The effect of SME productivity increases on large firm productivity in the EU-27

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Abstract
We investigate to what extent productivity of large firms is influenced by productivity growth of small and medium-sized enterprises (SMEs). We specify an econometric model which we estimate using a data base of the European Commission for the 27 Member States of the EU for the period 2002-2008. Our main findings are as follows. First, we find evidence for a positive effect of SME labour productivity increases on labour productivity increases of large firms. Second, we find that this primarily reflects an effect of medium-sized firm productivity increases, and not so much an effect of micro or small firms. Third, these effects are considerably stronger for those EU-27 countries with relatively lower levels of economic development. Our paper has several policy implications for developed and developing countries.

Keywords: labour productivity growth, SMEs, large firms, spillovers, EU-27 economies, stages of economic development

JEL-codes: L11, O11, O40

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1. Introduction

Achieving sustainable rates of economic growth is one of the most important goals for policy makers across the world. Economic growth can be decomposed into two components: employment growth and growth of labour productivity. However, particularly in the long run, employment growth is constrained by the size of the labour force. Therefore, the second component of economic growth, labour productivity growth, may be equally important, if not more important. The current paper focuses on the role of small and medium-sized enterprises (SMEs) in labour productivity growth, in particular their role in stimulating productivity growth of large firms.

Small and medium-sized enterprises, including micro enterprises, make a significant contribution to the economic performance of the private enterprise sector, accounting for more than half of all formal employment worldwide and an estimated 67% of permanent, full-time employment in developing countries[1] (Ayyagari et al, 2011). Moreover, the importance of the SME size-class as a source of employment growth has been widely documented, in particular for developed countries (e.g., De Wit and De Kok, 2014), but also for developing countries (Ayyagari et al., 2014; De Kok et al., 2013). These studies show that employment growth of SMEs is generally found to be proportionally higher than that of large firms. SMEs may therefore be seen as the job engine of economies.

Although there is a considerable knowledge base concerning the different contributions to job creation of smaller and larger firms, studies focusing on *productivity* differences between firms of different sizes are less frequent, in particular the dynamic interaction between productivity increases of SMEs and large firms. The current paper focuses on the impact of SME productivity increases on large firm productivity and macro-level productivity.

At the macro-level, the *level* of labour productivity can be expressed as a weighted average of small firm productivity and large firm productivity, where it is a stylised fact that the latter is higher in most sectors of economic activity (European Commission, 2010). However, when the *dynamics* of labour productivity are considered, interactions between firms of different sizes play an important role. In this respect, it is well-known that small firms may benefit from the higher productivity of large firms. For instance, foreign multinational enterprises (MNEs) may stimulate productivity of small, local firms when their knowledge spills over into the local economy through commercial links with local suppliers, imitation by local small and medium-sized enterprises (SMEs), training of local employees, or increased local competition as a result of MNEs infusing new technologies into the local market (De Clercq et al., 2008).

However, large enterprises may also benefit from labour productivity increases in SMEs, via knowledge spillovers and competition effects. For instance, by supplying high quality intermediate goods and services, small firms may positively influence productivity of larger firms. Also, by increasing their productivity, smaller firms are

[1] This is the median employment share of the SME size class across a sample of 99 developing and emerging countries, where the SME size class is defined as all private enterprises with up to 250 employees.

more likely to actually compete with larger firms, stimulating the latter to improve their performance (Fritsch and Mueller, 2004; Van Stel and Suddle, 2008).

Unfortunately, empirical studies on this reversed direction of productivity spillovers are lacking so far. In the present paper we therefore investigate empirically to what extent productivity growth of large firms is influenced by productivity growth of SMEs. We are particularly interested in this relation for developing countries. However, since the required data at size-class level are lacking for developing countries, we use a database for European countries. By distinguishing between country groups at different levels of economic development within the EU-27, we make an attempt to draw implications for countries at lower stages of economic development.

We specify an econometric model which we estimate using a data base of the European Commission for the 27 Member States of the EU for the period 2002-2008. In particular, our model explains changes in labour productivity of large firms from productivity changes of micro, small, and medium-sized firms, as well as a set of control variables. Moreover, we implement a Granger set-up, thereby ensuring predictive causality. Next to estimating these productivity interrelations between different size-classes, we also focus on possible differences between relatively higher and lower developed countries within the EU-27. To the best of our knowledge, the present study is the first that empirically investigates the interrelation between small firm productivity and large firm productivity across countries.

This paper is structured as follows. The next section provides a short literature review about the economic interdependencies between smaller and larger firms, as well as a short overview of empirical literature in this area. Section 3 derives the empirical models to be estimated in the econometric analysis. Sections 4 and 5 deal with the data and the results of our empirical analysis while Section 6 draws conclusions and implications for policy and research.

2. Literature review

In this section we will first provide a short review of economic interdependencies between smaller and larger firms. Second, we will provide a short overview of empirical literature in this area.

2.1 Interdependencies between small and large firms

By and large, the literature provides three mechanisms through which small firms can influence the productivity of larger firms: through knowledge spillovers, through competition effects and through their enabling role in increasing flexibility of large firms. Each of these three mechanisms will be discussed below.

Knowledge spillovers

Firms often grow faster than expected on the basis of the growth of their labour and capital inputs because of the occurrence of knowledge spillovers. Firms may increase productivity by benefiting from (new) knowledge developed in other firms when this knowledge spills over between firms. This may happen, for instance, because workers of different firms meet in business meetings, but also because workers transfer from

one firm to another and bring their tacit knowledge with them. Knowledge spillovers may occur between firms of all sizes, and in all directions. Hence, large firms will not only benefit from knowledge generated by small firms but also vice versa. Despite the current state of information technology, knowledge spillovers appear to be a local phenomenon (Audretsch and Feldman, 1996). Whereas codified information (e.g. the gold price in Tokyo or the weather in New York) can easily be transferred across the globe, knowledge is typically highly specific and tacit in nature (e.g., technical knowledge). Accordingly, face-to-face contacts are important in spreading knowledge (Audretsch and Thurik, 2001). The local nature of knowledge spillovers explains why clusters of nearby firms and more generally, agglomerations, form the best environment for knowledge spillovers to occur.

Three main sources of knowledge spillovers between firms may be identified: suppliers, employees and competitors (Syverson, 2011). First, knowledge may spill over from suppliers to customer firms, particularly when these suppliers provide high quality intermediate goods and services. Second, knowledge may spill over when employees move between firms and bring their tacit knowledge with them. Particularly when the employee possesses scarce knowledge which was not present in the firm before, a firm may considerably benefit from hiring such an employee. The degree to which employees move between firms in an economy is called labour mobility. Research shows that at the aggregate level, higher labour mobility has a particularly strong impact on productivity increases, because of the associated knowledge spillovers stemming from employee job changes (see, e.g., Stephan, 1996; Breschi and Lissoni, 2001). Third, knowledge may also spill over between competitors. Most of the time, these spillovers are involuntarily, as firms do no want to share their (newly generated) knowledge with competitors. But because of meetings or other contacts between firms, involuntary knowledge spillovers are sometimes hard to avoid. In other cases, knowledge spillovers between competitor firms occur intentionally, for instance when firms cooperate on innovation efforts (Audretsch and Thurik, 2001, p. 295).

It is clear from the above that knowledge spillovers may have pronounced positive effects on productivity. One might be inclined to think then that facilitating knowledge spillovers (for instance by clustering firms closely together) could be a way for governments to stimulate productivity growth. It is not that simple however. When knowledge spills over too easily, it does not pay off any more for individual firms to invest in innovation (as they cannot appropriate the benefits of their innovation), and the generation of new knowledge (and accordingly, also the spillover of such knowledge) may actually decline (Syverson, 2011, p. 351).

Competition effects

Small firms may also cause productivity increases in larger firms via their contribution to competition. Particularly when productivity levels of small firms are higher, they are better able to compete with large firms. When there is a viable SME sector which constantly improves productivity levels, large firms will experience serious competitive pressure from the SME sector, which will stimulate them to increase their performance (Fritsch and Mueller, 2004; Van Stel and Suddle, 2008). Without such a viable SME sector, incentives for larger firms to innovate or increase their productivity are much lower.

At the aggregate levels of industries and economies, competition drives productivity through two key mechanisms: Darwinian selection among producers with different productivity levels, and productivity improvements within firms (Syverson, 2011). Regarding the selection mechanism, competition causes low-productivity producers to contract and ultimately exit the market, whereas high-productivity producers will survive and grow bigger.[2] Hence, at the firm level, strong competition with other firms implies that it is necessary to constantly improve productivity in order to survive. This is the above-mentioned second mechanism of productivity improvements within firms. At the economy level, productivity is then increased because the composition of the business population constantly changes, i.e., weaker firms are constantly being replaced by stronger firms, and inputs and outputs are constantly being reallocated from less productive to more productive producers. This is the Darwinian selection mechanism. Haltiwanger, Jarmin and Miranda (2013) provide empirical evidence supporting the existence of such a selection mechanism. They find, for a large panel of firms in the United States, that young firms (which are most often small), are subject to a rich 'up-or-out' dynamic: they have a higher probability of growing fast compared to older firms, but also a much higher likelihood of exit.

In his authoritative review of productivity determinants, Syverson (2011) identifies two more interesting competition effects between firms. First, trade competition may stimulate productivity. By opening up markets for competition from abroad (i.e., by allowing import), productivity levels are not only stimulated by competition from other domestic firms, but also by competition from foreign competitors. Syverson provides examples of studies which found considerable productivity increases stemming from trade liberalization. Second, competition between suppliers may also increase productivity levels. Just as competition on the product market causes firms to increase productivity, competition on the input market may also increase productivity. For instance, if producer firms have a choice between several potential supplier firms to outsource their intermediate goods production to, the supplier firms will do their best to provide these goods at low price, so that the producer firm will choose to do business with them instead of with a more expensive supplier. This mechanism may increase productivity of both the supplier firms and the customer firms.

The enabling role of small businesses

Small firms can also have a positive effect on larger firm productivity by their enabling role for entrepreneurial activity of larger firms. The importance of scale economies has been reduced in the last decades as a result of the ICT revolution and globalisation (Audretsch and Thurik, 2001). Therefore, competitive advantage in present-day economies is not only based on (internal) economies of scale, but also on flexibility. In industries where demand for particular products is constantly shifting, a flexible system of production is required (Audretsch and Thurik, 2001, p. 296). Small firms can provide this flexibility by acting as suppliers of goods and services on a contingent basis. Therefore, the larger firms do not have to hire employees on a permanent basis with the risk of suffering periods of low productivity resulting from worker downtime when demand is low. Hence, by being able to outsource economic activities which do not need to be performed all the time, larger firms become more flexible, and their risk of worker downtime (in economic terms: the risk of having high

[2] This is because high-productivity firms have lower costs and are therefore able to ask lower prices on the product market, which will result in a higher market share.

fixed sunk labour costs) is reduced (Burke, 2011). The risk of downtime is higher for specialist workers (as they are less flexible to carry out other tasks if there is temporarily no demand for their specialist tasks). Therefore, it may be particularly interesting for larger firms to outsource specialist work. It may be argued that higher productivity of small scale suppliers will induce larger firms to outsource more specialized work. Consequently the risk of specialist downtime in larger firms is reduced by enabling specialisation of labour outside of the firm.

Summarising, small scale entrepreneurship can enable productivity increases of larger firms by creating a positive business context conducive for entrepreneurial performance (Burke, 2011). Small businesses enable entrepreneurial performance of larger businesses by providing flexibility and reducing risk and financial constraints. By providing flexibility to larger firms, the latter face lower risk in the production process. Because of this lower risk, entrepreneurs in larger firms may also find it easier to raise finance, which in turn makes it easier to run their business and enhance entrepreneurial performance (Burke, 2011).

2.2 Empirical literature

When investigating interrelations between smaller and larger firms at country level, there are generally two ways to approach the issue (Audretsch et al., 2002). One way is to look at the intermediate mechanisms causing small firm presence to influence macro-level outcomes. Such intermediate mechanisms may include small firms' entrepreneurial and innovative activity, stimulation of industry evolution, and job creation by small firms (Acs, 1992). However, quantifying such mechanisms would require data by size-class which are harmonized across countries on variables such as research and development expenditures, human capital of entrepreneurs and employees, entrepreneurial activity by employees, and knowledge spillovers.

Since such data are generally not available, in this study we choose the second way to investigate small and large firm interrelations, which is to model these interrelations directly. That is, we study the interrelations in terms of the implications of the mentioned mechanisms for competitiveness, as measured by changes in labour productivity of small and large firms. This still requires harmonized data by size-class on value added and employment, but, fortunately, such data are available in the database used in the present study (see Section 4). Nevertheless, because of the high data requirements, cross-country studies on the interrelation between economic performance of small and large firms are scarce. In fact, we only know of two such studies, Audretsch et al. (2002) and Carree and Thurik (1998). Specifically regarding the interrelation between small firm productivity and large firm productivity across countries, to the best of our knowledge, the present paper is the first study that empirically investigates this issue.

3. Empirical models

This section will explain how we model the relation between labour productivity in the SME size-class and macro-level labour productivity. These theoretically derived models will form the basis of our empirical exercises.

3.1 Modelling macro-level labour productivity as a function of SME labour productivity

We define labour productivity as the average amount of output per employee. This is captured by the following equation: $LPR = \frac{Y}{EMP}$, where *LPR*, *Y* and *EMP* stand for labour productivity, output and private sector employment, respectively. This definition can be applied to individual size classes (in which case we can define LPR_{SME} and LPR_{LARGE}) as well as to the macro-level (resulting in LPR_{TOTAL}).

Next, we know that employment in large firms and employment in SMEs sum up to the total macro-level (private sector) employment. This is by definition the case and is captured by the following equation: $EMP_{TOTAL} = EMP_{LARGE} + EMP_{SME}$. Within this framework, labour productivity at macro-level can be expressed as a weighted average of productivity levels of large firms and SMEs:

$$(1)\quad LPR_{TOTAL} = \frac{EMP_{LARGE}}{EMP_{TOTAL}} LPR_{LARGE} + \frac{EMP_{SME}}{EMP_{TOTAL}} LPR_{SME}$$

As is often the case, in this study we are not as much interested in the *level* of labour productivity but in the *relative changes* in labour productivity. A standard method to measure the relative change is to calculate the log-difference: the absolute change (Δ) in the natural logarithm (*ln*) of the level. In addition, we define $s_{LARGE} = \frac{EMP_{LARGE}}{EMP_{TOTAL}}$ (i.e., variable *s* represents the share of large firms, respectively SMEs, in macro-level employment). Within this framework, we can obtain an equation where the relative change of labour productivity at macro level depends on the relative changes of large firm-productivity and SME-productivity:[3]

$$\begin{aligned}(2)\quad \Delta \ln LPR_{TOTAL,t} = {} & s_{LARGE,t-1}\left(\frac{LPR_{LARGE}}{LPR_{TOTAL}}\right)_{t-1} \Delta \ln LPR_{LARGE,t} + \\ & s_{SME,t-1}\left(\frac{LPR_{SME}}{LPR_{TOTAL}}\right)_{t-1} \Delta \ln LPR_{SME,t} + \\ & s_{LARGE,t-1}\left(\frac{LPR_{LARGE}}{LPR_{TOTAL}}\right)_{t-1} + s_{SME,t-1}\left(\frac{LPR_{SME}}{LPR_{TOTAL}}\right)_{t-1} - 1\end{aligned}$$

So far, we are just describing identities. However, in reality several complementarities exist between smaller and larger firms, as described in the literature review. In the current paper we model the interaction between (the productivity of) SMEs and large firms, as described below.

3.2 Interaction between SME and large firm productivity: basic specification

Large firms may benefit in several ways from the presence of a competitive SME sector. In particular, competitiveness levels of large firms (as measured by their productivity) may depend on competitiveness levels of SMEs.

[3] The mathematical derivation from equation (1) to equation (2) is available on request from the authors.

In order to estimate the impact of SME productivity on large firm productivity, we estimate the following equation:

$$\begin{aligned}(3)\quad \Delta \ln LPR_{LARGE,i,t} &= \alpha + \beta\, \Delta \ln LPR_{LARGE,i,t-1} + \gamma\, \Delta \ln LPR_{SME,i,t-1} + \\ &\rho_1\, \Delta LCOQ_{LARGE,i,t-1} + \rho_2\, INVQ_{LARGE,i,t-1} + \sum D_t\end{aligned}$$

where indicators *i* and *t* represent country and year, respectively, and *D* represents a set of year dummies. The coefficients for the year dummies reflect technological change as well as the impact of structural changes in the number of hours worked per occupied person. Furthermore, variables *LCOQ* and *INVQ* represent labour costs per employee and the rate of investments, respectively. These variables may also influence productivity and are therefore included as control variables in the model.

The parameter of interest is γ, which reflects the influence of SME productivity on large firm productivity. As described above, the expected sign of γ is positive. The set-up of equation (3), in particular the inclusion of a lagged dependent variable, assures that estimated impacts of SME productivity on large firm productivity can be interpreted as causal effects, in the sense of predictive causality (Granger, 1969).

From equation (3) it can easily be derived that the long-run cumulative impact of a unit increase in SME productivity on large firm productivity equals $\frac{\gamma}{1-\beta}$. Considering equation (2), the long-run cumulative effect (labeled Eff_{CUMUL}) of a unit increase in SME productivity on macro-level productivity then equals:

$$\begin{aligned}(4)\quad Eff_{CUMUL} &= s_{SME,t-1}\left(\frac{LPR_{SME}}{LPR_{TOTAL}}\right)_{t-1} + s_{LARGE,t-1}\left(\frac{LPR_{LARGE}}{LPR_{TOTAL}}\right)_{t-1}\frac{\gamma}{1-\beta} \\ &= s_{SME,t-1}\left(\frac{LPR_{SME}}{LPR_{TOTAL}}\right)_{t-1} + \left(1 - s_{SME,t-1}\right)\left(\frac{LPR_{LARGE}}{LPR_{TOTAL}}\right)_{t-1}\frac{\gamma}{1-\beta}\end{aligned}$$

In equation (4), the first term may be labeled the direct effect, which equals the employment share of SMEs in the economy, adjusted for their relative productivity level. The second term may be labeled the indirect effect, where increases in the labour productivity levels within the SME size class influence macro-level productivity via the productivity of large firms. The magnitude of this indirect effect depends on the employment share and relative productivity level of large firms, as well as parameters γ and β, estimated from equation (3). As the expected sign of $\frac{\gamma}{1-\beta}$ is positive, we now see that there is a trade-off between the direct effect and the indirect effect. A higher share of SMEs in total employment increases the direct effect but decreases the indirect effect. Hence, we see that the size-class structure of the economy might play a role in determining the impact of SME productivity improvements on macro-level productivity improvements. The role of size-class structure will be elaborated upon in a more detailed manner below, where we discuss an extended version of model (3).

3.3 Interaction between SME and large firm productivity: extended specification

In equation (3), productivity of the large firm sector is assumed to be dependent on productivity of the SME sector, while the magnitude of this impact is independent of

the size of the SME sector. However, one can imagine that the impact of higher SME productivity on large firm productivity is bigger when the size of the SME sector is bigger. For instance, if there are more SMEs with a certain productivity increase, the competitive threat for large firms is bigger, and they will be more stimulated to increase their performance compared to a productivity increase of only a few SMEs (in case of a small SME sector). In equation (5) below we allow the impact of SME productivity to depend on the size of the SME sector, by extending equation (3) as follows:

$$\Delta \ln LPR_{LARGE,i,t} = \alpha + \beta \Delta \ln LPR_{LARGE,i,t-1} + \left(\gamma_0 + \gamma_1 s_{SME,i,t-1}\right) \Delta \ln LPR_{SME,i,t-1} + \rho_1 \Delta LCOQ_{LARGE,i,t-1} + \rho_2 INVQ_{LARGE,i,t-1} + \sum D_t \quad (5)$$

The long-run cumulative impact of an improvement in SME productivity on large firm productivity now equals $\frac{\gamma_0 + \gamma_1 s_{SME,t-1}}{1-\beta}$. Again considering equation (2), the long-run cumulative effect of a unit increase in SME productivity on macro-level productivity now equals:

$$\begin{aligned} Eff_{CUMUL} &= s_{SME,t-1}\left(\frac{LPR_{SME}}{LPR_{TOTAL}}\right)_{t-1} + s_{LARGE,t-1}\left(\frac{LPR_{LARGE}}{LPR_{TOTAL}}\right)_{t-1} \frac{\gamma_0 + \gamma_1 s_{SME,t-1}}{1-\beta} \\ &= s_{SME,t-1}\left(\frac{LPR_{SME}}{LPR_{TOTAL}}\right)_{t-1} + \left(1 - s_{SME,t-1}\right)\left(\frac{LPR_{LARGE}}{LPR_{TOTAL}}\right)_{t-1} \frac{\gamma_0 + \gamma_1 s_{SME,t-1}}{1-\beta} \end{aligned} \quad (6)$$

In our empirical analysis we will estimate equations (3) and (5) and show how the effects vary with the size of the SME sector. We will also estimate two alternative specifications of equation (3). First, we will distinguish size-classes within the SME sector (i.e., micro, small and medium-sized enterprises), and second, we will investigate whether the interdependency between SME and large firm productivity varies by level of economic development.

4. Data

We make use of a unique and rich database prepared in part by Panteia on behalf of the European Commission (see European Commission, 2010). The database provides information on employment, value added, turnover and other variables for all 27 countries of the European Union. The information is also disaggregated by sector and size-class.[4] This enables us to compute employment shares and productivity levels by sector and size-class.

4.1 Definitions of sectors, size-classes and variables

We will make use of data for the period 2002-2008.[5] We use data for the following sectors[6] and size-classes:

[4] Nevertheless, we recognise that even within narrowly defined industries and size-classes, large and persistent productivity differences exist across firms and among countries.

[5] For more recent years the data required to construct deflator series at the level of sector times size-class are not available.

[6] In the other parts of economy (e.g., mining; electricity), interplay between small and large firms is less likely to occur.

Sectors[7]:

- Manufacturing (sector D)
- Construction (F)
- Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods (G)
- Hotels and restaurants (H)
- Transport, storage and communication (I)
- Non-financial private sector: the aggregate of these sectors

Size-classes:

- Micro: 1-9 occupied persons
- Small: 10-49 occupied persons
- Medium-sized: 50-249 occupied persons
- SMEs: 1-249 occupied persons (aggregate of micro, small and medium-sized)
- Large: 250 or more occupied persons
- Total: the aggregate of these size-classes

We use the following operationalisations for the model variables introduced in section 3. All variables are available at the sector and size-class level defined above. The data source of the variables is the above-mentioned data base which was prepared for the Annual Report on SMEs in the EU (see European Commission, 2010).

Y: real value added at factor cost, in Euros
EMP: number of persons employed
LCOQ: real labour costs per employee (in Euros), defined as total labour costs (wages and salaries plus social security costs), *LCO*, divided by the number of employees
INVQ: rate of investments, defined as gross investment in tangible goods as a percentage of value added at factor cost

The raw variables *Y* and *LCO* as provided in the Annual Report database are expressed in nominal values and in Euros. Hence, inflation developments and differences in purchasing power across countries are not taken into account. It is important to correct for inflation because otherwise it is possible that productivity improvements are solely due to price level developments while volume per worker is unchanged. It is also important to correct for differences in purchasing power. For instance, if labour productivity in country A is half that of country B, but the average price level of goods and services in country A is also half that of country B, productivity in real terms is equal.

In our empirical application we correct the raw variables *Y* and *LCO* (and hence also the derived variables *LPR* and *LCOQ*) for inflation and country differences in purchasing power. Data on purchasing power parities (with EU-27=100) are taken from Eurostat for the year 2005 (the middle year of our estimation sample). Deflator series by sector and size-class are constructed using data of additional variables from the Annual Report database, as well as price indices data from Eurostat. For the methodology to construct these deflator series we refer to Appendix 1.

[7] Sector classification is based on Nace Revision 1.1.

The data required to construct the deflator series by size-class are completely missing for Malta. Furthermore, data for Ireland are only available for 2005. As a result, our empirical analysis will use data of 25 out of the 27 countries of EU-27.

4.2 Labour productivity by size-class in the EU-27, 2002-2008

Table 1 illustrates the variation in labour productivity (corrected for inflation and country differences in purchasing power) for the non-financial private sector across countries and size-classes, and over the period 2002-2008.[8] From the first block of (four) columns we can see that there is pronounced country variation in labour productivity, where in general the old (EU-15) member states have higher productivity levels than the new member states of the EU-27. We also see that large firm productivity is higher than SME productivity, as expected. In the second block of (two) columns we see that there is also pronounced country variation in the *change* in labour productivity over the period 2002-2008. Several Central and East-European economies catch up fast. For instance, labour productivity in Romania increased with more than 200% between 2002 and 2008, both for SMEs and large firms. Relative large productivity increases are also found for Slovakia, Slovenia, Latvia, Estonia, Czech Republic, Hungary, Lithuania, Poland and Bulgaria. The high productivity increases in Central and East European countries can be explained to a large extent by a strong positive effect of foreign direct investments (FDI), where MNEs enter emerging economies with considerably higher productivity levels than those of the local firms. In particular during the period of investigation (2002-2008), levels of FDI inflows in Central and East European countries increased fast (Hanousek et al., 2011). In addition, there is a strong catching-up effect where latecomer countries imitate technologies which have been developed and tested in mature economies. Again, foreign companies play an important role here as the productivity of domestic firms may be increased by FDI spillovers. The last block of three columns show that there is also pronounced country variation as regards the level and development of the productivity gap between large firms and SMEs.

In Figure 1 the country variation in productivity levels is illustrated graphically for 2008 (or the most recent year available in our data set), where the countries are ordered by SME productivity. From this picture we can derive that higher SME productivity not necessarily implies higher productivity of large firms (as the LPR-large firms bars are not ordered similarly as LPR-SME).

[8] Our empirical analysis is not affected by the inclusion of the year 2008, the first year of the crisis. First, the crisis only started in the second half of 2008. Second, the crisis started in the financial sector, which is excluded from our study.

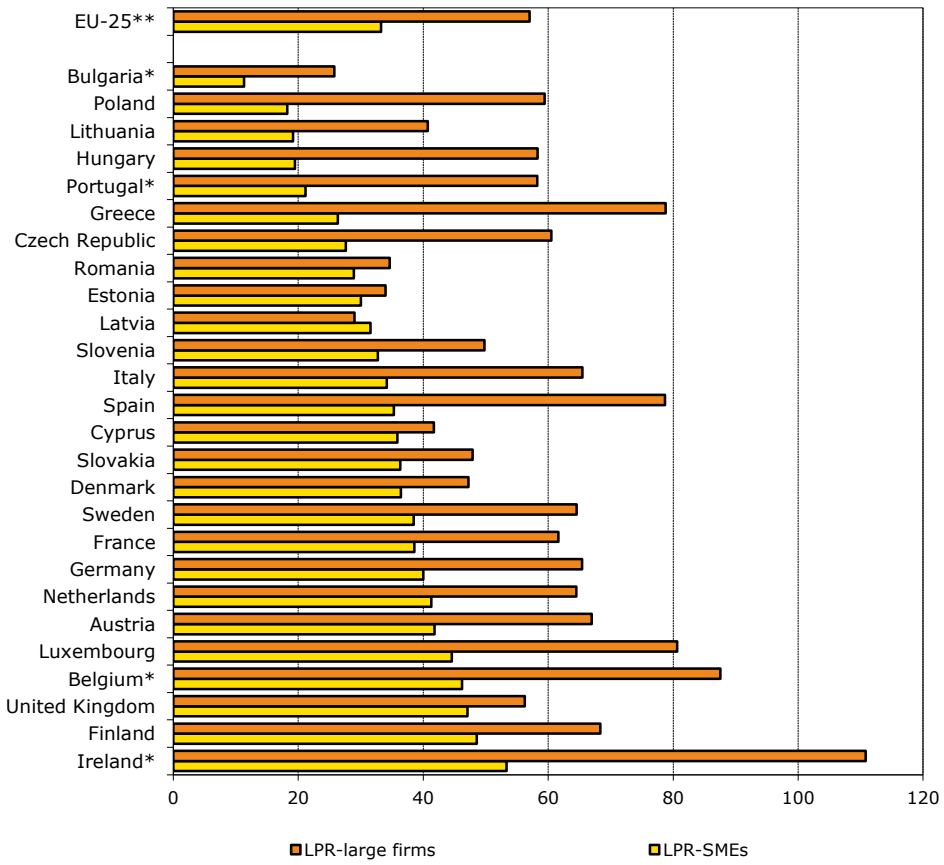
Table 1 Development of labour productivity between 2002 and 2008, by country and size-class

	2002	*2002*	*2008**	*2008**	*2002-2008*	*2002-2008*	*2002*	*2008*	*2002-2008*
	LPR-SMEs	LPR-large firms	LPR-SMEs	LPR-large firms	ΔLPR-SMEs	ΔLPR-large	(LPR-large – LPR-SMEs)	(LPR-large – LPR-SMEs)	Δ(LPR-large – LPR-SMEs)
	(x €1.000)				*(%)*		*(x €1.000)*		
Ireland*	n.a.	n.a.	53.3	110.8	n.a.	n.a.	n.a.	57.5	n.a.
Finland	42.2	59.2	48.6	68.3	15.1	15.5	17.0	19.7	2.8
United Kingdom	42.0	48.4	47.1	56.3	12.1	16.3	6.4	9.2	2.8
Belgium*	41.5	70.5	46.2	87.5	11.3	24.2	29.0	41.4	12.4
Luxembourg	36.3	63.0	44.6	80.6	22.8	27.9	26.7	36.1	9.3
Austria	39.5	57.6	41.8	67.0	5.9	16.3	18.1	25.2	7.0
Netherlands	43.2	56.4	41.3	64.5	-4.4	14.3	13.3	23.2	10.0
Germany	36.2	59.1	40.0	65.4	10.4	10.7	22.8	25.4	2.6
France	38.0	51.8	38.6	61.6	1.5	18.9	13.8	23.1	9.2
Sweden	35.3	48.9	38.5	64.6	9.1	32.0	13.6	26.1	12.5
Denmark	33.9	42.8	36.4	47.3	7.5	10.4	9.0	10.8	1.9
Slovakia	16.9	20.3	36.3	47.9	115.3	136.0	3.4	11.6	8.2
Cyprus	30.5	43.6	35.8	41.7	17.7	-4.4	13.2	5.8	-7.3
Spain	30.3	62.1	35.3	78.7	16.6	26.6	31.9	43.4	11.5
Italy	32.5	56.6	34.1	65.5	5.2	15.7	24.1	31.3	7.2
Slovenia	26.1	33.2	32.7	49.8	25.4	49.8	7.1	17.0	9.9
Latvia	17.4	21.4	31.6	29.0	81.6	35.6	4.0	-2.5	-6.6
Estonia	16.8	19.7	30.0	34.0	78.7	72.3	2.9	3.9	1.0
Romania	7.7	10.7	28.9	34.6	275.7	222.9	3.0	5.7	2.7
Czech Republic	18.9	26.9	27.6	60.5	46.1	124.9	8.0	32.9	24.9
Greece	24.0	49.4	26.3	78.8	9.7	59.7	25.4	52.5	27.1
Portugal*	19.7	49.0	21.2	58.3	7.4	18.9	29.3	37.1	7.8
Hungary	15.6	29.0	19.5	58.3	24.5	101.1	13.4	38.8	25.5
Lithuania	11.6	18.9	19.2	40.7	65.9	115.2	7.4	21.5	14.2
Poland	12.0	52.4	18.3	59.4	51.7	13.4	40.3	41.1	0.8
Bulgaria*	7.2	15.0	11.3	25.8	56.4	72.2	7.7	14.5	6.7
Malta	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
EU-25**	27.0	42.6	33.2	57.0	23.1	33.8	15.6	23.8	8.2

NOTE: Countries ordered by LPR-SMEs 2008. Labour Productivity (LPR): value added at factor costs per worker, corrected for inflation and country differences in purchasing power. Data refer to the aggregate of sectors D, F, G, H and I (NACE Revision 1.1 classification).
*) Data in 2008 columns refer to 2007 for Belgium and Portugal, 2006 for Bulgaria and 2005 for Ireland.
**) EU-25 is unweighted EU-27 average excluding Malta and Ireland.

Source: Own calculations, based on European Commission (2010): Database for the Annual Report

Figure 1 Labour productivity 2008*, by country and size-class



*) Data in 2008 columns refer to 2007 for Belgium and Portugal, 2006 for Bulgaria and 2005 for Ireland.
**) EU-25 is unweighted EU-27 average excluding Malta and Ireland.

Source: Own calculations, based on European Commission (2010): Database for the Annual Report

5. Results

In this section we will present the results of our empirical analysis. In particular, we will present the estimation results of equations (3) and (5) introduced in Section 3. These equations were presented at the level of the aggregate economy. However, as shown in Section 4, our data are also disaggregated by sector of economic activity. As these sectoral data are (obviously) more detailed than data at the aggregate economy level, more precise results are to be expected when using data at sector level. Equations (3) and (5) will therefore be estimated at the country-sector level, using the five-sector classification introduced in Section 4. To account for structural productivity differences between sectors of economic activity, equations (3) and (5) are extended with a set of sector dummies.

As explained before, in the regression equations changes in large firm labour productivity are partly explained by changes in SME labour productivity. We also include two control variables, change in labour costs per employee and the rate of investments. The sign of the first variable is indeterminate from theory: from a static

point of view, higher labour costs decrease value added and hence labour productivity (value added per worker). However, from a dynamic point of view, higher wages may reflect higher worker quality (i.e., human capital) and hence higher productivity. Although it is not a priori clear which effect dominates, it is clear that it is important to control for these effects. The expected sign of our second control variable, the rate of investments, is clearly positive as higher capital rates make it easier to achieve higher output per worker.

Data at the sector level are available for 22 out of 27 EU-27 countries.[9] This yields a potential number of observations of 22 (countries) times 5 (years; 2004-2008) times 5 (sectors) = 550 observations.[10] For some countries, data for individual years or sectors are also not available. Finally, when considering the deflator series we spotted four clear outliers which we removed from the estimation sample.[11] Our final estimation sample therefore consists of 517 observations.

5.1 Estimation results, total sample

Table 2 presents the estimation results for the available observations. The first column presents results from equation (3). First, we notice that the estimated impact of SME productivity increases on large firm productivity is positive and significant at the 5% level. Hence, SME productivity increases indeed positively influence productivity of large firms. Taking account of the impact of the lagged dependent variable, the long-run cumulative elasticity between productivity changes of SMEs and large firms is computed as 0.175. This implies that a one percent increase in SME productivity increases productivity of large firms with 0.175 percent.

[9] Missing countries are Malta, Cyprus, Austria, United Kingdom and Ireland.
[10] Note that because of the use of a lag and a first difference in equations (3) and (5), the equation cannot be estimated for the first two years of our data sample period (2002-2008).
[11] Removal of these four observations hardly affects our estimates but we still found it better to remove them from our estimation sample because productivity in these cases is highly affected by extreme price developments.

Table 2 Effects of SME–productivity changes on large firm productivity

		Eq. (3)	*Eq. (3) by size-class*	*Eq. (5)*
ΔLPR large firms$_{t-1}$	β	-0.0782	-0.153 **	-0.0882 *
		(-1.4)	(-2.3)	(-1.8)
ΔLPR SMEs$_{t-1}$	γ (γ_0)	0.189 **		-0.289 **
		(2.2)		(-2.3)
ΔLPR medium-sized firms$_{t-1}$			0.166 **	
			(2.8)	
ΔLPR small firms$_{t-1}$			0.0976	
			(1.1)	
ΔLPR micro firms$_{t-1}$			0.0114	
			(0.9)	
Employment share SMEs$_{t-1}$				-0.015
				(-0.3)
Employment share SMEs$_{t-1}$ x ΔLPR SMEs$_{t-1}$	γ_1			0.682 **
				(2.5)
ΔLCOQ large firms$_{t-1}$	ρ_1	0.00095	0.00014	0.00064
		(0.6)	(0.1)	(0.4)
INVQ large firms$_{t-1}$	ρ_2	0.00101 ***	0.00096 ***	0.00095 ***
		(7.5)	(6.8)	(6.2)
Constant	α	0.0508 ***	0.0523 **	0.0688
		(2.9)	(2.8)	(1.6)
Sector dummies		*yes*	*yes*	*yes*
Year dummies		*yes*	*yes*	*yes*
Observations		517	517	517
R-squared		0.127	0.135	0.138
Adj. R-squared		0.106	0.111	0.114
Elasticity between LPR-SME and LPR-large		0.175		0.189
Elasticity between LPR-medium and LPR-large			0.144	
Elasticity between LPR-SME and LPR-total (see equations (4) and (6))				
Indirect effect (via LPR-large)		0.064		0.069
Direct effect		0.617		0.617
Total elasticity		0.681		0.686
Direct effect as % indirect effect		10.4%		11.2%

*Note: Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Dependent variable: annual change in large firm labour productivity. Reported elasticities equation (5) computed for sample averages of productivity levels (SME, large and total) and employment share SMEs.*

Source: Own calculations

Regarding the impact on total labour productivity (i.e., productivity of SMEs and large firms together), using equation (4) this elasticity is estimated to be 0.681. This implies

that a one percent increase in SME productivity increases total labour productivity by 0.681 percent. This elasticity consists of a direct effect (0.617) and an indirect effect (0.064). The direct effect refers to the impact of the SME productivity increase itself: since SMEs form an important part of total economy, an increase of SME productivity in itself has already an important impact on total productivity. It is not surprising that this direct effect forms the main part of the total elasticity. More interesting is the indirect effect, i.e. the part of total elasticity that an increase in SME productivity causes via productivity increases in large firms. This indirect effect is estimated to be 0.064 which is approximately 10 percent of the total effect. Hence, about 10 percent of the impact of an increase in SME productivity on total economy productivity is caused by increases in large firm productivity. The magnitude of this indirect effect may be called substantial.

Regarding our control variables, we note that labour costs per employee in large firms is not related to productivity increases, suggesting that the static and dynamic impact discussed above cancel each other out. Furthermore, higher investment rates are positively and highly significantly related to productivity: a one percent point increase in the investment rate of large firms causes an increase of large firm labour productivity of 0.1 percent.

Results by size-class

In the second column we re-estimate equation (3), but we split the SME size-class in three separate size-classes: micro, small and medium-sized firms. The main outcome of this regression is that the effects of SMEs described earlier is mainly an effect of medium-sized firms. The results show that productivity increases in micro and small firms do not have a significant impact on large firm productivity whereas productivity increases in medium-sized firms have a positive and significant impact on large firm productivity. Accordingly, we find that the elasticity of medium-sized firms productivity and large firm productivity is almost as high as that between SMEs and large firms found earlier (0.144 versus 0.175).

Results by SME-share

The third column of Table 2 presents estimation results of equation (5).[12] In this model the impact of SME productivity increases on large firm productivity increases is allowed to vary with the employment share of SMEs. Large firms will be more responsive to increases in competitiveness of SMEs if the SME sector is larger, as explained in Section 3.3. Our results provide support for this hypothesis as the coefficient of the interaction term between the SME employment share and change of SME labour productivity is indeed found to be significantly positive.

The estimation results imply that the long-run cumulative impact of an improvement in SME productivity on large firm productivity equals $\frac{-0.289+0.682 \cdot s_{SME}}{1+0.0882}$. Using this formula, Table 3 illustrates how this impact varies with different levels of s_{SME}, the employment share of SMEs. In Table 3 the elasticity between SME productivity and large firm productivity is displayed for sample averages per sector of economic activity. Here we can see that, on average, the elasticity is lowest for transport, storage

[12] Note that, compared to equation (5), we also include the SME employment share separately. In models that include an interaction term, it is usual to also include the component variables separately, in order to avoid omitted variable bias.

and communication (0.05), and highest for construction and hotels and restaurants (0.28). The bigger size of the SME sector in the hospitality industry may form a more serious competitive threat to large firms in that industry, so that productivity increases in the SME sector may form a bigger impulse for larger firms to increase their performance as well, compared to other industries with smaller SME sectors.

Table 3 Elasticity between SME productivity and large firm productivity, by sector

	Employment share of SMEs in sample average	*Elasticity between LPR-SME and LPR-large*	*Observations*
Manufacturing (D)	0.598	0.109	103
Construction (F)	0.867	0.278	104
Wholesale and retail trade, etcetera (G)	0.797	0.234	106
Hotels and restaurants (H)	0.869	0.279	98
Transport, storage and communication (I)	0.503	0.050	106
Total	0.724	0.189	517

Source: Own calculations

5.2 Estimation results by country group

In this section we will investigate to what extent results differ for countries with different levels of economic development. The impact of SME productivity on large firm productivity may be dependent on the stage of economic development, for instance because of a different role and importance of scale economies (Audretsch and Thurik, 2001). As one of the goals of the current paper is to provide implications for developing countries, it is interesting to split the estimation sample based on the level of economic development, to see whether results differ between relatively higher and lower developed economies. Within the EU-27 there are substantial differences in level of economic development, as expressed by gross national income per capita. These differences are shown in Appendix 2, based on data from 2005. In this appendix we also present a crude classification of EU-27 countries in relatively lower, medium, and relatively higher developed countries (within EU-27 context). In Table 4 below we present results for equation (3) for medium and relatively higher developed countries on the one hand, and relatively lower and medium developed countries on the other hand.

We see clear differences in results between the two country groups. In particular, the impact of SME productivity increases on large firm productivity is much stronger for the lower developed group than for the higher developed group of countries. Whereas the elasticity between SME productivity and large firm productivity is 0.218 for the lower developed countries, it is only 0.086 for the higher developed countries. Moreover, we see that for both groups of countries, it is primarily increases in medium-sized firm productivity (as opposed to small and micro firms) that influences productivity of large firms.

Explanation

The impact of productivity increases in medium-sized firms is quite strong, particularly in relatively lower developed countries. A one percent increase in medium-sized firm labour productivity has a positive effect on large firm productivity of 0.23 percent. The strong impact illustrates the importance of scale economies at relatively lower stages of economic development. Indeed, large firms play an important role in the transformation process from a developing to a developed country (Van Stel, Carree and Thurik, 2005). Porter, Sachs and McArthur (2002) distinguish between three stages of economic development: in ascending levels of economic development, a *factor-driven* stage, an *investment-driven* stage, and an *innovation-driven* stage.[13] In the factor-driven stage competitiveness is based on low factor costs and/or the presence of minerals and other commodities. In contrast, at the investment-driven stage competitiveness is based on higher capital intensity (Wennekers et al., 2005). For developing countries to move to middle-income economies, a transition from the factor-driven stage to the investment-driven stage is required. Large firms play an important role in this transition. By exploiting economies of scale and scope they are able to produce medium-tech products. They also improve local worker skills by training on the job (Van Stel, Carree and Thurik, 2005).

Hence, given the importance of scale economies in investment-driven economies, it is conceivable that in order to be actually able to stimulate large firm productivity, a certain level of scale is required. This may explain that particularly medium-sized firms have an impact on large firm productivity. The medium-sized firms may stimulate large firms in two ways: first, by their higher productivity levels (compared to micro and small firms) they are more likely to form a threat to large firms, stimulating the latter to improve their performance. Second, if they act as suppliers to large firms, they may be able to supply higher quality products and services, thereby stimulating large firm performance.

Control variables

Results for our control variables are also in accordance with the development levels described above. For the relatively lower developed countries, in our database primarily Central and East-European (transition) countries, the impact of investments in physical capital on productivity is positive and highly significant, consistent with the importance of scale economies in investment-driven economies. By contrast, for the higher developed economies we find a positive impact of wages (labour costs per employee), consistent with a higher importance of human capital and knowledge generation for competitiveness in innovation-driven economies (Wennekers et al., 2005; Audretsch and Thurik, 2001), assuming that a higher wage reflects higher worker skills.

[13] The investment-driven stage is also known as efficiency-driven stage.

Table 4 Effects of SME–productivity changes on large firm productivity, by country group

		Medium and higher developed countries		*Lower and medium developed countries*	
		Eq. (3)	Eq. (3) by size-class	Eq. (3)	Eq. (3) by size-class
ΔLPR large firms$_{t-1}$	β	0.00541	-0.0631	-0.0356	-0.109
		(0.1)	(-0.8)	(-0.6)	(-1.5)
ΔLPR SMEs$_{t-1}$	γ	0.0854		0.226 *	
		(1.1)		(2.0)	
ΔLPR medium-sized firms$_{t-1}$			0.0830 **		0.252 **
			(2.7)		(2.4)
ΔLPR small firms$_{t-1}$			0.0846		0.0912
			(1.4)		(0.8)
ΔLPR micro firms$_{t-1}$			0.00295		-0.0294
			(0.4)		(-0.8)
ΔLCOQ large firms$_{t-1}$	ρ_1	0.00315 *	0.00312 **	-0.00386	-0.00949 *
		(1.9)	(2.7)	(-1.3)	(-2.0)
INVQ large firms$_{t-1}$	ρ_2	0.00026	0.00025	0.00099 ***	0.00093 ***
		(0.5)	(0.5)	(4.4)	(4.7)
Constant	α	0.0578 ***	0.0586 ***	0.0621 *	0.0671 *
		(4.2)	(4.1)	(2.1)	(2.1)
Sector dummies		yes	yes	yes	*yes*
Year dummies		yes	yes	yes	*yes*
Observations		335	335	275	275
R-squared		0.177	0.184	0.129	0.149
Adj. R-squared		0.147	0.148	0.089	0.103
Elasticity between LPR-SME and LPR-large		0.086		0.218	
Elasticity between LPR-medium and LPR-large			0.078		0.228

*Note: Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Dependent variable: annual change in large firm labour productivity.*

Source: Own calculations

6. Discussion and conclusions

Across the world, the size-class of small and medium-sized enterprises constitutes an important part of the private enterprise sector. From a static point of view, the importance of this size-class follows from its share in total employment in the formal sector (Ayyagari et al., 2011). From a dynamic point of view, the importance of the SME size-class is related to its share in employment growth (e.g., De Wit and De Kok, 2014) and in growth of labour productivity. The present study focuses on the latter

aspect. In particular, we empirically investigate whether SME labour productivity increases affect labour productivity of large firms.

We are particularly interested in this relation for developing countries. However, due to a lack of data, we have examined this relationship for a sample of European countries. An important question is therefore, to which extent the findings of this study also apply to developing countries. In this section we first present the main findings for the sample of European countries, after which we argue why these results also provide relevant insights for developing and emerging countries.

6.1 Main results

Our main findings are as follows. First, we find evidence for a positive effect of SME labour productivity increases on labour productivity increases of large firms. Our empirical analysis implies that a one percent increase in SME productivity increases productivity of large firms with 0.175 percent. The impact of a one percent increase in SME productivity on total (economy-wide) productivity growth is 0.681 percent. Of this effect, a relatively large part (about 10 percent) is due to the indirect impact via large firm productivity increases.

Second, we find that the impact of SME labour productivity increases on labour productivity increases of large firms primarily reflects an effect of medium-sized firm productivity increases, and not so much an effect of micro or small firms. Third, the effect is considerably stronger for the EU-27 countries with relatively lower levels of economic development, where the elasticity between labour productivity of medium-sized firms and labour productivity of large firms is as high as 0.228.

6.2 Relevance for developing and emerging countries

Although the empirical results of the study are based on data from developed economies, these results may also be relevant for developing and emerging countries. First of all, the main explanations as to why labour productivity increases in smaller firms can also benefit productivity of large firms, are the presence of knowledge spillovers and competition effects. There is no a priori reason to expect that these explanations are only valid for developed countries.

Secondly, within the group of European countries, the effect on large firm labour productivity increases are higher for the countries with relatively lower welfare levels. Thus, there is no sign that these effects only occur amongst the richest countries.

Furthermore, these country differences are consistent with theories distinguishing different stages of economic development (a *factor-driven* stage, an *investment-driven* stage, and an *innovation-driven* stage). The results for the relatively low-income European countries are in line with a more investment-driven stage of development, where competitiveness is based on higher capital intensity. To the extent that developing and emerging economies have not yet reached this stage, they have to make a transition from the factor-driven stage to the investment-driven stage, which makes the results presented here very relevant for them.

Hence, although extrapolation of the quantitative results to developing countries is difficult, it may be expected that our results (in particular those for the relatively lower

and medium developed countries as defined in this study) apply in a qualitative sense to developing countries as well. This is particularly true for investment-driven economies as their development levels are closer to the countries included in the present study, compared to factor-driven economies.[14]

6.3 Policy implications for developing countries

Several policy implications can be derived from our empirical analysis. First, the results suggest that policies that aim to promote economic growth in developing and emerging countries should not be restricted to large enterprises. Policies that succeed in improving average labour productivity amongst small and medium-sized enterprises, will generate considerable effects at macro level. Not only because of the large share of the SME size class in many countries, but also because large enterprises benefit from productivity increases of SMEs.

Our second policy implication is related to our finding that, particularly in developing countries, large firm productivity is influenced by medium-sized firms but hardly by micro and small firms. This can be explained by the importance of scale economies in investment-driven economies. Since primarily medium-sized firms are thus able to stimulate productivity of large firms, it is important that there are no barriers that prevent micro and small firms to become medium-sized firms. Hence, firm growth of micro and small firms should be facilitated. This is particularly important given the often relatively small size of the medium-sized enterprise sector in developing countries (which is known as the 'missing middle' phenomenon (Dinh et al., 2010; De Kok et al., 2013)).

Finally, and more generally, the results of the present paper are consistent with those found by Wennekers et al. (2005) who investigated the relation between the level of economic development and the rate of nascent entrepreneurship. We believe that the policy implications formulated in their paper apply just as well to the empirical results generated in the current paper: "… low-income nations, given their stage of development, should not consider the promotion of new business start-ups as a top priority on their policy agenda. Instead, they may be better off investing in the management qualities of their population and fostering the exploitation of scale economies through foreign direct investment and the growth of young businesses. To that purpose, governments of these countries must establish confidence in property rights, promote education, guarantee access to capital markets, safeguard stable macro-economic conditions and make sure that the necessary physical infrastructure is in place. Moreover, they may consider providing specific tax incentives for foreign direct investment." (Wennekers et al., 2005, p. 306).

6.4 Suggestions for future research

Our paper also has implications for research and data collection. First, when investigating interrelations between smaller and larger firms at country level, there are generally two ways to approach the issue. One way is to look at the intermediate mechanisms causing small firm presence to influence macro-level outcomes. Such intermediate mechanisms may include small firms' entrepreneurial and innovative activity, stimulation of industry evolution, and job creation by small firms (Acs, 1992).

[14] For an overview of countries belonging to the different stages of economic development, we refer to World Economic Forum (2012).

Because of a lack of data on such mechanisms, the present paper has chosen the second way to investigate small and large firm interrelations which is to model these interrelations directly. Nevertheless, it would be desirable to have data on the intermediate mechanisms. Data collection by major international institutes (e.g., World Bank) should focus on facilitating this type of quantitative research.

Second, since the aim of the present paper was to derive implications for developing countries, it would be interesting to be able to repeat the current analysis by directly using data for developing countries. For this, major international institutes (e.g., World Bank) should concentrate on collecting relevant data at the level of size-classes. The present analysis, particularly the distinct results found for relatively lower and higher developed economies, shows that such data collection could open a promising avenue of research into interdependencies between small and large firms in developing countries.

Third, the present study only takes into account relations between productivity changes of small and large firms within a single country. Since globalization has considerably increased international trade and contacts between firms of different countries, it would be interesting to extend the model to account for productivity spillovers between small and large firms across country borders.

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Appendix 1: Methodology to calculate deflator series

The deflator series are calculated in a series of steps using data from EUROSTAT and the Annual Reports composed for the SME Performance Review initiated by the European Commission (see European Commission, 2010). First, data on employment, gross value added, employee compensation and the indicator 'other taxes less other subsidies on production' are gathered, as are data on price indices for the gross value added in percentage changes with respect to the previous period. The latter serves as the deflator of gross value added at both basic prices and factor costs. Data are collected on NACE rev1.1 sector level. Second, the labour share in gross value added is calculated from these data as well as the labour costs per employee. Third, these two and the deflator of gross value added serve as input for the deflator for capital remuneration. This results in an extensive set of deflators for all EU-27 countries (barring Malta, for which no price indices data is available from EUROSTAT) by five NACE rev1.1 sectors.

Deflators for capital remuneration for the non-financial economy (consisting of NACE rev1.1 sectors D, F, G, H and I) are obtained by aggregating the underlying sector-level data on employment and gross value added and calculating a weighted average of the deflator for gross value added. The deflators for gross value added at the sector level are weighed by the sector's share in total gross value added for the non-financial economy.

The obtained deflators for capital remuneration are then disaggregated by size-class using data on the labour share in value added and labour costs per employee from the Annual Reports. Again, this is done per country and per sector. Calculating these deflators using NACE rev1.1 data results in a great number of missing values for some countries. Observations for Austria, Cyprus, Estonia, Ireland and the United Kingdom are completely missing; Denmark has missing values from 2006 onwards. The missing values at the macro non-financial economy level are accounted for by repeating the above steps using NACE rev.2 data. This sector classification splits the sector information and communication from transport and storage. Taking this into account, the rev.2 classification can be used to demarcate a highly similar non-financial economy (now consisting of NACE rev.2 sectors C, F, G, H, I, J).

Appendix 2: Classification by economic development level

Table 5 EU-27 countries, by economic development level, 2005

Relatively lower developed countries	*Gross national income (GNI) per capita in purchasing power parities (current international $), 2005*
Romania	9280
Bulgaria	9840
Latvia	12880
Poland	13470
Lithuania	14050
Slovak Republic	15720
Estonia	15920
Hungary	16060
Medium developed countries	*GNI per capita*
Malta	20070
Czech Republic	20370
Portugal	21050
Slovenia	23280
Cyprus	23400
Greece	23990
Relatively higher developed countries	*GNI per capita*
Spain	27000
Italy	28290
France	29910
Finland	30850
Germany	31470
Belgium	32400
Sweden	32940
Austria	33300
Ireland	33450
United Kingdom	33490
Denmark	33660
Netherlands	35270
Luxembourg	58640

Source: World Bank, World Development Indicators