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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 real (human animate) materials (*M*) factor inputs is reduced sufficiently through appropriate quality adjustment (using appropriate quality indicators), then it is possible that estimated negative multifactor productivity might disappear from certain service industries' landscapes. Currently, capital *(K*), labor (*L*), energy (*E*), and certain services (*S*) factor inputs are quality adjusted in a KLEMS framework.

We posit that economists/statisticians may have conceded acceptance of negative multifactor productivity (MFP) 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 materials factor inputs for these services; and (iii) adoption of the view that there are at least three roles for humans in MFP 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 the production of certain services for animate inputs.

*—The author thanks economists/statisticians at the Bureau of Economic Analysis and the Bureau of Labor Statistics for their willingness to clarify points concerning existing MFP estimates, and Barbara Fraumeni for commenting on an earlier draft of this BlackEconomics.org Working Paper.

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 MFP. 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 MFP 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 conceptual and theoretical 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 real materials (*M*) factor inputs is reduced sufficiently through appropriate quality adjustment (using appropriate quality indicators), then it is possible that estimated negative MFP might disappear from certain service industries' landscapes, certain service industries.[vi,vii] Also, 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 materials factor inputs for these services; and (iii) adoption of the view that there are at least three roles for humans in MFP 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 the production of certain services for animate units.

Analysis

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

- Mismeasurement of the growth of real *M* factor inputs can contribute to the negative MFP 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 major mismeasurement concerns about capital, labor, energy, and services in a KLEMS framework when measuring MFP given available data and resources. However, mismeasurement of materials (*M*) may

constitute an important explanation for the negative MFP conundrum.

- To consider thoroughly the "materials" problem in a KLEMS model when estimating MFP, 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 little-to-no accounting for humans (in the form of human materials) being transformed during the production of certain services.

- To recognize "human materials," estimators of MFP 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 MFP results when the sum of real growth in *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 *M* 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) MFP 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 for *Computer manufacturing* is much faster than growth in related intermediate KLEMS inputs. This outcome occurs because, while real growth in the gross output 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 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 materials inputs, we believe that two measurement elements are not accounted for adequately. First, the volume and price of certain *M* 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 MFP 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 inputs), 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, quality declines in human health result largely from an aging population and declines in the quality of our environment. Hence, environmental quality indices should also 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, selected media platforms (especially social media) are 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.

To elaborate a model for value added that is quality adjusted consider the following set of equations

Equation 1:
$VA\ (\ K, L, T, OS) = GO - (\ E, M, S)$

Where the variables are expressed in nominal terms: *VA* is for value added, which is equal to *K* (capital services), *L* (compensation for labor), *T* (taxes), and OS (operating surplus of the entrepreneur), *GO* is for gross output, *E* is energy, *M* is for materials, and *S* is for services; the latter three inputs are considered intermediate.

Using "*R*" to indicate a transformation of equation 1 from nominal to real (price adjusted) terms either using standard (deflation with price indices or by extrapolation using

quantity indexes) or quality adjusted methods, now consider equation 2:

Equation 2:
$RVA = RGO - [R(E, M, S)]$

Now consider that current methods for transforming nominal to real values in the above two equations entails "no quality adjustment" (*nqa*) or "quality adjustment" (*qa*). For simplicity, and based on our research of PPIs and CPIs, we conclude the following:

- *RGO*, which begin as market value for sales or shipment of goods or services produced, may very well be available on a *qa* basis. Similarly, BLS and other agencies can generally identify *qa* based indices or quantity indicators to quality adjust two relevant aspects of *RVA: K*, and *L*. *E*, too, inherently embodies its own type of *qa* because energy comes in many forms and gradations [e.g., for petroleum based energy, there are jet fuels, fuel oil, gasoline, etc.; the following are forms of gas energy gas: Natural gas, and liquified natural gas (LNG), etc; for electrical energy, which is produced widely using petroleum or gas sources of energy, can also be produced using "green" sources: Solar, wind, wave, thermal, etc. We skip for a moment and return to *M* after addressing S. We believe that it is safe to say that *S* inputs for the production of *Health* and *Education* services are generally not *qa* when transforming them from nominal to real value. As for *M*, we raise and reemphasize the point that *M* is usually not fully accounted for in economic measurement. That is, *M* may be composed of two subcomponents: "Animate" (*A*) and "Inanimate" (*IA*) inputs. The *A* portion of *M* is typically excluded from

most economic measures, which is, in and of itself, a potential source of mismeasurement. This is particularly so for *Health* and *Education* services because human *A* sources are the most important component of M_A. Economic measurement typically only accounts for sources of M_{IA} production inputs, which are largely void of *qa*. The remainder of this portion of this portion of this BlackEconomics.org working paper concerns *A* sources of *M* and how proper *qa* of these sources may produce a reversal of the current and widely replicated negative MFP results.

To reverse current MFP results, especially for the production of Health and Education services, there should be agreement that there are good reasons to suspect and expect that M_A sources are likely to reflect quality declines. For *Health* and *Education* services, humans are the primary M_A source, and the following are reasons why humans are likely to reflect quality declines:

- For the production of *Health* services, declining human M_A sources reflect quality declines due to the inversion of the population pyramid; widespread degradation of the environment in which humans live; social practices that contribute to a diminution in the quality of the human body; increasing economic inequality that results in more "have nots" with the wherewithal to ensure against quality declines due the lifestyle and quality of life that is available to them; etc.

- For the production of *Education* services, declines in the quality of (human) M_A sources are attributable to some of the same sources cited for *Health* immediately above; especially various aspects of economic inequality. These quality declines in human M_A sources are easily identifiable in the

increased number of disabled, slow learners, special needs, and socially disoriented students who receive *Education* services. Beyond economic inequality, the diversification of populations within borders due to migration can complicate the delivery of *Education* services due to cultural differences; especially language. Finally, probably an increasing source of relative quality declines in human *M*A in the production of *Education* services is the role of technology in preparing and aiding societal elites in exploiting the benefits of technology for learning, while such benefits are not so easily accessible by nonelites.

As indicated, a key to the potential reversal of negative MFP is to account for declines in human M_A sources. It is possible that these sources have not been consciously accounted for heretofore because they may have been viewed as a "free" input. Therefore, we suggest as a starting point to simply incorporate *qa* indicators into MFP measurement for human M_A. M_{IA} components are measured, and it appears logical to simply apply appropriate *qa* factors to the M_{IA} components because the volume of M_{IA} components are directly affected by the quality of the human M_A components.

Specifically, Equation 3 reflects our hypothesis concerning the potential reversal of negative MFP measures now existing for Health and Education services:

Equation 3:

$$RVA_{nqa} = RGO_{nqa} - \left[R(E_{nqa}), R(M_{A_{nqaindicators}}, M_{IA_{nqa}}), R(S_{nqa})\right]$$

$$<$$

$$RVA_{qa} = RGO_{qa} - \left[R(E_{qa}), R\left(M_{A_{qa}indicators}, M_{IA_{qa}}\right), R(S_{qa})\right].$$

Equation 3 will prove to be true to the extent that appropriate quality indicators that are discussed above reflect declines in (human) M_A inputs that reduce the value of overall M and its growth. That is, if quality indicators for M_A reflect declines and those indicators are applied to M_{IA} inputs, then M on a qa basis will be reduced relative to current MFP measurement; thereby opening the door to a reduction in the value of charges (costs) against RGO, which will yield a relative increase in RVA. Of course, the increase in RVA must be sufficient to swamp the current negative MFP outcome.

The inference from equation 3 is reflected in equation 4:

Equation 4:

$$\Delta RVA_{nqa} = \Delta RGO_{nqa} - \left[\Delta R(E_{nqa}), \Delta R(M_{A_{nqaindicators}}, M_{IA_{nqa}}), \Delta R(S_{nqa})\right] < \Delta RVA_{qa} = \Delta RGO_{qa} - \left[\Delta R(E_{qa}), \Delta R\left(M_{A_{qaindicators}}, M_{IA_{qa}}\right), \Delta R(S_{qa})\right]$$

Accordingly, we conclude that the growth in RVA for the *Health* and *Education* services industries on a qa basis may very well exceed the growth for these two industries on an nqa basis, and may reach a positive versus negative level, which implies positive, not negative, MFP.

Conclusion

This conceptual and theoretical submission resurrects the negative MFP 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 MFP 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 MFP 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-thirds of US expenditure measures economic activity, 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 inputs.

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

Positive, not negative, MFP estimates for certain service industries would be a favorable outcome especially for Black Americans (Afrodescendants). 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 those services that are produced by the public sector. Negative MFP 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 the production of goods and services that reflect positive MFP and may slow or reduce support for industries that reflect negative MFP.

If the negative MFP 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 (Afrodescendants) 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.

Notably, the analysis presented here may also carry significant implications for developed and emerging market economies and how they are viewed; whether they do or do not produce estimates of MFP today.

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.

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