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Persistent Misallocation and the Productivity Slowdown in EU

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Abstract

Why did the productivity slowdown in EU happen at a time of increasing financial market deregulation and generally easing credit conditions? The fact that productivity growth was declining at a time of rising credit is in contrast to the standard prediction of macroeconomic models which find a positive relation between credit and productivity growth. I argue in this

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paper that if the conventional channel though which such a productivity increase occurs - the reallocation of capital from less to more productive businesses - is impaired, then a decline in credit constraints has the opposite effect in the standard model and aggregate productivity declines. There is in fact ample evidence in the literature to support the impairment of capital reallocation in the EU during this period.

Journal of Economic Literature Classification: D24, D25, D5, D61.

Keywords: capital misallocation, financial constraints, heterogenous firms, productivity slowdown, aggregate productivity, EU.

1 Introduction

The current slowdown in productivity in advanced economies was well underway by the time the financial crisis of 2007-8 broke out. In the European Union (EU) particularly, the beginning of the slowdown dates back to the mid-1990's as highlighted by Cete, Fernald and Mojon (2016) among others. In this paper I am concerned with multifactor or total factor productivity (TFP), which measures the efficiency with which inputs are used in the production process. It includes pure technological change, along with changes in returns to scale and in mark-ups. TFP, as a residual measure, also includes measurement errors and the effects from unmeasured output and inputs, such as research and development and other intangible investments. Despite its multiple interpretations as a residual measure, it reflects in some way the overall efficiency of the production process. It is also the main reason why productivity growth in the EU has consistently fallen behind the US in recent decades (van Ark et al (2008)).

I postulate a new channel through which aggregate TFP may have been declining within the EU; it has to do with the increasing role of finance in the face of persistent capital misallocation. Capital misallocation refers to more productive firms operating with less than efficient levels of capital stock. When there is capital misallocation in an economy, but credit constraints are not the main drivers of such misallocation, an improvement in credit constraints is unable to lower misallocation as predicted by the standard model. I argue that when a fall in credit constraints cannot alter the distribution of capital across firms (that is capital distribution is determined by 'other' factors), relative productivity of financially constrained but more efficient firms fall, due to a *productivity crowding-out* effect. This in turn lowers aggregate TFP.

Figure 1 presents the slowdown and fall in productivity in five EU economies and the US. It shows that all but Germany experienced productivity declines in the 2005-2016 period with the TFP decline in Italy and Spain manifesting earlier, between 96-2004. Interestingly, events occurring around this period, namely, progressive deregulation and integration of financial markets within the EU, a worldwide easing of credit conditions and the introduction of the Euro, all point to a lowering of aggregate credit constraints. Indeed Figure 2 illustrates that private credit-to-GDP ratio, a standard measure of financial depth in the literature, rose for the same sample of EU economies as in Figure 1. Although credit-to-GDP declined in the post-crisis period, there is no mistaking the general upward trend in credit in all economies barring Germany during this period, even after accounting for the crisis.

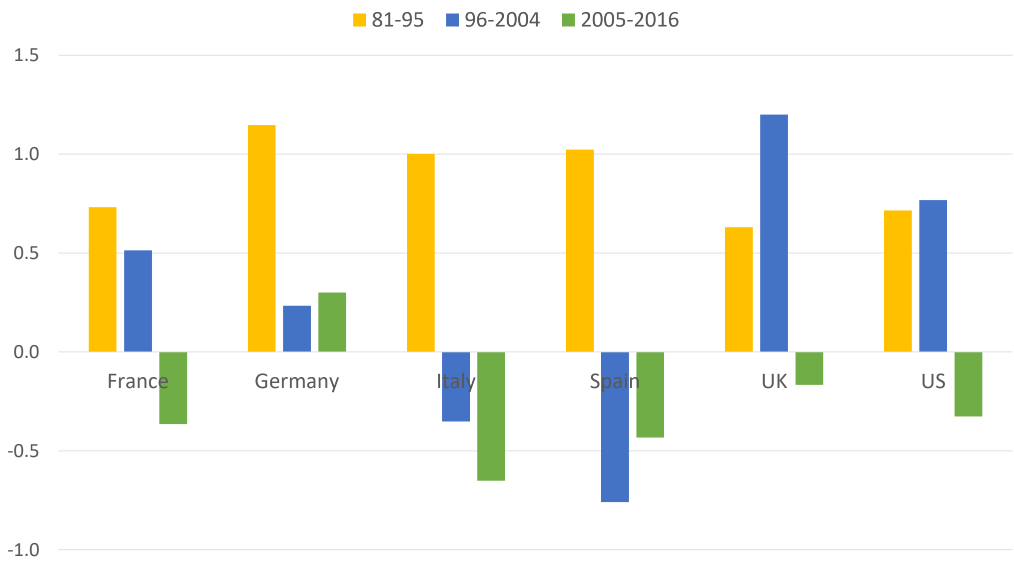

Figure 1: Total Factor Productivity Growth (in percent). Source: Author's calculations using the Conference Board Total Economy Database (Adjusted version), November 2017.

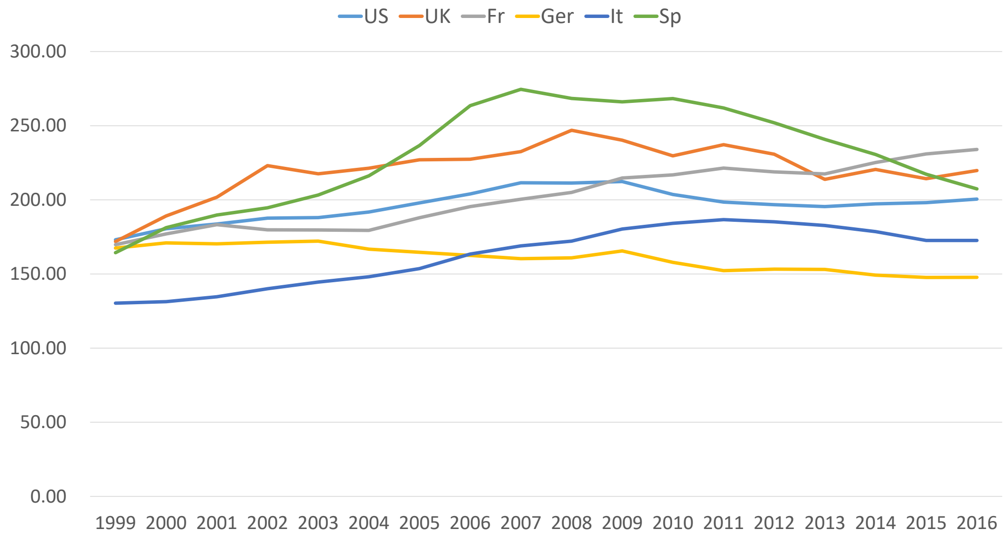

Figure 2: Private debt-to-GDP ratio. Private debt is the sum of Non-financial Corporations and Households' debt. Source: Author's calculations using OECD.Stat, Annual National Accounts, Table 720 - Financial Balance Sheets

The fact that the productivity slowdown in EU coincided with a period of easing credit conditions, is in contrast to the standard macroeconomic model which predicts a rise in productivity with falling financial frictions. I argue in this paper that the loss in productivity growth leading up to and continuing after the financial crisis, happened *because* of, and not *in spite* of, the increasing availability (or decreasing cost) of credit during this period. The main reason, as highlighted earlier, is persistent misallocation of capital caused by factors other than finance, for which there is sufficient evidence in the literature.

Gorodnichenko et al (2018) find for instance, using a new firm level dataset across

8 EU countries, that business, institutional and policy environment of countries in the EU play the primary role in driving misallocation rather than the differences in individual firm characteristics. In the context of the current paper, this implies, how different firms are in terms of their financial constraints, matters little for determining how capital is allocated across these firms. The authors do find however, that countries in the core are better at allocating resources more efficiently across firms with different characteristics i.e., across heterogenous firms, while those in the periphery are particularly worse. Fernandez-Villaverde and Ohanian (2018) also discuss the main causes of misallocation within the EU and award a limited role to finance (particularly focusing on venture capital).

Finally, according to the literature, not all EU economies that experienced a rise in credit saw a fall in misallocation, lending further credence to our premise that credit constraints were (are) not the main drivers of misallocation within the EU. For instance, studies are unanimous in their finding that misallocation rose in southern Europe, or the periphery, whereas there is less consensus on what happened to misallocation in the core. Garcia-Santana, Pijoan-Mas, Moral-Benito, and Ramos (2016) show, using administrative data, that within-industry misallocation of production factors increased substantially in all industries during the 1995-2007 expansion. Similarly, Calligaris et al (2018) find that a rise in resource misallocation has played a sizeable role in slowing down Italian productivity growth. If misallocation had remained at its 1995 level, in 2013 Italys aggregate productivity would have been 18% higher than its actual level. Gopinath et al (2017) find evidence of rising misallocation of capital in Italy, Spain and Portugal between 1999-2012, although they do not find any evidence of similar trends for Germany, France and Norway. Gamberoni, Giordano, and Lopez-Garcia (2016) find that misallocation in capital trended upwards during 2002-2012 for five major Eurozone economies namely, Belgium, France, Germany, Italy and Spain, across nine macro sectors. Bartelsman et al. (2009) look at the U.S., U.K., Germany, and several other countries (but not Spain or Italy) and find that misallocation remained roughly constant in the 1990s and early 2000s. Similarly, Bellone and Mallen-Pisano (2013) find little change in misallocation in France from 1998-2005. Therefore, while these studies unanimously find that capital allocation worsened in the periphery of Europe the evidence for misallocation worsening is not conclusive for other countries.

When capital misallocation between productive and unproductive firms is due to financial frictions, an easing of these frictions causes more productive entrepreneurs who were previously limited by the lack of sufficient funds (for example due to higher interest rates) to borrow more and expand. Less productive businesses decline as they find it difficult to compete with their more productive counterparts. Capital misallocation thus falls, causing aggregate productivity to rise. When falling financial frictions is unable to reallocate resources in this way, because for example, (mis)allocation is determined by policy or the regulatory environment, aggregate productivity declines in the standard model in response to falling financial frictions.

The above result is due to a productivity crowding-out effect which works in the following way. A fall in credit constraints causes existing distortionary forces in the economy to divert funds to less productive firms as well. This prevents more productive firms from reaching their most efficient *relative* scale of operation at the new, lower level of credit constraints. More specifically, greater availability of finance, in the presence of policy, regulatory or institutional distortions, unfairly advantages the less productive sector which is able to access funds (implicitly in the model), to survive and grow as a sector. They use resources that, in the absence of distortions, would have flown to the productive sector and allowed them to achieve the 'correct' (higher) relative economies of scale for their higher relative efficiency. Failing this, productive firms are unable to maintain their efficiency as frictions fall causing them to become less productive over time and putting downward pressure on aggregate productivity.

The final effect on aggregate TFP depends on what happens to misallocation in the interim. If misallocation does not change at all, as in this paper, aggregate TFP falls. However, the fall in TFP is much lower than if misallocation was rising during this period, as was the case in Southern Europe. Finally, if misallocation was falling at the same time as financial frictions were too, the net effect on aggregate productivity would reflect the balance of the larger effect - the negative effect of falling frictions vis-a-vis the positive effect of falling misallocation. In this case, productivity would grow for example, if the fall in misallocation was large enough. However, productivity *growth* would still decline with the rising availability of credit due to the latter's negative effect on relative firm level productivity.

The rest of the paper is organized as follows: Section 2 lays out the basic theoretical framework for analysis and outlines the main results, Section 3 calibrates and simulates the model to quantitatively analyze the size of the effect of falling financial frictions on firm level and aggregate TFP and Section 4 concludes.

2 Theoretical set-up

The economy is populated by two types of firms - financially constrained firms owned by individual entrepreneurs and unconstrained firms owned by the household. Both types of firms produce the same homogenous final good. Let firms $i \in [0, n]$ denote the names of the n financially constrained firms and $i \in [n, 1]$ denote the names of the $1 - n$ unconstrained firms in the model. I also assume that production technology $A_{i,t}$ is the same for each type of producers, that is

$A_i = A_e$ for $i \in [0, n]$ and $A_i = A_h$ for $i \in [0, 1-n]$. Thus the equilibrium outcomes will be the same for projects of the same type allowing us to work with a representative entrepreneur and a representative firm. The household supplies labor endogenously to both entrepreneurs and firms and owns the capital rented out to unconstrained firms. The entrepreneur owns her own capital and can borrow funds from the household against her capital stock. However, financial markets are imperfect and hence the entrepreneur's borrowing is subject to collateral constraints as in Kiyotaki and Moore (1997, 1998). The firms owned directly by the household face no such constraints. In each period, firms of either type produce output according to a constant returns to scale production function.

The production function for the homogenous final good is given by,

$$y_{i,t} = z_t A_{i,t} \left(k_{i,t}^{\alpha} l_{i,t}^{1-\alpha} \right)^{\mu}, \tag{1}$$

where $i = e, h$ stands for firms owned by the entrepreneur and the household respectively. $\alpha < 1$ and $\mu \leq 1$ implies $\alpha\mu$ and $(1-\alpha)\mu$ are the shares of capital and labor in production respectively. Note that $\mu \leq 1$ allows for both decreasing and constant returns to scale in production which is important to distinguish the models's predictions from those obtained in the literature. $A_{i,t}$, $k_{i,t}$ and $l_{i,t}$ are the idiosynacratic productivity, capital input and labor input of firm i in period t. z_t

is an aggregate technology shock that follows a first order autoregressive process,

$$\log z_t = \rho_z \log z_{t-1} + e_t^z,$$

where e_t^z are zero-mean, i.i.d. innovations.

2.1 Constrained Entrepreneurs

The entrepreneur faces the following budget constraint

$$c_{e,t} + i_{e,t} + w_t\, l_{e,t} = y_{e,t} + b_{e,t} - R_t\, b_{e,t-1}, \tag{2}$$

where consumption (c_e), investment (i_e) and wage payment ($w_e l_e$) in period t on the left are financed by final output and net borrowing on the right. The entrepreneur borrows from the household every period. Borrowing is secured by collateral in order to prevent default such that the entrepreneur can only borrow up to a fraction θ of their total capital stock.

$$R_t b_{e,t} \leq \theta\, k_{e,t}\,. \tag{3}$$

They accumulate capital according to,

$$k_{e,t+1} = i_{e,t} + (1-\delta)\ k_{e,t}. \tag{4}$$

The entrepreneur solves the following problem

$$\text{Max}\, E_t \sum_t \gamma^t \ln c_{e,t}$$

subject to her budget constraint (2), the borrowing constraint in (3), the capital accumulation equation (4) and the production function in (1). γ is the subjective discount factor of the entrepreneur.

The first order conditions are,

$$\gamma E_t u'(c_{e,t+1}) \left(\frac{\alpha \mu y_{e,t+1}}{k_{e,t+1}} + (1-\delta) \right) + \lambda_{t+1}\theta = u'(c_t), \tag{5}$$

$$\frac{(1-\alpha)\,\mu y_{e,t}}{w_t} = l_{e,t}, \tag{6}$$

$$\gamma R_{t+1} = E_t \frac{u'(c_{e,t+1})}{u'(c_{e,t})} - \lambda_t R_t, \tag{7}$$

where λ_t is the lagrange multiplier associated with the entrepreneur's borrowing constraint. In equation (5) the opportunity cost of holding one unit of capital on the right hand side is equated to the expected discounted marginal benefit of holding one unit of capital on the left. Because the entrepreneur is financially constrained, the marginal benefit of holding more capital is given not only by its marginal product but also by the marginal benefit of being able to borrow more. Equation (6) gives the entrepreneur's labor demand and equation (7) is the optimality condition with respect to borrowing.

2.2 Unconstrained Firms

The household-owned firm uses the same production function as in (1). They rent capital and hire labor every period from the household and maximize profits to be paid back as dividends to the household. The dividends to be maximized by the firm are given by,

$$d_t = y_{h,t} - w_t l_{h,t} - (r_t + \delta) k_{h,t}, \tag{8}$$

where $l_{h,t}$ is labor employed and $k_{h,t}$ is capital rented in period t by this sector.

Being financially unconstrained, the firm simply equates the marginal product of capital to its rental rate and the marginal product of labor to the wage rate to arrive at their demand for these inputs respectively,

$$\alpha\mu\frac{y_{h,t}}{k_{h,t}} = (r_t+\delta), \quad (9)$$

$$(1-\alpha)\mu\frac{y_{h,t}}{l_{h,t}} = w_t. \quad (10)$$

2.3 Household

In each period, households decide how much to work, how much to consume, how much to lend to the entrepreneurial project and how much to invest in the firm they own. They maximize lifetime expected utility given by

$$\text{Max} \quad E_t \sum_t \beta^t (\ln c_{h,t} - \psi \frac{l_{s,t}^{1+\frac{1}{\eta}}}{(1+\frac{1}{\eta})}),$$

where β is the household discount factor. As is standard in the literature, I assume that the household is patient while the entrepreneurs are impatient such that $\beta > \gamma$. This allows for credit flows in the economy.

The household budget constraint is given by,

$$c_{h,t} + i_{h,t} + R_t\, b_{h,t-1} = d_t + w_t\, l_{s,t} + (r_t+\delta)k_{h,t} + b_{h,t}, \quad (11)$$

where $c_{h,t}$ is household consumption, $i_{h,t}$ is investment in physical capital, $l_{s,t}$ is their total labor supply and $b_{h,t}$ is borrowing by the household in period t. Negative $b_{h,t}$ denotes lending by the household. The household earns income from dividends, wages, rent and interest payments on loans every period and uses it to finance consumption and investment in capital stock.

The household accumulates capital according to,

$$k_{h,t+1} = i_{h,t} + (1-\delta)\ k_{h,t}, \tag{12}$$

where $i_{h,t}$ is the current period investment in physical capital.

The household's optimality conditions are,

$$\beta E_t \frac{u'(c_{h,t+1})}{u'(c_{h,t})}(r_{t+1}+\delta) = 1 - \beta E_t (1-\delta)\zeta_{t+1}\frac{u'(c_{h,t+1})}{u'(c_{h,t})} \tag{13}$$

$$w_t u'(c_{h,t}) = \psi l_{s,t}^{\eta}, \tag{14}$$

$$\beta R_t = E_t \frac{u'(c_{h,t})}{u'(c_{h,t+1})}. \tag{15}$$

In equation (13) the household equates the opportunity cost of holding a unit of capital on the right to its expected discounted marginal benefit which in this case is simply equal to the rental rate plus depreciation paid by the firm. Equation (14) is the household's labor supply decision and equation (15), the euler equation.

2.4 Equilibrium and Market clearing

The necessary and sufficient conditions that characterize an equilibrium in this economy are given by the production function in (1), the borrowing constraint of the entrepreneur in (3), the budget constraints of the household and the entrepreneur given by equations (2) and (11) respectively, the capital accumulation equations (4) and (12), the first order conditions of the entrepreneurs, firms and households given by equations (5) – (7), (9) – (10) and (13) – (15) respectively. Additionally markets for labor, capital, bonds and goods markets clear as follows:

$$l_{e,t} + l_{h,t} = l_{s,t}, \tag{16}$$

$$b_{e,t} + b_{h,t} = 0, \tag{17}$$

$$k_{e,t} + k_{h,t} = k_t, \tag{18}$$

$$c_t + i_t = y_t. \tag{19}$$

Equation (16) implies that total labor demanded by the two sectors is equal to the total labor supplied by the household, net borrowing in the economy is zero according to equation (17). Equation (18) specifies the aggregate capital stock in the economy as the sum of the capital owned by the constrained entrepreneurs and household. Finally the aggregate resource constraint (19) implies that total consumption, c_t and total investment, i_t in the economy must be equal to aggregate output, y_t where $y_t = y_{e,t} + y_{h,t}$.

Finally, under constant returns to scale (CRS), the following equation for capital allocation needs to be satisfied,

$$k_{h,t} = \pi k_{e,t}, \tag{20}$$

where $\pi > 0$ and equation (20) pins down the ratio of the unconstrained to constrained firm's capital exogenously. Under decreasing returns to scale (DRS), π is endogenously determined, given the relative productivity of firms, as demonstrated by the analysis in the next section. Given that the entrepreneurial sector is financially constrained, this sector operates with a lower stock of physical capital than the unconstrained firm owned by the household implying, $\pi > 1$. This is in keeping with empirical evidence on the relative share of constrained versus unconstrained firms in the economy. For instance, Hadlock and Pierce (2009) find that the fraction of potentially financially constrained firms ranges from 39.2% to 13.2% in COMPUSTAT, depending on classification schemes.

2.5 Steady state determination of relative firm level productivity.

Let us first define the concept of TFP given our model, before we proceed to deriving the main result. Following the literature, TFP of firm i, is calculated as a residual from the production function in equation (1) as,

$$TFP_i = \frac{y_i}{(k_{i,t}^{\alpha} l_{i,t}^{1-\alpha})^{\mu}} = z_t A_{i,t}.$$

Therefore, at steady state, the ratio of the TFP of the constrained to unconstrained firm, can be written down as,

$$\frac{TFP_e}{TFP_h} = \frac{\frac{y_e}{k_e^{\alpha} l_e^{1-\alpha}}}{\frac{y_h}{k_h^{\alpha} l_h^{1-\alpha}}} = \frac{A_e}{A_h},$$

Let $\frac{A_e}{A_h} = \phi$. For the rest of the section I focus only on the steady state of the model and therefore do away with the time subscripts. From equations (7) and (15) we obtain $\lambda = (\beta - \gamma)u'(c_e)$ where λ is the lagrange multiplier associated with the entrepreneur's borrowing constraint. Our assumption of $\beta > \gamma$ in Section 3 therefore, allows for a positive value of λ in the model, implying that the credit constraint is binding on the entrepreneurs. Substituting the value for λ into the first order condition for capital of the entrepreneurs, that is in equation (5), gives us,

$$k_e = \frac{\mu\alpha\gamma}{1 - (\beta - \gamma)\theta - \gamma(1 - \delta)} y_e, \tag{21}$$

Similarly combining the steady state versions of the first order conditions w.r.t., capital for firms and the household in equations (9) and (13) gives us,

$$k_h = \frac{\mu\alpha\beta}{1 - \beta(1 - \delta)} y_h \tag{22}$$

The f.o.c's with respect to labor, for the entrepreneur and the firm from equations (6) and (10) respectively, generates steady state employment in these two sectors,

$$l_i = \mu(1-\alpha)\frac{y_i}{w}. \tag{23}$$

Substituting the steady state values of capital and labor from equations (21), (22) and (23) above, into the production function in equation (1) for both the entrepreneur and the firm yields,

$$y_e = \left(A_e\left(\frac{\mu\alpha\gamma}{1-(\beta-\gamma)\theta-\gamma(1-\delta)}\right)^{\mu\alpha}\left(\frac{\mu(1-\alpha)}{w}\right)^{\mu(1-\alpha)}\right)^{\frac{1}{1-\mu}} \tag{24}$$

$$y_h = \left(A_h\left(\frac{\mu\alpha\beta}{1-\beta(1-\delta)}\right)^{\mu\alpha}\left(\frac{\mu(1-\alpha)}{w}\right)^{\mu(1-\alpha)}\right)^{\frac{1}{1-\mu}}. \tag{25}$$

Relative output of the firm is then given by,

$$\left(\frac{y_h}{y_e}\right)^{1-\mu} = \phi\left(\frac{\beta}{\gamma}\frac{\{1-(\beta-\gamma)\theta-\gamma(1-\delta)\}}{1-\beta(1-\delta)}\right)^{\alpha\mu},$$

which, from equations (21) and (22), can be expressed in terms of the relative capital stock as follows,

$$\pi^{1-\mu} = \frac{1}{\phi}\left(\frac{\beta}{\gamma}\frac{\{1-(\beta-\gamma)\theta-\gamma(1-\delta)\}}{1-\beta(1-\delta)}\right)^{\alpha\mu+1}, \tag{26}$$

where $\pi = k_h/k_e$ from equation (20). When $\mu < 1$, or there is DRS in production, as in the standard macroeconomic model with heterogeneously productive firms, capital allocation π is determined endogenously according to equation (26). Specifically, a fall in financial frictions, that is, a rise in θ generates a fall in π. In other words, the relative size (capital stock) of the less (more) productive firm falls (rises), or misallocation decreases, as more credit becomes available. This, in the standard model, causes aggregate productivity to increase thereby generating the usual positive credit-productivity relation.

Under CRS or $\mu = 1$, however, capital allocation cannot be determined by equation (26) anymore. In other words capital allocation is now determined independently of financial frictions, by equation (20). This, recall, is the main premise of the current paper - that is, financial frictions are not among the main determinants of capital (mis)allocation within EU. If this is the case (as argued in Section 1), then equation (26) simply becomes,

$$\phi = \left(\frac{\beta}{\gamma} \frac{\{1 - (\beta - \gamma)\theta - \gamma(1 - \delta)\}}{1 - \beta(1 - \delta)} \right)^{\alpha}, \tag{27}$$

Proposition 1 below, and the discussion that follows, establishes that $\phi > 1$ or, TFP of the financially constrained entrepreneur is higher in equilibrium, than that of the unconstrained firm.

Proposition 1. *At steady state, for $\theta < 1/\beta$, $\phi > 1$.*

Proof. From equation (27), $\phi > 1$, requires, $\frac{1-(\beta-\gamma)\theta-\gamma(1-\delta)}{\gamma} > \frac{1-\beta(1-\delta)}{\beta}$, or, $\frac{1-(\beta-\gamma)\theta}{\gamma} > \frac{1}{\beta}$, or, $\frac{1}{\gamma} - \frac{1}{\beta} > \frac{(\beta-\gamma)\theta}{\gamma}$, or, $\frac{\beta-\gamma}{\beta\gamma} > \frac{(\beta-\gamma)\theta}{\gamma}$, or, $\theta < 1/\beta$. □

The condition $\theta < 1/\beta$, simply implies, from the borrowing constraint of the entrepreneur in equation (3), that the amount the entrepreneur can borrow is less than its capital stock at steady state (recall $R = 1/\beta$ at steady state). So long as this is the case, from proposition 1, the constrained entrepreneur is more productive than the unconstrained firm. Intuitively this makes sense, since for financial frictions to be inefficient, it must be that the more productive firms are borrowing constrained. In my discussion involving the specific parameter values in Section 3.1, I show that the condition $\theta < 1/\beta$ is satisfied by a wide enough margin, which leads us to the following corollary:

Corollary 1.1. *ϕ falls as θ rises.*

Proof. Since $(\beta - \gamma) > 0$, this is clear from equation (27). $\square$

Therefore, a lowering of financial frictions, or rise in θ, causes relative productivity of the more efficient but financially constrained entrepreneurs to decline. As financial frictions fall, there is no lowering of misallocation in this case (which is the case in the standard framework), implying, underlying distortions in the economy prevent the less productive firms from shrinking relative to the more productive businesses. This in turn prevents more productive businesses from expanding enough to achieve the relative scale economies required to maintain their level of efficiency, ϕ, relative to their less productive counterparts. Productivity of these more efficient firms therefore decline as financial frictions fall. This is the productivity crowding out effect. It occurs when changes in financial frictions do not effectively alter the distribution of capital in the economy, mainly because, capital (mis)allocation is determined by other (exogenous) factors.

3 Quantitative Results

In this section, I present a calibrated version of the model in order to quantitatively assess how the effect of rising θ on relative TFP of firms, laid out in the previous section, affects aggregate TFP. I also study the sensitivity of the model's results to changes in key model parameters.

3.1 The calibrated model

I calibrate the model so that the time period is a year. I set the discount factor of households to $\beta = 0.96$ which corresponds to an annual interest rate of 4% as is standard in the literature. Capital's share in income α is set equal to 0.33 while the depreciation rate of capital is set to $\delta = 0.05$, again, standard values used in the literature.

ψ, the disutility parameter associated with labor supply is set to match an average time spent at work of 0.33 in steady state (as in Cooley, Marimon and Quadrini, 2004; Bachmann and Bayer, 2014 and Shourideh and Zeltin-Jones, 2017). I set η, the Frisch elasticity of labor supply equal to 3.5, in line with values used in calibrated macro models. Micro studies for η estimate a low value ranging from 0.1 to 0.4 while macroeconomic models typically use higher values. Gertler and Kiyotaki (2010) argue that the presence of labor market frictions ensure that aggregate labour is highly elastic even though individuals are relatively unwilling to vary their market hours over time and use a Frisch elasticity of 10 in their model. Aoki and Nikolov (2015), on the other hand, use a value of 5 for η.

The parameter θ is our measure of financial frictions in the model and therefore the parameter of interest. I set the value of θ to reflect the debt-to-GDP ratio of the non-financial corporate sector in the Euro area which went from 57% in the first quarter of 1999 to a peak of 81% in the fourth quarter of 2009 according to the ECB monthly Bulletin (2012). I therefore allow θ to go from 60% to 81% in my model reflecting the increase in credit during the period under consideration.

Recall that the entrepreneur has a lower discount factor than the household who owns the firm. This makes the entrepreneur more impatient than the households in the model causing them to borrow from the households. Recall also from our analysis in Section 2.5 that $\gamma < \beta$ is required for credit constraints to matter to the entrepreneur in our model. Once the parameters β, δ and θ are set as above, using equation (27) I set $\gamma = 0.88$ so that the entrepreneur is at least 10% more productive than the firm (that is, $\phi = A_e/A_h = 1.10$). This is in keeping with Gal (2013) who provides TFP calculations based on production function estimations for OECD economies. The dispersion in TFP for selected EU economies ranges between 0.99 and 1.75 depending on the measure of TFP used, where dispersion is the difference between the 90th and the 10th percentile of log TFP (as in Syverson

(2011)). The resulting value for γ lies within the range of values estimated for the discount factor of impatient agents and commonly used in calibrating models with collateral constraints (see for example, Campbell and Hercowitz (2005), Chen and Song (2013), Iacoviello (2005), Iacoviello and Minetti (2007), Iacoviello (2008), Iacoviello and Neri (2010)).

π, the capital allocation parameter is set to reflect the proportion of constrained firms in the economy. Hadlock and Pierce(2009) find that the fraction of potentially financially constrained firms ranges from 39.2% to 13.2% in COMPUSTAT, depending on classification schemes. I set $\pi = 2.05$ in my model, such that the share of the constrained sector's output ranges from 36-39% depending on the value assigned to θ. Finally, I normalize the project-specific technology parameter A_h to unity.

3.2 Effect of rising credit

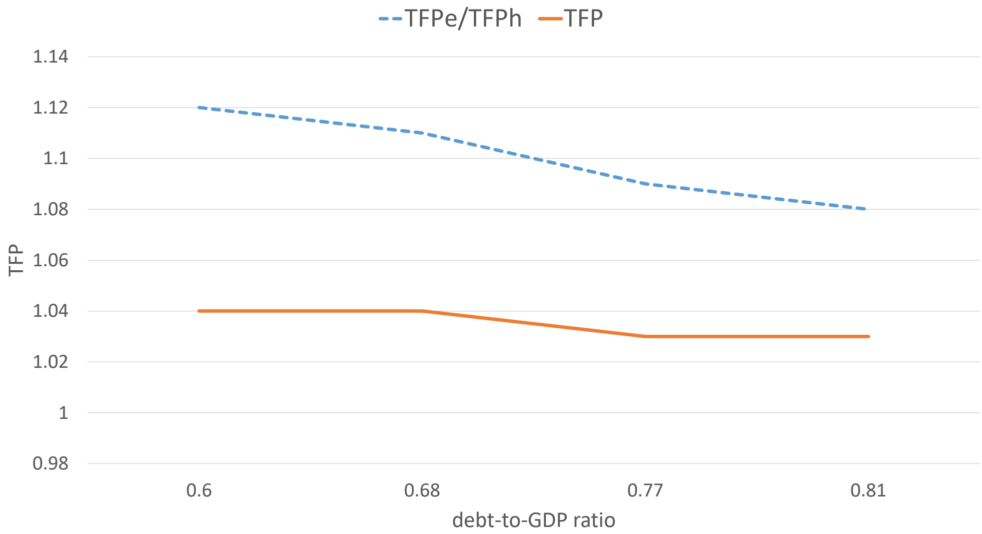

Figure 3: Aggregate and Sectoral Total Factor Productivity.

Figure 3 plots the decline in the relative productivity of constrained firms that occurs with a rise in credit, as predicted by equation (27) and the concomitant decline in aggregate TFP. From Table 2, the magnitude of the fall in relative productivity of the constrained, more productive sector, is 3.5% which generates a drop in aggregate productivity of 1%. In the next section, I show that the decline in aggregate TFP generated by the model is robust to changes in parameter values. Thus the benefits of easing financial frictions in the model, that is a rise in constrained and unconstrained firm's investment and output is overshadowed by the negative impact of the fall in the relative productivity of the former such that although the capital stock of the constrained firm rises with θ, output and employment in these firms fall in the net as shown in Table 2.

Note that, in Table 2, there are no changes to capital allocation (k_h/k_e) as financial frictions fall. This is because both constrained and unconstrained firms' capital stock increase in order to maintain the exogenously specified allocation π. Therefore a closing of the gap in the MPK of the two firms, as frictions are reduced is brought about solely by the downward adjustment of the relative firm level productivity in the first row of the Table. This is as opposed to a relative adjustment of the capital stock through a fall in misallocation, in the standard model. In fact, this decline in the relative productivity of the constrained firm causes employment in these firms to fall while employment in the unconstrained sector rises (since productivity of unconstrained firm relative to the constrained one is now higher) generating a shift in employment and output from the more to the less productive firms of the economy.

These results are in keeping with recent evidence for several OECD economies. For example, the Office of National Statistics in UK in their February 2018 report find that such a shift in the aggregate mix of activity has occurred in UK in recent decades whereby workers have moved from the more productive mining, manufacturing and telecommunications industries to the less productive food, drugs and real estate sectors of the economy. The same report also finds a decline in the productivity of some of these more productive industries in recent years. Andrews et al (2017) provide evidence of the increase in prevalence of 'zombie' firms in several European economies that has led to a decline in the growth of high-productivity firms (measured by investment and employment growth) in these economies.

The shift in employment and output to the less productive sector of the economy, driven by a decline in the relative productivity of the constrained frontier firm as financial frictions fall, therefore lowers aggregate TFP in the model.

Debt-GDP ratio

	0.60	0.67	0.75	0.81	% Change
$\frac{TFP_e}{TFP_h}$	1.12	1.11	1.09	1.08	-3.5%
TFP	1.04	1.04	1.03	1.03	-1%
k_e	0.69	0.7	0.71	0.71	+2.9%
k_h	1.41	1.43	1.45	1.46	+3.5%
k	2.1	2.13	2.16	2.17	+3.3%
k_h/k_e	2.04	2.04	2.04	2.05	-
y_e	0.27	0.27	0.25	0.25	-7.4%
y_h	0.39	0.4	0.4	0.41	+5%
y	0.67	0.66	0.66	0.66	-1.4%
l_e	0.15	0.14	0.14	0.13	-13%
l_h	0.21	0.21	0.21	0.22	+4.8%
l_s	0.35	0.35	0.35	0.35	0%

Table 2: Effect of lowering financial frictions in the model.

3.3 Sensitivity Analysis

Table 3 presents the main results of the model for alternative parameter values. Firstly, in panel 1, I allow π to be lower. A lower π is associated with a higher aggregate TFP, but only at the lower end of the values assigned to θ. A lower π implies that a larger share of the economy's capital, employment and output is with the constrained sector. Thus a larger proportion of the producers in the economy are affected by financial frictions generating lower output and productivity. However, given that the constrained sector is also more productive, a larger proportion of output and employment is now concentrated in the more productive sector in the economy implying higher TFP. From Table 3, the latter effect dominates, although only at lower levels of θ. As θ rises and the productivity edge of the constrained sector erodes, aggregate TFP falls such that at the higher levels of θ considered, there is no difference in aggregate TFP due to π.

I allow for changes in the depreciation rate (δ), capital's income share (α) and the Frisch elasticity of labor supply (η) in panels 1-3 of Table 3 in line with other values of these parameters commonly used in the literature. We find that quantitatively, the drop in relative sectoral productivity due to θ is largely unaffected by changes in parameter's values, and more importantly there is always a net decline in aggregate TFP of between 1-2% depending on the parameter values chosen, with a fall in financial frictions. Thus the relative decline in productivity of constrained frontier firms in the economy due to easing credit conditions, in the absence of capital reallocation, depresses aggregate TFP irrespective of the parameter values considered.

	θ		
	0.6	0.81	$\%change$
Panel 1: $\pi = 1.5$ *(lower)*			
$\frac{TFP_e}{TFP_h}$	1.13	1.08	-4%
TFP	1.05	1.03	-2%
Panel 2: $\delta = 0.075$ *(higher)*			
$\frac{TFP_e}{TFP_h}$	1.1	1.06	-3.6%
TFP	1.04	1.02	-2%
Panel 3: $\alpha = 0.36$ *(higher)*			
$\frac{TFP_e}{TFP_h}$	1.14	1.09	-4.4%
TFP	1.05	1.03	-2%
Panel 4: $\eta = 4$ *(higher)*			
$\frac{TFP_e}{TFP_h}$	1.13	1.08	-4.4%
TFP	1.04	1.03	-1%

Table 3: Sensitivity analysis for alternative values of model's parameters

4 Conclusion

In this paper I argue that the slowdown in productivity in advanced economies that began in the mid 1990's in Europe can be attributed to the rising importance of finance (measured by the credit-to-GDP ratio) during this period. In an otherwise standard model of heterogenously productive firms with financial constraints, I show that when capital allocation is determined independently of financial frictions, such that changes in financial frictions do not cause a reallocation of capital, there is an endogenous adjustment of firm level productivities with rising credit. Specifically, productivity of the more efficient financially constrained firms fall as they fail to increase their relative scale of production sufficiently to maintain their level of relative efficiency. This is the productivity crowding-out effect of a fall in financial frictions and it occurs when misallocation is mainly the result of other distortionary forces in the economy. In this case, a fall in financial frictions causes aggregate TFP to be lower thus reconciling the fact that the loss of productivity or productivity growth in the EU since the mid 1990's coincided with a period of significantly easing credit conditions.

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