The Impact of Subsidies on Measuring Productivity and the Sources of Economic Growth

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Abstract   Taxes and subsidies drive a wedge between "market prices" at which the official GDP is valued and prices received and paid by producers. Motivated by the large economic subsidies that were part of the policy response to the COVID–19 pandemic, this paper introduces a new treatment for taxes and subsidies into the BEA-BLS integrated industry-level production account. Over shorter time periods, and for particular individual industries, these adjustments affect measured productivity growth but have a minimal impact at the aggregate. Nevertheless, for shorter time periods, and for industries that receive large subsidies, accounting for the effect of taxes and subsidies has a noticeable impact on the measured sources of growth.

Keywords   Total factor productivity measurement, economic growth, taxes and subsidies

JEL Code   E01, H20, D24

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1. Introduction

The economic policy response to the COVID–19 pandemic included the largest subsidies recorded in the history of the National Income and Product Accounts (NIPAs).[2] In 2020 and 2021, the U.S government awarded about $657 billion and $483 billion in subsidies, respectively, almost all of it from the federal government. The ratio of subsidies to gross domestic product (GDP) was over 3% in 2020 and was about 2% in 2021; previously, the largest ratio on record was just over 0.06% in 1987. In the 63 years of data on subsidies available from the Bureau of Economic Analysis (BEA), only in 10 of those years was the ratio of subsidies to GDP higher than 0.05%. Clearly, the subsidies during the COVID–19 pandemic were unprecedented in postwar U.S. economic history.

The need to record subsidies in the national income accounts is not new to national accountants, but the scope and breadth of the subsidies in the early 2020s led BEA to implement a new taxonomy for measuring economic subsidies. The distinguishing feature of the new taxonomy for subsidies was to divide subsidies into (1) subsidies on product and (2) other subsidies on production. Subsidies on product can be thought of as a negative *ad valorem* sales tax. For example, a $1 quantity of eggs sold directly to the consumer with a 5% sales tax would be purchased for $1.05, while a 5% subsidy on eggs (with no sales tax) would lead to a market price of $0.95. That is, the price a producer charges for a product in the marketplace reflects the value of **net taxes** (taxes less subsidies). GDP, the official measure of the value of final goods and services produced in the United States, takes this approach. GDP is measured in market prices, as this reflects what the final purchaser pays.

The other component of total subsidies that now is tabulated by BEA is other subsidies on production. This also has an analogy with the classification of taxes. BEA divides taxes into taxes on product (like above) and other taxes on production. The simplest example of a tax on production is a property tax on tangible business assets that are used in production, like a motor vehicle tax. A subsidy on production can be understood as a negative tax on production. For example, for every unit of property (capital) or every worker (labor) employed by a producer, the producer would receive a payment from the government. Consider the Paycheck Protection Program:[3] Autor et al. [2022] analyze how these payments were used and find that about $1/3$ of the payments were allocated to retaining workers.[4] Importantly, official GDP at market prices is invariant to whether a tax or subsidy is a tax or subsidy **on product** or other tax or subsidy **on production** because the final price paid by the consumer reflects net total taxes. But, this paper demonstrates that this distinction is important for for measuring total factor productivity (TFP) and defining an internally consistent industry-level production account (ILPA).[5]

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[2] The subsidy line item in the NIPAs begins in 1960. Prior to 1960, only subsidies net of the current surplus of government enterprises is available.

[3] https://www.sba.gov/funding-programs/loans/covid-19-relief-options/paycheck-protection-program

[4] The program permitted funds to be used to maintain payroll but also for rent, mortgage, and utilities.

[5] See https://www.bea.gov/data/special-topics/integrated-industry-level-production-account-klems for a discussion of the ILPA, its construction, and its uses.

The purpose of this paper is to present a new methodology for incorporating taxes and subsidies into measures of productivity. The basic mechanism for the approach is that net taxes on **product** should be removed from the output and income sides of the GDP account in market prices to derive the production account, while net taxes on production remain in the production account (when starting with the GDP account in market prices). Some intuition for this is that taxes on product do not affect costs of the primary factors of production, while taxes on production do affect these costs. The adjustment to remove the value of taxes and subsidies on products results in an adjusted output and income account that reflects only those net taxes and factor costs impacting production decisions. Furthermore, taxes and subsidies on production need to be allocated between capital and labor to derive accurate productivity measures. For example, the payment of property taxes is a component of the cost of capital and is appropriately included in this adjusted account along with the customary costs of capital.

We are not attempting to model the economic responses to tax policy. Our method takes the observed data (that was realized under the actual policy regimes) and provides an internally consistent accounting, conditional on the recorded taxes and subsidies. In the simple example above, the same quantity of eggs are produced and purchased with and without the taxes and subsidies. We are not making that assumption in our application, nor are we modeling the response to try to determine what production would have been without the tax and subsidy policy. We simply lay out that if a tax or subsidy policy is in effect, that market prices differ from prices received and paid by producers, and this impacts how productivity should be measured.

The empirical implementation of the adjustments to the productivity measures draws heavily from the work of Mandel and Ludwick [2021]. That paper describes each of the federal recovery programs related to COVID–19 and translates these to the NIPAs. Work by BEA further decomposes all taxes and subsidies by industry to taxes and subsidies on product and other taxes and subsidies on production. This paper describes how other taxes and subsidies on production are allocated to capital and labor for the purpose of measuring TFP.

The paper finds that in certain cases the adjustment for net taxes can be empirically important, especially for individual industries and over short time periods. For example, in 2020, this adjustment adds about 0.2pp to aggregate TFP growth, but this is small relative to the large swings in growth over the early pandemic period. Similarly, the adjustment subtracts about the same amount from TFP growth in 2021, but this pales in comparison to the recovery from the sharp economic downturn in 2020. The results show that this can be accounted for by measured TFP growth in a subset of industries that were directly targeted for economic relief including the trade, transportation, and a couple service sectors like food service and accommodation. For those studying changes in annual TFP and individual industries, this adjustment can be important.

The remainder of the paper proceeds as follows: section 2 specifies the basic setup and adjusts it for different types of taxation and subsidies and section 3 discusses how the data are constructed to implement the new measures. Section 4 presents how the methods impact the measured sources of growth at the aggregate and industry levels. Section 5 concludes.

2.   Productivity Accounting With Taxes and Subsidies

This section extends the standard equations for measuring productivity to distinguish between taxes and subsidies on product and on production. This is not the first research to recognize that the treatment of taxes impacts productivity measures. For example, Jorgenson et al. [2005] includes an adjustment for net taxes on product and other taxes on production, and the official productivity statistics produced by the U.S. Bureau of Labor Statistics (BLS) include an adjustment for taxes as well. What is new in this paper is the treatment of types of subsidies and how those should be incorporated into the production account.

Ignoring taxes and subsidies and intermediate inputs (there is additional discussion about intermediate inputs below), under the basic neoclassical assumptions, the producer seeks to maximize the following profit function[6]

$$\pi = pQ(K, L) - p_L L - p_K K$$

Taking the derivative of the above and using the first order conditions from the maximization problem yields the standard formulation for measuring the growth rate of TFP.

$$\Delta \ln v_T = \Delta \ln Q_t - \bar{w_K} \Delta \ln K_t - \bar{w_L} \Delta \ln L_t$$

where $\bar{w_K}$ and $\bar{w_L}$ are the average two period nominal shares of capital and labor, respectively, in value added.[7]

To derive the measurement equation with taxes and subsidies, we define the following notation[8]:

A bit of explanation of p_M is warranted. The market price, p_M, is the observed price paid by the final purchaser in the marketplace. When economic statisticians observe sales, often it is inclusive of sales taxes and less subsidies, i.e., includes net taxes. For example, if we observe eggs being sold for $2.20 at the point of sale, and taxes were $0.20, p_M includes the sales tax. Let's say a new $0.10 subsidy was added onto each bundle of eggs. For eggs sold, the farm would have to pay $0.20 in tax, but now it

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[6] Abstracting from intermediate inputs does not change the basic intuition. To include intermediates at the industry level, output is gross output and intermediate input price and quantity appear on the right hand side of the equation.

[7] The growth rate of TFP can be defined independently of the underlying economic model simply as the growth rate of output less the share weighted growth in inputs. For the formulation without taxes an subsidies this yields the same equation but when including taxes and subsidies specifying the producer problem instead of the index number problem yields useful insights on the origin of the equations.

[8] We treat all taxes and subsidies as ad valorem.

Tax and Subsidy Related Variables

p_M: market price paid by purchaser

t_P: tax rate on products as a share of market price

s_P: subsidy rate on products as a share of market price

$t_{K,L}$: tax rate on capital and labor, respectively

$s_{K,L}$: subsidy rate on capital and labor, respectively

would receive \$0.10 in subsidy, so the market price observed would be \$2.10. That is, even though there is no explicit accounting for the subsidy, the subsidy on product is reflected in the market price. \$0.20 is the gross tax, but \$0.10 is the net tax; the market price reflects the net taxes on products because the producer builds the subsidy into the price before taxes on products.

Labeling the price before taxes and subsidies on product p_B, the value of output accruing to the producer for quantity Q of production is:

$$p_B Q = p_M Q - t_P p_M Q + s_P p_M Q$$

This implies that

$$p_B = p_M[1 - t_P + s_P] \tag{1}$$

That is, the price received by the producer is the market price adjusted to subtract the rate of taxes and add the subsidies on product.[9]

Facing these prices, the producer solves the following maximization problem:

$$
\begin{aligned}
\pi = {} & p_M Q(K, L) - t_P p_M Q(K, L) + s_P p_M Q(K, L) \\
& - p_K K - t_K p_K K + s_K p_K K \\
& - p_L L - t_L p_L L + s_L p_L L
\end{aligned} \tag{2}
$$

The first line of the above equation specifies that the producer retains the value of its output that is sold on the market after it remits net taxes of product. Going back to the example of eggs that cost \$2.10, after taxes and subsidies on product, the producer retains \$2.10 less the sales tax of \$0.20 plus the subsidy of \$0.10, so \$2.00 per bundle of eggs. To try to avoid confusion, this can be stated again in a case without taxes on product and only subsidies on product. Suppose that the market price of eggs was \$2.10 and there was a subsidy on product of \$0.10. Consumers would pay \$2.10 for eggs but producers would earn \$2.20. This is because the subsidy allowed producers to charge \$0.10 lower on

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[9] Note that it is possible to formulate this in the way that is typically observed by purchasers, that is by defining the tax rate relative to prices before taxes, but that formulation obscures the accounting. The interpretation of the tax and subsidy rates on product used here are as share of market price.

the market knowing that for each dozen eggs sold, an additional \$0.10 would be earned via the subsidy. In the parlance of the national accounts, p_B corresponds to GDP valued at basic prices.

The second and third lines of the above equation introduces other taxes and subsidies on production. Taxes on capital and labor increase the costs of the factors of production faced by the producer, while subsidies on production reduce these costs.[10] In this setup, all taxes and subsidies on production are associated with purchases of either capital or labor services, even though the dataset to which the setup is applied includes intermediate inputs. One could imagine a policy that targeted intermediate purchases for either taxes or subsidies. But, the application of this would most likely be an excise tax or subsidy which is a net tax on product, not on production. Furthermore, all net taxes on production must be attributed to either capital or labor across the industry value-added chain because total GDP equals total payments to factor inputs. Therefore, a net tax on intermediate input would need to be associated with a net tax on the value added (either capital or labor) of the producing industry. An alternative way of thinking about this is that conceptualizing a net tax on the purchase of intermediate inputs breaks the value link between value of the purchase of that input and the production costs attributed to that same input. As a result of all of this, net taxes on production must either be attributed to capital or labor services and we ignore the description of intermediate inputs in these equations, even though the dataset to which they are applied necessarily includes intermediate inputs.

It is useful to relate equation (2) to the components of value added published in BEA's GDP by industry accounts (again, without loss of generality, assuming no intermediate inputs):

$$
\begin{aligned}
&\text{Gross output} \\
&= \\
&+ \text{Gross operating surplus} \\
&+ \text{Compensation of employees} \\
&+ \text{Taxes on production and imports} \\
&- \text{Subsidies}
\end{aligned}
$$

The new taxonomy for taxes and subsidies contains information to decompose the taxes and subsidies into two pieces:

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[10] Note that here the interpretation of p_K is the price of capital services before taxes and subsidies on production.

Gross output

=

+ Gross operating surplus

+ Compensation of employees

+ Taxes on product

+ Other taxes on production

− Subsidies on product

− Other subsidies on production

The next step is to align each of these with the components of equation (2), recognizing that other taxes and subsidies on product need to be divided into those on capital and those on labor:

Gross output : $p_M Q(K, L)$

=

+ Gross operating surplus : $p_K K$

+ Compensation of employees : $p_L L$

+ Taxes on product : $t_P p_M Q(K, L)$

+ Taxes on capital : $t_K p_K K$

+ Taxes on labor : $t_L p_L L$

− Subsidies on product : $s_P p_M Q(K, L)$

− Other subsidies on capital : $s_K p_K K$

− Other subsidies on labor : $s_L p_L L$

Finally, subtracting net taxes on product from both sides yields nominal accounting consistent with the production account:

Production Account Gross output : $p_M Q(K,L) - t_P p_M Q(K,L) + s_P p_M Q(K,L)$

$=$

$+$ Gross operating surplus : $p_K K$

$+$ Compensation of employees : $p_L L$

$+$ Taxes on capital : $t_K p_K K$

$+$ Taxes on labor : $t_L p_L L$

$-$ Other subsidies on capital : $s_K p_K K$

$-$ Other subsidies on labor : $s_L p_L L$

With this, it is straightforward to see how this formulation relates to the concepts of capital and labor compensation:

Production Account Gross output : $p_M Q(K,L) - t_P p_M Q(K,L) + s_P p_M Q(K,L)$

$=$

$\left.\begin{array}{l} +\text{Compensation of employees} : p_L L \\ +\text{Taxes on labor} : t_L p_L L \\ -\text{Other subsidies on labor} : s_L p_L L \end{array}\right\}$ Labor Compensation

$\left.\begin{array}{l} +\text{Gross operating surplus} : p_K K \\ +\text{Taxes on capital} : t_K p_K K \\ -\text{Other subsidies on capital} : s_K p_K K \end{array}\right\}$ Capital Compensation

On the left hand side, producers receive the value of output in market prices, less taxes on product, plus subsidies on product. Under zero profits, this is divided between labor and capital compensation from the perspective of the producer. Importantly, taxes on capital and labor add to each cost, respectively, from the perspective of the producer, and subsidies on factors of production reduce these costs.

3.   Source Data and Implementation

The first issue in adjusting the productivity statistics for taxes and subsidies is dividing taxes and subsidies into those on product and other taxes and subsidies on production. The starting point for this was BEA's 2018 comprehensive update of the industry accounts that distinguished between the two

types of taxes (Howells et al. [2018]).[11] Subsequent to that, Mandel and Ludwick [2021] translated the federal legislation regarding COVID–19 relief policies to be consistent with concepts in the national accounts. Finally, BEA analysts used expert judgment to allocate both taxes and subsidies on products and other taxes on production to individual industries. Importantly, the tabulation of other subsidies on production begins only in 2020, so how subsidies impact the allocation of costs between capital and labor can only be analyzed after 2020. But because these programs were largely unprecedented before 2020, this is not a major deficiency and the results will show that most of the difference between the methods is due to properly capturing net taxes on product and the allocation between capital and labor is less important.[12]

Second, real industry output growth and the corresponding output prices must be defined to be consistent with equation (1). Notice that the Q^* that solves the producer's maximization problem in equation (2) applies to both the valuation of output including and excluding net taxes. That is, actual real output is the same regardless of whether the valuation is in market prices or in adjusted prices. Thus, real output growth at the industry level is the same regardless of the treatment of taxes. So the first issue to address is how are prices applied to get Q^* in BEA's currently published industry accounts. The typical deflator for industry gross output in BEA's industry accounts is a producer price index (PPI). The PPI is before tax, but BEA's industry accounts are in market prices (after net taxes). To get consistency between prices and the value of output, BEA constructs a temporary version of gross output that subtracts only the value of taxes on product and uses this new nominal value divided by the PPI to derive Q^*. This ensures that the Q^* measures the real quantity produced. Then a new implicit price in market prices is defined as the value of gross output in market prices, divided by Q^*. Thus the difference between the two prices is the tax rate.

Similarly, the price of industry output in the industry-level production account needs to be adjusted; however, this needs to be adjusted by the net taxation rate on products. We do this by deriving the implicit price by dividing adjusted nominal gross output $(p_M Q(K,L) - t_P p_M Q(K,L) + s_P p_M Q(K,L))$ by Q^*. Here the difference between the implicit price of gross output in the production account and in BEA's official statistics on industry output is the rate of net taxes on product.

The next step is to split other taxes and subsidies on production between capital and labor. The major component on the tax side is property taxes, which is allocated to a component of the cost of capital (Jorgenson et al. [2005]). Thus, our default treatment is to determine which components of the other subsidies on production directly affect the cost of labor and allocate the remainder to capital as a residual. For each program, the shares we use are presented in Table A along with the source we use for determining the share. For many of the programs, the details do not specify how the funds are

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[11] In the recent history before the 2018 comprehensive update, BEA published information on taxes on production and imports less subsidies by industry.

[12] See Tables 4-6.

to be used. Thus, to avoid biasing the TFP calculation, we split the subsidies in proportion to labor and capital costs. Because most of the programs related to labor costs target payroll, we adjust only the employee compensation portion of labor compensation and leave self-employed labor compensation unchanged.

Like the adjustment for output prices, the prices of capital and labor need to be adjusted. To do this, we hold the quantity of capital and labor services fixed from the previous methodology of the ILPA and construct a new implicit price after the nominal capital and labor compensation adjustments have been applied. This amounts to treating the other taxes and subsidies on production as if they were not targeted to specific capital assets (like computers) or labor (like workers with a high school degree).

4.   Results

To assess the impact of the treatment of taxes and subsidies, we compare three different versions of the ILPA. The first version corresponds to the version published in September 2023.[13] This version fully implements the adjustment for taxes on product, subsidies on product, other taxes on production, and other subsidies on production. The second version adjusts the production account for only net taxes on products (implicitly allocating all of net taxes on production to capital), and the third version makes neither adjustment. This third approach corresponds to the approach taken for all ILPA vintages prior to the 2023 release.

Our first finding is that the adjustment for net taxes has the potential to make a noticeable impact on the aggregate measured sources of growth when taxes and subsidies are large during short time periods, but these adjustments were not significant enough to impact the narrative around the sources of growth during the sharp economic movements around the COVID–19 pandemic.

Table 1 gives the aggregate sources of growth based on the three treatments and indicates that, for the most part, differences in measured growth are minor across the three approaches. It is worth noting that, as discussed above, measured industry-level real output growth is the same regardless of the treatment of net taxes. But, the nominal valuation of gross output may differ; thus when weighted up to aggregate growth, aggregate real industry value-added growth may differ based on the treatment of taxes. The periods chosen to display are subjective but broadly correspond to: the entire time period for which ILPA data is available (1987–2021), the years before the information technology (IT) boom (1987–1995), an IT boom period (1995–2004), the period after the IT boom (2004–2021), with some additional subsamples that are included to isolate the recovery from the Great Recession, and the later years directly impacted by COVID–19.

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[13] Dataset is available at https://www.bea.gov/data/special-topics/integrated-industry-level-production-account-klems

The noticeable differences in aggregate measured growth occur in the 2019–2020 and the 2020–2021 periods.[14] After adjusting for taxes and subsidies, measured real value-added growth was about 0.2pp faster during the 2019–2020 period and about 0.2pp slower during the 2020–2021 period. The interpretation of this is that the adjusted measure reflects real aggregate output growth based on the prices and costs facing producers while the unadjusted measure reflects output measured using market prices. But as just mentioned, the aggregate result basically reflects weighting differences in industry-level growth rates. A related interpretation of this is that the production account weights using prices reflecting production while aggregate GDP weights using market prices. The difference between these two concepts is a known issue in the national accounting community, thus this paper presents some empirical impacts of using the different concepts.[15]

Table 1 indicates that the allocation of net other taxes on production across capital and labor inputs has only a minor impact on the measured contributions of capital and labor at the aggregate level, thus almost all of differences in measured aggregate value-added growth show up in measured TFP. That is, TFP growth was measured to be faster by about 0.2pp during the 2019–2020 period and slower by about the same during the 2020–2021 period. As noted earlier, due to the large swings in the aggregate economy beginning in 2020, the impacts on measured growth are small relative to these large changes; but, in the 2004–2009 period, aggregate TFP growth would be measured to be negative without these adjustments. With these adjustments, TFP growth was basically zero, on average. The major point is that because aggregate value-added growth was relatively slow over the period, the 0.10pp difference may be large enough relative to other issues that impact measured sources of growth to make a difference in understanding aggregate economic change.

The discussion reinforces the need to distinguish between the production account (which is used for measuring TFP and the sources of economic growth) from the income and expenditure account.[16] For example, the labor share within the production account reflects the output and income generated from the perspective of the producer. Table 2 shows that this distinction has a small impact on the level of the measured capital share, but not on the trend change. On average over the 1987–2021 period, the capital share was about 2pp lower after adjusting for net taxes. The gap between the measures trended down over time; toward the end of the sample, the difference between the two measures was about 1pp.

Measured aggregate price change depends on the basis on which prices are measured as well. Equation (1) indicates that aggregate prices grow faster than prices from the production account if the growth

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[14] Obviously these are short periods in comparison to the other longer presented in this table. It could be the case that other single periods also have significant differences but given the size of the subsidies during the response to the pandemic, we focus on these narrow periods.

[15] The issue of GDP at market prices versus basic prices has been on the agenda of the Intersecretariat Working Group on National Accounts (ISWGNA) since at least 2008: https://unstats.un.org/unsd/nationalaccount/issue11.asp

[16] See Samuels [2018] for a discussion of the differences between the production account and the income and expenditure account.

rate of net taxes on product is positive. This is intuitive, if taxes are adding to prices, prices after taxes grow faster than prices without taxes. Over the period for which the data for this paper is assembled, the opposite was true. That is, aggregate GDP in market prices grew by less than aggregate prices based on the production account. This occurs when subsidies on product are growing faster than taxes on product because subsidies have the opposite effect of taxes. Subsidies on product lower the price charged on the market *ceteris paribus*. The largest of these impacts were in 2020 and 2021 when the change in net taxes accounted about 0.10pp and 0.07pp of the change in aggregate prices, as shown in Table 4.

Importantly, this result should not be interpreted as causal in that a reduction of taxes or an increase in subsidies of x pp would reduce aggregate GDP prices by y pp. The economic response to taxes and subsidies is complicated and dynamic, and like the other components of growth accounting should be interpreted as reflecting many unspecified underlying economic responses.

The impact of net taxes on the measured aggregate growth accounts obscures the potential disparate impact across industries because some of the COVID–19 relief programs were targeted toward specific industries. For example, there were targeted programs like the Airline Assistance Program and the Restaurant Revitalization Fund. Tables 4–6 show that for individual industries the treatment of taxes and subsidies may impact measured TFP over the short and medium terms. Over the 2004–2009 period, measured TFP growth was significantly higher for the wholesale trade, retail trade, and air transportation sectors after adjusting for net taxes. The broadcasting and telecommunications, legal, and accommodation sectors all had faster measured TFP growth as well (although the latter two still had significantly negative measured TFP growth). Over shorter terms of a year and during the COVID–19 economic relief packages, the impacts were even larger overall but the annual fluctuations of industries were so large that most of these do not change the basic qualitative stories about productivity growth. In 2020, measured TFP growth in air transportation was about −30% so the 2.3pp adjustment for net taxes is not large enough to paint a different picture. On the other hand, for wholesale trade, the adjustment took measured TFP growth in 2020 to about 2% from about 1.1% so for those looking at large sectors over short time periods, this adjustment may be important. The tabulation in Table 5 shows similar impacts: the adjustment matters for a few industries but does not change most basic results.

Finally, we show how measured TFP differences at the industry level contribute to differences in measured aggregate TFP growth. Table 7 shows sector contributions to aggregate TFP growth.[17] The sectors that are large enough and where the underlying industries have measured TFP growth different enough to impact the aggregate are the Trade and Other services sectors. The contribution of Trade to aggregate TFP growth was adjusted by about 0.1pp in the 2004–2009 period due to the new treatment of net taxes. Between 2019 and 2020 TFP was also adjusted upwards by about the same, but the TFP contribution

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[17] Sector contributions are sums over industry domar weighted contributions.

between 2020 and 2021 was lower by about 0.15pp due to the adjustment. Out of total aggregate TFP growth of about 2.5%, this is a non-negligible difference. Within the Other services sector, the contribution of TFP growth was higher by about 0.1pp in 2020 and lower by about the 0.06pp in 2021.

5.   Conclusions

Taxes and subsidies drive a wedge between what producers receive and purchasers pay for output and inputs used in production. This paper derives an internally consistent production account that treats these taxes and subsidies, with a special focus on large economic subsidies that accompanied the policy responses to the COVID–19 pandemic.

Adjusting the BEA-BLS industry-level production account for different type of taxes and subsidies has a relatively minor impact on the measured sources of growth over the medium and longer periods, but potentially non-negligible impacts over shorter periods, for example annual results during the large subsidies in 2020 and 2021.

Impacts at the level of the individual industry are larger, especially if the industry received large subsidies. The largest impacts on measured TFP from net taxes are in the farm, wholesale trade, retail trade, air transportation, food services, and accommodation sectors. While some of these sectors are potentially large enough to impact the aggregate, the individual industry impacts often are different in sign. Therefore, when the differences in measured TFP growth are aggregated across industries, measured aggregate TFP growth does change enough to impact the qualitative narrative on the sources of economic growth. Nevertheless, for analysts tracking short-term movements in measured TFP or tracking the productivity growth of individual industries, accounting for taxes and subsidies can be important. Because of this, the BEA-BLS industry-level production account has incorporated this adjustment as of its release in September 2023.

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Table 1: Sources of Real Aggregate Value-Added Growth

	1987-2021	1987-1995	1995-2004	2004-2021	2004-2009	2009-2019	2019-2021	2019-2020	2020-2021
Value Added Growth									
Adjusts for net taxes on product and other taxes	2.35	2.60	3.32	1.72	1.13	2.08	1.41	-2.49	5.31
Adjusts for net taxes on product	2.35	2.60	3.32	1.72	1.13	2.08	1.41	-2.49	5.31
No adjustments for taxation	2.37	2.64	3.34	1.74	1.07	2.13	1.42	-2.68	5.52
Contributions of Capital Input									
Adjusts for net taxes on product and other taxes	1.13	1.14	1.50	0.94	1.12	0.85	0.91	0.93	0.89
Adjusts for net taxes on product	1.13	1.14	1.50	0.93	1.12	0.85	0.90	0.92	0.87
No adjustments for taxation	1.22	1.24	1.63	0.99	1.18	0.91	0.93	0.96	0.90
Contributions of Labor Input									
Adjusts for net taxes on product and other taxes	0.73	1.15	0.73	0.53	0.00	0.90	-0.02	-1.98	1.93
Adjusts for net taxes on product	0.73	1.15	0.73	0.53	0.00	0.90	-0.01	-2.01	1.99
No adjustments for taxation	0.70	1.11	0.71	0.51	0.00	0.87	-0.01	-1.95	1.92
Contributions of TFP									
Adjusts for net taxes on product and other taxes	0.49	0.32	1.08	0.26	0.02	0.33	0.52	-1.45	2.49
Adjusts for net taxes on product	0.49	0.32	1.08	0.26	0.02	0.33	0.53	-1.39	2.46
No adjustments for taxation	0.45	0.30	1.01	0.24	-0.10	0.35	0.50	-1.69	2.69

Notes: Average annual percentages.

Table 2: Aggregate Capital Share

	Adjusts for net taxes on product and other taxes	Adjusts for net taxes on product	No adjustments for taxation
1987-2021	41.6	41.6	43.6
1987-1995	37.1	37.1	39.4
1995-2004	38.6	38.6	40.7
2004-2009	42.1	42.1	44.1
2004-2021	43.4	43.2	45.1
2009-2019	43.7	43.7	45.6
2019-2020	43.5	42.5	44.3
2019-2021	44.0	43.2	45.0
2020-2021	44.5	43.7	45.6

Table 3: Measured Aggregate Price Growth

	Adjusts for net taxes on product and other taxes	Adjusts for net taxes on product	No adjustments for taxation
1987-2021	2.35	2.35	2.32
1987-1995	3.07	3.07	3.05
1995-2004	2.08	2.08	2.03
2004-2009	2.31	2.31	2.30
2004-2021	2.16	2.16	2.14
2009-2019	1.88	1.88	1.87
2019-2020	1.25	1.24	1.15
2019-2021	3.20	3.20	3.12
2020-2021	5.15	5.15	5.08

Table 4: TFP Growth by Industry 2004-2009

	Adjusts for net taxes on product and other taxes	Adjusts for net taxes on product	No adjustments for taxation
Farms	0.48	0.48	0.50
Forestry, fishing, and related activities	-1.30	-1.30	-1.36
Oil and gas extraction	6.13	6.13	6.04
Mining, except oil and gas	-2.40	-2.40	-2.44
Support activities for mining	2.12	2.12	2.12
Utilities	-0.73	-0.73	-0.79
Construction	-2.05	-2.05	-2.05
Wood products	1.44	1.44	1.43
Nonmetallic mineral products	-1.74	-1.74	-1.75
Primary metals	-0.53	-0.53	-0.53
Fabricated metal products	-1.20	-1.20	-1.20
Machinery	0.30	0.30	0.30
Computer and electronic products	6.80	6.80	6.80
Electrical equipment, appliances, and components	0.40	0.40	0.41
Motor vehicles, bodies and trailers, and parts	-1.96	-1.96	-1.96
Other transportation equipment	1.50	1.50	1.50
Furniture and related products	-1.37	-1.37	-1.37
Miscellaneous manufacturing	2.03	2.03	2.03
Food and beverage and tobacco products	0.28	0.28	0.26
Textile mills and textile product mills	-0.59	-0.59	-0.59
Apparel and leather and allied products	-0.43	-0.43	-0.37
Paper products	0.21	0.21	0.21
Printing and related support activities	0.51	0.51	0.51
Petroleum and coal products	-1.25	-1.25	-1.25
Chemical products	-0.89	-0.89	-0.90
Plastics and rubber products	-0.44	-0.44	-0.45
Wholesale trade	-0.75	-0.75	-1.12
Retail trade	-0.64	-0.64	-1.12
Air transportation	3.16	3.16	2.89
Rail transportation	-0.40	-0.40	-0.34
Water transportation	6.86	6.86	6.85
Truck transportation	-0.72	-0.72	-0.73
Transit and ground passenger transportation	-1.01	-1.01	-1.01
Pipeline transportation	-1.41	-1.41	-1.42
Other transportation and support activities	-1.36	-1.36	-1.36
Warehousing and storage	0.24	0.24	0.24
Publishing industries, except internet (includes software)	-0.30	-0.30	-0.32
Motion picture and sound recording industries	2.70	2.70	2.60
Broadcasting and telecommunications	2.19	2.19	2.01
Data processing, internet publishing, and other information services	-0.99	-0.99	-0.96
Federal Reserve banks, credit intermediation, and related activities	2.02	2.02	2.02
Securities, commodity contracts, and investments	0.69	0.69	0.69
Insurance carriers and related activities	0.34	0.34	0.32
Funds, trusts, and other financial vehicles	-0.92	-0.92	-0.92
Real estate	0.49	0.49	0.51
Rental and leasing services and lessors of intangible assets	-1.99	-1.99	-2.09
Legal services	-1.73	-1.73	-2.18
Computer systems design and related services	2.80	2.80	2.77
Miscellaneous professional, scientific, and technical services	-0.41	-0.41	-0.43
Management of companies and enterprises	-3.06	-3.06	-3.06
Administrative and support services	0.73	0.73	0.70
Waste management and remediation services	-0.18	-0.18	-0.19
Educational services	0.13	0.13	0.13
Ambulatory health care services	0.56	0.56	0.56
Hospitals and Nursing and residential care	0.53	0.53	0.52
Social assistance	-0.82	-0.82	-0.81
Performing arts, spectator sports, museums, and related activities	1.20	1.20	1.15
Amusements, gambling, and recreation industries	-0.01	-0.01	-0.07
Accommodation	-2.89	-2.89	-3.15
Food services and drinking places	-0.92	-0.92	-0.85
Other services, except government	-1.26	-1.26	-1.31
Federal	-0.13	-0.13	-0.14
State and local	-0.09	-0.09	-0.09

Table 5: TFP Growth by Industry 2019-2020

	Adjusts for net taxes on product and other taxes	Adjusts for net taxes on product	No adjustments for taxation
Farms	-0.13	-0.15	-0.47
Forestry, fishing, and related activities	12.27	12.38	12.28
Oil and gas extraction	6.74	6.75	6.32
Mining, except oil and gas	1.36	1.37	1.01
Support activities for mining	-6.32	-5.90	-6.02
Utilities	1.25	1.25	0.86
Construction	-0.65	-0.60	-0.60
Wood products	2.88	2.89	2.89
Nonmetallic mineral products	-0.11	-0.10	-0.10
Primary metals	4.33	4.34	4.33
Fabricated metal products	-2.20	-2.14	-2.16
Machinery	-1.31	-1.28	-1.29
Computer and electronic products	3.25	3.26	3.25
Electrical equipment, appliances, and components	-2.11	-2.10	-2.10
Motor vehicles, bodies and trailers, and parts	-0.83	-0.82	-0.83
Other transportation equipment	-4.27	-4.26	-4.27
Furniture and related products	-0.74	-0.68	-0.69
Miscellaneous manufacturing	0.11	0.16	0.15
Food and beverage and tobacco products	-0.53	-0.53	-0.53
Textile mills and textile product mills	-0.43	-0.42	-0.42
Apparel and leather and allied products	-8.59	-8.51	-8.51
Paper products	2.21	2.21	2.20
Printing and related support activities	-2.95	-2.85	-2.86
Petroleum and coal products	-8.24	-8.24	-8.25
Chemical products	-0.36	-0.36	-0.40
Plastics and rubber products	-0.62	-0.61	-0.62
Wholesale trade	1.95	1.96	1.14
Retail trade	-1.07	-1.05	-1.07
Air transportation	-32.68	-32.14	-35.02
Rail transportation	-3.22	-3.22	-2.91
Water transportation	4.41	4.42	4.25
Truck transportation	0.07	0.09	0.09
Transit and ground passenger transportation	2.26	2.62	1.89
Pipeline transportation	-5.47	-5.47	-5.48
Other transportation and support activities	-2.64	-2.64	-2.64
Warehousing and storage	-1.84	-1.85	-1.85
Publishing industries, except internet (includes software)	8.36	8.36	8.35
Motion picture and sound recording industries	2.78	2.84	2.63
Broadcasting and telecommunications	-1.33	-1.33	-1.44
Data processing, internet publishing, and other information services	-3.39	-3.38	-3.40
Federal Reserve banks, credit intermediation, and related activities	6.33	6.33	6.31
Securities, commodity contracts, and investments	-4.20	-4.19	-4.20
Insurance carriers and related activities	-3.83	-3.83	-3.89
Funds, trusts, and other financial vehicles	1.96	1.96	1.97
Real estate	-1.42	-1.42	-1.41
Rental and leasing services and lessors of intangible assets	-5.22	-5.20	-5.28
Legal services	-4.85	-4.84	-4.82
Computer systems design and related services	3.37	3.39	3.32
Miscellaneous professional, scientific, and technical services	0.67	0.69	0.68
Management of companies and enterprises	-2.44	-2.44	-2.44
Administrative and support services	-1.76	-1.73	-1.79
Waste management and remediation services	-1.95	-1.94	-2.00
Educational services	-4.24	-4.21	-4.23
Ambulatory health care services	-1.81	-1.76	-1.77
Hospitals and Nursing and residential care	-0.09	-0.08	-0.11
Social assistance	-1.85	-1.86	-1.86
Performing arts, spectator sports, museums, and related activities	-12.77	-12.53	-13.55
Amusements, gambling, and recreation industries	-11.36	-11.04	-14.83
Accommodation	-5.00	-4.09	-9.76
Food services and drinking places	-5.19	-4.81	-5.82
Other services, except government	-0.92	-0.84	-1.03
Federal	-0.02	-0.02	-0.02
State and local	0.29	0.29	0.23

Table 6: TFP Growth by Industry 2020-2021

	Adjusts for net taxes on product and other taxes	Adjusts for net taxes on product	No adjustments for taxation
Farms	-4.52	-4.47	-4.25
Forestry, fishing, and related activities	-4.95	-4.99	-4.88
Oil and gas extraction	-13.01	-13.01	-12.72
Mining, except oil and gas	0.18	0.18	0.20
Support activities for mining	2.33	2.12	2.14
Utilities	-4.07	-4.06	-3.89
Construction	-0.75	-0.73	-0.73
Wood products	-0.91	-0.92	-0.92
Nonmetallic mineral products	1.53	1.53	1.53
Primary metals	-3.09	-3.09	-3.09
Fabricated metal products	3.02	3.00	3.00
Machinery	5.17	5.17	5.17
Computer and electronic products	3.52	3.52	3.52
Electrical equipment, appliances, and components	5.02	5.01	5.01
Motor vehicles, bodies and trailers, and parts	5.31	5.30	5.30
Other transportation equipment	3.22	3.21	3.22
Furniture and related products	1.60	1.59	1.59
Miscellaneous manufacturing	4.34	4.29	4.30
Food and beverage and tobacco products	2.06	2.05	1.92
Textile mills and textile product mills	1.96	1.94	1.94
Apparel and leather and allied products	9.29	9.21	9.22
Paper products	-0.47	-0.47	-0.47
Printing and related support activities	1.90	1.85	1.85
Petroleum and coal products	-0.69	-0.70	-0.69
Chemical products	-1.99	-1.99	-2.02
Plastics and rubber products	0.13	0.13	0.12
Wholesale trade	1.22	1.22	2.22
Retail trade	-0.85	-0.85	-0.29
Air transportation	15.23	13.60	16.11
Rail transportation	5.43	5.43	5.30
Water transportation	-8.73	-8.77	-8.73
Truck transportation	-2.56	-2.60	-2.58
Transit and ground passenger transportation	0.71	0.77	1.01
Pipeline transportation	0.98	0.98	0.98
Other transportation and support activities	-2.64	-2.65	-2.63
Warehousing and storage	-1.28	-1.29	-1.28
Publishing industries, except internet (includes software)	11.74	11.74	11.75
Motion picture and sound recording industries	-0.45	-0.65	-0.54
Broadcasting and telecommunications	1.66	1.67	1.67
Data processing, internet publishing, and other information services	4.36	4.36	4.38
Federal Reserve banks, credit intermediation, and related activities	5.13	5.13	5.11
Securities, commodity contracts, and investments	-1.09	-1.09	-1.10
Insurance carriers and related activities	1.45	1.45	1.39
Funds, trusts, and other financial vehicles	8.50	8.49	8.49
Real estate	1.02	1.02	1.01
Rental and leasing services and lessors of intangible assets	3.29	3.28	3.38
Legal services	1.96	1.97	2.02
Computer systems design and related services	4.08	4.08	4.05
Miscellaneous professional, scientific, and technical services	4.15	4.16	4.16
Management of companies and enterprises	5.97	5.97	5.97
Administrative and support services	3.49	3.48	3.53
Waste management and remediation services	2.92	2.93	2.98
Educational services	0.09	0.08	0.08
Ambulatory health care services	0.71	0.67	0.67
Hospitals and Nursing and residential care	1.79	1.81	1.81
Social assistance	-0.66	-0.60	-0.60
Performing arts, spectator sports, museums, and related activities	14.63	14.46	14.94
Amusements, gambling, and recreation industries	5.45	5.16	7.28
Accommodation	11.68	11.36	14.43
Food services and drinking places	6.75	6.32	7.43
Other services, except government	1.33	1.32	1.31
Federal	0.12	0.12	0.11
State and local	-0.27	-0.27	-0.25

Table 7: Contributions to Aggregate TFP Growth

	1987-2021	1987-1995	1995-2004	2004-2021	2004-2009	2009-2019	2019-2021	2019-2020	2020-2021
Adjusts for net taxes on product and other taxes									
Aggregate	0.49	0.32	1.08	0.26	0.02	0.33	0.52	-1.45	2.49
Agriculture, Forestry, Fishing, Hunting, Mining	0.06	0.07	0.07	0.05	0.12	0.05	-0.09	0.10	-0.29
Transportation, Warehousing, Utilities	0.00	0.04	0.01	-0.03	-0.01	-0.01	-0.19	-0.28	-0.09
Construction	-0.07	-0.03	-0.07	-0.08	-0.19	-0.03	-0.06	-0.05	-0.06
Manufacturing	0.24	0.22	0.58	0.07	0.10	0.06	0.10	-0.27	0.47
Trade	0.16	0.23	0.39	0.00	-0.10	0.04	0.06	0.08	0.03
Information	0.06	0.00	0.06	0.09	0.11	0.06	0.23	0.05	0.41
Finance, Insurance, Real Estate, Rental and Leasing	0.00	-0.06	-0.07	0.08	0.15	0.04	0.11	-0.37	0.58
Other Services	0.02	-0.16	0.07	0.07	-0.12	0.11	0.36	-0.76	1.48
Government	0.01	0.01	0.04	0.00	-0.03	0.01	0.01	0.05	-0.04
Adjusts for net taxes on product									
Aggregate	0.49	0.32	1.08	0.26	0.02	0.33	0.53	-1.39	2.46
Agriculture, Forestry, Fishing, Hunting, Mining	0.06	0.07	0.07	0.05	0.12	0.05	-0.09	0.11	-0.29
Transportation, Warehousing, Utilities	0.00	0.04	0.01	-0.03	-0.01	-0.01	-0.19	-0.27	-0.10
Construction	-0.07	-0.03	-0.07	-0.08	-0.19	-0.03	-0.05	-0.05	-0.06
Manufacturing	0.24	0.22	0.58	0.07	0.10	0.06	0.10	-0.27	0.46
Trade	0.16	0.23	0.39	0.00	-0.10	0.04	0.06	0.08	0.03
Information	0.06	0.00	0.06	0.09	0.11	0.06	0.23	0.05	0.41
Finance, Insurance, Real Estate, Rental and Leasing	0.00	-0.06	-0.07	0.08	0.15	0.04	0.11	-0.37	0.58
Other Services	0.02	-0.16	0.07	0.07	-0.12	0.11	0.37	-0.72	1.46
Government	0.01	0.01	0.04	0.00	-0.03	0.01	0.01	0.05	-0.04
Adjusts for net taxes on product									
Aggregate	0.45	0.30	1.01	0.24	-0.10	0.35	0.50	-1.69	2.69
Agriculture, Forestry, Fishing, Hunting, Mining	0.06	0.06	0.07	0.05	0.11	0.05	-0.09	0.09	-0.27
Transportation, Warehousing, Utilities	0.00	0.04	0.00	-0.03	-0.01	0.00	-0.20	-0.32	-0.08
Construction	-0.07	-0.03	-0.07	-0.08	-0.19	-0.03	-0.05	-0.05	-0.06
Manufacturing	0.23	0.21	0.56	0.07	0.09	0.06	0.09	-0.26	0.44
Trade	0.15	0.24	0.36	0.00	-0.19	0.07	0.10	0.01	0.18
Information	0.06	0.00	0.06	0.09	0.10	0.05	0.22	0.04	0.40
Finance, Insurance, Real Estate, Rental and Leasing	0.00	-0.08	-0.08	0.07	0.14	0.04	0.10	-0.37	0.56
Other Services	0.01	-0.16	0.06	0.07	-0.14	0.11	0.34	-0.87	1.54
Government	0.01	0.01	0.04	0.00	-0.03	0.01	0.00	0.04	-0.03

Notes: Average annual percentages. A contribution is defined as two period average share times log growth rate.

Table A: Share of Other Subsidies Allocated to Labor by Program

Name	Begins	Description	Share to Labor	Source
Paycheck Protection Program	2020m4	The PPP is a Small Business Administration (SBA) loan program designed to provide a direct incentive for small businesses to keep their workers on the payroll. These loans will be forgiven by the SBA if all employees are kept on the payroll for eight weeks and the money is used for payroll, rent, mortgage interest, or utilities. Spread amounts evenly across the 6 months following loan approval.	0.34	https://www.nber.org/system/files/working_papers/w29669/w29669.pdf
Employee Retention Tax Credit	2020m4	The ERTC under the CARES Act is a refundable tax credit of 50% of up to $10,000 in wages paid by an eligible employer whose business has been financially impacted by COVID-19.	1	https://home.treasury.gov/policy-issues/coronavirus/assistance-for-american-industry/coronavirus-economic-relief-for-transportatio
Families First Coronavirus Response Act	2020m4	The FFCRA requires certain employers to provide their employees with paid sick leave or expanded family and medical leave for specified reasons related to COVID-19.	1	https://www.irs.gov/newsroom/covid-19-related-tax-credits-for-paid-leave-provided-by-small-and-midsize-businesses-faqs#:~:text=7
Health and Human Services Public Health & Social Services Emergency Fund	2020m4	Outlays from the Health and Human Services *Public Health & Social Services Emergency Fund* increased by $80 billion in 2020q2, representing part of the $175 billion of funding for healthcare providers appropriated in the CARES Act (see here and here for information).	2019 Class 1 COMP/(Class 1 COMP+GOS)	FAQ: Public Health and Social Service Emergency Fund - House Committee on Ways and Means
Airline Assistance	2020m4	The CARES act provides for financial assistance to aviation workers and loans to airlines. Assistance to airlines will show up in NAICS 481 air transportation.	1	
Golden State Stimulus	2021m2	California Small Business COVID-19 Relief Grant Program; state-funded pandemic relief program	2019 Class 1 COMP/(Class 1 COMP+GOS)	https://careliefgrant.com/faq/
Economic Industry Disaster Loan	2020m4	In response to the Coronavirus (COVID-19) pandemic, small business owners, including agricultural businesses, and nonprofit organizations in all U.S. states, Washington D.C., and territories can apply for an Economic Injury Disaster Loan. The EIDL program is designed to provide economic relief to businesses that are currently experiencing a temporary loss of revenue due to COVID-19.	2019 Class 1 COMP/(Class 1 COMP+GOS)	
Community Development Financial Institutions	2021m4		2019 Class 1 COMP/(Class 1 COMP+GOS)	https://www.cdfifund.gov/sites/cdfi/files/2022-11/Rapid_Response_Program_FactSheet.pdf
Shuttered Venue Operators Grant	2021m6		2019 Class 1 COMP/(Class 1 COMP+GOS)	https://www.sba.gov/sites/default/files/2021-10/10-20-21%20SVOG%20FAQ%20FINAL_508_final.pdf
Childcare assistance	-		2019 Class 1 COMP/(Class 1 COMP+GOS)	COVID-19 Resources and Information	Childcare.gov
Restaurant Revitalization Fund	2021m5	The American Rescue Plan Act established the Restaurant Revitalization Fund (RRF) to provide funding to help restaurants and other eligible businesses keep their doors open. This program will provide restaurants with funding equal to their pandemic-related revenue loss up to $10 million per business and no more than $5 million per physical location.	2019 Class 1 COMP/(Class 1 COMP+GOS)	
Transportation Services Economic Relief	2021m4	Established by the Consolidated Appropriations Act, 2021, the Coronavirus Economic Relief for Transportation Services (CERTS) Program was created to support transportation service providers affected by the COVID-19 pandemic, including motorcoach, school bus, passenger vessel, and pilot vessel companies.	2019 Class 1 COMP/(Class 1 COMP+GOS)	https://home.treasury.gov/policy-issues/coronavirus/assistance-for-american-industry/coronavirus-economic-relief-for-transportatio