The Concept of Fixed Assets in Production Function and Growth Estimations

The key assumption underlying the use of the original value of fixed assets as measure of capital in production function estimations is that the contribution of a fixed assets (say, machine) does not change with the age of the fixed asset. When the fixed asset is operational, it has the potential to produce at full capacity. For example, a computer which is being used for four years still runs at the same speed in the fourth year as it did in the first.

But the machine may break down. Suppose one part (only) of the machine breaks down and causes the machine to stop working. There are two possible consequences: the machine is repaired, or it leaves the production process.

Suppose the machine is repaired, at night, to cause no further disturbance to the production process. Suppose this requires $100 worth of labor and a $5 spare part. At given output prices, the $100 worth of labor enters the GDP component “labor remuneration” positively (increasing value-added), as a cost item that reduces profit, and the GDP component “operating surplus” negatively (decreasing value-added). So far, total value-added (the left-hand side variable in production function estimations) is unchanged. If the firm has some pricing power and profit is not affected, value-added may actually go up. Because the machine continues to function after the repairs as before, the original value of fixed assets continues to measure the contribution of the fixed asset to production.

From the point of view of production function estimations, if the need for the presence of a mechanic does not change over time, the values of the dependent variable value-added and the independent variables capital (original value of fixed assets) and labor all do not change with repairs. If the need for mechanics increases with the age of the machines, there could be an increase in labor over time. At given output prices and therefore unchanged value-added, the right-hand side variable labor increases; in this case it would seem appropriate to decrease the original value of fixed assets proportionally. If the firm has some pricing power and profit is not affected, value-added simply goes up by the value of the number of additional laborers (repair persons) hired times their wage.

The $5 spare part is an intermediate input and, at given output prices, reduces the component “operating surplus” in value-added. If the need for spare parts does not depend on the length of time a particular machine has been in use, the original value of fixed assets measures the contribution of the fixed asset to production independent of time, with value-added being $5 lower in every period than it would be without the periodic repairs.

However, if the need for spare parts increases as the length of time the machine has been in use increases, and if output prices are given, value-added (as the difference of gross output value and intermediate inputs) is decreased proportionally more in later years. Gross output value does not change, nor does the contribution of the machine to production. What changes is the value of intermediate inputs and value-added. In production function estimations, the dependent variable value-added is decreased while the value of all independent variables remains the same; in this case it would seem appropriate to decrease the original value of fixed assets proportionally. The same holds if the dependent variable is gross output value (unchanged), because the value of the independent variable intermediate inputs increases. If

the firm has some pricing power, gross output value is likely to increase by the same amount as the value of intermediate inputs (and value-added stays constant).

The same problems apply to an ageing labor force when health care costs (an intermediate input in the consideration of an individual firm) increase with the average age of the labor force. Production function estimations don't correct the quantity(!) of laborers used in the estimation for increasing health care costs. At given output prices, using the gross output value as dependent variable in the production function estimation means that the increased health care costs are captured in intermediate inputs (independent variable), with no equivalent change in any other variable. Using value-added as dependent variable will show lower value-added (lower operating surplus) with no change in the values of the right-hand side variables. If the firm has some pricing power, gross output value and intermediate inputs both increase, while value-added stays constant.

One small, negative impact on output could occur if the machine breaks down in mid-day and is not usable for the rest of the day (no output) until it is repaired, or if the repair takes several days. However, in practice, the incidence of breakdowns is likely to be small due to ongoing maintenance that is intended to prevent exactly this event of a disruption in production.

I do not deny that frequent breakdowns potentially have the implication that value-added is reduced if the firm has no pricing power. This fixed asset, then, does not provide the same contribution to production as does the same fixed asset without frequent breakdowns, just as an aging labor force with higher health care costs, all else equal, does not provide the same contribution to production as does a younger, healthier labor force. But the assumption that the reduction in the contribution to production matches the accounting concept of cumulative depreciation for the particular fixed asset appears absurd, as the example in the text illustrates. Or, to continue with the computer example above, assuming linear depreciation by 25% per year, it is simply not the case that the computer provides only 25% of the original services in the fourth year; in my experience, it still offers 100% of the original services, without any need for repairs. I have experienced only one exception, when a repair was needed, but it was needed *early on*, in the first year, which would turn the depreciation concept, if it had any relevance, on its head.

I find the assumption realistic that any increase in the frequency of repairs needed due to the aging of fixed assets has a sufficiently minor impact on the overall value of labor remuneration and/or intermediate inputs to be ignored. I find this assumption more realistic than the assumption that the contribution of a fixed asset to production equals the remaining book value of the fixed asset (as calculated following an initially perceived depreciation pattern).

To consider the second possible consequence of a breakdown, suppose the machine leaves the production process following the breakdown. At this point, the account "original value of fixed assets" is reduced by the full, original value of the machine (as is the account "cumulative depreciation," with possibly additional accounting entries for extraordinary depreciation or sales receipts etc.). There is no ambiguity in this case.

With the reservations about the potential impact of a possibly increasing need for spare parts with the age of the fixed asset, the account "original value of fixed assets," throughout, correctly captures the ongoing contribution of the fixed asset to production. No other

available measure appears superior. Therefore, the original value of fixed assets is the measure of choice to use in production function estimations and growth studies, and the measure pursued further in the paper.

Use of the original value of fixed assets as a measure of physical capital in production function estimations does not imply the assumption of a “one hoss shay” model. The “one hoss shay” model refers to every part of a fixed asset ending its lifetime at the same point of time (the shay turns from a workable shay into a pile of dust in one flash). The account original value of fixed assets changes by the original purchasing price of the machine when the machine is decommissioned. The account goes from “machine fully operational” to “machine no longer part of the production process;” intermediate steps are theoretically possible but probably not used in practice. Perhaps the machine is still functioning at 100% capacity, but is being sold. Or one small part (only) of the machine has broken down and the management has decided that it is not economical to repair the machine. (In terms of the one hoss shay, the equivalent is a broken axle, not a pile of dust.) Such profitability-oriented decisions bear no necessary relationship to the potential current contribution of a fixed asset to production.