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Abstract

This paper attempts to shed light on the nexus between firm productivity and economies of agglomeration in Egypt. Using a large dataset of 62,108 firms in 342 four-digit activities in 27 regions governorates, we introduce three measures of agglomeration, which are urbanization or firm diversification, measured by the number of firms in the governorate, localization and specialization, measured by the average productivity in the governorate and sector (generating externalities and knowledge spillovers), and finally competition, measured by the number of firm operating in the same governorate and the same sector. We find strong evidence for the existence of agglomeration economies in Egypt after controlling for firm age, location, economic activity and legal status. In the Egyptian context, productivity spillovers gained from agglomeration economies outweighed the negative effects of congestion implied by our competition measure. The latter is chiefly due to the lack of good infrastructure. When regressions are run by firm size and activity, our main findings show, first, that micro and small firms are more likely to benefit from localization and diversification compared to medium and large firms. Finally, service firms benefit more from a high level of diversification, while manufacturing firms gain more from knowledge spillovers and specialization. Our results support promoting entrepreneurship through the creation of industrial clusters located outside Cairo to lessen disparities between regions and acquire the full advantages of agglomeration.

JEL classification: D24, R11, R30

Keywords: Productivity, Agglomeration, Egypt, Firms.

ملخص

تحاول هذه الورقة تسليط الضوء على العلاقة بين إنتاجية الشركات واقتصاديات التكتلات في مصر. باستخدام مجموعة كبيرة من الشركات البالغ عددها 62،108 شركة في 342 نشاط من أربعة أرقام في محافظات 27 منطقة ، نقدم ثلاثة مقاييس للتكتل ، وهي التحضر أو تنويع الشركات -ويقاسان بعدد الشركات في المحافظة ، والتوطين والتخصص و تقاسان بمتوسط الإنتاجية في المحافظة والقطاع (بما يخلق عوامل خارجية و نتشار المعارف) ، وأخيرا المنافسة ، وتقاس من خلال عدد الشركات العاملة في نفس المحافظة ونفس القطاع . نجد دليلا قويا على وجود اقتصادات التكتل في مصر بعد التحكم من خلال عمر الشركة والموقع والنشاط الاقتصادي والوضع القانوني. في السياق المصري ، فاقت الآثار غير المباشرة الناتجة عن اقتصادات التكتلات الآثار السلبية للازدحام الذي ينطوي عليه مقياس المنافسة لدينا. هذا المقياس الأخير يرجع أساسا إلى عدم وجود بنية تحتية جيدة. عندما يتم التحكم في الانحدارات من خلال حجم الشركة ونشاطها ، تظهر نتائجنا الرئيسية ، أولاً ، أن الشركات الصغرى والصغيرة من المرجح أن تستفيد من التوطين والتنويع بالمقارنة مع الشركات المتوسطة والكبيرة. وأخيراً ، تستفيد شركات الخدمات بدرجة أكبر من المستوى العالي للتنويع ، بينما تستفيد الشركات الصناعات التحويلية من أثر ما يتوفر لديها من معارف وتخصصات. تدعم نتائجنا تشجيع ريادة الأعمال من خلال إنشاء مجموعات صناعية تقع خارج القاهرة لتقليل الفوارق بين المناطق واكتساب المزايا الكاملة للتكتل.

1. Introduction

Spatial agglomeration has always been the most important driver of industrial growth in developing countries. The linkage between spatial agglomeration of production and firms' productivity have received less attention, particularly in the Egyptian contexts. Indeed, agglomeration benefits economic agents according to two basic ways (Rosenthal & Strange, 2004). The first, localization economies, arises from the concentration of firms in the same industry. While, the second is urbanization economies, which occurs from an increase in the city size that enables cross- fertilization of ideas among diverse economic activities (Jacobs, 1969). Some empirical studies support localization economies more than urbanization economies such as J. Henderson (2003); Li, Lu, & Wu (2012).

There are different arguments about the positive spillover effects of economies of agglomeration (Ohlin 1933; Hoover 1937). According to the early work of Marshall (Marshall, 1920), it is better for small and very small firms to cluster together because they of the benefit they obtain from knowledge spillovers, similarity of cultural and psychological attitudes (Cainelli, 2008; P Krugman & Venables, 1996). Moreover, agglomeration facilitates the mobility of skilled workers and other specialized inputs for the firms (Krugman, 1991;Helsley & Strange, 1991). Finally, the regional system of innovation approach covers a broader aspects of innovative relations covering the intra-firm as well as the extra-firm relations and process (Cainelli, 2008; Iammarino & McCann, 2006). On the other hand, agglomeration could be associated with diseconomies of scale. Congestion that occurs from a dense firm location could be severe if infrastructure is a bottleneck to economic activity (Hu, Xu, & Yashiro, 2015a; Lall, Shalizi, & Deichmann, 2004).

Among the studies that relate several urban agglomeration channels to total factor productivity (TFP), Ellison, Glaeser, & Kerr (2010) reveal that all three Marshallian approaches of economies of agglomeration are found to have positive influence, with input-output linkage being extremely important. This is also supported by the work of Baldwin, Brown, & Rigby (2010) that claimed the importance of buyer-supplier networks, labor market matching and local spillovers that enhance productivity within firms. Vernon Henderson (2003) showed that local information spillovers have a positive impact on the productivity of high –tech industries but not machinery industries. Several studies find a positive relationship between the overall size of a region and productivity (Shefer 1973, Segal 1976, Sveikauskas 1975, Nakamura 1985, Rice et al. 2006), as well as between employment density and productivity (Ciccone and Hall 1996, Ciccone 2002, Brülhart and Mathys 2008).

Against this literature, this paper's contribution is threefold. First, it combines different measures of agglomeration (urbanization or firm diversification measured by the number of firms in a governorate, localization and specialization, measured by the average productivity in the governorate and sector, and finally competition, measured by the number of in the same sector firms operating in the governorate) and examines their relationship with productivity. Second, it takes into consideration heterogeneity implied by economic activities, firm size and firm location. Third, it uses a rich dataset (firms in 342 four-digit activities in 27 governorates, adding

up to a total of 62,108 firms) for Egypt, in order to examine the effect of such agglomerations on firms' productivity. The Egyptian case is particularly interesting since the industrial sector has been facing several problems affecting its productivity, and the government is currently implementing several structural reforms to improve its competitiveness. Hence, an evidence-based study on the importance of clusters and agglomeration is crucial from a policy perspective.
We find strong evidence for the existence of agglomeration economies in Egypt after controlling for firm age, location, economic activity and legal status. In the Egyptian context, productivity spillovers gained from agglomeration economies outweighed the negative effects of congestion implied by our competition measure. The latter is chiefly due to the lack of good infrastructure. When regressions are run by firm size and activity, our main findings show first that micro and small firms are more likely to benefit from localization and diversification economies, compared to medium and large firms. Finally, service firms benefit more from a high level of diversification, while manufacturing firms gain more from knowledge spillovers and specialization. Our results support promoting entrepreneurship through the creation of industrial clusters located outside Cairo to lessen disparities between regions and acquire the full advantage of agglomeration.
The remainder of the paper is organized as follows. Section 2 reviews the literature. Section 3 presents the methodology. Section 4 presents the data and some stylized facts on TFP by firm size, activity and the correlation between agglomeration indices and TFP. Section 5 is dedicated to empirical findings. Section 6 provides conclusion and policy recommendations.

2. Literature Review

The theoretical underpinnings of agglomeration economies are based on two main hypotheses. The localization or specialization hypothesis, which suggests that externalities occur from clustering firms in the same industry (Marshall, 1920). The urbanization or diversification hypothesis refer to urban regions with diversified industries that enables sharing ideas and practices among different economic activities (Jacobs, 1969). Localization economies promote knowledge spillovers and labor pooling due to regional specialization (Saxenian, 1994).
There is a body of literature that distinguishes between urbanization and localization on a number ofc aspects. Localization is associated with several channels of economies of scale. It creates the basis of the intra-industry transmission of knowledge and technology. For instance Jaffe & Manuel Henderson (1993) found that patent citations are more likely to be domestic and came from the same state. Rauch & Casella (2003) argued that knowledge spillover is not confined to technology only, but also includes business opportunities and market knowledge. Baldwin et al. (2010) found that knowledge spillovers are highly localized and enhance the productivity of firms within industries rather than between them. Spatial concentration gives rise to pecuniary externalities (Henderson, 1988; Fujita, Krugman & Venables, 1999). For instance, it promotes the emergence of a thick labour market, where it is easier to find highly skilled workers and reduces job search costs (Helsley & Strange, 1991). Moreover, large markets trigger entry in the production of intermediate goods that is sufficent to scale economies and allows firms to outsource a large share of their intermediate inputs and thus gain from specialization (Holmes,

1999; Rodríguez-Clare, 1996). Finally, forward and backward linkages in the production function arise thanks to such agglomerations (Hirschman, 1958). In contrast, concentartion of firms could generate congestion especially if infrastucture is a bottleneck to economic activity, which can increase business costs (Hu et al., 2015a). In addition, Broersma & Oosterhaven (2009) concluded that congestion dominated agglomeration externalities and impeded productivity.

With respect to the urbanization hypothesis, Jacobs argued that large cities are charactrized by diversity of industries that bring benefits to all firms located in the region (Jacobs, 1984). Duranton & Puga (2004) offered three mechansims for explaining urban increasing returns, namely sharing, matching and learning. Sharing enables firms to increase their gains from being able to access a variety of inputs and from a deeper divison of labor that can be sustained from large production and risk sharing. Moreover, with regard to matching, agglomeration improves the expected quality of matching between agents and reduces the hold-up problems. Finally, learning enables firms to benefit from the creation, accumulation and transmission of knowledge. Moreover, Andersson, Burgess, & Lane, (2007) argued that a thicker labor market, along with complementarity in production, contributed to an urban premium. However, empirical evidence showed contradicting conclusions. Henderson (1997) found that diversity and narrower specializations of workers improved firm growth. Moreover, Glaeser, Kallal, Scheinkman & Shleifer (1992) found that sectoral diversity and competition improved firms employment in the USA. In contrast, diversity is found to have a negative impact on most industries except services, while deeper specialization reduces employment growth (Combes, 2000).

Another strand of literature examines the agglomeration hypothesis based on theories related to firms and their market size (Rizov, Oskam, & Walsh, 2012). *Co-location* to large markets could induce agglomeration effects through lower transportation costs and labor mobility (Krugman, 1991; Krugman & Venables, 1996). Furthermore, clustering near large firms provides opportunities to benefit not only from technology spillovers, but also from management practices and a large variety of intermediate inputs (Hu, Xu, & Yashiro, 2015b). For instance, Greenstone, Hornbeck & Moretti (2010) found that productivity spillovers are found to be higher with firms sharing the same pool of labor and technology across new firms in the USA. Li et al., (2012) argued that Chinese firms are more likely to upgrade if they are located near large firms. Moreover, *market access* as a result of exports and trade liberalization could create export externalities to agglomerated firms through shared infrastructure and input-output linkages. For instance, Saito, Gopinath, & Wu (2011) found that agglomeration increased among high productivity firms. Sjöberg & Sjöholm, (2002) observed that firms engaging in international trade are comparably clustered in Indonesia. Conversely, proximity to foreign markets could make the domestic market less attractive which might work against regional agglomeration (Damijan & Konings, 2011). Finally, sectoral competition is another agglomeration externality that could be a source of productivity gains (Porter, 1990). However, severe competition can lower firms productivity by raising input prices and lowering product prices (Lall et al., 2004).

The empirical evidence on the relationship between productivity and different types of agglomeration was inconclusive. For instance, Choi & Choi (2017) showed that concentration of firms within the same industry contributes to both employment and productivity growth, while, little evidence was found in favor of urbanization economies in South Korea. Moreover, employment density and localization resulted in raising labor productivity, but diversity and competition were found to have negative effects in the Netherlands (Groot, de Groot, & Smit, 2014). Howell (2017) found that the Marshallian theory of agglomeration mattered in China, as technology proximity reduced the cost of moving people, ideas and goods. Using USA data, Ciccone & Hall (1996) found that productivity increased when firms with similar activities cluster together. Using different methodologies, Melo, Graham, Levinson, & Aarabi (2017) found that employment density has a stronger impact on productivity in the USA, compared with shared infrastructure. In addition, M. Andersson & Lööf (2011) concluded that urbanization favored firms' growth. With regard to developing countries, few studies examined the agglomeration-productivity nexus. Siba, Soderbom, Bigsten, & Gebreeyesus (2012) concluded that Ethiopian firms are more likely to be productive if they produce similar products to other firms in the cluster. Fafchamps & Hamine (2017) showed strong effects of a large magnitude for specialization but found no clear-cut evidence for the diversity argument in Morocco.

Against this literature, this paper's contribution is threefold. First, it combines different measures of agglomeration and examines their relationship with productivity. Second, it takes into consideration heterogeneity implied by economic activities and firm size. Third, it uses a rich dataset for a developing country (Egypt) in order to examine the effect of such agglomerations on firm productivity.

3. Methodology

3.1 Estimating the Production Function

The analysis is done in three stages: The first is estimating TFP, and then using the predicted TFP as a dependent variable with other explanatory variables. TFP is estimated using a log linear Cobb-Douglas production function with constant returns to scale as follows:

$$Y_{ikg} = A_{ikg} L_{ikg}^{\alpha} K_{ikg}^{\beta} \quad (1)$$

where Y is value-added, K is capital, L is labor, A is technology efficiency parameter, i denotes individual establishment, k denotes sector and g governorate. By log-linearizing equation (1), we obtain an estimable equation as follows:

$$logY_{ikg} = logA_{ikg} + \alpha \, log \, L_{ikg} + \beta \, log \, K_{ikg} + \varepsilon_{ikg} \quad (2)$$

where A is the residual (TFP).

We estimate the TFP as follows:

$$TFP_{ikg} = logA_{ikg} = logY_{ikg} - \widehat{logY}_{ikg} \quad (3)$$

with $\widehat{logY}_{ikg}$ the estimated value-added.

3.2 Computing Agglomeration Indices

The paper makes use of a large dataset of 62,108 firms in 342 four-digit activities in 27 governorates. Following Howard et al. (2014), we use several indices to proxy for economies of agglomeration.

First, to measure urbanization or diversification economies (Jacobs, 1969), we define the size of the region as the number of firms located in the region, which is a governorate in our case *(firm gov)*. Indeed, we follow Henderson (2003) in counting the number of firms in each governorate rather than focusing on employment. In his seminal work, he showed that the sources of agglomeration externalities are individual firms rather than individual employees (similar to Fujita and Ogawa, 1982). Therefore, firms will be attracted to areas where there is more economic activity.

Second, localization economies or specialization associated with agglomeration are measured by the average productivity of the activity and governorate (Marshall, 1920): for firm *i,* we calculate the average productivity of all other firms in area *g* in sector *k*, excluding firm *i (Avg. TFP Gov)* to avoid endogeneity. Indeed, if knowledge and technology spillovers are more likely to occur, average productivity of other firms in the same cluster will have an impact on firm productivity when more productive firms are in close proximity. Moreover, having some champions in the cluster might be a proxy for the average productivity in a particular sector and a particular governorate. This is why we construct another variable *Ln(Num 90)* that measures the number of firms per sector and per governorate whose sales are greater or equal to the 90^{th} percentile.

Third, to measure competition, we compute the number of firms in the same cluster (or governorate) that are operate in the same sector (measured at the 4-digit ISIC level) *(firm gov. sec)*. The higher the proportion of firms in the same sector in the governorate, the greater the competition. Hence, in order to survive, firms must be highly productive. We also control for possible cross-effects between them. We interact agglomeration variables with both Marshall-type and Jacobs-type knowledge spillovers to account for possible amplification of within-and cross-industry agglomeration effects when region and industries are more exposed to foreign market access.

3.3 Examining Productivity and Agglomeration

To reiterate, the aim of our paper is to investigate the extent to which agglomeration variables have an impact on firm-level productivity. This part will assess the impact of Marshallian externalities, Jacobs's externalities and competition. The type of externality could be indicative of the structure of the market (monopolistic or competitive). Hence, our third step is to use this estimated TFP to examine which agglomeration variable matters most as follows:

$$TFP_{ikg} = \alpha_0 + \alpha_1 ln(age_{ikg}) + \alpha_2 Priv_{ikg} + \alpha_3 Leg_{ikg} + \alpha_4 Num.Firm_{kg} + \alpha_5 Num.Fim_g + \alpha_6 Avg.Prod_{kg} + \mu_{k+} \eta_{ikg} \quad (4)$$

where $ln(age_{ikg})$ is the age of firm *i* operating in sector *k* and governorate *g, Priv* is a dummy variable that takes the value of 1 if the firm is privately owned and zero otherwise, *Leg* measures the legal status of the firm. As per agglomeration variables, we include the number of firms by sector and governorate to measure competition $Num.Firm_{kg}$, the number of firms by governorate to measure urbanization/diversification (Jacob's externalities) $Num.Fim_g$ and the average productivity by governorate and activity $Avg.Prod_{kg}$ to measure specialization/localization externalities (Marshall's externalities). μ_k are sector dummies (at the 2-digit level) and η_{ikg} is the disturbance term.

Furthermore, we extend our analysis in two ways. First, to examine the differential impact of agglomeration economies on TFP of different firms, we run regressions for micro (less than 5 employees), small (from 5 to 19), medium (from 20 to 99) and large (greater than 100) firms. Second, we run regressions for both the manufacturing and services sector as the former is likely to be more affected by agglomeration economies than the latter (Krugman, 1991). For the sake of robustness checks, we run this regression using a TFP estimated using a translog function.

4. Descriptive Statistics

This section will show some descriptive statistics that serve as an introduction to a more thorough quantitative analysis. The section, first, describes aggregate measures of firm productivity, Jacob and Marshall externalities indices, as well as, the correlations between them. Second, the section will present some stylized facts by firm size and sector for these variables.

4.1 Aggregate Indices

Firm productivity is heterogenous among governorates in Egypt (Figure 1). The governorates that enjoyed higher than average productivity are either metropolitan governorates (Cairo, Giza, Alexandria and Suez) or highly populated governorates in Lower Egypt (Al-Sharkeya, Al-Beheira and Al-Gharbeya). Al-Dakahleya is another highly populated governorate in Lower Egypt that enjoys relatively high firm productivity, yet lower than the country average. These governorates also exhibit relatively lower poverty rates, higher living standards, and easier connections to markets compared to the rest of Egypt. All governorates in Upper Egypt (with the exception of Giza) show lower productivity levels for their firms, which coincides with high poverty levels, lower welfare and difficult connectivity to markets. Furthermore, productivity is also surprisingly high in three frontier governorates; namely Matrouh, North and South Sinai (for the latter, mainly thanks to tourism).

Most of the governorates have diverse industries (Figure 2), where few have positive externalities from industry specialization (Figure 3). Governorates with high Marshall specialization index, compared to the average, also enjoy higher productivity and relatively higher living standards (Cairo, Giza, Alexandria and Al-Kalyoubia).

Higher productivity is correlated with a high specialization index, measured by Marshallian Intra-Industry index (Figure 4) and with urbanization (Figure 5) and business clusters (Figure 6). Indeed, simple regressions show that a 10% increase in the specialization index increases TFP by 6%, providing preliminary evidence that spillovers from specialization and business clusters enhance productivity, hence support the economies of agglomeration hypothesis in Egypt.

4.2 Firm Size and Agglomeration Economies

Firm size is inversely related to productivity. Table 1 shows that smaller firms have higher productivity than larger ones. The data also shows that firm age increases with firm size, yet the differences are not large. Larger firms have higher spillovers from diversification measured by the number of firms by governorate, while competition measured by the number of firms by governorate and by sector is higher for micro and small firms than medium and large ones. By contrast, externalities related to average productivity by governorate and by sector is higher for

large and medium firms than for micro and small ones. This can be explained by the externalities related to the presence of high growth firms in particular sectors.

4.3 Economic Activity

Productivity and spillovers vary widely among sectors (Table 2). Productivity by sector is heterogenous, where mining enjoys the highest TFP, followed by agriculture, then manufacturing and services. However, the latter two sectors have the highest spillover from diversification and specialization compared to the former ones. Additionally, competition is higher for manufacturing and services compared to the other two sectors.

5. Empirical Findings

Before reporting the estimates of different agglomeration measures in Tables (4-13), we estimated the production function using Cobb-Douglas and Trans-log approach by clustering the errors at the governorate level. A number of covariates representing firm characteristics such as age, firm ownership and legal status is added. All regressions included 4-digit sector dummies.

5.1 Aggregate regressions

Tables 3 and 4 show the results of aggregate regressions[5]. As the most basic setting, column (1) shows the results where only the firm's legal status, ownership and age are included. Table 4 shows that a firm's private-ownership contributes positively to productivity compared to any other ownership structure. Firm age is also positively associated with higher productivity. This result also holds for trans-log estimates of total factor productivity as shown in Table 5. In column 2, we added the number of firms located in the region (firm gov), which represent "Urbanization externalities." As expected, diversification or urbanization is found to have a positive impact on firm productivity and the result holds for all specification and productivity measures. Consistent with theory, firms tend to be more productive in governorates where there are a larger number of firms. In column (3), we include the proportion of firms in the governorate that are in the same 4-digit economic activity as a proxy for competition. We find that competition spurs productivity (Schiffbauer & Ospina, 2010).

As revealed in columns (4-5), our externality variable is found to be positive and significant either measured by average productivity of the cluster excluding the individual firm in question or the highest growth firms. In column (6) to (9), we include the three measures simultaneously and their interactions. In column (7), we introduce the number of firms in the same sector in the same cluster whose sales are greater than or equal the 90^{th} percentile as a measure of productivity. We find that firm's productivity increases when located in the same sector in the same cluster near large firms pointing out the importance of knowledge spillovers. However, the coefficient of the competition variable becomes negative. This is probably due to the presence of congestion when there is deficient infrastructure, as discussed in the literature.

[5] TFP is estimated using a log linear Cobb-Douglas production function with constant returns to scale. We also use Translog and find similar results in all cases.

Finally, column (8) and (9) add interactions between different measures of agglomeration. While all interactions are insignificant (and hence they will be removed from the remaining regressions), the urbanization or diversification index and the specialization index (whether average productivity or large firms) are still positive and significant. Table 5 confirms these findings using translog TFP estimation.

Therefore, in a nutshell, we found that agglomerations measured by specialization (the average productivity by sector and governorate) and diversification (the number of firms by governorate) boost productivity, whereas competition (the number of firms by governorate and by sector) has a detrimental effect on it, possibly due to congestion and the lack of a developed infrastructure.

Next, for a better understanding of the agglomeration-productivity nexus in Egypt, we analyze differences in firm productivity controlling for different categories; firm size (micro, small, medium and large) and economic activity (agriculture, mining, manufacturing and services).

5.2 Heterogeneous Effects by Firm Size

Table 5 presents the results by firm size: micro, small, medium and large firms. While firm age is positively associated with TFP only for micro firms, we find strong evidence to suggest that private ownership contributes positively to productivity of all firms, regardless of their size and TFP measure used.

As per our measures of agglomeration, it is interesting to note that urbanization externalities are strong for all types of firms, regardless of their size and TFP specification, as revealed in Tables (5-6). Urbanization or diversification is highly beneficial for small and medium sized firms compared to both large and micro firms. Indeed, small and medium firms have no resources to invest in R&D and, therefore, being located in clusters that are characterized by a high density of various economic activities can result in learning from large firms, without incurring R&D costs *(Damijan & Konings, 2011)*. In addition, localization or specialization is found to have a positive a significant impact on firm's productivity regardless of their size and TFP specification. Yet, it is important to note that this pattern holds for micro and small firms and vanishes for medium and large, when we measure externality by the number of large firms. This suggests that micro and small firms experience higher positive productivity spillovers compared to other firm sizes when they are close to large firms. Finally, competition is found to have a significant and negative impact on the productivity for firms of all size categories except large firms, where it is insignificant (Fafchamps & Hamine, 2017). The results suggest that both urbanization/diversification and specialization matter for the productivity of micro and small firms, so does private ownership. However, competition is detrimental, possibly due to congestion effects and deficient infrastructure. Similar results are obtained with a translog specification as it is shown in Table 6.

5.3 Agglomeration Economies and Economic Activities

Finally, we analyze TFP by economic activity as it is shown in Tables (7-8). We found that diversification (number of firms by governorates) does not follow a unique pattern using different specification of TFP. In fact, we find that while mining and manufacturing firms are negatively affected by the number of firms by governorates, firms in the services sector are

positively affected. Yet, when we control for the large firms located in the cluster, manufacturing and services firms tend to benefit more from diversification whereas mining firms do not. With regard to our translog estimation, shown in Table (8), urbanization agglomeration is stronger for both manufacturing and services firms. At the same time, the average productivity by sector and governorate has strong productivity effects on manufacturing firms compared to services and mining for different TFP measures (Henderson, 2003). Indeed, co-agglomeration of similar economic sectors can help only manufacturing firms to benefit from input-output linkages and labor pooling (Baldwin et al., 2010; Ellison et al., 2010). Competition between firms with similar economic sectors in the same cluster is found to improve productivity in agriculture firms, while decreasing productivity for mining, manufacturing and services firms. These results also hold using the trans-log measure of TFP and attributed to severe congestion (Hu et al., 2015a).

Firm age is positively associated with productivity regardless of industry type with the exception of manufacturing. On reason is that manufacturing sector requires more innovation and investment in both labor and capital to sustain productivity increases. This is why younger firms are more likely to innovate and hence to have a higher TFP than older firms. At the same time, private ownership of firm is found to improve firm productivity, but the effect vanishes for agriculture firms. This pattern is consistent with results of the trans-log TFP estimation, as shown in Table 11. We observe that service firms benefit more from high levels of urbanization, while manufacturing firms gain more from localization in Egypt. The rationale behind this could be that the embedded knowledge in service firms are less tangible and benefits more from labor pooling, while on the contrary, manufacturing firms require more investment in R&D and benefit more from knowledge spillovers and specialization (Ehrl, 2013; Rizov et al., 2012).

6. Conclusion and Policy Recommendations

This paper contribution is threefold. First, it estimates different measures of agglomeration, namely (i) urbanization or firm diversification, as measured by the number of firms by governorate, (ii) localization and specialization, as measured by the average productivity by governorate and sector, and (iii) competition, measured by the number of firm operating in the same governorate and the same sector, and examines the relationship of these measures with productivity. Second, it takes into consideration heterogeneity implied by economic activities and firm size. Third, it uses a rich dataset of 62,108 firms in 342 four-digit activities in 27 governorates for a developing country (Egypt) in order to examine the effect of such agglomeration economies on firm productivity. The Egyptian case is particularly interesting since the industrial sector has been facing several problems affecting its productivity and the government is currently implementing several structural reforms to improve its competitiveness. Hence, an evidence-based study on the importance of clusters and agglomeration is crucial from a policy perspective.

Overall, we find strong evidence for the existence of agglomeration economies in Egypt after controlling for firm age, location, economic activity and legal status. Similar to other work on Egypt (Howard, Newman, Rand, & Tarp, 2014), we find that productivity spillovers gained from agglomeration economies outweighed the negative effects of congestion due to

competition. The latter is probably due to the lack of adequate infrastructure. When regressions are run by firm size and activity, our main findings show first that micro and small firms are more likely to benefit from localization and diversification compared to medium and large firms. Finally, service firms benefit more from high level of diversification while manufacturing firms gain more benefits from knowledge spillovers and specialization in Egypt. Clearly, our result might be suffering from an endogeneity between productivity and agglomeration. Yet, because of data constraints (we only have a cross-section for 2013), it is impossible to control for this.

The study highlights the importance of investing in business cluster development to enhance productivity through utilizing economies of agglomeration. One policy recommendation could be developing specialized business clusters based on each governorate's comparative advantage. Furthermore, these clusters should have the appropriate hybrids of different firm sizes. As highlighted in this research, smaller firms tend to have higher total factor productivity. Furthermore, micro, small and medium firms benefit from specialization and diversification spillovers resulting from agglomeration.

From a policy perspective, first, facilitating mobility of factors of production (labor and capital) is integral to promote economies of agglomeration and consequently boosting firm productivity. Enhanced transportation and access to markets close to business clusters locations could be one policy advice to the government.

Second, further development to the existing business clusters is needed. Government efforts should be focused on supporting the existing business clusters, expanding the supply chain, and linking them to markets (internal and external). Rigorous efforts are needed to expand and enhance existing clusters, develop further the supply chain of feeding industries, and fostering specialization. It is recommended to establish specialized industrial zones for promising business clusters that have high growth potentials.

Third, it is advisable that the government invest in human capital through providing vocational educations and training centers that are related to the business clusters. These human capital centers would be in the proximity of the business clusters. A tripartite arrangement among the ministry of trade and industry, the ministry of higher education and the private sector could be useful in setting vocational education and training programs for labor working in these industries.

Fourth, enhancing access to finance for firms in these business clusters is important to ensure sustainability and growth. Access to finance is one of the obstacles facing firms in Egypt in general. However, the government and the banking sector are encouraged to enhance access to finance for firms in these clusters and develop customized financial product that could help in financing the working capital needs and increasing investments.

Fifth, the government is advised to ensure proper infrastructure is well connected to the business clusters all over Egypt. Electricity, water, sanitation and waste disposal systems are important factors to attract business and to develop the clusters.

Sixth, on the sectoral side, manufacturing will benefit most from specialization. Hence, promoting business clusters in manufacturing and creating a value chain could greatly enhance

productivity of the sector and promote forward and backward linkages. On the other hand, services will benefit most from spillovers resulting from diversification.

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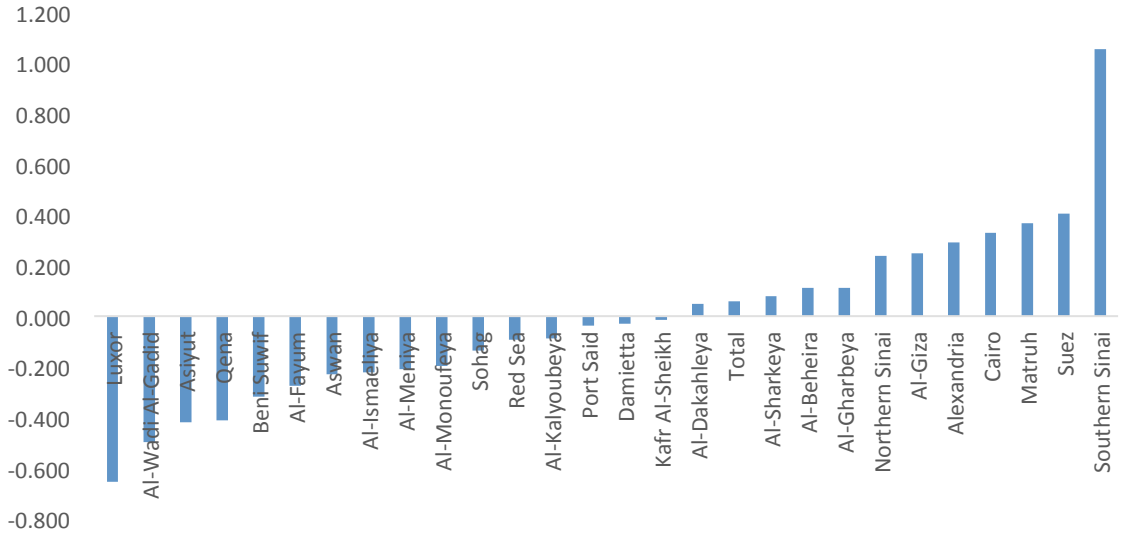
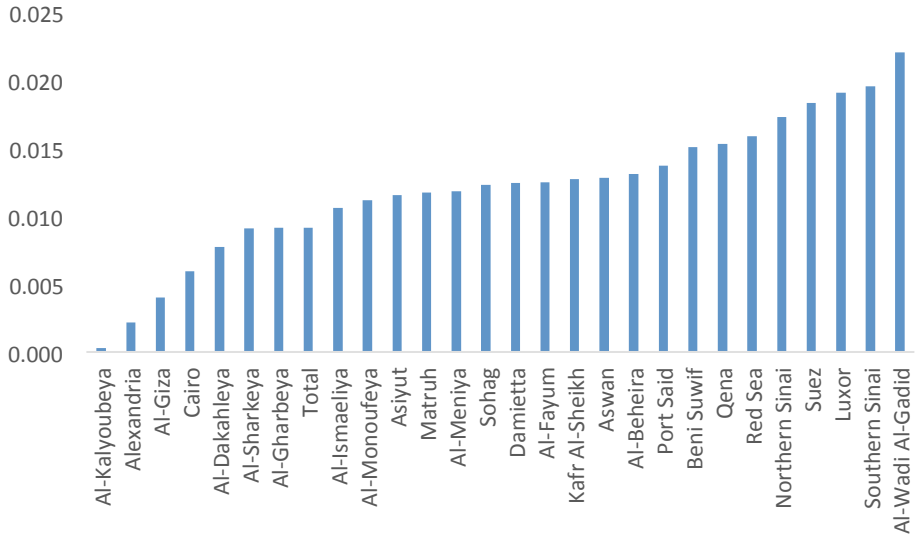
Figure 1. TFP by Governorate



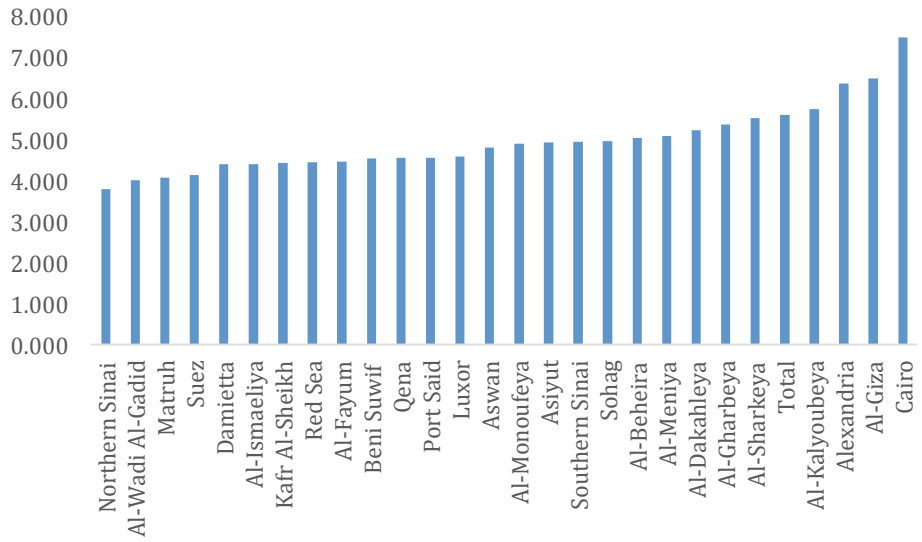
Source: Constructed by the authors using the Economic Census data (2012/13)

Figure 2. Jacobs Externalities Index by Governorate



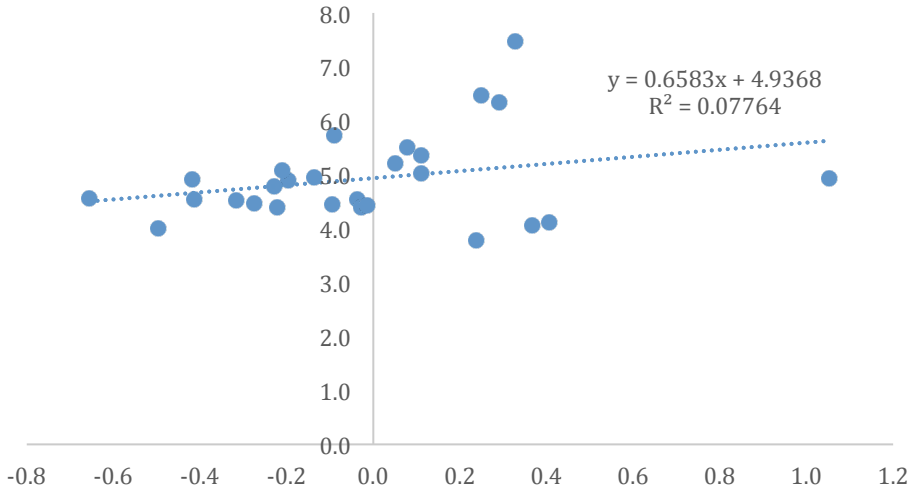
Source: Constructed by the authors using the Economic Census data.
Note: Jacobs externalities are measured by Hirschmann-Herfindhal index $invH_N = 1/\sum_{i \in k} s_{ikg}{}^2$
Where s is the share of firm i in sector k and region g.

Figure 3. Marshallian Intra-Industry Index by Governorate



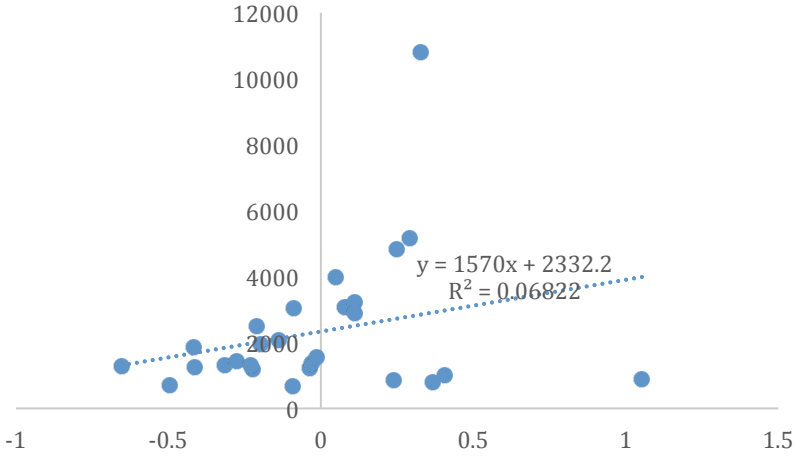
Source: Constructed by the authors using the Economic Census data.
Note: Marshallian externalities are measured by the intra-industry index
$IIS = \langle \sum_{i \in k} E_{ikg} - E_{ikg} + 1 \rangle$ where E is measured by employment for firm i in sector k and region g.

Figure 4. Correlation between TFP and the Marshallian Intra-Industry Index



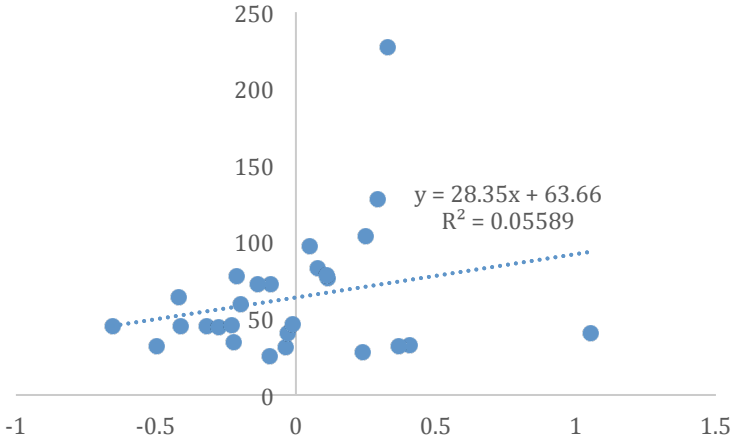
Source: Constructed by the authors using the Economic Census data.
Note: Each dot represents a governorate. The X-axis represents TFP and Y-axis Marshallian externalities that are measured by the intra-industry index $IIS_{ijr} = \langle \sum_{i \in jur} E_{ijr} - E_{ijr} + 1 \rangle$

Figure 5. Correlation between TFP and Cluster Size



Source: Constructed by the authors using the Economic Census data.
Note: Each dot represents a governorate. The X-axis represents TFP and Y-axis the cluster size which is measured by the number of firms by governorate.

Figure 6. Correlation between TFP and Competition



Source: Constructed by the authors using the Economic Census data.
Note: Note: Each dot represents a governorate. The X-axis represents TFP and Y-axis competition which is measured by the number of firms by governorate and by sector.

Table 1. Indices by Firm Size

	Micro	Small	Medium	Large	Total
TFP	0.11	0.00	-0.25	0.01	0.06
Ln(Age)	1.91	2.43	2.85	2.91	2.13
Firm Gov.	3655.46	4921.96	5395.78	5741.68	4138.07
Firm Gov. Sec.	100.01	106.26	85.02	66.94	99.34
Avg. TFP Gov.	0.03	0.10	0.13	0.19	0.06

Source: Constructed by the authors using the Economic Census data.

Table 2. Indices by Economic Activity

	Agriculture	Mining	Manufacturing	Services	Total
TFP	0.25	0.83	0.06	0.05	0.06
Ln(Age)	2.22	1.61	2.34	2.07	2.13
Firm Gov.	2789.54	2873.62	4147.25	4165.53	4138.07
Firm Gov. Sec.	21.08	41.38	64.54	110.34	99.34
Avg. TFP Gov.	0.02	-0.06	0.05	0.06	0.06

Source: Constructed by the authors using the Economic Census data.

Table 3. Aggregate Results with Cobb-Douglas TFP

	TFP (1)	TFP (2)	TFP (3)	TFP (4)	TFP (5)	TFP (6)	TFP (7)	TFP (8)	TFP (9)
Ln(Age)	0.0720***	0.0679***	0.0713***	0.0678***	0.0715***	0.0687***	0.0676***	0.0687***	0.0676***
	(0.00442)	(0.00441)	(0.00442)	(0.00432)	(0.00442)	(0.00432)	(0.00441)	(0.00432)	(0.00441)
Private	0.915***	0.902***	0.897***	0.867***	0.917***	0.891***	0.927***	0.891***	0.927***
	(0.0783)	(0.0779)	(0.0783)	(0.0764)	(0.0782)	(0.0764)	(0.0779)	(0.0764)	(0.0781)
Ln(Firm gov.)		0.129***				-0.00378	0.162***	0.0106	0.0662***
		(0.00573)				(0.00782)	(0.00724)	(0.0212)	(0.0188)
Ln(Firm sec. gov.)			0.0309***			-0.0455***	-0.0466***	-0.0274	-0.247***
			(0.00432)			(0.00530)	(0.00549)	(0.0439)	(0.0359)
Avg. TFP. Gov.				0.857***		0.916***		1.066***	
				(0.0157)		(0.0183)		(0.230)	
Ln(Firm sec. gov.)*Avg. TFP.								-0.00274	
								(0.0167)	
Ln(Firm gov.)*Avg. TFP.								-0.0193	
								(0.0318)	
Ln(Firm gov.)*Ln(Firm sec. gov.)								-0.00218	0.0247***
								(0.00546)	(0.00437)
Ln(Num. 90)					0.0301***		0.0136***		0.0736
					(0.00447)		(0.00465)		(0.0479)
Ln(Firm sec. gov.)*Ln(Num. 90)									-0.00524
									(0.00649)
Ln(Firm gov.)*Ln(Num. 90)									-0.00338
									(0.00508)
Constant	-0.541***	-1.607***	-0.647***	-0.641***	-0.561***	-0.461***	-1.735***	-0.574***	-0.967***
	(0.0773)	(0.0904)	(0.0786)	(0.0755)	(0.0773)	(0.0938)	(0.0923)	(0.182)	(0.166)
Legal Form	YES	YES	YES	YES	YES	YES	YES	YES	YES
Act. Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	60,056	60,056	60,056	60,056	60,056	60,056	60,056	60,056	60,056
R-squared	0.223	0.230	0.224	0.260	0.224	0.262	0.231	0.262	0.231

Standard errors in parentheses

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

Table 4. Aggregate Results with Translog TFP

	TFP	TFP	TFP	TFP	TFP	TFP	TFP
Ln(Age)	0.0657***	0.0614***	0.0648***	0.0654***	0.0653***	0.0627***	0.0612***
	(0.00445)	(0.00444)	(0.00445)	(0.00434)	(0.00445)	(0.00434)	(0.00444)
Private	1.137***	1.123***	1.114***	1.112***	1.138***	1.125***	1.142***
	(0.0788)	(0.0784)	(0.0788)	(0.0768)	(0.0788)	(0.0767)	(0.0785)
Ln(Firm gov.)		0.135***				0.113***	0.161***
		(0.00577)				(0.00715)	(0.00729)
Ln(Firm sec. gov.)			0.0394***			-0.0404***	-0.0362***
			(0.00435)			(0.00532)	(0.00553)
Avg. TFP.				13.76***		13.17***	
				(0.245)		(0.249)	
Ln(Num. 90)					0.0273***		0.00806*
					(0.00450)		(0.00468)
Constant	-1.103***	-2.216***	-1.237***	-1.106***	-1.120***	-1.907***	-2.320***
	(0.0778)	(0.0910)	(0.0792)	(0.0759)	(0.0778)	(0.0910)	(0.0929)
Legal Form	YES	YES	YES	YES	YES	YES	YES
Act. Dummies	YES	YES	YES	YES	YES	YES	YES
Observations	60,056	60,056	60,056	60,056	60,056	60,056	60,056
R-squared	0.207	0.214	0.208	0.247	0.208	0.250	0.215

Standard errors in parentheses

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

Table 5. Results with Cobb-Douglas TFP by firm size

	Micro TFP	Small TFP	Medium TFP	Large TFP	Micro TFP	Small TFP	Medium TFP	Large TFP
Ln(Age)	0.101***	0.00196	0.00643	-0.0473	0.101***	-0.00519	0.00981	-0.0557
	(0.00449)	(0.0109)	(0.0267)	(0.0464)	(0.00465)	(0.0110)	(0.0267)	(0.0467)
Private	0.818	1.582***	0.476**	0.513***	0.903*	1.604***	0.493**	0.534***
	(0.516)	(0.320)	(0.233)	(0.125)	(0.534)	(0.322)	(0.234)	(0.126)
Ln(Firm gov.)	-0.0535***	0.0774***	0.124***	0.0824	0.129***	0.201***	0.202***	0.188***
	(0.00852)	(0.0189)	(0.0416)	(0.0592)	(0.00814)	(0.0171)	(0.0357)	(0.0545)
Ln(Firm sec. gov.)	-0.0334***	-0.0690***	-0.0889***	0.00314	-0.0347***	-0.0867***	-0.0972***	0.0220
	(0.00614)	(0.0123)	(0.0232)	(0.0364)	(0.00637)	(0.0128)	(0.0248)	(0.0423)
Avg. TFP.	1.004***	0.736***	0.410***	0.709***				
	(0.0186)	(0.0465)	(0.117)	(0.164)				
Ln(Num. 90)					0.0107*	0.0554***	0.0325	-0.00238
					(0.00596)	(0.00885)	(0.0224)	(0.0437)
Constant	0.720	-1.425***	-1.223***	-0.995**	-0.769	-2.318***	-1.824***	-1.797***
	(0.516)	(0.346)	(0.393)	(0.483)	(0.534)	(0.343)	(0.355)	(0.450)
Legal Form	YES	YES	YES	YES	YES	YES	YES	YES
Act. Dummies	YES	YES	YES	YES	YES	YES	YES	YES
Observations	40,838	13,280	4,410	1,528	40,838	13,280	4,410	1,528
R-squared	0.165	0.398	0.419	0.336	0.105	0.388	0.418	0.327

Standard errors in parentheses

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

Table 6. Aggregate Results with Translog TFP by firm size

	Micro TFP	Small TFP	Medium TFP	Large TFP	Micro TFP	Small TFP	Medium TFP	Large TFP
Ln(Age)	0.102***	-0.0137	0.00970	-0.0343	0.102***	-0.0210*	0.00999	-0.0351
	(0.00451)	(0.0108)	(0.0264)	(0.0473)	(0.00465)	(0.0110)	(0.0265)	(0.0473)
Private	0.869*	1.462***	0.255	0.385***	0.954*	1.489***	0.264	0.387***
	(0.517)	(0.316)	(0.231)	(0.128)	(0.533)	(0.321)	(0.232)	(0.128)
Ln(Firm gov.)	0.0803***	0.166***	0.163***	0.149***	0.129***	0.207***	0.191***	0.151***
	(0.00789)	(0.0168)	(0.0362)	(0.0554)	(0.00814)	(0.0170)	(0.0354)	(0.0552)
Ln(Firm sec. gov.)	-0.0301***	-0.0694***	-0.0613***	0.0706*	-0.0345***	-0.0776***	-0.0748***	0.0796*
	(0.00615)	(0.0122)	(0.0230)	(0.0370)	(0.00637)	(0.0127)	(0.0246)	(0.0429)
Avg. TFP.	15.56***	10.17***	3.102***	1.972				
	(0.305)	(0.478)	(0.962)	(3.196)				
Ln(Num. 90)					0.0117**	0.0565***	0.0263	-0.0170
					(0.00595)	(0.00882)	(0.0222)	(0.0443)
Constant	-0.465	-1.950***	-1.669***	-2.408***	-0.824	-2.331***	-1.918***	-2.436***
	(0.517)	(0.337)	(0.360)	(0.459)	(0.533)	(0.342)	(0.352)	(0.456)
Legal Form	YES	YES	YES	YES	YES	YES	YES	YES
Act. Dummies	YES	YES	YES	YES	YES	YES	YES	YES
Observations	40,838	13,280	4,410	1,528	40,838	13,280	4,410	1,528

Standard errors in parentheses

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

Table 7. Sectoral Results with Cobb-Douglas TFP

	Agr. TFP	Mining TFP	Manuf TFP	Ser. TFP	Agr. TFP	Mining TFP	Manuf TFP	Ser. TFP
Ln(Age)	0.100**	0.126**	-0.0160**	0.118***	0.102**	-0.0191	-0.0209***	0.118***
	(0.0473)	(0.0581)	(0.00788)	(0.00513)	(0.0471)	(0.0626)	(0.00803)	(0.00523)
Private	0.475	2.678***	0.266***	1.423***	0.528	2.563***	0.280***	1.471***
	(0.391)	(0.448)	(0.0921)	(0.129)	(0.389)	(0.443)	(0.0939)	(0.132)
Ln(Firm gov.)	-0.00564	-0.397***	-0.0640***	0.0189**	-0.00154	-0.279***	0.132***	0.181***
	(0.0879)	(0.0985)	(0.0150)	(0.00847)	(0.0878)	(0.0829)	(0.0130)	(0.00776)
Ln(Firm sec. gov.)	0.0818*	-0.299***	-0.0223***	-0.0393***	0.0904*	-0.500***	-0.0383***	-0.0392***
	(0.0470)	(0.0594)	(0.00672)	(0.00466)	(0.0466)	(0.0767)	(0.00787)	(0.00476)
Avg. TFP.	0.247	0.616**	0.964***	0.917***				
	(0.201)	(0.247)	(0.0424)	(0.0212)				
Ln(Num. 90)					0.150	0.153***	0.0142***	0.0197
					(0.132)	(0.0381)	(0.00501)	(0.0211)
Constant	-0.615	2.090**	0.383**	-1.642***	-0.730	1.936**	-1.118***	-2.937***
	(0.762)	(0.915)	(0.149)	(0.144)	(0.755)	(0.848)	(0.141)	(0.143)
Legal Form	YES	YES	YES	YES	YES	YES	YES	YES
Observations	673	402	12,721	46,260	673	402	12,721	46,260
R-squared	0.048	0.464	0.061	0.232	0.048	0.478	0.023	0.201

Standard errors in parentheses

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

Table 8. Sectoral Results with Translog TFP

	Agr. TFP	Mining TFP	Manuf TFP	Ser. TFP	Agr. TFP	Mining TFP	Manuf TFP	Ser. TFP
Ln(Age)	0.0913**	-0.0424	-0.0165**	0.0937***	0.0937**	-0.0537	-0.0294***	0.111***
	(0.0452)	(0.0630)	(0.00795)	(0.00503)	(0.0472)	(0.0622)	(0.00812)	(0.00524)
Private	0.0706	2.453***	0.206**	1.912***	0.0871	2.502***	0.180*	1.998***
	(0.373)	(0.443)	(0.0927)	(0.126)	(0.390)	(0.439)	(0.0950)	(0.132)
Ln(Firm gov.)	0.00268	-0.146	0.116***	0.0974***	0.00914	-0.249***	0.140***	0.176***
	(0.0842)	(0.0952)	(0.0120)	(0.00753)	(0.0880)	(0.0823)	(0.0132)	(0.00778)
Ln(Firm sec. gov.)	0.00904	-0.343***	-0.00552	-0.0383***	0.103**	-0.312***	-0.00766	-0.0320***
	(0.0462)	(0.0963)	(0.00676)	(0.00456)	(0.0467)	(0.0762)	(0.00796)	(0.00477)
Avg. TFP.	67.05***	13.38**	25.94***	13.65***				
	(8.606)	(6.599)	(1.039)	(0.211)				
Ln(Num. 90)					0.0847	0.0959**	0.00589	0.00662
					(0.132)	(0.0379)	(0.00507)	(0.0212)
Constant	-0.230	0.450	-1.100***	-2.677***	-0.420	1.125	-1.243***	-3.452***
	(0.725)	(0.828)	(0.131)	(0.138)	(0.757)	(0.842)	(0.142)	(0.143)
Legal Form	YES	YES	YES	YES	YES	YES	YES	YES
Observations	673	402	12,721	46,260	673	402	12,721	46,260
R-squared	0.139	0.294	0.093	0.256	0.060	0.298	0.049	0.188

Standard errors in parentheses

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