Review of Income and Wealth
Series 45, Number 4, December 1999

THE ROLE OF FINANCIAL CAPITAL IN PRODUCTION

BY STEVEN KEUNING

Statistics Netherlands

It is increasingly acknowledged that the financial structure of a firm is an important determinant of its production costs. This paper argues that the use of a firm's liabilities should be seen as a separate input in the production process. At the same time, the input of non-financial assets is limited to the value that is used up during the reference period. The paper elaborates on these ideas and shows their use in empirical work. It is concluded that the approach set out in this paper establishes a much closer relationship of general economic accounting and analysis to business economics.

1. INTRODUCTION

Present theories of economic growth assume that the contribution of financial capital to production can be analyzed separately from the contribution of the "real" production factors labour, physical capital, etc.[1] In other words, it is assumed that the way in which a firm is financed has nothing to do with its production "technology." It is increasingly acknowledged, though, that in practice the financial structure of the firm is an important determinant of its economic activity (e.g. Gertler, 1988) and investment (Scaramozzino, 1997). In any case, transactions money is needed for working capital requirements and many producers are faced with constraints on borrowing, for instance in the absence of sufficient collateral or when outsiders find it hard to predict and monitor the firm's performance. Moreover, the cost of borrowing differs substantially among firms, countries and periods. For example, "... borrowers with longer banking relationships pay lower interest rates ... than those with less mature banking relationships." (Levine, 1997: 715.)

Simultaneously, on the one hand many firms do not have access to equity capital, while on the other hand bank loans are highly non-marketable, and cannot be seen as perfect substitutes for equity. Finally, various studies point to the imperfect substitutability of financial claims to productive assets in different countries (e.g. Bovenberg and Goulder, 1991).

By now, the influence of imperfect capital markets on investment decisions has been substantiated empirically in various studies (e.g. van Ees *et al.*, 1997). However, if that is the case, the use of financial capital should also be seen as an input in the production function. This is elaborated in the next section of this

Note: The author is head of the National Accounts Department. The views expressed in this paper are his own and do not necessarily reflect the views of his employer. He would like to thank various colleagues and in particular T. K. Rymes for their helpful suggestions.

[1]The definition of the capital input in production has been discussed by many eminent economists in the past. As in Triplett (1996) and Hulten (1996), this paper attempts to reconcile the capital concept that can be used for production analysis and productivity measurement with the capital concept reflected in the national (income and wealth) accounts. It is this paper's intention, though, to add a new perspective to this long-standing debate.

paper, according to the ideas set out earlier by the author (Keuning, 1995, 1996: Section II.3.3). The third section summarizes the results from a recent study on the estimation of multi-factor productivity change (Keuning and Reininga, 1997), using both the conventional approach and the approach advocated in this paper. It appears that the incorporation of financial inputs in productivity calculations indeed provides an alternative view of inter-industry variations in productivity growth. The paper ends with some conclusions.

2. What is the Capital Input in Production?

In productivity change calculations, capital input is often equated with the use of *tangible* assets, such as land, machinery and buildings. Concomitantly, the physical contribution of capital to output is emphasized. This study takes the economic *cost* of capital inputs as a point of departure. Cost is what matters in the real world, both to the users of capital services and to the suppliers, as it represents their remuneration. The underlying volume and price changes of transactions or reservations can be disentangled only when it is known what kind of payments or reservations have actually been made in connection with the use of capital. Besides, such a procedure ensures consistency with the exchange value approach that is followed in every economy-wide analysis.

Ex post, the cost of capital inputs at the industry level is embodied in the gross operating surplus/mixed income generated by the industries concerned. In fact, if the (imputed) cost of self-employed labour input is isolated from this balancing item, an estimate for the "pure" capital input cost by industry remains. The next question is: what kind of capital inputs have been remunerated from this "residual?"

Three categories of capital can be distinguished (United Nations *et al.*, 1993: Annex V.D):

1. produced assets, consisting of fixed assets (e.g. buildings, machinery and software), inventories, and such;
2. non-produced, non-financial assets, such as land, subsoil assets, patented entities and purchased goodwill; and
3. financial assets/liabilities, such as currency, deposits, securities and loans.

For the production activities of enterprises, the following balance sheet can be drawn up:

TABLE 1
Production Balance Sheet of Enterprises

Assets	Liabilities and Net Worth
Produced assets	Bonds, loans, deposits, trade credits, etc.
fixed assets (e.g. buildings, machinery & equipment, software)	short-term
inventories (e.g. supplies, finished goods, goods for resale)	long-term
Non-produced, non-financial assets (e.g. land, patents, goodwill)	Shares, other equity and net worth
Financial assets (currency, non-interest bearing deposits)	

TABLE 2

CURRENT PRODUCTION INCOME AND OUTLAYS OF ENTERPRISES

Income	Outlays
Output	Intermediate consumption Consumption of (owned) fixed assets Compensation of labour input (paid and unpaid) Rent (hire of non-produced, non-financial assets) Consumption of (owned) non-produced, non-financial assets Interest (on bonds, loans, deposits, trade credits, etc.) Dividends and net saving

This balance sheet[2] is connected to the following statement of current income and outlays from production:[3]

Note that in this table the net returns to the stock of capital are split into two categories: interest, and dividends plus net saving. These categories correspond with the remuneration for the usage of the two main categories of liabilities and net worth in the production balance sheet shown in Table 1. The income and outlays statement in Table 2 can be formalized in the following equation:

$$\tilde{p}q = \sum_j p_j x_j + \sum_k p_k \delta_k K_k + \sum_l w_l l_l + \sum_m h_m b_m + \sum_m \pi_m \delta_m N_m + \sum_n r_n C_n + iV \quad (1)$$

with:[4]

$\tilde{p}$ = (producers') price of the output;
q = volume of the output;
p_j = purchasers' price of intermediate input j;
x_j = volume of intermediate input j;[5]
p_k = purchasers' price of fixed asset k;
δ_k = depreciation rate of fixed asset k;
K_k = volume of the stock (owned) of fixed asset k;

[2]All assets and liabilities are valued at current market values. Interest bearing financial assets and equity (in other enterprises) owned by the enterprises are excluded from the asset side of this balance sheet, because these assets are not directly used in the production of goods and services by the firm itself. The same applies to liabilities that only serve to finance such assets that are not used in own production. The net worth used in production is then equal to the total market value of the assets used in production minus the total market value of the liabilities used in production. Net worth of listed corporations may be negative, e.g. if the stock exchange anticipates a future rise in corporate profits or in the value of non-produced, non-financial assets (e.g. patents), so that present share prices are already higher than is warranted by the balance sheet statement. Shares, other equity and net worth have thus been combined into a single balance sheet item. An additional advantage is that the volatility of share prices unrelated to firms' performance or prospects is now automatically offset by contrary changes in the value of net worth. Finally, equity and net worth have been combined into a single category because their remuneration cannot usually be separated (cf. Section 3 below).

[3]This statement combines the production account and the income distribution and use accounts of the national accounts. All outlays are valued at "purchasers' prices," that is, including taxes and such. For instance, taxes on corporate profits are included in the item "dividends and net saving." The design of the tax system is obviously an important determinant of the actual composition of the balance sheet and the concomitant outlays, but an analysis of those causalities goes beyond the subject of this paper.

[4]In empirical applications, "volume" means constant price value.

[5]Intermediate consumption includes the rent of produced assets (buildings, machinery and equipment, software, etc.).

w_l = wage rate of labour type l (incl. self-employed etc., who receive an imputed wage rate);
l_l = input volume of labour type l (incl. self-employed and unpaid family workers);[6]
h_m = price of hiring non-produced non-financial asset type m;
b_m = volume of hiring non-produced non-financial asset type m;
π_m = purchasers' price of non-produced non-financial asset m;
δ_m = depreciation rate of non-produced non-financial asset m;
N_m = volume of the stock (owned) of non-produced non-financial asset m;
r_n = price of the use of category n of interest bearing liabilities (bonds, loans, etc.);[7]
C_n = volume of the use of category n of interest bearing liabilities (bonds, loans, etc.);
i = (residual) remuneration rate for the use of shares, other equity and net worth; and
V = volume of the use of the shares, other equity and net worth.

This equation can be viewed as the outcome of the production function of the enterprises. In other words, the enterprises have combined intermediate inputs, fixed assets, labour, non-produced non-financial assets *and* all kinds of funds (deposits, loans, equity) to generate output. Obviously, the economic production function of enterprises is more comprehensive than "technology" in an engineering sense.[8] Without access to finance no production whatsoever can take place. On the other hand, generating the same output with less funds (because of a "shorter" balance sheet) implies a higher productivity, *ceteris paribus*. Finally, it is not the stock of fixed assets owned by the firm that earns a return, but the fund that is invested in the firm.

The role of finance as an input in production can be illustrated by comparing two enterprises with the same output and the same production technology in an engineering sense. However, enterprise A owns its office whereas enterprise B rents it. In these circumstances, enterprise A uses both the office itself and the funds tied up in its stock value. Note that the market price of offices determines the price of using up the office (the second term on the right-hand side of equation (1) above), but that this market price, in common with the prices (and volumes) of all other assets of A, also influences the total stock value of A's assets, which in turn determines the *volume* of the funds used (i.e. tied up) in A's production process. The average *price* for the use of these funds depends on the way the

[6]If labour input is subdivided by educational level, human capital input is implicitly taken into account in the production function.

[7]The interest rate on bank deposits equals the full rate and thus not just some sort of "reference" rate (that is, the interest rate minus the so-called service charge of the bank). It follows that in the national accounts the bank service charge (usually labelled FISIM) should not be treated as an intermediate input of the enterprises, but as part of their primary (factor) input.

[8]Note, for instance, that the *actual* services provided by the stock of fixed assets, or the capacity utilization, in the reference period are irrelevant to this income and outlay statement. In an economic (and thus not an engineering) production function, even a machine left idle (e.g. because of maintenance) is used up as long as its market price declines with its age. On the other hand, it is obvious that the quality, and thus the volume, of the capital stock (K) is directly related to the quantity and quality of the services it *can* provide.

enterprise is financed, as is reflected on the liabilities side of *A*'s balance sheet, and on the prices (various interest rates, rate of return on the use of equity) that must be paid for the use of all these types of liabilities.

In comparison with enterprise *A*, less funds are tied up in the production process of enterprise *B*. Enterprise *B* just uses the amount of funds needed to pay the office rent to the leasing company. On the other hand, the office rent that *B* pays obviously exceeds the office depreciation cost (consumption of fixed capital), which equals *A*'s cost of using up the office. So, if finance did not matter in the production function, *B*'s total production costs would always be higher than those of *A*. However, in reality this may not be the case, as *B*'s financing costs are lower, in view of its smaller total balance sheet value. The exact size of *B*'s financing costs depends on the composition of the liabilities' side of its balance sheet. In other words, if an enterprise has easy access to cheap finance, it may be more inclined to own its office instead of renting it.

This example also demonstrates that non-financial assets owned by the enterprise and used for production are in fact used in two respects: first, these assets are (gradually) used up and secondly, their stock *value* is tied up, and thus used, in that process. Both these aspects should be reflected in the production function.

At present, mainstream theory and empirical research in general economics do not distinguish financial capital as a separate factor of production. Harper (1997) concludes "By excluding financial assets, productivity economists have effectively classified portfolio management decisions as 'investor' issues. These issues presumably are not of concern to our stylized "production manager". ... Miller and Modigliani (1966) discussed the conditions under which production decisions could be presumed separable from decisions affecting the firms financial portfolio. It is clear that most of the productivity literature has assumed these decisions are separable." However, these conditions, including equal access to bank loans, the absence of distortions by taxation, low bankruptcy costs, perfect(ly symmetric) information, fully competitive capital markets, are often not fulfilled in practice; cf. e.g. Levine (1997). Moreover, even if financing and "production" decisions are taken separately, still the *economic performance* of firms, industries and complete economies is highly dependent upon their access (or not) to finance. The recent crisis in Asia testifies this.

Yet, productivity analyses and production functions typically define the capital input volume as the volume of the stock of, or services from, non-financial (fixed) assets.[9] This amounts to the following equation:

$$\tilde{p}q = \sum_j p_j x_j + \sum_k p_k \delta_k K_k + \sum_l w_l l_l + \sum_k p_k \rho_k K_k \qquad (2)$$

with:

ρ_k = internal rate of return on fixed asset k (also called the profit rate on fixed asset k).

[9]Refer to e.g. Baumol *et al.* (1989), Englander and Mittelstädt (1988), Jorgenson (1990), Maddison (1987), Rymes (1983), and Scott (1993). Examples of attempts to distinguish financial capital as a separate factor of production can be found in Hasan and Mahmud (1993), Stiglitz (1992), and Yeager (1979).

In equation (2) a remuneration for the use of (part of) the *assets side* of the balance sheet is included ($\sum_k p_k \rho_k K_k$), whereas equation (1) incorporates a remuneration for the use of the *liabilities side* of the balance sheet; cf. the last two terms of equation (1) and Table 1 above. Equations (1) and (2) are more similar than they may seem at first sight, because both sides of the balance sheet obviously add up to the same total. Besides, the fourth and the fifth term on the right-hand side of equation (1) could just as well be added to the right-hand side of equation (2). Then:

$$(2') \qquad \tilde{p}q = \sum_j p_j x_j + \sum_k p_k \delta_k K_k + \sum_l w_l l_l + \sum_m h_m b_m + \sum_m \pi_m \delta_m N_m + \sum_k p_k \rho_k K_k .$$

Now, by definition:

$$(3) \qquad \sum_n r_n C_n + iV = \sum_k p_k \rho_k K_k$$

with the left-hand side of equation (3) reflecting the remuneration for using the liabilities side of the balance sheet and the right-hand side the remuneration for using (part of) the asset side. The conventional equation, (2), suffers from two important shortcomings:

(1) it only includes a remuneration for the use of fixed assets; in other words, it is assumed that the funds used in production are fully embodied in fixed assets, and

(2) it assumes that the price change for the use of these funds depends on the price change of the non-financial (fixed) assets utilized in production, and *not* on the price change for the use of all kinds of liabilities (and net worth) of which these funds consist.

The former deficiency can be mitigated by including a remuneration for the use of land and several other non-produced non-financial assets such as patents. In terms of formula (2) above, this means that non-produced, non-financial assets also generate a return:

$$(2'') \qquad \tilde{p}q = \sum_j p_j x_j + \sum_k p_k \delta_k K_k + \sum_l w_l l_l + \sum_m h_m b_m + \sum_m \pi_m \delta_m N_m + \sum_k p_k \rho_k K_k + \sum_m \pi_m \rho_m N_m .$$

However, even in that case, the use of some assets is overlooked. The asset side of the balance sheet in Table 1 shows that every production process also uses inventories and non-interest bearing financial assets ("cash"), in other words: working capital. Especially in activities like trade, working capital is an important factor of production. The use of working capital also reflects the fact that before someone can start producing, a fund must be available to pay for the wages, the intermediate inputs, the cost-of-living of the producer, etc. The use of this fund, which amounts to abstaining from consumption ("waiting"), obviously fetches a price.[10] Note that the costs for using this fund are *in addition to* the costs of using

[10]In addition, in circumstances of substantial inflation "depreciation of non-interest bearing financial assets" should be included as a cost item on the right-hand side of Table 2 and equation (1). This depreciation, that is, using up the financial assets concerned, is then computed as the loss in purchasing power of the stock value of non-interest bearing financial assets as a consequence of inflation.

up the intermediate inputs, fixed assets, labour services, etc. Therefore, including these fund use costs does not involve double-counting. This also means that important trends such as increasing just-in-time delivery of supplies will show up as productivity increases in my approach, whereas they are overlooked in the conventional approach.

Let us now turn to the second deficiency of the conventional approach. Even if the use of all productive assets (including working capital) was covered in the production function (2), its decomposition of changes in the value of this usage into price and volume changes is not in conformity with reality. At the end of the day, the owners of the liabilities (and net worth) of the firm are paid, and not the firm's assets. These payments reflect:

(a) a compensation for the loss in the purchasing power of the underlying value as a consequence of inflation,
(b) a remuneration for the risk of bankruptcy or any other loss in the underlying value,
(c) a remuneration for intermediation services, such as checking the borrower's creditworthiness, administering the loan, etc., and
(d) a remuneration for the owners' willingness to abstain from consumption during the reference period.

Liabilities differ particularly in the role that is played by determinants (a), (b) and (c) above. Determinant (d) can be expressed as the price of "waiting," that is carrying the total stock value of assets through time. As Rymes (1998) correctly puts it: "Waiting requires liquidity." The liability side of the balance sheet reflects the different types of liquidity with their specific risk and inflation compensation profiles and the concomitantly different prices (remuneration rates) for their usage.

Changes in the price of using the fund are determined by shifts in the above three determinants, and *not* by a relative price change of the fixed assets [as erroneously assumed in all versions of equation (2)]. This is easily demonstrated for the case of a loan. If a large proportion of the liabilities-side of a firm's balance sheet consists of short-term loans, an increase in the short-term interest rate implies a significant rise in production costs, regardless of any price changes of fixed assets used in the production process. This rise in costs is *not* faced by a firm with the *same* kind of fixed assets in the *same* industry which is financed by e.g. long-term loans that do not expire in the immediate future.

In addition, even though the price for the use of equity is not fixed *ex ante*, these funds are continuously seeking a use with the highest expected remuneration. Take a situation where in a certain industry the profit rate is expected to rise while the interest rate does not change. If under these circumstances two firms are exactly equal except for the composition of the liability side of their balance sheet, the firm that is financed to a larger extent by equity capital must realise a higher rise in operating surplus in order to offer the same profit rate growth to the investor. Again, it is the difference in the composition of the liabilities side of the balance sheet that determines the relative rise in production costs of either firm.

On the other hand, price changes of fixed assets are not relevant to the *whole* asset stock value, as is assumed in equation (2), but only to the depreciation of that stock value during the year; cf. the second term in equations (1) and (2). For, at the end of the year, all fixed assets can be sold, and leased back if so required.[11] In other words, the capital fund is not sunk in the fixed assets, but in the underlying liabilities and net worth.

The first conclusion is that all production processes use a fund (equal to the total value of either side of the balance sheet) in addition to the use of labour, intermediate inputs, fixed assets, etc.

The second conclusion is that the creditors supply this fund and must be paid afterwards. Thus, in order to determine the average price (change) for the use of this fund, it is the composition of the liabilities side of the balance sheet that matters and not the composition of the assets side.

The third, related conclusion is that not the stock value of the assets, but only the depreciation of this value is an input in the current production process.

For a further operationalization of the non-financial capital input in production, a distinction should be made between fixed assets, inventories, and non-produced, non-financial assets. When computing **the input cost of using up fixed assets**, it should be realised that a change in the market price of any fixed asset over time reflects a combination of two, usually contrary price movements: (a) depreciation, that is the price decrease because of ageing, and (b) revaluation, that is the price change of asset types of a certain fixed age.[12] The revaluation is not related to the production process; that is, it is excluded from the items in Table 2 and equation (1), and booked on the "other changes in assets" account instead.

The depreciation is thus roughly equal to the percentage difference, in the reference year, between the price of the assets concerned and the price of the same assets which are one year older. Revaluation is then the price change (usually a price rise) of an asset type of a certain fixed age (cf. Hulten, 1996: 155). However, if the price rise during the reference year of an asset type of a certain fixed age is lower (or even becomes negative) as the vintage is older, this means that economic obsolescence occurs; in that case, the price change of the new asset of that type (corrected for quality change!) equals the revaluation for all vintages and the depreciation value for each vintage is computed as a residual.

A decomposition of the change in the depreciation value between two consecutive years into a volume and price change is straight-forward, cf. formulas (1) and (2); the price change equals the price change of the new assets of the type concerned (again, corrected for quality change), and the volume change is then computed residually.

[11]In particular, this applies to economies with a well-developed lease-industry. For that reason, this statement may have been less valid several decades ago.

[12]Using up an asset reflects both the decline in productive efficiency of the fixed asset, if applicable (that is, its "physical" decay including normal damage), and the (certain) decline in value because of the reduction in the remaining number of years that it can be used (cf. Triplett, 1996; Section II and A.5). For any category of assets, their depreciation includes the value of the assets that are discarded under normal circumstances, including losses as a consequence of accidental damage (which is usually equal to the proportion of damage in the economy as a whole). Finally, the extra value reduction of older vintages due to foreseeable economic obsolescence is also incorporated in their depreciation costs.

The **input cost of using up inventories** equals the reduction in the market value of the stock during the reference year, after a correction for revaluation. For *materials and supplies* the gross reduction in inventories is incorporated in intermediate input costs in the national accounts. The change in the stock value of *work in progress*, of *finished goods*, or of *goods for resale* is already accounted for in the output value of the product group concerned; that is why the output and not the sales value is taken as the production value. Summarizing, the input costs of a change in all kinds of inventories has already been included elsewhere in the system, and are thus not reflected separately on the right-hand side of Table 2. This also means that, when it comes to a decomposition of the value change into a price and volume change, the intermediate input or output price change of the product group concerned also applies to the change in inventories.

Concerning **the input cost of hiring and using up non-financial, non-produced assets**, a distinction must first be made between the use of *hired* assets and the *use* of own assets; cf. Table 2 and equation (1). The cost of rental services associated with hiring non-financial assets (land, subsoil assets, etc.) equals the actual rents paid. The decomposition of input cost changes into price and volume changes should be done according to the same method as is applied for the (intermediate) input cost of renting produced assets.

Concerning the input cost of using up owned non-financial, non-produced assets the same rule applies as for fixed assets: the input cost equals the reduction in their stock value, after a correction for the revaluation of the assets concerned. The input volume equals the reduction in their stock volume or the reduction in their constant price stock value, so that the input price can then be derived. This applies to land, subsoil assets and other non-produced, non-financial assets such as patented entities and purchased goodwill. Note that the input cost ("depreciation") of (own) land that is not overexploited is normally equal to zero. Of course, the value of the land owned does influence the input costs indirectly, since it affects the volume of funds tied up in the production process (the financial capital input). The input costs of e.g. patents are normally positive, because their value continuously declines (apart from their revaluation) with the nearing of their expiration date.

Although estimating the input volume of using up owned subsoil assets and other natural resources may not be too difficult in most cases (e.g. the number of barrels of oil extracted), establishing the price (and the value) of this capital input is more cumbersome. Of course, the output price for crude oil and such cannot be used, as that price also covers all other costs (including financing costs!) made by the extractors. Even taking the quotient of the extraction activity's net operating surplus and the output volume as the "pure" resource price is clearly incorrect, because the financing costs are then double-counted. In addition, subsoil assets and other natural resources are often not explicitly recorded on the owners' balance sheets, nor do these statements allow for a reliable computation of the value reduction as a consequence of the stock depletion. The input cost for using up these assets must therefore be estimated indirectly. For instance, in various countries the extractors' profits are liable to a special tax or, if the extractor is state-owned, to an extraordinary dividend payment. If the rate of this special tax or dividend payment is the result of prolonged negotiations between the government and the extractor, it can be argued that the eventual rate is such that the extractor is precisely left with a "normal" rate of return on his investment. The implicit costs of using up the subsoil assets are then equal to the special tax or dividend receipts; as the volume used up is known, the price can thus be computed residually.[13]

Finally, the identification of **the input cost of using liabilities and net worth** proceeds in stages. As usual, the first step is a breakdown into categories. For instance, interest payments are costs for the use of all kinds of loans, securities other than shares, and other credits. These categories of liabilities should be subdivided, by their risk and inflation compensation profiles, that is, by term-structure, by type of conditionality, etc. Changes in these payments depend on changes in the principal and on changes in the interest rate (e.g. when a loan is renewed). The net operating surplus that remains after subtraction of the input cost of (a) self-employed labour, (b) hiring and using up own non-produced, non-financial assets, and (c) using interest bearing liabilities, then equals "dividends and net saving," that is the input cost of the use of the firm's equity and net worth in production.

The next step is a decomposition of the input value changes into price and volume changes. The general rule applies that the price for using a liability includes a compensation for both inflation, risk, intermediation services and waiting. For instance, if sufficient collateral is available, the risk compensation element and concomitantly the total price can be lower. The volume of the use of the liability equals the fund made available. In the absence of inflation, the volume change (in practice, the constant price value change) then equals the change in the fund made available. However, if next year more funds are needed simply because of the existence of inflation, this should not be viewed as a productivity loss. As a consequence, the volume change of the use of the liability concerned equals the change in the funds made available corrected for inflation. This also means that if inflation accelerates, the price change for the use of the liability will increase.

Summarizing, the volume change of the use of a liability equals the volume change of the principal of that liability.[14] This implies that the price index of the use of a liability equals the price index of the principal times the remuneration rate index for the liability concerned. For example, in the case of a loan the remuneration rate equals the nominal interest rate, so that the remuneration rate index equals the (percentage) change in the nominal interest rate. Note that the price index of the principal usually reflects the relevant inflation rate, while the remuneration rate index normally reflects the change in that inflation rate. This decomposition of a value change of the use of a liability into a price and volume change is in fact similar to the case of a car rental, where the car performs an analogous function as the principal in the case of a loan. Indeed, if car prices rise, so do the car rental prices, irrespective of the price development of the hiring service itself.

[13]If such a special tax or dividend payment does not exist and if the investors and the industry concerned do not worry about the (complete) depletion of the resource, the actual costs of using up the resource are (close to) nil. In that case, there must have been a downward pressure on the output price of the extracted resource until the industry profits reflect only the required rate of return on investment.

[14]I would like to thank André Vanoli for pointing this out to me.

The volume change of the "dividends and net saving," which are expressed as iV in equation (1), also equals the volume change of the underlying principal, that is the change in V, the constant price stock of "shares, other equity and net worth." This volume change is computed by deflating the value change of this item on the balance sheet by a relevant inflation rate (cf. phase 4 in the empirical application described in Section 3 below). The price change of "dividends and net saving" is residual by definition. In other words, a higher profit rate reflects a higher price, to the firm, of the use of the stock of "shares, other equity and net worth." Whether this higher profit rate is reflected in a higher dividend payout ratio or in higher share prices induced by a rising retained earnings rate of the firm does not make a difference in our approach, as dividends and net saving have been combined in a single category. Note that the above procedure implies that a real holding gain on an owned asset used in production leads to a higher real net worth of the enterprise and thus to a volume increase of the use of net worth in production. This is a correct interpretation because in that case relatively more funds are tied up in the production process and this greater use of inputs implies a productivity loss, *ceteris paribus*.

When applying the above line of reasoning to an empirical analysis, operating surplus/mixed income by industry must be decomposed into the remunerations for the different types of capital inputs. Concerning actual payments for capital inputs (interest, dividends, land rents, subsoil asset rents), the main difficulty is the reallocation of such payments by institutional (sub)sector to the industries concerned. Concerning the imputed payments for using own-account capital inputs, the construction of balance sheets by industry is indispensable. This brings us to the following observation.

In the national accounts for production, the institutional units (enterprises) should be classified into more homogeneous categories than the subsectors distinguished in the present System of National Accounts (United Nations *et al.*, 1993). For instance, non-financial corporations should be cross-classified by ownership (national private, public or foreign) and by principal production activity. For those categories it should be possible to decompose changes in *all* input costs into price and volume changes. In fact, in modern economies the production function may be more homogeneous among firms with a similar institutional structure (e.g. multinationals versus the self-employed) and a roughly equal type of market (e.g. fast moving consumer goods like food, detergents and cosmetics) than among all establishments in a 2- or 3-digit ISIC-category. This notion, however, leads to a radically different way of classifying production processes in the national accounts and in productivity analyses and such.

It should not come as a surprise that presently available data by industry in the national accounts do not yet allow a rigorous empirical analysis of the above ideas. Yet, a first attempt to incorporate this new view on capital inputs into productivity analysis is reported next.

3. A Comparison of New and Conventional Estimates of Multi-Factor Productivity Change

The new method of estimating multi-factor productivity change differs from the traditional method by the recognition of financial capital use as a separate input. This requires the compilation of balance sheets by industry.[15] For the time being, the necessary data could only be compiled for four broad industry clusters in the Netherlands: (1) fixed capital intensive manufacturing (petroleum, other chemicals and transport equipment); (2) less fixed capital intensive manufacturing (all other manufacturing); (3) trade, hotels, restaurants and consumer goods repair services; and (4) transport, storage and communication services.

The estimation of capital input price and volume changes by industry has proceeded in stages:

(1) Annual gross operating surplus/mixed income in the four industries concerned has been reduced by an imputed compensation for self-employed labour and subsequently split into:[16]
   (a) consumption of capital,[17]
   (b) short-term interest payments,
   (c) long-term interest payments, and
   (d) dividends and retained earnings.[18]

(2) The volume growth of category (a) in step 1 equals the growth rate of the consumption of fixed capital at constant prices. The weight of this category agrees with the average share of fixed capital consumption in total output.

(3) Annual opening and closing balance sheets by industry have been compiled, subdividing the liabilities/net worth side into:
   (a) short-term deposits, securities other than shares, loans and other accounts payable;
   (b) long-term deposits, securities other than shares, loans and other accounts payable;
   (c) shares, other equity and net worth.

The balance sheet for each year has been estimated as the average of the opening and closing balance sheet. The remuneration for using each of these categories of liabilities/net worth equals the categories (b), (c) and (d) that were distinguished in step 1.

(4) The stock of the three categories of liabilities and net worth of year $t+1$ at prices of year t has been estimated by deflating with the industry output price index, as this may be an "inflation rate" that is relevant to the industry concerned.[19] This yielded the annual volume growth of the principal of each category of liabilities/net worth.

[15]Refer to Keuning and Reininga (1997) for a more extensive review of the compilation method and of the results.

[16]Rents and the consumption of owned non-produced, non-financial assets have been considered negligible in the industries concerned.

[17]In a more detailed approach, a subdivision by type of fixed asset would be advisable.

[18]Distinguishing between dividends and retained earnings does not make sense in the Netherlands, because for fiscal reasons a large but fluctuating part of the shareholders' remuneration consists of an increase in the market value of their shares, induced, among other things, by high retained earnings.

[19]An alternative possibility would have been to assume that financial capital is quite mobile across industries, so that a general inflation rate could have been selected. In that case, though, it would still have been assumed that financial capital is not internationally mobile. Finally, one could imagine distinguishing various types of firms by industry (e.g. multinationals, listed national corporations, small firms) depending on differences in the inflation rates that are relevant to their owners.

(5) The volume growth of the input of the three categories of liabilities/net worth equals the volume growth of the principal. The price changes follow from these volume changes and the value changes estimated in step 1. The input weight of the three categories of liabilities/net worth equals the average share of the remuneration categories (b), (c) and (d) in step 1 in total output.

The main difference between both methods is thus that in the new method the capital input weight is split into four categories of capital inputs, among which three categories of financial capital inputs and that the decomposition of the value change into price and volume changes diverges for each of these categories.

Table 3 summarizes multi-factor productivity growth rates for the four above-mentioned industry clusters:[20]

TABLE 3

MULTI-FACTOR PRODUCTIVITY CHANGE (1988–92) IN THE NETHERLANDS

	Logarithmic Growth Rates (%)				
Years	1989	1990	1991	1992	1988–92[a]
Chemical Industry, Petroleum Industry, and Transport Equipment Industry					
Traditional method	0.88	0.32	−0.58	−0.09	0.53
New method	1.36	0.55	−0.74	−0.42	0.75
Other Manufacturing Industry					
Traditional method	0.80	0.45	0.13	−0.45	0.94
New method	1.22	0.43	0.23	−0.60	1.29
Trade, Hotels, Cafés, Restaurants, and Repair of Consumer Goods					
Traditional method	0.48	0.42	0.02	−1.27	−0.35
New method	1.84	1.76	1.57	−2.47	2.75
Transport, Storage and Communication					
Traditional method	2.04	1.83	2.09	0.92	7.11
New method	−1.26	2.17	2.79	1.41	5.25

[a]Cumulative growth rate for the period 1988–92 as a whole.

For both clusters of manufacturing industries, the results of the new approach resemble those of the traditional method. The productivity growth pattern is the same, by and large: a worsening of productivity change over the period 1988–92. The productivity change estimates for the period as a whole do not differ very much either. However, the traditional method somewhat dampens the actual productivity changes, both the positive and the negative ones.

In the trade and related services industry, the new method yields quite different insights. In fact, during the period concerned a substantial productivity growth occurred, while the conventional computation method yielded a small decline. Notably, a relatively large volume decrease of the input of both long-term loans, etc. and shares plus net worth contributed to the relatively high productivity growth in 1989–91. The reverse holds for 1992. Both methods yield a declining pattern of multi-factor productivity change over the period 1989–92.

[20]In this application, the conventional (Hicksian) measures of productivity change have been computed. However, our approach to capital input measurement can just as well be applied to the Harrodian productivity measures advocated by e.g. Rymes (1972, 1983, 1998).

Finally, in the transport, storage and communication industry the new approach results in a lower productivity growth estimate for the period as a whole. For each of the years 1990, 1991 and 1992, the outcomes of both methods are similar, albeit the new method yields slightly higher growth rates. In 1989, however, a very high volume growth of the input of both long-term loans, etc. and shares plus net worth caused a productivity decline in this industry, which was not picked up by the traditional method.

Overall, the spread of productivity change estimates among industries was, for the period as a whole, smaller according to the new method (between 0.75 percent and 5.25 percent) than according to the traditional method (between −0.35 percent and 7.11 percent).

4. Conclusions

The growing awareness that the financial structure of a firm affects its activity should also be reflected in production functions, productivity calculations and so on. This paper has attempted to design and bring into use a macro-economic measurement of financial capital inputs in production and to show the consequences for the estimation of multi-factor productivity change by industry.

The core of our findings is the following. First, the input of fixed assets ("capital goods") in production does not differ fundamentally from intermediate inputs, albeit services from fixed assets are spread out over more than one year.[21] Secondly, in addition to the costs due to the depreciation of fixed assets, there are costs connected with the use of the funds tied up in these assets owned by the enterprise. These funds are used for production and cannot simultaneously be used for other purposes, such as the immediate satisfaction of wants. That abstinence must be remunerated. Moreover, this remuneration depends on (information available to the fund owners on) the risk that the real value of this fund is (partially) lost during the production process.

The essence of the argument developed in this article is that in production analyses this remuneration for the usage of funds in production should not be assigned to the kinds of assets and working capital financed with these funds, but to the categories of liabilities and net worth that acquire this income. In comparison with present macro-economic production theory and practice, this implies a shift in emphasis from the assets-side of the balance sheet to the liabilities-side. The total value of both sides of the balance sheet is of course the same. What differs is the classification of items and, particularly, the decomposition of value changes into volume changes and price changes when it comes to productivity analyses, production functions, etc.

A rigorous empirical application of these ideas requires a different meso- and macro-economic data base than is presently available. Following Keuning and Reininga (1997), Section 3 of this paper contains an application of this new concept of capital input in production to the estimation of productivity change for

[21] In so far as well-developed markets for second-hand capital goods do not exist, these commodities are less fungible than intermediate inputs. However, the delivery of intermediate inputs may also be fixed in long-term contracts.

four industry clusters in the Netherlands. The results have been compared with the outcomes according to the traditional estimation method. The new method has resulted in a substantially smaller range of productivity change estimates by industry. Particularly in the trade and related services industry, the new method yielded quite different results. Whereas originally this seemed the only industry with a productivity loss over the whole period concerned, the new method yielded a productivity gain, in between the gain of the manufacturing and the transport industries.

This modest experiment cannot yet substantiate the accuracy or the relevance of this new approach to measuring capital input in production. Besides, more research is needed to determine the most accurate deflator for various categories of liabilities under various circumstances; cf. Footnote 19. However, it may be worthwhile to repeat this exercise for other countries and other periods. In addition, it may be of interest to compare the productivity performance of countries, or individual firms, with this new method.

By recasting the model of economic production in the way described here, the differences in productivity growth among firms, industries or countries may be viewed in a new light. In turn, that may yield a new perspective on the determinants of economic growth. Finally, the approach in this study also establishes a much closer link of macro-economic accounting and analysis to business economics. In fact, the relative neglect of financial inputs in present mainstream macro-economic theory of production is all the more surprising, in view of the paramount importance of these inputs in business economics.

References

Baumol, W. J., S. A. B. Blackman, and E. N. Wolff, *Productivity and American Leadership*, MIT Press, Cambridge, Massachusetts, 1989.

Bovenberg, L. and L. H. Goulder, Introducing Intertemporal and Open Economy Features in Applied General Equilibrium Models, *De Economist*, 139(2), 1991.

Ees, H. van, H. Garretsen, L. de Haan, and E. Sterken, *Investment and Debt Constraints*; *Evidence from Dutch Panel Data*, DNB-Staff Reports No. 10/1997, De Nederlandsche Bank, Amsterdam, 1997.

Englander, A. S., and A. Mittelstädt, Total Factor Productivity: Macroeconomic and Structural Aspects of the Slowdown, *OECD Economic Studies*, 10, Spring 1988.

Gertler, M., Financial Structure and Aggregate Economic Activity, *Journal of Money, Credit and Banking*, 20, 559–88, 1988.

Harper, M.J., *Estimating Capital Inputs for Productivity Measurement: An Overview of Concepts and Methods*, Paper prepared for the Conference on Measuring Capital Stock, Canberra, March 10–14, 1997.

Hasan, M. A. and S. F. Mahmud, Is Money an Omitted Variable in the Production Function? Some Further Results, *Empirical Economics*, 18(3), 1993.

Hulten, C. R., Capital and Wealth in the Revised SNA, in J. W. Kendrick (ed.), *The New System of National Accounts*, Kluwer Academic Publishers, Boston/Dordrecht/London, 1996.

Jorgenson, D. W., Productivity and Economic Growth, in E. R. Berndt and J. E. Triplett (eds.), *Fifty Years of Economic Measurement*, University of Chicago Press, Chicago, 1990.

Keuning, S. J., Productivity Changes and Shifts in the Income Distribution; with An Application to the Case of Indonesia, *Economic Systems Research*, 7(3), 1995.

———, *Accounting for Economic Development and Social Change*, IOS Press, Amsterdam, 1996.

———, and T. Reininga, *Accounting for the Use of Financial Capital as an Input in Production*, National Accounts Occasional Paper Series No. NA–085, Statistics Netherlands, Voorburg/Heerlen, 1997.

Levine, R., Financial Development and Economic Growth: Views and Agenda, *Journal of Economic Literature*, XXXV, 688–726, June 1997.

Maddison, A., Growth and Slowdown in Advanced Capitalist Economies: Techniques of Quantitative Assessment, *Journal of Economic Literature*, XXV(2), 1987.

Miller, M. H. and F. Modigliani, Some Estimates of the Cost of Capital to the Electric Utility Industry, 1954-57, *American Economic Review*, 56(3), 1966.

Rymes, T. K., The Measurement of Capital and Total Factor Productivity in the Context of the Cambridge Theory of Capital, *The Review of Income and Wealth*, Series 18, Number 1, 1972.

———, More on the Measurement of Total Factor Productivity, *The Review of Income and Wealth*, Series 29, Number 3, 1983.

———, The Cambridge Capital Controversy: Fifty Years After and Measurement in National Accounting, *Paper prepared for the 25th General Conference of the International Association for Research in Income and Wealth*, Cambridge, August 23–29, 1998.

Scaramozzino, P., Investment Irreversibility and Finance Constraints, *Oxford Bulletin of Economics and Statistics*, 59(1), 1997.

Scott, M. F. G., Explaining Economic Growth, *American Economic Review*, 83(2), 1993.

Stiglitz, J. E., Capital Markets and Economic Fluctuations in Capitalist Economies, *European Economic Review*, 36, 1992.

Triplett, J. E., Depreciation in Production Analysis and in Income and Wealth Accounts: Resolution of an Old Debate, *Economic Inquiry*, 34, January, 1996.

United Nations, Eurostat, International Monetary Fund, Organisation for Economic Co-operation and Development, and World Bank, *System of National Accounts 1993*, Series F, No. 2, Rev. 4, United Nations, New York, 1993.

Yeager, L. B., Capital Paradoxes and the Concept of Waiting, in M. J. Rizzo (ed.), *Time, Uncertainty and Disequilibrium*, D. C. Heath, Lexington, 1979.