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Working Paper

"Addressing the Negative Multifactor Productivity Conundrum: Elevating Black Americans' Contributions to US Productivity"

There is No Full Accounting for *Homo Economicus* (*HE*)—Especially Black *HE*

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Abstract

This working paper suggests that, if the growth in quality adjusted real gross output exceeds the growth in quality adjusted real materials (M) factor inputs (where growth is estimated using quality adjusted volume/quantity or price indices), then it is possible that estimated negative multifactor productivity might disappear from the landscape of certain service industries. This is assured when capital (K), labor (L), energy (E), and services (S) factor inputs are quality adjusted in a KLEMS framework when and where required.

We posit that economists/statisticians may have conceded acceptance of negative multifactor productivity for certain industries too soon. We urge that consideration be given to: (i) Revising methods for estimating the nominal value of nonmarket gross output of *Health* and *Education* services when current measures are based on cost; (ii) incorporation of quality adjustments into estimates of real gross output and materials factor inputs for these services; and (iii) adoption of the view that there are at least three roles for humans in multifactor productivity and economic measurement broadly. Humans provide labor; using incomes earned from labor, humans drive demand and consumption—determinants of gross output and value added; and humans serve as materials factor inputs in production of services for animate units.

Introduction

As a near quarter-century plyer of the official government economist/statistician's trade, what becomes obvious during discussions of macroeconomics statistics with the uninitiated is that most users of these statistics possess little knowledge concerning the "sausage making." Plyers of the trade recognize that measuring an evolving economy is a task likened to a tailor measuring a customer for suit-making while the customer is in perpetual motion at a rapid gait. Consequently, tradeoffs are confronted when taking decisions to incorporate newly evolving economic production into official statics in a timely fashion—even before perfect source data are available for measurement. In the latter case, economists/statisticians must use less than perfect data (sometimes akin to lemons) and make various adjustments to produce estimates that reflect economic activity accurately; i.e., they make lemonade.

This BlackEconomics.org working paper concerns a formerly existing conundrum for certain service industries, when measured using a KLEMS ((K) capital, (L) labor, (E) energy, (M) materials, and (S) services) framework: Namely, negative multifactor productivity. We contend that economists and statisticians, who have reconciled themselves to negative productivity as an accepted and explained reality, may have conceded too quickly.[i] Two very important industries for which concerted efforts were made to resolve the conundrum are *Health* (61) and *Education* (62).[ii] Today, official multifactor productivity estimates for *Health* are more negative than those for *Education*.

Our thinking about this topic emerged in 2003 when the anxiety-inducing movie, *Dirty Pretty Things*, was released. At the time, we had gained certain knowledge about three relatively eclectic topics: (1) Quality adjusted price indices using hedonic techniques; (2) distinctions between measurement of public and private sector production; and (3) US Government operations of human organ donor programs. The movie motivated the realization that marketization of human organs could shake up that program and improve outcomes for some (those with financial

resources), but injure others (the indigent). The most important realization, however, was that proper pricing of human organs would require recognizing quality differences, and that these organs help sustain life and health as a human materials input.[iii] Hence, humans—at least their organs—should be considered a materials factor input to the production of *Health* services. If a human organ is a materials factor input, then why not human bodies in their entirety?[iv] In addition, this theoretical and conceptual submission notes that BlackEconomics.org has analyzed the extent to which the US economy utilizes human factor inputs to drive economic growth in recent submissions—this spans Americans generally, but also Black Americans specifically.[v]

A brief summary of this working paper is: If the growth in quality adjusted real gross output exceeds the growth in quality adjusted real materials (M) factor inputs (where growth is estimated using quality adjusted volume/quantity or price indices), then it is possible that estimated negative multifactor productivity might disappear from the landscape of certain service industries.[vi,vii] This is assured when capital, labor, energy, and services factor inputs are quality adjusted or such quality adjustments are not required.

Analysis

Efforts to resolve the negative multifactor productivity conundrum should consider anew the following observations:

- Mismeasurement of the rate of real gross output growth can contribute to the negative multifactor productivity conundrum for the service industries of concern (*Health* and *Education*) because these industries reflect both public and private production—with public production typically exceeding private production. Given "nonmarket" public production, the value of real output and its growth may not reflect market prices. Rather, the growth in nominal output is based on "the cost of

production." This is bothersome and complicated. We will go no further with this topic for now, other than to say that it may be worthwhile to explore why a "cost measure of nominal output" was adopted for publicly produced services. For other components of macroeconomic statistics, other approaches have been adopted, including a combination of quantities and shadow prices to estimate nominal gross output. Production of public *Health* and *Education* services have private sector analogs that function in market space and involve transactions for services based on market prices. Is it not reasonable then that a similar proxy or shadow price approach could be adopted for measuring the nominal output of *Health* and *Education* services?

Another concern is that, while the nominal value of output is based on cost for publicly provided *Health* and *Education* services, estimates of real output growth are measured using volume/quantity or composite price indices. A critical question to pose about these indices is whether they are adjusted to account for quality change.

- Typically, there are likely to be few measurement concerns about capital, labor, energy, and services in a KLEMS framework when measuring multifactor productivity. However, measurement of materials may constitute an important element of the negative multifactor productivity conundrum.

- To consider thoroughly the "materials" problem in a KLEMS model when estimating multifactor productivity, there must be recognition that **human economic agents are not fully accounted for in economic measurement.** Our concern is that human

economic agents are only accounted for in two aspects of productivity measurement.

First, labor is a transparent element in accounting for productivity measurement. The second element—although implicit—is gross output growth itself. Humans serve as consumers, who generate the value of gross output using incomes earned from their provision of labor. Humans use their income to purchase and consume goods and services that are produced. Clearly, humans operate as suppliers of labor and as consumers of the goods and services that are produced. However, there is no accounting for humans (in the form of human materials) being transformed during the production of certain services.

- To recognize "human materials," estimators of multifactor productivity should consider that services can be provided for inanimate and animate units. Production of *Health*, *Educational*, and certain other services are provided mainly for animate units.

- We are not contending that there is absolutely no accounting for "human materials" in productivity measurement. However, we contend that accounting for "human materials" is inadequate, the absence of such accounting affects productivity measurement, and it likely contributes to the negative multifactor productivity conundrum. (See Endnote vi concerning our perspective on how human materials factor inputs are already accounted for in multifactor productivity measures.)

  Specifically, human materials as factor inputs are accounted for in productivity measures inadequately

because there is no comprehensive effort to account for the quality of "human materials" that enter the production process. It is transparent that negative multifactor productivity results when the sum of real growth in intermediate (EMS) factor inputs exceeds real growth in value added. Hence, it is as important to measure the real growth in these factor inputs as it is to measure real growth in gross output and value added.

- Assuming for now that there is accurate measurement of real growth in materials factor inputs for services, we now consider the proper and accurate measurement of real gross output growth for services.

  An important case of very favorable (positive) multifactor productivity outcomes is *Electronic computer manufacturing* (henceforth *Computer manufacturing*; today's (2017) NAICS 334111), say during 1998-2023.[viii] The average growth in real gross output (and value added) for *Computer manufacturing* is much faster than growth in related intermediate (EMS) inputs. This outcome occurs because, while real growth in gross output (and value added) of *Computer manufacturing* is bolstered by quality adjustment of computer prices over the period, the combination of declines in the volume and price of intermediate inputs enabled growth in real gross output and value added to proceed at a relatively elevated rate for much of the period.

- Beginning in the second half of the 1980s, quality adjustment of producer prices for *Computer manufacturing* was performed using hedonic techniques, which yielded negative parameter

estimates for key technology characteristic variables that were included in hedonic equations (e.g., random access memory, computer chip speed, etc.).[ix] These negative parameter estimates implied an inverse relationship between the price of computers and the just-mentioned technology characteristic variables. In other words, the quality (usefulness) of computers was rising faster than their associated sales prices.

- For *Health*, *Education*, and other service industries that are provided primarily for animate units, we believe that two measurement elements are not accounted for adequately. First, the volume and price of certain materials factor inputs used to produce expected outcomes are increasing rapidly due to reasons outlined in Endnote vi. However, there appears to be little effort to quality adjust relevant producers prices as was, and is, done for *Computer manufacturing*. For example, pharmaceuticals are materials factor inputs in the production of *Health* and *Education* services. These pharmaceutical products are proliferating, are associated with new, improved, and increased quality characteristics, but their prices are not quality adjusted.

  Second, when the real gross output of *Health* services is measured using volume/quantity or price indices it is critical that these indices account for the fact that today's average recipients of human health services may be declining in quality—if for no other reason than that the US population continues to age—and healthcare recipients are the beneficiaries of complex cures characterized by simultaneous healings of increasingly new and more virulent diseases and comorbidities than in the past that result

from degradation of our physical and social environments. That is, the measurement of a health treatment episode may be complex and may reflect more quality characteristics (types of healing) with increased values, which may require quality adjustment.

For the production of *Education* services, there are quality declines in many of today's students vis-à-vis their historical counterparts; e.g., certain students reflect larger skill deficiencies, more mental health concerns, they may not be properly socialized, and they may reflect other concerns that were less prevalent or were overlooked in the past. Therefore, the delivery of one unit of *Education* services (say, a completed grade level) for students may be an inaccurate metric because, hypothetically, not only does the student reflect educational advancement commensurate with an academic standard, but the student may also have gained augmented socialization skills, and stabilization of the student's mental health (the latter being a *Health* service).

It appears reasonable that quality adjustment of volume/quantity and price indices is indicated, at least for now, as a sound approach for improving multifactor productivity estimates for services that are produced mainly for animate units. However, at some point, it may be necessary to view establishments that produce certain combinations of services as producing joint products, which may complicate industry assignment.

- In support of the foregoing discussion, Table 1 provides estimates of the growth in real gross output and materials factor inputs as reflected in chain-type

quantity and price indices for *Computer manufacturing* and *Health* and *Education* services.[x]

Table 1.—Annual Average Percent Change in Real Gross Output and Materials Factor Inputs for *Computer Manufacturing* and *Health* and *Education* Services, 1998-2023

Line No.	Industries	Chain-Type Quantity Indices	Chain-Type Price Indices
Gross Output			
1	*Computer manufacturing* (334)	4.250%	-4.069%
2	*Health Services* (61)	3.054%	2.396%
3	*Education Services* (62)	2.654%	2.977%
Materials Factor Inputs			
4	*Computer manufacturing* (334)	-2.173%	-1.491%
5	*Health Services* (61)	0.880%	2.995%
6	*Education Services* (62)	0.037%	2.085%

Source: BEA and BlackEconomics.org visualization.

- While the *Computer manufacturing* industry is dissimilar in many respects from the *Health* and *Education* services industries, Table 1 amplifies difference that are, in large measure, accounted for by the incorporation of quality adjustment of gross output and materials factor input measures for *Computer manufacturing*, and the absence of such quality adjustment for *Health* and *Education* services measures. For gross output, *Computer manufacturing's* chain-type quantity index grows much faster and its chain-type price index declines considerably more rapidly due to quality adjustment than the same measures for *Health* and *Education* services. For materials factor inputs, *Computer manufacturing's* chain-type quantity and price indices decline considerably more rapidly than the same measures for *Health* and *Education* services due to quality adjustment.

As consideration is extended to using quality adjusted volume/quantity and/or price indices to produce estimates of real gross output growth and real growth in materials factor inputs for industries that produce services for humans (animate units), the following points are worthy of consideration:

- Assess the efficacy of quality adjusting volume/quantity indices that are used to estimate the growth of real gross output.

- Where price indices are used to estimate components of the real gross output of service industries by deflation, consider the potential need to employ a measure of quality declines in "human materials" based on human capital indices (HCIs) or other quality indices. Our brief assessment of HCIs that are readily available engendered an opinion that incorporating quality adjustments using HCIs may not be the most efficacious method.[xi] Rather, because quality declines in human health result largely from an aging population and declines in the quality of our environment. Hence, environmental quality indices should be considered for this purpose.

- The quality of the human condition and our environment (they help produce our quality of life) can affect educational outcomes. Therefore, social quality indices may be more appropriate for estimating the real value and growth of the gross output of *Education* services. For example, and on a temporal basis, the proportion of households that are single headed has increased substantially in recent decades. Also, family members spend less time together (even when they are together), which can affect socialization and mental health outcomes.

- In addition, the media (especially social media) is known to produce adverse outcomes for youth (and adults), impinge upon their proper socialization, and their ability to benefit from *Education* services.

- If there is a temporal decline in the quality of human inputs for the production of *Health* and *Education* services, and if the growth in real gross output for these industries is estimated using volume/quantity indices, then adoption of quality adjustment could produce accelerations in real gross output growth.

- This outcome results because quality adjustment of volume/quantity indices should enter inversely. For example, assume that one standard unit of service output produced in periods t and t+1 is unadjusted for human inputs' quality. However, when the indices are adjusted to account for poorer quality human inputs (declining quality) in period t+1 than in period t, the implication is that more than one standard unit of real service output produced in period t+1. Therefore, quality adjusted volume/quantity indices for *Health* and *Education* services may reflect faster growth of real gross output as the quality of human inputs declines .

- Composite price indices (CPIs*) that are used to deflate the value of gross output for services provided mainly to animate units (humans), are composed of various Consumer Price Indices (CPIs) that are associated with specific sub-elements of service. Quality adjustment of the CPIs* to reflect declines in human quality should produce a deceleration in inflation.

For example, assume that there is a $1 price for one standard unit of service output produced in periods t and t+1 that is unadjusted for declines in the quality of human inputs. Also, assume that after adjusting for declines in human quality in period t+1, two sub-elements of service are required to produce one standard unit of service output in period t (i.e., the implied price for each sub-element of service is $0.500), but three sub-elements of service are required to produce one standard unit of service output in period t+1 (i.e., the implied price for each sub-element of service is $0.333).

Given reductions in implicit prices for underlying sub-elements of service from $1.500 to $0.333 from period t to period t+1, the levels of the related CPIs and CPIs* should fall. Viewed differently, if two sub-elements of service are required in period t, but three sub-elements of service are required in period t+1 to produce one unit of service output that is priced at $1 for both periods, then CPIs* for the standard unit of service output should be adjusted down for period t+1. The downward adjustment to the CPIs* will reflect the decline in the quality of human inputs, which precipitated the requirement for an additional sub-element of service to produce one standard unit of service output. Such downward quality adjustment to CPI*s that are used to deflate the gross output of *Health* and *Education* services, should cause real gross output growth for these services to accelerate.

Conclusion

This theoretical and conceptual contribution to the literature resurrects the negative multifactor productivity conundrum for service industries. It focuses specifically on the production of

privately and publicly provided *Health* and *Education* services. We conclude that economists/statisticians may have conceded acceptance of negative multifactor productivity for these industries too soon. We suggest that consideration be given to: (i) Revising methods for estimating the nominal value of nonmarket gross output of *Health* and *Education* services when current measures are based on cost; (ii) incorporation of quality adjustments into estimates of real gross output and materials factor inputs for these services; and (iii) adoption of the view that there are at least three roles for humans in multifactor productivity and economic measurement broadly.

Consideration of the latter point is warranted because not only do humans contribute labor to the economy, but humans (consumers) also account for about two-third of private economic expenditures which links directly to economic demand and the value of gross output and value added. In addition, there is an important third human role in the economy: Humans as very important materials factor inputs for the production of services that are provided for animate units.

To the extent that this submission stands up to scrutiny, it is transparent that the negative multifactor productivity conundrum may be, at least partly, resolved. If so, then re-estimation of multifactor productivity for certain industries should reflect positive, not negative, multifactor productivity.

Positive, not negative, multifactor productivity estimates for certain service industries would be a favorable outcome especially for Black Americans. Black Americans are overrepresented as employees in certain service industries (including certain detailed *Health* and *Education* industries), and we are very active consumers of, and thereby materials factor inputs for, the gross output of these services—especially services produced by the public sector. Negative multifactor productivity measures are not expected as the "norm." They infer some deficiency and/or inefficiency in production. When resources are constrained, to spur economic growth governments may extend more support to goods and services that reflect positive multifactor productivity,

and may slow or reduce support for industries that reflect negative multifactor productivity.

If the negative multifactor productivity conundrum can be resolved using estimation methods and procedures discussed herein, then this could help ensure against reductions in support for services that Black Americans require desperately. The two services discussed here—*Health* and *Education*—are core requirements for Black Americans as we seek to reduce Black versus non-Black American gaps across the United States' socioeconomic spectrum.

Endnotes

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[i] See "The Case of the Missing Productivity: A Mystery." *IRConcepts*, Spring 1999, Industrial Relations Counselors, Inc. https://irc4hr.org/resources/the-case-of-the-missing-productivity-a-mystery/ (Ret. 092424).

[ii] Barbara Fraumeni, Marshall Reinsdorf, Brooks Robinson, and Matthew Williams (2009). *Price Index Concepts and Measurement*, W. Erwin Diewert, John Greenlees, and Charles Hulten Editors. University of Chicago Press. Chicago; pp. 373-404. The numerical values in parenthesis, 61 and 62 for *Health* and *Education* respectively, are *2017 North American Classification System* (NAICS) codes.

[iii] At the time (2003) we mentioned to the leadership responsible for producing the US National Accountants Statistics (Brent Moulton and Carol Moylan), that the Bureau of Economic Analysis (BEA) should consider developing a program for measuring prices of human organs on a quality adjusted basis.

[iv] It is important to note that the *System of National Accounts 2008* and *2025* (forthcoming) (*SNA*) does not describe or characterize in detail "materials" factor inputs when discussing the KLEMS productivity framework. Hence, there are no references to humans as "materials." The Organization for Economic Corporation and Development's *Measuring Productivity* manual follows the *SNA* in this regard. However, *Measuring Productivity*, includes references to humans as possessors of "human capital."

[v] The following are two recent sources that reflect references to Black Americans as human factor inputs for production: Brooks Robinson

(2024 and 2023, respectively). “Strings Attached” and “Missing the Point.” BlackEconomics.org. Honolulu; https://www.blackeconomics.org/BEFuture/stb081924.pdf and https://www.blackeconomics.org/BEFuture/mtp062323.pdf, respectively. (Ret. 091424)

[vi] Note that materials factor inputs do not now include humans. However, changes in the quality of humans (their bodies) that enter the production of *Health* and *Education* services is reflected in the increased volume of material factor inputs (e.g., pharmaceutical goods for *Health* services and training and pharmaceuticals goods for *Education* services) that are required to address declining quality in human bodies—if for no other reason than that the US has an aging population. This can be seen in more comorbidities, conditions associated with more virulent forms of diseases, and other conditions for *Health*. For *Education*, quality declines in humans can be observed in students, who are increasingly less prepared to participate in learning environments because of skill gaps, poor socialization skills, and mental health concerns.

[vii] For clarity on why we use the “volume/quantity” convention, see Chapters 15 and 18 of the *SNA* (2008 and 2025 (forthcoming)).

[viii] We reference the 1998-2023 period because the U.S. Department of Commerce’s BEA provides selected details of its Industry Economics program on its website currently. See BEA’s Interactive data tool: https://www.bea.gov/itable/gdp-by-industry.

[ix] Hedonic regressions were used to estimate the values of the parameter estimates. See Rosanne Cole, *et al* (1986). “Quality-Adjusted Price Indexes for Computer Processors and Selected Peripheral Equipment.” *Suuvey of Current Business*. Vol. 66, No. 1; pp. 41-50. https://apps.bea.gov/scb/issues/1986/scb-1986-january.pdf (Ret. 092324). At the time, quality-adjusted computer prices were also produced using “time dummy” and “matched model” approaches.

[x] The estimates appear in BEA’s interactive tables: i.e., Percent change in Chain-Type Quantity and Price Indexes for Gross Output by Industry, and Chain-Type Quantity and Price Indexes for Materials Inputs by Industry.

[xi] One could measure quality declines in human materials factor inputs using human capital indices (HCIs). Currently, the World Bank, the United Nations, and the Institute for Health Metrics and Evaluation all produce HCIs. See Gang Liu and Barbara Fraumeni (2020). “A Brief Introduction to Human Capital Measures.” IZA Institute of Labor Economics. Bonn, Germany: https://docs.iza.org/dp13494.pdf (Ret. 092324). HCIs reflect account for intellectual or academic skills, not so much the physical condition of the human body. Hence, HCIs do not

appear to be appropriate for quality adjusting the physical condition of human bodies. On the other hand, some composite of HCIs and environmental quality indices might be ideal.