



Money and the Measurement of Total Factor Productivity

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PRELIMINARY AND INCOMPLETE

Abstract

Firms have greatly increased their holdings of monetary deposits since the mid-1990s. These monetary holdings have an opportunity cost; i.e., allocating firm financial capital into monetary deposits means that investment in real assets is reduced. Traditional measures of Total Factor Productivity (TFP) do not take into account these holdings of monetary assets. Given the recent large increases in these holdings in the U.S. and other advanced economies, it is expected that adding these monetary assets to the list of traditional capital services will reduce the TFP of the business sector in advanced economies. We measure this effect for the U.S. aggregate (corporate and non-corporate) business sector, noting the implications for the System of National Accounts of this expanded definition of capital services.

JEL Classification: D24, E01, E41

Key Words: Productivity, money, national accounts, capital services

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1. Introduction

Firms hold cash balances for a variety of reasons. Motivations for holding such liquid assets, rather than e.g. investment assets, include the need to cover immediate commitments (such as payments to suppliers, and the payment of dividends) and unexpected contingencies. These assets represent underutilised resources, in the sense that if a firm can effectively keep such low-yield balances to a minimum, it can invest in higher return assets, such as physical capital that can produce more output. In times of uncertainty, such as during a financial crisis or a change in government policies, firms may choose to hold more precautionary cash balances. An increase in unproductive cash holdings can then potentially lower investment, output and productivity.

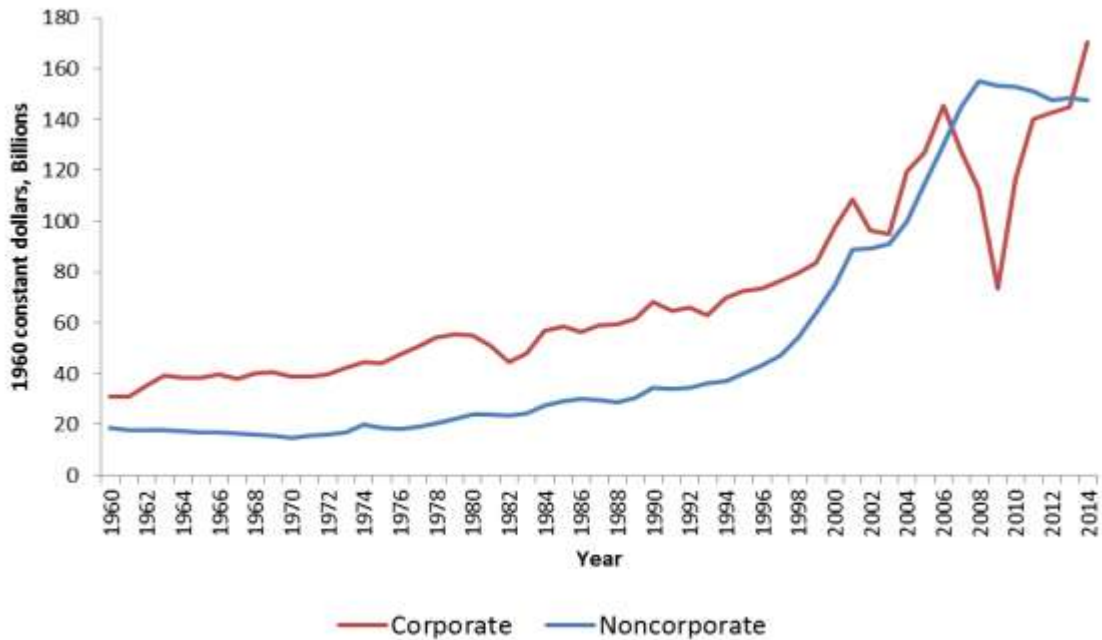
In assessing a firm's performance, ignoring cash holdings as an asset can then give a misrepresentation of its productivity performance.¹ Ideally, it should be included as another input in the construction of Total Factor Productivity (TFP), which is the ratio of output to an aggregate of inputs; higher cash balances with no corresponding increase in outputs means lower productivity. As for a firm, at the aggregate economy level, high overall cash balances means that the economy is not using its full capacity. While there is a long-standing literature on the role of money in the production function (e.g. Gabor and Pearce, 1958; Nadiri, 1969; Sinai and Stokes, 1972; Fisher, 1974) the issue of increasing cash balances has not, to the best of our knowledge, has never been explored from the perspective of productivity analysis. There are a number of conceptual problems that need to be addressed in order to implement this new way of thinking about productivity, and this paper takes up this task.

The extent of the increase in cash holdings (real currency and deposits) since the late 1990s can be seen from figure 1, for both the corporate and noncorporate sectors.²

¹ We use the expressions "cash holdings", "money balances" and "currency and deposits" interchangeably.

² Nominal currency and deposits are from BEA (2015b), while the deflator is taken to be the consumption expenditure index (BEA 2015a). See section 3 for more details on the data

Figure 1: U.S. Real Currency and Deposits



The dramatic fall in currency and deposits in the corporate sector in the wake of the global financial crisis was quickly reversed by an equally dramatic rise, and recent growth in holdings continues to be rapid. For the noncorporate sector, there was very rapid growth prior to the global financial crisis, with holding subsequently being maintained at an historically high level.

The increase in cash holdings by firms has been noted as an area of policy concern, often because of concerns that investment opportunities are being forgone, notably in the U.S. (Sánchez and Yurdagul, 2013), Canada (IMF, 2014) and Australia:

“...at some point, it is going to be in the interests of the owners for investment to take place in new technologies, better processes, new lines of business and, in time, more capacity. At some stage, the equity analysts, shareholders, fund managers, commentators and so on will want to be

asking not ‘where's your cost cutting or capital return plan?’, but ‘where's your growth plan?’”

Glenn Stevens, Governor of the Reserve Bank of Australia (2014)³

Cash balances are well-known to industry as underutilised resources.⁴ However, there could be good reasons for firms to increase their cash holdings. Motivations for holding such liquid assets, rather than e.g. investment assets, can include the need to cover immediate commitments (such as payments to suppliers, and the payment of dividends), unexpected contingencies and investment purchases:

“With imperfect capital markets and information asymmetries that make external financing costly, firms may decide to keep their cash holdings at a level that equates its marginal costs and benefits... Firms may thus increase their holdings of cash if they face a higher level of uncertainty and greater potential future investment needs as the opportunity costs from having to forgo spending due to a of lack of adequate external funding is higher in these cases.”

IMF (2014; 26)

Bates, Kahle and Stulz (2009) emphasized the role of precautionary motives in the increase in the cash-to-assets ratio, linking the increase to increased uncertainty in the cash flows of firms. Other explanations have included a significant role for foreign income and repatriation taxes; see Foley, Hartzel, Titman and Twite (2007).⁵

From a productivity point of view, for non-financial firms, even if the cash accumulation responses are optimal for firms, this does not diminish the fact that holding these assets

³ Similarly: “Our analysis also shows that firms’ high cash balances are typically associated with higher levels of capital expenditure, which bodes well for the acceleration of business investment in the near future.” IMF (2014; 30).

⁴ “Companies are sitting on significant cash reserves and are well placed to invest, employ and embrace future opportunities such as mergers and acquisitions. Indeed investors will want to know how Aussie companies plan to utilise cash reserves to lift future returns.” Craig James, Chief Economist CommSec, ABC News Online (3 March 2014).

⁵ They found that a modest increase in repatriation taxes would lead to a large increase in liquid asset holdings. See Pinkowitz, Stulz and Williamson (2012) for a conflicting view.

means that there is an opportunity cost in that they are not investing in assets with higher productive potential. And a firm that can produce the same output with less cash holdings, all else constant, is making more efficient use of its available resources, making it more productive. It is primarily productivity in this accounting sense, rather than a production function or demand for money sense that we explore in this paper.

The rest of the paper is organized as follows. In the following section we examine the literature on money in the production function, and contrast the approach that we are taking. In section 3 we introduce the data, and discuss conceptual issues that need to be resolved, such as the choice of appropriate deflator to use in constructing real money balances for our purposes. Section 4 presents results from implementing our approach on recently released U.S. data from the Bureau of Economic Statistics, 1960-2013, for both the corporate and non-corporate sectors. We consider not only the sensitivity of productivity estimates to real money balances, but also to the exclusion of land and inventories, as is standard in e.g. the EU KLEMS data set (O'Mahony and Timmer, 2009). Section 5 concludes.

2. Money in the Production Function

There has long been interest in the possible role of money in the production function; see e.g. Gabor and Pearce (1958) and the references therein. Empirical models of production functions including money as a factor of production, such as those of Levhari and Patinkin (1968), Nadiri (1969) and Sinai and Stokes (1972) generated much commentary. Central to this view of money as an input factor is its ability to allow firms to economize on the use of other factors, essentially acting as an index of resources freed from transacting (Fisher 1974; 531). That is, “an economy without money would have to devote effort in order to devote effort in order to achieve the multitude of ‘double coincidences’ – of buyers who want exactly what the seller has to offer – on which successful barter is based” (Levhari and Patinkin, 1968; 737-738).

The inclusion of money as a factor of production the estimation of production functions has been far from uncontroversial. In particular, there has been debate about whether it is best thought of as a direct input into production or as having an indirect effect through

switching “real resources from the exchange activity to the production activity” (Claassen, 1975). For example, Moroney (1972) emphasized that as an exchange innovation, money has broader implications than can be obtained from specifying money as an input, and Davidson (1979; 281) asserted that “there is no elasticity of substitution between money and real capital or labor services along an isoquant”.

In a seminal paper on this topic, Fisher (1974; 517) sought “to show that there is a well-defined sense in which real balances may be said to be a factor of production” but also “to warn that to treat real balances as a factor of production is in general a dangerous procedure” due to the stringent conditions required for this to make sense.

In re-examining the empirical evidence for money in the production function, Nguyen (1986; 150) concluded that “money plays a role, not as an input, but as a factor whose growth rate contributes to productivity growth”.⁶

We abstract from the debate on the role of money balances in the production function, but pursue this idea that, regardless of the purposes for holding cash and other liquid assets, they play a role in determining productivity growth. Essentially, if there are two otherwise identical firms (or the same firm between two periods), facing the same market conditions but one has higher cash balances, then this firm has more idle assets that could have been put into productive use. The recent large increase money balances held by firms suggests that, even if the accumulation of these balances are optimal responses to e.g. uncertainty and transaction needs, there is potential for lowering cash holdings, increasing investment, productivity and economic growth through appropriate policy responses.⁷

⁶ Other contributions to this literature have gone beyond the simple estimation of production functions with money as a factor input: e.g. estimation of translog cost functions (such as Dennis and Smith, 1978, LeBlanc *et al.*, 1987 and Betancourt and Robles, 1989), and a stochastic frontier production function approach which finds that real money balances enhance the technical efficiency of the economy (Delorme, Thompson and Warren, 1995).

⁷ Poschmann (2014; 7): “... the accumulation of cash in firms is best explained as an expression of caution on the part of firms, and of prudent or efficient asset reallocation. To the extent that slack business investment poses a challenge for policymakers, cash holdings should be seen not as a cause, but at most as a symptom.” Sánchez and Yurdagul (2013; 8): “Although the magnitude of the effect is not clear, it seems

3. Data

We use data from both National Income and Product Accounts (NIPAs) (BEA, 2015a) and the relatively recently developed Integrated Macroeconomic Accounts (IMAs) for the United States (BEA, 2015b; Yamashita, 2013).⁸ The data cover 1960-2013 the business sector, with a breakdown that separates the nonfinancial noncorporate sector and the nonfinancial corporate sector from the financial sector, which is excluded from the analysis that follows.

Besides the standard national accounts data from the NIPAs, the IMAs include useful information on the value of real estate and on holdings of currency and demand deposits, which is our measure of “cash holdings”. Although we take an alternative approach to value residential land in the noncorporate sector, we otherwise draw heavily on these BEA data sources; see the Data Appendix for further details of additional data sources and adjustments.⁹

For both the corporate and noncorporate sectors, we include equipment, intellectual property products, nonresidential and residential structures, inventory stocks, land and holdings of currency and deposits in our capital stock measures. Capital services are constructed using a standard user cost approach (Jorgenson, 1963; Diewert, 1974; Schreyer, 2009), using BEA depreciation rates, endogenous (balancing) real rates of return and ex post inflation rates.

that designing and communicating a long-run plan to deal with the increasing fiscal deficit would reduce uncertainty about future taxes, reduce abnormal cash holdings and potentially favor private investment.”

⁸ “These tables present a sequence of accounts that relate production, income and spending, capital formation, financial transactions, and asset revaluations to changes in net worth between balance sheets for the major sectors of the U.S. economy. They are part of an interagency effort to further harmonize the BEA National Income and Product Accounts (NIPAs) and the Federal Reserve Board Financial Accounts of the United States (FAUS).” BEA (2015b), http://www.bea.gov/national/nipaweb/Ni_FedBeaSna/Index.asp. The IMAs we are using were published on March 18, 2015.

⁹ The use of data from both sources is not entirely straightforward: “Cautionary note on the use of the integrated macroeconomic accounts - The tables and estimates that are provided on this page are based on a unique set of accounting standards that are founded on the SNA. Accordingly, some of the estimates in these tables will differ from the official estimates that are published in the NIPAs and FAUS due to conceptual differences. There will also be some statistical differences between the estimates in these tables and those in the related accounts.” BEA (2015b).

As five of the calculated user costs were negative for the corporate sector,¹⁰ and user costs should not be negative, we also considered smoothed inflation rates in the calculation of user costs to remedy this problem, using LOWESS (locally weighted scatterplot smoothing) (Cleveland, 1979), with the cross validation criterion to select the optimal smoothing parameter.¹¹ For the noncorporate sector, there were eight negative user costs, so again we also tried smooth inflation rates in our user cost formula and calculated the corresponding capital services index.¹²

For our labor input, we use (non-quality-adjusted) hours worked, allowing us to calculate the average full-time wage rates (which we assume to be constant across the corporate and noncorporate sectors) from the total value of employee compensation. We make adjustments for the noncorporate sector, as we assume that self-employed workers earn a fraction of the annual private sector full-time wage.

For currency and deposits, there is a choice of alternative deflators that can be considered, each with legitimate justifications depending on the predominant reason why firms are holding cash balances, such as follows: 1) Consumption price index: firms may be holding funds in trust for shareholders as they want to pay a dividend. 2) Labour wages: cash is held to cover wage commitments. 3) Intermediate inputs price index: firms hold cash balances to pay suppliers, so an intermediate inputs price index could be a reasonable choice. 4) Capital price index: cash is held in preparation for capital purchases.

We consider both 1) the consumer expenditure deflator and 2) the employee wage index in the next section, and given that there is no great change in the estimates depending on which is used we leave an exploration of the use of additional deflators for future research.

¹⁰ The negative user costs were for currency and deposits in 1985, and land in 1997, 2004, 2007 and 2013.

¹¹ For land, using the cross validation criterion to select the smoothing parameter resulted in a smoothed series that was too close to the original, so we arbitrarily set the parameter for this asset to be 0.3, which remedied the problem of negative user costs.

¹² Again, there was a problem with the smoothed series being too similar to the original series for the (business residential and business nonresidential) land assets, so we arbitrarily set the parameter for these assets to be 0.3.

To construct our measure of productivity, we follow the approach of Diewert and Morrison (1986) by dividing our real value added output index by a direct Törnqvist input quantity index of our inputs.

4. Results

Figure 2 plots TFP for the corporate sector under our two different choices for the deflator of currency and deposits, the consumer expenditure deflator and the employee wage index. *Ex post* inflation is used in calculating user cost. The resulting series are indistinguishable, indicating that the choice of deflator does not matter. In addition, we consider excluding currency and deposits and find that the resulting series is also indistinguishable from the series for which it is included. This implies that productivity studies of the corporate sector that exclude money holdings in their analysis will not be greatly in error in terms of results.

Figure 2: Total Factor Productivity, Corporate and Noncorporate Sectors

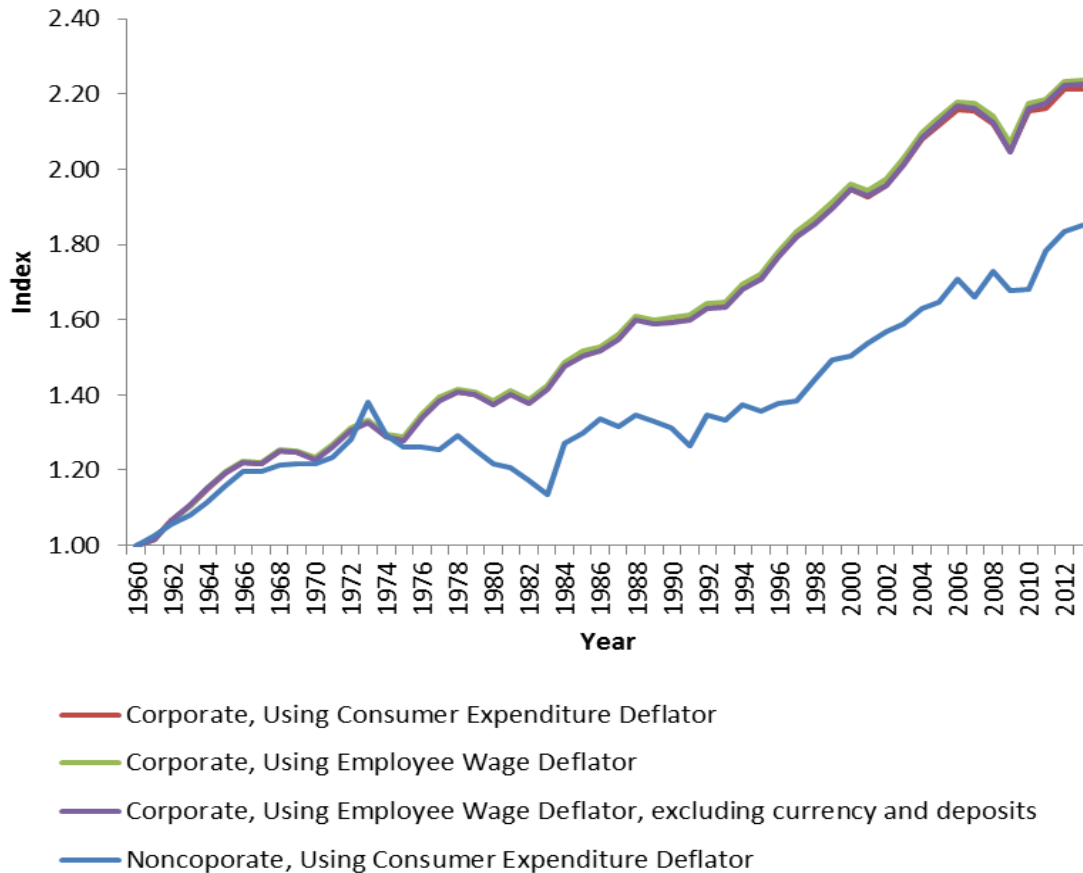
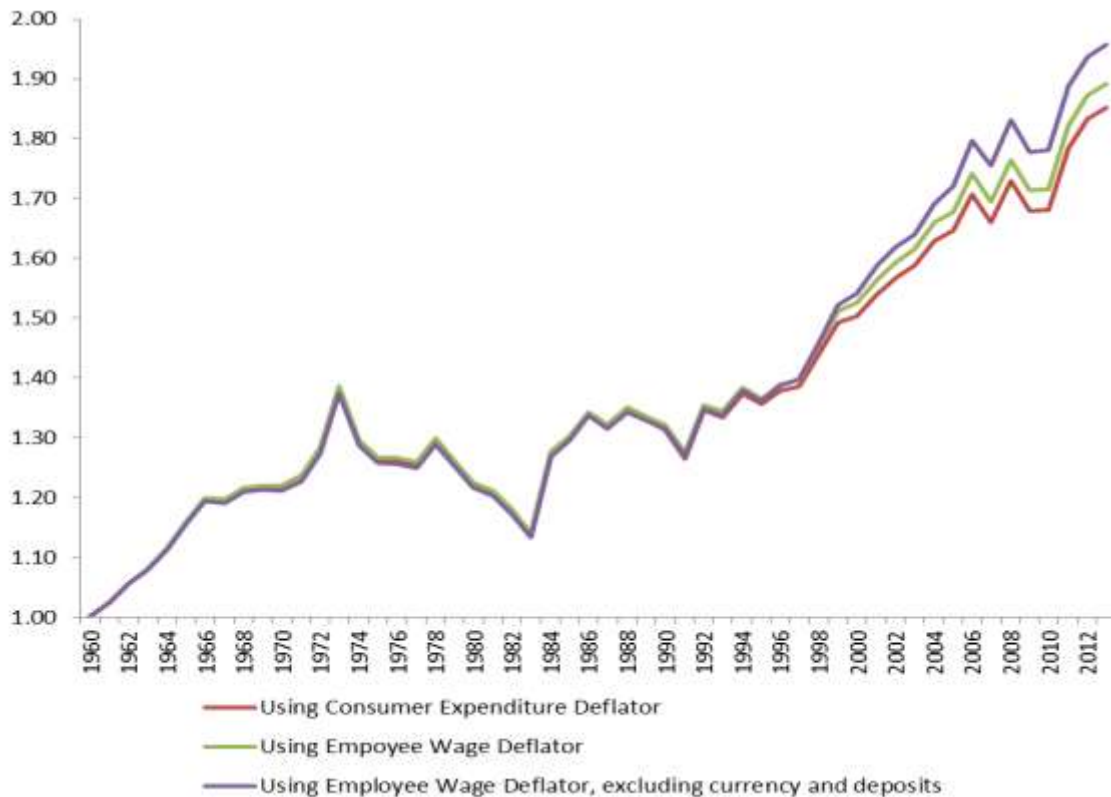


Figure 2 also plots the productivity series for the noncorporate sector, using the consumer expenditure deflator to deflate currency and deposits, and *ex post* inflation in calculating user cost. Note that there is a significant productivity gap between the estimates of corporate and noncorporate productivity; the corporate sector is the key driver of U.S. productivity growth.

Figure 3 presents the same series for the noncorporate sector as in figure 2, but also the series using the wage deflator to deflate currency and deposits, and excluding currency and deposits. In contrast to the concordance of the corresponding series in figure 2 for the corporate sector, the series diverge around the same time as currency and deposit holdings started to increase in the 1990s; see figure 1.

Figure 3: Total Factor Productivity, Noncorporate Sector



Geometric means of the productivity indexes are presented in tables 1 and 2, for the cases of *ex post* inflation and smoothed inflation being used in the calculation of user cost, respectively. All tabulated figures are averages of indexes, so subtracting 1 and multiplying by 100 yields results in percentage terms.

From table 1, for the corporate sector we see that there is very little difference between the estimates across the different approaches, including by decade. This is consistent with figure 1. For the noncorporate sector, the differences are more notable, especially in the case when currency and deposits are dropped, particularly in the later decades when balances increased.

Table 1: Geometric Mean Productivity Index Statistics: *Ex Post* Inflation

	Consumer Expenditure Deflator	Employee Wage Deflator	Employee Wage Deflator, No Currency & Deposits
Corporate			
1960-2013	1.0151	1.0153	1.0152
1960-1970	1.0210	1.0213	1.0208
1970-1980	1.0112	1.0113	1.0112
1980-1990	1.0149	1.0150	1.0149
1990-2000	1.0201	1.0202	1.0202
2000-2014	1.0100	1.0101	1.0104
Noncorporate			
1960-2013	1.0117	1.0121	1.0127
1960-1970	1.0199	1.0201	1.0193
1970-1980	1.0001	1.0003	1.0005
1980-1990	1.0075	1.0077	1.0078
1990-2000	1.0136	1.0145	1.0160
2000-2014	1.0162	1.0166	1.0186

From table 2, for the corporate sector we again see that there is very little difference between the estimates across the different approaches, including by decade. For the noncorporate sector, the differences are again more notable, especially in the case when currency and deposits are dropped, particularly in the later decades when balances increased.

Table 2: Geometric Mean Productivity Index Statistics: Smoothed Inflation

	Consumer Expenditure Deflator	Employee Wage Deflator	Employee Wage Deflator, No Currency & Deposits
Corporate			
1960-2013	1.0152	1.0154	1.0153
1960-1970	1.0211	1.0214	1.0209
1970-1980	1.0113	1.0115	1.0114
1980-1990	1.0150	1.0151	1.0150
1990-2000	1.0201	1.0202	1.0202
2000-2014	1.0101	1.0102	1.0104
Noncorporate			
1960-2013	1.0118	1.0122	1.0128
1960-1970	1.0197	1.0199	1.0190
1970-1980	1.0008	1.0011	1.0012
1980-1990	1.0072	1.0073	1.0075
1990-2000	1.0139	1.0146	1.0162
2000-2014	1.0164	1.0168	1.0185

An average annual growth rate of around 1.5 percent for corporate TFP growth may seem quite high; it is certainly very robust growth that has been (perhaps) surprisingly persistent across decades. As a check on the reasonableness of these results, we compare them with those of Diewert (2014), who used a “top-down” approach to calculating TFP for the U.S., 1987-2011. The average annual geometric growth rate of TFP was 1.33

percent, whereas our corporate sector TFP growth averaged 1.41 per cent over the same period. The relative consistency of estimates is reassuring.

A comparison of the results in tables 1 and 2 show that the assumption of perfect foresight in inflationary expectations formation, through the use of *ex post* inflation rates in calculating user costs and hence capital services, makes little difference compared to a method that assumes the expectations are more accurately represented by smoothed (or trend) inflation. This is encouraging for the *ex post* approach; even though the rental prices that arise from this approach are frequently not credible, the productivity growth estimates are reasonable.

5. Conclusions

We have found that, while conceptually more correct, adding real money balances to our input aggregate does not change aggregate measured productivity performance very much for the corporate sector. This is because the asset share is relatively small. The impact on the noncorporate sector is larger, especially in the latter decades of the sample, when currency and deposit holdings increased substantially (figure 1). Regardless of the measured impact, this does not diminish the point that it should be standard for money balances to be included in productivity (and efficiency) analysis at all levels; *ex post*, empirically it may make little difference to productivity growth estimates in most years at the aggregate level, but this should not be a justification for its *ex ante* exclusion. More generally, when calculating TFP growth rates, it is important to account for *all* relevant assets, including land and inventories (Diewert, 2000; Schreyer, 2014).

Further, the relative productivity of individual firms can be significantly impacted by differences in money holdings, even if there is little aggregate effect at the sectoral level. Indeed, understanding productivity differences between small and large firms can be enhanced by taking into account currency and deposits; small firms are often credit constrained and therefore have greater cash holdings (IMF, 2014). Similarly, accounting for cash holdings can provide an augmented understanding of productivity and

profitability in studies of firm dynamics. In addition, understanding productivity differences between risky and less risky sectors and firms can be informed by differences in money balances, where e.g. dependence on R&D is taken as a proxy for risk (Sánchez and Yurdagul, 2013).

In constructing our capital services series, we considered using smoothed asset inflation rates instead of the standard *ex post* actual asset inflation rates in the user costs calculations; the idea is that expectations are formed around the general trend of price changes, rather than implicitly assuming perfect foresight as in the *ex post* inflation case. Smoothing inflation eliminates negative user costs, and yields much more “reasonable” user costs in general. However, this change in approach does not materially affect overall rates of TFP growth. Even so, if a statistical agency were to publish user cost components, it will be much more credible if it uses smoothed asset inflation rates instead of the raw *ex post* inflation rates.¹³

In constructing the data set, it became clear that there is great uncertainty about the price and quantity of land inputs. A major implication for the System of National Accounts is that the measurement community needs to urgently address the lack of information on land inputs, a point emphasized by Schreyer (2014).

While considerable effort was put into constructing our data set from the National Income and Product Accounts (NIPAs) (BEA 2015a) and the relatively recently developed Integrated Macroeconomic Accounts (IMAs), there remain significant data “gaps”; it would have been useful to have data on gross outputs and intermediate inputs by corporate and noncorporate sectors (and hours of work estimates by sector) so that the productivity of the two sectors could be better measured.¹⁴ That is, it is important for

¹³ However, for purposes of calculating *ex post* rates of return on initial capital invested, *ex post* user costs are the “right” ones to use.

¹⁴ The relative productivity of the noncorporate sector is an important policy issue as far as tax policy is concerned: if the productivity of the noncorporate sector is far below the corporate sector, is it really justified to give the noncorporate sector tax breaks? From our results for the U.S., the noncorporate sector appears to be relatively productive so that is not a major issue, but it could be for other countries.

statistical agencies to provide better “flow” statistics to go with their balance sheet statistics for the corporate and noncorporate sectors and to publish the data.

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Data Appendix

In progress.