Paper to be presented at the DRUID Academy conference in Rebild, Aalborg, Denmark on January 15-17, 2014

The impact of international and inter-regional graduate flows on plant economic performance in Denmark

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Abstract

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Introduction. Based on the idea that graduates can be crucial to collect knowledge, bring it with them and transmit or use it in their workplaces, many governmental and non-governmental institutions have been spending considerable amounts of money both to attract foreign graduates and to promote domestic and international graduate mobility. The general belief is that an injection of non-locally educated human capital into firms' workforce can bring new ideas and new capabilities that increase their creativity, their innovation performances and, in turn, their productivity.
State-of-the-art. The paper builds on and cross-fertilizes three sub-strands of literature:
1. Mobile highly-skilled individuals as knowledge transmission channel. As technological knowledge is often tacit and embodied into people, it moves together with the people who master it. Recent evidence (e.g. Zucker and Darby, 2006) indicates that high-skilled mobile individuals are strategic 'knowledge spillover agents' (Trippl and Maier, 2010) who promote new combinations of scientific, technical and managerial knowledge.
2. Migrants and labour productivity. Migrant workers can significantly affect the human capital composition of firms, and, in turn, their innovation and productivity (e.g. Paserman, 2008).
3. Ethnic or cultural diversity, innovation and productivity. It is not the mere quantity of migrants working in a certain

environment but the variety of cultures to improve problem-solving, stimulate creativity, increase innovation and productivity (e.g. Alesina and La Ferrara, 2005; Fujita and Weber, 2003; Østergaard et al, 2011).
Research gap. Studies that test the impact of graduate mobility as a knowledge transmission channel have been scarce, and no systematic study assessing the impact of graduates? mobility on firm productivity has been carried out. In a similar fashion to Timmermans and Boschma (2013), the paper aims to fill the gap and understand if international and inter-regional graduate flows can bring about a significant impact on plant productivity.
Theoretical arguments. We believe that graduates represent a particular segment of the highly-skilled and that studying in a different country or region can shape the personalities and capacities of individuals in a crucial period of their life and have long-lasting effects. As a consequence, an individual that works in an area which is different from the one where he or she studied can bring ideas and methodologies different from the ones that are known by the graduates who come from the local universities (that usually represent the bulk of the employees of the plants operating in the area) and improve its productivity.
Method and data. The dependent variable of the study is labour productivity variation calculated as the variation of value added per worker at plant level. The key independent variables of interest are two: the net inflows of graduates who studied abroad and the net inflows of graduates who studied in a region different from the one of the plant. We include an indicator of cultural diversity (proxied as Herfindahl index of each plant and calculated by using the employees? country of birth) as additional right-hand side variable. The relation is estimated by using Ordinary Least Squares. Data relies on the Integrated Database for Labour Market Research (IDA), maintained by Statistics Denmark.

Jelcodes:J61,R11

The impact of international and inter-regional graduate inflows on firm economic performance in Denmark

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Abstract

Does graduate mobility play a significant role in fostering plant economic performances? Do employees that studied in a different area or country increase the productivity of the firm they work in? Despite the large amount of resources spent by public and private institutions to finance graduate mobility programmes, no systematic study specifically analyses the impact of mobile graduates on firm productivity. By making use of a Danish matched employer-employee dataset and implementing an OLS regression model, this paper aims to test the hypothesis that international and inter-regional student flows - by bringing with them the knowledge and skills acquired elsewhere - can have a positive impact on plant productivity.

Keywords : productivity, graduate flows, human capital, skilled migration.

INTRODUCTION

International and domestic inter-regional[1] graduate flows have become an important reality in developed and developing countries. Based on the idea that graduates may be crucial to collect knowledge, bring it with them and transmit or use it in their workplaces, many governmental and non-governmental institutions have been spending considerable amounts of money both to attract fresh foreign graduates, and to let their graduates study abroad, and as well as to promote national and international study exchanges among national universities. In fact, the general belief is that an injection of non-locally educated human capital into firms' and regions' workforce can carry new ideas and new capabilities that increase their creativity, their innovation performances and - in turn - their productivity.

Although studying abroad is a very old phenomenon, internationally educated people have drastically increased in the last decades. A recent report by the OECD illustrates an increase in international student flows in the OECD countries,, reaching 2.6 million in 2010, which is 20% higher than the average number over the period 2004-

[1] In the rest of the paper, by "inter-regional" graduate flows we mean the flows of domestic non-locally educated graduates, i.e. graduates who received their degree in a university located in an area different from the local labour market area where they work.

2009 and 6% higher than 2009[2] (OECD, 2013). Similarly, in many developing countries several funding schemes have been created to let students pursue graduate studies in the developed world: the Colombian Colfuturo, the Brazilian Capes, the Panamas Senacy or the Mexican Conacyt are just some examples of institutions providing national graduates with scholarships to study abroad. Less diffused but increasingly more common are programmes or scholarships to promote intra-national student mobility (e.g. SENECA project in Spain).

At the same time, increasing attention has been devoted to the mechanisms of knowledge transmission and on their impact on firm innovative and economic performances. Knowledge diffusion channels studied by the literature have included FDIs, import flows and high-skilled migrants. However, research testing the impact of graduate mobility as a knowledge transmission channel has been scarce, and no systematic study assessing the impact of graduates' migration on plant productivity has been carried out.

The main purpose of this study is to fill this gap and understand if international and extra-regional student flows - by bringing into firms ideas and capabilities different from those of the employees that studied locally – can bring about a significant impact on firm productivity.

The paper is organized as follows: section 2 discusses the main literature on the links between highly-skilled migrants, innovation and productivity; based on the discussion, some hypotheses are outlined. Section 3 presents the data, explains the methodology and how variables are constructed and used. In section 4 the main empirical findings and some robustness checks are presented. Finally, section 5 offers some concluding remarks and suggestions for further research.

CONCEPTUAL FRAMEWORK: SKILLED MIGRANTS, INNOVATION AND PRODUCTIVITY

Skilled migrants and graduates on-the-move as knowledge transmission channels

Since the advent of new growth theory, human capital and knowledge have been considered crucial to explain firm performance and, at the aggregate level, growth. This is why in the last decades, many studies have investigated the way in which knowledge transmits and gets absorbed by individuals and, in turn, by the enterprises and/or the region they work in.

As technological knowledge is often tacit and embodied into people and in particular communities, it is difficult to transfer (Audretsch and Feldman, 2004). Economic geographers have often emphasized the fact that geographical proximity can favour its transfer: actors geographically close are not only more likely to meet but also to develop some key interconnections and "untraded interdependencies" (Storper, 1997), which increase the possibilities for knowledge transmission. Several empirical studies – starting from the seminal works of Acs, Audretsch and Feldman (1992) and of Jaffe, Trajtenberg and Henderson (1993) – have found a significant positive relation between geographic proximity and human capital externalities.

[2] Note that this number includes only students who follow an entire bachelor or master's programme: short exchange programmes (e.g. Erasmus) are excluded from these figures.

However, the stickiness of knowledge to a certain place is strongly challenged when people get mobile because knowledge travels along with them. In other words, knowledge sticks to one place only to the extent to which people who master it do not migrate. Therefore, mobile skilled individuals – by bringing with them knowledge, expertise and know-how from a certain geographical context and acquiring new knowledge from another place – can be strategic "knowledge spillover agents" (Trippl and Maier, 2010) who promote new combinations of scientific, technical and managerial knowledge.

In the last decades, studies on the mechanisms of knowledge transmission abounded (Döring and Schnellenbach, 2006). Knowledge diffusion channels analysed by the literature have included FDIs (e.g. Branstetter, 2006), import flows (e.g. Coe and Helpman, 1995) and the channel of our interest, i.e. high-skilled migrants. With respect to this, some recent evidence seems to indicate that the geographical relocation of the highly-skilled - as well as the sector where they work and the interactions they establish between the places of origin and of destination - plays an important role to transfer technological knowledge. Recently Trippl (2013) found that mobile star scientists played an important role to promote international transfer of knowledge between their sending and their receiving regions. Similarly, Breschi and Lenzi (2010), when looking at the spatial mobility of inventors in the US, found migration to be a fundamental channel to bring new knowledge in the local knowledge base and avoid lock-in. Gagliardi (2011) found that the migration of the highly-skilled represents a crucial channel of knowledge diffusion which fosters the UK regional innovative performance.

However, specific researches testing graduates and students mobility as a mechanism of knowledge transfer have been scarce (Park, 2004; Faggian and McCann, 2006, 2009; Le, 2010, 2012), and no systematic study assessing the impact of foreign and external graduate flows on firm productivity has been carried out.

Fresh graduates can represent a key segment of the highly-skilled as studying abroad or in a university that is located in a different area can shape the personality of the individuals in a crucial period of their life and have long-lasting effects on their personalities and abilities. As Fry (1984) pointed out, studying abroad can make students develop multicultural, regional and international identities at the same time, providing them with new tools to develop technical skills as well as foreign language competences (which, in turn, are a fundamental vehicle to get in touch with more ideas codified in those languages). As a consequence, an individual that works in an area which is different from the one where he or she got his or her education may bring different ideas and methodologies from the ones that are known by the graduates who come from the local universities (who usually represent the bulk of the labour force of the plants operating in the area). This can happen both when an individual migrates from a country to another but also when he or she moves within the same country but to a different area. In this regard, Faggian and McCann (2009) - looking at the graduate migration and innovation in British regions - found very little or no evidence supporting the idea that the presence of local universities is beneficial for regional innovation; this may suggest that graduates who come from universities that are not closely located may bring more ideas and can better stimulate creativity and innovation. Along the same lines, Simonen and McCann (2008) - looking at the relationship between innovation outcomes in Finnish high-tech firms and the proportion of their workforces hired outside the region - found that hiring extra-regional workers who worked in the same industry has a positive impact on innovation performances.

Migrants' skills and labour productivity

A large part of the literature has stressed the importance of migrants (also the "graduates on the move") to modify the skills composition of a plant or of a region. In other words, when migrant workers join a firm, they "inject" new human capital and ideas into it; this can affect both the firm-level productivity and the aggregated productivity of the region, also through potential externalities. Furthermore, as mobility of individual usually increase their likelihood to find jobs consistent with their education level (e.g. Hensen et al., 2009; Iammarino and Marinelli, 2012), it may increase also the possibilities to mobilize r skills and capacities which otherwise may have remained unused.

Recent studies have looked at the relation of migrants' skills and productivity (both at the national, regional and at the firm level) showing rather mixed results. Huber and Tondl (2012), analysing migration flows in European regions, found that emigration is associated to a reduction in productivity in emigration regions and to an analogous increase in productivity in immigration regions, suggesting that migrants in Europe tend to positively contribute to the human capital composition of the region of destination. Huber et al (2010) used both cross-sectional and panel regression to analyze how migrants' skills have affected productivity in European countries: their findings indicate that the share of highly-skilled migrants over the total highly-skilled workers has had a positive and significant effect on the industry-level Total Factor Productivity (TFP) growth in high-tech sectors. Paserman (2008) – by analysing the productivity of Israeli manufacturing firms through a conventional production function[3] and regressing the TFP estimates generated by growth accounting on the migrant share of the workforce – found that the latter has had a negative effect on productivity in low-tech sectors and a weak positive effect in high tech sectors. Peri (2012) making use of the variation in the inflows of immigrants across US states found robust evidence supporting the hypothesis that immigration increase state TFP. Quispe-Agnoli and Zavodny (2002) found that in the US a larger share of immigrants is linked to lower (state level) labour productivity both in high and in low-skill industries. Kangasniemi et al (2008), looking at the relationship between migrants and productivity in Spanish and UK firms, got very different results for the two countries: using simple OLS regression on a standard Cobb-Douglas production function estimation, they found generally positive effects of migration on productivity in the UK but negative in Spain, even if they were not always significant.

All in all, migrants workers *per se* do not appear beneficial nor detrimental for innovation and productivity both at the micro (plant) level and at the macro (country) or meso (region) level: a big part of the story lies on their specific skills and attributes as well as on the institutional arrangements of the plants and of the regions where they end up working. Furthermore, existing research on the topic has focused on regional variation and studies micro-level investigations on the topic are absent.

Ethnic Diversity, Innovation and Productivity

A growing literature has also been concentrating on the role played by ethnic or cultural diversity for innovation and productivity: this strand of literature argues that it is not the mere number of migrants working in a certain environment to determine its innovative and productive performances but the variety of cultures and ethnicities

[3] i.e. a classical Cobb-Douglas with perfect substitutability between native and immigrant labour and possible differences in productivity.

that are in there. The main idea relies on the fact that people coming from different countries, by having different cultures and traditions, are likely to be different in personalities and in the ways of interpreting problems: in other words, a team including different nationalities is more prone to think differently and to get less stuck into problems than a team made up of people with the same cultural background. As a consequence, individual heterogeneity can provide with a wider range of perspectives that can improve problem-solving, stimulate creativity, increase innovation and, in turn, labour productivity (Alesina and La Ferrara, 2005). Fujita and Weber (2003) maintain that individuals with diverse ethnic background might be complementary in the production; therefore, new ideas, new processes and new products can be favoured when talents coming from diverse cultural environments come together.

However, cultural diversity or ethnic heterogeneity is also associated to cultural costs and frictions, which can be counterproductive for innovation and productivity: in fact, different languages, abilities and cultures can hinder the exchange of ideas and integration. Furthermore, natives can have a negative bias for immigrants' culture, behavioural attitudes or religions, which translate into lower trust and poor communication; on the same line of thought, Alesina and La Ferrara (2005) argue that people often do not trust culturally diverse individuals. As a consequence, cultural diversity leads to a trade-off between the importance of complementarities that it favours and the "inter-cultural" cost which a firm or an area can face when its workers come from different countries, speak different languages and have different behavioural attitudes (Lazear, 1999).

Empirical studies[4] have recently looked at the impact of ethnic or cultural diversity on innovative and productivity performances. Niebuhr (2010), analysing the regional innovative performance of German NUTS3 regions, found a strong positive effect of ethnic diversity on innovation, especially when highly qualified employees are highly ethnically diverse. Ottaviano and Peri (2006), looking at US cities, found a net positive significant effect of cultural diversity on the productivity of natives. More recently, Maré et al (2013) tested the possible link between three different types of heterogeneity and innovative performances: their study analysed the impact of local workforce composition in New Zealand regions measured according to the workers' qualifications, their country of birth and to the length of the period they have spent in New Zealand on average firm innovation outcomes. Once firm characteristics (e.g. firm size, industry R&D expenditure, and the like) are controlled for, they found no systematic influence between local workforce diversity and innovation. Same is true in a study by Østergaard et al. (2011), which did not find a significant impact of ethnic diversity on the likelihood to innovate based on a sample of Danish firms.

In sum, most empirical researches on cultural diversity and innovation or productivity have been based on regional data or on case studies of particular firms (rather than on comprehensive firm-level data) and provided rather mixed findings. As stressed by Nathan (2012), this impact needs to be underpinned by better individual and firm-level data (e.g. Østergaard et al., 2011; Ozgen et al., 2013).

Considering the above, this study aims to test the following hypothesis:

[4] Such kinds of studies have usually calculated the cultural or ethnic diversity index calculated as Herfindahl index (of the workers' nationalities or countries of birth). The index combines two different information at the same time : i.e. the richness (i.e. the number of nationalities or countries which are represented in a certain firm or geographical area) and the evenness (i.e. how evenly each nationality or country is present in the firm or the area).

1. "Fresh"[5] foreign educated graduates joining a plant have a positive impact on its productivity.
2. "Fresh" domestic non-local educated graduates joining a plant have a positive impact on its productivity.
3. The cultural or ethnic diversity among the employees of a certain plant has a positive effect on its productivity.

METHODOLOGY

Data and sampling

To investigate the above-mentioned issues this study will rely on the *Integrated Database for Labour Market Research* (IDA). IDA is a linked employee-employer database constructed from government records and individuals, plants and firms and maintained is by Statistics Denmark. IDA is particular suitable for our analysis as it holds a rich set of information on individuals (e.g. gender, age, nationality, country of origin, education, occupation, work experience, salary, etc.) and all firms registered in Denmark (e.g. sector, municipality code, equity, fixed assets, purchases, turnover, profits, exports, paid wages, value added) from 1980 onwards. The unique personal and firm identification numbers create the opportunity to track both individuals and firms over time making it possible, to identify the yearly net inflows of employees.[6]

Because our interest is to investigate the impact of graduate inflows on the performance of firms, the first step is to identify all recent graduates in the Danish labour force where a recent graduate is a person that has received a professional bachelor degree or higher in the previous five years. [7] This degree can be obtained in Denmark or abroad. For Danish degrees it is possible to identify, the type of degree, the university or college that has granted the degree, the municipality where the university of college is located and the date in which the graduate has received the degree. To identify whether a person has a foreign degree we apply a different approach. First, we identify the year in which a person enters Denmark. Up to 2006, it was a procedure of Statistics Denmark to survey migrants about their highest level of education. Thus, contrary to those degrees received in Denmark, this information is self-reported and has several limitations. Many Danes will not be going through this process; consequently, only a few Danes are identified of having a foreign degree. Furthermore, migrants are not obliged to fill in this information and thus we can expect a higher margin of error compared to the information on Danish graduate degrees. After identifying these graduates we link these recent graduates with the firm registers to ascertain whether the graduate is also a *recent* graduate inflow. To be regarded as a graduate inflow the person in question has to: (i) enter the firm after graduating; (ii) the job is registered as being the primary workplace; and (iii) the employee has a contract of at least 15 hours a week.

In addition to making a distinction between a Danish and a foreign degree, we also want to investigate the impact of recruiting a recent graduate with a local and a non-local graduate. A local recent graduate is an employee that received a graduate degree from a college or university located in the same Local Labour Market Area (LLMA) while a non-local graduate has received a degree from another LLMA. These LLMAS are self-containing labour

[5] We consider "fresh" graduates those who graduated no more than 5 years before.
[6] The IDA database contains only yearly observations: therefore, it is not possible to capture any change in an employer-employee relationship if it stops some months after November and starts again (maintaining the same position) before the following November.
[7] If a person has obtained multiple degree during his lifetime we count the year in which the latest degree has been received.

markets in terms of commuting patterns and appear to be more suitable for our analysis compared to administrative regions.[8] To identify these LLMAs we use the same classification as used in Timmermans and Boschma (2013) by applying the algorithm developed by Andersen (2002) to individuate the LLMAs in year 2003.

Before we proceed with exactly identifying the firms and conducting our models on the impact of recent graduates inflow we deem it necessary to present some of the overall characteristics on the graduates we have identified, i.e. which industries do they enter, in which regions are they recruited, and do they work for large or small firms. To present these numbers we focus on the recent graduate inflow in the period 1999-2004. This period is chosen for two main reasons. First, between 1998 and 1999 we observe a break in the financial dataset, which will have an effect on how we calculate some of our dependent and independent variables. Second after 2004 we observe a sudden drop in the number of foreign graduates that enter Denmark. We have at this point no explanation on the exact reasons why; although some of it might be explained by the fact that Statistics Denmark stopped surveying immigrants about their education in 2006. Overall, we observe 207,047 recent graduate inflows; these recent graduate inflows are based on 149,505 unique individuals where the majority, i.e. 69.84 percent, only appears once in the sample. In Table 1, we present a frequency table where we have assigned the inflows into NACE industry classes. Based on these classes we can observe that the majority of recent graduates, local non-local and foreign graduates alike, start working in non-private sectors, most notably education and healthcare; public administration is also an industry with a high inflow of recent graduates but understandably only a few with a foreign degree.

Table 1: Recent graduate inflow by Industry

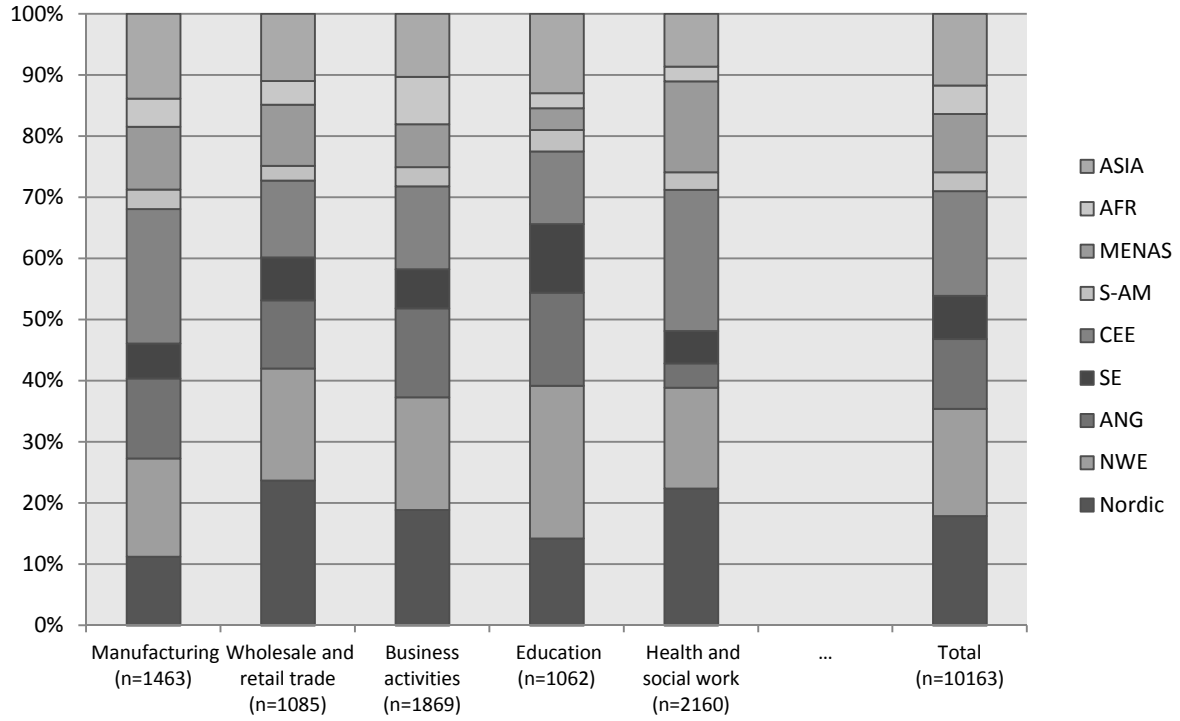
	Local Graduates		Non Local Graduates		Foreign Graduates		Total	
Industry Class	**Freq.**	***Perc***	**Freq.**	***Perc***	**Freq.**	***Perc***	**Freq.**	***Perc.***
A,B,C: Agriculture, Fishing, Mining	288	*28.07%*	441	*42.98%*	297	*28.95%*	**1026**	***0.50%***
D: Manufacturing	9007	*50.17%*	7484	*41.68%*	1463	*8.15%*	**17.954**	***8.67%***
E: Electricity, gas and water supply	508	*61.95%*	295	*35.98%*	17	*2.07%*	**820**	***0.40%***
F: Construction	1897	*60.74%*	1022	*32.72%*	204	*6.53%*	**3123**	***1.51%***
G: Wholesale and retail trade;	6326	*58.88%*	3333	*31.02%*	1085	*10.10%*	**10.744**	***5.19%***
H: Hotels and restaurants	744	*40.63%*	392	*21.41%*	695	*37.96%*	**1831**	***0.88%***
I: Transport, storage and communication	3287	*45.17%*	3380	*46.45%*	610	*8.38%*	**7277**	***3.51%***
J: Financial intermediation	2646	*64.96%*	1252	*30.74%*	175	*4.30%*	**4073**	***1.97%***
K: Real estate, renting and business activities	21.035	*64.66%*	9629	*29.60%*	1869	*5.74%*	**32.533**	***15.71%***
L: Public administration	8885	*57.47%*	6464	*41.81%*	110	*0.71%*	**15.459**	***7.47%***
M: Education	24.148	*62.39%*	13.498	*34.87%*	1062	*2.74%*	**38.708**	***18.70%***
N: Health and social work	40.219	*62.73%*	21.738	*33.90%*	2160	*3.37%*	**64.117**	***30.97%***
O: Other community, social and personal service activities	5356	*57.09%*	3610	*38.48%*	416	*4.43%*	**9382**	***4.53%***

[8] At least 75% of the residents of a Local Labour Market Area work inside the area. In order to determine the Danish Local Labour Market Areas, we look at residence and workplace addresses of the entire labour force (available in the IDA database).

Total	**124346**	***60.06%***	**72.538**	***35.03%***	**10.163**	***4.91%***	**207.047**	**100.00%**

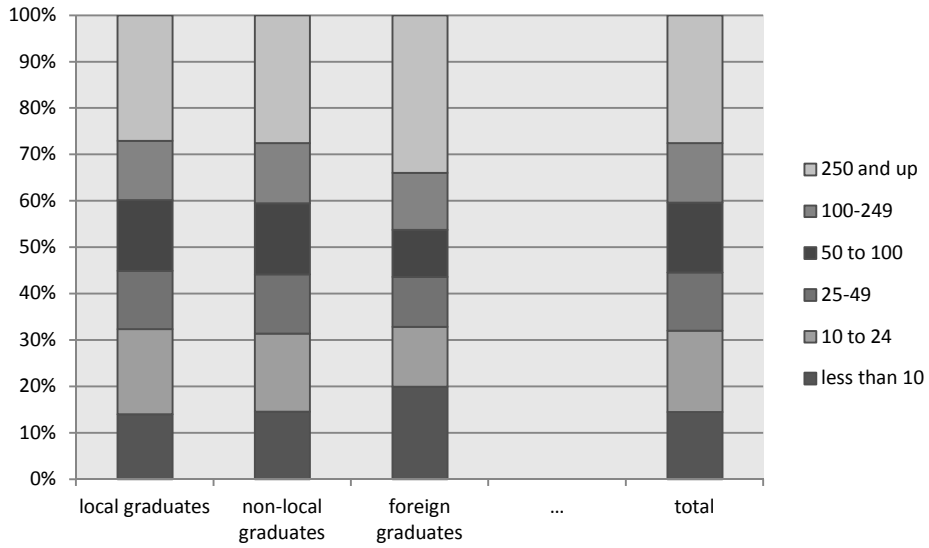
In Table 2 we have plotted the five industry classes with the highest absolute number of foreign graduate inflow. In addition, we have categorized these foreign inflows based on their country of origin and divided them in the following regional classes: Nordic, North West Europe (NWE, which includes the German speaking countries, Benelux and France), Anglo Saxon nations (ANG), Southern Europe (SE), Central and Eastern Europe (CEE), Latin America (S-AM), Middle Eastern and Northern African States (MENAS), Sahara and Sub-Sahara Africa (AFR), and Asia. Please not that this classification does not indicate the country in which these individuals have obtained the degree or the country of residence prior to entering Denmark. Based on this classification we observe clear differences in the distribution among these industries. Employees with a Nordic origin are more inclined to work in health care and wholesale but to a lesser extent in manufacturing and (higher) education. Recent foreign graduates from North West Europe and Southern Europe are relatively more represented in this industry. Foreign graduates from Anglo Saxon countries are to a lesser extent working in healthcare, contrary to our recent foreign graduates in the sample that originate from Central and Eastern Europe and Middle East and Northern Africa. CEE is also the largest group with a foreign degree represented in manufacturing.

Table 2: five industries with most foreign degrees, distribution based on area of origin



When taking a closer look at the size distribution and in which size workplaces different type of foreign graduates join firms, we observe that foreign graduates start working for relatively smaller firms compared to domestic graduates. In addition, we observe that these foreign graduates also are more included to work for larger firms, i.e more than 250 employees. However, this is driven by the graduates entering the public sector, i.e. hospital and education. If we only look at private industries foreign graduates work relatively less at larger workplaces.

Table 3: Recent Graduates and size of the workplace



Denmark is a country where the capital region, and the Local Labour Market Area of Copenhagen (LLMA CPH) is heavily concentrated in terms of overall population, i.e. nearly half of the population of Denmark lives in this area, and economic activity. It is not surprising to see that the majority of recent graduates inflow occur in this area (see Table 1). This also means that most of the inflows in LLMA CPH are local. Also the most graduates with a foreign degree work in this area, although the relative size is smaller.

Table 4: Graduates in LLMA CPH and rest of Denmark

Graduate type	*LLMA CPH*	*Rest of DK*	*Total*
Local Graduates	*82.102*	*42.244*	*124.346*
Non Local Graduates	*22.289*	*50.249*	*72.538*
Foreign Graduates	*6.148*	*4.015*	*10.163*
Total	*110539*	*96508*	*207.047*

Graduate inflows and firm performance

Based on the above-mentioned descriptive statistics we identify some clear differences in particular in the industries where individuals with a foreign graduate start working. Now we will continue to investigate in further detail the impact of recent graduate inflow on firm performance. Because these performance measures are only available for firms in non-public industries we have to limit our sample of firms. In addition, we also exclude firms in agriculture and industries that are under government regulation. In addition to the industry criteria, we have set some additional requirements. First, we want to measure the impact of inflow on the growth of plants; therefore, financial data needs to be available in two points in time, i.e. in the year in which graduate inflow is observed and two years after. Second, ownership remains the same, i.e. firms that change ownership and for that reason change identification number will be removed from our sample. Finally, we only select firms that over the entire period consist of only one-plant firms.[9] For all the firms that we identify we create a panel

[9] There are ways to deal with multiplant firms but for this version of the paper we start with a more simple approach.

dataset covering the period 1999-2004. Not all firms will be present at the start nor at the end of this period; consequently, we will have an unbalanced panel covering 45.842 observations with just under 11.000 firms.

Dependent variable: labour productivity growth

The performance indicator used in our regression analysis is labour productivity growth, i.e. *labprob*. This measure is calculated in the similar way as Boschma et al. (2009) and Timmermans and Boschma (2013) by using value added growth per full-time employee. As a first step, we identify the value added per full-time employee in the year the graduate entered the firm (t=0) and two years ahead in time (t+2) [10]. Dividing the reported value added in the firm by the number of full time employees creates this measure. To measure labour productivity we take the log value of labor productivity in t=0 and subtract this value from the log value of labor productivity in t+2.

Independent variables

Three of the four main variables of interest are the inflow of graduates with a foreign, local and non-local degree. These variables, which are termed *forgrad*, *locgrad* and *nonlocgrad* respectively, are all count variables. To identify the inflow of a foreign degree is the most elaborate procedure where we first identified all the individuals that immigrated, or re-migrated, to Denmark after the age of 20 and upon entering Denmark have indicated to: (i) own a graduate degree and (ii) have listed the year in which they completed this graduate degree. In our sample, we observe that around 5.690 times a person who (re)-migrated with a foreign college degree[11] starts working for a firm in the manufacturing or service industry up to five years of graduating..

For the individuals that obtained their graduate degree in Denmark we can rely on the variable in IDA that indicates the college or university that has awarded the graduate with the degree. This same variable can also be used to determine the municipality where the degree was obtained and to identify if the degree is local or non-local. In this case, we define local as the same region and for this regional classification we will use Local Labour Market Areas (LLMAs). These LLMAS are self-containing labour markets in terms of commuting patterns and appear to be more suitable for our analysis compared to administrative regions. [13] To identify these LLMAs we use the same classification as used in Timmermans and Boschma (2013) where they used the algorithm developed by Andersen (2002) to individuate the LLMAs in year 2003. We then classify as domestic non-local educated graduates those who received a degree from a university located in a LLMA different from the one where they end up working. Based on this criteria we identify 42301 graduates with a local degree and 25078 graduates with a non-local college degree. We have to note here that the LLMA that includes Copenhagen is the main driver that these graduate flows are local. Firms in other regions receive graduates that are non-local.

[10] We have assumed that the effects on productivity materialize with a 2 year-lag. One-year lag showed lower level of significance whereas and three and five -years lags have shown similar results.

[13] At least 75% of the residents of a Local Labour Market Area work inside the area. In order to determine the Danish Local Labour Market Areas, we look at residence and workplace addresses of the entire labour force (available in the IDA database).

The final main dependent variable is the cultural diversity in the firm, i.e. *culdiv*. The cultural diversity is proxied by a Herfindahl index index calculated by using the employees' country of origin.[14] Therefore, the cultural diversity of firm *a* is represented as:

$$culdiv_{a,t} = 1 - \sum_{i=1}^{N} sharecountry_{a,i,t}^{2}$$

where $sharecountry_{a,i,t}$ is the share of people originating from country *i* who work in firm *a* at time *t*. To create more easy to handle measures we have created categories of countries making the distinction between: Those with a Danish origin, a Nordic origin (i.e. Sweden, Norway, Finland, Iceland, Greenland and Faroe Islands), other North Western European origin (i.e. Germany, Austria, Switzerland, France, Luxemburg, Belgium and The Netherlands), Anglo Saxon origin (i.e. UK, Ireland, US, Canada, Australia and New Zealand), African origin, Latin American origin and the rest of the work.

Control variables

In addition to the above-mentioned explanatory variables we include a range of control variables. Because productivity numbers and the inflow of graduates are expected to vary significantly between industries we use industry control. In this case create dummy variables for different industry classes where we make a distinction based on the high-tech, medium high-tech, medium low-tech and low-tech classification, where the largest sectors are low-tech which are 34% of all firms followed by medium high-tech with 29% of the firms in the sample. Similar differences in productivity could potentially be observed in geographic location: as evolutionary economics literature has stressed (e.g. Nelson and Phelps, 1965) the effect of graduates and hi-skilled on the economic and innovative performances depends on the level of economic and technological development present in the regions they work. We take the earlier mentioned LLMA function as our geography control variables. The LLMA that includes Copenhagen is the region with the most firms, i.e. 36% of the sample, which is three times as large as the second largest, i.e. Århus. Because we identify the inflow of firms in the period 1999-2006 we also include control variables for the year in which we observe the inflow. Labour productivity growth is also expected to be influenced by a series of other firm characteristics, e.g. size, share of highly educated individuals and age of the firm. Moreover, we also include control variables for employment growth, investments in tangible assets, and the growth of the average wage level. An overview of all the variables is presented in Table 5.

[14] Country of origin is considered to be a more reliable indicator of the diversity of the individual than his or her nationality as the latter might change during his or her life whereas the country of origin cannot.

Table 5: Description of the variables

Name of the variable	Definition
Ln_Labprod_growth	Labour productivity growth measured as value-added per full-time employee in log value.
Grad_inflow	Number of graduates that enter the firm
Locgrad_inflow	Number of locally-educated graduates entering the firm which is located in the same local labour market area of their university.
Forgrad_inflow	Number of foreign-educated university graduates entering the firm in a plant.
Non-localgrad_inflow	Number of graduates coming from a Danish university and entering a firm which is located in a local labour market area different from the one of their university.
Culdiv	Cultural diversity index calculated as Herfindahl index on the shares of employees' countries of birth: $culdiv_{a,t} = 1 - \sum_{i=1}^{N} sharecountry_{a,i,t}^{2}$
LnAge	Log of the age of a firm.
ht, mht ,mlt, lt	Dummy variables corresponding the high tech(ht), medium high-tech(mht), medium low-tech (mlt), and low-tech (lt) industry classes.
Llma	Dummy variables corresponding to each local labour market area which assume value 1 when the plant is located in that particular local labour market area.
Hieduc	Share of employees in the firm with at least a bachelor degree.
Cap_growth	Growth of capital invested in tangible assets per employee of the plant.
LnSize	Number of employees of the plant.
Avgwage_growth	Growth of average wage of all the employees operating in the plant.

The estimation model

The structural equation of the model is specified as follows:

$$\ln\_labprod\_growth_a = \beta_0 + \beta_1 (locgrad_{a,b}) + \beta_2 (forgrad_a) + \\ + \beta_3 (non - locgrad_{a,b}) + \beta_4 (culdiv_a) + \beta\ (X_a) + \varepsilon$$

Where

- $\ln labprod\_growth_a$ is the variation in labour productivity between the period *t=0* and *t2* in plant *a*;
- $locgrad_{a,b}$, $forgrad_a$, $non-locgrad_{a,b}$ represent respectively the net inflows of local educated graduates, foreign-educated graduates, and domestic extra-regional educated graduates entering plant *a* located in LLMA *b* between year *t-1* and year *t0*;
- $culdiv_a$ is the ethnic diversity index at year *t0* in plant *a*;
- X_a is the sum of other relevant controls (see variable table);
- ε_a is the variation in the idiosyncratic error.

PRELIMINARY RESULTS

The relationship between local, inter-regional and international graduate flows is analysed by using standard cross sectional OLS models, as well as fixed effects and random effects ones.

The results of our estimations are reported in Table 6, 7 and 8. In table 6 we run simple cross-sectional OLS regressions, looking at different sizes of firms and at different industries as specified below. Due to the high number of observations, the estimations are subject to a high unobserved heterogeneity.

In table 7 and 8, in order to control for firm unobserved heterogeneity, we construct and make use of a panel dataset. As not all firms are present at the start nor at the end of the period of our analysis (1999-2004), we have an unbalanced panel covering 45.842 observations with just under 11.000 firms. We run the Hausman test to compare random versus fixed effects, finding that random effect models are not consistent. However, as fixed effect models take into account only variation over time within a single firm, throwing out all cross-firm variation, they can offer a rather limited perspective. In tables 7 and 8 we show the results both for fixed effects models (table 7) and random effects ones (table 8).

In all the three regression tables, 7 different estimations models are used. Model 1 reports a labour productivity function taken as baseline model where the productivity growth is related to the initial labour productivity, the labour growth, the growth of fixed assets, the age of the firm, the growth of the wages, the firm size, the firm age, the share of high educated employees and the total inflows of graduates. In model 2 the key regressors of interest (i.e. inter-regional, international, and local graduate inflows) are included. In model 3, 4 and 5 we decomposed the analysis focusing just on Small and Medium Enterprises (model 3), on high-tech and knowledge intensive industries (model 4), and on non-high-tech and non-knowledge intensive industries (model 5). In model 6 and model 7 we further decompose the sample analysing respectively high-tech and knowledge intensive SMEs and SMEs operating in non high-tech and knowledge intensive ones.

Table 6: Cross sectional regressions.

Dep. Var.	all firms	all firms	SMEs	High-Tech and KI	Other sectors	SMEs Hi-Tech and KI	SMEs Other sect.
Productivity Growth	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Intercept	10.777 ***	10.785 ***	10.882 ***	11.325 ***	10.053 ***	11.343 ***	10.101 ***
	(0.067)	(0.067)	(0.070)	(0.086)	(0.093)	(0.095)	(0.098)
Labour productivity in the first year	-0.840 ***	-0.840 ***	-0.845 ***	-0.876 ***	-0.789 ***	-0.875 ***	-0.789 ***
	(0.004)	(0.004)	(0.005)	(0.006)	(0.006)	(0.007)	(0.007)
Employment growth	-0.072 ***	-0.072 ***	-0.053 ***	-0.070 ***	-0.095 ***	-0.038 **	-0.090 ***
	(0.012)	(0.012)	(0.012)	(0.015)	(0.019)	(0.015)	(0.018)
Fixed assets growth	0.016 ***	0.016 ***	0.018 ***	0.014 ***	0.020 ***	0.015 ***	0.021 ***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Wage growth	0.054 ***	0.054 ***	0.056 ***	0.050 ***	0.055 ***	0.055 ***	0.055 ***
	(0.004)	(0.004)	(0.003)	(0.004)	(0.006)	(0.004)	(0.005)
Firm size	0.018 ***	0.017 ***	0.007	0.007	0.033 ***	0.003	0.016 **
	(0.004)	(0.005)	(0.005)	(0.007)	(0.007)	(0.007)	(0.007)
Firm age	0.034 ***	0.035 ***	0.034 ***	0.050 ***	0.026 ***	0.043 ***	0.027 ***
	(0.006)	(0.006)	(0.006)	(0.008)	(0.009)	(0.008)	(0.009)
High educated ratio	0.302 ***	0.297 ***	0.253 ***	0.197 ***	0.561 ***	0.168 ***	0.481 ***
	(0.023)	(0.023)	(0.022)	(0.027)	(0.042)	(0.027)	(0.039)
Cultural diversity	-0.372 ***	-0.335 ***	-0.311 ***	-0.232 ***	-0.373 ***	-0.200 ***	-0.367 ***
	(0.032)	(0.035)	(0.034)	(0.054)	(0.048)	(0.053)	(0.045)
Total graduate inflow	0.009 ***						
	(0.003)						
Local graduate inflow		0.007 **	0.005	0.011 ***	-0.026 ***	0.007	-0.012
		(0.003)	(0.004)	(0.004)	(0.008)	(0.004)	(0.010)
Inter-regional graduate inflow		0.019 ***	0.019 ***	0.0172 ***	0.009	0.016 **	0.017
		(0.005)	(0.006)	(0.007)	(0.009)	(0.007)	(0.012)
International graduate inflow		-0.016	-0.046 ***	0.030 **	-0.051 ***	-0.019	-0.060 ***
		(0.011)	(0.012)	(0.015)	(0.016)	(0.019)	(0.017)
R^2	0.765	0.765	0.749	0.818	0.725	0.799	0.705
Adjusted R^2	0.764	0.765	0.748	0.816	0.723	0.797	0.703
Number of observations	13013	13013	12356	6489	6524	6218	6138

*** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Table 7: Fixed effect regressions.

Dep. Var. Productivity Growth	all firms (1)	all firms (2)	SMEs (3)	High-Tech and KI (4)	Other sectors (5)	SMEs Hi-Tech and KI (6)	SMEs Other sect. (7)
Intercept	12.290 *** (0.062)	12.291 *** (0.062)	12.900 *** (0.052)	13.256 *** (0.091)	11.392 *** (0.088)	13.168 *** (0.070)	12.555 *** (0.080)
Labour productivity in the first year	-0.932 *** (0.003)	-0.932 *** (0.003)	-0.980 *** (0.003)	-0.995 (0.004)	-0.868 *** (0.005)	-0.996 *** (0.004)	-0.956 *** (0.005)
Employment growth	-0.262 *** (0.008)	-0.262 *** (0.008)	-0.252 *** (0.008)	-0.247 *** (0.011)	-0.283 *** (0.012)	-0.229 *** (0.012)	-0.275 *** (0.011)
Fixed assets growth	0.015 *** (0.001)	0.015 *** (0.001)	0.014 *** (0.001)	0.009 *** (0.001)	0.019 *** (0.001)	0.009 *** (0.001)	0.019 *** (0.001)
Wage growth	0.045 *** (0.001)	0.045 *** (0.001)	0.043 *** (0.001)	0.044 *** (0.002)	0.045 *** (0.002)	0.045 ** (0.002)	0.041 *** (0.002)
Firm size	-0.193 *** (0.011)	-0.193 *** (0.011)	-0.201 *** (0.010)	-0.207 *** (0.016)	-0.181 *** (0.015)	-0.197 *** (0.015)	-0.201 *** (0.014)
Firm age	0.174 *** (0.010)	0.174 *** (0.010)	0.181 *** (0.010)	0.193 *** (0.014)	0.158 *** (0.015)	0.195 *** (0.014)	0.170 *** (0.013)
High educated ratio	-0.014 (0.022)	-0.015 (0.022)	-0.012 (0.020)	0.011 (0.026)	-0.051 (0.035)	0.002 (0.026)	-0.049 (0.032)
Cultural diversity	0.017 (0.030)	0.019 (0.030)	0.021 (0.028)	0.030 (0.044)	0.006 (0.040)	0.037 (0.044)	0.013 (0.036)
Total graduate inflow	-0.004 (0.002)						
Local graduate inflow		-0.006 * (0.003)	-0.003 (0.003)	-0.001 (0.003)	-0.019 *** (0.007)	-0.005 (0.004)	0.002 (0.007)
Inter-regional graduate inflow		0.004 (0.005)	0.006 (0.005)	0.000 (0.005)	0.010 (0.009)	0.005 (0.006)	0.012 (0.009)
International graduate inflow		-0.009 (0.009)	-0.008 (0.009)	-0.005 (0.014)	-0.009 (0.012)	-0.015 (0.016)	-0.003 (0.011)
R^2	0.723	0.723	0.731	0.815	0.632	0.803	0.639
Number of observations	45804	45804	44786	19342	26462	18979	25807

*** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

Table 8: Random effect regressions.

Dep. Var. Productivity Growth	all firms (1)	all firms (2)	SMEs (3)	High-Tech and KI (4)	Other sectors (5)	SMEs Hi-Tech and KI (6)	SMEs Other sect. (7)
Intercept	11.318 *** (0.048)	11.320 *** (0.048)	11.763 *** (0.041)	11.763 *** (0.041)	10.510 *** (0.069)	12.320 *** (0.056)	11.135 *** (0.064)
Labour productivity in the first year	-0.859 *** (0.003)	-0.859 *** (0.003)	-0.897 *** (0.00)	-0.937 *** (0.004)	-0.788 *** (0.004)	-0.942 *** (0.004)	-0.841 *** (0.004)
Employment growth	-0.165 *** (0.006)	-0.166 *** (0.006)	-0.161 (0.006)	-0.145 *** (0.008)	-0.192 *** (0.009)	-0.131 *** (0.008)	-0.194 *** (0.008)
Fixed assets growth	0.017 *** (0.001)	0.017 *** (0.001)	0.016 *** (0.001)	0 .011 *** (0.001)	0.021 *** (0.001)	0.011 *** (0.001)	0.020 *** (0.001)
Wage growth	0.048 *** (0.001)	0.048 *** (0.001)	0.046 *** (0.001)	0 .048 *** (0.002)	0.046 *** (0.002)	0.048 *** (0.002)	0.044 *** (0.002)
Firm size	-0.022 *** (0.004)	-0.023 *** (0.004)	-0.030 *** (0.004)	-0.023 *** (0.007)	-0.021 *** (0.006)	-0.022 *** (0.006)	-0.032 *** (0.006)
Firm age	0.041 *** (0.005)	0.041 *** (0.005)	0.050 *** (0.005)	0.059 *** (0.007)	0.030*** (0.007)	0.061 *** (0.007)	0.041 *** (0.007)
High educated ratio	0.135 *** (0.015)	0.133 *** (0.015)	0.124 *** (0.014)	0.109 *** (0.018)	0.189 *** (0.025)	0.105 *** (0.017)	0.161 *** (0.024)
Cultural diversity	-0.146 *** (0.022)	-0.139 *** (0.022)	-0.135 *** (0.021)	-0.041 (0.035)	-0.194 *** (0.029)	-0.042 (0.034)	-0.184 *** (0.027)
Total graduate inflow	-0.002 (0.002)						
Local graduate inflow		-0.004 (0.003)	-0.003 (0.003)	-0.003 (0.003)	-0.017 *** (0.006)	-0.006 * (0.003)	0.000 (0.006)
Inter-regional graduate inflow		0.006 (0.005)	0.006 (0.005)	0.004 (0.005)	0.009 (0.008)	0.006 (0.006)	0.008 (0.008)
International graduate inflow		-0.016 * (0.009)	-0.021 ** (0.009)	0.007 (0.013)	-0.024 ** (0.011)	-0.008 (0.015)	-0.022 (0.011)
R^2	0.643	0.643	0.639	0.734	0.579	0.7347	0.564
Number of observations	45804	45804	44786	19342	26462	18979	25807

*** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level.

DISCUSSION ON THE RESULTS

With the purpose to contribute to the debate on the impact of human capital flows on innovation and productivity, in this paper we ran a preliminary analysis on recent graduate inflows in Danish firms.

We analyzed 11.000 Danish firms for which we observe a recent graduate inflow from 1999 to 2004, seeking to identify the relationships between local, inter-regional, and international graduate flows and labour productivity performances. In order to understand the relationship between recent graduate inflows and productivity, we implemented cross-sectional models as well fixed effect and panel effect ones, and we controlled for other factors such as geographical location, investments in tangible assets, firm size, firm age or employment growth; we looked at different sizes (SMEs versus large firms) and at different industries (high tech, medium high-tech, medium low-tech, and low-tech industry classes). Overall, our findings are not conclusive. It emerges a positive impact of the growth of firm fixed assets and of firm age on firm productivity, whereas the growth of firm employees has a negative impact in all our specifications. However, when we look at the key regressors of interest, findings are very different across models and prevent to draw precise indications. For instance, in cross-sectional analysis, when high-tech and knowledge intensive sectors are included, the inflows of inter-regional graduates positively impacts on productivity; at the same time, when we use fixed effect models to control for firm unobserved heterogeneity, virtually all kinds of graduate flows as well as cultural diversity result insignificant.

Therefore, this paper has to be considered as an exploratory analysis which has shed light on the peculiarities and the selection processes that seem to characterize recent domestic and foreign graduates working in Denmark. Expanding the sample of analysis by including also multi-plant firms, as well as exploring graduates' earning dynamics and their degree of education-job (mis)matching, appear to be important steps to take in order to understand the real effects of local, inter-regional and international graduates flows on economic performances.

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