An Improved Production Model to Estimate Productivity with Lifetime (Adjusted) Hours Human Capital Stocks for the United States, 1976-2013

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Production models can take a variety of forms, but frequently there is a mismatch between inputs or between inputs and output, or an inconsistency in the measurement of inputs, which impacts on productivity estimates. The purpose of this proposed paper is to point out the problems with mixing stocks and flows in a production model and continuing an inconsistency in the treatment of labor or human capital and physical capital stocks that both impact on productivity estimates. Typically in a value-added production model, GDP is the output measure. Inputs take a variety of forms. Capital is often represented by capital stock, but sometimes by capital service flows. Labor is often represented by the number of workers or by those in the labor force, but sometimes by labor services or hours worked. These input choices are often dictated by the available data, however, mixing stocks with flows creates a mismatch in most cases, which is a concern if researchers want to estimate productivity. GDP is a flow, capital stocks are a stock as are the number of workers or those in the labor force. Flows are the output or input to a production process over a set period (say a year; current period); stocks are the input to a production process over a longer period of time (say several years; current period and future periods). In addition to the mismatch created when flows and stocks are used in a production model, the basic accounting identity that the sum of nominal inputs must equal the nominal value of output may not hold. There also is an inconsistency when physical stocks are adjusted for efficiency as these assets age, although hours worked are not as workers age. Although there may well be a correlation with between stocks and flows and hours and efficiency-adjusted physical stocks and GDP as represented by an econometric model, the underlying premise of a production model is violated in the presence of mismatches, accounting issues, or inconsistencies, and consequently productivity estimates may be misestimated.

Interest in this mismatch and inconsistency arises from a desire to measure human capital productivity or total factor productivity (TFP) when human capital is a stock, such as that with Jorgenson-Fraumeni. The term "human capital" is applied in a variety of research contexts. Sometimes when education is a component of a production model, when entered separately or as a composition or quality adjustment to labor input, the term is used. In this paper, the term human capital refers only to a measure that has current and future flows as a physical capital stock does, for example from structures or equipment. This definition allows a focus on productivity estimation highlighting stock and flow mismatches, and physical stock and hours inconsistencies.

A new human capital stock measure, called Fraumeni lifetime hours, is created to allow for a human capital stock and a physical capital stock as the inputs in a production model with GDP as the output. An essential assumption to avoid a mismatch with GDP is to maintain that the quality of both physical and Fraumeni lifetime hours stock by category is constant, mimicking the physical capital stock methodology in Jorgenson, Fraumeni and Gollop (JGF - 1987). In the case of hours, use of a 1975-2013 detailed data set constructed by Christian from the Consumer

Population Survey (CPS) makes this assumption reasonable as there are over 2,000 non-zero hours and earnings categories per year.[1] In addition, the hours "inconsistency" adjustment describe later in this proposal increases the validity of this assumption. Similar to what is done for Jorgenson-Fraumeni lifetime income stock, the future hours worked as they age is taken from the hours worked by those older in the year in which the estimates are being constructed. Unlike lifetime income, these future hours are not discounted to the present as they are quantities and not assumed to change at some rate. This treatment is similar to that of physical capital stock because this stock quantity is the current productive capability of the physical stock, e.g., structures and equipment, which will be used in the current and future periods. An individual is a storehouse of future work hours used in production in current and future periods in the same way that the quantity of physical capital is.

In both cases, the Törnqvist index weights applied to the logarithmic growth rates of the current quantity of the stocks are the nominal average shares in total input (capital or labor) as is true with physical capital stocks following JGF. The accounting identity that the sum of the nominal value of inputs equals the value of nominal output holds as the nominal values are the nominal values of capital and labor input in the current period.

Both the Programme for International Assessment of Adult Competencies (PIAAC - OECD, 2019) and the Inklaar and Papakonstantinou article (2020) results support the notion that the efficiency of hours worked by individuals vary by age.[2] [3] Accordingly, the efficiency of hours worked will be allowed to vary by age based on the PIAAC results. One difference from physical stocks which decline in efficiency as assets age, hours will be allowed to increase in efficiency as younger workers age, before hours efficiency will be allowed to decline in efficiency, at least through age group 55-59. This will probably not eliminate the possible vintage effects to which Inklaar and Papakonstantinou (2020) refer, but it should decrease its occurrence in the estimates.[4]

With the introduction of Fraumeni lifetime hours human capital where hours are efficiency adjusted, productivity estimates will be more credible than those previously estimated when mismatches and a stock inconsistency occur in the production model.

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[1] This data underlies Fraumeni, Christian, and Samuels (2021).

[2] Inklaar and Papakonstantinou (2020, p. 24) write in their conclusions section that a standard assumption used in growth accounting: "an hour worked by a worker of a given type,…., represents a constant amount of labor services per hour worked over time. Yet if there are vintage effects, this assumption may be violated."

[3] See Figure 9 of OECD 2019 which shows literacy and numeracy scores of individuals by age groups who participated in PIAAC both in 2012-2104 and in 2017.

[4] Inklaar and Papakonstantinou (2020) conclude that the vintage effects are important in the U.S. between 1975 and 2014, a time period which is almost identical to that to be covered in the proposed paper. Hudomiet and Willis (2021) analyze how computerization affected the labor market outcomes of older workers between 1984 and 2017.

Bibliography

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