Local Government as a Homeowners Association: Implications for GDP and Productivity

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Paper prepared for the 34th IARIW General Conference

Dresden, Germany, August 21-27, 2016

PS2.7: Tax and Transfer Programs of Governments

Time: Thursday, August 25, 2016 [Late Afternoon]

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Abstract

The international guidelines for national accounts, SNA 2008, recommend that services like trash collection should be allocated to final demand when they are funded by property taxes. In contrast, the same services are excluded from final demand when they are funded by property association dues serving businesses. This paper develops an experimental methodology where measured GDP is invariant to the funding mechanism. Conceptually, our approach is similar to treating local government as if it was a homeowner association.

We apply our experimental methodology to both US time series data and OECD cross-country data. In the United States, our experimental methodology reduces the nominal level of GDP by $445 billion in 2012, a 3.2% drop. In comparison, the experimental methodology only lowers the nominal level of GDP by 1.4% across non-US countries in the OECD. Despite the large cross-country differences, there is little impact on GDP growth in the United States. Between 1929 and 2014, nominal GDP growth is unchanged and real GDP growth rises slightly. Between 1948 and 2012, productivity growth rises slightly.

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Introduction

This paper introduces an experimental GDP methodology that treats local governments symmetrically with non-profit associations. We argue that this experimental methodology provides more intuitive welfare comparisons, so it is theoretically appealing. In addition, the experimental methodology is much simpler to implement because it does not require analysts to determine whether a particular entity should be in the government sector or the non-profit sector.

This experimental methodology also has implications for capital measurement and productivity growth. The current productivity statistics treat property taxes as a component of capital services. Based on that treatment, measured capital services depend on the property tax rates paid by each asset category. This data is not readily available, so researchers are forced to impute property tax rates using an economic model. In contrast, our experimental methodology does not requiring imputing property tax rates by asset category, so it is much simpler to implement.

This paper will be divided into four sections. Section 1 will discuss the theory and practice of GDP measurement. Section 2 will show how our experimental method changes measured GDP for the United States and other OECD countries. Section 3 will discuss the theory and practice of capital measurement. Section 4 will show how our experimental methodology changes measured productivity by industries in the United States.

Section 1: Measuring Private Value-Added and GDP

The System of National Accounts 2008 (SNA 2008) is clear that output from the government sector is automatically considered part of final expenditures (4.20). The only exception is the small portion of government output which is sold in the market sector and purchased by private businesses. The SNA's example is a government museum bookshop. All the operating expenses for the museum are allocated to final expenditures except for the small portion funded by books sold in the bookshop and purchased by private business (4.120-4.123). In contrast, non-profits can serve either households or businesses. Thus, the provision of similar services may be treated as intermediate input or a final expenditure depending on the provider and user (4.41-4.46).

To demonstrate the distortions, we investigate a stylized economy where property owners can use three funding options to pay for current local services:

1) Property owners can pay dues for services provided by property associations. In the United States, residential property associations are commonly called 'homeowner associations' and commercial property associations are commonly called 'business improvement districts'.

2) Property owners can pay property taxes now. The local governments then use that revenue to provide current services to property owners.

3) Property owners can pay property taxes later. In that case, the local government borrows money to pay for local services now and repays the borrowed money with future taxes.

Landlords, tenants, home owners, and businesses all are indifferent to the funding mechanism in this stylized economy. SNA's current methodology, however, treats these three funding options differently. Outlays funded by dues from homeowner associations or business improvement districts are considered an intermediate expense and therefore not counted in final demand. In contrast, outlays funded by property taxes paid to local governments are considered part of value-added and therefore counted in final demand in the year paid. As a result, measured nominal GDP depends on how and when local services are funded.

This paper develops an experimental methodology where measured GDP is invariant to the funding mechanism. Conceptually, our approach is similar to treating local governments as if they were homeowner associations or business improvement districts. We also apply property taxes to the year when services occur and obligations are accrued, rather than the year they are paid. This is analogous to the accrual-based treatment of pensions. Our experimental methodology provides more intuitive welfare comparisons across countries and over time.

The experimental methodology also simplifies GDP measurement. In the earlier stylized example, we assumed that it was straightforward to determine whether local services are provided by a property association or a local government and what measured GDP 'should' be. In fact, the line between property associations and local governments is extremely fuzzy. SNA 2008 has a very long discussion to help determine which sector an entity should be placed in (4.90-4.92). And even that long discussion cannot cover all possible cases, so analysts must use their own judgment when assigning sectors. Compounding the measurement problem, business improvement districts frequently collect their dues by voting for a special property tax assessment that is collected by the local government and then remitted to the business improvement district. The Census of Governments and other survey data do not always cleanly separate these special property tax assessments from the general property taxes. Under the current SNA methodology, analysts are forced to estimate the share of property taxes which are really business improvement district dues and handle them separately when calculating GDP. Under our experimental methodology, business improvement district dues are treated identically to general property taxes and so there is no need to handle them separately.

Finally, our experimental methodology reduces the sensitivity of GDP to local government accounting. Government output is not sold in the market sector, so its value cannot be observed directly. Instead, SNA 2008 recommends that countries use current government expenditures as a proxy for current government output (4.120). In turn, those current government expenditures depend on specific accounting choices like the assumed discount rate for pensions promised to government workers or the assumed rate of return on government capital. As we discussed earlier, the current SNA methodology allocations government output to final expenditures almost completely. As a result, any increased government output increases GDP almost one for one. In contrast, our experimental methodology allocates a large share of government output to intermediate input. As a result, a large share of the increased government output is balanced by a decrease in private business value-added. Measured GDP still increases when government output increases, but the GDP increase is muted.

Section 2: Empirical GDP Data Across Countries

Recalculating GDP for the United States

Our primary data on nominal property taxes is taken from BEA's Table 3.3 (line 8). That table reports nominal property taxes paid from 1929 forward. In the current SNA methodology, those property taxes are included in gross operating surplus and counted in final output. Under our experimental methodology, those property taxes are considered equivalent to property association dues and therefore excluded from final output. BEA currently accounts for the intermediate inputs provided by property associations on an accrual basis,[1] so we will account for property taxes on an accrued basis to be

[1] In other words, measured intermediate inputs are equal to the property association operating expenses rather than property association dues. Accrual accounting is used for pensions and other parts of the NIPA's as well.

consistent.[2] In practice, local governments rarely run large surpluses or deficits – so there is little difference between the paid basis and the accrual basis.

Figure 1 shows the change to nominal GDP from 1929 until 2014. We find that property taxes have hovered around 3% of nominal GDP for most of the time period. Accordingly, there is little change in the nominal GDP growth. However, nominal GDP becomes more cyclical. The cyclicality increase is most visually apparent during the Great Depression, but it shows up in other recessions as well. Intuitively, local government services are currently a very stable component of the overall economy. Our experimental methodology removes local government services from final output, and so the remaining GDP becomes more cyclical.

Our primary price data is taken from BEA's table 3.9.4 (line 33). That table tracks prices for all state and local government current output, without any differentiation between funding sources. As a robustness test, we tried weighting the function-specific price indexes in Table 3.15.4 to match better with the government expenditures financed by property taxes. We found that this weighting scheme added complexity without changing price growth much. For simplicity, we stick with the aggregate price index from table 3.9.4.

Figure 2 shows the change to GDP prices from 1929 to 2014. Between 1929 and 2014, prices for local government services rose 1.3% faster per year than overall GDP prices. Our experimental methodology removes those local government services from final output, and so it lowers average inflation rates by 0.1% per year. The experimental methodology has little consistent impact on prices over the business cycle, so short-term inflation rates are generally unchanged.

Figure 3 shows the change in GDP quantities from 1929 to 2014. Our experimental method raises real GDP growth by 0.1% per year. Interestingly, the increase in measured growth appears to be largest during the 1970's. That period was characterized by relatively slow economic growth and so our experimental methodology helps smooth out historical GDP growth. But our experimental methodology has little impact on measured GDP growth since the mid 1980's.

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[2] We are not able to calculate surpluses or deficits for the portion of local government services paid for by property taxes, so we use aggregate surpluses for local governments instead. This data is available in Table 3.21 from lines 1 and 23 back to 1960. Before then, net state and local government savings from Table 5.1 as a proxy.

Recalculating GDP for OECD Countries.

Our data here is taken from the OECD website. Across countries, there are huge differences in the property tax rate. Under our experimental methodology, those property tax differences are correlated with huge differences in local government services. Countries with low property taxes are assumed to spend very little on services used by businesses. It is also possible that countries with low property taxes assign a different tax for local government services like waste disposal or police protection. These taxes are a topic for future research.

Figure 4 shows property taxes across countries in 2012. There appears to be a positive correlation between property tax rates in 2012 and GDP per capita. However, this correlation is mostly driven by the high GDP per capita and high property taxes for English speaking countries. These countries also share many other demographic and institutional characteristics, so it seems unlikely that property tax rates have any direct causal relationship with GDP per capita.

Figure 5 shows property taxes for a sample of major countries from 1965 to 2012. We find that the stable U.S. property taxes shown in Figure 1 are not representative. Over the same time period, both France and Japan experienced rising property tax rates. Furthermore, the United Kingdom had a temporary drop in property tax rates during the 1990's. On the other hand, Germany's property taxes stayed fixed at 0.5% of nominal GDP over the entire time period. Because of all this variation, researchers need to study each country individually when applying our experimental methodology.

Section 3: Measuring Capital Stock and Capital Services

International guidelines for measuring the sources of growth emphasize the importance of using the flow of capital services as a component of total inputs in estimates of MFP growth. Unfortunately, this flow of capital services is difficult to measure because producers typically own the capital stock that they use for both current and future production. The standard approach taken by statistical agencies and researchers following the guidelines is to estimate the capital stock using the perpetual inventory method, estimate rental prices, and then combine the two pieces to arrive at an estimate of capital input, also known as capital services. The importance of using capital services measures versus capital stock decomposing growth is labeled as "capital quality" by (Jorgenson, Ho, & Stiroh, 2005), and they estimate that substitution towards relatively more productive capital accounts for a significant share of economic growth in the U.S.

Even within the "standard approach", however, there can be differences in methodology and how those methodologies are implemented. The guidelines themselves note broad issues affecting capital measurement such as choice of depreciation formula and its relation to the age-efficiency profile, aggregation of assets, rates of return, and the treatment of negative user costs as implementation issues for which there is no international consensus. It is an open question how much these methodological and implementation choices, which are all consistent with the guidelines, affect empirical estimates of the sources of growth in an integrated framework.

In this paper, we will review two existing methodologies for estimating capital services: the methods used by the Bureau of Labor Statistics (BLS) and the methods described in (Jorgenson, Ho, & Stiroh, 2005) (JHS) (produced to be consistent with the BEA accounts for research purposes). Both BLS and JHS calculate aggregate measures of capital services using the same general methodology. Both calculate the productive capital stock from investment data using the perpetual inventory method (PIM), calculate the rental price for each industry x asset category cell and then aggregate to get an overall measure of capital input. The major conceptual difference between the two is the specification of the age-efficiency function.

Both methods that we discuss incorporate property taxes into the capital service calculations, and measured capital services are sensitive to the precise property tax allocated to each asset. Despite the conceptual similarities in their treatment of property taxes, the empirical effect of a property tax is sometimes different across the two methodologies. In contrast, our experimental methodology avoids all of these issues by reclassifying property taxes. In the next section we provide an overview of capital measurement in order to highlight the role complications in modeling property taxes. This section draws heavily from Samuels, Stewart, Strassner, and Wasshausen (2016).

BLS Methodology

Capital services measurement requires an estimate of the productive capital stock. Conceptually, this captures the quantity of capital assets that are available to yield a capital service flow into production at time t. As noted above, the PIM requires an assumption about how assets deteriorate over time. BLS assumes that assets deteriorate according to a hyperbolic age-efficiency function, which is given by:

$$\lambda(a,\Omega) = \frac{(\Omega - a)}{(\Omega - \beta a)} \quad \text{if } a < \Omega \text{ (and 0 otherwise),} \tag{1}$$

where λ is the efficiency of that asset at age a relative to the efficiency at age = 0, Ω is the maximum service life of the asset, and β is a shape parameter. The hyperbolic function is very flexible, allowing for different deterioration patterns—convex, straight line, or concave—depending on whether β is less than, equal to, or greater than zero. BLS assumes β = 0.75 for structures and β = 0.5 for equipment.[3] These values result in a concave age-efficiency function, and reflect the casual empiricism that assets deteriorate more slowly when they are new and that they deteriorate more rapidly as they age.[4]

The age-efficiency function in equation (1) describes the deterioration of a single asset or a group of identical assets—that is, assets with the same maximum service life. But the investment data for asset categories includes assets with different service lives. For example, personal computers include top-of-the-line models, which may have a maximum service life of 5 or 6 years, but also low-end models that my last for only 2 or 3 years. To account for heterogeneity of service lives within asset classes, BLS assumes that asset service lives are distributed according to a modified truncated normal distribution, $\tilde{\phi}(\cdot)$.[5] BLS then computes a cohort age-efficiency function, which calculates the average efficiency of assets in an asset category that were purchased in the same year (cohort). It is calculated as a weighted average of the age-efficiency functions within an asset category, where the weight is the fraction of assets with a given maximum service life. The cohort age-efficiency function is defined over the interval, $[\Omega^{min}, \Omega^{max}]$, is given by:

(2) $$\bar{\lambda}(a, \bar{\Omega}) = \int_{\Omega^{min}}^{\Omega^{max}} \tilde{\phi}(a, k) \cdot \lambda(a, k) dk$$

where the limits of the integral are the upper and lower bounds of the distribution of service lives (BLS assumes that $\Omega^{min} = 0.02\bar{\Omega}$ and $\Omega^{max} = 1.98\bar{\Omega}$).[6] The productive capital stock of asset j in industry i is given by:

[3] These values were chosen because they are close to values estimated by Hulten and Wykoff (1982) using actual data.

[4] The age-efficiency function also accounts for obsolescence, time out of service for repairs, and failure. For example, a one year-old computer runs at about the same speed as a new computer. It is the introduction of new software that places greater demands on the computer that makes the computer obsolete. A one-year-old car and a five-year-old car provide the same service as a new car, but the five year-old car is more likely to be out of service for maintenance or repairs. A two year-old light bulb shines just as brightly as a new bulb, but is more likely to fail.

[5] The BLS assumes that $\tilde{\phi}(\cdot)$ is a modified truncated normal distribution with mean $\bar{\Omega}$ and $\sigma = 0.49\bar{\Omega}$. It is derived by truncating the normal distribution at ±2 standard deviations ($\bar{\Omega} \pm 0.98\bar{\Omega}$), shifting the density function downward so that it equals zero at the upper and lower bounds of the distribution, and then inflating the density function proportionately so that the final modified density, $\tilde{\phi}(\cdot)$, integrates to 1.

[6] This assumption results in a wide range of service lives within each asset category.

(3) $$K_{ij,t} = \sum_{a=0}^{\Omega^{max}} \bar{\lambda}(a,\overline{\Omega}) I_{ij,t-a}$$

As noted above, the rental price of capital is the opportunity cost of holding and using it for a period of time. BLS calculates the rental price along the lines of the specification in Hall and Jorgenson (1967), except that the BLS equation accounts for inflation in the price of new assets that was assumed to be zero in the original Hall and Jorgenson implementation.[7] The BLS calculates rental prices by industry and asset class using the following rental price formula:

(4) $$c_{ij,t} = \frac{(1 - u_t z_t - e_t)\left(P_{ij,t-1} r_{i,t} + P_{ij,t-1} d_{ij,t} - \Delta P_{ij,t-1}\right)}{1 - u_t} + P_{ij,t-1} x_{ij,t}$$

where:

u_t is the corporate income tax rate

z_t is the present value of $1 of tax depreciation allowances (usually between .8 and 1.0)

e_t is the effective rate of the investment tax credit (zero since 1979)

r_{it} is the nominal (internal) rate of return on capital

d_{ijt} is the average rate of economic depreciation

P_{ijt} is the industry deflator for new capital goods

ΔP_{ijt} is the revaluation of assets due to inflation in new goods prices

$x_{ij,t}$ is the rate of indirect (property) taxes

The term $x_{ij,t}$, the property tax rate paid by industry i on asset j in at time t, is extremely difficult to measure. In the United States, property taxes are generally collected by local governments and each local government has its own tax rates and assessment procedures. Furthermore, many local governments vary their tax rate depending on the identity of the property owner and their ownership history. For example, California caps property tax increases for home-owners, and so long-time home-owners pay

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[7] The BLS equation for the rental rate differs slightly from the original Hall and Jorgenson (1967) formulation. BLS includes an inflation term that was assumed to be zero in the Hall and Jorgenson (1967) implementation; this assumption has been dropped in subsequent work, such as (Jorgenson, Ho, & Stiroh, 2005). The equations also differ in the treatment of the investment tax credit. Both equations treat the tax benefits as a reduction in the purchase price of the asset, but it is additive in the BLS equation and multiplicative in the Hall and Jorgenson equation.

much lower rates than new buyers. In their current productivity statistics, BLS uses the average property tax rate, $x_{i,t}$ as a proxy for the property tax rate assessed on each individual asset.

The price indexes are available at the industry by asset level. The depreciation rate is calculated from the wealth stock, which is given by:

$$(5) \qquad K_t^W = \sum_{\tau=t}^{2t} p(\tau - t, \overline{\Omega}) \cdot I_{2t-\tau}$$

where I_t is investment in year t, and $p(a, \overline{\Omega})$ is the age-price function (the price of an a year-old asset [group] that has an average maximum service life of $\overline{\Omega}$). The age-price function is derived from the cohort age-efficiency function:

$$(6) \qquad p(a, \overline{\Omega}) = \frac{\sum_{\alpha=a}^{\infty} \bar{s}(\alpha, \overline{\Omega}) \cdot (1-r)^{\alpha-a}}{\sum_{\alpha=0}^{\infty} \bar{s}(\alpha, \overline{\Omega})(1-r)^{\alpha}}$$

where r is the real discount rate, which is assumed to be 4% per year. Both the age-efficiency and the age-price function decline over time from 1.0, when the asset is new, to 0 at the end of its service life. The age-price function declines more quickly than the age-efficiency function, because it accounts for the decline in the remaining productivity capacity of the asset as it ages as well as the decline in current productive capacity.

The internal rate of return, r_{it}, is calculated using the accounting identity that capital income is equal to the price of capital services times the quantity of capital services:

$$(7) \qquad Y_{i,t}^K \equiv K_{i,t}^S c_{i,t},$$

where $Y_{i,t}$ is capital income in industry i, and $K_{i,t}$ is the productive capital stock in industry i.[8] It would be straightforward to calculate the internal rate of return by substituting equation (4) into equation (7) and solving for r_{it}. But capital income is available only at the industry level, which makes it necessary to modify equation (4) as follows:

[8] BLS estimates capital income for the non-corporate sector as follows: BLS calculates separate estimates of labor compensation and capital income for proprietors, sum them, and then proportionately inflates or deflates them so that they sum to proprietors' income. In the initial calculations. Note that in the initial calculations, BLS assumes that proprietors earn the same hourly wage as wage and salary workers and that non-corporate capital earns the same rate of return as corporate capital.

$$c_{it} = \frac{(1 - u_t z_t - e_t)\left(P_{i,t-1} r_{it} + P_{i,t-1} d_{i,t} - \Delta P_{i,t-1}\right)}{1 - u_t} + P_{i,t-1} x_t \tag{4'}$$

The differences between equations (4) and (4') are that the prices and depreciation are now industry averages. The industry-level deflator for new capital goods is calculated as:

$$P_{i,t-1} = \sum_{j \in J_i} \frac{K_{ij,t-1}}{\sum_{j \in J_i} K_{ij,t-1}} \cdot \frac{I^N_{ij,t-1}}{I^R_{ij,t-1}} = \sum_{j \in J_i} \frac{K_{ij,t-1}}{K_{i,t-1}} p_{j,t-1} \tag{8}$$

where $I^N_{ij,t-1}$ and $I^R_{ij,t-1}$ are nominal and real investment in asset *j* by industry *i*., and the capital stocks (K) are as defined in equation (3). The industry level depreciation rate is derived by aggregating industry × asset category wealth stocks into an industry wealth stock, and computing the depreciation rate as the percentage change in the wealth stock (excluding current-year investment). BLS calculates the internal rate of return by substituting equation (4') into equation 5 and solving for r_{it}.

BLS assumes that the flow of capital services is proportional to the productive capital stock. Industry × asset category capital stocks are Tornqvist aggregated, using capital cost shares for each cell as weights, into capital input. The cost shares are calculated using the capital stocks from equation (3) and the rental prices from equation (4). Capital composition is calculated by dividing capital input by the productive capital stock.

Jorgenson, Ho, Stiroh Methodology (JHS)

The second methodology that we consider is that of (Jorgenson, Ho, & Stiroh, 2005), which we will refer to as JHS. The main conceptual difference between the JHS and BLS methodologies is the age-efficiency function. Below, we present the relevant equations from JHS so that we can highlight the differences between the methodologies. Assuming geometric deterioration, the capital stock of asset *j* in industry *i* at time *t* is:

$$K^S_{ijt} = \sum_{\tau=0}^{\infty} \left(1 - \delta_j\right)^{\tau} I_{ij,t-1} = K^S_{ij,t-1}\left(1 - \delta_j\right) + I_{ijt} \tag{9}$$

The service flow from the capital stock, capital input K^I_{ijt}, is assumed to be a constant proportion of the average of the current and lagged capital stock

$$K^I_{ijt} = \kappa_{ij} \frac{1}{2}\left(K^S_{ijt} + K^S_{ij,t-1}\right) \tag{10}$$

where κ_{ij} is a time invariant constant of proportionality that transforms the capital stock to capital services. [9] κ_{ij} represents the "quality of capital" of type j and makes it clear that capital is measured in constant quality units. [10]

Because the age efficiency profile of each asset is geometric, the age-price price profile follows the same geometric pattern. [11] Thus, the tax-adjusted cost of capital is a function of this same depreciation rate and is specified as:

$$(11) \qquad c_{ijt} = \frac{(1 - u_t z_{jt} - e_{jt})(P_{ijt-1} r_{ijt} + P_{ijt}\delta_j)}{1 - u_t} + P_{ijt-1} x_{ijt}$$

where the terms are defined as above.

At first glance, the JHS equation (11) treats property taxes nearly identically to the BLS equation (4). So, it might seem that property taxes should not create any differences between the two methodologies. That might be true **if** productivity researchers could observe the $x_{ij,t}$. In fact, the property taxes paid by each asset class are generally unobservable. The other modeling choices discussed earlier interact with the process for imputing property taxes, and so the imputed property taxes frequently differ between the BLS and JHS method.

The real rate of return on capital is r_{ijt}. This return is estimated using nominal rate of return that exhausts capital income across assets. In particular, the nominal rate of return is constructed to satisfy the following two equations:

$$(12) \qquad \sum_j c_{ijt} K^I_{ijt} = Y^K_{i,t}$$

and

$$r_{ijt} = \varphi[i_t - \pi_{ijt} + (1 - \varphi)[\rho_t - \pi_{ijt}]$$

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[9] κ_{ij} drops out of growth accounting equations because its assumed that investment is in constant quality units, that is constant quality price deflators are used to estimate real investment.

[10] See (Jorgenson, Ho, & Stiroh, 2005)

[11] See (Jorgenson D. W., 1996)

where φ is the fraction of the industry's capital stock that is financed by debt, i_t is the nominal interest rate on debt[12], π_{ijt} is the asset-specific inflation rate, and ρ_t is the nominal rate of return on all assets in the industry. φ accounts for the economy's financing structure[13]; a portion of the capital is financed by issuing debt for which there is an observed interest rate, and the remainder if financed with equity which has an unobserved rate of return ρ_t that is assumed to be the same across assets.

The Importance of Property Taxes in Current Model

To the best of our knowledge, no productivity researcher has yet published estimates of property taxes rates by industry, asset class and time. It is simply too difficult to read the tax laws for fifty states and thousands of local governments. And even if a researcher did read those laws, the actual practice frequently varies. Local governments frequently assess properties for tax purposes using set formulas that do not match market prices perfectly. In some cases, the written property tax law remains constant over time but the actual implementation varies depending on case law and market conditions. In addition, many local governments categorize assets differently than BLS's capital accounts. For example, land improvement investment like smoothing or drainage is frequently considered a component of land by local governments but it is considered a type of structure in BLS and JHS's asset categories. Finally, businesses frequently negotiate lower property taxes in return for providing community benefits like jobs or health care. Conversely, businesses sometimes negotiate higher property taxes in return for extra government services like special police patrols or parking exemptions.

Both the BLS and JHS methodologies use average property taxes, $x_{i,t}$, as a proxy for asset-specific property tax rates, $x_{ij,t}$. The precise imputation methods are complex, but the general idea is that property taxes are proportional to the nominal value of individual capital assets. In turn, that nominal value depends on the age-efficiency profile, the discard schedule, the inflation rate and the rate of return on assets. In other words, productivity researchers generally assume that each asset pays the same tax rate. Measured productivity growth rates are very sensitive to this assumption.

To illustrate some of the differences, we construct hypothetical industry with separate assets: structures which have a lifespan of 50 years and equipment which has a lifespan of 10 years. Both asset types decay geometrically. Structures prices rise 1% each year and equipment prices decrease by 1% per year. The industry invests smoothly so that the capital stock of structures is steady at 300% of gross

[12] Set equal to the BAA bond rate.

[13] Calibrated with flow of funds data.

output and the capital stock of equipment is steady at 100% of gross output. The nominal rate of return is 3% and property taxes are equal to 4% of total capital stock.

Figure 6 shows how average capital service prices depend on the precise property tax allocation. This hypothetical industry is simplified, but the general result holds true for a more complex industry with dozens of assets. Measured capital services prices rise faster when property taxes are allocated to assets with rapid price growth like structures or land. Holding nominal capital services fixed, this faster price growth decreases the real growth in capital services and increases measured productivity growth. Conversely, capital services prices and measured productivity rise slower when property taxes are allocated to assets like computers with price declines.

The problem of allocating property taxes across asset categories is especially highlighted when researchers introduce a new asset category like entertainment originals or own-account software into the productivity accounts. This newly recognized asset frequently receives a portion of the property taxes which were previously allocated entirely to the existing assets. As a result, measured capital services change for the existing assets. In fact, one can write a plausible example where the indirect effect on productivity from the reallocation of property taxes is larger than the direct effect from capitalizing the newly recognized asset.

Property Taxes In Our Experimental Model

This experimental methodology simplifies the capital service calculations enormously. In the earlier subsections, we showed that both BLS and JHS's formulas for calculating capital services depend on the precise property taxes paid by each asset category. It would be an enormous undertaking to measure property tax rates across industries, assets and time. To the best of our knowledge, no researcher has ever collected the data necessary and we do not plan to collect that data ourselves. Our experimental methodology reclassifies all property taxes from a component of capital services to an intermediate input.[14] Regardless of which asset the property taxes are assessed on, they are treated identically – so there is no need to measure property tax rates across asset categories.

In addition, the experimental methodology provides more intuitive productivity comparisons. To illustrate this omission starkly, imagine two farms which use the same technology, own the same acreage and pay the same wage rate, and the same price for all privately purchased intermediate inputs. The only

[14] It is true that property taxes are generally a fixed sum per year regardless of the precise quantity of local government services used by businesses. However, private property services like security monitoring frequently charge a fixed monthly rate rather than a per alarm cost. The question of non-linear pricing has been extensively explored in the existing literature. We will not study it further here.

difference is that one farm pays property tax on their land and that property tax is then used to produce locally tailored agricultural advice like planting schedules. It is likely that the farm which receives agricultural advice will produce higher output. The BLS and JHS productivity formulas both treat the higher output as a higher TFP for the farm which receives agricultural advice. In contrast, our experimental methodology treats the agricultural advice as an intermediate input, and therefore the two farms have the same measured TFP.

This stylized example is consistent with a rich literature studying how government services affect private sector productivity. Most existing research has focused on long-lived infrastructure (Gu and MacDonald 2009), but current services like trash collection may also be important. Our experimental methodology provides a consistent framework to study property taxes and the government services funded by the property taxes. This consistent framework ensures that the input-output tables balance.

Section 4: Measuring Productivity By Industry

Our primary data is taken from BEA's industry and national accounts. Property taxes by industry are available as an underlying table provided to us for research purposes.[15] From 1997 forward, the property tax data is split by NAICS and so it matches closely with the JHS data used to calculate productivity by industry. Before 1997, the property tax data is split by SIC code and we mapped those SIC codes to the NAICS code according to our best judgment. The individual industry results are sometimes sensitive to the mapping, but aggregate productivity growth is not particularly sensitive. When calculating productivity, we use the JHS data and methodology.

Figure 7 shows the change in productivity growth by industry. There is wide variation across industries, but aggregate productivity growth rises by only 0.05% per year from 1948 until 2012. This is similar to the real GDP increase from 1948 until 2012 shown in Figure 3. The similarity can be explained by the capital services formulas shown in equations (4) and (11). The previous formula included property taxes as a component of capital service prices. Between 1948 and 2012, average capital service prices rose at approximately the same rate as prices for local government services. As a result, shifting property

[15] The published property tax data appear to include government licensing fees and similar taxes. For example, hospitals are reported to pay high property taxes despite the fact that they are non-profits which are exempt from many traditional property taxes.

taxes from a component of capital into an intermediate input has little impact on average input prices or measured productivity.

Figure 8 graphs the productivity revisions against property tax changes. There is a clear negative correlation: our experimental methodology raises TFP growth for industries which experienced property tax increases and lowers TFP growth for industries which experienced property tax decreases. Between 1948 and 2012, average property tax rates in the United States remain relatively steady – and so there is little change to aggregate TFP in the United States. But Figure 6 suggests that average property tax rates increased dramatically in France and Japan. Our experimental methodology might have a large impact on measured TFP in those countries.

We should note that the productivity revisions in Figure 7 are very sensitive to our modeling choices. As we discussed earlier, both the BLS and JHS capital measurement formulas use average industry property taxes to impute property tax rates for each asset. In turn, the imputed property tax rates depend on the assumed rate of return on capital, the formula for allocating property taxes across industries and other modeling assumptions. In contrast, our experimental methodology is much less sensitive. As a result, the sensitivity of the JHS calculations is fully reflected in Figure 7.

To illustrate how modeling choice might matter, Figure 9 graphs the productivity revisions against the previously measured inflation rate for capital services. There is a clear negative correlation: industries with higher capital inflation rates experience lower increases in measured TFP growth. In turn, the higher capital inflation rates are primarily explained by capital composition. Industries with more equipment and less land tend to experience slower inflation rates for capital services. The correlation shown in Figure 9 relies on the modeling assumption that property taxes should be allocated across real estate and equipment equally. If we allocate property taxes on real estate only, the correlation in Figure 9 becomes much weaker.

Section 5: Conclusions

In the U.S., most property taxes are assessed by and paid to local governments. The basic underlying assumption in our experimental approach is that property owners receive local services in exchange for these payments. Thus, local government services funded by property tax payments closely resemble non-profit institutions serving businesses and households. We argue that treating local government services funded by property taxes as intermediate inputs simplifies the GDP and productivity accounts, and provides cleaner comparisons over time and across countries.

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Figure 1: Reduction in Nominal U.S. GDP from Experimental Method

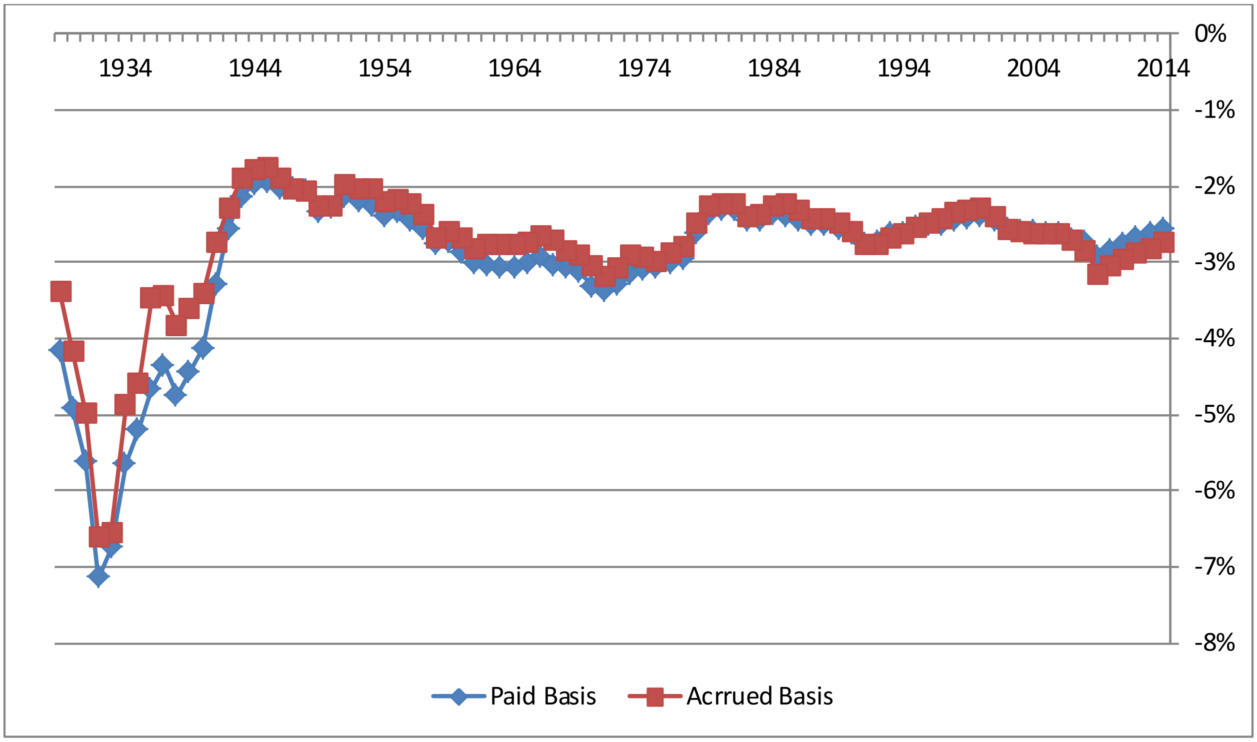

Figure 2: Change in U.S. GDP Prices from Experimental Method

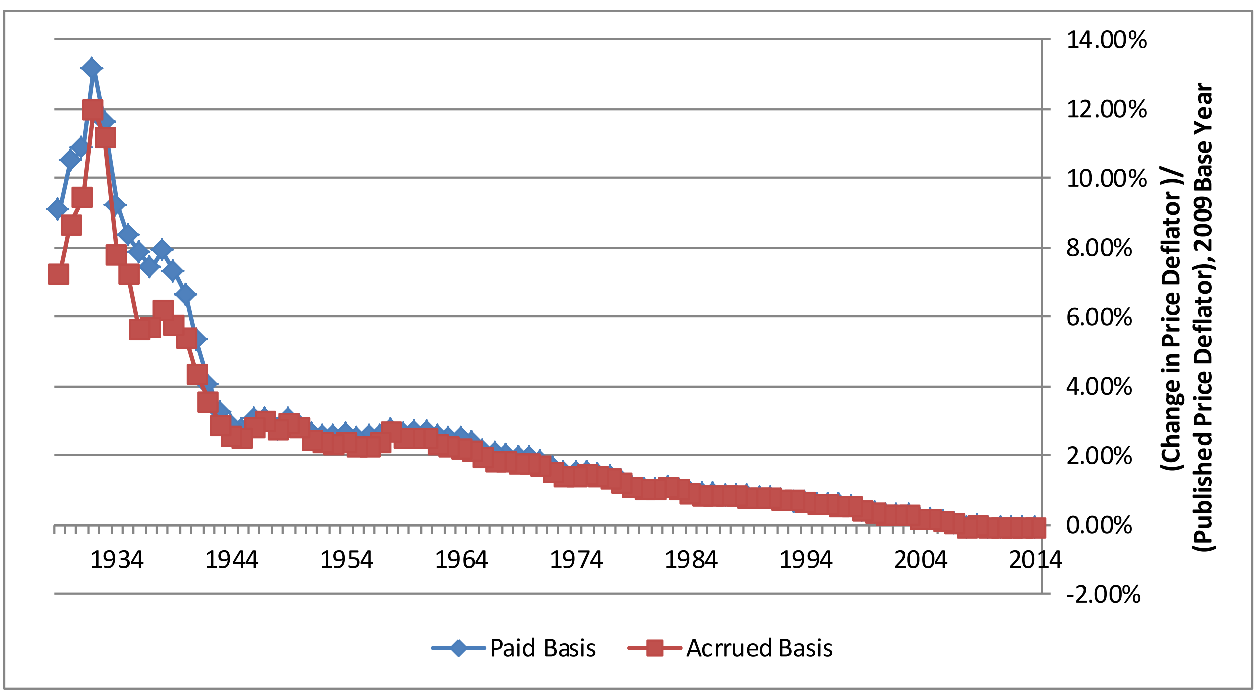

Figure 3: Change in U.S. GDP Quantities from Experimental Method

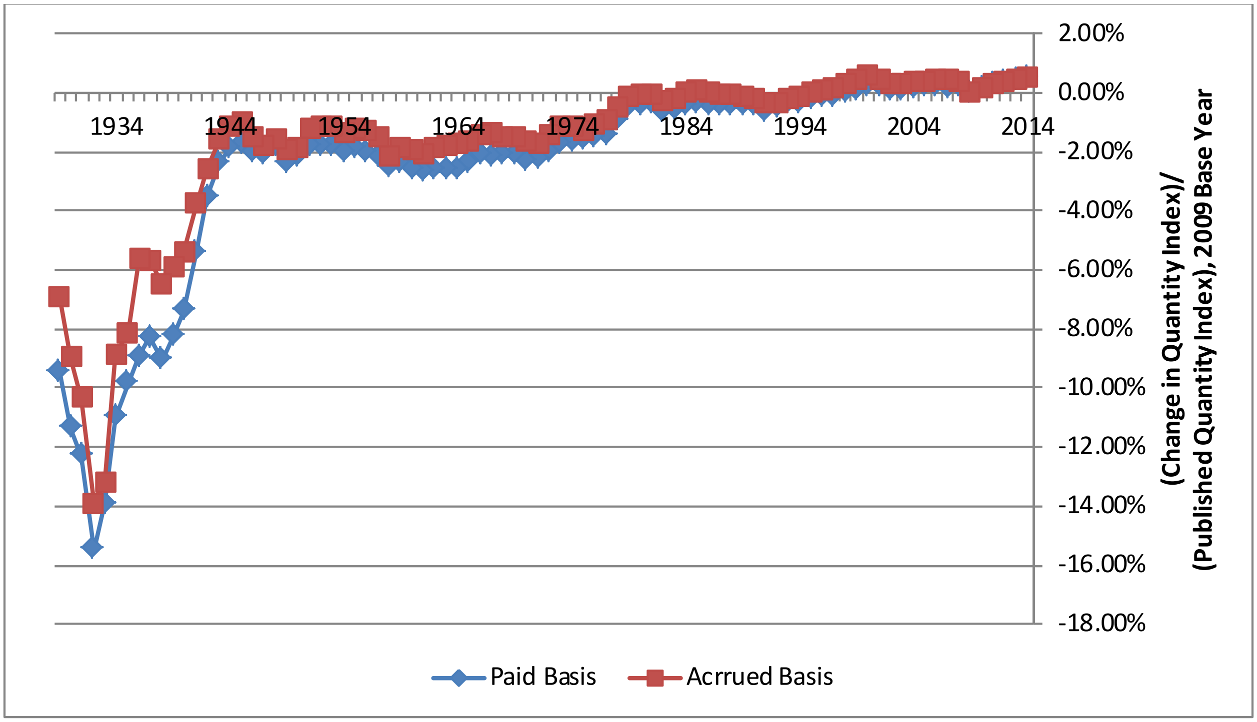

Figure 4: Property Taxes Across OECD Countries in 2012

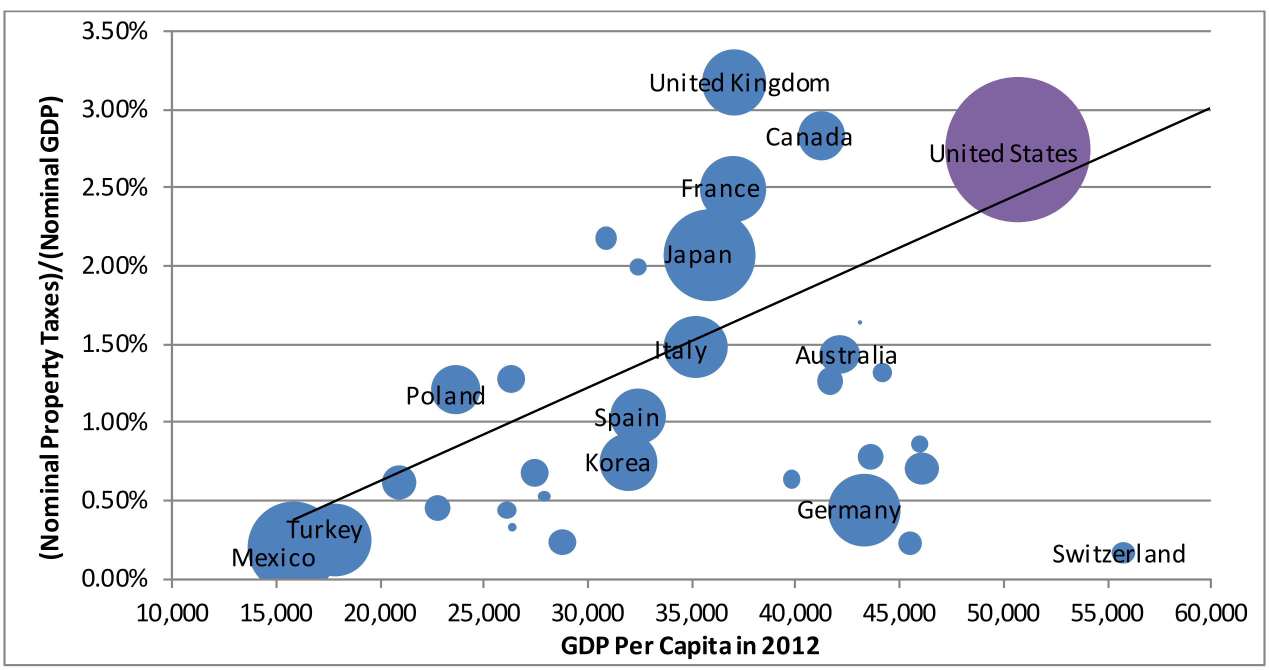

Figure 5: Property Taxes for Selected OECD Countries Over Time

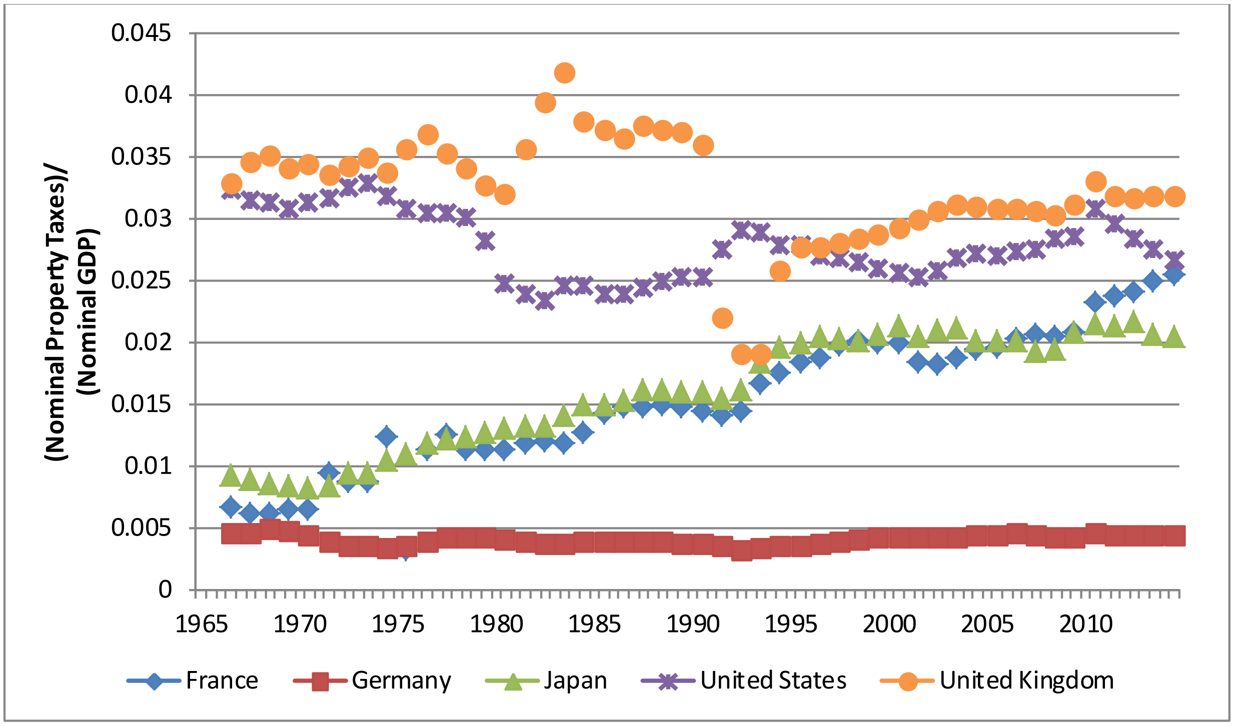

Figure 6: Capital Service Prices in Hypothetical Model

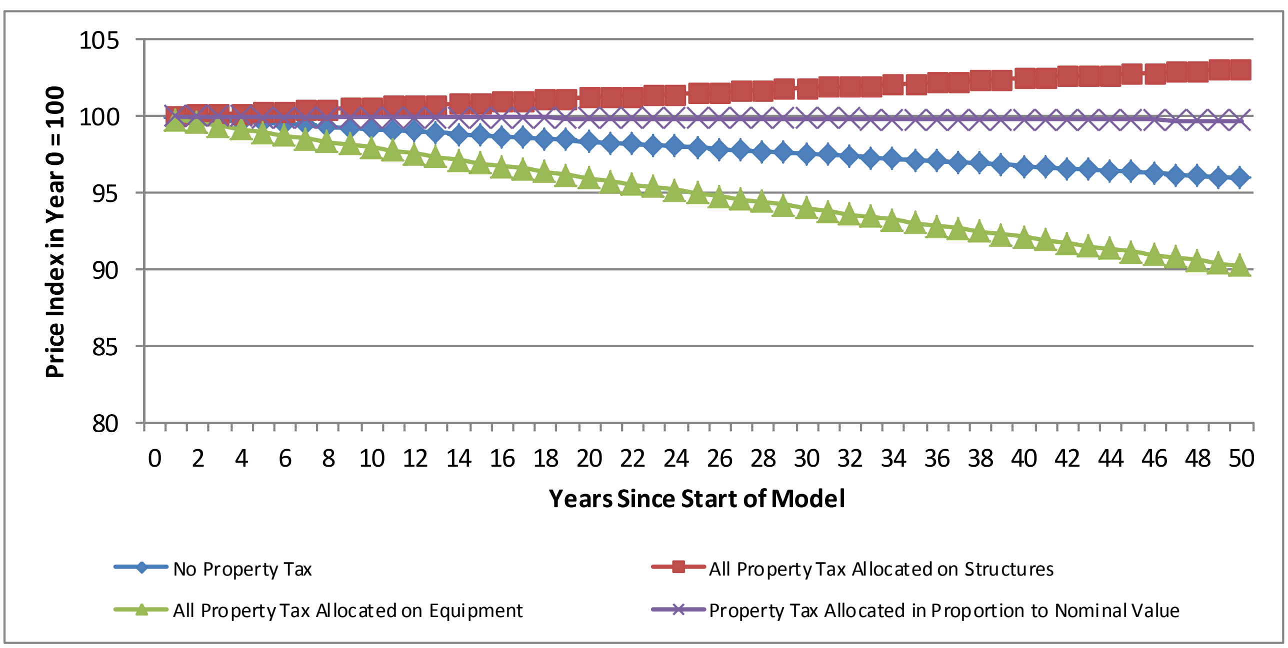

Figure 7: Industry Contributions to TFP Growth Revision, 1948-2012

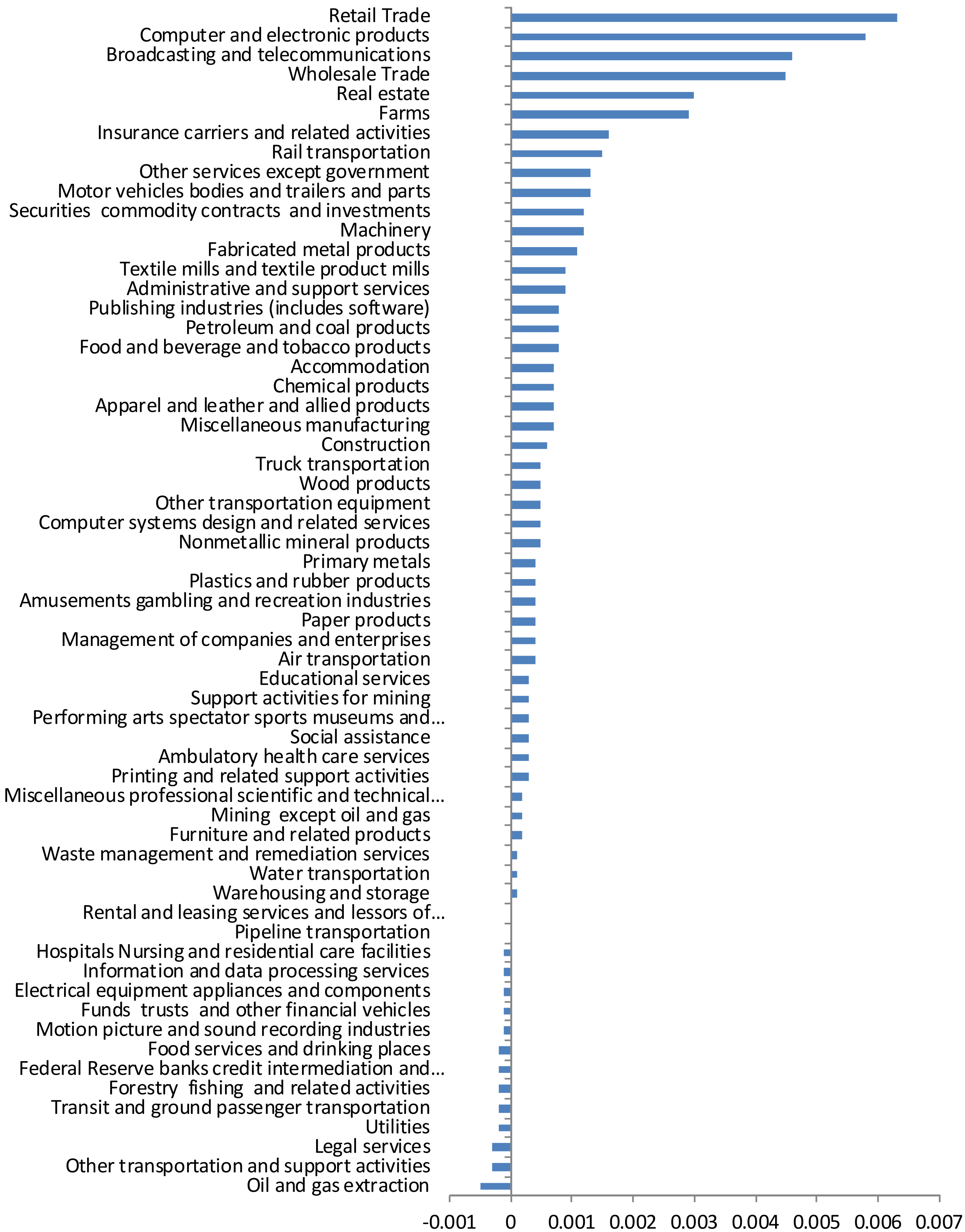

Figure 8: TFP Revisions by Property Tax Rates, 1948 to 2012

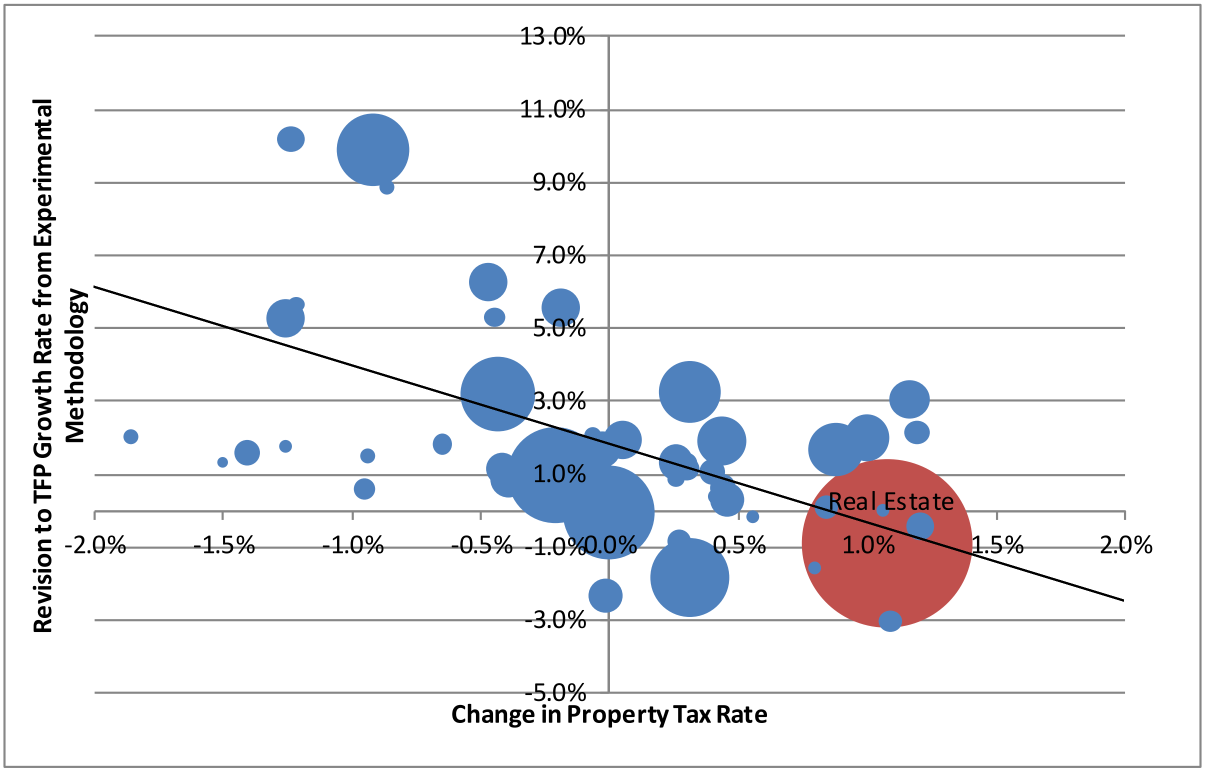

Figure 9: TFP Revisions by Capital Services Price, 1948 to 2012