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Reallocation of Tangible Assets and Productivity*

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Abstract

We study the reallocation of land and other tangible assets across firms and examine its relationship with productivity. Focusing on Japanese firms during the period 1980-2014, which includes massive asset price fluctuations, we find the following. First, there exists no obvious cyclicality in the extent of land and other tangible asset reallocation. Instead, the reallocation of land has been sluggish for more than 20 years since the burst of the asset price bubble. Second, reallocation of land and non-land tangible assets is efficiency-reducing rather than efficiency-enhancing in that firms with high total factor productivity (TFP) reduced their holdings of these assets more than low TFP firms. Third, the relationship between reallocation and productivity has changed over time. Even though the reallocation of land was efficiency-enhancing around the end of the 1980s, it turned efficiency-reducing afterward.

Keywords: Land, Total factor productivity, Asset price bubble, Business cycle

JEL classification: E22; G34; R33

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1. Introduction

The interfirm allocation of inputs for production such as labor and capital is as important for the performance and efficiency of an economy as the amount of inputs available. This has motivated many economists to construct aggregate measures for input reallocation and to examine its extent and the relationship with the business cycle. Scholars first focused on the reallocation of jobs across firms (Davis and Haltiwanger, 1999; Davis, Haltiwanger, and Schuh, 1996) to find that the gross flow of labor input is substantially more sizable than its net flow and that the extent of reallocation is counter-cyclical. Scholars then turned to the reallocation of physical capital (Eisfeldt and Rampini, 2006; Ramey and Shapiro, 1998), although compared to the study of labor reallocation, the examination of physical capital reallocation is still limited.

The importance of input reallocation also prompted economists to theoretically investigate its mechanism. Jovanovic (1982) and Hopenhayn (1992) provide models of heterogeneous firm dynamics to show that unproductive firms exit the market while productive firms survive, in which case resources are reallocated from exiting unproductive firms to surviving productive firms. Other studies examine how input reallocation is related to the business cycle. Caballero and Hammour (1994) and Mortensen and Pissarides (1994) show that the lower cost of input reallocation during recessions leads to the extent of reallocation being counter-cyclical. In all of these models, reallocation is always "efficiency-enhancing" in that resources are shifted away from low-productivity firms to high-productivity firms through reallocation to increase the average productivity of the entire economy.

In contrast, there are also several theoretical studies that examine distortions to the efficiency-enhancing reallocation of inputs. Barlevy (2003) develops a model of credit market imperfections in which productive firms with a large number of investment opportunities tend to be financially constrained during recessions and release their resources. In this case, the reallocation is "efficiency-reducing" in that resources are shifted away from high-productivity firms to low-productivity firms to decrease the average productivity of the economy. Osotimehin and Pappàda (2016) provide a related model of credit frictions which have distortionary effect on the selection of exiting firms but the model still maintains the characteristics of efficiency-enhancing reallocation even during recessions. Ouyang (2009) points out that recessions increase the exit of young and potentially productive firms before they learn about their productivity, and may thus lower the average productivity. Hence, it is an empirical matter which one of the two theoretical predictions, that reallocation is efficiency-enhancing or efficiency-reducing, holds true in practice.

However, previous empirical studies examining if reallocation is efficiency-enhancing or efficiency-reducing, such as the studies by Foster, Haltiwanger, and Krizan (2006) and Foster, Grim, and Haltiwanger (2016) mostly focus on the reallocation of labor. To the authors' best knowledge, there are no such studies that focus on the reallocation of capital along the lines of Foster, Grim, and Haltiwanger's study on labor.

Against this background, this study focuses on the reallocation of tangible assets, which has been less frequently scrutinized than that of labor, and examines the relationship with productivity. Further, it takes account of the heterogeneity of tangible assets and focuses on the reallocation of land and other tangible assets rather than on the overall capital stock, as Eisfeldt and Rampini (2006) did. There are several reasons for distinguishing between land and non-land tangible assets in our analysis.

First, the relevance of reallocation varies across different types of tangible assets that have different rates of depreciation. Tangible assets with high depreciation rates such as equipment decay so quickly that it is difficult for their owners to sell them to others. For such assets, reallocation (i.e., purchases and sales of existing assets) plays a smaller role than new investment (i.e., installation of new equipment). In contrast, tangible assets with low depreciation rates decay slowly and firms have sufficient time to reallocate these capital goods to others. For these types of assets, reallocation plays a larger role than new investment. This is particularly so in the case of land, which rarely depreciates and new investment in which is very limited.[1] This makes land a unique class of tangible asset whose reallocation should be closely examined.

Second, volatility in the value of tangible assets, which is an important determinant of the acquisition and sale of assets, differs substantially between land and other tangibles such as structures and equipment. For instance, Davis and Heathcote (2007) show that fluctuations in the value of real estate are mostly due to fluctuations in the value of land rather than that of structures. For this reason, it is important to distinguish between and compare the extent of reallocation of land on the one hand and other tangible assets on the other. This distinction is especially pertinent during periods of real estate booms and busts, such as those in the latter half of the 2000s in the United States and in the late 1980s and early 1990s in Japan.

This study addresses three distinct research questions on the reallocation of land and other tangible assets. First, what is the pattern of reallocation of land and non-land tangible assets over the business cycle and over time? Second, is the reallocation productivity enhancing? And third, does the nature of the relationship between productivity and reallocation change over the business cycle or over time?

Our analysis to answer these three questions consists of two parts. In the first part, we construct aggregated variables for the reallocation of two types of tangible assets, namely, land and non-land tangible assets, employing a firm-level panel dataset spanning a period of more than three decades. Using these variables, we summarize the characteristics of capital reallocation over

[1] To be precise, there is a small amount of new investment in land due to land reclamation and grading. Also, there is a small amount of land depreciation due to quarrying. However, both of them are very small in size.

the business cycle and answer the first question. In the second part, we estimate a production function for each industry to calculate firm-level total factor productivity (TFP). After doing so, we examine the role of TFP in capital reallocation to address the second and third questions.

For these analyses, we employ the firm-level data from the Quarterly Financial Statement Statistics of Corporations by Industry (QFSSC) assembled by the Ministry of Finance. The statistics are from the first quarter of fiscal 1980 to the fourth quarter of fiscal 2014. The QFSSC cover all large corporations with paid-in capital of no less than 500 or 600 hundred million yen and randomly sample smaller corporations in Japan.[2] The advantages of the QFSSC are two-fold. First, they contain not only balance sheet information, which is necessary to construct firm-level statistics for TFP, but also information on sales and purchases of land and non-land tangible assets. We use this information to construct the reallocation variables. Second, they cover both manufacturing and non-manufacturing industries. This is a substantial advantage over the data used by Foster, Grim, and Haltiwanger (2016), which is the study closest to ours but employs data solely on manufacturing businesses.

The major findings of our analysis can be summarized as follows. First, the extent of tangible asset reallocation in the case of both land and non-land tangibles is not significantly correlated with the business cycle as measured by the change in the unemployment rate. This differs from the results obtained by Eisfeldt and Rampini (2006), who, using data for the United States, find that capital reallocation is pro-cyclical. Instead, what we find is that, in Japan, the extent of land transactions among firms substantially decreased after the burst of the bubble in the early 1990s and has remained largely unchanged since then. Second, firms with higher TFP tend to reduce the amount of land and non-land tangible assets they are holding rather than to

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[2] In 2009, there was a substantial change in the way sample firms are chosen and the minimum paid-in capital threshold for large firms was lowered from 600 to 500 million yen. See the Appendix for details.

increase it. This indicates that the reallocation of tangible assets, be they land or non-land tangibles, is efficiency-reducing rather than efficiency-enhancing. This contrasts with the results obtained by Foster, Grim, and Haltiwanger (2016) for the United States, which indicated that job reallocation was efficiency-enhancing. Third, we find that in Japan, the reallocation of land had a statistically significant efficiency-*reducing* effect in the early 2000s, while in the late 1980s – during the peak of Japan's real estate bubble – the reallocation of both land and non-land tangibles had an efficiency-*enhancing* effect. During other periods, reallocation did not have a significant effect on efficiency.

The remainder of the study is organized as follows. Section 2 describes the data and the empirical approach employed for the analysis. This is followed by the presentation of our results in Sections 3 and 4. Section 3 presents our results on the extent of reallocation, while Section 4 examines if the reallocation is efficiency-enhancing or efficiency-reducing by estimating the determinants of reallocation of tangible assets. Section 5 concludes.

2. Data and empirical approach

This section describes the dataset we construct and the empirical methodologies we employ for our analysis. After presenting details of our data sources, we explain how we measure reallocation, how we calculate firm-level TFP, and how we use the firm-level TFP to examine the efficiency of reallocation.

2.1 Data sources

The main data source for our analysis is the Quarterly Financial Statement Statistics of Corporations by Industry (QFSSC). In addition, we use the Japan Industrial Productivity (JIP) database for industry-level deflators and average working hours. The QFSSC are a survey of business corporations whose headquarters are located in Japan. It contains information on firms' balance sheets, employment, industry, geographic location, and transactions in fixed assets. They cover both manufacturing and non-manufacturing industries, although we exclude the financial and insurance industries from the analysis.[3] The QFSSC comprise two parts: a part that covers all large corporations, and a part that consists of a sample of smaller firms. For the latter part, firms are randomly chosen and given questionnaires for four to eight quarters (one to two years). Details about what firms are chosen for the first part and how smaller firms are sampled are provided in the Appendix.

2.2 Measuring reallocation

We measure the extent of land and non-land tangible asset reallocation using transaction information from the QFSSC. The information available for a particular quarter, denoted by t, is shown in Table 1(a). Notably, not only information on the net change in asset holdings but also information on the purchase and sale of these assets are available. Note that new investment in land, N_Land_t, and depreciation of the value of land, D_Land_t, are very small, since investment in land is limited to reclamation and grading, and land depreciation is observed only if it is used for quarrying. This can also be seen in Table 1(b), which, for illustration, provides actual values for the variables for a specific quarter, the fourth quarter of fiscal 2014. The values for N_Land_t and D_Land_t are only 6 billion and 0.08 billion yen, respectively, while the values for land purchases, P_Land_t and land sales, S_Land_t, are 1,441 billion and 2,246 billion yen, respectively. This indicates that in the case of land assets, reallocation (purchases and sales) is far more important than new investment. On the other hand, in the case of non-land tangibles, new

[3] We do so because the QFSSC has covered these industries only for a limited period (since the first quarter of fiscal 2008).

investment is quite sizeable and of a similar scale as sales and purchases.

Based on the information above, we define variables for the reallocation of these two types of assets as well as a variable for new investment in non-land tangibles. Specifically, we start by defining the aggregate sales and purchases for each type of assets and aggregate new investment for non-land tangible assets in quarter *t*:[4] Specifically, we start by defining the aggregate purchases (POS) and sales (NEG) for each type of assets and aggregate new investment (NEW) for non-land tangible assets in quarter *t*:

$$POS\_Land_t = \sum_i \frac{P\_Land_{it}}{0.5(Land_{it-1} + Land_{it})} \frac{Land_{it}}{\sum_i Land_{it}}$$

$$NEG\_Land_t = \sum_i \frac{S\_Land_{it}}{0.5(Land_{it-1} + Land_{it})} \frac{Land_{it}}{\sum_i Land_{it}}$$

$$POS\_Tangibles_t = \sum_i \frac{P\_Tangibles_{it}}{0.5(Tangibles_{it-1} + Tangibles_{it})} \frac{Tangibles_{it}}{\sum_i Tangibles_{it}}$$

$$NEG\_Tangibles_t = \sum_i \frac{S\_Tangibles_{it}}{0.5(Tangibles_{it-1} + Tangible_{it})} \frac{Tangibles_{it}}{\sum_i Tangible_{it}}$$

$$NEW\_Tangibles_t = \sum_i \frac{N\_Tangibles_{it}}{0.5(Tangibles_{it-1} + Tangibles_{it})} \frac{Tangibles_{it}}{\sum_i Tangibles_{it}}$$

Note that P_Land_{it} and S_Land_{it} are both deflated by the land value deflator, while $P\_Tangibles_{it}$, $S\_Tangibles_{it}$, and $N\_Tangibles_{it}$ are deflated by the investment deflator, which will be detailed in Section 2.3.2. Next, we define the total sum of assets that are reallocated (sales plus purchases) as well as the net amount of assets that are reallocated (sales minus purchases):

[4] In the QFSSC, some of the new investment in non-land tangibles is counted as acquisitions of existing non-land tangible assets after it has appeared as new investment in construction in progress. This may result in the overestimation of existing non-land tangible asset acquisitions. We take necessary measures to correct for this possible overestimation.

$$SUM\_Land_t = POS\_Land_t + NEG\_Land_t$$

$$NET\_Land_t = POS\_Land_t - NEG\_Land_t$$

$$SUM\_Tangibles_t = POS\_Tangibles_t + NEG\_Tangibles_t$$

$$NET\_Tangibles_t = POS\_Tangibles_t - NEG\_Tangibles_t$$

The definitions of these reallocation variables are in line with those in previous studies and we employ these variables in the following analysis of capital reallocation.

2.3 Calculating total factor productivity

2.3.1 Procedure for estimating the production function

Firm-level TFP can be calculated using one of two different methods: subtracting the cost share of each input from output, or estimating a production function to calculate TFP based on the estimated parameters. While Foster, Grim, and Haltiwanger (2016) employ the former approach, we adopt the latter, since the assumption of perfect competition in input markets, which is necessary for the former approach, may not hold in practice. Note, however, that production function estimation itself faces a fundamental challenge. If unobserved productivity shocks are correlated with firms' input choices, simple ordinary least squares estimation will yield biased estimates of the production function coefficients. Among the various methods proposed in the literature to solve this issue, we adopt the control function approach. The control function approach, which was originally proposed by Olley and Pakes (1996), considers a firm's observed input demand as a proxy for unobserved productivity shocks and substitutes the inverted demand function for these unobserved shocks in the estimation.

More specifically, we follow the methodology of Ackerberg, Caves, and Frazer (2015, hereafter ACF), who, like Levinsohn and Petrin (2003, hereafter LP), focus on the demand for intermediate inputs but employ a more flexible functional form. The only difference in our study from ACF is the number of inputs. We add land stock in addition to labor, capital, and intermediate goods as inputs in the production function and estimate the following equation:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_n n_{it} + \beta_l l_{it} + \omega_{it} + \varepsilon_{it},$$

where y_{it} is the log of value added of firm i in period t, k_{it}, n_{it}, and l_{it} are respectively the logs of non-land capital, land, and the amount of labor of the firm in the period, ω_{it} represents unobservable productivity shocks, and ε_{it} represents transitory shocks. We assume here that land is used as an input for production like labor and other tangible assets. It is possible to argue that firms hold land for other purposes than production such as assets to be pledged as collateral for loans or as assets to be sold for capital gain in the future. However, we treat land as input for production, since firms in Japan leave only a very limited portion of their land assets idle.[5] We further assume that firms' intermediate input demand is given by

$$m_{it} = \widetilde{f_t}(k_{it}, n_{it}, l_{it}, \omega_{it})$$

and that $\widetilde{f_t}(k_{it}, n_{it}, l_{it}, \omega_{it})$ is strictly increasing in ω_{it}. Given these assumptions, we invert intermediate input demand and substitute it into the production function to obtain

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_n n_{it} + \beta_l l_{it} + \widetilde{f_t^{-1}}(k_{it}, n_{it}, l_{it}, m_{it}) + \varepsilon_{it} = \widetilde{\Phi_t}(k_{it}, n_{it}, l_{it}, m_{it}) + \varepsilon_{it},$$

[5] According to the Survey on Firms' Land Transactions implemented by the Ministry of Land, Infrastructure, Transport and Tourism in 2012, 94.3% of land owned by firms that responded was used for their activities.

resulting in the following first-stage moment condition:

$$\mathrm{E}[\varepsilon_{it}|I_{it}] = \mathrm{E}\big[y_{it} - \widetilde{\Phi_t}(k_{it}, n_{it}, l_{it}, m_{it})|I_{it}\big] = 0.$$

In the first stage of the estimation, we produce an estimate $\widehat{\widetilde{\Phi_t}}(k_{it}, n_{it}, l_{it}, m_{it})$ of $\widetilde{\Phi_t}(k_{it}, n_{it}, l_{it}, m_{it})$ but not an estimate $\hat{\beta}_l$ of β_l. The difference between ACF's methodology and LP's is that the former does not estimate β_l at this stage but does so along with other production function parameters in the second stage. Following ACF, we obtain the following second-stage conditional moment:

$$\begin{aligned}
&\mathrm{E}[\xi_{it} + \varepsilon_{it}|I_{it-1}] \\
&= \mathrm{E}\big[y_{it} - \beta_0 - \beta_k k_{it} - \beta_n n_{it} - \beta_l l_{it} - g\big(\widetilde{\Phi_{t-1}}(k_{it-1}, n_{it-1}, l_{it-1}, m_{it-1}) - \beta_0 - \beta_k k_{it-1} - \\
&\quad \beta_n n_{it-1} - \beta_l l_{it-1}\big)|I_{it-1}\big] = 0,
\end{aligned}$$

where $\widetilde{\Phi_{t-1}}$ is replaced by the estimate from the first stage. We then estimate the parameters in the production function for each industry and calculate TFP for each firm within the industry.

2.3.2 Variables

To estimate the above production function and calculate firm-level TFP, we need to construct the variables. These are variables for output, labor, non-land capital, land, and intermediate inputs.

Output

We calculate real firm-level value-added, Y_{it}, based on the following formula:

$$Y_{it} = \frac{Current\ Profits_{it} + Personnel\ Costs_{it} + Interest\ Payments_{it} + Depreciation_{it}}{PVA_{sy}},$$

where $Personnel\ Costs_{it}$ consists of salaries for executives and employees, bonuses for executives and employees, and welfare expenses, all of which are obtained from the QFSSC. We construct the value added deflator PVA_{sy} for a particular year y by dividing the industry-level nominal value-added by the real value-added obtained from the JIP database. We calculate the deflator annually rather than quarterly because the JIP database provides value-added statistics only at an annual frequency.

Labor

For L_{it}, we calculate the total hours based on the following formula:

$L_{it} = Number\ \ of\ \ Employees_{it} * Yearly\ \ working\ \ hours_{st}.$

We obtain the firm-level number of employees from the QFSSC. We also calculate industry-level yearly working hours per person from the man-hours and the number of employees in the JIP database.

Non-land capital

We calculate real non-land capital (tangible assets) K_{it} in terms of market values from the nominal book value information stored in the QFSSC, KN_{it}. We first calculate industry-level series of non-land tangible assets in terms of market values, K_{sy}, for a particular year y, using the following formula:

$K_{s0} = \frac{KN_{s0}}{PINVEST_{s0}}$

$K_{sy} = K_{sy-1} + \left(1 - \delta_{sy}\right)\frac{INVEST_{sy}}{PINVEST_{sy}}$, t=1,…, Y,

where KN_{sy} is the industry-level nominal amount of non-land tangible assets outstanding measured at the end of y, $PINVEST_{sy}$ is the industry-level investment deflator, $INVEST_{sy}$ is the nominal investment amount in non-land tangible assets, and δ_{sy} is the industry-level depreciation rate. We set the year 1975 as the starting year, i.e., y=0. All information for the above calculations is obtained from the JIP database and the Annual Financial Statement Statistics of Corporations by Industry.[6] We obtain the industry level market-to-book value ratio and the firm-level amount of real non-land tangible assets at market prices using the following formula:

$$Ratio_{sy} = \frac{K_{sy}}{KN_{sy}}$$

$$K_{it} = Ratio_{sy} * KN_{it}.$$

Land

We calculate firm-level real land asset holdings, N_{it}, using the following formula:

$$N_{it} = \frac{NN_{it}}{PLand_y}$$

$$PLand_y = \frac{Unit\ \ Land\ \ Value_y}{Unit\ \ Land\ \ Value_{2000}} \ ,$$

where NN_{it} is the firm-level nominal land asset holdings from the QFSSC and $Unit\ \ Land\ \ Value_y$ is the nominal sum of the value of all land in Japan in year y from the SNA statistics divided by the total land area of Japan in the year.[7]

Intermediate inputs

We calculate the real firm-level input of intermediate goods, M_{it}, using the following formula:

$$M_{it} = \frac{Sales\ \ Cost_{it}+Sales\ \ Administrative\ \ Expense_{it}-(Personnel\ \ Cost_{it}+Depreciation_{it})}{PM_{sy}},$$

[6] The Annual Financial Statement Statistics of Corporations by Industry (AFSSC) are annual statistics on firms' financial statements reported by the same ministry (Ministry of Finance) as the QFSSC. We employ the AFSSC instead of the QFSSC since we construct the variable $Ratio$ at an annual frequency.

[7] Note that the total land area of Japan has increased slightly year by year mainly due to land reclamation.

where PM_{sy} is the industry-level intermediate input deflator in year y calculated from the industry-level nominal intermediate inputs and real intermediate inputs obtained from the JIP database.

2.3.3 Industries

We also need to specify the industries for which we estimate the production function. In principle, we employ the industry classifications used in the QFSSC. However, we combine some of them to have consistent industry classifications before and after the revision of classifications in the QFSSC in 2009. We also do this in order to be able to match them with the classifications used in the JIP database. The set of industry classifications used for the analysis is shown in Appendix Table A1.

2.4 The relationship between reallocation and TFP

Employing the TFP calculated using the procedure detailed in the previous subsections, we examine the relationship between the reallocation of land and non-land tangible assets and productivity at the firm level. We employ a simple regression model connecting the growth of each type of capital and productivity. The baseline specification is given by the following equation:

$$Y_{it+1} = \alpha_r + \varphi_t + \beta TFP\_dev_{it} + \gamma Cycle_{rt+1} + \delta TFP\_dev_{it} * Cycle_{rt+1} + X_{it}\theta + \varepsilon_{it+1}. \tag{1}$$

Y_{it+1} is the rate of growth of land and other tangible assets of firm *i* from quarter *t* to *t*+1, which we use to gauge the reallocation of these assets. For Y_{it+1}, we use the following seven variables introduced earlier: sales and purchases of land and non-land tangible assets (S_Land_{it}, P_Land_{it},

$S\_Tangibles_{it}$, and $P\_Tangibles_{it}$), the net changes in land and non-land tangible asset holdings as a result of these sales and purchases ($P\_Land_{it} - S\_Land_{it}$, $P\_Tangibles_{it} - S\_Tangibles_{it}$), and new investment in non-land tangibles ($N\_Tangibles_{it}$). Note that these are denominated in terms of the amount of land or non-land tangible assets outstanding. TFP_dev_{it} is the deviation of firm i's TFP from the industry average in that quarter, and $Cycle_{rt+1}$ is the change in the unemployment rate from t to t+1 in the region where firm i's headquarters are located. X_{it} is a control variable for firm size, for which we use the number of a firm's employees.

We estimate this equation for the period from the first quarter of fiscal 1980 to the fourth quarter of fiscal 2014. We pool all observations and include quarter dummies as well as prefecture dummies to take potential regional differences into account. There are 47 prefectures in Japan, so we use 46 prefecture dummies, with Hokkaido serving as the reference prefecture. If there is a cleansing effect in which resources are reallocated from low-productivity to high-productivity firms, we expect the coefficient β to be positive in equations with the net change in assets or the purchase of assets as the dependent variable and negative in equations with the sale of assets as the dependent variable. If the cleansing effect is larger during times of recessions, the coefficient δ should again be positive in equations with the net change in assets or the purchase of assets as the dependent variable and negative in equations with the sale of assets as the dependent variable. Examining these coefficients allows us to answer the second and the third research questions we posited in the introduction.

Note, however, that there may be other time-varying factors that affect the link between TFP and capital reallocation than the change in the unemployment rate. For example, higher volatility in asset prices may discourage firms from acquiring additional assets. Or an institutional change in the way firms disclose the value of their tangible assets in their balance sheets may promote or discourage the sale of assets. In order to capture such time-varying factors other than the change in the unemployment rate, we employ the following alternative specification:

$$Y_{it+1} = \alpha_r + \varphi_t + \sum_{y=t_0}^{T} \beta_y \, TFP\_dev_{it} + \gamma Cycle_{rt+1} + X_{it}\theta + \varepsilon_{it+1} \tag{2}$$

The difference of this specification from the baseline is that we allow the coefficient on TFP_dev_{it} to be time-varying, while we omit the interaction term between TFP_dev_{it} and $Cycle_{rt+1}$. Using these two specifications, we examine the relationship between reallocation and productivity and test our second and third research questions in the following sections.

3. Reallocation of land and non-land tangibles

3.1 Reallocation in all industries

In this section, we show the extent of reallocation of land and non-land tangible assets over the observation period. Figure 1 shows the pattern of reallocation of these assets. Panels (a) and (b) present the reallocation of land. The bold line in panel (a) represents the amount of land acquisitions (POS_Land_t), while the dotted line represents the amount of land sales (NEG_Land_t). In panel (b), the bold line shows the sum of these two (SUM_Land_t) and the dotted line the difference between the two (NET_Land_t). Panels (c) and (d) present the reallocation of non-land tangibles in a similar manner. Panel (e) presents new investment in non-land tangibles ($NEW\_Tangibles_t$). As can be seen in the definitions of these variables in Section 2.2, each of the variables presents the extent of reallocation relative to the amount of land/non-land tangibles outstanding. For example, in panel (a) in the fourth quarter of fiscal 1980, POS_Land is 0.025 and NEG_Land is 0.007, which indicates that the land firms purchased in the quarter amounted to 2.5 percent of their total land holdings in the previous quarter and that the land they sold in the same quarter was 0.7 percent of their total land holdings. Further, panel (f) presents the change in the unemployment rate, which we refer to as $Cycle_t$. We use this to examine the cyclical nature of asset reallocation by comparing developments in $Cycle_t$ with developments in the capital reallocation measures.

There are several notable features in these figures. Until the early 1990s, the amount of land reallocation, POS_Land_t, was in a region between around 0.025 and 0.040 per quarter. There was a clear spike around the time of the burst of the bubble in the Japanese real estate market, but since then POS_Land_t has been much lower, with the exception of a temporary increase in the late 1990. In fact, at around 0.01 since the early 2000s, POS_Land_t has been less than half of the value before the early 1990s. This indicates that the burst of the bubble economy has dampened the amount of land transactions for more than two decades. Further, the global financial crisis of 2008 does not appear to have had a conspicuous impact. NEG_Land_t was stable and lower than POS_Land_t until the late 1990s but increased in size around the mid-2000s and became larger than POS_Land_t. It peaked at the beginning of fiscal 2005, which coincides with the introduction of impairment loss accounting for fixed assets for listed companies in Japan.[8] The overall amount of reallocation, SUM_Land_t, and the net change in allocation, NET_Land_t, were mostly driven by POS_Land_t, except for a brief period in the mid-2000s.

Regarding the cyclical nature of land reallocation, the panels appear to suggest negative correlations between $Cycle_t$ on the one hand and POS_Land_t and SUM_Land_t on the other. However, as shown in Table 2, which presents the correlation coefficients between the reallocation variables and $Cycle_t$, it turns out that the only reallocation variable that shows any statistical significant cyclicality is NEG_Land_t, which is marginally negatively correlated with

[8] For the possible impact of impairment loss accounting on firms' sales of fixed assets, see Uesugi, Nakajima, and Hosono (2017, in Japanese).

$Cycle_t$.

Turning to the magnitude of non-land tangible asset reallocation, which is measured by $POS\_Tangibles_t$, $NEG\_Tangibles_t$, and $SUM\_Tangibles_t$, we find that this has gradually increased over the years. This contrasts with the reallocation of land, the magnitude of which has become smaller since the burst of the asset price bubble. $POS\_Tangibles_t$ was relatively low in the 1980s and 1990s except for fiscal 1991 and 1992. However, it gradually increased in the 2000s to peak in fiscal 2008–2009. $NEG\_Tangible_t$ shows a similar pattern to that of $POS\_Tangible_t$, but it is generally larger than $POS\_Tangible_t$. The difference between these two represents the substantial depreciation of these tangible assets, which corresponds to the difference between original acquisition prices measured by the book value of sold tangibles ($NEG\_Tangibles_t$) and the new acquisition prices measured by the book value of purchased tangibles ($POS\_Tangibles_t$). In order to evaluate the economic significance of reallocation and of new investment, we compare the size of $SUM\_Tangibles_t$ in panel (d) and that of $NEW\_Tangibles_t$ in panel (e). Doing so indicates that $SUM\_Tangibles_t$ used to be smaller than $NEW\_Tangibles_t$; however, it has steadily increased, while $NEW\_Tangibles_t$ has declined substantially, so that since the latter half of the 2000s the former is larger than the latter.

3.2 Reallocation in different industries

Next, we show the extent of the reallocation in different industries in order to examine if there is any heterogeneity across industries. For brevity, we only show POS_Land_t, NEG_Land_t, $POS\_Tangibles_t$, $NEG\_Tangibles_t$, and $NEW\_Tangibles_t$ for nine out of the 26 industries. The results are shown in Figure 2(a) for land reallocation, 2(b) for non-land tangibles reallocation, and 2(c) for new non-land tangible investment.

In Figure 2(a), which is for land reallocation, several common features across industries can be observed. First, except in the mid-2000s, the amount of acquisitions (POS_Land_t) in all industries is generally larger than that of sales (NEG_Land_t) . Second, POS_Land_t was quite high until the early 1990s but then dropped sharply. Third, sales (NEG_Land_t) increased substantially in the mid-2000, which coincides with the introduction of impaired loss accounting for listed companies in 2005. On the other hand, there is also considerable heterogeneity across industries. For instance, the magnitude of land reallocation differs across industries. Real estate and construction are the industries with the largest average amount of land acquisitions over the period, while the chemical and the electrical and IT machinery industries are the industries with the smallest amount of land acquisitions. Moreover, firms in some industries continued to purchase large amounts of land even after the burst of the bubble at the start of the 1990s. Most of them belong to the manufacturing sector, such as the chemical, automobile and parts, and iron and steel industries, with the wholesale industry being the exception.

Next, Figure 2(b) shows the reallocation of non-land tangibles by industry. A common pattern across industries is that both acquisitions and sales of non-land tangibles tend to gradually increase over time, with $NEG\_Tangibles_t$ for the construction industry being an exception. This upward trend contrasts with the downward trend in $NEW\_Tangibles_t$ observed in most industries, which is shown in Figure 2(c). Comparing Figures 2(b) and 2(c) shows that in most industries the reallocation of non-land tangibles was larger than new investment.

4. The relationship between reallocation and productivity

In this section, we aim to answer our second and third research questions, namely, whether the reallocation of assets is productivity-enhancing, and whether the nature of the reallocation-TFP relationships changes over the business cycle or has changed over time.

4.1 Baseline estimation results

We start by presenting the results of the estimation using the baseline specification (1) in Table 3. The most striking results are the coefficients on TFP_dev_{it} in columns (1) and (4), which are both negative. Another notable result is that the coefficient on the interaction term $TFP\_dev_{it} * Cycle_{rt+1}$ in column (1) is positive and significant. The first result indicates that firms with higher productivity than the industry average tended to reduce the amount of land and non-land tangibles they hold. The second result suggests that the negative link between TFP and land reallocation becomes weaker during economic downturns.

These results suggest that the reallocation of capital assets in Japan is efficiency-reducing, which contrasts with the findings by Foster, Grim, and Haltiwanger (2016) regarding the reallocation of labor in the United States, which they found to be efficiency-enhancing. In order to see why our results show that firms with higher productivity tended to reduce land and non-land tangibles, we decompose the net change in asset holdings into sales and purchases and examine how they are related to firms' productivity.

Columns (2) and (3) present the estimation results when land purchases (P_Land_{it}) and sales (S_Land_{it}) are used as the dependent variable, respectively. Each column shows the coefficients on TFP_dev_{it} and on the interaction term $TFP\_dev_{it} * Cycle_{rt+1}$. In both columns, the coefficient on TFP_dev_{it} is positive, indicating that more productive firms not only purchase but also sell larger amounts of land than less productive firms. Note that the size of the coefficient is larger in the land sales estimation than in the land purchases estimation. This indicates that a one unit increase in TFP_dev for a firm results in a higher increase in its land sales than its land purchases, thus decreasing the firm's total land holdings. In column (3), the coefficient on the interaction term is negative and marginally significant, indicating that the above tendency of more productive firms to sell larger amounts of land becomes weaker during economic downturns.

In order to evaluate the economic significance of the impact of productivity on capital reallocation, we use the estimation results in column (1) and (4). We multiply each of the coefficients on TFP_dev_{it} in these columns with the value of one standard deviation of TFP_dev_{it} (0.2915) to obtain 0.0007 and 0.0005. These mean that with a shock in the productivity of one standard deviation, a firm increases the net land holdings by 0.07 percent and the non-land tangible holdings by 0.05 percent on the quarterly basis. Considering the fact that the growth of land and non-land tangibles is rather small on the quarterly basis, which is 0.8 percent and -0.6 percent, respectively, the impact of a productivity shock on reallocation is economically significant.

We obtain similar findings for the reallocation of non-land tangibles in columns (5) and (6), which show the estimation results when non-land tangibles purchases ($P\_Tangibles_{it}$) and sales ($S\_Tangibles_{it}$) are employed as the dependent variable, respectively. In both columns, the coefficient on TFP_dev_{it} is positive and significant, indicating that more productive firms not only purchase larger amounts of tangible assets but also sell larger amounts than firms with lower productivity. Further, the size of the coefficient is larger in the $S\_Tangible_{it}$ estimation than in the $P\_Tangible_{it}$ estimation. This again indicates that a one unit increase in TFP_dev for a firm results in a higher increase in its non-land tangibles sales than its purchases, thus decreasing the firm's total holdings of non-land tangibles. Turning to the interaction term, we find that in the estimation in column (6) the coefficient is negative and marginally significant, indicating that the tendency of more productive firms to sell larger amounts of land becomes weaker during economic downturns.

Note, however, that land and non-land tangibles differ in terms of depreciation and new investment, as pointed out earlier. Therefore, in order to evaluate if non-land tangibles reallocation really is efficiency-reducing, we also need to additionally examine whether new investment is efficiency-reducing or not. If firms with high productivity implement new investment less frequently than low productivity firms, we can say that the non-land tangibles holdings of these high productivity firms fall relative to firms with low productivity. Since non-tangible assets are reallocated from high productivity firms to low productivity firms, the average productivity weighted by the amount of non-land tangibles declines, indicating that the reallocation is efficiency-reducing. Column (7) shows the results on the link between productivity and the amount of new investment in tangibles. The coefficient on TFP_dev_{it} is positive and significant, while that on the interaction term is insignificant. These results indicate that new investment works in the direction of enhancing efficiency; that is, more productive firms tend to conduct more new investment.

4.2 Time-varying relationship between reallocation and productivity

In order to detect the sources of the efficiency-reducing reallocation of capital, we implement estimations using specification (2). Since the coefficient on TFP_dev_{it} is time-varying, so that we obtain a coefficient estimate for each year, we show the results graphically in Figure 3. The different panels show the time-varying coefficient estimates for TFP_dev_{it} over the years when using the different dependent variables, with the bold line representing the coefficient estimate and the weaker lines showing the 95% confidence band.

The different panels show how the link between firms' productivity and capital reallocation varied over the years. Panels (a) through (c) show the estimation results for land reallocation. Panel (a) shows the time-varying coefficient estimates for TFP_dev_{it} in the estimation with the net change of land reallocation as the dependent variable. We find that the size and the statistical significance of the coefficient on TFP_dev_{it} vary over the years. For the years from 1988 through 1992, the coefficient estimates are positive and some of them are also statistically significant. However, the size of the coefficient decreases over time and the coefficient is negative in the latter half of the 1990s and the first half of the 2000s. In the period from 2003 to 2005, the negative coefficient estimates are also statistically significant. These results indicate that there has been a gradual but persistent change in the way productivity affects land reallocation. From the late 1980s to the early 1990s, more productive firms increased their amount of land holdings while less productive ones reduced it. This tendency reversed in the early 2000s, when more productive firms decreased rather than increased their land holdings.

Next, panels (b) and (c) examine whether purchases or sales of land, or both, contribute to the results shown in panel (a). Starting with the results for land purchases in panel (b), we find that although the coefficient estimates fluctuate over time, the size and statistical significance do not differ substantially over the years. On the other hand, the coefficient estimates in the estimation for land sales show a considerable increase during the first half of the 2000s. These results indicate that the changes in the coefficient in the estimation for the net change in land asset holdings in panel (a) are mainly driven by the changes in the coefficient in the estimation for land sales rather than those in estimation for land purchases.

Turning to the reallocation of non-land tangibles, the results are shown in panels (d) through (g). In panel (d), the coefficient is positive and significant in 1989 but is negative and insignificant in most other years. Panels (e) and (f) show the coefficient estimates in the estimation for purchases and sales of tangibles, respectively. As can be seen, while the patterns over time differ somewhat, in both cases the coefficient estimates are mostly positive. In panel (e), the coefficient estimate for 1989 is much larger than those for other years, while in panel (f) the coefficient estimates do not vary that much but gradually increase in size over the years. These results indicate that the changes in the coefficient in the estimation for the net change in tangible assets in panel (d) are mainly driven by the large positive coefficient in 1989 in the purchase estimation.

Finally, panel (g) show the results for new investment. The coefficient estimates for TFP_dev are positive and significant in most years but gradually decrease in size and statistical significance.

5. Conclusion

In this study, we examined on the inter-firm reallocation of tangible assets, distinguishing between land and non-land tangible assets, and considered its relationship with productivity. Focusing on Japanese firms during the period from 1980 to 2014, which includes the period of massive asset price fluctuations during the bubble economy and its subsequent collapse, we found the following empirical regularities. First, there exists no obvious cyclicality in the extent of reallocation, but the burst of the bubble economy dampened the amount of land transactions for more than 20 years. Second, our results suggest that, during the period examined, the reallocation of land and non-land tangibles in Japan has been efficiency-reducing rather than efficiency-enhancing in that firms with high TFP have tended to reduce their holdings of these assets more than firms with low TFP.[9] Third, the relationship between reallocation and productivity has changed over time. The reallocation of land was efficiency-reducing in the first half of the 2000s, while it was efficiency-enhancing around the end of the bubble period in the late 1980s.

[9] We need to examine factors for such efficiency-reducing reallocation in the future study. Although we need a detailed statistical investigation on this, a simple comparison of summary statistics (not shown in the paper) indicates that firms that decreased tangible assets are more likely to be located in metropolitan areas than in country areas.

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Appendix

A. Firm-level data of the Quarterly Financial Statement Statistics of Corporations by Industry

The Quarterly Financial Statement Statistics of Corporations by Industry (hereafter QFSSC) are a survey of business corporations whose headquarters are located in Japan. The QFSSC started in the fourth quarter of fiscal 1949 and firm-level data in electronic form are available to researchers (after a careful but time-consuming application process!) for the period from the first quarter of fiscal 1980.

The QFSSC contain information on individual corporations' balance sheets, employment, industry, geographic location, transactions in fixed assets, and etc. They cover all manufacturing and non-manufacturing industries, although we exclude finance and insurance from the analysis. The QFSSC consist of two parts: a part that covers all large corporations, and a part that consists of a sample of smaller firms.

There was a substantial change in fiscal 2009 in the way firms were chosen for the survey. Up to the fourth quarter of fiscal 2008, the first part covered all corporations with paid-in capital of 600 million yen or more, while the second part consisted of a sample of smaller firms, which were subdivided into those with paid-in capital ranging from 100 to 600 million yen and those with paid-in capital of less than 100 million yen. In the second part, sampling was conducted in a manner such that among firms in the 100 to 600 million yen bracket larger firms were more likely to be chosen, while among firms with paid-in capital of less than 100 millions firms were chosen randomly regardless of their capital size. All smaller firms with paid-in capital of less than 600 million yen that were surveyed received a questionnaire for four quarters from the first to the fourth quarter of the fiscal year, while all larger corporations always receive a survey questionnaire.

Since the first quarter of fiscal 2009, the first part covers all corporations with paid-in capital of 500 million yen (instead of 600 million yen) or more. On the other hand, the second part is no longer subdivided. Instead, firms are randomly chosen from the pool of firms with paid-in capital of less than 500 million yen. All firms with less than 500 million yen of paid-in capital that are surveyed receive a questionnaire for eight quarters (two years), with half of the firms replaced in the first quarter of each fiscal year. As before, all larger corporations continue to always receive the survey questionnaire.

Tables and figures

Table 1(a): Information on transactions in fixed tangible assets in quarter *t* in the QFSSC

	Outstanding amount at beginning of t	New investment	Purchases of existing assets	Depreciation	Sales of existing assets	Outstanding amount at end of t
Land	$Land_{t-1}$	N_Land_t	P_Land_t	D_Land_t	S_Land_t	$Land_t$
Non-land tangibles	$Tangible_{t-1}$	$N\_Tangible_t$	$P\_Tangible_t$	$D\_Tangible_t$	$S\_Tangible_t$	$Tangible_t$

Table 1(b): Actual amount of transactions in fixed tangible assets for Q4 of FY2014 (billion yen)

	Outstanding amount at beginning	New investment	Purchases of existing assets	Depreciation	Sales of existing assets	Outstanding amount at end
Land	165,724	6	1,441	0.08	2,246	164,925
Non-land tangibles	230,930	5,032	6,819	7776	3,396	231,610

Table 2: Correlation coefficients between reallocation variables and *Cycle*

	POS_ Land	NEG_ Land	SUM_ Land	NET_ Land	POS_ Tangibles	NEG_ Tangibles	SUM_ Tangibles	NET_ Tangibles	NEW_ Tangibles
Correlation coefficient with *Cycle*	0.0396	-0.1507	-0.0101	0.0853	0.0139	0.0648	0.0507	-0.0635	0.0247
P-value	0.646	0.0788	0.9063	0.3217	0.8722	0.4518	0.5566	0.461	0.7747

Table 3: Determinants of capital reallocation: Baseline specification

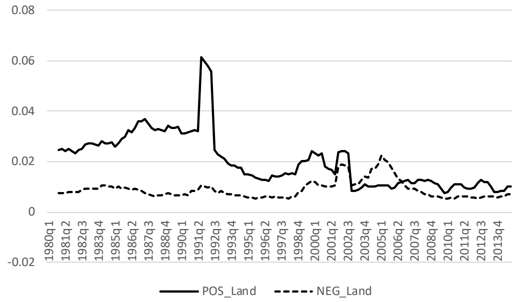
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	P_Land-S_Land	P_Land	S_Land	P_Tangibles-S_Tangibles	P_Tangibles	S_Tangibles	N_Tangibles
TFP_dev	-0.00251***	0.00528***	0.00779***	-0.00172***	0.00441***	0.00590***	0.00845***
	(0.000495)	(0.000477)	(0.000455)	(0.000648)	(0.000477)	(0.000445)	(0.000546)
Cycle	0.000703	0.00113	0.000424	-0.000380	-2.34e-05	0.000317	0.000530
	(0.000752)	(0.000725)	(0.000692)	(0.000990)	(0.000729)	(0.000676)	(0.000829)
TFP_dev*Cycle	0.00614***	0.00251	-0.00363*	0.00147	-0.00166	-0.00345*	-0.000915
	(0.00210)	(0.00202)	(0.00193)	(0.00275)	(0.00202)	(0.00189)	(0.00231)
EMP	2.81e-07***	2.39e-07***	-4.30e-08	5.57e-08	1.74e-07***	6.65e-08	-1.91e-07***
	(4.53e-08)	(4.37e-08)	(4.18e-08)	(7.99e-08)	(5.88e-08)	(4.08e-08)	(5.00e-08)
Constant	0.0128***	0.0184***	0.00554***	-0.00442	0.00279	0.00767***	0.0229***
	(0.00225)	(0.00217)	(0.00207)	(0.00295)	(0.00217)	(0.00202)	(0.00248)
Quarter dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	799,478	799,486	799,479	679,304	679,350	799,538	799,595
R-squared	0.006	0.005	0.003	0.001	0.001	0.002	0.003
F-stat	27.85	24.66	13.36	3.079	2.176	9.919	14.76

Standard errors in parentheses.

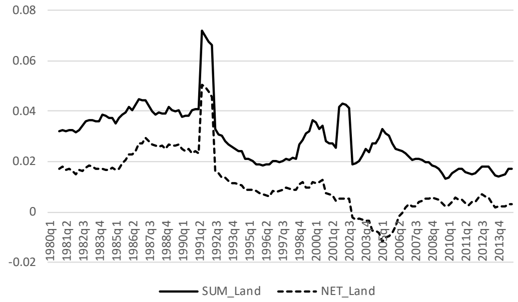
*** p<0.01, ** p<0.05, * p<0.1

Figure 1: Reallocation of land and non-land tangibles and new investment in non-land tangibles

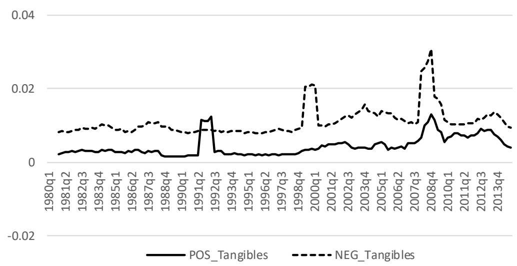
(a) Purchases (POS) and sales (NEG) of land



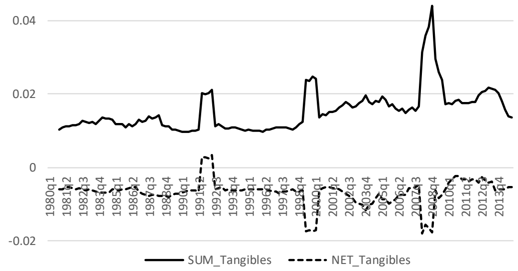
(b) Sum of purchases and sales (SUM) and difference between purchases and sales of land (NET)



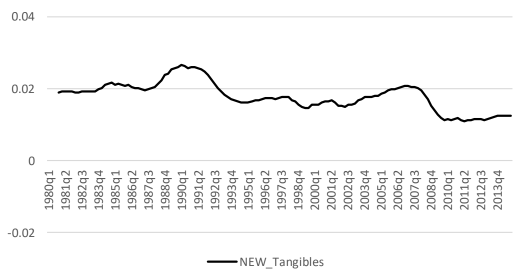
(c) Purchases (POS) and sales (NEG) of non-land tangibles



(d) Sum of purchases and sales (SUM) and difference between purchases and sales of non-land tangibles (NET)



(e) New investment in non-land tangibles



(f) Change in the unemployment rate

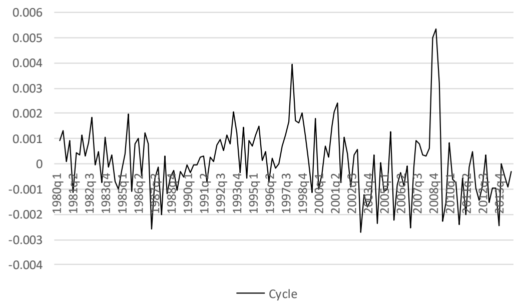


Figure 2(a): Purchases (POS) and sales (NEG) of land by industry

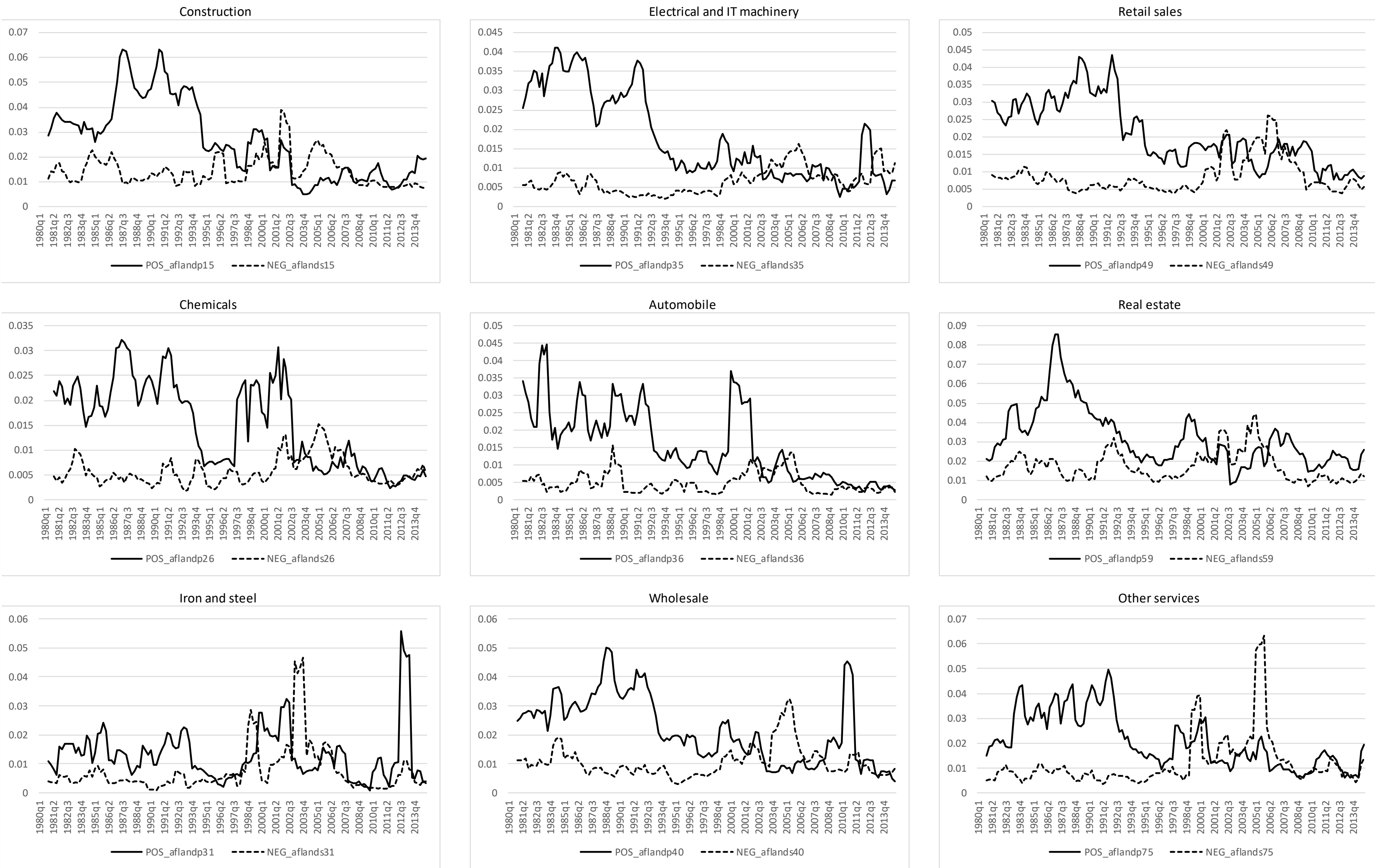


Figure 2(b): Purchases (POS) and sales (NEG) of non-land tangibles by industry

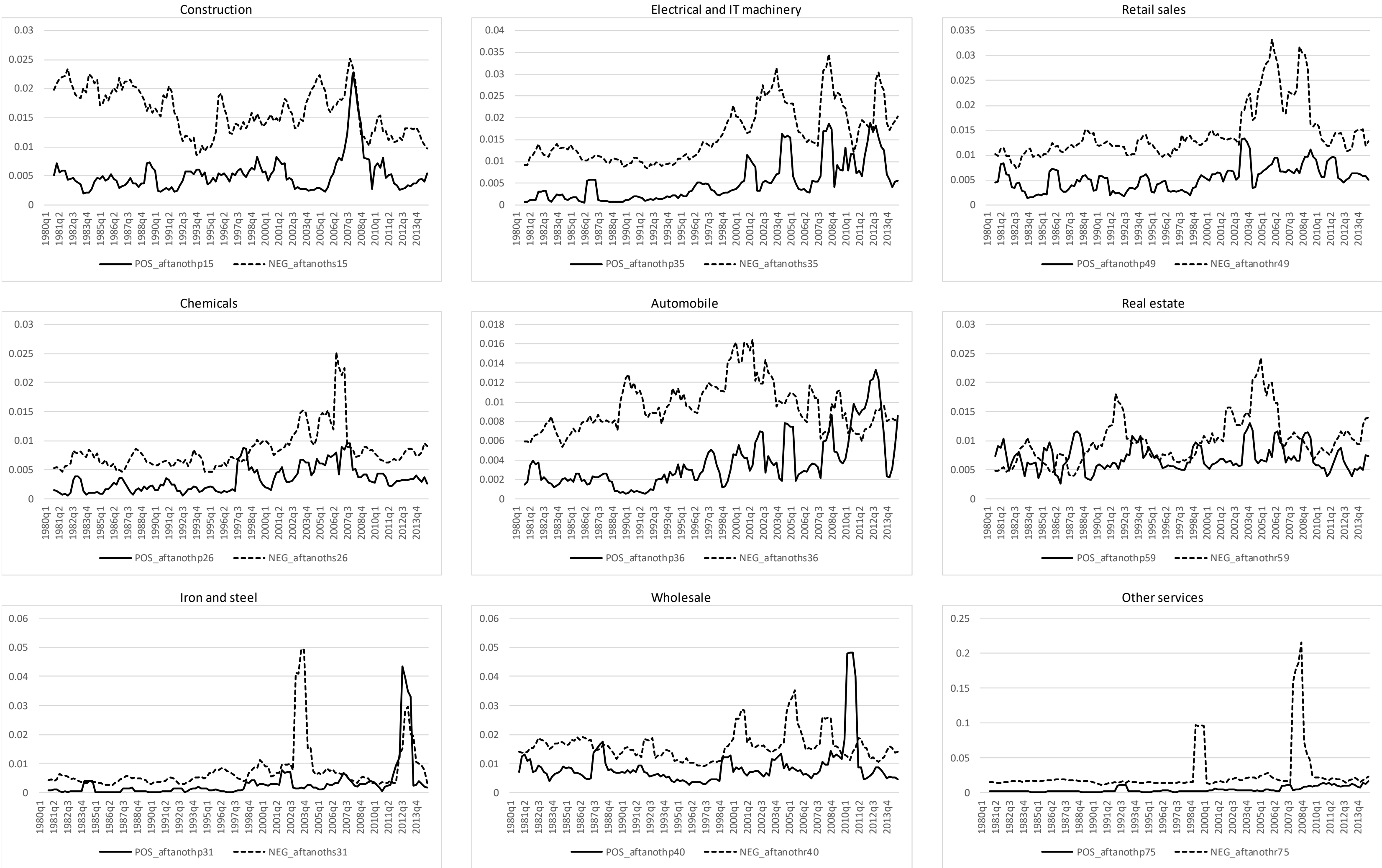


Figure 2(c): New investment in non-land tangibles (NEW) by industry

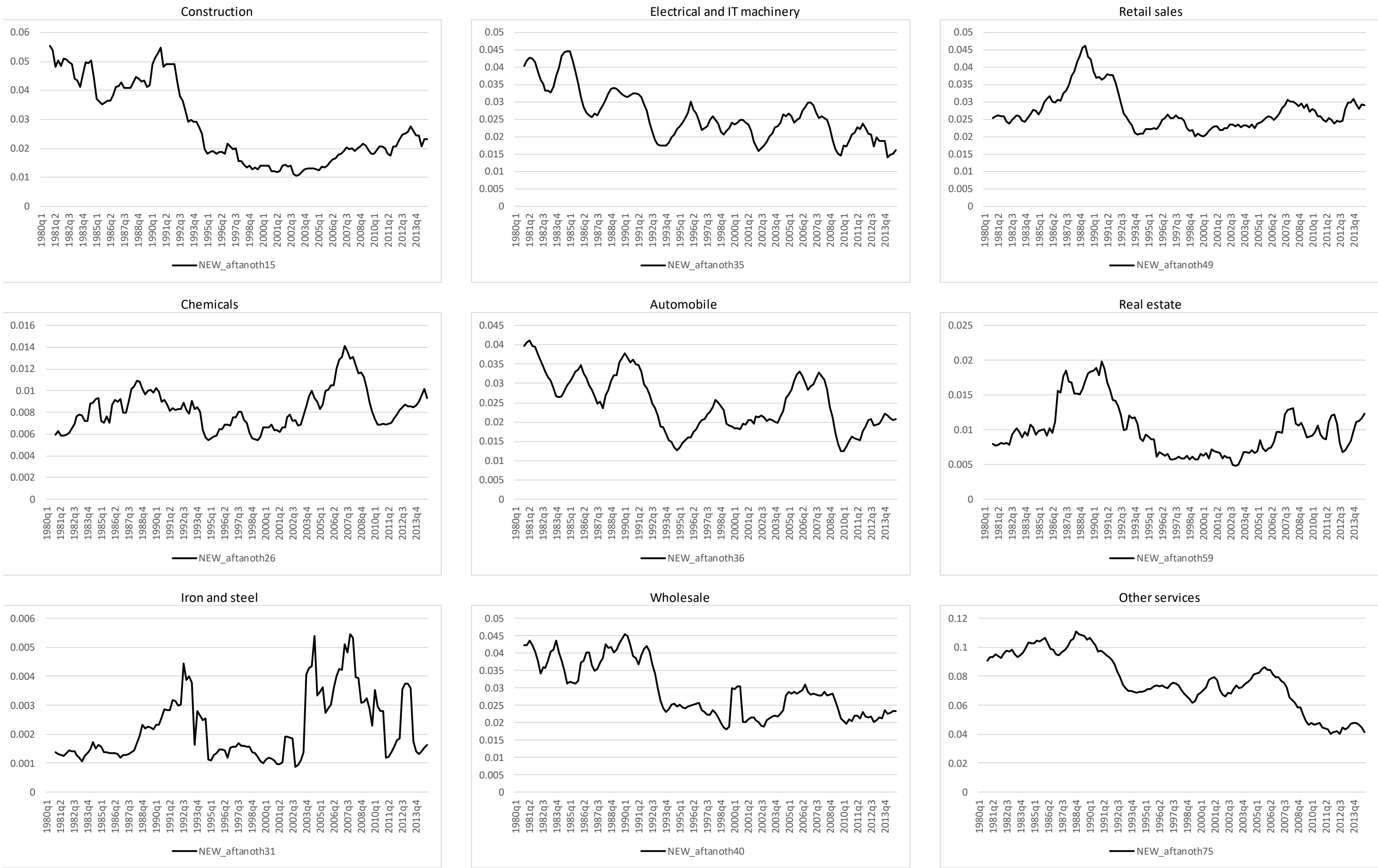
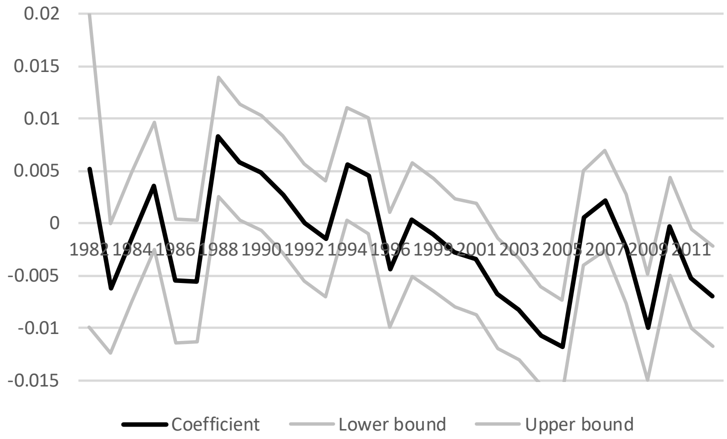
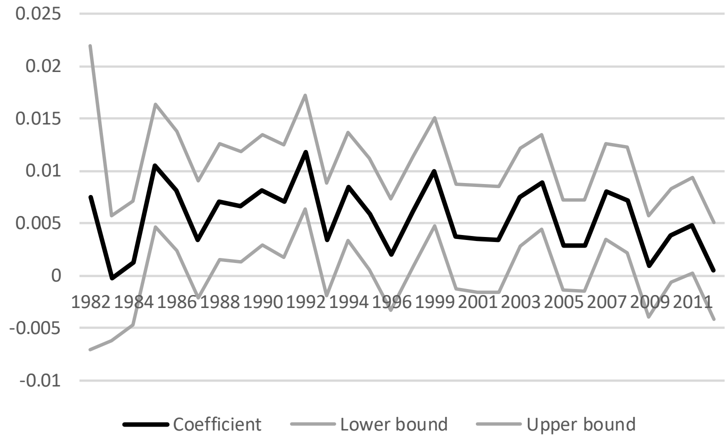


Figure 3: Time-varying coefficients on *TFP_dev*

(a) P_Land-S_Land



(b) P_Land



(c) S_Land

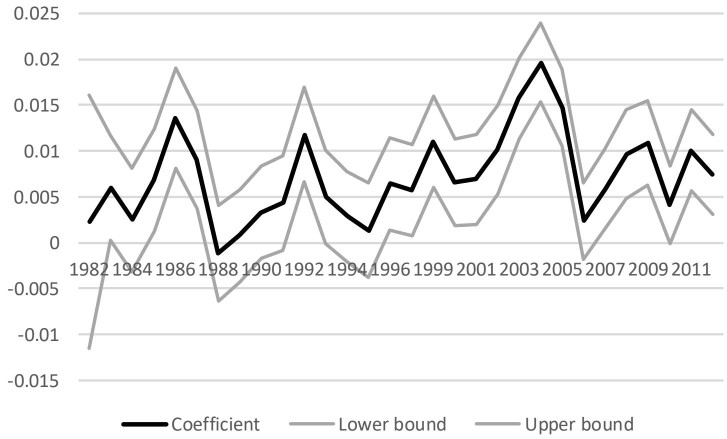
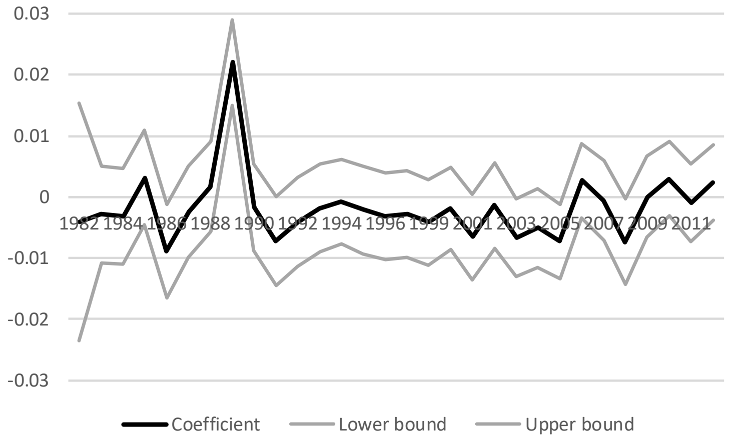
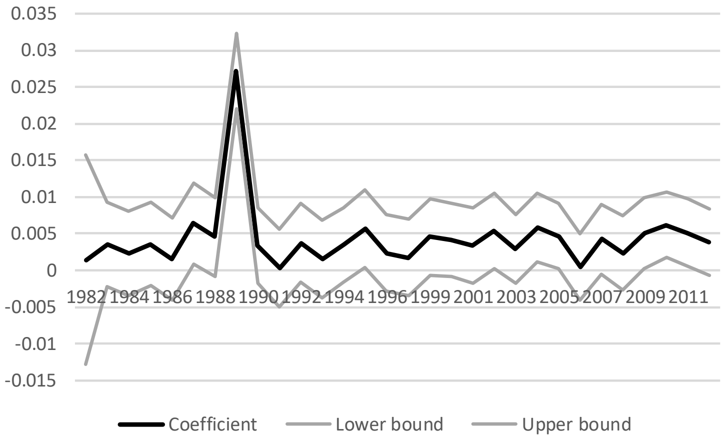


Figure 3: Time-varying coefficients on *TFP_dev*

(d) P_Tangibles-S_Tangibles

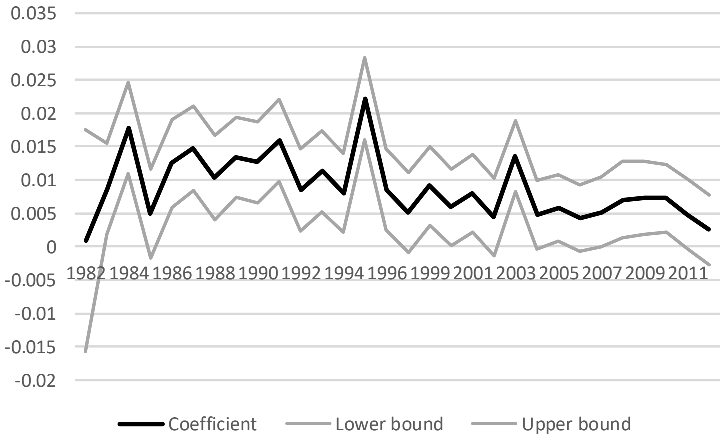


(e) P_Tangibles



(f) S_Tangibles

(g) N_Tangibles



Appendix Table

Table A1: Industry classifications used for analysis

Industry code	Name of industry
1	Agriculture, forestry, and fishery
10	Mining and quarrying of sand and gravel
15	Construction
18	Food processing
20	Textiles and clothing
22	Wood and wood products
24	Pulp and paper
25	Printing and related
26	Chemicals
27	Petroleum and coal products
30	Ceramic products
31	Iron and steel
32	Non-ferrous metal
33	Metal products
34	General and precision machinery
35	Electrical and IT machinery
36	Automobiles and parts
38	Other transportation machinery
39	Other manufacturing
40	Wholesale
49	Retail
59	Real estate
60	Information and telecommunication
61	Land, water, and other transportation
70	Electricity, gas, heat supply, water
75	Other services