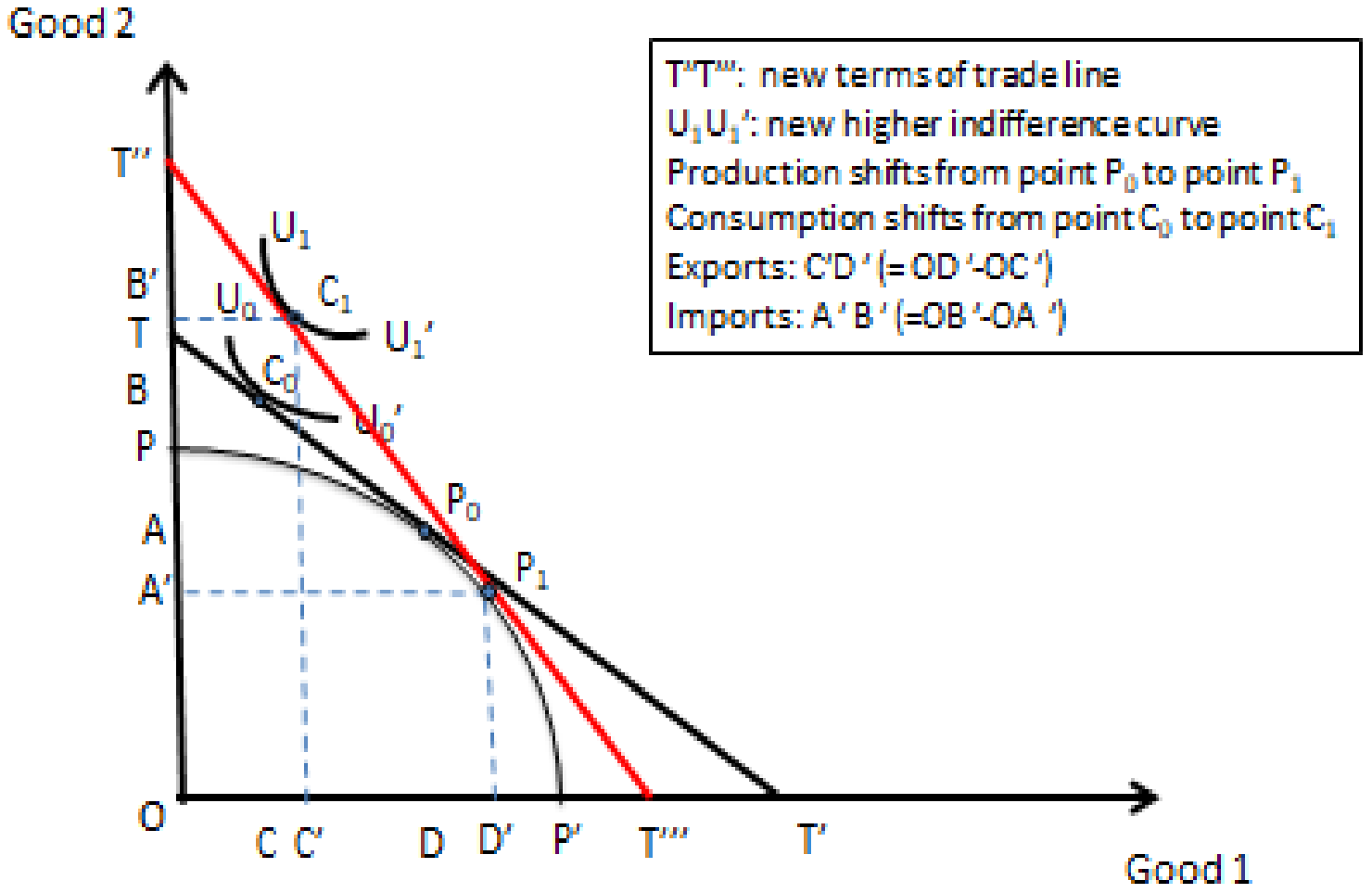
Hecksher-Ohlin-Samuelson (HOS) model of a trading economy

- Small open economy. Terms of trade are exogenous.
- 2 goods. The country exports good 1.
- Technology and factor endowments (land and labour) are fixed. *No saving or investment*.
- Constant returns to scale and perfect competition, so prices equal marginal costs and factors paid their marginal products.

Model 1


Good 2
TT': terms of trade line
PP: production possibility curve
U0U0': indifference curve
Production is at point P0
Consumption is at point C0
Exports: CD (= OD-OC)
Imports: AB (=OB-OA)
U0
T
C0
B
U0'
P
P0
A
O
C
D
P'
T'
Good 1

Model 1, after improvement in terms of trade



The theorist's answer for Model 1

- Welfare increases since the economy moves to a higher indifference curve.
- There has been a reallocation of resources towards the export good. The economy moves *around* the production possibility curve. But the curve does not shift since factor endowments and technology are fixed.
- On a reasonable definition, aggregate output is unchanged.

Aggregate output in Model 1

The production possibility frontier $\left(\text{or transformation curve}\right)$:

$$F(Y_1, Y_2; R, L, \tau) = 0$$

Y_1, Y_2 : outputs of goods 1 and 2

R, L : endowments of land (R) and labour (L), both constant

τ: level of technology (constant)

In a competitive economy, the slope of the production possibility frontier equals the relative price of the two goods. This implies that, moving around the frontier,

$$s_{Y_1}^{GDP}\hat{Y}_1 + s_{Y_2}^{GDP}\hat{Y}_2 = 0$$

where

a hat denotes a growth rate, e.g. $\hat{Y}_1 = d \ln Y_1 / dt$

and

$s_{Y_1}^{GDP}, s_{Y_2}^{GDP}$: shares of goods 1 and 2 in the total value of output (GDP)

Divisia indices

The Divisia index of aggregate output Y is defined as:

$$\hat{Y} = s_{Y_1}^{GDP}\hat{Y}_1 + s_{Y_2}^{GDP}\hat{Y}$$

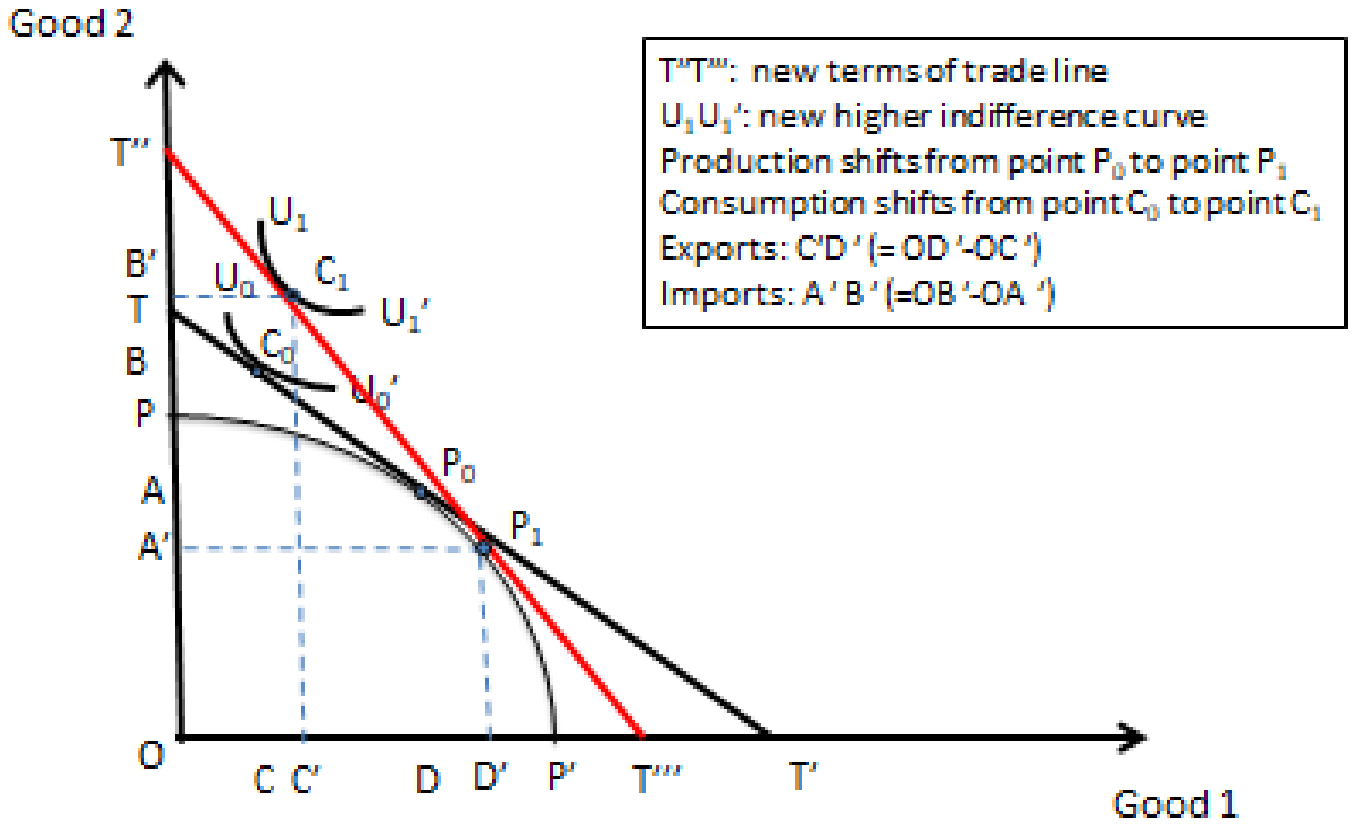
But for Model 1 we have just found that

$$s_{Y_1}^{GDP}\hat{Y}_1 + s_{Y_2}^{GDP}\hat{Y}_2 = 0$$

So we have shown that under the assumptions of Model 1

$$\hat{Y} = 0$$

Improvement in terms of trade is thought of as taking place over a finite interval, say (0,T)



Total change over a finite interval

The Divisia index of aggregate output gives the instantaneous growth rate at a point in time. The total proportionate change over a finite interval $(0, T)$ is given by integration:

$$\log\left(\frac{Y(T)}{Y(0)}\right) = \int_0^T \hat{Y}(t)dt = \int_0^T \left[s_{Y_1}^{GDP} \hat{Y}_1 + s_{Y_2}^{GDP} \hat{Y}_2 \right] dt$$

$$= 0 \text{ in this case.}$$

This is the continuous analogue of a discrete chain index.

Properties of Divisia indices

1. Price index times quantity index equals value index:
2. Divisia indices are consistent in aggregation

$$PQ = Z$$

(These properties are not shared by any discrete index number in common use.)

Only one problem: Divisia indices are defined in continuous time!

Would the national income accountant agree with the theorist about Model 1? (1)

Yes.

If the national income accountant measured growth in real GDP by a Divisia index, he/she would find that *empirically*

$$\hat{Y}(t) = 0, \qquad 0 \leq t \leq T$$

So the total change in GDP between 0 and *T* is zero, in agreement with the theorist.

A national-accounts-based welfare measure

- Real consumption is a good measure of welfare in Model 1.
- If household demand is homothetic, a Divisia price index of consumption is also a true cost-of living index.
- So welfare can be measured *either* by nominal consumption deflated by the Divisia *price* index of consumption or by the Divisia *quantity* index of consumption.

Welfare versus output

- In Model 1, nominal consumption is equal to nominal GDP because the trade balance is zero.
- But real consumption is growing faster than real GDP, when both are measured by Divisia indices:

$$\hat{C} = -s_M^{GDP}(\hat{X}_1 - \hat{M}_2)$$

$$= s_M^{GDP}(\hat{P}_1 - \hat{P}_2) = s_M^{GDP}\,\hat{p} \;> 0$$

p : terms of trade ($:=P_1 / P_2$)

s_M^{GDP} : share of imports in GDP

Would the national income accountant agree with the theorist about Model 1? (2)

- Yes.
- The national income accountant would find that real consumption had increased while real GDP had stayed constant.
- It follows that GDP is a measure of output but not a measure of welfare.
- But, going beyond GDP, the SNA does allow one to measure welfare using real consumption.

Model 2

The country specialises on good 1. Good 1 is for final consumption and export, good 2 is an imported intermediate input (e.g. energy) into good 1.

(Bruno and Sachs 1985; Barsky and Kilian 2002; Blinder and Rudd 2008)

Model 2: theory

Production function for good 1:

$$Y_1 = Y_1(R, L, M_2, \tau)$$

Land (*R*), labour (*L*) and technology (τ) assumed fixed. So fall in relative price of imported energy (*M*) leads to increase in volume of imports which raises output of good 1:

$$\dot{Y}_1 = \frac{\partial Y_1}{\partial M_2}\dot{M}_2$$

or

$$\hat{Y}_1 = \left(\frac{s_M^{GDP}}{1 + s_M^{GDP}}\right)\hat{M}_2 > 0$$

assuming inputs are paid their marginal products.

Back to the national accounts …

Empirically, the national income accountant in model 2 would then find:

$$\hat{Y} = (1 + s_M^{GDP})\hat{Y}_1 - s_M^{GDP}\hat{M}_2 = 0$$

i.e. *no change in GDP*. But welfare (real consumption of good 1) *rises*:

$$\hat{C}_1 = -s_M^{GDP}(\hat{X}_1 - \hat{M}_2)$$

$$= s_M^{GDP}\hat{p} > 0 \qquad p: \text{terms of trade}$$

NB: volume of imports rises faster than that of exports (trade balance is zero).

Summary

- In both models, GDP is **constant** but welfare (real consumption) **rises** when the terms of trade improve.
- This is because the models are static. In Model 2 allowing capital to be accumulated would cause GDP to increase.
- There is a third case: the second good is an imported *capital* good. Improving terms of trade now lead to faster capital accumulation so that both GDP and consumption (welfare) rise (Oulton 2012).

Coming down to earth a bit …

- Data are discrete, not continuous. So Divisia indices can’t be calculated.

Real world indices

- Annually-chained indices (Laspeyres, Fisher or Törnqvist) are now the standard. They are the real world counterparts of Divisia indices
- They can be regarded as approximations to Divisia indices.
- Perhaps the approximations may get better if the world moves over time to quarterly or even monthly chaining? (It's already moved from fixed base to annual chaining).

Conclusions

- GDP is a measure of output, not welfare.
- But welfare can be measured within the framework of the SNA.
- Divisia indices provide a sound conceptual basis for measuring prices and volumes in the national accounts.

THE END

ADDITIONAL SLIDES

Divisia indices

Suppose we have some aggregate

$$Z = \sum_{i=1}^{i=N} p_i q_i$$

We want to split this into an average price P and an average quantity Q:

$$PQ = \sum_{i=1}^{i=N} p_i q_i = Z$$

Calculus tells us that

$$\hat{P} + \hat{Q} = \sum_{i=1}^{i=N} s_i \hat{p}_i + \sum_{i=1}^{i=N} s_i \hat{q}_i \qquad s_i := p_i q_i / Z, \text{ the shares}$$

So define

$$\hat{P} := \sum_{i=1}^{i=N} s_i \hat{p}_i \qquad \hat{Q} := \sum_{i=1}^{i=N} s_i \hat{q}_i$$

NB: the shares can change continuously with time.

Properties of Divisia indices

1. Price index times quantity index equals value index: $PQ = Z$
2. Divisia indices are consistent in aggregation

These properties are not shared by any index number in common use.

Only one problem: Divisia indices are defined in continuous time!

François Divisia (1889-1964)

National accounts in Model 1

Supply Use relationships:

$$P_1 Y_1 = P_1 C_1 + P_1 X_1$$

$$P_2 Y_2 + P_2 M_2 = P_2 C_2$$

GDP:

$$GDP(E) := P_E E \equiv P_1 C_1 + P_2 C_2 + P_1 X_1 - P_2 M_2$$

$$GDP(O) := P_Y Y \equiv P_1 Y_1 + P_2 Y_2$$

Easy to see that

$$GDP(E) = GDP(O)$$

$$\hat{P}_E = \hat{P}_Y$$

$$\hat{E} = \hat{Y}$$

National accounts in Model 2

Supply Use relationships:

$$P_1 Y_1 = P_1 C_1 + P_1 X_1$$

GDP:

$$GDP(E) := P_E E \equiv P_1 C_1 + P_1 X_1 - P_2 M_2$$
$$GDP(O) := P_Y Y \equiv P_1 Y_1 - P_2 M_2$$

Easy to see that:

$$GDP(E) = GDP(O)$$
$$\hat{P}_E = \hat{P}_Y, \qquad \hat{E} = \hat{Y}$$

Divisia index for GDP:

$$\hat{Y} = (1 + s_M^{GDP})\hat{Y}_1 - s_M^{GDP}\hat{M}_2$$

What does SNA 2008 say?

- Chapter 15: “Real GDI = Real GDP + Trading gain”. Real GDI is a welfare measure, a step on the road to “Real net national disposable income”.
- Trading gain is:

$$\text{Trading gain} = \frac{P_X X - P_M M}{P} - (X - M)$$

- In Models 1 and 2, the first term is zero. The second term corresponds to the effect on real consumption derived for Models 1 and 2.
- So no conflict here.

The trade balance

- Both Models 1 and 2 exclude saving and investment and therefore assume a zero trade balance.
- In a closed economy, the best welfare measure is net national income deflated by a consumption price index. I.e. net investment should be deflated by the consumption price index, not by the investment price index. (Weitzman 1976; Sefton and Weale 2006).
- In an open economy, Sefton and Weale (2006) argue that the trade balance should also be deflated by the consumption price index.
- SNA 2008 is agnostic on this. But ***unfortunately*** ESA 2010 recommends deflating by an average of export and import price indices.