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Master Thesis Industrial Dynamics and Strategy

The Effect of Fixed Taxation on Inter-industry Capital Reallocation: A Cross-country Analysis

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Abstract

Following the rationale of the Baily-Bartelsman-Haltiwanger decomposition model, this study analyses the contribution made to aggregate productivity growth by inter-industry capital reallocation in five large OECD countries from 1995 through 2014. The results show that the between-effect of reallocation can indeed play an important role in stimulating aggregate capital productivity growth. In light of this finding, this study attempts to conceptualize a model to measure the extent to which industry-fixed taxation inhibits the efficient allocation of capital across heterogeneous industry. The results of the regression analyses dot not allow for a concise measurement of the effect of industry-fixed taxation on inter-industry capital reallocation. The limitations of this study which have been identified offer a hopeful outlook for future research on this topic.

I would like to thank everyone who played a role in my academic accomplishments. First of all my parents, for their endless support and belief in me. Secondly my supervisor, Gianluca Antonecchia, for having patiently guided me during this process. Lastly, my thanks go out Jeff.

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1. Introduction

The topic of industrial policy has long been disregarded by neoclassical orthodox economists and policy-makers alike. Since the financial crisis of 2008 however, Rodrik (2009) has been one of the first to acknowledge the necessity of well-defined industrial policies in the event of global market failures. Rodrik believes that the stimulation of economic development, along with the promotion of structural change within industries, are essential approaches to resolving market imperfections in developed economies. Skuflic and Druzic (2016) support Rodrik's view as they accentuate the need for the EU to focus on the development of highly adaptive and productive industries in the face of ongoing deindustrialisation. The reallocation of resources across industries is one aspect of such policy. The central concept behind this idea is that economies which lack financial resources for investments, and developed technologies, are able to stimulate productivity growth by moving resources from less productive industries to more productive ones. Two resources in particular are at the centre of this reallocation theory; labour and capital. Baily et al. (1996) and Aw et al. (2001) find that firms with above-average productivity are able to further stimulate total factor productivity as workers are allocated to them from below-average productivity firms. At the same time, Eisfeldt and Rampini (2006), and Eberly and Wang (2009) find that the reallocation of capital across heterogeneous sectors is a driving force for productivity growth at the aggregate level. Unfortunately, this approach is not free of flaws. Bartelsman et al. (2013) show how policy-induced distortions can be the cause of sectoral-heterogeneities which result in observed differences in performance at the aggregate level. Cooper and Schott (2015) have observed how the reallocation process can also be influenced by so-called frictional forces, which result in inefficient allocations of resources. Gopinath et al. (2017) have studied the particular case of Southern-European countries which experienced slower productivity growth throughout the 1990's compared to their Northern neighbours, despite receiving significant capital inflows. The authors find that this was the result of a misallocation of resources across firms and sectors in the South.

Having established the potential of resource reallocation in stimulating aggregate growth, it seems necessary for industrial policy instruments to ensure an efficient allocation for the desired outcomes. Vartia (2008) and Fatica (2013), both confirm that taxation can indeed act as a frictional force in that it may distort the efficient allocation of resources. Against this backdrop, the research question which this study will attempt to answer reads: *to what extent is industry-fixed taxation a frictional force in the efficient allocation of capital between industries?* In order to provide an answer to this question, two distinct analyses will be carried out. First, a cross-country analysis will be carried out in order to measure the contribution of between-industry capital reallocation to aggregate productivity growth. The analysis will be based on the Baily-Bartelsman-Haltiwanger decomposition model. The required data will be obtained from the OECD STrutctural ANalysis Database. Specifically, information will be obtained on the volumes of value added, and of capital stock in use across nine industry sectors. This information will be collected for Italy, the Netherlands, Germany, France, and the United Kingdom from 1995 through 2014. After having quantified the contribution of capital reallocation to aggregate productivity, this study will attempt to model the inter-sectoral distortions arising from differences in industry-level taxation. Additional data regarding industry-fixed taxation, industry size, and national capital flows will be obtained from the OECD STAN Database and the World Bank World Development Indicators Database. The sample of observation and time span of this analysis are the same as those mentioned above. In first instance, the regression model will be used in an attempt to determine both the direction and magnitude of the relationship between industry-fixed taxation and capital reallocation. Thereafter, based on the characteristics of the Baily-Bartelsman-Haltiwanger decomposition model, two additional regression models will be used to test whether industry-level capital productivity and capital productivity growth-rates influence the effect of taxation on reallocation.

The results that have been obtained from the first analysis in this study suggest that the between-effect of capital reallocation can significantly contribute to stimulating aggregate productivity growth. The magnitude of this contribution however appears to have steadily decreased during the period of observation. The results of the different regression models have been unable to provide any conclusive findings regarding the effect of industry-fixed taxation on the allocation of capital across industries.

This study further builds on the existing body of literature by taking a different approach to the measurement of taxation. Previous studies by Harberger (1966), Auerbach et al. (1983), and Fullerton and Henderson (1989) have focused on the effect of capital income taxes on capital reallocation. In contrast, this study analyses the effect of industry-fixed taxation as a source of heterogeneity across industries in the reallocation of capital. This study's most significant contribution to the field is its attempt to quantify the distortive effect, as well as measure whether it is symmetric across all industries, or whether the strength of this effect varies as a result of differences in productivity growth rates. In addition to this principal analysis, this study will also determine the extent to which capital reallocation both within and between industries contributes to aggregate productivity growth in the sample of observation.

The thesis proceeds as follows. Section 2 presents the relevant theoretical framework for this study, thereby expanding on central concepts such as resource reallocation, productivity, and taxation. Section 3 outlines the methodology which will be employed to answer the research question. Section 4 provides a description the data that has been collected for the various analyses, along with the relevant sources. Section 5 presents the results of the first analysis of this study, namely a measure of the contribution of between-industry capital reallocation to aggregate productivity growth. The implications of these results for this study are also discussed in this section. Section 6 presents the results of the regression analyses of the effect of industry-fixed taxation on between-industry capital reallocation. Section 7 provides a discussion of the obtained results as well as of the most relevant limitations of this study. Section 8 provides concluding remarks.

2. Theoretical Framework

Before expanding on this study's theoretical framework, it is important to define the process of reallocation as well as the context in which it takes place. Consider an economic system in which the volume of any single productive resource cannot be increased, either exogenously or endogenously. Given the scope of this study, input reallocation is defined as the movement of capital across heterogeneous industry sector within a single national economy. Reallocation is recognized as an important driver of productivity. Countries which cannot rely on high rates of investments, or which do not possess developed technologies, are able to stimulate growth simply by reallocating resources from low productivity activities to high productivity activities.

Traditionally, neo-classical exogenous growth theories have focused on the role of capital accumulation in stimulating economic development. Solow (1956) and Swan (1956) both conceptualized individual long-term growth models in which capital is accumulated at a constant rate, as a share of the economy's total output. An assumption which is central to their findings is that the economies exhibits production functions with constant returns to scale. This implies that an increase in the saving rate results in a direct increase of the capital stock. The occurrence of neutral technological developments enhances the economy's production function, resulting in higher outputs. These developments imply an increase in absolute savings and in turn also an increase of the capital stock in the economy. At this point, it is important to note that neutral technological developments are so defined if they do not affect the marginal rates of substitution and the returns to scale in any way. An interesting insight regarding the returns of capital accumulation is provided by the continuation of Solow's work. Having analysed the U.S. aggregate production function from 1909 through 1949, Solow (1957) finds the function to exhibit distinct diminishing marginal returns of capital. Even though he claims to have found no evidence to support the notion of capital saturation in the American economy, Solow recognizes that the net marginal productivity of capital may be equal to zero when the gross marginal product of capital equals the marginal rate of depreciation.

Romer (1986) and Lucas (1988) propose a further alternative for long-term economic development with their endogenous growth theories. According to the authors, economies can stimulate productivity growth from within through the accumulation of knowledge and investment in human capital. This internal focus will result in further improvements in terms of productivity.

2.1. Reallocation and Productivity

Two examples of resources which are commonly reallocated for such growth purposes are labour and capital.

2.1.1. Labour

Baily et al. (1996) have studied the effect of labour reallocation on within-plant productivity growth. Their research finds the movement of workers across productive environments to actively contribute to firms' total factor productivity (TFP) growth. Plants with above-average productivity can further increase their TFP simply by increasing their shares of employment relative to below-average productivity firms. The same relationship is found to be true for plants with above-average productivity growth-rates. Research on firm entry-and-exit dynamics in Taiwan's manufacturing sector conducted by Aw et al. (2001) finds similar results to those of Baily et al. (1996). Similarly, Eslava et al. (2004) find that the facilitation of labour reallocation towards high-productivity firms throughout the 1990s largely accounted for aggregate productivity growth in Colombia. More generally, Foster et al. (2001, 2008) find that on the microeconomic level, the reallocation of inputs across heterogeneous producers is a significant driver of economic growth. Reallocation can take place through either shifts among incumbents, or entry and exit.

2.1.2. Capital

Similarly, the reallocation of capital across firms and industries is viewed as a direct means to stimulate productivity and economic growth, as capital is moved from less productive sectors to more productive sectors. An analysis of the existing empirical literature offers a useful insight into the dynamics and benefits of capital reallocation.

Eberly and Wang (2009) have looked at capital reallocation dynamics in an economy consiting of two heterogenoues sectors. The authors show that the reallocation of capital between these sectors is responsible for governing investment and growth at the aggregate level. There are two assumptions which are central to this model. First of all, the authors assume that there are reallocation costs to be incurred in moving capital from one sector to the other. Second, the assumption is made that capital is reallocated from the high-output, low-productivity sector to the low-output, high-productivity sector.

Eisfeldt and Rapmini (2006) were the first to document two central findings regarding the relationship between capital reallocation and productivity growth. First, volumes of capital reallocation appear to move prociclically with aggregate productivity trends and equity market valuations. Second, capital tends to flow from less productive firms and industries to more productive ones. This second finding has since been confirmed in other literature by David (2011), Giroud and Mueller (2015), and Kehrig and Vincent (2017). Motivated by these general findings, Eisfeldt and Shi (2018) have focused on capital reallocation over business cycles in the United States (US), and the impact of such reallocation practices on aggregate productivity. The authors view dispersions in productivity levels across firms and industries as opportunities for productive reallocation. In their view, capital reallocation can directly contribute to aggregate productivity growth by moving assets from less productive units to more productive ones.

Throughout the 1990s, countries in Southern Europe saw a significant inflow in capital investments. Despite these investments, Gopinath et al. (2017) have found that the inefficient allocation of these investments caused aggregate country-level productivity growth rates in South-European coutnries to fall, compared to countries in Northern Europe.

Cooper and Schott (2015) have studied how capital reallocation across firms affects productivity growth rates in the presence of frictions. The authors identify differences in firm-level productivity as the basis for reallocation. The effect of this reallocation is similar to that identified by Eberly and Wang (2009), in that capital is moved, in the form of investments, from less productive firms to more productive firms. In addition however, Cooper and Schott also identify the presence of so-called frictions to reallocation, in the form of adjustment costs, that prevent the full realization of these benefits.

2.2. Productivity Decomposition

Over the past twenty years, the body of literature which focuses on aggregate productivity growth decomposition has increased significantly. This expansion has produced a variety of decomposition models, each with different scopes for application depending on the decomposition-perspective of the studies. The perspective which is most interesting for this particular study is whether heterogeneities are measured at the firm- or industry-level. Murao (2017) provides an overview of different productivity decomposition methods, the most relevant among which are introduced in the following section.

Static Olley-Pakes Decomposition

Olley and Pakes (1996) developed a decomposition model used to analyse changes in aggregate productivity growth (APG) following structural and technological developments in the telecommunications industry in the U.S.A in the 1970's and 1980's. According to the authors, an economy's aggregate productivity in a period t, can be defined as a function of the mean productivity across all firms in the economy, and the cross-section covariance between market share and productivity measured at the firm level. The Olley-Pakes (OP) decomposition function is expressed as:

$$\Phi_t = \bar{\varphi}_t + cov(s_{it}, \varphi_{it})$$

where the first term $\bar{\varphi}_t$ is the mean productivity, and the cov operator is the so-called covariance effect between a firm-level market share s_{it} and productivity φ_{it}. The growth in aggregate productivity over two periods, $\Phi_2 - \Phi_1$, is hence expressed as:

$$\Delta\Phi = \Delta\bar{\varphi} + \Delta cov(s_i, \varphi_i)$$

where $\Delta\bar{\varphi}$ is the growth in the mean productivity across all firms and Δcov is the growth in the covariance effect. Given that both measurements are observed in a single moment, this model is referred to as the static OP decomposition.

Dynamic Olley-Pakes Decomposition

Melitz and Polanec (2015) have expanded the OP APG framework to account for the effects of firm entry and exit on the market share of firms. Depending on their activity status in the economy over the periods of observation, the authors classify firms into three different categories:

i. Surviving firms (i.e. active in both periods)
ii. Entering firms (i.e. active only in the second period)
iii. Exiting firms (i.e. active only in the first period).

Following this classification, Melitz and Polanec express APG over two periods, $\Phi_2 - \Phi_1$, as:

$$\Delta\Phi = \Delta\bar{\varphi}_S + \Delta cov_S(s_i, \varphi_i) + s_{E2}(\Phi_{E2} - \Phi_{S2}) + s_{X1}(\Phi_{S1} - \Phi_{X1})$$

where the upper-case subscripts reflect the activity status of firms, respectively surviving (S), entering (E), and exiting (X). As a result of the inclusion of entry and exit effects in the economy over multiple periods, this model is referred to as the dynamic OP decomposition.

Baily-Bartelsman-Haltiwanger Decomposition

Baily et al. (1996) developed another productivity decomposition model, used to analyse the relationship between reductions in employment and productivity growth in the manufacturing sector in the U.S.A. between 1977 and 1987. This conceptualization suggests that APG can be broken down into two components, namely firm-level productivity growth and productivity growth due to labour reallocation. The authors further distinguish between two types of productivity effects of labour reallocation; level-effects and growth-effects. On the one hand, changes in APG may arise because of labour reallocation between firms with different productivity levels. This component contributes positively to APG if workers are allocated from firms with below-average productivity levels to firms with above-average levels. On the other hand, changes in APG may also arise from the movement of workers between firms with different productivity growth rates. In this case, the contribution to APG is positive is workers are allocated from firms with negative productivity growth to firms with positive growth. The Baily-Bartelsman-Haltiwanger decomposition function is expressed as:

$$\frac{\Delta\Pi_t}{\Pi_{t-1}} = \frac{\sum_i \Phi_{t-1,i}\Delta\Pi_{t,i}}{\Pi_{t-1}} + \frac{\sum_i \Delta\Phi_{t,i}(\Pi_{t-1,i} - \Pi_{t-1})}{\Pi_{t-1}} + \frac{\sum_i \Delta\Phi_{t,i}\Delta\Pi_{t,i}}{\Pi_{t-1}}$$

where Φ_i and Π_i are respectively the share of total employment and the productivity level of firm i. The first term reflects the contribution to productivity growth of individual firms in the sector. The second terms reflects the reallocation level-effect, and the third term the reallocation growth-effect.

Daveri et al. (2005) have adapted the Baily-Bartelsman-Haltiwanger decomposition function in order to analyse labour productivity trends in Italy for the aggregate economy. The same adaptation has also been develop by Gozzi et al. (2005). The authors find that there are two possible ways in which an industry segment may contribute to APG.

Consider first the case in which the labour productivity level is equal across all industries in the economy. The aggregate productivity growth rate is derived as the average of each industry's growth rate, weighted by the respective share of added value. This condition implies that there are no benefits to be gained from the reallocation of resources across industries, and that an increase in the aggregate growth rate must therefore be the result of an increase in the growth rate within each individual industry. This is referred to as the within-effect of reallocation. Now consider the case in which industries differ from one another in terms of productivity levels and growth rates. In this scenario, the reallocation of resources across industries over time can impact aggregate productivity. The effect of this redistribution can be positive if capital is shifted from less productive firms to more productive ones. This is referred to as the between-effect of reallocation. The between-effect can again be further broken down into the between level-effect and the between growth-effect.

2.3. Taxation as a Source of Friction

Following the work of Cooper and Schott (2015), this study aims to determine the extent to which industry-level taxation prevents the efficient reallocation of capital between industries in national economies. Given the scope of this study, industry-level taxation refers to fixed, as opposed to proportional, tax expenses. The rationale behind this distinction is that proportional taxes, such as capital income taxes, are more likely to be the same across industries, and therefore less likely to act as a frictional force in the reallocation process.

Generally speaking, taxation can have a distortive effect on capital allocation in various ways. Consider for example discrepancies in depreciation allowances across different categories of capital assets, or tax burdens which are not related to corporate income, such as property taxes. There is a broad body of literature which studies the effect of taxation on capital allocation. Existing studies however, tend to quantify this effect from the perspective of capital income taxes. Among the first to research this relationship was Harberger (1966), who found that differences in corporate income taxes resulted in losses due to the misallocation of investments between the corporate and non-corporate sectors. Auerbach et al. (1983) have built on Harberger's findings by examining the losses resulting from discrepancies in income taxes, within as well as between industries in the U.S. His findings show that despite a constant decrease in corporate tax collections over the years, the overall loss from capital misallocation has exceeded 1.54 percent of the net corporate capital stock from 1972 through 1982. In 1981 alone, the loss from misallocation due to tax differences was equal to 3.19 percent of the net corporate capital stock or 2.05 trillion dollars. Fullerton and Henderson (1989) have further expanded on the findings of both Harberger and Auerbach et al. by further disaggregating tax differences between sectors of the economy, industries, and types of assets. Interestingly, their findings suggest that losses due to capital misallocation are better explained by tax discrepancies between classes of assets rather than sectors or industries.

According to the methodology first introduced by Jorgenson (1963) and Hall and Jorgenson (1967), the effects of taxation on capital investment are best reflected by the tax-adjusted user cost of capital (COC). Based on this approach, Fatica (2013) has explored the relationship between corporate industry-level taxation, measured as the tax-adjusted COC, and the allocation of new capital investments. Her findings suggest that corporate taxes have a significant inter-asset distortion effect. Over the period 1991-2007, differential taxation has resulted in underinvestment in ICT capital, and transportation equipment, and overinvestment in other machinery and equipment.

3. Methodology

3.1. Capital Reallocation and Productivity

Given the point of focus of this study, the decomposition model which will be employed to analyse the effect of industry heterogeneities on capital reallocation is the adaptation by Daveri et al. (2005) of the Baily-Bartelsman-Haltiwanger decomposition model. Following the approach of Daveri et al. (2005), the growth rate of aggregate capital productivity of the business sector must be decomposed into its three components; the *within* effect, the *level reallocation* effect, and the *growth reallocation* effect. For the purpose of this study, the decomposition equation developed by Daveri et al. (2005) is adapted to analyse the effect of capital reallocation on APG. The relationship between the components is expressed as:

$$\frac{CP_T - CP_0}{CP_0} = \frac{\sum_i w_{i0}(CP_{iT} - CP_{i0})}{CP_0} + \frac{\sum_i(w_{iT} - w_{i0})(CP_{i0} - CP_0)}{CP_0} + \frac{\sum_i(w_{iT} - w_{i0})[(CP_{iT} - CP_{i0}) - (CP_T - CP_0)]}{CP_0}$$

where w_i and CP_i are respectively the share of capital in use and the capital productivity level in industry i. Similarly to the Daveri-Lasinio-Zollino decomposition, capital productivity is measured as the share of value added per Euro of capital employed in the industry. Again, the first term reflects the growth in capital productivity of individual firms in the aggregate economy, which is referred to as the within-effect of reallocation. The second term reflects the between level-effect and the third term the between growth-effect of reallocation. The decomposition will be calculated for nine industry sectors in Italy, the Netherlands, Germany, France, and the United Kingdom over a fifteen year period from 1995 through 2014.

3.2. Taxation and Capital Reallocation

In order to address the research question, three hypotheses have been formulated regarding the nature of the relationship between taxation and capital reallocation at the industry-level. The hypotheses and their respective regression equations are presented below. Each hypothesis will be tested using Pooled Ordinary Least Squares (POLS), Panel Fixed Effects (FE), and Panel Random Effects (RE) regression models.

Hypothesis 1.

Based on the reasoning of Cooper and Schott (2015), and the findings of Fatica (2013), it is reasonable to postulate that industry-level taxation acts as a frictional force in the reallocation of capital across industries. As the level of fixed taxation that is levied within an industry rises compared to others within the same economy, capital investments are likely to be reallocated to those industries which charge less taxes. This movement is expected as investors attempt to minimise the share of capital that is lost to taxes. Therefore, the first hypothesis that will be researched in this study assumes that an increase in the fixed industry-level taxation is expected to result in a decrease in the share of total capital in use.

$$w_{it} = \beta_1 \pi_{it} + \beta_2 Capital\ productivity_{it} + \beta_3 Capital\ productivity\ growth_{it} + \beta_4 Capital\ flow_t + \beta_5 \log(Labour)_{it} + \beta_6 \log(Output)_{it} + \beta_7 Year + \beta_8 Country + \beta_9 Industry + \varepsilon_{it}$$

The dependent variable w_{it} is the share of capital in use in industry i in year t. In order to fully reflect the productivity decomposition model discussed above, this study analyses the effect of fixed taxation on the absolute level of capital allocated in an industry, w_{it}, as well as on the growth of the share of capital, $(w_{iT} - w_{i0})$. The explanatory variable is the industry-fixed taxation π_{it}. The relationship between π_{it} and the dependent variable has been studied using both normalized measures of fixed industry taxation as discussed in the following section. $Capital\ productivity$ and $Capital\ productivity\ growth$ have been included to control for the effects of each individual industry's capital productivity level, capital productivity growth-rate. The variable $Capital\ flow$ controls for the effect of each country's net flow of capital in the economy. The variables $\log(\text{Labour})$ and $\log(Output)$ have been included to control for the industries' size in terms of both labour force and output. Finally, the model also controls for time- and country-fixed effects. Industry-fixed taxation is expected to have a negative coefficient, thereby implying a negative effect of taxation on capital allocation. The capital productivity level and growth-rate variables are expected to have positive coefficients.

Hypothesis 2.a.

Regarding the relationship between capital reallocation and productivity, Eberley and Wang (2009), Cooper and Schott (2015), and Eisfeldt and Shi (2018), highlight the common finding that capital investments tend to be reallocated from low-productivity environments to high-productivity firms and sectors. These findings are also in line with the rationale of the Daveri-Lasinio-Zollino productivity decomposition model. The between-level effect of reallocation contribute positively to APG if resources are moved from less productive industries to more productive industries. Following these observations, this study assumes that the frictional effect of fixed taxation is not symmetric across all industries, but rather increases or decreases depending on the level of capital productivity of the individual industries. Assuming that increases in fixed taxation result in a decrease in the share of capital in use in an industry, the second hypothesis that will be researched in this study assumes that the frictional effect of an increase in the fixed industry-level taxation is expected to be smaller for industries with higher than average capital productivity levels.

$$\begin{aligned} w_{it} = {} & \beta_1 \pi_{it} \times 1\left[CP_{it} > CP_{avg}\right] + \beta_2 \pi_{it} \times 1\left[CP_{it} < CP_{avg}\right] + \beta_3 Capital\ productivity_{it} \\ & + \beta_3 Capital\ productivity\ growth_{it} + \beta_4 Capital\ flow_t + \beta_5 \log(Labour)_{it} \\ & + \beta_6 \log(Output)_{it} + \beta_7 Year + \beta_8 Country + \beta_9 Industry + \varepsilon_{it} \end{aligned}$$

To test the second hypothesis, the variable π_{it} as described above is modified to reflect the differences between industries with above- and below-average levels of capital productivity. Respectively, the variable $\pi_{it} \times 1\left[CP_{it} > CP_{avg}\right]$ multiplies a given industry's taxation value by one if said industry's capital productivity level is above-average. Conversely, the variable $\pi_{it} \times 1\left[CP_{it} < CP_{avg}\right]$ multiplies an industry's taxation value by one if the industry's capital productivity level is below-average. Both taxation variables are expected to have negative coefficients, however the frictional effect of taxation is expected to be smaller for industries which exhibit above-average capital productivity compared to those with below-average levels of capital productivity. The capital productivity level and growth-rate variables are expected to have positive coefficients.

Hypothesis 2.b.

Similarly to the between-level of reallocation, Daveri et al. (2005) find that the between-growth effect of reallocation positively contributes to APG if resources are move from industries with lower productivity growth-rates to industries with higher productivity growth-rates. The effect of taxation as frictional force is hence expected to also be asymmetric across industries depending on their respective capital productivity growth-rates. The third and final hypothesis that will be researched in this study therefore assumes that the frictional effect of an increase in the fixed industry-level taxation is expected to be smaller for industries with higher than average capital productivity growth rates.

$$
\begin{aligned}
w_{it} = {} & \beta_1 \pi_{it} \times 1\left[CG_{it} > CG_{avg}\right] + \beta_2 \pi_{it} \times 1\left[CG_{it} < CG_{avg}\right] + \beta_3 Capital\ productivity_{it} \\
& + \beta_3 Capital\ productivity\ growth_{it} + \beta_4 Capital\ flow_t + \beta_5 \log(Labour)_{it} \\
& + \beta_6 \log(Output)_{it} + \beta_7 Year + \beta_8 Country + \beta_9 Industry + \varepsilon_{it}
\end{aligned}
$$

To test the final hypothesis, the variable π_{it} is again modified to reflect differences between industries with above- and below-average capital productivity growth-rates. The variable $\pi_{it} \times 1\left[CG_{it} > CG_{avg}\right]$ multiplies an industry's taxation value by one if its exhibits an above-average capital productivity growth-rate. The variable $\pi_{it} \times 1\left[CG_{it} < CG_{avg}\right]$ multiplies an industry's taxation value by one if the industry's capital productivity growth-rate is below-average. As with the previous hypothesis, industry-level taxation is expected to have negative coefficients, and the frictional effect of taxation is expected to be smaller for industries with above-average capital productivity growth-rates. The capital productivity level and growth-rate variables are expected to have positive coefficients.

4. Data

4.1. OECD and World Bank Databases

The first section of this study examines the effect of capital reallocation, within as well as between industries, on productivity growth. The second section of this study examines the relationship between industry-level taxation and the allocation of capital between industries. Annual industry-data has been obtained from the OECD STructural ANalysis (STAN) Database for both sections for The Netherlands, Germany, Italy, France, and the United Kingdom (UK) from 1995 through 2014. Additionally, data on national net capital flows has been obtained from the World Bank World Development Indicators Database

For the analysis regarding capital reallocation and productivity growth, productivity is measured at the single factor level and is defined as value added divided by capital in use. The variable $Value\ Added$ represents the industry's value of output as contribution to GDP, and is measured in millions of Euros. The variable $Net\ capital\ stock$ represents the value of all fixed assets still in use, and is measured in millions of Euros. The variable $Capital\ productivity\ per\ Euro$ is calculated as the share of value added produced in each industry, per unit of capital. In total, the dataset contains 3600 observations across 5 countries and 11 industry clusters over the 20 year period.

The industries which are included in this analysis have been coded following EU NACE guidelines, and have been restricted to the business sector. The public administration (O), education (P), and human health (Q) industries have therefore been excluded from the analysis. Furthermore, the real-estate (L) industry has also been left out from the analysis. See Table 1 for the list of industry codes.

Industry	**NACE Code**
Agriculture	A
Industry	B – D – E
Manufacturing	C
Construction	F
Wholesale and retail trade, transportation and storage	G – H – I
ICT	J
Finance	K
Professional services	M – N
Other services	R – U

Table 1 - NACE Industry Codes

For the analysis regarding industry-fixed taxation and capital reallocation, the variable $Capital\ Productivity$ is calculated as a result of the above-mentioned analysis. It represents the aggregate annual capital productivity growth-rate resulting from within- and between-industry capital reallocation. The variable $Capital\ productivity\ growth$ reflects the absolute growth of an industry's capital productivity level over successive years. The variable $Capital\ flow$ is a dummy variable which takes value '1' if the net capital-account balance is positive, thereby indicating an inflow of capital into the country. Conversely, the dummy variable takes value '0' if the net capital-account balance is negative, thereby indicating an outflow of capital from the country. The variables $log(Labour)$ and $\log(Output)$ reflect two dimensions of an industry's size. They are defined as the common logarithms of respectively the total number of individuals employed per industry and the gross output per industry.

4.2. Capital Productivity

The dependent variable w_{it} reflects the reallocation of capital between different industries. It is calculated as the share of total capital in use in industry i in year t, and has been obtained from the $Net\ capital\ stock$ variable mentioned above.

4.2.1. Stylized Facts on Share of Capital in Use w_{it}

Figures 1-9 in Appendix 1.1 show the progression of w_{it} for all industries in all countries during the period of observation. The manufacturing sector, Industry 3, appears to be the most capital-intensive accounting for between 15 and 30 percent of the total capital in use across all countries. The heavy industry sector, Industry 2, and the agriculture, forestry, and fishing sector, Industry 1, follow as close seconds accounting respectively for between 12 and 20 percent and 2 and 14 percent of the total capital in use during the period of observation. Industry 5 also appears to account for a significant share of the aggregate capital in use. It should however be pointed out that this industry is in fact an agglomeration of three different sectors, namely the motor vehicle wholesale and repair sector, the transportation and storage sector, and the accommodation- and food-services sector.

4.3. Normalised Industry-Fixed Taxation

The basis for the measurement of the effect of fixed taxation is the $Other\ taxes$ variable. According to the OECD Glossary of Statistical Terms, this variable consists of other taxes than those which are directly incurred by engaging in production, such as current taxes on vehicles or buildings employed in the enterprise (OECD, 2019). The Italian National Institute of Statistics (ISTAT) further specifies that this variable encompasses all tax expenses related to the production and sales of goods and services, independently of their quantity or value (ISTAT, 2019). It is important to recognize that this variable is not able to fully capture the measure of industry-level taxation. An example of industry-fixed taxes that are not included in this variable are R&D tax incentives (Vartia, 2008). The $Other\ taxes$ variable is therefore taken as a proxy of industry-fixed taxation. Nonetheless, the $Other\ taxes$ variable has been selected for this study as it provides a measure of fixed taxation costs at the industry-level, albeit partial, which is easily comparable across countries and sectors.

Given the scope of this study, it is necessary that fixed taxation values be expressed in the same scale across all industries, namely as a share of industry-level value added. Initially, this is achieved by calculating the normalized variable π_{it} where:

$$\pi_{it} = \frac{T_{it}}{VA_{it}}$$

In addition, a supplementary normalized fixed taxation variable is calculated to measure the deviation of π_{it} from the aggregate-economy mean. This is expressed as:

$$\tau_{it} = \pi_{it} - \Pi_t$$

where Π_t is the total taxation as a share of value added across the aggregate economy in year t. Note that negative values of τ_{it} reflect a larger deviation from the aggregate mean taxation, thereby suggesting a lower industry-fixed taxation compared to the aggregate economy.

4.3.1. Stylized Facts on Industry-fixed Taxation π_{it}

Figures 10-18 in Appendix 1.2 show the progression of the $Other\ Taxes$ variable for all industries in all countries during the period of observation. The most striking observation that is drawn from this comparison is the difference in the taxation charged between on one hand the Netherlands and

Germany, and on the other Italy, France, and the United Kingdom. Whereas aggregate taxation appears to be positive in the latter throughout the period of 1995-2014, the level of aggregate taxation levied across the Dutch and German industries is overwhelmingly negative during the same period. The figures also show that the agricultural sector, Industry 1, is significantly subsidised in all countries by their respective governments compared to other industries.

4.4. Descriptive Statistics

Variable		Mean	Std. Dev.	Min	Max	Observations	
Industry	overall	5	2.583.425	1	9	N =	900
	between		2.611.165	1	9	n =	45
	within		0	5	5	T =	20
Year	overall	2004.5	5.769.487	1995	2014	N =	900
	between		0	2004.5	2004.5	n =	45
	within		5.769.487	1995	2014	T =	20
wit	overall	.1114899	.0796864	.01546	.31676	N =	900
	between		.0800285	.017163	.310418	n =	45
	within		.0089839	.0617309	.1446779	T =	20
Δwit	overall	-.0000676	.0021369	-.0096	.01574	N =	900
	between		.0014031	-.0030375	.0036665	n =	45
	within		.0016245	-.0077436	.0120059	T =	20
Tit/VAit	overall	-.0003701	.0602044	-.4851505	.08092	N =	900
	between		.0511979	-.2439101	.0579753	n =	45
	within		.0325382	-.2416105	.1587252	T =	20
Δ(Tit/Vait)	overall	-.0003213	.0181831	-.2607684	.1499059	N =	900
	between		.002572	-.0097164	.004003	n =	45
	within		.0180042	-.2522098	.1584644	T =	20
(Tit/VAit) - Πt	overall	.0029606	.1739262	-.3219471	.5226684	N =	900
	between		.1550682	-.2623696	.2995137	n =	45
	within		.081929	-.1695055	.2347812	T =	20
Δ[(Tit/VAit) - Πt]	overall	.0025701	.0562282	-.20696	.2577634	N =	900
	between		.0065729	-.012829	.0125566	n =	45
	within		.0558508	-.1958594	.2536704	T =	20
Capital productivity	overall	.7181868	.4512065	.0971	234.725	N =	900
	between		.441758	.1206245	2.092.523	n =	45
	within		.1120785	.1984402	1.781.601	T =	20
Capital productivity growth	overall	.0062831	.1169228	-.53625	170.344	N =	900
	between		.0219885	-.0307685	.052384	n =	45
	within		.1148811	-.5722039	1.663.778	T =	20

Capital flow	overall	.58	.4938329	0	1	N =	900
	between		.2743588	.25	.95	n =	45
	within		.4125398	-.37	1.33	T =	20
Output	overall	241409.2	265961.7	18200	1790862	N =	900
	between		261268.4	23946.55	1410298	n =	45
	within		62587.01	-135038.3	621973.7	T =	20
log(Out)	overall	1.193.474	.9651737	9.809.176	1.439.821	N =	900
	between		.9513454	1.007.832	1.414.273	n =	45
	within		.2136124	1.111.012	1.240.488	T =	20
Labour	overall	2.175.008	2.275.445	59	9801	N =	900
	between		2.283.337	62.3	9302.45	n =	45
	within		2.724.205	5.678.578	3.505.858	T =	20
log(Lab)	overall	7.140.679	1.116.289	4.077.538	919.024	N =	900
	between		1.123.688	4.131.484	9.137.528	n =	45
	within		.1005593	6.692.459	7.434.504	T =	20
Country	overall	3	1.415	1	5	N =	900
	between		1.430.194	1	5	n =	45
	within		0	3	3	T =	20

Table 2 - Descriptive Statistics

5. A Cross-country Analysis of Capital Reallocation

In this section, the stylized facts on the effect of capital reallocation on capital productivity will be presented. The implications of these findings for this study will also be discussed.

The decomposition analysis has been conducted for The Netherlands, Germany, Italy, France, and the UK over four five-year periods, namely: 1995-1999, 2000-2004, 2005-2009, and 2010-2014. Please consult Tables 13-17 in Appendix 2.1-2.5 for a detailed overview of individual industry contributions to aggregate productivity growth for all countries.

Table 3 shows the decomposition of the aggregate capital productivity growth-rates from 1995 through 1999. The Netherlands and France stand out among the other countries in this period for their positive growth rates, respectively 12.9 and 5.5 percent. In both countries, the largest contribution to the aggregate growth rate is made by the within reallocation effect, which respectively accounts for 64 and 58 percent of the aggregate growth rate. Italy, the UK, and Germany all experienced negative aggregate capital productivity growth-rates, respectively -1.6, -0.3, and -0.2 percent. It is worth noticing that the contribution of the level reallocation effect is positive for all three countries, respectively 1.6, 2.7, and 1.5 percent. This implies that capital is being efficiently reallocated between industries, from sectors with lower levels of capital productivity to ones with higher levels.

	Within	Level	Growth	(Between)	Total
Netherlands	8,2	4,6	0,1	4,7	12,9
Germany	-1,2	1,5	-0,5	1,0	-0,2
Italy	-2,9	1,6	-0,2	1,4	-1,6
France	3,2	2,4	-0,1	2,3	5,5
UK	-2,2	2,7	-0,8	1,9	-0,3

Table 3 - Aggregate Capital Productivity Growth Rate Decomposition 1995-1999

Table 4 shows the decomposition of the aggregate capital productivity growth-rates from 2000 through 2004. The Netherlands once more stands out among the other countries, being the one with the highest aggregate capital productivity growth-rate, namely 8.4 percent. Again the within reallocation effect accounts for most of this growth. One common trend that can be identified over this period across all countries, is a decrease in the aggregate capital productivity growth-rates compared to the previous five-year period. This development may be explained by the dot-com crash in 2001. Italy and France seem to have suffered the most from the crisis, as their aggregate growth rates respectively fell from -1.6 to -6.2, and from 5.5 to -0.3.

	Within	Level	Growth	(Between)	Total
Netherlands	7,6	1,0	-0,2	0,8	8,4
Germany	-0,2	0,2	-0,2	0,0	-0,2
Italy	-7,8	1,7	-0,2	1,5	-6,3
France	-2,9	3,0	-0,5	2,5	-0,4
UK	0,1	0,9	-0,4	0,5	0,6

Table 4 - Aggregate Capital Productivity Growth Rate Decomposition 2000-2004

Table 5 shows the decomposition of the aggregate capital productivity growth-rates from 2005 through 2009. The common trend of decreasing aggregate capital productivity seems to continue over the five-year period, as Germany, Italy, France, and the UK all exhibit negative aggregate growth rates. Despite being the only country with a positive growth rate, the Netherlands seems to also have experienced a significant capital productivity slow-down as the aggregate rate has fallen from 8.4 percent in the previous period to 3.1 percent in the current period. As was the case with the previous period, this overall slow-down in capital productivity growth-rates may be a consequence of the global financial crisis in 2008.

	Within	Level	Growth	(Between)	Total
Netherlands	2,6	0,9	-0,3	0,6	3,2
Germany	-3,4	0,3	-0,3	0,0	-3,4
Italy	-10,7	0,6	-0,1	0,5	-10,2
France	-4,5	1,7	-0,1	1,6	-2,9
UK	-6,0	0,0	-0,5	-0,5	-6,5

Table 5 - Aggregate Capital Productivity Growth Rate Decomposition 2005-2009

Table 6 shows the decomposition of the aggregate capital productivity growth-rates from 2010 through 2014. The results from the final period of analysis suggest a significant recovery by Germany, the UK, and France, as all three countries exhibit positive aggregate growth rates, respectively 7.6 percent, 3.8 percent, and 0.2 percent. Italy once more exhibits a negative aggregate growth rate, thereby being the only country with a negative capital productivity growth-rate across all four periods. Interestingly the results do show an improvement over the previous periods, as the growth rate seems has increased from -10.2 percent to -1.3 percent. This is about the same level as in the first period of this analysis. Perhaps surprisingly, the Netherlands has continued to exhibit a decreasing aggregate growth rate, thereby being the only country to have done so across all four periods.

	Within	Level	Growth	(Between)	Total
Netherlands	2,3	-2,2	-0,4	-2,6	-0,3
Germany	6,2	1,0	0,4	1,4	7,6
Italy	-1,5	0,2	0,0	0,2	-1,3
France	0,2	0,0	0,0	0,0	0,2
UK	5,1	-0,9	-0,4	-1,3	3,8

Table 6 - Aggregate Capital Productivity Growth Rate Decomposition 2010-2014

5.1. Implications

The findings presented above offer some useful insights into the relationship between capital reallocation and aggregate capital productivity growth. The quantification of this relationship forms in part the basis for the successive analysis of this study.

The results shows that the within reallocation effect appears to make the most significant contributions to aggregate capital productivity growth. This is very much in line with the findings of existing literature. Nonetheless, the between-effect also seems to have made positive contributions to in almost every country throughout the period of observation. This finding suggests that the movement of capital between different industries can indeed play an important role in stimulating aggregate capital productivity growth. From 1995 through 1999 for example, inter-industry capital reallocation accounted for over a third of the aggregate capital productivity growth-rate in the Netherlands. In the same period, the between reallocation effect accounted for almost half of the aggregate growth-rate in France. During the following two periods, 2000 through 2004 and 2005 through 2009, most economies exhibited both negative within effects, and aggregate capital productivity growth rates. The aggregate between reallocation effects however have positively contributed to the aggregate growth rates. These findings suggest that inter-industry capital reallocation can indeed positively impact aggregate productivity growth when resources are moved from less productive industries to more productive ones. There are two particular aspects of the between reallocation effect which are worth mentioning. First, even though the aggregate effect is mostly positive in all observation periods, the between growth-effect is largely negative. This suggests that there is an inefficient reallocation of capital between industries with different capital productivity growth-rates. Second, the average between effect appears to decrease steadily over all periods of observation, from 2.26 percent in 1995-1999 to -0.46 percent in 2010-2014.

6. Results

The results obtained from the analysis of the relationship between industry- fixed taxation and capital allocation will be presented in the following section. The asymmetric characteristic of fixed taxation as frictional force will also be discussed.

6.1. Hypothesis 1

Table 7 and 8 show the outputs of the regression equations for the hypothesis 1, namely that an increase in the fixed industry-level taxation is expected to result in a decrease in the share of total capital in use. The results obtained for the OLS, RE and FE estimation methods are presented in the first, second and third columns respectively. In each column, the effects on the level of capital allocated in an industry are presented first, followed by the effects on the growth of the share of capital.

The first specification of industry-fixed taxation, namely the taxation that is charged relative to the value-added produced, does not appear to have a clear effect on either the share of capital allocated, or the growth of the share of capital in an industry (see Table 7). The OLS regression method estimates a negative effect of fixed taxation on the allocated share of capital, significant at the 0.1 percent level. This implies that on average, a one Euro increase in the amount of tax payed per Euro of value-added, results in a reallocation of 0.05 percentage points of the capital in use to other industries. Both the RE and FE regressions return positive and non-significant estimates. It is interesting to note that all of the regression methods yield negative and highly significant estimates for the effect of capital productivity. This is contrary to the findings of Eberley and Wang (2009), Cooper and Schott (2015), and Eisfeldt and Shi (2018), that resources are allocated from low-productivity to high-productivity firms and sectors. The capital productivity growth-rate instead does not appear to have any significant effect. With regards to the growth of the share of capital, all three regression methods yield negative, yet non-significant estimates.

Table 7 – Hypothesis 1 Regression Analysis I

	OLS		Random Effects		Fixed Effects	
	(1)	(2)	(1)	(2)	(1)	(2)
	wit	Δwit	wit	Δwit	wit	Δwit
πit	-0.0546***	-0.000331	0.00301	-0.00282	0.00357	-0.00378
	(-3.50)	(-0.35)	(0.38)	(-1.62)	(0.46)	(-2.05)
capprod	-0.0759***	0.000298	-0.0119***	0.0000732	-0.0105***	-0.000433
	(-19.51)	(1.19)	(-5.17)	(0.21)	(-4.54)	(-0.80)
capgrow	-0.0191*	-0.00117*	-0.00253	-0.000845	-0.00210	-0.000894
	(-2.57)	(-2.39)	(-1.11)	(-1.63)	(-0.93)	(-1.69)
capflow	0.00154	0.0000281	-0.0000770	0.0000235	-0.000110	0.0000253
	(0.69)	(0.15)	(-0.12)	(0.15)	(-0.17)	(0.17)
loglab	0.0344***	-0.00216***	0.0649***	-0.00233***	0.0656***	-0.00286***
	(7.85)	(-5.67)	(20.09)	(-4.42)	(20.37)	(-3.78)
logout	0.0319***	0.00149***	-0.0126***	0.00141**	-0.0134***	0.00134
	(5.99)	(3.56)	(-4.30)	(2.60)	(-4.61)	(1.96)

Note: t-statistics are reported in parentheses. Significance: * $p<0.05$, ** $p<0.01$, *** $p<0.001$

The second specification of industry-fixed taxation, namely the deviation from the mean, also appears to yield inconclusive results (see Table 8). The RE and FE regression methods find a positive effect of industry-fixed taxation on the allocated share of capital, significant at the 1 percent level. On average, an additional deviation of one Euro from the average fixed taxation results in a reallocation of respectively 0.008 and 0.009 percentage points of the capital in use from other industries. This finding is in line/not in line with the hypothesis. The OLS estimator is negative, however non-significant. The level of capital productivity again appears to have a negative and highly significant effect on the allocated share of capital, and the capital productivity growth-rate does not appear to have a significant effect. Similarly to the previous outputs, all three methods yield negative and non-significant estimates regarding the growth of the share of allocated capital.

Table 8 – Hypothesis 1 Regression Analysis II

	OLS		Random Effects		Fixed Effects	
	wit	Δwit	wit	Δwit	wit	Δwit
(πit - Πt)	-0.0163 (-1.27)	-0.000178 (-0.21)	0.00847* (2.17)	-0.000828 (-0.92)	0.00871* (2.25)	-0.00101 (-1.10)
capprod	-0.0757*** (-19.65)	0.000300 (1.19)	-0.0119*** (-5.18)	0.0000925 (0.26)	-0.0105*** (-4.55)	-0.000389 (0.72)
capgrow	-0.0180* (-2.48)	-0.00116* (2.38)	-0.00275 (-1.21)	-0.000801 (-1.54)	-0.00233 (-1.04)	-0.000846 (-1.59)
capflow	0.00170 (0.76)	0.0000299 (0.16)	-0.000189 (-0.29)	0.0000321 (0.21)	-0.000225 (-0.35)	0.0000361 (0.24)
loglab	0.0338*** (7.61)	-0.00217*** (-5.66)	0.0658*** (20.42)	-0.00242*** (-4.58)	0.0666*** (20.72)	-0.00312*** (-4.11)
logout	0.0305*** (5.73)	0.00149*** (3.51)	-0.0142*** (-4.75)	0.00136* (2.48)	-0.0150*** (-5.06)	0.00129 (1.84)

Note: t-statistics are reported in parentheses. Significance: * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Thus far, the regression analysis has not been able to yield conclusive estimates for the direction, magnitude, and significance of the relationship between industry-fixed taxation and the share of allocated capital in use. The results which have been obtained are either contrary to the expected outcomes, or non-significant. In addition, the analysis has not been able to confirm the findings of previous studies, regarding the movement of resources from low-productivity industries to high-productivity industries.

Two additional measures have been taken in an attempt to obtain different outcomes. First of all, an observation of the fixed taxation charged across all industries reveals that the agricultural industry has been subsidised in all countries in the sample throughout the entire period of observation. This is shown in figure 10 in Appendix 1.2. In order to determine whether the inclusion of this industry has skewed the outcomes of the analysis, additional OLS, RE and FE regressions have been executed without the inclusion of the Agriculture, Forestry and Fishing industry. The results of this analysis are shown in tables 18 and 19 in Appendix 3.1 and 3.2. Regarding the first specification of industry-fixed taxation, the OLS model estimates a negative effect, significant at the 0.1 percent level. This effect is larger compared to that of the model which includes the agricultural industry. On average, a one Euro increase in the tax paid per Euro of value added results in a reallocation of 0.46 percentage points of the capital in place to other industries. Once again, the RE and FE models yield positive non-significant estimates, and all three models yield negative estimates for the effect of the capital productivity level, significant at the 0.1 percent level. Regarding the second specification of industry-fixed taxation, all three regression models are unable to provide significant estimates for the explanatory variable. Second, additional OLS, RE and FE regressions which include time-lagged effects have also been executed in order to control for heterogeneities in capital fluidity. Up to this point, this study has not differentiated between different types of capital. In reality, there are significant differences which can influence the fluidity of capital, therefore making it more difficult to reallocate said capital from one industry to another. In this context, it may be the case that the effect of an increase in fixed taxation on capital reallocation is not felt immediately, but rather in later periods. Tables 20 and 21 in Appendix 3.3 and 3.4 respectively, show the results of the regressions which have been executed with 1-year lagged fixed taxation variables. With regards to the first specification of industry-fixed taxation, the RE and FE models yield positive estimates, significant at the 5 percent level. The significance of this effect appears to strengthen when using the second specification of industry fixed taxation, as the models yield positive estimates significant at the 0.1 percent level. All models yield negative estimates for the effect of the capital productivity level, significant at the 0.1 percent level.

6.2. Hypothesis 2

Tables 9-10 and 11-12 show the outputs of the regression as formulated in hypothesis 2.a and 2.b respectively. According to the hypotheses, the frictional effects of fixed taxation are expected to be smaller for industries with above-average levels, and growth-rates of capital productivity. The results obtained for the OLS, RE and FE estimation methods are presented in the first, second and third columns respectively. In each column, the effects on the level of capital allocated in an industry are presented first, followed by the effects on the growth of the share of capital.

6.2.1. Hypothesis 2.a

With regards to heterogeneities in capital productivity levels, the analysis is not able to confirm the asymmetric effect of fixed taxation as predicted (see Table 9). Under the first specification of fixed taxation, the OLS model finds that a one Euro increase in fixed taxes per Euro of value added results in the reallocation of 0.38 percentage points of the capital in use is from industries with above-average levels of capital productivity to others. Simultaneously, a unit increase in taxes in industries with below-average levels of capital productivity results in the reallocation of only 0.04 percentage points of the capital in use to other industries. These effects are significant at the 0.1 and 1 percent level respectively.

Table 9 – Hypothesis 2.a. Regression Analysis I

	OLS		Random Effects		Fixed Effects	
	(1) wit	(2) Δwit	(1) wit	(2) Δwit	(1) wit	(2) Δwit
πit * HCP	-0.380*** (-4.89)	0.0250** (-2.82)	-0.193*** (-5.16)	0.0148 (-1.95)	-0.191*** (-5.17)	0.0104 (-1.17)
πit * LCP	-0.0440** (-2.93)	-0.00118 (-1.29)	0.00665 (-0.85)	-0.0033 (-1.89)	0.00713 (-0.92)	-0.00406* (-2.19)
capprod	-0.0750*** (-20.10)	0.000226 (-0.92)	-0.0111*** (-4.86)	0.0000211 (-0.06)	-0.00968*** (-4.26)	-0.000498 (-0.92)
capgrow	-0.0204** (-2.82)	-0.00107* (-2.14)	-0.00249 (-1.12)	-0.000817 (-1.58)	-0.00208 (-0.94)	-0.000898 (-1.70)
capflow	0.00151 (-0.69)	0.0000289 (-0.16)	-0.0000884 (-0.14)	0.0000244 (-0.16)	-0.00012 (-0.19)	0.0000267 (-0.18)
loglab	0.0311*** (-6.63)	-0.00191*** (-4.69)	0.0663*** (-20.85)	-0.00226*** (-4.31)	0.0670*** (-21.12)	-0.00299*** (-3.94)
logout	0.0330*** (-6.18)	0.00143*** (-3.37)	-0.0120*** (-4.16)	0.00137* (-2.55)	-0.0128*** (-4.46)	0.00133 (-1.94)

Note: t-statistics are reported in parentheses. Significance: * p<0.05, ** p<0.01, *** p<0.001. HCP: High capital productivity. LCP: Low capital productivity.

The RE and the FE models yield negative estimates for the effect of fixed taxation in industries with above-average capital productivity, significant at the 0.1 percent level. The effect of fixed taxation in industries with below-average capital productivity however, is positive and non-significant. Again, all three models find that an increase in the level of capital productivity results in a reallocation of capital to other industries, significant at the 0.1 percent level.

The results obtained under the second specification of fixed taxation also appear to be inconclusive (see Table 10). The effect of fixed taxation in industries with above-average levels of capital productivity is non-significant in all three regression models. In industries with below-average productivity levels, the direction and magnitude of the effect of fixed taxation appears to differ depending on the regression model. The OLS regression yields a negative estimate, indicating that a one Euro increase in fixed taxation results in a reallocation of 0.04 percentage points of the capital in use to other industries. The RE and FE regressions both yield the same positive estimate, namely 0.01. All effects are significant at the 5 percent level.

Table 10 – Hypothesis 2.a. Regression Analysis II

	OLS		**Random Effects**		**Fixed Effects**	
	(1) wit	(2) Δwit	(1) wit	(2) Δwit	(1) wit	(2) Δwit
(πit - Πt) * HCP	0.00427	-0.000681	0.0059	-0.000601	0.00606	-0.000365
	(-0.32)	(-0.78)	(-1.28)	(-0.58)	(-1.33)	(-0.34)
(πit - Πt) * LCP	-0.0353*	0.000273	0.0105*	-0.00103	0.0108*	-0.00152
	(-2.57)	(-0.29)	(-2.43)	(-1.04)	(-2.52)	(-1.50)
capprod	-0.0780***	0.000354	-0.0117***	0.000071	-0.0103***	-0.000438
	(-20.24)	(-1.34)	(-5.09)	(-0.2)	(-4.46)	(-0.80)
capgrow	-0.0200***	-0.00112*	-0.0026	-0.000821	-0.00217	-0.000884
	(-2.96)	(-2.26)	(-1.14)	(-1.57)	(-0.97)	(-1.66)
capflow	0.00164	0.0000308	-0.000174	0.0000315	-0.000211	0.0000338
	(-0.74)	(-0.17)	(-0.27)	(-0.2)	(-0.33)	(-0.22)
loglab	0.0336***	-0.00217***	0.0654***	-0.00242***	0.0662***	-0.00303***
	(-7.5)	(-5.66)	(-20.12)	(-4.59)	(-20.42)	(-3.96)
logout	0.0304***	0.00151***	-0.0141***	0.00138***	-0.0150***	0.00129
	(-5.88)	(-3.57)	(-4.73)	(-2.53)	(-5.05)	(-1.84)

Note: t-statistics are reported in parentheses. Significance: * p<0.05, ** p<0.01, *** p<0.001. HCP: High capital productivity. LCP: Low capital productivity.

6.2.2. Hypothesis 2.b

The final analysis considers the effect of heterogeneities in capital productivity growth-rates between industries on capital reallocation. Using the first specification of industry-fixed taxation, the OLS model produces the most interesting results (see Table 11). The regression finds negative effects of fixed taxation on capital reallocation for industries with both above- and below-average capital productivity growth-rates. In the former, an additional Euro of fixed taxation per Euro of value added results in a reallocation of 0.05 percentage points of the capital in use to other industries. In the latter, the effect results in a reallocation of 0.07 percentage points. The estimates are significant at the 1 and 0.1 percent levels respectively. The RE and FE models yield non-significant estimates for the effect of fixed taxation in both industry sub-sets. The results suggest once again a negative effect of capital productivity, significant at the 0.1 percent level.

Table 11 – Hypothesis 2.b. Regression Analysis I

	OLS		Random Effects		Fixed Effects	
	(1) wit	(2) Δwit	(1) wit	(2) Δwit	(1) wit	(2) Δwit
πit * HCG	-0.0456** (-2.80)	-0.000695 (-0.67)	0.00826 (-0.93)	-0.00342 (-1.74)	0.00889 (-1.01)	-0.00446* (-2.16)
πit * LCG	-0.0653*** (-3.32)	0.0000541 (-0.05)	-0.0025 (-0.28)	-0.00222 (-1.10)	-0.00202 (-0.23)	-0.0031 (-1.47)
capprod	-0.0758*** (-19.48)	0.000296 (-1.18)	-0.0118*** (-5.09)	0.0000616 (-0.17)	-0.0103*** (-4.47)	-0.000457 (-0.84)
capgrow	-0.0186* (-2.46)	-0.00119* (-2.35)	-0.00222 (-0.97)	-0.000875 (-1.68)	-0.0018 (-0.80)	-0.000933 (-1.75)
capflow	0.00157 (-0.71)	0.0000262 (-0.14)	-0.0000557 (-0.09)	0.0000212 (-0.14)	-0.000088 (-0.14)	0.0000233 (-0.15)
loglab	0.0344*** (-7.84)	-0.00217*** (-5.70)	0.0650*** (-20.15)	-0.00235*** (-4.45)	0.0657*** (-20.42)	-0.00289*** (-3.81)
logout	0.0322*** (-6.04)	0.00150*** (-3.56)	-0.0127*** (-4.35)	0.00142** (-2.63)	-0.0135*** (-4.65)	0.00138* (-2.02)

Note: t-statistics are reported in parentheses. Significance: * p<0.05, ** p<0.01, *** p<0.001. HCG: High capital productivity growth. LCG: Low capital productivity growth.

The results obtained from the final analysis using the second specification of fixed taxation do not contribute to the clarification of the relationship which is being investigated (see Table 12). The FE model yields positive estimates for the effect of fixed taxation, significant at the 5 percent level. Respectively, a one Euro increase in the deviation from the economy aggregate mean fixed taxation results in a reallocation of 0.009 and 0.008 percentage points of the capital in use to industries with above- and below-average capital productivity growth rates. The OLS model yields negative estimates for the effect of fixed taxation in line with the hypothesis, however they are non-significant. An increase in the level of capital productivity results in a reallocation of capital to other industries in all three models, significant at the 0.1 percent level.

Table 12 - Hypothesis 2.b. Regression Analysis I

	OLS		**Random Effects**		**Fixed Effects**	
	(1) wit	(2) Δwit	(1) wit	(2) Δwit	(1) wit	(2) Δwit
(πit - Πt) * HCG	-0.0116 (-0.86)	-0.00136 (-1.56)	0.00926* (-2.2)	-0.00175 (-1.79)	0.00941* (-2.25)	-0.00181 (-1.84)
(πit - Πt) * LCG	-0.0203 (-1.46)	0.000787 (-0.88)	0.00789 (-1.91)	-0.0000838 (-0.09)	0.00818* (-2.00)	-0.000347 (-0.36)
capprod	-0.0759*** (-19.60)	0.000347 (-1.38)	-0.0119*** (-5.16)	0.000146 (-0.41)	-0.0105*** (-4.55)	-0.000293 (-0.54)
capgrow	-0.0179* (-2.44)	-0.00121* (-2.49)	-0.00269 (-1.19)	-0.00084 (-1.62)	-0.00229 (-1.02)	-0.000874 (-1.65)
capflow	0.0018 (-0.81)	0.00000034 (0.00)	-0.00017 (-0.26)	0.00000959 (-0.06)	-0.000206 (-0.32)	0.0000163 (-0.11)
loglab	0.0335*** (-7.5)	-0.00212*** (-5.61)	0.0659*** (-20.46)	-0.00241*** (-4.53)	0.0666*** (-20.74)	-0.00310*** (-4.09)
logout	0.0310*** (-5.79)	0.00141*** (-3.35)	-0.0143*** (-4.80)	0.00132* (-2.4)	-0.0151*** (-5.10)	0.00128 (-1.83)

Note: t-statistics are reported in parentheses. Significance: * $p<0.05$, ** $p<0.01$, *** $p<0.001$. HCG: High capital productivity growth. LCG: Low capital productivity growth.

7. Discussion and Limitations

Throughout the late 1990's, inter-industry capital reallocation appears to contribute more significantly to aggregate capital productivity growth than intra-industry reallocation in almost every country. During this period, the mobility of capital appears to be such that it can efficiently be moved from less productive industries to more productive ones. In subsequent periods, the positive contribution of the between reallocation effect to aggregate capital productivity growth continues to be observed, however in decreasing magnitudes. Two possible explanations for this trend are that reallocations may have become increasingly inefficient, or that capital mobility has decreased significantly over time. The analysis however does not provide a definite answer as to what may have catalysed this trend. In addition, it appears that differences in capital productivity growth-rates do not sufficiently stimulate the reallocation of capital to make a significant contribution to aggregate capital productivity growth. Overall, this study finds support for the reallocation theories of Baily et al. (1996), Eisfeldt and Rampini (2006), and Eberly and Wang (2009). The movement of capital from less productive industries to more productive ones indeed appears to be able to stimulate aggregate productivity growth.

Having determined the importance of efficient capital reallocation for aggregate productivity growth, this study set out to determine the extent to which industry-fixed taxation impedes such movements of resources. Unfortunately, the results that have been obtained from this study do not allow to make any conclusive statements regarding the effect of industry-fixed taxation on the allocation of capital across industries. The analyses which have been executed in relation to the first hypothesis were unable to demonstrate that increasing fixed taxation indeed acts as a frictional force in the movement of capital from one industry to another. This finding holds true even after having corrected for the heavily subsidised Agriculture, Forestry and Fishing industry, as well as time-lagged effects of reallocation. Surprisingly, the results of all analyses seem to suggest that within this model, increasing levels of capital productivity within a given industry have a negative effect on the share of the total capital that is allocated to said industry. Such results are not in line with the findings of Eberley and Wang (2009), Cooper and Schott (2015), and Eisfeldt and Shi (2018). According to previous studies, resources are in fact expected to be allocated from less productive firms and industries to more productive ones. Considering the findings of such previous studies, as well as the nature of the Baily-Bartelsman-Haltiwanger decomposition model, this study proceeded to analyse whether the frictional effects of fixed taxation on reallocation are asymmetric in nature, depending on the levels and growth-rates of different industries' capital productivity. The models which have been used in these analyses were unable to provide sufficient evidence of this asymmetric relationship, neither in terms of productivity levels nor growth-rates.

Despite lacking the ability to produce any significant quantitative results, this study is based on and builds upon a solid theoretical base. The knowledge of how capital reallocation can positively and significantly influence an economy's aggregate productivity growth is undoubtedly valuable, and especially relevant in times of political and economic unrest, such as the present. It is therefore worth to take a moment to discuss the limitations of this study, and how these can be addressed in future research.

Other taxes. Given that it does not encompass all measures of fixed taxation, the $Other\ taxes$ variable obtained from the OECD STAN database can only be considered as a proxy for industry-fixed taxation. The availability of a more complete measure of taxation would greatly benefit the analysis conducted in this study.

Capital intensity. This study does not consider differences in capital intensity across industries when analysing the effect of fixed taxation on capital reallocation. It is plausible that the share of capital in use in an industry at a given point in time is determined primarily by the nature of that industry, rather than the fixed taxation that is charged. The manufacturing industry is an example of a sector which exhibits high levels of capital intensity, yet relatively low levels of capital productivity in all economies within the sample. In contrast, the Information and Communication industry achieves similar levels of productivity with merely a fraction of the capital. It may very well be the case that less productive industries continue to attract more capital than other more productive ones merely because they have historically accounted for a significant share of the total capital in use within an economy.

Cost of capital reallocation. This study principally assumes that capital can instantly be allocated from one industry to another, without incurring and financial cost. In reality however, as pointed out by Eberly and Wang (2009), there are reallocation costs to be incurred in moving resources from one sector to another. An attempt has been made in this study to control for heterogeneities in capital fluidity by including time-lagged effects in the regressions. However this is not the case with regards to reallocation costs. It is conceivable that these costs could significantly affect both the direction and magnitude of capital reallocation, particularly if such costs greatly exceed the potential tax-related benefits to be earned. The effect of such costs is expected to be even more significant with regards to non-fluid assets such as buildings.

Cross-border mobility of capital. Since the opening up of economic borders and the establishment of a common monetary union such as the Euro, it is reasonable to assume that it has become considerably easier to reallocate capital investments across similar industries in different countries. The idea behind this assumption is that the costs associated with capital reallocation are smaller when this occurs across similar industries, as opposed to when investments are reallocated across distinctively different industries. Furthermore, the concept of cross-border mobility of capital can also be applied to the effect of fixed taxation on reallocation.

Self-growing capital. Finally, it is worth considering a particular characteristic of capital growth, namely that the stock of capital in an economy in period t is dependent on the initial stock in period $t-1$ (Solow, 1956). This relationship is known as the law of motion for the stock of capital and it is expressed as:

$$K_t = K_{t-1}(1-\delta) + I_t$$

where K is the capital stock in period t and $t-1$ respectively, I is the investment rate, and δ is the depreciation rate of capital. This function reflects how industry-level capital stocks are able to grow at different rates in different industries, due to endogenous factors such as the depreciation rate. It may be possible to account for this characteristic by defining the variable w_{it} as the share of investments per industry, rather than as the share of capital in use.

8. Conclusion

This study has looked at how capital reallocation across heterogeneous industries can stimulate aggregate productivity growth. The theoretical basis for this effect is based off the Baily-Bartelsman-Haltiwanger productivity decomposition model. According to this rationale, the simple process of shifting capital from less productive industries to more productive ones will result in an increase in an economy's aggregate capital productivity. Daveri et al. (2005) identify two ways in which this process can stimulate aggregate productivity growth; the within-effect of reallocation and the between-effect of reallocation. The first analysis conducted in this study has analysed how the movement of capital across heterogeneous industries has contributed to aggregate productivity growth in Italy, the Netherlands, Germany, France, and the United Kingdom from 1995 through 2014. The results show that the between-effect seems to have made positive contributions to in almost every country throughout the period of observation. Following the work of Cooper and Schott (2015), this study has attempted to quantify the extent to which industry-fixed taxation acts as a frictional force against the reallocation of capital. The results obtained from the different regression analyses which have been executed do not provide sufficient evidence to determine whether industry-fixed taxation indeed hinders the efficient allocation of capital across industries. If successfully resolved, the limitations of this study which have been outlined may provide a hopeful outlook for further research on this topic.

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Appendix 1.1 Share of Capital in Use per Industry (1995-2014)

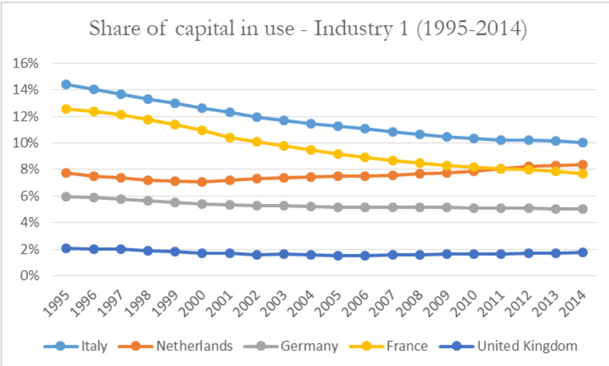


Figure 1

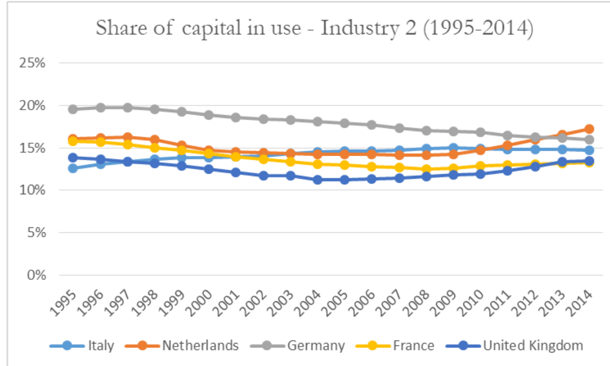


Figure 2

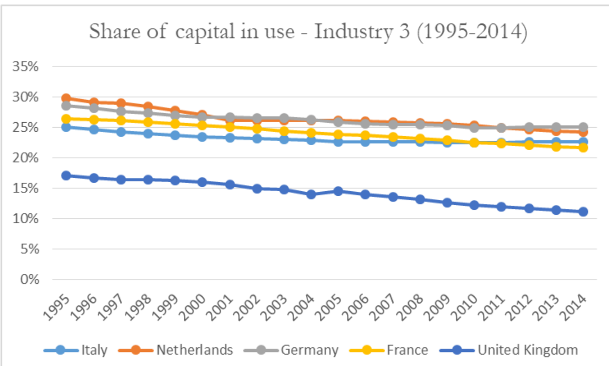


Figure 3

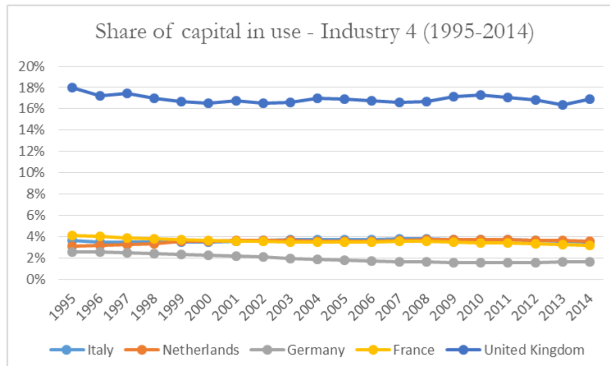


Figure 4

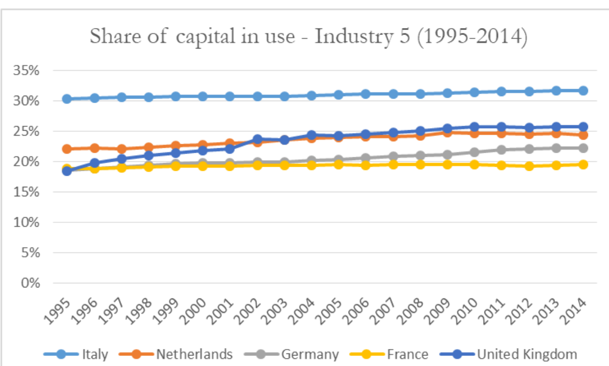


Figure 5

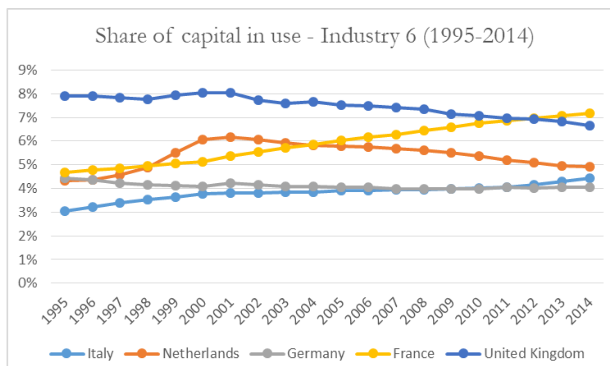


Figure 6

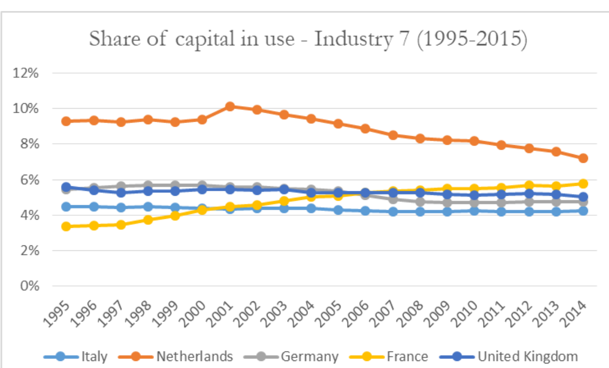


Figure 7

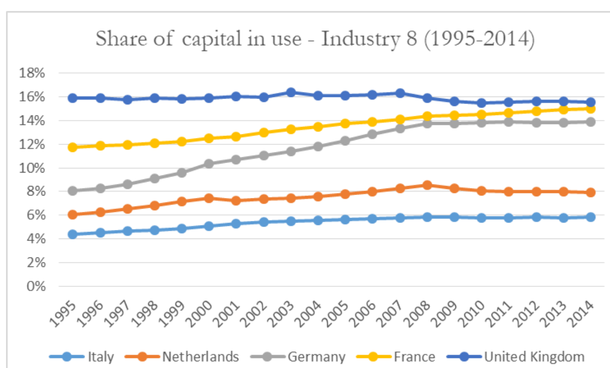
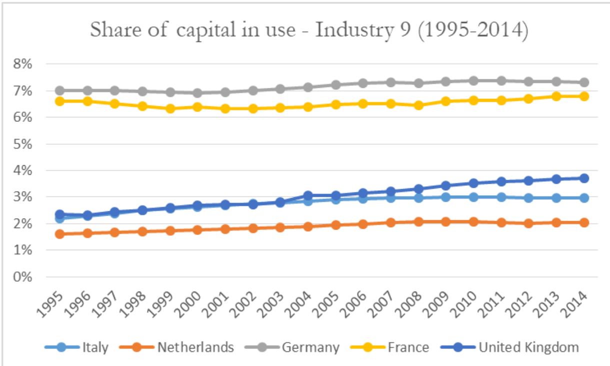


Figure 8


Share of capital in use - Industry 9 (1995-2014)
8%
7%
6%
5%
4%
3%
2%
1%
0%
1995
1996
1997
1998
1999
2000
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2005
2006
2007
2008
2009
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2011
2012
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2014
Italy
Netherlands
Germany
France
United Kingdom

Figure 9

Appendix 1.2 Fixed Taxation per Industry (1995-2014)

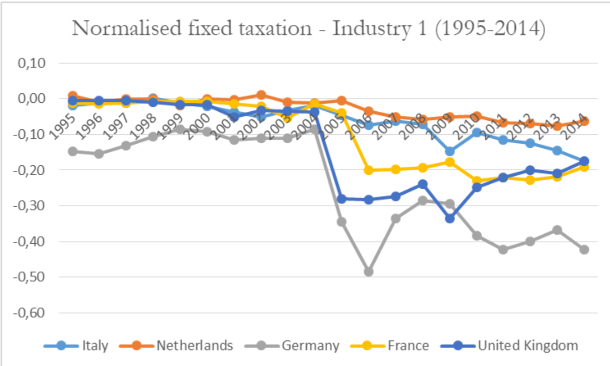


Figure 10

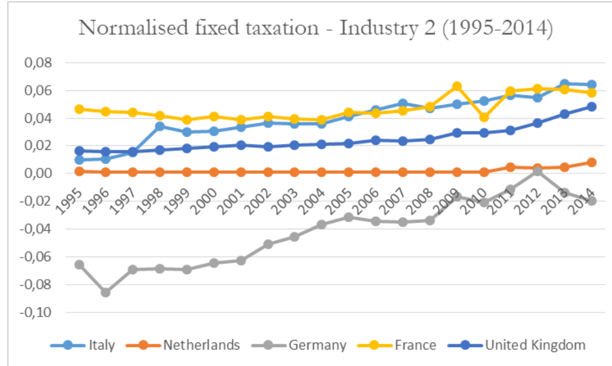


Figure 11

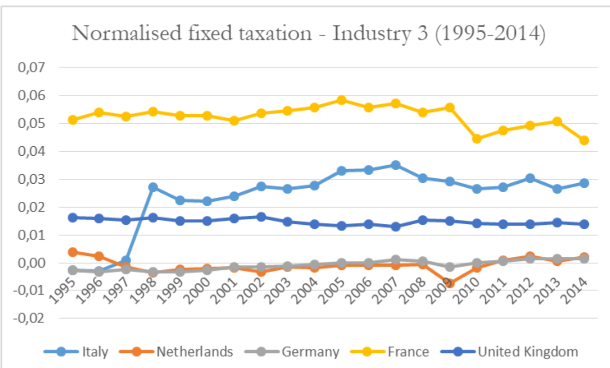


Figure 12

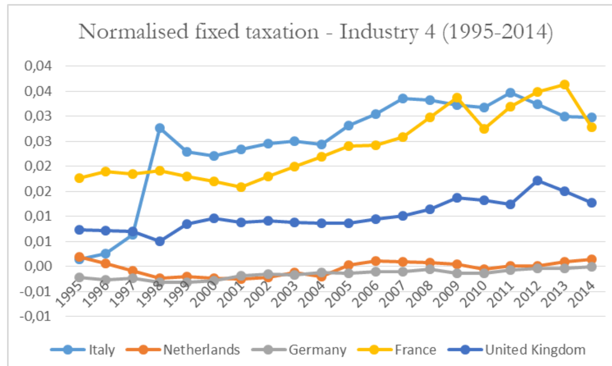


Figure 13

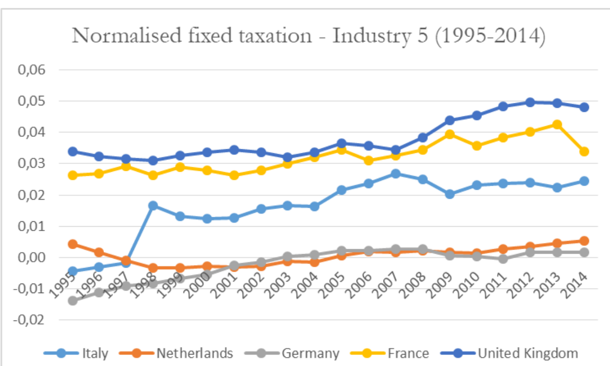


Figure 14

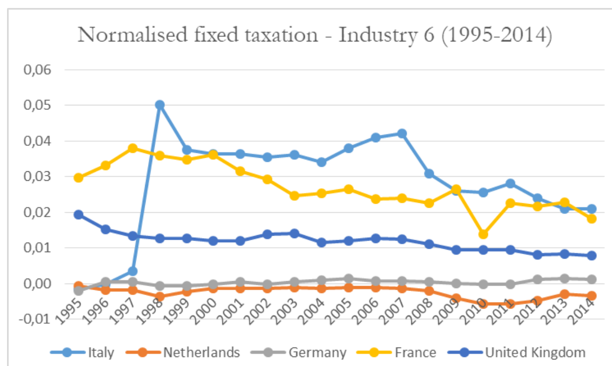


Figure 15

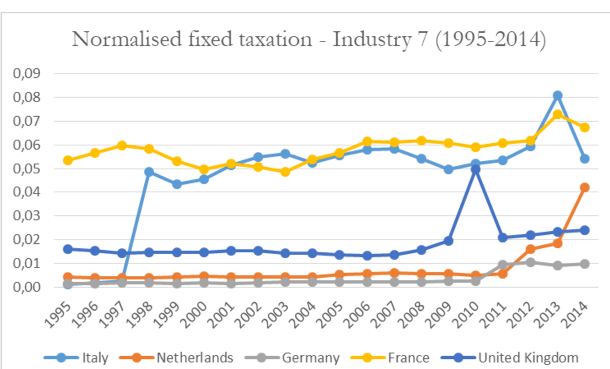


Figure 16

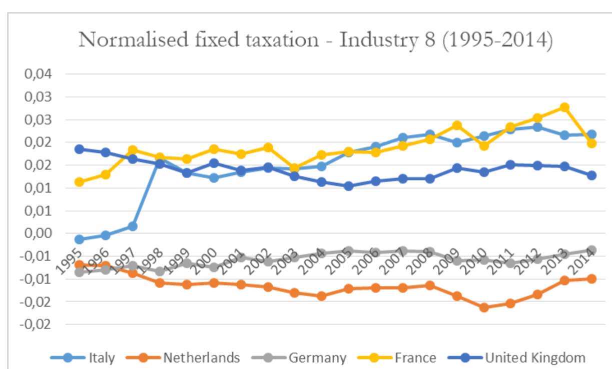
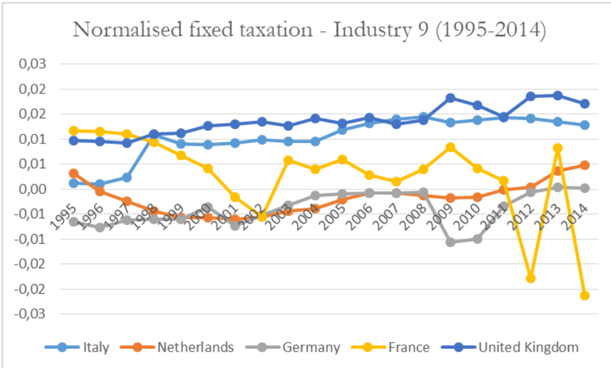


Figure 17


Normalised fixed taxation - Industry 9 (1995-2014)
0,03
0,02
0,02
0,01
0,01
0,00
-0,01
-0,01
-0,02
-0,02
-0,03
1995
1996
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Netherlands
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France
United Kingdom

Figure 18

Appendix 2.1 – Detailed tables on industry contributions to capital productivity growth: Italy

	Capital productivity (€2010/€)					Share of total capital in use per industry				
	1995	1999	2004	2009	2014	1995	1999	2004	2009	2014
1 - Agriculture	0.12	0.14	0.14	0.13	0.14	0.14	0.13	0.11	0.10	0.10
2 - Industry	0.22	0.20	0.17	0.15	0.13	0.13	0.14	0.15	0.15	0.15
3 - Manufacturing	0.62	0.61	0.57	0.46	0.50	0.25	0.24	0.23	0.22	0.23
4 - Construction	1.38	1.32	1.31	1.12	0.95	0.04	0.03	0.04	0.04	0.03
5 - Wholesale and retail trade, trasnportation and storage	0.56	0.55	0.51	0.45	0.46	0.30	0.31	0.31	0.31	0.32
6 - ICT	0.60	0.64	0.75	0.77	0.69	0.03	0.04	0.04	0.04	0.04
7 - Finance	0.86	0.81	0.76	0.85	0.92	0.04	0.04	0.04	0.04	0.04
8 - Professional services	1.66	1.56	1.39	1.14	1.14	0.04	0.05	0.06	0.06	0.06
9 - Other services	1.41	1.23	1.01	0.94	0.97	0.02	0.03	0.03	0.03	0.03

	1995-1999				2000-2004				2005-2009				2010-2014			
	Within	Between level	Between growth	Total	Within	Between level	Between growth	Total	Within	Between level	Between growth	Total	Within	Between level	Between growth	Total
1 - Agriculture	0.5	1.1	-0.1	1.5	0.0	0.9	-0.1	0.8	0.0	0.6	-0.1	0.5	0.1	0.2	0.0	0.4
2 - Industry	-0.5	-0.7	0.0	-1.2	-0.5	-0.4	0.0	-0.9	-0.5	-0.3	0.0	-0.8	-0.3	0.1	0.0	-0.2
3 - Manufacturing	-0.2	-0.1	0.0	-0.3	-1.9	0.0	0.0	-1.9	-4.4	0.0	0.0	-4.4	0.1	0.0	0.0	0.1
4 - Construction	-0.4	-0.2	0.0	-0.6	-0.1	0.3	0.0	0.1	-1.3	0.0	0.0	-1.3	-1.0	-0.3	0.1	-1.2
5 - Wholesale and retail trade, trasnportation and storage	-0.6	0.0	0.0	-0.7	-2.8	0.0	0.0	-2.8	-3.3	0.0	0.0	-3.3	0.1	0.0	0.0	0.0
6 - ICT	0.2	0.0	0.0	0.3	0.6	0.0	0.0	0.6	0.2	0.0	0.0	0.2	-0.6	0.2	-0.1	-0.5
7 - Finance	-0.4	0.0	0.0	-0.4	-0.6	0.0	0.0	-0.6	0.4	0.0	0.0	0.3	0.2	0.0	0.0	0.3
8 - Professional services	-0.8	0.9	-0.1	0.0	-1.6	0.8	-0.1	-0.9	-1.8	0.3	0.0	-1.5	-0.3	0.1	0.0	-0.3
9 - Other services	-0.7	0.5	-0.1	-0.2	-0.8	0.2	0.0	-0.6	-0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.1

Table 13 – Business Sector Productivity Growth Decomposition (1995-2014): Italy

Appendix 2.2 – Detailed tables on industry contributions to capital productivity growth: Netherlands

	Capital productivity (€2010/€)					Share of total capital in use per industry				
	1995	1999	2004	2009	2014	1995	1999	2004	2009	2014
1 - Agriculture	0.21	0.22	0.22	0.23	0.21	0.08	0.07	0.07	0.08	0.08
2 - Industry	0.30	0.28	0.33	0.30	0.24	0.16	0.15	0.14	0.14	0.17
3 - Manufacturing	0.31	0.35	0.42	0.41	0.46	0.30	0.28	0.26	0.26	0.24
4 - Construction	1.63	1.44	1.41	1.53	1.26	0.03	0.04	0.04	0.04	0.04
5 - Wholesale and retail trade, trasnportation and storage	0.58	0.66	0.71	0.71	0.79	0.22	0.23	0.24	0.25	0.24
6 - ICT	0.38	0.49	0.68	0.84	0.99	0.04	0.06	0.06	0.06	0.05
7 - Finance	0.50	0.62	0.69	0.94	0.97	0.09	0.09	0.09	0.08	0.07
8 - Professional services	1.46	1.52	1.50	1.54	1.66	0.06	0.07	0.08	0.08	0.08
9 - Other services	1.25	1.21	1.20	1.17	1.15	0.02	0.02	0.02	0.02	0.02

	1995-1999				2000-2004				2005-2009				2010-2014			
	Within	Between level	Between growth	Total	Within	Between level	Between growth	Total	Within	Between level	Between growth	Total	Within	Between level	Between growth	Total
1 - Agriculture	0.1	0.3	0.1	0.6	0.1	-0.2	0.0	-0.2	0.1	-0.2	0.0	-0.1	-0.2	-0.3	0.0	-0.5
2 - Industry	-0.5	0.3	0.1	-0.1	1.4	0.2	0.0	1.6	-0.2	0.0	0.0	-0.3	-1.6	-1.4	-0.3	-3.3
3 - Manufacturing	2.4	0.8	0.1	3.3	2.4	0.4	0.0	2.8	-1.1	0.2	0.0	-0.9	0.7	0.4	0.0	1.1
4 - Construction	-1.2	1.0	-0.2	-0.4	-0.2	0.0	0.0	-0.2	0.3	0.1	0.0	0.4	-0.5	-0.1	0.0	-0.7
5 - Wholesale and retail trade, trasnportation and storage	3.5	0.1	0.0	3.7	0.9	0.2	-0.1	1.1	-0.7	0.1	0.0	-0.6	1.6	0.0	0.0	1.6
6 - ICT	1.0	-0.3	0.1	0.8	1.8	0.0	-0.1	1.8	1.1	0.0	0.0	1.0	1.0	-0.1	-0.1	0.8
7 - Finance	2.3	0.0	0.0	2.3	1.3	0.0	0.0	1.3	3.0	-0.1	-0.3	2.6	0.0	-0.4	0.0	-0.4
8 - Professional services	0.7	2.1	0.0	2.8	0.0	0.2	0.0	0.2	0.2	0.7	0.0	0.9	1.3	-0.1	0.0	1.1
9 - Other services	-0.1	0.2	0.0	0.0	0.0	0.1	0.0	0.1	-0.1	0.1	0.0	0.0	-0.1	0.0	0.0	-0.1

Table 14 - Business Sector Productivity Growth Decomposition (1995-2014): Netherlands

Appendix 2.3 – Detailed tables on industry contributions to capital productivity growth: Germany

	Capital productivity (€2010/€)					Share of total capital in use per industry				
	1995	1999	2004	2009	2014	1995	1999	2004	2009	2014
1 - Agriculture	0.11	0.12	0.16	0.15	0.10	0.06	0.06	0.05	0.05	0.05
2 - Industry	0.17	0.16	0.16	0.18	0.18	0.20	0.19	0.18	0.17	0.16
3 - Manufacturing	0.59	0.61	0.68	0.62	0.82	0.29	0.27	0.26	0.25	0.25
4 - Construction	2.19	2.01	1.99	2.11	2.21	0.03	0.02	0.02	0.02	0.02
5 - Wholesale and retail trade, trasnportation and storage	0.64	0.60	0.65	0.64	0.64	0.19	0.20	0.20	0.21	0.22
6 - ICT	0.42	0.61	0.73	0.93	1.14	0.04	0.04	0.04	0.04	0.04
7 - Finance	1.03	1.05	0.76	0.79	0.84	0.05	0.06	0.05	0.05	0.05
8 - Professional services	0.98	0.87	0.73	0.62	0.67	0.08	0.10	0.12	0.14	0.14
9 - Other services	0.52	0.52	0.49	0.48	0.46	0.07	0.07	0.07	0.07	0.07

	1995-1999				2000-2004				2005-2009				2010-2014			
	Within	Between level	Between growth	Total	Within	Between level	Between growth	Total	Within	Between level	Between growth	Total	Within	Between level	Between growth	Total
1 - Agriculture	0.1	0.3	0.0	0.5	0.4	0.2	0.0	0.5	0.4	0.0	0.0	0.4	-0.2	0.1	0.0	-0.1
2 - Industry	-0.4	0.2	0.0	-0.2	0.4	0.5	0.0	0.9	0.5	0.7	-0.3	0.9	0.1	0.6	0.3	1.0
3 - Manufacturing	1.1	-0.1	-0.1	0.9	1.2	-0.1	0.0	1.1	-3.5	-0.1	0.2	-3.4	3.4	0.0	0.0	3.4
4 - Construction	-0.8	-0.6	0.1	-1.4	0.0	-1.0	0.0	-1.0	0.3	-0.5	0.0	-0.2	-0.2	0.2	0.0	0.0
5 - Wholesale and retail trade, trasnportation and storage	-1.3	0.2	-0.1	-1.2	1.4	0.0	0.0	1.5	-0.7	0.1	0.0	-0.5	0.9	0.0	0.0	0.9
6 - ICT	1.5	0.1	-0.1	1.5	0.6	0.0	0.0	0.6	1.4	0.0	0.0	1.4	1.4	0.0	0.0	1.4
7 - Finance	0.2	0.2	0.0	0.4	-2.0	-0.2	0.1	-2.1	0.3	-0.2	0.0	0.1	0.2	0.0	0.0	0.2
8 - Professional services	-1.6	1.2	-0.3	-0.7	-1.8	0.7	-0.3	-1.4	-2.1	0.4	-0.2	-1.9	0.7	0.0	0.0	0.7
9 - Other services	-0.1	0.0	0.0	-0.1	-0.4	0.0	0.0	-0.4	-0.2	0.0	0.0	-0.2	-0.1	0.0	0.1	0.0

Table 15 - Business Sector Productivity Growth Decomposition (1995-2014): Germany

Appendix 2.4 – Detailed tables on industry contributions to capital productivity growth: France

	Capital productivity (€2010/€)					Share of total capital in use per industry				
	1995	1999	2004	2009	2014	1995	1999	2004	2009	2014
1 - Agriculture	0.20	0.23	0.26	0.29	0.31	0.13	0.11	0.10	0.08	0.08
2 - Industry	0.23	0.26	0.30	0.24	0.22	0.16	0.15	0.13	0.13	0.13
3 - Manufacturing	0.57	0.61	0.64	0.62	0.68	0.26	0.26	0.24	0.23	0.22
4 - Construction	2.34	2.26	2.41	2.29	2.17	0.04	0.04	0.03	0.04	0.03
5 - Wholesale and retail trade, trasnportation and storage	1.19	1.24	1.21	1.16	1.19	0.19	0.19	0.19	0.20	0.20
6 - ICT	0.89	0.97	1.02	0.98	1.03	0.05	0.05	0.06	0.07	0.07
7 - Finance	1.55	1.30	1.09	1.07	1.08	0.03	0.04	0.05	0.06	0.06
8 - Professional services	1.34	1.35	1.19	1.10	1.10	0.12	0.12	0.13	0.14	0.15
9 - Other services	0.51	0.57	0.58	0.58	0.54	0.07	0.06	0.06	0.07	0.07

	1995-1999				2000-2004				2005-2009				2010-2014			
	Within	Between level	Between growth	Total	Within	Between level	Between growth	Total	Within	Between level	Between growth	Total	Within	Between level	Between growth	Total
1 - Agriculture	0.5	0.9	0.0	1.4	0.3	1.1	-0.1	1.3	0.4	0.6	-0.1	1.0	0.3	0.3	0.0	0.6
2 - Industry	0.5	0.8	0.0	1.3	0.6	0.9	-0.1	1.4	-0.7	0.3	0.0	-0.4	-0.2	-0.3	0.0	-0.5
3 - Manufacturing	1.4	0.2	0.0	1.6	0.4	0.3	0.0	0.7	-0.9	0.2	0.0	-0.7	1.0	0.2	0.0	1.2
4 - Construction	-0.4	-0.8	0.1	-1.1	0.1	-0.3	0.0	-0.2	-0.7	0.1	0.0	-0.6	-0.5	-0.5	0.0	-0.9
5 - Wholesale and retail trade, trasnportation and storage	1.1	0.2	0.0	1.3	-1.3	0.1	0.0	-1.2	-1.1	0.0	0.0	-1.1	0.1	0.0	0.0	0.1
6 - ICT	0.5	0.0	0.0	0.5	0.2	0.1	0.0	0.4	-0.1	0.1	0.0	0.0	0.3	0.1	0.0	0.4
7 - Finance	-1.1	0.6	-0.2	-0.7	-0.9	0.4	-0.1	-0.7	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.1
8 - Professional services	0.3	0.3	0.0	0.5	-2.4	0.6	-0.2	-2.0	-1.5	0.3	-0.1	-1.3	-0.5	0.2	0.0	-0.4
9 - Other services	0.5	0.1	0.0	0.6	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	-0.4	0.0	0.0	-0.4

Table 16 - Business Sector Productivity Growth Decomposition (1995-2014): France

Appendix 2.5 – Detailed tables on industry contributions to capital productivity growth: United Kingdom

	Capital productivity (€2010/€)					Share of total capital in use per industry				
	1995	1999	2004	2009	2014	1995	1999	2004	2009	2014
1 - Agriculture	0.32	0.35	0.36	0.33	0.33	0.02	0.02	0.02	0.02	0.02
2 - Industry	0.37	0.39	0.36	0.27	0.19	0.14	0.13	0.11	0.12	0.13
3 - Manufacturing	0.59	0.56	0.58	0.54	0.62	0.17	0.16	0.14	0.13	0.11
4 - Construction	0.27	0.26	0.28	0.22	0.24	0.18	0.17	0.17	0.17	0.17
5 - Wholesale and retail trade, trasnportation and storage	0.75	0.64	0.58	0.50	0.52	0.19	0.21	0.24	0.25	0.26
6 - ICT	0.30	0.36	0.49	0.56	0.65	0.08	0.08	0.08	0.07	0.07
7 - Finance	0.84	0.91	1.05	1.22	1.06	0.06	0.05	0.05	0.05	0.05
8 - Professional services	0.35	0.40	0.43	0.48	0.62	0.16	0.16	0.16	0.16	0.16
9 - Other services	1.41	1.22	0.99	0.85	0.81	0.02	0.03	0.03	0.03	0.04

	1995-1999				2000-2004				2005-2009				2010-2014			
	Within	Between level	Between growth	Total	Within	Between level	Between growth	Total	Within	Between level	Between growth	Total	Within	Between level	Between growth	Total
1 - Agriculture	0.1	0.1	0.0	0.2	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	-0.2	0.0	0.0	0.0	0.0
2 - Industry	0.4	0.2	0.0	0.6	-0.6	0.3	0.1	-0.3	-1.7	-0.2	0.0	-1.9	-1.7	-0.7	-0.3	-2.7
3 - Manufacturing	-1.1	-0.2	0.1	-1.2	0.3	-0.3	0.0	0.0	-0.3	-0.1	-0.1	-0.5	1.1	-0.2	-0.1	0.8
4 - Construction	0.0	0.6	0.0	0.6	0.5	-0.2	0.0	0.3	-1.7	-0.1	0.0	-1.8	0.2	0.2	0.0	0.4
5 - Wholesale and retail trade, trasnportation and storage	-4.1	1.6	-0.7	-3.2	-2.0	0.7	-0.3	-1.7	-3.5	0.2	-0.1	-3.5	1.7	0.0	0.0	1.7
6 - ICT	1.0	0.0	0.0	1.0	1.1	0.1	0.0	1.1	0.5	0.0	0.0	0.4	0.9	-0.1	0.0	0.8
7 - Finance	0.8	-0.1	0.0	0.6	1.4	-0.1	0.0	1.2	1.2	-0.1	0.0	1.1	-0.6	-0.1	0.0	-0.7
8 - Professional services	1.6	0.0	0.0	1.6	0.6	0.0	0.0	0.5	0.7	0.0	0.0	0.7	3.5	0.0	0.0	3.5
9 - Other services	-0.9	0.5	-0.1	-0.5	-1.1	0.5	-0.2	-0.8	-1.0	0.4	-0.1	-0.8	0.0	0.1	0.0	0.1

Table 17 - Business Sector Productivity Growth Decomposition (1995-2014): United Kingdom

Appendix 3.1 Hypothesis 1 - Omitted Agriculture

Table 18 - Hypothesis 1 Regression Analysis III (Omitted Agriculture)

	OLS		Random Effects		Fixed Effects	
	(1) wit	(2) Δwit	(1) wit	(2) Δwit	(1) wit	(2) Δwit
πit	-0.460*** (-6.44)	0.0200*** (3.51)	0.0545 (1.42)	0.00606 (0.82)	0.0636 (1.67)	-0.0121 (-1.28)
capprod	-0.0772*** (-19.04)	0.000255 (0.98)	-0.0109*** (-4.62)	0.0000879 (0.25)	-0.00946*** (-4.02)	-0.000603 (-1.03)
capgrow	-0.0208* (-2.36)	-0.00124* (-2.04)	-0.000989 (-0.40)	-0.000947 (-1.58)	-0.00052 (-0.21)	-0.000998 (-1.63)
capflow	0.00172 (0.70)	0.0000311 (0.15)	-0.000106 (-0.15)	0.0000203 (0.12)	-0.000140 (-0.21)	0.0000224 (0.13)
loglab	0.0182*** (3.69)	-0.00127** (-2.77)	0.0678*** (19.44)	-0.00177** (-3.03)	0.0689*** (19.86)	-0.00295*** (-3.41)
logout	0.0434*** (6.51)	0.00162** (3.23)	-0.0144*** (-4.54)	0.00154* (2.57)	-0.0153*** (-4.89)	0.00186* (2.39)

Note: t-statistics are reported in parentheses. Significance: * p<0.05, ** p<0.01, *** p<0.001.

Appendix 3.2 Hypothesis 1 - Omitted Agriculture

Table 19 - Hypothesis 1 Regression Analysis IV (Omitted Agriculture)

	OLS		Random Effects		Fixed Effects	
	(1) wit	(2) Δwit	(1) wit	(2) Δwit	(1) wit	(2) Δwit
(πit - Πt)	-0.0203 (-1.30)	0.0008 (0.79)	0.00821 (1.90)	0.000212 (0.20)	0.00847* (1.98)	-0.0000912 (-0.09)
capprod	-0.0766*** (-18.80)	0.000226 (0.88)	-0.0115*** (-4.94)	0.0000642 (0.18)	-0.0101*** (-4.37)	-0.000467 (-0.81)
capgrow	-0.0196* (-2.28)	-0.00129* (-2.15)	-0.00121 (-0.48)	-0.000948 (-1.58)	-0.000750 (-0.30)	-0.000993 (-1.61)
capflow	0.00215 (0.87)	0.0000128 (0.06)	-0.000217 (-0.31)	0.0000161 (0.009)	-0.000255 (-0.37)	0.0000234 (0.14)
loglab	0.0261*** (5.55)	-0.00161*** (-3.68)	0.0679*** (19.73)	-0.00188** (-3.28)	0.0688*** (20.10)	-0.00268** (-3.14)
logout	0.0395*** (5.80)	0.00179*** (3.61)	-0.0144*** (-4.65)	0.00162** (2.72)	-0.0512*** (-4.95)	0.00157* (2.05)

Note: t-statistics are reported in parentheses. Significance: * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

Appendix 3.3 Hypothesis 1 - Lag 1A

Table 20 - Hypothesis 1 Regression Analysis V (One Period Lag)

	OLS		Random Effects		Fixed Effects	
	(1) wit	(2) Δwit	(1) wit	(2) Δwit	(1) wit	(2) Δwit
πit (t-1)	0.0174 (1.15)	-0.00148 (-0.74)	0.0203* (2.50)	-0.00535** (-3.16)	0.0193* (2.40)	-0.00808*** (-4.28)
capprod	-0.0758*** (-19.73)	0.000298 (1.19)	-0.0126*** (-5.44)	0.000136 (0.40)	-0.0111*** (-4.82)	-0.000115 (-0.21)
capgrow	-0.0183* (-2.42)	-0.00118* (-2.41)	-0.00277 (-1.22)	-0.000839 (-1.62)	-0.00235 (-1.05)	-0.000783 (-1.49)
capflow	0.00152 (0.69)	0.0000271 (0.15)	0.0000153 (0.02)	0.00000679 (0.04)	-0.0000211 (-0.03)	-0.0000190 (-0.13)
loglab	0.0343*** (7.80)	-0.00216*** (-5.79)	0.0621*** (18.42)	-0.00213*** (-4.12)	0.0629*** (18.67)	-0.00194* (-2.45)
logout	0.0293*** (5.82)	0.00145*** (3.49)	-0.00946** (-3.03)	0.000849 (1.58)	-0.0103*** (-3.33)	-0.000154 (-0.21)

Note: t-statistics are reported in parentheses. Significance: * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

Appendix 3.4 Hypothesis 1 - Lag 1B

Table 21 - Hypothesis 1 Regression Analysis VI (One Period Lag)

	OLS		Random Effects		Fixed Effects	
	(1)	(2)	(1)	(2)	(1)	(2)
	wit	Δwit	wit	Δwit	wit	Δwit
(πit - Πt) (t-1)	0.00739	-0.000632	0.0130***	-0.00126	0.0129***	-0.00144
	(0.69)	(-0.67)	(3.72)	(-1.53)	(3.74)	(-1.75)
capprod	-0.0758***	0.000301	-0.0123***	0.000118	-0.0109***	-0.000337
	(-19.76)	(1.19)	(-5.39)	(0.34)	(-4.77)	(-0.62)
capgrow	-0.0184*	-0.00117*	-0.00274	-0.000819	-0.0233	-0.000849
	(-2.43)	(-2.40)	(-1.22)	(-1.57)	(-1.04)	(-1.60)
capflow	0.00142	0.0000357	-0.000205	0.0000354	-0.000236	0.0000362
	(0.64)	(0.19)	(-0.32)	(0.23)	(-0.37)	(0.24)
loglab	0.0343***	-0.00217***	0.0648***	-0.00237***	0.0655***	-0.00301***
	(7.75)	(-5.74)	(20.32)	(-4.59)	(20.59)	(-3.98)
logout	0.0287***	0.00149***	-0.0127***	0.00129*	-0.0135***	0.00110
	(5.62)	(3.63)	(-4.46)	(2.45)	(-4.75)	(1.64)

Note: t-statistics are reported in parentheses. Significance: * p<0.05, ** p<0.01, *** p<0.001.