

What Can Be Done to Measure Productivity Better?

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The Importance of Productivity

Economies

- Productivity growth is speed limit on per capita income growth
- Productivity measurement was recently focus of “mismeasurement hypothesis” source of productivity slowdown

Industries

- Across-sector productivity differences drive large resource reallocations over short and long horizons

Producers

- Enormous and persistent productivity variation exists even in narrowly defined industries
- Differences affect companies, employees, and customers
- Firm-level productivity dynamics shape aggregate productivity

Productivity Measures

Boiled down, all productivity measures are output-to-input ratios

Differ in input scope

- Single factor productivity (e.g., labor productivity)
- Total factor productivity

Paper's discussion is organized along the ratio's dichotomy

- Output measurement
- Input measurement
- (Plus an additional issue, market power)

Caveat: Productivity measures are also residuals, so they can reflect output variation not conceptually related to production functions

Challenges in Output Measurement

1. Expenditure-based output measures
2. Difficulties in defining output
3. Uncounted outputs

Expenditure-Based Output Measures

Outputs are rarely directly measured in physical units (e.g., board-feet of lumber, patient-nights, tax returns filed)

While perhaps ideal for physically homogenous goods, directly measured output units are typically impractical

- Incomparability across producers
- Need to aggregate across multiple outputs

Outputs almost always measured as expenditures/revenues divided by a price

Price index accuracy critical for output measurement accuracy

- A price index error creates mirror-image output error

Expenditure-Based Output Measures

Price index should, when divided into expenditures on a good or bundle, return effective quantity of good in consumers' utility functions, or producers' PFs if intermediate input

Well known sources of error: unmeasured quality, inability to incorporate new product benefits, substitution bias (for fixed-weight indexes)

Statistical agencies often do apply some treatments of quality change into their price indexes

- But considerable variation in type and extent of treatment
 - Resource and time constraints limit capabilities
- A rationalization of which goods yield greatest benefit-to-cost of quality treatment would be valuable

Expenditure-Based Output Measures

In micro data, typically no producer-specific price indexes at all

Output instead usually measured as producer revenue

Price differences remain in output and productivity measures

If prices reflect demand shifts or market power rather than quality or technology, high measured productivity doesn't have to imply efficiency

Affects inferences about productivity's connections to outcomes like survival, growth, wages, prices, etc.

Expenditure-Based Output Measures

Current treatment of product turnover is primitive

Small-sample price surveys of most statistical agencies don't capture turnover well (esp. if product defined as good-location-of-sale)

Also, quantitative effects of new goods depend on assumptions about consumers' utility functions or producers' production functions

Good first step: more systematic evidence about product turnover

Difficulties in Defining Output

Sometimes primary output measurement problem is properly defining output in the first place

What do financial firms “make”?

We hope the healthcare sector actually produces *health*, but how to measure that?

Other sectors with big issues: education, government, nonprofits

Common approach: measure outputs using inputs

- Especially problematic for productivity measurement
- Necessarily assumes something about productivity (including fixed productivity in some cases)

Difficulties in Defining Output

Some improvements underway to use “quality-augmentation” to obtain measures closer to conceptual outputs

Example: U.S. BLS once measured education sector output by enrollment

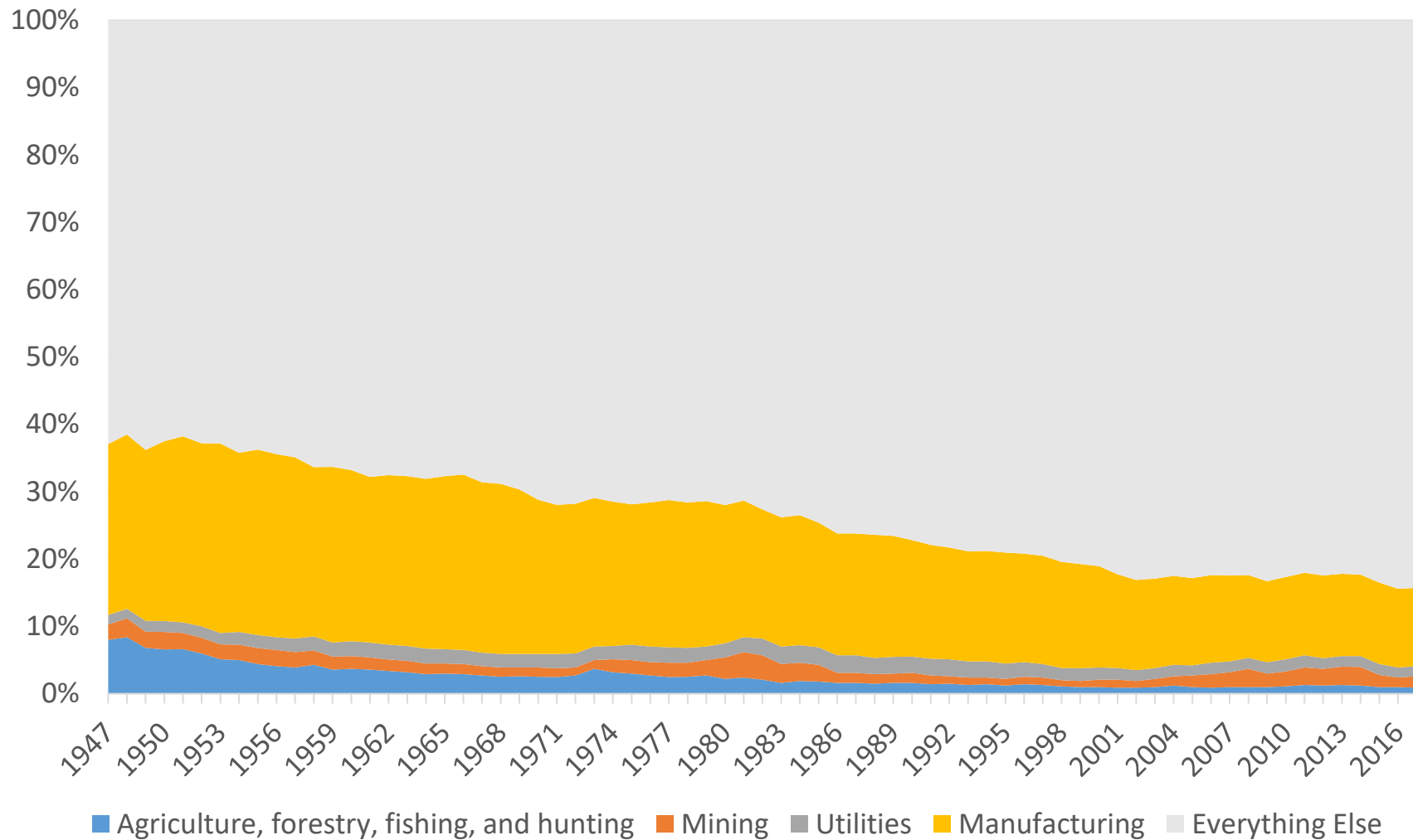
- Now BLS adjusts enrollment by attendance and weights result using changes in a benchmark exam
- More closely matches human capital formation

Quality-augmentation easier in aggregate data

- Education (and healthcare) involves lags between purchase and outcomes, noisy connections between them, and few cardinal metrics
- Creates disconnects at person level between inputs and output
- Person-level noise and time lags averaged over in aggregates, so tighter link between *average* input levels and *average* outcomes

Difficulties in Defining Output

This is a growing problem—“unmeasurable” sectors keep expanding



Uncounted Outputs

Sometimes productive activity isn't measured at all

- Home production
- Environmental goods
- Omission of health as an output

Could be quite large

- Home production: Estimated to be 26% of GDP in 2010 in U.S.; larger before—move away means GDP growth overstated economic activity
- Environmental goods: EU-28 annually spends 2.2% of GDP on environmental protection
- Health: U.S. life expectancy grew 0.178 years/yr from 1970-2015; that's \$17,800 annual income growth (\$100K/QALY); real GDP per capita growth over same period was \$1600/yr

Uncounted Outputs

Another issue is “free” digital goods

- Google, Facebook, Snapchat, etc.
- Consumers do not engage in monetary transactions when they use

Not a new problem (e.g., TV, radio, newspapers)

But, some value is in fact captured in transactions

- Advertisers buy access to consumers
- Consumers buy necessary complementary goods (e.g., smartphones, broadband) that embody value of consumption

Recent work (Nakamura et al., 2017) suggests missing output is small

- Real GDP correction of -0.002%/year over 1929-1998
- Real GDP correction of +0.009%/year over 1998-2012

Challenges in Input Measurement

1. Labor
2. Intermediate inputs
3. Capital
4. Estimating Output Elasticities

Labor

Labor quantities (employees or hours) can vary substantially in quality

At aggregate levels, one can merge quantities with info on workers' average education, training, experience, etc.

- Similar to quality augmentation of output)

In microdata, total wage bill sometimes used to measure labor inputs rather than quantities

- Idea is that wages reflect MPL variation
- Drawback is wages might also reflect priced influences not tied to MPL (e.g., local labor market competitiveness)
- Some research (Fox and Smeets, 2011) suggests wage bill captures most info in more detailed data on labor quality

Intermediate Inputs

Almost invariably measured as expenditure on inputs divided by price index

Very similar issues to that with expenditure-based output

Issues may be even more prominent than with output

- High product turnover
- Input customization

Statistical agencies do perform some quality adjustments with inputs too

Capital

Probably the most mismeasurement-prone input

Several issues

- Unmeasured quality—adjustments can be more difficult than for labor
- Using stocks to measure flows
- Incorrect depreciation rates and investment deflators when building capital stock using perpetual inventory method
- Intangibles—almost surely growing in importance

Estimating Output Elasticities

TFP requires input “denominator” that indexes total input use

Theory: (logged) composite input is weighted sum of (logged) factor inputs, where weights are **factors’ output elasticities**

One approach to estimate elasticities: index number construction

- Static cost minimization implies factors’ shares of total costs equal their elasticities
- Assumes away factor adjustment costs (at least at aggregate level)

Second approach: production function estimation

- “Transmission bias”: productivity (error term) correlated with regressors (factors)
- Large literature tries to solve this problem, though with assumptions

Market Power

Market power creates a wedge between changes in inputs and changes outputs

Causes TFP measures to embody not just “technology,” shift-in-PF concept, but also market power variation

- Related to, but distinct from, demand entering productivity when revenues are used as an output measure

I am not aware of any statistical agency that adjusts productivity estimates for market power

Researchers have usefully turned this relationship on its head to estimate the magnitude of market power from production data

Priority Areas to Address

1. Improve and expand price data
2. Expand the set of measured outputs
3. Improve capital measurement, especially intangibles

Improve and Expand Price Data

Aggregate price indexes

- Conduct rationalization of which products receive quality adjustment treatment, and under which procedures
- Leverage existing digital pricing information (e.g., Goolsbee and Klenow, 2018) to augment current collection practices without large additional costs

Micro-Level

- Producer-specific prices would open up entirely new set of questions
- Experience from limited current datasets with this information suggests large insights about firms', workers', and consumers' fortunes

Expand the Set of Measured Outputs

Priority areas for expansion: Health outputs and household production

Health outputs

- Enormous share of resources are dedicated to its production, but no sharp measures of how efficient allocations are
- Can be done in aggregates with quality-augmentation
- Micro-level more difficult, but e.g. survival or readmission rates for hospitals

Household production

- Enormous in aggregate
- Important to understand long-run income trends and distribution
- Some building blocks already in place with time-use surveys
 - For example, see experimental accounts of U.S. BEA

Capital Measurement, Especially Intangibles

Would help address most pressing input measurement problem

Intangibles are already highly important factor and continue to grow in importance (e.g., Haskel and Westlake, 2017)

Closing Thoughts

None of these measurement issues are trivial to solve

(If they were, we would have solved them already)

Progress will require considerable research and organization building

But these challenges are matched by higher expected returns to collecting and analyzing such data