Money and the Measurement of Total Factor Productivity

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Abstract

Firms have greatly increased their cash holdings since the mid-1990s. These 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 sources of capital services will reduce the TFP of the business sector. We measure this effect for the U.S. corporate and non-corporate business sectors.

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 underutilized 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, they 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 output 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; Fischer, 1974) the issue of increasing

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[1] We use the expressions "cash holdings", "money balances" and "currency and deposits" interchangeably. We focus here on currency and deposits rather than including service inputs provided by broader classes of financial assets with various levels of liquidity. Due to their investment nature, considering service inputs provided by other financial assets introduces potential complexities beyond the scope of this paper.

cash balances has, to the best of our knowledge, 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 rest of the paper is organized as follows. In the following section we describe the accumulation of cash holdings (real currency and deposits) since the 1990s, highlighting the policy concerns that this raises. In section 3 we examine the literature on money in the production function, and contrast the approach that we are taking. In section 4 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 5 presents results from implementing our approach on recently released U.S. data from the Bureau of Economic Statistics (BEA), 1960-2014, for both the corporate and non-corporate sectors. Section 6 concludes.

2. The Accumulation of Cash Holdings in the U.S. Business Sector

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]

Figure 1: U.S. Real Currency and Deposits

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[2] Nominal currency and deposits are from BEA (2016), while the deflator is taken to be the consumption expenditure index (BEA 2015). See section 3 for more details on the data.
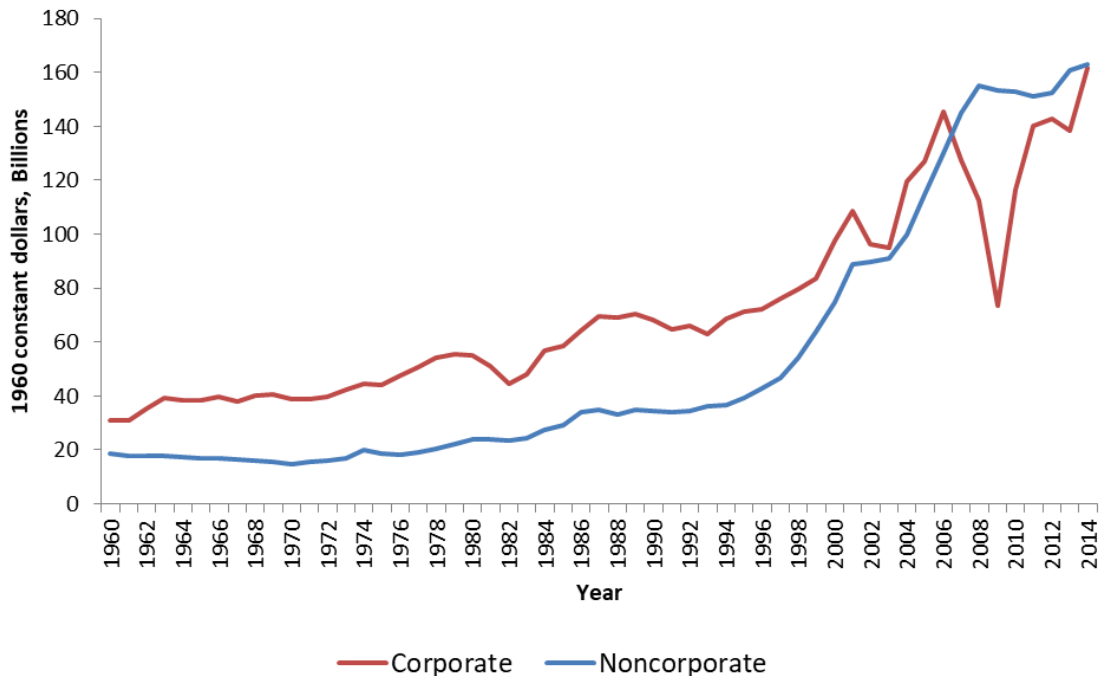
The dramatic fall in currency and deposits in the corporate sector in the wake of the global financial crisis was quickly reversed by an equally dramatic rise, and recent growth in holdings continues to be rapid. For the noncorporate sector, there was very rapid growth prior to the global financial crisis, with holdings subsequently being maintained at historically high levels.

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]

However what has not been documented to date, as far as we are aware, is that the increase is a particular puzzle for the noncorporate sector. That is, the increase in noncorporate currency and deposit holdings is particularly notable when considered as a ratio to net assets, i.e. to all assets other than currency and deposits, as illustrated in Figure 2. There is a dramatic deviation in ratios for the two sectors from the early 1990s, with the noncorporate sector ratio increasing from 0.044 in 1990 to 0.122 in 2014, while the corporate ratio only increases from 0.039 to 0.056 over the same period. Hence, the phenomenon of increasing holdings of cash balances by firms is primarily a noncoporate sector phenomenon when considered relative to increases in other asset holdings. This increase of cash holdings is then not a phenomenon of behavior of multinationals in the corporate sector, but rather primarily of the noncorporate sector. These firms are typically not under pressure from the "equity analysts, shareholders, fund managers, commentators and so on" mentioned in the previous quote.

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[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).

Figure 2: Ratio of Currency and Deposits to Net Assets[4]
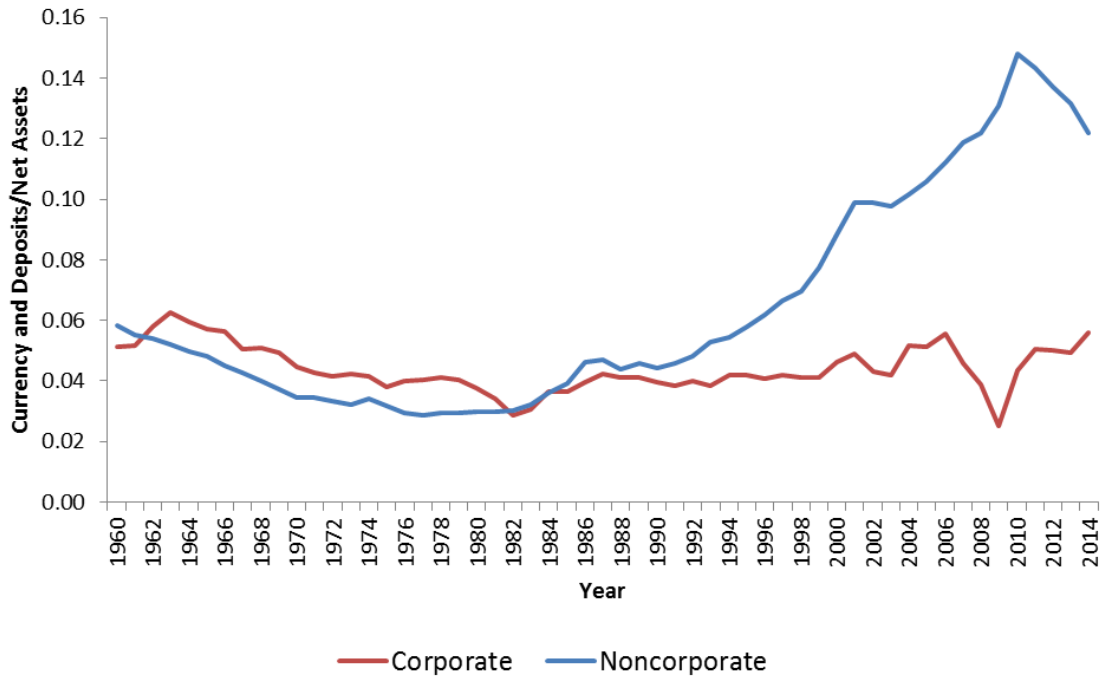
Cash balances are well-known to industry as underutilized resources.[5] However, there could be good reasons for firms to increase their cash holdings:

> "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."
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> IMF (2014; 26)

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[4] *Corporate Sector Assets*: Equipment; Intellectual Property Products; Nonresidential Structures; Residential Structures; Land; Inventories; Currency and Deposits.
Noncorporate Sector Assets: Sole Proprietor Equipment; Partnership Equipment; Sole Proprietor Intellectual Property Products; Partnership Intellectual Property Products; Sole Proprietor Nonresidential Structures; Partnership Nonresidential Structures; Residential Structures; Nonresidential Land; Residential Land; Inventories; Currency and Deposits
[5] "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).

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. Brown et al. (2012) show that firms tend to smooth R&D expenditures by maintaining a buffer stock of liquidity in the form of cash reserves.[6] King and Low (2014) and Summers (2014) have noted the long-run decline in real interest rates; lower interest rates lower the opportunity cost of holding cash balances and hence may explain their increase.[7] For Australia, La Cava and Windsor (2016) find the rise in corporate cash is due to changes in company characteristics.[8] Other explanations have included a significant role for foreign income and repatriation taxes; see Foley et al. (2007).[9] The increase in cash balances relative to net assets for the noncoporate sector, as illustrated in Figure 2, brings into question all these potential explanations; the explanations seem either general (and hence should affect both sectors similarly, such as a falling opportunity cost of holding cash balances) or to be primarily related to the corporate sector. For example, considerations of R&D expenditure and repatriation taxes would seem to be mainly of relevance for corporate firms.

Exploring the potential reasons why firms, especially in the noncorporate sector, have increased cash balances is beyond the scope of the current paper.[10] From a productivity point

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[6] Yet we have identified, for the first time we believe, that the increase in cash holdings is primarily a noncorporate phenomenon and noncoporates are usually thought to be less likely to have major R&D expenditures.

[7] Summers (2014, 69-71), proposes six reasons why there might have been a decline in equilibrium real interest rates: 1. A decline in debt-financed investment; 2. A declining rate of population growth; 3. Changes in the distribution of income; 4. Cheaper capital goods; 5. The importance of after-tax real interest rates, meaning that disinflation implies a lower pre-tax real rate; and 6. "substantial global moves to accumulate central bank reserves, disproportionately in safe assets in general, and in U.S. Treasuries in particular."

[8] "Despite Australian non-financial companies holding high levels of cash by international standards, we find little evidence that the increase has been 'excessive'. Instead, we find that the rise in corporate cash is mostly due to changes over time in observable company characteristics, including an apparent increase in the growth opportunities of publicly listed companies (as proxied by Tobin's Q). We also find some evidence of 'cohort effects' as Australian companies are more likely to be 'born', or come into existence, today in industries that have relatively high levels of cash, such as information technology, pharmaceuticals and biotechnology." La Cava and Windsor (2016).

[9] They found that a modest increase in repatriation taxes would lead to a large increase in liquid asset holdings. See Pinkowitz et al. (2012) for a conflicting view.

[10] A referee provides an interesting list of questions that seem worth considering in addressing the difference between the non-corporate and corporate sectors: Do corporations typically have greater ability to economize on cash holdings? Do non-corporate entities depend more on liquid assets, and if so, is this because they tend to be smaller firms? Did technological innovation induce more individuals to operate

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

3. 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 Levahari 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 (Fischer 1974; 531). That is, "an economy without money would have 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 in 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

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their own small businesses? The share of consumption to GDP rose until the Great Recession, and if suppliers for consumption goods are more likely to be non-corporate entities, does this imply a need for more liquid assets? Is the accumulation of cash balances due to growth in the underground economy?

elasticity of substitution between money and real capital or labor services along an isoquant".

In a seminal paper on this topic, Fischer (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".[11]

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 in 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 holdings, increasing investment, productivity and economic growth through appropriate policy responses.[12]

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[11] 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 et al., 1995).

[12] 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 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."

4. Data

We use data from both National Income and Product Accounts (NIPAs) (BEA 2015) and the relatively recently developed Integrated Macroeconomic Accounts (IMAs) for the United States (BEA 2016; Yamashita 2013).[13] The data cover the business sector, 1960-2014, 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.[14]

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 Diewert and Fox (2016) for further details of additional data sources and adjustments.[15]

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 expected (or predicted) inflation rates. Expected asset inflation rates were used

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[13] "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 (2016), http://www.bea.gov/national/nipaweb/Ni_FedBeaSna/Index.asp. The IMAs we are using were published on March 18, 2015.

[14] Using Table S.2.A from the IMAs, we can calculate the average shares of private business sector gross value added over the years 1960-2014 for our nonfinancial corporate and noncorporate sectors and a third sector, equal to the financial business sector: 0.705, 0.218 and 0.077. The maximum and minimum shares for the financial sector over the sample period were 0.107 and 0.048.

[15] 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 (2016).

as using *ex post* inflation rates led to five of the calculated user costs being negative for the corporate sector, and user costs should not be negative.[16] A moving average process was used to determine to the expected inflation rates; see Diewert and Fox (2018, 2016). For the noncorporate sector, there were eight negative user costs when using *ex post* inflation, so again we expected inflation rates in our user cost formula and calculated the corresponding capital services index.

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 impute the full time wage to the self-employed, and a wage of zero for unpaid family workers; see Diewert and Fox (2016, Appendix 10) for details.[17]

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 considered both 1) the consumption expenditure deflator and 2) the employee wage index, but there was no great change in the estimates depending on which is used. The results in the following section use the consumption expenditure deflator and we leave exploration of the use of additional deflators for future research.

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

[17] It is unlikely that the employee wage rate is the same across our sectors but we do not have any information on the distribution of employees by industry and by type of employer (corporate or noncorporate). Thus our estimates for the price and quantity of employee labour input by sector are subject to an unknown amount of measurement error.

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 quantity index of our inputs.

5. Results

Figure 3 plots TFP for the corporate sector including our full set of assets. 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 3 also plots the productivity series for the noncorporate sector. 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. In contrast to the concordance of the corresponding series for the corporate sector, there excluding currency and deposits causes the respective TFP series to diverge around the same time as currency and deposit holdings started to increase in the 1990s; see figures 1 and 2.

Figure 3: Total Factor Productivity, Corporate and Noncorporate Sectors
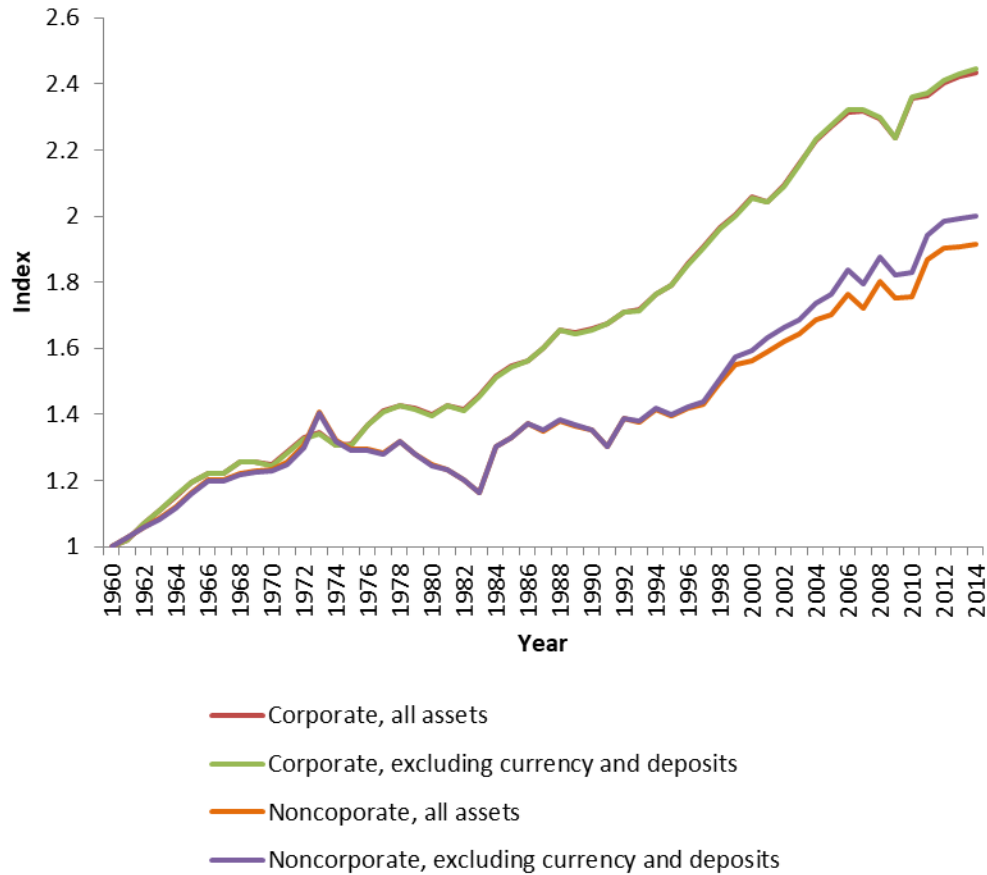
Geometric means of the productivity indexes are presented in Table 1, represented as annual percentages changes. Sub-periods are chosen as follows: 1974-1995, the period of the computer productivity paradox;[18] 1996-2004, a period of higher productivity growth; and 2005-2014, a much-debated period of slower productivity growth.[19] For the corporate sector, consistent with Figure 3, we see that there is very little difference between the estimates depending on whether or not currency and deposits are included in the asset base. For the noncorporate sector, the differences are more notable, especially in the case when currency and deposits are dropped, particularly in the later periods when balances increased. In addition, we note that the productivity slowdown in the period 1974-1995

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[18] See e.g. Diewert and Fox (1999).
[19] See e.g. Gordon (2016), Sichel (2016), Mokyr, Vickers and Ziebarth (2015), and Brynjolfsson and McAfee (2011).

was particularly pronounced for the noncorporate sector, with negative average growth rates using either asset base.

Table 1: Geometric Mean Productivity, Annual Percentages

	All Assets	No Currency & Deposits
Corporate		
1961-2014	1.66	1.67
1961-1973	2.30	2.28
1974-1995	1.32	1.32
1996-2004	2.46	2.49
2005-2014	0.88	0.91
Noncorporate		
1961-2014	1.21	1.29
1961-1973	2.67	2.64
1974-1995	-0.04	-0.01
1996-2004	2.12	2.41
2005-2014	1.21	1.42

An average annual growth rate of over 1.6 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. business sector, 1987-2011. The average annual geometric growth rate of TFP was 1.33 percent, whereas our corporate sector TFP growth averaged around 1.7 per cent over the same period. This is higher, but the relative consistency of estimates is reassuring.[20]

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[20] Given the slower average TFP growth in the noncorporate sector, aggregating our two sectors to form a comparable business sector would result in an estimate even closer to that found by Diewert (2014).

6. 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, even though there is some variation, the asset share is relatively small, as can be seen from Figure 2. The impact on the noncorporate sector is larger, especially in the latter decades of the sample, when currency and deposit holdings increased substantially, especially relative to other asset holdings (figures 1 and 2). 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). [21] Similarly, accounting for cash holdings can provide an augmented understanding of productivity and profitability in studies of firm dynamics.[22] In addition, understanding productivity differences between risky and less risky sectors and firms can be informed by differences in monetary balances, where e.g. dependence on R&D is taken as a proxy for risk (Sánchez and Yurdagul, 2013). If financial institutions are less likely to provide loans for

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[21] Bank of England (2016, p. 4) found that "the vast majority of small firms do not have access to market-based finance, and are heavily dependent on bank funding or internal funds. The investment decisions of small firms, which account for around 30% of total business investment, are likely to be sensitive to their access to external finance."

[22] Kueng et al. (2014) found that "financial frictions are an important determinant of firm exit, conditional on firm age."

risky investment in intangibles such as R&D, consideration of monetary balances is especially important for understanding the productivity of innovative firms and industries.

This paper has for the first time, to the best of our knowledge, set out the importance of expanding the set of assets considered in productivity analysis to include cash balances. Even if not empirically significant in magnitude for a particular industry or country, the exclusion of cash balances is a significant specification error and hence a weakness in current official productivity statistics.

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