

Alternative Output, Input and Income Concepts for the Production Accounts

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Background

GDP is not a measure of income.

- GDP **includes** depreciation as part of “income”
- GDP **excludes** resource depletion (or augmentation)

The international System of National Accounts (SNA) was last revised in 2008. A new revision is underway which it seems will take at least the resource problem into account.

We look at the current SNA production accounts and suggest a way forward that addresses the above problems.

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Summary

- Definitions of output and input are key to the national accounts of countries, and productivity studies
- We consider alternative measures of income generated by the production sector of an economy
- The differences in definitions have their roots in an Austrian model of production (Böhm-Bawerk 1891) and the debate between Pigou (1941) and Hayek (1941) on the maintenance of physical versus financial capital
- Systematically review alternative definitions at production unit and aggregate levels, illustrating different perspectives on production and income
- A case is made for their use in understanding different aspects of firm and country economic performance
- **Stay within the current production boundaries of the SNA 2008.** Not a contribution to the growing literature on “Beyond GDP” concepts nor on “GDP and Beyond”, but rather focussed on alternatives within the existing SNA production boundary.

Summary

- Our basic approach is to take depreciation out of user costs, replace user costs by waiting costs and replace gross investment by the changes in the capital stocks of the production unit over the accounting period.
- Our approach to firm accounting is essentially the same as that advocated by Hicks (1961) and the accountants Edwards and Bell (1961).
- “...the Closing Capital Stock is an Output, a Stock Output to match the Flow Output of Consumption Goods...**capital appears both as input and as output**” John R. Hicks (1961; 23).

The Accounting Framework for a Firm

Production unit's *pure profits*:

$$\Pi^t \equiv P_Y^t Q_Y^t - P_Z^t Q_Z^t - P_{IP}^t Q_{IP}^t - P_L^t Q_L^t + P_K^t Q_K^t - (1 + r^t) P_K^{t-1} Q_K^{t-1}$$

P_Y^t \equiv (unit value) price of output Y during period t ;

Q_Y^t \equiv total quantity of output y produced during period t ;

P_Z^t \equiv (unit value) price of intermediate input Z purchased during period t ;

Q_Z^t \equiv total quantity purchased of intermediate input Z purchased during period t ;

P_{IP}^t \equiv (unit value) price of one unit of an investment good *purchased* during period t ;

Q_{IP}^t \equiv total number of units of the investment good *purchased* during period t ;

P_L^t \equiv wage rate for one hour of labour used by the producer during period t ;

Q_L^t \equiv total hours worked in period t by the type of labour under consideration;

P_K^t \equiv price of a unit of the capital stock held by the unit at the end of period t ;

Q_K^t \equiv quantity of the capital stock held by the production unit at the end of period t ;

P_K^{t-1} \equiv price of a unit of the capital stock held by the unit at the beginning of period t ;

Q_K^{t-1} \equiv quantity of the capital stock held by the unit at the beginning of period t ;

r^t \equiv period t cost of capital for the production unit.

Accounting Framework for a Firm

Define period t *total investment* as the sum of purchased investment, plus internally produced investment:

$$Q_I^t = Q_{IP}^t + Q_{II}^t$$

End-of-period capital stock:

$$Q_K^t = (1 - \delta^t)Q_K^{t-1} + Q_I^t$$

where δ^t is the *period t geometric depreciation rate* that is applied to the production unit's beginning of the period capital stock Q_K^{t-1} in order to obtain the number of constant quality units of the initial capital stock at the end of period t that are equivalent to new units of the capital stock.

Accounting Framework for a Firm

Using $P_K^t = (1 + i^t)P_K^{t-1}$, we can re-write pure profits:

$$\begin{aligned}\Pi^t &= P_Y^t Q_Y^t - P_Z^t Q_Z^t - P_{IP}^t Q_{IP}^t - P_L^t Q_L^t \\ &\quad + (1 + i^t)P_K^{t-1}[(1 - \delta^t)Q_K^{t-1} + Q_I^t] - (1 + r^t)P_K^{t-1}Q_K^{t-1} \\ &= P_Y^t Q_Y^t - P_Z^t Q_Z^t - P_{IP}^t Q_{IP}^t + P_K^t Q_I^t - P_L^t Q_L^t - U^t Q_K^{t-1}.\end{aligned}$$

where U^t is the user cost of capital:

$$\begin{aligned}U^t &= [(1 + r^t) - (1 + i^t)(1 - \delta^t)]P_K^{t-1} \\ &= [r^t - i^t + (1 + i^t)\delta^t]P_K^{t-1}\end{aligned}$$

Conventional economic accounting would immediately capitalize all investments and define *conventional pure profits* of the production unit as follows:

$$\Pi^{t*} \equiv P_Y^t Q_Y^t - P_Z^t Q_Z^t - P_L^t Q_L^t - U^t Q_K^{t-1}$$

Alternative Domestic Net Output, Input and Income Concepts

Gross Domestic Input or Income generated by the production unit, GDI^t :

$$GDI^t \equiv P_L^t Q_L^t + U^t Q_K^{t-1} + \Pi^t$$

Gross Domestic Output, GDO^t , is then defined as follows, plugging the definition of Π^t into GDI^t :

$$\begin{aligned} GDO^t &\equiv P_Y^t Q_Y^t - P_Z^t Q_Z^t - P_{IP}^t Q_{IP}^t + P_K^t Q_I^t \\ &= CVA^t + P_K^t Q_I^t \\ &= GDI^t \end{aligned}$$

where *Comprehensive Value Added* is

$$\begin{aligned} CVA^t &\equiv P_Y^t Q_Y^t - P_Z^t Q_Z^t - P_{IP}^t Q_{IP}^t \\ &= VA^t - P_{IP}^t Q_{IP}^t \end{aligned}$$

and regular value added is $VA^t \equiv P_Y^t Q_Y^t - P_Z^t Q_Z^t$.

Note: If $P_K^t = P_{IP}^t$ and $Q_I^t = Q_{IP}^t$, then $CVA^t = VA^t$.

Alternative Domestic Net Output, Input and Income Concepts

Net Domestic Income generated by the production unit:

$$\begin{aligned}NDI^t &\equiv GDI^t - (1 + i^t)\delta^t P_K^{t-1} Q_K^{t-1} \\ &= P_L^t Q_L^t + [r^t - i^t] P_K^{t-1} Q_K^{t-1} + \Pi^t\end{aligned}$$

Plug in the definition of Π^t to get *Net Domestic Output* NDO^t produced by the production unit.

We can also define *Comprehensive Net Domestic Income*, $CNDI^t$, and the corresponding *Comprehensive Net Domestic Output*, $CNDO^t$.

These different concepts are summarized in the following table.

Alternative Domestic Net Output, Input and Income Concepts

Output Concepts	Income Concepts
$GDO^t = CVA^t + P_K^t Q_I^t$	$GDI^t = P_L^t Q_L^t + [r^t - i^t + (1 + i^t)\delta^t]P_K^{t-1} Q_K^{t-1} + \Pi^t$
$NDO^t = GDO^t - (1 + i^t)\delta^t P_K^{t-1} Q_K^{t-1}$	$NDI^t = P_L^t Q_L^t + [r^t - i^t]P_K^{t-1} Q_K^{t-1} + \Pi^t$
$CNDO^t = NDO^t + i^t P_K^{t-1} Q_K^{t-1}$	$CNDI^t = P_L^t Q_L^t + r^t P_K^{t-1} Q_K^{t-1} + \Pi^t$

Notice how the definitions change as components of traditional user cost are moved from the income column to the output column.

If i^t is negative due to obsolescence or other reasons, then $CNDO^t$ will be less than NDO^t .

That is: the comprehensive net income measure is a **maintenance of financial capital approach** to the measurement of income whereas the net income measure is a **maintenance of real physical capital approach**.

Alternative Domestic Net Output, Input and Income Concepts

Which income concept is “best”?

- The gross income concept clearly overstates sustainable consumption and so this concept can be dismissed.
- Choosing between the other perspectives is more difficult: reasonable economists could differ on this choice.
- The merits of the two perspectives were discussed by Pigou and Hayek over 80 years ago.
 - Pigou (1941; 273-274) favoured the maintenance of physical capital approach
 - Hayek (1941; 276-277) favoured the maintenance of real financial capital approach.
- Hayek noted that obsolescence of a capital good leads to a loss of income which is not captured in the maintenance of physical capital approach to income measurement but it is captured in the maintenance of financial capital approach.

Alternative Domestic Net Output, Input and Income Concepts

- The current System of National Accounts omits the capital terms from Gross Domestic Product if the asset K is land or a natural resource.
- Our suggested measures of **net output** are more consistent with “green accounting” and the sustainability literature than the current System of National Accounts.

Alternative Domestic Net Output, Input and Income Concepts

Generating estimates of the nominal income generated by a production unit is not the end of the story.

To evaluate the contributions of a production sector to the creation of income, it is necessary to convert the nominal income measure into a real income measure:

The nominal measure of income should be divided by a consumer price index to convert nominal income flows into real income flows

The aggregate income concepts are straightforward summations of the production unit income contributions.

Conclusion

As Hicks (1946; 184) said in his income chapter: “What a tricky business this all is!”

The current System of National Accounts for the production sector of the economy are not suitable for all purposes:

- i. They do not allow changes in resource stocks and land usage to enter the flow accounts of the production sector;
- ii. They include depreciation as part of “income” and
- iii. They do not allow capital gains or losses on beginning of the period asset holdings to enter the definition of “income”.

Our suggested Comprehensive Net Domestic Income measure addresses the above problems.

We propose Comprehensive Net Domestic Income and Output as supplements to the current SNA.