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CATCHING UP TO THE TECHNOLOGY FRONTIER: THE DICHOTOMY BETWEEN INNOVATION AND IMITATION

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Abstract: This research examines whether technology transfer, research intensity, educational attainment and the ability to absorb foreign technology help explain cross-country differences in productivity growth. Our data comprise a panel of 55 countries including 23 OECD and 32 developing economies over the period 1970-2004. The results show that TFP growth in both OECD and developing countries is positively affected by research intensity, distance to the frontier, research intensity-based absorptive capacity and educational attainment-based absorptive capacity. However, they reveal large differences between developed and developing countries.

JEL Classifications: O30; O40

Keywords: R&D; endogenous growth theory; absorptive capacity

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1. Introduction

Endogenous growth theory has increasingly focused on the roles of technology transfer and absorptive capacity in explaining productivity growth across countries (Eaton and Kortum, 1999; Howitt, 2000; Xu, 2000; Keller, 2002a, b; Griffith et al., 2003, 2004; Hu et al., 2005; Kneller, 2005; Kneller and Stevens, 2006; Madsen et al., 2009). Countries that are technologically backward may have greater potential for growth than more advanced countries (Gerschenkron, 1962), essentially because of their lower effective costs in creating new and better products (Howitt, 2000). However, backwardness does not automatically translate into higher growth. First, given that technological knowledge is tacit, adaptors need to spend time and resources to master the technologies that are developed elsewhere (Howitt, 2005). Second, the increasing complexity of products requires a large investment in knowledge in order to take advantage of the technology developed elsewhere (Howitt, 2005). Third, factory workers, technicians, engineers, and managers need to be trained in new technologies (Hobday, 2003).

This research explores the effects of R&D intensity, educational attainment, distance to the technological frontier and their interactions on TFP growth in developed and developing countries. Specifically, we focus on testing whether research and education play a more important role in creating new knowledge or in imitating technologies that are developed elsewhere. This provides some insights into whether investments in R&D and education have resulted in more innovative or imitative activity. Despite the importance of these issues for growth in developing countries, empirical studies on the growth effects of the interaction between distance to the frontier and R&D intensity or educational attainment have focused exclusively on OECD countries (e.g., Griffith et al., 2003, 2004; Kneller, 2005; Kneller and Stevens, 2006), which is probably due to the difficulty associated with obtaining R&D data for developing countries.

Developing countries that are far from the technological frontier may derive more benefits from investment in knowledge than OECD countries. By acquiring foreign technology, developing countries may obtain additional economies of scale through leapfrogging over the early stages of development (Gerschenkron, 1962). As shown by Coe et al. (1997), TFP in developing countries is positively and significantly related to international R&D spillovers from advanced economies. Moreover, Savvides and Zachariadis (2005) argue that TFP growth for developing countries that are relatively close to the frontier is likely to be significantly boosted by technological diffusion from the frontier countries. These insights suggest that more attention should be paid to the roles played by R&D and educational attainment for growth in developing countries.

Absorptive capacity captures the idea that the benefit of technological backwardness enjoyed by a laggard country can be enhanced if it has sufficient capability to exploit the technology developed in the frontier countries (Abromovitz, 1986). Although countries may be endowed with different abilities in adopting new technologies, more investment in domestic R&D and education may generally increase their capacity to effectively absorb foreign technology. Hobday (2003) shows that a common factor behind the success of the NICs was large investment in training and R&D in order to adapt the technologies that were developed elsewhere.

New technology is often complex and is embedded in physical capital that creates a large scale of interdependence between the leader and follower countries. Effective transfer of foreign technology may be hindered unless the follower countries undertake adequate local R&D investments so that knowledge developed in the frontier countries can be appropriately adapted to local conditions (Verspagen, 1991; Fagerberg, 1994; Aghion and Howitt, 2005; Howitt, 2005). Furthermore, higher educational attainment of the work force may also facilitate the assimilation of new foreign technology (Nelson and Phelps, 1966; Abromovitz, 1986; Cohen and Levinthal, 1989; Benhabib and Spiegel, 1994, 2005; Engelbrecht, 1997). These investments are essential for the laggards to upgrade their technology, move up the development ladder, and catch up to the frontier. Hence, R&D and educational attainment have two facets with respect to the production of knowledge - a direct effect and an indirect effect through enhancing the ability to absorb new technology (Kneller and Stevens, 2006).

The paper is structured as follows. Section 2 briefly discusses the analytical framework which is used to guide our empirical formulation. Section 3 discusses the data and construction of variables. The results are presented and discussed in Section 4 and robustness checks are undertaken in Section 5. The empirical estimates are obtained using the system GMM estimator for a panel of 55 countries covering the period 1970-2004. The sample is further divided into 23 OECD and 32 developing countries to gain some insights into the importance of R&D, educational attainment and their absorptive capacities on TFP growth in laggard economies relative to advanced economies. The last section concludes.

2. Empirical Framework

The empirical analysis in this paper integrates the hypothesis of Nelson and Phelps (1966), which focuses on the interaction between educational attainment and distance to the frontier, with that of Howitt (2000) and Griffith et al. (2000, 2003), in which research intensity and the interaction between research intensity and distance to the frontier play the key roles for growth.

First, consider the following equation that characterizes the complementary relationship between educational attainment (*SCH*) and TFP growth ($\dot{A}_t / A_t$), as postulated by Nelson and

Phelps (1966). In their model, TFP growth is an increasing function of educational attainment and is proportional to the gap between the theoretical level of technology (T_t) and the technology in practice (A_t), as follows:

$$\frac{\dot{A}_t}{A_t} = \phi\left(SCH_t\right)\ln\left[\frac{T_t - A_t}{A_t}\right]. \qquad \phi(0) = 0, \qquad \phi'(SCH) > 0. \tag{1}$$

Allowing the gap between the actual and theoretical level of technology to influence TFP growth with a time lag, the empirical counterpart of this equation can be written as follows (Benhabib and Spiegel, 1994):

$$\frac{\dot{A}_t}{A_t} = \phi\left(SCH_t\right)\ln\left(\frac{A_{t-1}^{\max}}{A_{t-1}}\right), \tag{2}$$

where A^{max} is the TFP at the technology frontier country. This equation shows that the further a country is behind the technological frontier the higher is its growth potential, provided that it has a sufficiently high level of educational attainment, or absorptive capacity, to take advantage of its backwardness. This reasoning follows the seminal hypothesis of Gerschenkron (1962) that backward countries possessing an educated labor force are able to take advantage of the technology developed elsewhere to catch up to the frontier. Similarly, Easterlin (1981) notes that more productive nations have used the same technology throughout history and that Japan modernized in the Meiji restoration period using Western technology, suggesting that personal contacts and the availability of an educated work force have been essential for the assimilation of foreign technology. Thus, given that technology must be taught and learned, education becomes an integral factor for the transfer of technology. In other words, it is simply easier for an educated rather than an uneducated labor force to master new technologies that have been developed elsewhere.

Based on the insights from Schumpeterian growth models, the important roles of innovation and assimilation of foreign technology for growth have been further highlighted by Howitt (2000) and Griffith *et al.* (2003). They demonstrate that domestic R&D activity, in addition to stimulating TFP growth, facilitates technology transfer. They suggest that the following specification is appropriate for testing the influence of R&D on growth:

$$\frac{\dot{A}_t}{A_t} = \alpha\left(\frac{X}{Q}\right)_{t-1} + \beta \ln\left(\frac{A^{\max}}{A}\right)_{t-1} + \chi\left(\frac{X}{Q}\right)_{t-1} \text{ x } \ln\left(\frac{A^{\max}}{A}\right)_{t-1}, \qquad (3)$$

where X is R&D, Q is product variety and (X/Q) is research intensity. The technology gap is lagged by one period to allow for the time it takes for the domestic economy to absorb the technology developed at the frontier country.

This Schumpeterian model maintains the scale effects that are present in the first-generation endogenous growth models. However, it deviates from the first-generation endogenous growth models by allowing for product proliferation effects to overcome Jones' critique. Jones (1995a, b) shows that the increasing number of scientists and engineers engaged in R&D in the US since the 1950s has not been followed by a concomitant increase in TFP growth rates, thus refuting the first-generation R&D-based endogenous growth models of Romer (1990) and Aghion and Howitt (1992). To address this problem, the Schumpeterian models of Aghion and Howitt (1998) and Howitt (2000) assume that the effectiveness of R&D is diluted due to the proliferation of products as the economy expands. Thus, growth can still be sustained if R&D is kept to a fixed proportion of the number of product lines, which is in turn proportional to the size of the population along the balanced growth path.

Considering the joint effects of educational attainment and R&D, Eqs. (2) and (3) yield the following empirical specification, which is augmented to allow for the direct effects of trade openness, foreign direct investment (FDI), and educational attainment:

$$\Delta \ln A_{it} = \beta_{0i} + \beta_1 \ln\left(\frac{X_{it}}{Q_{it}}\right) + \beta_2 \ln\left(\frac{A_{t-1}^{\max}}{A_{i,t-1}}\right) + \beta_3\left(\frac{X_{it}}{Q_{it}}\right)\ln\left(\frac{A_{t-1}^{\max}}{A_{i,t-1}}\right)$$

$$+ \beta_4 \ln SCH_{it} + \beta_5 SCH_{it} \ln\left(\frac{A_{t-1}^{\max}}{A_{i,t-1}}\right) + \beta_6 \ln TO_{it} + \beta_7 FY_{it} + \varepsilon_{it}, \qquad (4)$$

where TO is trade openness; FY is FDI inflows as a percentage of nominal GDP; and ε is a disturbance term. TO and FY enter the equation in levels following most literature on growth and development. They are entered in first differences in the robustness section. Three different measures of research intensity are used and discussed in the next section. Schooling (SCH) is included as an additional regressor following Benhabib and Spiegel's (1994) extension of the Nelson-Phelps model.

This model is estimated using annual data over the period 1970-2004 for a panel of 55 countries (23 OECD countries and 32 developing countries). The countries included in the sample are listed in the notes to Table 1. In order to filter out the business cycle effects, TFP growth is measured in 5-year differences and the regressors are measured in 5-year averages (except for the last period where four year-averages or four-year-differences are taken). The sample includes as many countries as possible that have R&D data spanning at least 20 years and for which at least eight annual observations of R&D are available. The sample contains a wide cross section of countries with different per capita income levels including most OECD countries and other developing countries such as Niger, Peru, Senegal, Sudan and Thailand.

3. Data

The data used to estimate Eq. (4) are constructed as follows. TFP is recovered from the aggregate production function $Y = AK^{\alpha}L^{1-\alpha}$, where *Y* is real GDP, *K* is real physical capital stock and *L* is the total labor force. It is measured as $A = TFP = y/k^{\alpha}$, where y is the output-worker ratio (Y/L) and k is the capital-worker ratio (K/L). Capital's income share (α) is set to 0.30 following Gollin (2002). *K* is constructed using the perpetual inventory method. The initial capital stock is estimated using the Solow model steady-state value of $I_0/(\delta + g)$, where I_0 is initial real investment, δ is the rate of depreciation, which is assumed to be 5% following Bosworth and Collins (2003), and g is the growth rate in real investment over the period 1970-2004. These data are obtained from the Penn World Table.

R&D intensity, (X/Q), is measured by the following three indicators (see Ha and Howitt, 2007; Madsen, 2008b; Madsen et al., 2009): (1) the ratio of R&D scientists and engineers to the total labor force (N/L); (2) the share of R&D expenditures in GDP (R/Y);[1] and (3) the number of patent applications filed by domestic residents relative to the total labor force (P/L). Patent applications are used in preference to patents granted since the frequency of patent granting activities varies over time and across countries (Griliches, 1990; Jaffe and Palmer, 1997). R&D data are collected from various issues of the UNESCO Statistical Yearbook and patent data are obtained from the WIPO (2007). Some missing data between years are interpolated arithmetically. Distance to the frontier ($A^{\max}/A$) is measured by the TFP gap between the US and the country under consideration. Educational attainment (*SCH*) is measured by the average years of schooling of the population aged 25 and over using the dataset provided by Barro and Lee (2001). Trade openness (*TO*) is measured by the sum of exports and imports over GDP using data from WDI (2007). Data for foreign direct investment are taken from the IMF (2007).

[1] R&D expenditures are usually deflated by the arithmetic average of hourly labor costs and the GDP deflator (e.g., Coe and Helpman, 1995). We initially considered this approach; however, this leads to implausible movements in real R&D since labor earnings show abnormal fluctuations in several developing countries, particularly in Latin America and Africa. Therefore, we have simply used the GDP deflator to express R&D expenditures in real terms.

Table 1: Descriptive Statistics (1970-2004)

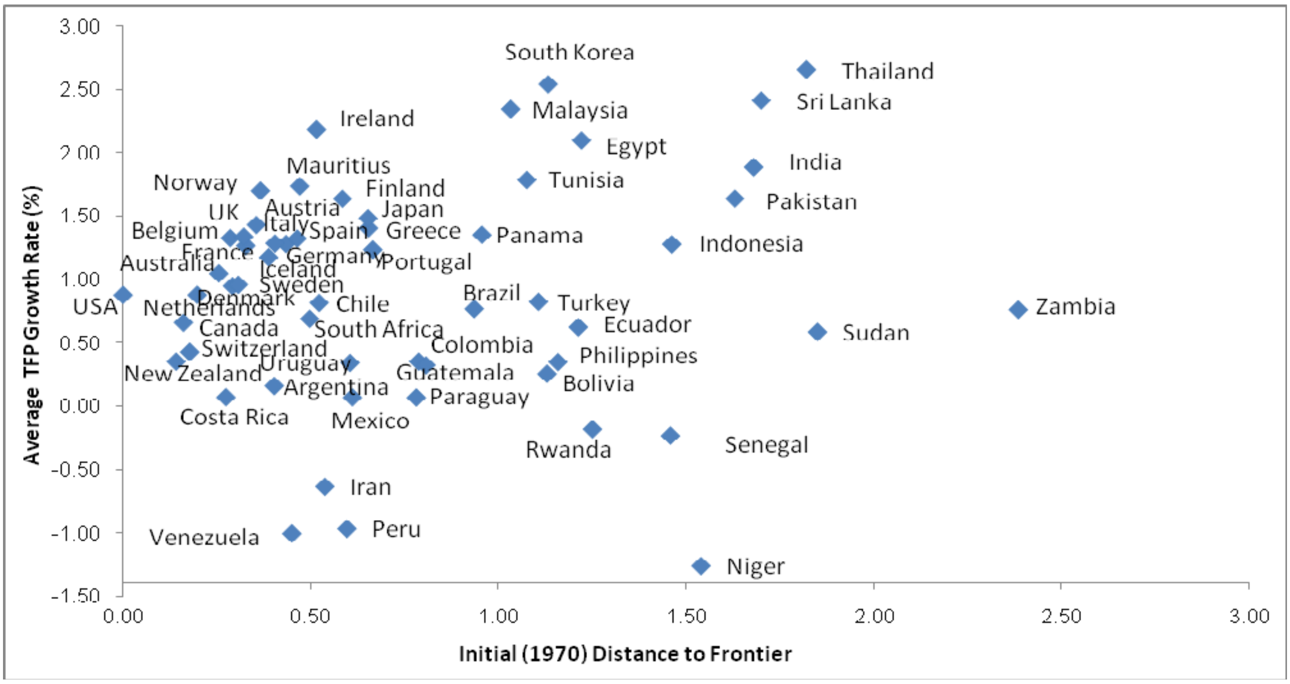
	$\Delta \ln A$	A^{US} / A	N / L	R / Y	P / L	*SCH*	*TO*	*FY*
Total Sample (55 Countries)								
Mean	4.52	252.36	0.23	0.99	0.04	6.11	57.70	1.58
Std. Dev.	9.81	187.98	0.26	0.84	0.07	2.88	31.36	1.79
Minimum	-35.22	100.00	0.00	0.01	0.00	0.28	9.61	-0.41
Maximum	37.11	1351.06	1.52	3.97	0.54	12.29	211.55	12.97
Observations	384	385	370	296	326	384	380	351
OECD Countries (23)								
Mean	6.16	139.67	0.45	1.57	0.07	8.59	61.63	1.65
Std. Dev.	6.24	30.06	0.25	0.77	0.09	1.96	28.04	1.88
Minimum	-8.58	100.00	0.05	0.18	0.00	2.65	13.98	-0.03
Maximum	29.20	310.45	1.52	3.97	0.54	12.29	161.72	12.97
Observations	160	161	160	154	159	160	160	139
Developing Countries (32)								
Mean	3.35	333.36	0.05	0.36	0.00	4.34	54.84	1.54
Std. Dev.	11.59	210.82	0.04	0.22	0.01	1.98	33.34	1.72
Minimum	-35.22	126.59	0.00	0.01	0.00	0.28	9.61	-0.41
Maximum	37.11	1351.06	0.26	1.08	0.04	8.68	211.55	11.09
Observations	224	224	210	142	167	224	220	212

Notes: all data are expressed in percentages, except *SCH* which is expressed in years. OECD countries include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States. Developing countries include Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Egypt, Guatemala, India, Indonesia, Iran, Malaysia, Mauritius, Mexico, Niger, Pakistan, Panama, Paraguay, Peru, the Philippines, Rwanda, Senegal, South Africa, Sri Lanka, Sudan, Thailand, Tunisia, Turkey, Uruguay, Venezuela and Zambia.

Table 1 presents the descriptive statistics for the variables used in the estimation. As would be expected, the mean values of all R&D intensity measures are much larger for OECD countries than for developing countries. According to the Schumpeterian theory, this implies that OECD countries have a larger growth potential than developing countries before the growth effects of distance to the frontier are accounted for. The schooling gap is much smaller than the R&D intensity gap. The average number of years of schooling of the working age population is only about twice as high in OECD countries compared to developing countries. Interestingly, *TO* (trade openness) and *FY* (the ratio of FDI inflows to GDP) are not significantly different between the two country groups. Trade openness has often been stressed as being an important factor for development and growth (Radelet et al., 2001). Clearly the statistics in Table 1 suggest that developing countries are as open as OECD countries and, therefore, that trade openness may not be a clear candidate in explaining growth differences between the two country groups. The variable *FY* shows that FDI does not automatically flow to developing countries despite the general assumption that their returns to capital are higher than those of OECD countries. The statistics reinforce the analysis of Lucas (1990) that the marginal productivity of capital is no larger in developing than in developed countries ones because of differences in educational attainment endowments.

Figure 1 shows a positive relationship between initial (i.e., 1970) distance to the frontier and the average TFP growth rates over the period 1970-2004. The figure provides some evidence of gravitation towards frontier technology countries independent of educational attainment and research intensity. However, the relationship between the two variables is blurred by a high standard deviation. Despite initially being technologically backward, several countries in Latin America (e.g., Venezuela and Peru), Sub-Saharan Africa (e.g., Niger, Rwanda and Senegal) and Asia (e.g., Iran) appear to be 'growth disasters' with no signs of taking off. On the other hand, the East Asian countries such as Thailand, Malaysia and South Korea appear to be 'growth miracles', with strong growth records over the last few decades. High growth rates have also been observed in some South Asian countries, including India, Pakistan and Sri Lanka.

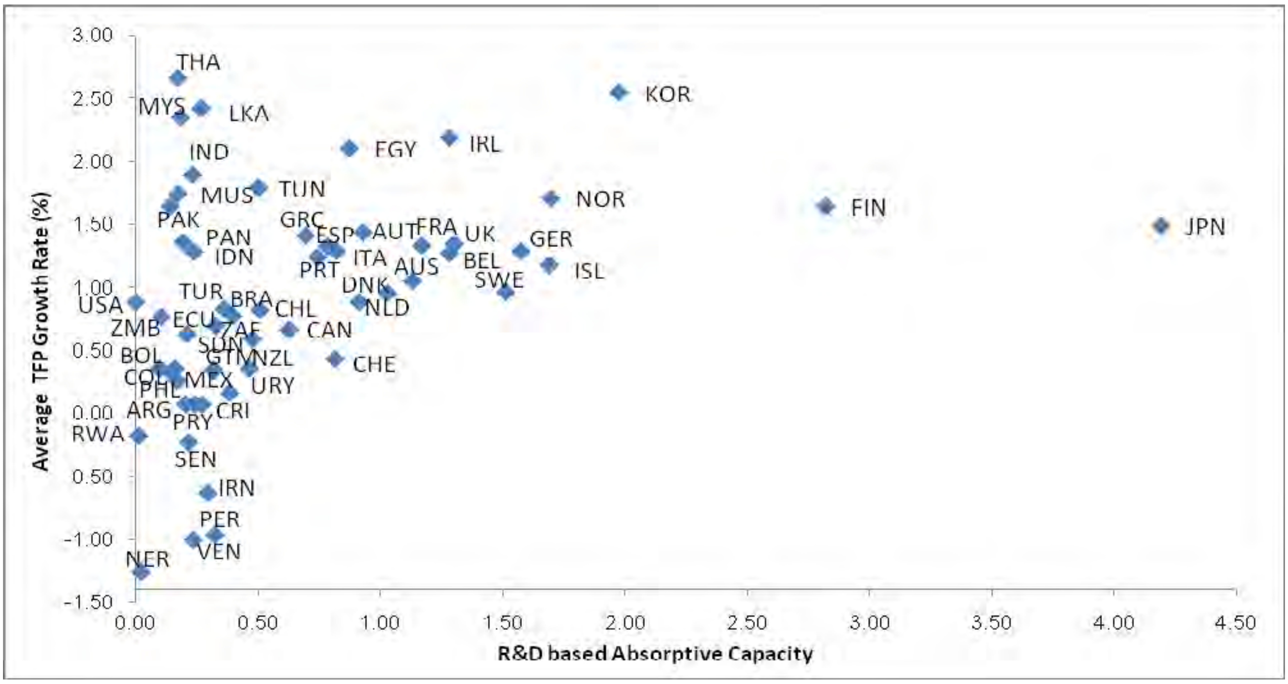
Figure 1: Initial distance to the frontier versus average TFP growth (1970-2004)



Notes: Initial distance to frontier is measured as the log of the relative TFP gap between the US and sample countries in 1970.

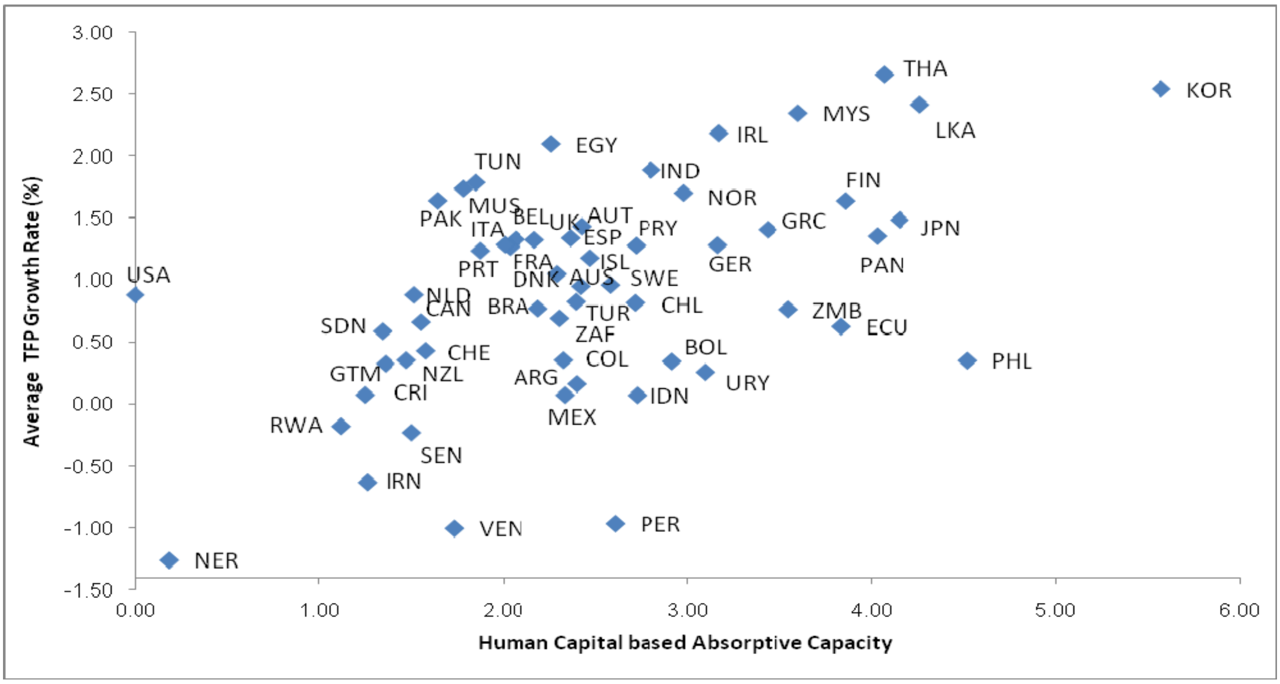
Figure 2 displays the relationship between R&D-based absorptive capacity and the average TFP growth rates, where R&D intensity is measured by *N*/*L*. There are some positive correlations between these two variables for higher values of the interaction variable; however, there appears to be no systematic relationship for very low values of the interaction term.

Figure 2: R&D-based absorptive capacity vs. average TFP growth



Notes: R&D intensity is measured as the average share of scientists and engineers in the total labor force.

Figure 3: Educational attainment-based absorptive capacity vs. average TFP growth



Notes: Educational attainment is measured as the average years of schooling of the total population aged 25 and over.

Finally, Figure 3 shows a positive relationship between average TFP growth rates and the interaction between educational attainment and the initial distance to the frontier. The high-growth Asian countries have experienced high growth rates in conjunction with initially large distances to the frontier and a reasonably highly educated labor force. The opposite holds true for many African and Latin American countries.

4. Estimation Results

The system GMM estimator of Arellano and Bover (1995) and Blundell and Bond (1998) is used to estimate Eq. (4). This technique has been widely used to deal with unobserved heterogeneity and endogeneity biases in estimation. Bond et al. (2001) show that the system GMM estimator is the most preferred approach for estimation of empirical growth models due to its superior ability in exploiting stationarity restrictions (see also Durlauf et al., 2005). Furthermore, to ensure that the empirical results are not driven by outliers, P/L (patent applications over the labor force) is winsorized at the top and bottom 5 percent of their distributions, i.e., values at the 5% and 95% percentiles are reduced. Winsorizing is not carried out for the regressions in which research intensity is measured by N/L (the ratio of R&D scientists and engineers to the labor force) and R/Y (the share of R&D expenditure in GDP) because the results are unaffected by winsorizing.

The estimation results using N/L as the indicator of research intensity are reported in Table 2. First, consider the estimation results for all 55 countries reported in the upper panel of the table. R&D research intensity enters significantly in all regressions except the one in column 10. The positive effect of R&D intensity on TFP growth is consistent with the findings of Griffith et al. (2003, 2004), Zachariadis (2003, 2004), Madsen (2008b) and Madsen et al. (2009), among others. The significance of this result is that R&D has permanent growth effects and that the growth effects will remain constant as long as the number of R&D workers is kept as a constant proportion of the labor force. Most of the estimated coefficients of educational attainment are insignificant. This result is consistent with the findings of Benhabib and Spiegel (1994), among others, who fail to find a robust direct relationship between educational attainment and growth. Intuitively, it also difficult to see why certain educational categories should induce growth permanently, given that growth is predominantly due to increasing product variety and higher product quality. Most educated people are not employed to carry out R&D and create new products and it is hard to see how certain types of education, such as law, would enhance growth.

Table 2: TFP growth equation (unrestricted and restricted estimates of Eq. (4) using *N*/*L*)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.03***			0.03**	0.02***	0.04***	0.03***	0.03***	0.02
		(2.69)			(2.22)	(3.52)	(4.29)	(3.15)	(2.78)	(0.46)
$\ln(A^{\max}/A_i)_{t-1}$	0.11**	0.13**		0.11**	0.11***		0.05*		0.13**	0.34***
	(2.03)	(2.48)		(2.21)	(2.67)		(1.93)		(2.01)	(4.01)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.02***	0.03***	0.02					0.07**
			(2.69)	(2.95)	(0.20)					(2.26)
$\ln SCH_{it}$	0.08**	0.05	-0.01	0.07**	0.05*			-0.02	0.05	0.07
	(2.19)	(1.53)	(-0.25)	(2.18)	(1.68)			(-1.14)	(0.98)	(0.91)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01**	0.01*	0.01***	-0.01	0.01
						(2.10)	(1.80)	(2.71)	(-0.81)	(0.56)
$\ln TO_{it}$	0.03	0.03	0.04	0.04	0.01	0.01	0.02	0.01	0.03	0.02
	(0.75)	(1.27)	(0.90)	(1.14)	(0.41)	(0.09)	(1.27)	(0.39)	(1.31)	(0.36)
FY_{it}	0.69	0.76	1.03	0.65	0.45	0.54	0.32	0.52	0.55	1.36***
	(0.92)	(1.32)	(1.41)	(0.89)	(0.82)	(0.93)	(0.56)	(0.97)	(1.21)	(2.66)
Hansen (p-value)	0.35	0.51	0.33	0.66	0.99	0.89	0.98	0.99	0.99	0.89
AR(2) (p-value)	0.32	0.48	0.35	0.44	0.47	0.47	0.63	0.53	0.50	0.14
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.09**			0.01	0.01	0.05**	0.03	0.10***	0.10
		(2.53)			(0.25)	(0.86)	(2.46)	(1.50)	(3.21)	(1.16)
$\ln(A^{\max}/A_i)_{t-1}$	0.20***	0.37***		0.35***	0.32***		0.33***		0.58**	0.59*
	(4.09)	(3.92)		(3.77)	(3.73)		(2.81)		(2.08)	(1.98)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.02**	0.04***	0.04**					0.02
			(2.10)	(2.89)	(2.20)					(1.21)
$\ln SCH_{it}$	0.03	-0.17	-0.03	-0.02	-0.03			-0.06	0.053	0.10
	(0.82)	(-1.09)	(-1.09)	(-0.28)	(-0.20)			(-1.33)	(0.43)	(0.63)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01***	-0.01	0.02**	-0.03	-0.04
						(4.00)	(-1.39)	(2.68)	(-0.92)	(-1.00)
$\ln TO_{it}$	0.01	-0.01	0.01	0.07	0.03	-0.01	-0.01	0.01	-0.01	0.01
	(0.32)	(-0.12)	(0.52)	(1.20)	(0.68)	(-0.24)	(-0.41)	(0.07)	(-0.07)	(0.74)
FY_{it}	0.76	1.31***	0.37	1.07*	1.01**	0.74	1.17**	0.73*	1.19***	1.06**
	(1.22)	(2.70)	(0.80)	(1.91)	(2.12)	(1.51)	(2.59)	(1.69)	(2.80)	(2.50)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00
AR(2) (*p*-value)	0.14	0.45	0.16	0.16	0.11	0.11	0.11	0.12	0.18	0.19
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.03*			-0.03	0.04	0.04**	0.07	0.07	-0.03
		(1.80)			(-0.84)	(1.11)	(2.59)	(1.51)	(1.28)	(-0.75)
$\ln(A^{\max}/A_i)_{t-1}$	0.13**	0.12**		0.08	0.08		0.08***		0.66***	0.11
	(2.08)	(2.10)		(0.82)	(1.47)		(3.14)		(2.77)	(1.52)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.07***	0.08**	0.13*					0.13*
			(3.08)	(2.16)	(1.78)					(1.74)
$\ln SCH_{it}$	0.08**	0.06*	-0.01	0.07	0.08**			-0.13	-0.16	0.10
	(2.52)	(1.67)	(-0.54)	(0.92)	(2.03)			(-0.74)	(-0.91)	(1.49)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.02*	-0.03	0.06*	0.01	-0.02
						(1.86)	(-0.80)	(1.72)	(0.40)	(-1.52)
$\ln TO_{it}$	-0.01	0.01	0.02	0.04	0.02	-0.01	0.05*	-0.07	0.01	0.04**
	(-0.33)	(0.09)	(0.70)	(0.83)	(0.99)	(-0.08)	(1.89)	(-1.19)	(0.01)	(2.39)
FY_{it}	0.41	0.76	1.50*	-1.01	0.99**	-1.90	0.39	0.56	0.49	0.87*
	(0.58)	(1.12)	(1.77)	(-0.46)	(2.03)	(-1.17)	(0.59)	(0.53)	(0.57)	(1.76)
Hansen (*p*-value)	0.99	0.99	0.99	0.40	0.99	0.92	0.99	0.97	0.96	0.99
AR(2) (*p*-value)	0.11	0.21	0.13	0.25	0.11	0.13	0.21	0.23	0.83	0.13

Notes: The numbers in parentheses are *t*-statistics and are based on robust standard errors. The Hansen test examines the validity of the instruments with the null hypothesis that the instruments are uncorrelated with residuals. The null hypothesis for the AR(2) test is that the error terms in the first-differenced regression exhibit no 2nd order serial correlation. All results satisfy the AR(1) test for 1st order serial correlation and *F*-test for joint significance; however, they are not reported to conserve space. Constants, time and country dummies are not reported due to space consideration. Research intensity (*X*/*Q*) is measured as number of R&D workers divided by the total labor force (*N*/*L*). *SCH* = educational attainment; $A^{\max}/A_i$ = technology gap between the U.S. and country *i*; *TO* = trade openness; and *FY* = foreign direct investment inflows as a percentage of nominal GDP. The 2nd and 3rd lags of the explanatory variables are taken as instruments for the differenced equation whereas 1st differences of the explanatory variables are taken as instruments for the level equation. Figures in parenthesis are *t*-statistics. *, ** and *** denote 10%, 5% and 1% significance levels, respectively.

Distance to the frontier and its interaction with research intensity and educational attainment are important for growth in almost all of the regressions involving the 55 countries. The estimated coefficients of distance to the frontier are statistically significant in all regressions, which is in line with the results of Griffith et al. (2004), Kneller (2005), Kneller and Stevens (2006) and Madsen (2007, 2008a), among others. This finding suggests that TFP growth convergence occurs due to autonomous transfer of foreign technology. However, the estimates for country groups suggest that this result is predominantly driven by the OECD group. The estimated coefficients of distance to the frontier are highly significant for OECD countries in all columns while they are only significant in about half of the cases for developing countries, at the 5% level. The latter result is consistent with the casual observation that many Sub-Saharan African countries have fallen further behind the frontier countries and have often experienced very low or even negative TFP growth rates over the past few decades. Thus, as discussed in the introduction, backwardness is not always an advantage if the right institutions are not in place and, particularly, if countries do not have a sufficiently educated labor force that can imitate and absorb the increasing complexity of the technology that is developed at the frontier.

The estimated coefficients of the interaction between research intensity and distance to the frontier are significant in three out of four cases; thus providing further supporting evidence for the Schumpeterian growth models of Howitt (2000) and Griffith *et al.* (2003). The results also corroborate the findings of Kneller (2005) for OECD countries. The estimated coefficients of $SCH_{it} \ln(A^{\max} / A_i)_{t-1}$ are economically and statistically significant in three of the five cases. This supports the hypothesis put forward by Nelson and Phelps (1966) and the empirical findings of Benhabib and Spiegel (1994) and Kneller and Stevens (2006) that an educated labor force increases the absorptive capacity of countries that are behind the technology frontier.

The regressions in the last column in Table 2 include all regressors in Eq. (4). However, a high degree of multicollinearity renders the results unsatisfactory (the correlation coefficients between the variables are higher than 0.8 in some cases). Research intensity, for instance, which is consistently highly significant in other regressions, is rendered insignificant by the inclusion of variables that are highly correlated with it such as the interaction between research intensity and distance to the frontier. Furthermore, the nested tests presented in the next section give evidence in favor of most of the simpler specifications in the other columns.

Turning to the results for OECD countries, the estimated coefficients of R&D intensity are significant, at the 5% level, in three out of the seven cases and are much more significant than those of the developing countries where research intensity has weak direct growth effects, as discussed below. This suggests that innovation, as opposed to duplication, is much more widespread in OECD countries than in developing countries.[2] Educational attainment only affects growth indirectly through interacting with distance to the frontier in two of the five cases. As noted above this may reflect the case that there are no level effects from certain categories of education and the difficulties associated with the measurement of educational attainment (see, e.g., de la Fuente and Doménech, 2006). This issue is further addressed in the next section.

For developing countries, the estimated coefficients of educational attainment are only significant in a quarter of the cases, at the 5% level of significance. Furthermore, educational attainment does not have positive direct growth effects in 87.5 percent of the cases in the estimates in which research intensity is measured in terms of R&D expenditures and patents, at the 5% level of significance (see Tables 3 and 4). Finally, in no cases is educational attainment significant, at the five percent level, when the dataset on educational attainment compiled by Cohen and Soto (2007) is used, as shown below. These results are not surprising given that most graduates in developing countries tend to seek employment in the government sector (Griliches, 1997). However, our results do not imply that investment in education is unimportant for growth in developing countries. The coefficients of interaction between educational attainment and distance to the frontier are weakly significant in about half of the cases, providing some support for the Nelson and Phelps (1966) hypothesis.

For developing countries there seem to be very few direct effects of research intensity on growth. Only one of the estimated coefficients of research intensity is statistically significant at the 5% level, and none of the coefficients are significant in the estimates in Table 4 at the same level of significance. This may reflect the fact that the R&D intensity is too low in developing countries to yield sufficiently large identifying variations in the data or to create positive externalities across a wide range of economic activities or simply that most innovations are duplications. However, the estimated coefficients of the interaction between research intensity and distance to the frontier are all significant at the 10% level and half of them are significant at the 5% level. It is interesting to note that R&D-based absorptive capacity plays a more important role for TFP growth in developing countries (average elasticities 0.1) than in OECD countries (average elasticities 0.03). These results

[2] Note that the coefficient of the log of research intensity does not indicate R&D productivity but duplication efforts. In the Schumpeterian productivity-growth function outlined by Ha and Howitt (2007), it is zero if all innovations are duplications and one if there are no duplicating innovations.

reinforce the earlier findings that R&D plays an important role for imitation in developing countries.

Finally, considering the effects of control variables, trade openness has little or no effect on productivity growth in all regressions. This finding is, perhaps, quite surprising given that more open economies may have greater growth potential (Radelet et al., 2001). Remarkably, the estimated coefficients of *FY* are significant in most of the OECD regressions but generally are not very significant for developing countries. One interpretation of these results is that it is the type of FDI that matters for growth and not necessarily the quantity. This line of reasoning suggests that OECD countries attract FDI that has significant spillover effects whereas the FDI externalities in developing countries are low.

Table 3: TFP growth equation (unrestricted and restricted estimates of Eq. (4) using *R*/*Y*)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.02^{**}			-0.02	0.03^{***}	0.03^{***}	0.03^{***}	0.034^{***}	-0.01
		(2.51)			(-1.02)	(2.70)	(3.12)	(2.94)	(2.83)	(-0.18)
$\ln(A^{\max}/A_i)_{t-1}$	0.11^{**}	0.08^{*}		0.05	0.34^{***}		0.01		0.01	0.12
	(2.03)	(1.91)		(1.41)	(4.20)		(0.44)		(0.12)	(0.89)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.05^{**}	0.05^{**}	0.07					0.12^{**}
			(2.49)	(2.31)	(1.24)					(2.47)
$\ln SCH_{it}$	0.08^{**}	0.06	0.01	0.07^{*}	-0.01			-0.02	-0.01	-0.07
	(2.19)	(1.56)	(0.23)	(1.92)	(-0.11)			(-0.66)	(-0.20)	(-0.64)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01^{**}	0.01^{**}	0.01^{**}	0.01	0.05^{*}
						(2.18)	(2.35)	(2.55)	(0.87)	(1.86)
Hansen (p-value)	0.35	0.99	0.63	0.99	0.74	0.97	0.99	0.99	0.99	0.97
AR(2) (p-value)	0.32	0.80	0.65	0.95	0.66	0.55	0.76	0.58	0.48	0.98
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.28^{**}			0.13^{**}	0.01	0.02	-0.07	0.09^{*}	0.09
		(2.67)			(2.12)	(0.47)	(1.06)	(-0.29)	(1.89)	(1.24)
$\ln(A^{\max}/A_i)_{t-1}$	0.20^{***}	0.87^{***}		0.74^{***}	0.47^{***}		0.20^{*}		0.08	0.68^{*}
	(4.09)	(2.97)		(4.43)	(3.18)		(1.98)		(0.30)	(1.68)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.18^{**}	0.28^{***}	-0.03					-0.08
			(2.02)	(3.19)	(-0.53)					(-0.78)
$\ln SCH_{it}$	0.03	-0.56	-0.10	-0.18	-0.05			-0.01	-0.28	0.08
	(0.82)	(-0.99)	(-0.67)	(-0.53)	(-0.21)			(-0.31)	(-1.43)	(0.50)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.02^{***}	-0.07	0.02^{**}	0.07	-0.02
						(5.24)	(-0.60)	(2.67)	(1.62)	(-0.50)
Hansen (*p*-value)	0.99	0.85	0.90	0.99	0.99	0.99	0.99	0.99	0.99	0.99
AR(2) (*p*-value)	0.14	0.17	0.12	0.15	0.11	0.12	0.11	0.13	0.12	0.97
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.03^{*}			-0.03	0.07	0.02^{*}	0.03^{**}	0.02^{*}	0.05
		(1.97)			(-1.61)	(1.43)	(1.96)	(2.25)	(1.68)	(1.11)
$\ln(A^{\max}/A_i)_{t-1}$	0.13^{**}	0.07^{*}		0.07^{**}	-0.02		0.03		0.11	0.02
	(2.08)	(1.86)		(2.09)	(-0.60)		(0.86)		(0.86)	(0.06)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.11^{***}	0.08^{*}	0.13^{*}					0.06
			(2.95)	(1.68)	(1.90)					(0.74)
$\ln SCH_{it}$	0.08^{**}	0.05	0.03	0.08	-0.03			-0.03	0.09	-0.35
	(2.52)	(0.86)	(0.51)	(1.31)	(-0.76)			(-0.79)	(0.69)	(-1.40)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.10^{***}	0.08	0.01^{**}	-0.01	0.10^{*}
						(3.97)	(1.10)	(2.26)	(-0.41)	(2.00)
Hansen (*p*-value)	0.99	0.99	0.99	0.96	0.99	0.99	0.99	0.99	0.99	1.00
AR(2) (*p*-value)	0.11	0.21	0.12	0.30	0.33	0.14	0.19	0.22	0.19	0.31

Notes: See notes to Table 2. (*X/Q*) is measured as the share of R&D expenditure in GDP (*R/Y*). The parameter estimates for *TO* and *FY* are included in the regressions but their coefficients are not reported.

Tables 3 and 4 report the results of estimating Eq. (4) where research intensity is measured as the share of R&D expenditure in total GDP (*R/Y*) and the number of patent applications divided by the labor force (*P/L*), respectively. The results are quite similar to those in Table 2. Overall the results reinforce the findings above that R&D intensity, distance to the frontier and its interaction with R&D and educational attainment are important for growth in OECD countries. The interaction between distance to the frontier and R&D intensity, and to some extent educational attainment, is influential for growth in developing countries.

Table 4: TFP growth equation (unrestricted and restricted estimates of Eq. (4) using *P*/*L*)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.03^{***}			0.04^{**}	0.02^{***}	0.03^{***}	0.13^{***}	0.03^{***}	0.06^{*}
		(3.22)			(2.61)	(3.13)	(3.46)	(2.74)	(2.97)	(1.84)
$\ln(A^{\max}/A_i)_{t-1}$	0.11^{**}	0.12^{*}		0.05	0.12^{*}		0.16^{**}		0.16	0.52^{**}
	(2.03)	(1.89)		(1.17)	(1.78)		(2.19)		(1.54)	(2.53)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.17^{**}	0.23^{**}	-0.09					0.19
			(2.01)	(2.17)	(-1.07)					(0.87)
$\ln SCH_{it}$	0.08^{**}	-0.03	-0.01	0.03	-0.03			-0.08	0.01	-0.07
	(2.19)	(-0.63)	(-0.41)	(0.08)	(-0.61)			(-1.56)	(0.02)	(-0.73)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01^{**}	-0.01	0.01^{**}	-0.01	0.01
						(2.02)	(-1.37)	(2.23)	(-0.79)	(0.36)
Hansen (p-value)	0.35	0.99	0.98	0.99	0.99	0.98	0.99	0.99	0.99	0.97
AR(2) (p-value)	0.32	0.56	0.49	0.42	0.63	0.83	0.57	0.61	0.52	0.46
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.05^{**}			-0.02	0.02	0.02	0.02	0.04^{**}	0.02
		(2.23)			(-0.05)	(1.25)	(1.27)	(1.13)	(2.07)	(0.03)
$\ln(A^{\max}/A_i)_{t-1}$	0.20^{***}	0.59^{**}		0.25^{***}	0.58^{**}		0.21^{**}		0.62^{*}	0.98^{**}
	(4.09)	(2.56)		(3.47)	(2.52)		(2.07)		(1.76)	(2.32)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.13^{***}	-0.02	0.24^{**}					0.26
			(2.94)	(-0.05)	(2.37)					(1.44)
$\ln SCH_{it}$	0.03	0.09	-0.01	0.53	0.13			-0.01	0.17	0.28^{*}
	(0.82)	(0.52)	(-0.35)	(1.29)	(0.77)			(-0.11)	(1.17)	(1.74)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.09^{***}	-0.08	0.09^{***}	0.02	-0.03
						(3.12)	(-0.59)	(3.26)	(0.32)	(-0.52)
Hansen (*p*-value)	0.99	0.99	0.99	1.00	0.99	0.99	0.99	0.99	1.00	0.99
AR(2) (*p*-value)	0.14	0.87	0.25	0.12	0.66	0.22	0.20	0.44	0.73	0.64
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.05^{*}			0.05	0.02	0.03^{*}	-0.09	0.04	0.02
		(1.96)			(0.82)	(1.31)	(1.99)	(-0.30)	(1.56)	(0.61)
$\ln(A^{\max}/A_i)_{t-1}$	0.13^{**}	0.83^{***}		0.67^{***}	0.98^{***}		0.15^{*}		0.72^{*}	0.49^{**}
	(2.08)	(4.81)		(3.48)	(3.45)		(1.99)		(1.71)	(2.20)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.10^{**}	0.06^{**}	0.03					-0.28
			(2.45)	(2.01)	(0.48)					(-0.09)
$\ln SCH_{it}$	0.08^{**}	-0.03	-0.03	-0.05	0.02			-0.35	-0.10	0.04
	(2.52)	(-0.11)	(-0.10)	(-0.03)	(-0.07)			(-1.25)	(-0.34)	(0.34)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01^{*}	-0.07	0.11^{***}	0.02	0.06
						(1.98)	(-0.82)	(4.90)	(0.28)	(0.23)
Hansen (*p*-value)	0.99	0.98	0.35	0.99	0.82	0.99	0.99	0.99	0.99	0.99
AR(2) (*p*-value)	0.11	0.52	0.78	0.30	0.46	0.17	0.36	0.86	0.71	0.05

Notes: See notes to Table 2. (*X/Q*) is measured as the number of patent applications filed by domestic residents relative to the total labor force (*P/L*). The parameter estimates for *TO* and *FY* are included in the regressions. Their coefficients are not reported.

5. Robustness Checks

A series of sensitivity checks are undertaken in this section to ensure robustness of the results reported in the previous section to the inclusion of additional control variables, measurement in 10 and 34-year intervals, TFP measurement, alternative data sets, different functional form and other specification issues. The estimation results are not reported here to conserve space but they are provided and discussed in detail in the Appendix. Since our results are not sensitive to the way research intensity is measured, it is computed as the ratio of R&D scientists and engineers to the labor force (N / L). This allows a direct comparison with the key results reported in Table 2. Unless otherwise stated, the estimates are based on the system GMM estimator and the variables are measured in 5-year intervals.

5.1 Omitted variables. The following additional control variables, which are widely used in growth regressions (see, e.g., Hall and Jones, 1999; Miller and Upadhyay, 2000), are included in the estimates of Eq. (4): inflation, financial development (proxied by the ratio of private credit to GDP), the terms of trade, distance from the equator and the quality of institutions (measured by the Composite International Country Risk Guide risk rating based on 22 components of risk). With the exception of the last two, all these variables are entered in first-differences. The growth in trade openness and changes in the ratio of FDI to income are included as additional explanatory variables noting that they enter Eq. (4) in levels. Since the ratio of private credit to GDP is likely to be endogenous, the legal origin of a country is used as the instrument. This is motivated by the insights of La Porta *et al.* (1998), who argue that the legal origin of a country strongly influences the legal environment governing the operation of financial systems.

Almost all the estimated coefficients of the control variables are insignificant in the full sample, with the exception of the growth in *FY*. Its effect is found to be highly significant in both country groups. Coupled with the finding above of a highly significant coefficient of the level of *FY* for OECD countries, this result suggests that FDI is important for growth. The basic results reported in Table 2 are not affected by the inclusion of the control variables, except that the effect of R&D-based absorptive capacity is marginally weaker in the sub-samples involving only the OECD or developing countries.

The estimates in the previous section are based on the Schumpeterian framework and, as such, do not allow for the possibility that R&D has only temporary growth effects following the predictions of the semi-endogenous growth theory of Jones (1995a, b) (see, e.g., Madsen, 2008b for a discussion). To cater for this, the growth rate of R&D workers ($\Delta \ln X_{it}$), the growth rate of educational attainment ($\Delta \ln SCH_{it}$) and their interaction with distance to the frontier [$(\Delta \ln X_{it}) \ln(A^{\max} / A_i)_{t-1}$ and $(\Delta \ln SCH_{it}) \ln(A^{\max} / A_i)_{t-1}$)] are included as additional regressors in Eq. (4). Contrary to the predictions of the semi-endogenous growth models, in hardly any cases is TFP growth significantly determined by these variables. Furthermore, the parameter estimates of the variables considered in Eq. (4) are largely unaffected by the inclusion of these additional regressors. Hence, we can conclude that the Schumpeterian growth model is the appropriate framework for the analysis in this paper.

5.2 Alternative TFP measures. To check the robustness of the results to measurement of TFP, the following alternative measures of TFP are used in the regressions of Eq. (4): 1) capital income shares of 0.35 and 0.40 (0.30 is used as the default value); 2) educational attainment is allowed for in the TFP estimates by assuming the following aggregate production function: $Y = AK^{\alpha}(HL)^{1-\alpha}$, where educational attainment (*H*) is computed using the Mincerian approach by assuming a 7% returns to schooling; 3) output per worker is used as a proxy for TFP since $Y/(K^{\alpha}L^{1-\alpha})$ and labor productivity are growing at the same rate along the balanced growth path; 4) capital stock is based on an alternative measure of initial capital stock; and 5) cyclically adjusted TFP following the method of Basu *et al.* (2006). The latter corrects for the effects of non-constant returns, imperfect competition, and varying utilization of capital and labor. Regarding capital stock, the initial level has thus far been computed as $I_0/(\delta + g)$. However, I_0 may be influenced by business cycles and transitional dynamics. To address this concern, the structural initial capital stock is estimated as a linear transformation of the average investment ratio over the period 1970-2004, as detailed in the Appendix. None of the estimation results obtained in Table 2 are significantly affected by these alternative measures of TFP, reinforcing the robustness of the results in Table 2.

5.3 Alternative measures of educational attainment and distance to the frontier. Educational attainment has thus far been measured as the average years of schooling of the population aged 25 and over provided by Barro and Lee (2001). Since educational attainment plays an important role in this study and is subject to large measurement errors, we also run the regressions using the dataset of educational attainment of the labor force compiled by Cohen and Soto (2007). They argue that their dataset is subject to fewer measurement errors than that of Barro and Lee (2001). Furthermore, $A^{\max}$ has thus far been measured by the TFP for the U.S. However, a closer examination of the data reveals that the TFP was indeed higher for Ireland than the U.S. over the period 2001-2004. We provide a sensitivity check in which the technological leader is the country with the highest TFP at any point in time. Allowing for these changes does not significantly affect the results obtained in Table 2. Interestingly, the direct growth effects of educational attainment are even less significant when the data set compiled by Cohen and Soto (2007) is used than when the Barro-Lee data set is used. This may suggest that educational attainment does not have a strong direct growth effect. However, the interaction between educational attainment and distance to the frontier remains important for growth for both country groups and the entire sample using the data set compiled by Cohen and Soto (2007).

5.4 Endogeneity of R&D. Thus far R&D intensity is found to have a significant positive impact on TFP growth. In OLS estimation, this could lead to a simultaneity bias because the decision to invest in R&D may be driven by changes in productivity. However, endogeneity is not a major concern here. The system GMM estimator used in this paper treats all regressors as potentially endogenous. Specifically, lagged explanatory variables are used as instruments for the differenced equation whereas the first-differences of the explanatory variables are taken as instruments for the levels equations in the estimation. The simultaneous use of both panel data in differences and the original data in levels produces substantial increases in both consistency and efficiency, thus mitigating the problems of endogeneity (see Arellano and Bover, 1995; Blundell and Bond, 1998). As a further robustness check for endogeneity, R&D intensity is lagged by one year in the regressions since the decision to invest in R&D is unlikely to be based on the expected productivity growth rate. Doing so does not change the results and indeed, these are almost identical to those in Table 2.

5.5 Long estimation intervals. In our empirical estimation, we have used data that are averaged or differenced over 5 year periods to filter out business cycle influences and to mitigate the effects of transitional dynamics. However, the longer is the period over which differences or the averages are taken, the less the estimates are influenced by business cycles and transitional dynamics. Thus, estimates in 10-year intervals as well as for the full sample period (1970 to 2004) are undertaken here. This comes at the cost of an efficiency loss due to a smaller number of available observations. The regression results are largely in line with those obtained in Table 2 except that the statistical significance of the coefficients of R&D-based absorptive capacity are slightly lower for the OECD sample due to the aforementioned efficiency loss.

5.6 The roles of trade openness and foreign direct investment. Keller (2004) argues that openness to international trade and FDI may work effectively as channels of international technology transfer. Countries that are more open to international trade and FDI are better equipped to take advantage of the technology that is developed in the frontier countries and, therefore, catch up quicker to the technology frontier. Allowing for these effects on growth yields the following specification (see Appendix for the derivation):[3]

$$\Delta \ln A_{it} = a_i + b' F_{it} + c \ln\left(\frac{A_{t-1}^{\max}}{A_{i,t-1}}\right) + d' F_{it} \ln\left(\frac{A_{t-1}^{\max}}{A_{i,t-1}}\right) + \upsilon_{it} \tag{5}$$

where F is a vector of variables consisting of R&D, educational attainment, trade openness and FDI divided by nominal GDP, and υ_{it} is the stochastic error term. Here, $b' F_{it}$ captures the direct effects and $d' F_{it} \ln(A_{t-1}^{\max} / A_{i,t-1})$ the indirect effects of *F* on TFP growth.

The results of estimating this equation give only limited support for the hypothesis that trade openness and FDI increase the pace at which countries gravitate to the technological frontier. The estimated coefficients of the interaction between FDI and distance to the frontier are only positive and significant in the developing country sample in 2 out of 10 cases. The estimated coefficients of the interaction between trade openness and distance to the frontier are only marginally significant for the OECD sample. The estimated coefficients of other variables are qualitatively very similar to the base case, suggesting that the benefits from technological backwardness can best be exploited by developing countries through enhancing domestic R&D intensity and investment in education.

5.7 Other robustness checks. Finally, the robustness of the results to OLS estimates (where time and country dummies are included in the regressions) to double log form of the absorptive capacity and to alternative model specifications are examined. First, the OLS estimator overcomes the finite sample bias that the GMM estimator is subject to (see, e.g., Windmeijer, 2005). Second, instead of measuring absorptive capacity by the terms $(X/Q)_{it} \ln(A^{\max}/A_i)_{t-1}$ and $SCH_{it} \ln(A^{\max}/A_i)_{t-1}$, they were expressed in a double-log form as $\ln(X/Q)_{it} \ln(A^{\max}/A_i)_{t-1}$ and $\ln SCH_{it} \ln(A^{\max}/A_i)_{t-1}$. Third, as alternative specifications, we enter the regressors in a more systematic manner than in Table 2 (see Appendix for a detailed explanation).[4] In all cases, the results are by and large very consistent with those reported in Table 2, thus reinforcing that the results in the previous section are fairly robust.

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[3] The framework of Griffith *et al.* (2000) can also be used to derive Eq. (5). In their model, the equilibrium R&D is at the point at which the individual is indifferent between intermediate production and R&D. Eq. (5) can be derived by allowing the potential of imitations through the channels of *FY* and *TO* to be a function of distance to the frontier.

[4] To ensure that the models in columns 1-9 are properly designed, we test whether the equations in columns 1 to 9 in Table 2 can be nested within the specification in column 10, which encompasses all variables. More specifically we regress the following general model (column 10):

6. Concluding Remarks

The role of R&D in promoting TFP growth has become increasingly prominent in the empirical growth literature. However, almost all empirical research so far has focused on OECD countries where evidence of the positive effects of domestic and foreign R&D on growth has been well-documented. Given that developing countries are latecomers, they may well have greater potential for catching up to the technology leader through investment in R&D and education that facilitates the transfer of foreign technology. This hypothesis is tested in this paper using data for 23 OECD countries and 32 developing countries over the period 1970-2004.

The results show that R&D intensity, educational attainment, their interaction with distance to the frontier, and distance to the frontier have positive effects on TFP growth for the whole sample of countries. While the growth effects of educational attainment and the interaction between distance to the frontier and research intensity apply to all countries in the sample, the growth-enhancing effects of educational attainment-based absorptive capacity and research intensity are generally limited to OECD countries. Furthermore, R&D intensity-based absorptive capacity is found to have the strongest growth effect in the developing country sample.

These results provide several important insights. First, that educational attainment facilitates convergence to the technological frontier only when the right institutions, such as those in OECD countries, are in place. Second, while the growth effects of R&D are through innovation as well as imitation in OECD countries, the growth effects of R&D are limited to imitation in the developing countries. Third, being far behind the technological frontier does not automatically generate growth. A country needs to invest in R&D to be able to take advantage of the technology that is developed at the frontier.

The findings of this study provide some insights into future growth prospects for both developed and developing countries and policy lessons for the formulation of development strategy. First, the significance of R&D intensity in explaining TFP growth in OECD countries implies that growth will continue at the present rates for countries at or close to the technology frontier,

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$$\Delta \ln A_{it} = \alpha' X_{it} + \lambda' Z_{it} + \upsilon_{it} ,$$

where X is a vector of variables contained in the restricted model under consideration (each of the models in columns 1-9), Z is a vector of the additional variables that are contained in the general model (column 10), and υ is a stochastic error term. We then test the null hypothesis that $\lambda' = 0$. The null hypothesis cannot be rejected at the 5% level for the models in columns 2, 4, 5, 7, 8 and 9 in 16 of the 18 cases, suggesting that these specifications are appropriate. The null hypothesis is rejected in all cases for the models in columns 1, 3, and 6, which indicates that these specifications are probably too simple.

provided that R&D is kept to a fixed proportion of the number of the number of product lines. Second, developing countries that invest in R&D will continue to grow in the near future due to the positive growth effects of the interaction between distance to the frontier and research intensity. When research intensive developing countries eventually move closer to the frontier, research intensity will take over as the engine of growth as the economies evolve from being just imitators to being both imitators and innovators.

Appendix: Further Robustness Checks

In this appendix we perform a series of sensitivity checks to ensure robustness of the results reported in the main text. While performing these checks, our results are not sensitive to the way research intensity is measured. We have therefore reported only the results for which research intensity is measured using the ratio of R&D scientists and engineers to the labor force (N/L) in order to conserve space. This allows a direct comparison with the key results reported in Table 2 in the main text. Moreover, unless otherwise stated, we continue to use a system GMM estimator with data in 5-year intervals to derive the estimates.

(O1) Controlling for institutional, geographical and other macroeconomic effects

Our empirical specification used in the main text may be subject to the problems associated with omitted variable bias. Although the estimations have controlled for the effects of foreign direct investment (*FY*) and trade openness (*TO*), they may not adequately capture the features and economic structure of less developed countries. To address this concern, we include the following additional control variables in the estimation: the rate of inflation (*INF*), financial development (*FD*), the terms of trade (*TOT*), the quality of institutions (*INS*), and distance from the equator (*DE*). These control variables are widely used in TFP growth empirics (see, e.g., Hall and Jones, 1999; Miller and Upadhyay, 2000).

The rate of inflation is measured by the growth rate of the CPI and financial development is measured by the ratio of private credit to GDP (both are obtained from the World Development Indicators CD Rom, 2009). In view that the debate regarding the causality between finance and growth is unresolved in the literature, we extract the exogenous component of financial development by using instrumental variables. For this purpose, we draw on the insights of La Porta *et al.* (1998), who suggest that the legal origin of a country strongly influences the legal environment governing the operation of financial systems. Given that legal origin is exogenous, it is an appropriate instrumental variable to control for simultaneity bias. Hence, following Beck *et al.* (2000), financial development is proxied by the ratio of private credit to GDP, and is instrumented by legal origins using the data provided by La Porta *et al.* (2002). The terms of trade is measured by the ratio of export unit value to import unit value, using data from the International Financial Statistics CD Rom (2009). The quality of institutions is measured by the Composite International Country Risk Guide (ICRG) risk rating based on 22 components of risk obtained from the World Development Indicators CD Rom (2009). Finally, data for the distance from the equator are obtained from the “Finance and the Sources of Growth” database compiled by the World Bank.

Except for the quality of institutions and distance from the equator, all control variables enter the equation in growth terms based on the assumption that they exert only temporary growth effects. We have also attempted to enter all control variables in levels so that they have permanent effects on growth. However, this did not alter the core results. The results in Table A1 are by and large very similar to those of the base specification reported in Table 2 in the main text, although the effect of R&D-based absorptive capacity is found to be marginally weaker in the sub-samples involving only the OECD or developing countries. This is probably associated with the use of a large number of instruments in our finite sample. Nevertheless, we can conclude that our main results are not driven by problems associated with omitted variable bias or country-specific effects.

(O2) Controlling for the endogeneity of R&D intensity

We have so far uncovered that R&D intensity has a significant positive impact on TFP growth. However, the decision to invest in R&D may be driven by changes in productivity and thus bias our results. It cannot be ruled out, for example, that an increase in productivity renders R&D more affordable. To address this concern, R&D intensity is lagged by one year in the regressions since the decision to invest in R&D is unlikely to be based on the future productivity growth rate, which is hard to predict in most circumstances. Our results reported in Table A2 are very consistent with those in the main text, suggesting that endogeneity bias associated with R&D may not be a concern. It is also worth highlighting that the system GMM estimator used in the paper combines in a system the regression in differences with the regression in levels (see Arellano and Bover, 1995; Blundell and Bond, 1998). Given that the design of the system GMM estimator is built on the assumption that some of the regressor may be endogenous, the simultaneous use of both panel data in differences and the original data in levels produces substantial increases in both consistency and efficiency, thus mitigating the problems of endogeneity.

(O3) Sensitivity of the TFP measure

Although we have followed the standard literature in constructing the TFP measure, which is recovered from the aggregate production function by assuming a capital income share of 0.30, it cannot be ruled out that our results are sensitive to the construction of TFP. To check the robustness of the results to different measures of TFP, we first consider alternative capital income shares of 0.35 and 0.40. The estimates reported in Tables A3 and A4 show that our principal results are not driven by the assumption regarding the share of income to capital.

In addition to varying the capital income share, the following alternative measures of TFP based on different assumptions regarding the factors of production are also considered. First, we allow for quality adjustment in the work force by assuming the following aggregate production function: $Y = AK^{\alpha}(HL)^{1-\alpha}$, where *Y* is real GDP, *K* is real physical capital stock, *L* is the total labor force, and *H* is human capital. TFP is measured by $A = Y/[K^{\alpha}(HL)^{1-\alpha}]$, and capital's income share (α) is set to 0.30. Human capital (*H*) is computed using the Mincerian approach, as follows:

$$H = \exp(\theta \cdot SCH) \qquad \text{(A1)}$$

where *SCH* is educational attainment, defined as the average years of schooling among the population of working age, and θ is the returns to schooling, which is set at 0.07 following the standard practice in the literature (see, e.g., Jones, 2002). The educational attainment data are obtained from the Barro-Lee data set. Next, we also consider a production function involving only labor as the single factor of production. The resulting measure ($A = Y/L$) indicates labor productivity.

The results reported in Tables A3 and A4 clearly demonstrate that our core results are not significantly affected by the assumption regarding capital's income share. Moreover, the estimates reported in Tables A5 to A6 also show that the key results in the main body of the paper are robust to alternative measures of TFP.

(O4) Pro-cyclical influence

In our empirical estimation, we have used data averaged or differenced over 5 years to filter out the influence of business cycles on the data. However, since there is no guarantee that all business cycle fluctuations are filtered out by the 5-year differences or averages, we also estimate in 10-year intervals as well as for the full sample period (1970 to 2004). Another advantage associated with the use of 10 year differences or one observation per country is that a long transitional period is required to achieve steady-state equilibrium in the Schumpeterian growth framework. The results reported in both Tables A7 and A8 are largely in line with those obtained in the main body of the paper, although the statistical significance of the coefficients of R&D-based absorptive capacity becomes slightly weaker for the OECD sample. The reduced statistical significance is not surprising given that the number of observations is substantially reduced by going from 5-year intervals to 10-year intervals or covering the entire sample period. On the whole, our findings are not distorted by the pro-cyclical influence that is unrelated to technology.

Pro-cyclical bias can also be removed using the regression approach suggested by Basu *et al.* (2006). This measure of technological change controls for the non-technological effects in TFP by correcting for the effects of non-constant returns, imperfect competition, varying utilization of capital and labor, and aggregation. The method is to regress income growth against input growth and cyclical shifts in hours worked, as follows:

$$d\ln Y_t = \gamma d\ln X_t + \beta d\ln H_t + dz_t\,, \qquad \text{(A2)}$$

where Y is output, X is inputs, H is weekly hours worked, and z is the Solow residual capturing the growth in technology. Since the growth in weekly hours worked captures the influence of the business cycle on output, the residual (z) can be interpreted as the trend growth in TFP. In our sample we modify Eq. (A2) by using cyclical labor productivity instead of weekly hours worked because weekly hours worked are mostly available only for OECD countries. Furthermore, growth in weekly hours worked cannot be used as a cyclical indicator for most OECD countries because it has shown a significant declining trend. This reduction has not been gradual but rather reflects an outcome of regulations in the workweek such as going from a six to a five-day week. Moreover, the workweek has often been permanently reduced following economic downturns, thus rendering it difficult to separate from the trend of the cycle. The U.S., which is the country considered by Basu *et al.* (2006), is one of the very few OECD countries in which weekly hours worked have fluctuated around a constant level over the last four decades.

The approach used in this paper first regresses the log of labor productivity against time:

$$\ln(Y/L)_t = \nu_0 + \nu_1 t + \nu_2 t^2 + cyc_t\,, \qquad \text{(A3)}$$

where L is labor input measured by the labor force or the labor force multiplied by annual hours worked for the countries for which annual hours are available (OECD countries), t is a time-trend and cyc is cyclical fluctuations in labor productivity and constitute the residual in Eq. (A3). Eq. (A3) is regressed for each country individually using the OLS estimator.

In the second step the growth rate in technology is recovered from the following model:

$$d\ln(Y/L)_{it} = \kappa_0 + \kappa_1 d\ln K_{it} + \kappa_2 d\ln L_{it} + \beta cyc_{it} + dz_{it}\,, \qquad \text{(A4)}$$

which is regressed as a panel using OLS.

Table A9 reports the TFP growth estimates based on this approach. It is evident that the results are by and large consistent with those reported in the main body of the paper, although the significance of the coefficients of both interaction terms becomes marginally weaker. Overall, our results are not significantly affected by the presence of pro-cyclical bias that may be present in the TFP measure.

(O5) Alternative human capital data

Human capital has been measured using data on the average years of schooling of the population aged 25 and over provided by Barro and Lee (2001). The dataset of Barro and Lee (2001), however, has been subject to much criticism in recent years (see, e.g., de la Fuente and Doménech, 2006). Furthermore, the estimated coefficients of educational attainment were in most cases insignificant. To address these concerns we use the human capital dataset compiled by Cohen and Soto (2007). They argue that this refined dataset is subject to fewer measurement errors than the Barro-Lee data set and produces more superior regression results. The use of the Cohen-Soto dataset, however, does not lead to any significant improvement in our estimates. As shown in Table A10, the regression results are quite similar to those obtained earlier, suggesting that the quality of human capital data may not be a concern in our context.

(O6) Alternative measure of capital stock

In this paper, the initial capital stock is estimated using the Solow model steady-state value of $I_0/(\delta+g)$, where I_0 is initial real investment, δ is the rate of depreciation (assumed to be 5%), and g is the geometric average annual growth rate in real investment over the period 1970-2004. While this is a standard practice in the literature, the procedure for selecting the initial value of capital may appear to be somewhat arbitrary and it may be subject to business cycle movements and transitional dynamics. To address this concern, the structural initial capital stock is estimated as a linear transformation of the average investment ratio. Assuming that the economies on average were in their steady states during the period 1970-2004 we can undertake the following transformation to find the steady-state investment in 1970. First, we compute $\hat{\alpha}_i$ for each individual country:

$$\left(\frac{I}{Y}\right)_{i,1970} = \hat{\alpha}_i \left(\frac{I}{Y}\right)_{i,1970-2004}, \tag{A5}$$

where $(I/Y)_{1970}$ is the investment ratio in 1970 and $(I/Y)_{1970\text{-}2004}$ is the average investment ratio in the period 1970-2004 and $\hat{\alpha}_i$ is a constant for country *i*. Here, $\hat{\alpha}_i$ may differ from one because country *i* was outside its balanced growth path in 1970 or because it was outside an average cyclical position. Once $\hat{\alpha}_i$ is calculated the steady-state investment can be readily computed from $I_{i,1970}^{SS} = \hat{\alpha}_i Y_{i,1970}$ and the initial steady-state capital stock is computed from the following expression:

$$K_{i,1970}^{SS} = \frac{I_{i,1970}^{SS}}{\delta + g_{i,1970-2004}}, \tag{A6}$$

where $g_{i,1970-2004}$ is the average annual growth rate in investment for country *i*.

The estimates reported in Table A11 show that the main results are not sensitive to the choice of the initial value of real investment. These findings reinforce the results from the estimates in very long first differences (see Section O4 above) that our estimates in the main body of the text are not influenced significantly by transitional dynamics.

(O7) Alternative measure of distance to the frontier

The distance to the frontier (A^{max}/A) is measured by the TFP gap between the U.S. and country *i* in the main text. We have, therefore, implicitly assumed that the technological leader has been the U.S. over the entire sample period. A closer examination of the data reveals that the TFP was indeed higher for Ireland than the U.S. over the period 2001-2004. Ireland has enjoyed very high TFP growth rates over the past two decades because of its high investment in R&D and its ability to attract high technology multinational firms. We provide a sensitivity check using an alternative measure of distance to the frontier where the technological leader is the country with the highest TFP at any point in time. The results, however, are unlikely to change significantly given that this affects only a small portion of the sample period. Our results reported in Table A12 confirm this conjecture. The estimates are almost qualitatively identical with those reported in the main text, suggesting the treatment of the U.S. as the technological leader throughout the sample period is a reasonable assumption.

(O8) Alternative estimator

Although the system GMM estimator used throughout the paper is efficient in exploiting the time series variations of data, accounting for unobserved country specific effects, and controlling for endogeneity bias, it is well known that this estimator may be subject to finite sample bias (see, e.g., Windmeijer, 2005). To provide a robustness check to the estimates, we also perform OLS regressions in which time and country dummies are included in the regressions. These considerations, however, do not distort our findings regarding the effects of technology transfer, R&D intensity and human capital on productivity growth. As shown in Table A13, the estimates are broadly in line with those reported in Table 2 in the main text.

(O9) Testing the implications of semi-endogenous theory for growth

The functional relationship between productivity growth and R&D is an active research topic in the extant literature. Following Jones' (1995) critique of the predictions of the first-generation endogenous growth models of Romer (1990) and Aghion and Howitt (1992), a positive relationship between the *level* of R&D and productivity growth is generally no longer accepted as an empirical regularity in the growth literature. Instead, the second-generation models such as Schumpeterian and semi-endogenous growth theory have gradually become the dominant paradigm in growth.

These second-generation growth models have recently been tested by Ha and Howitt (2007), Madsen (2008) and Madsen *et al.* (2009), and they consistently find more support for the Schumpeterian growth model than the semi-endogenous growth model in explaining growth in the U.S., OCED, and India, respectively. To compare our results with this strand of literature and check whether the use of a semi-endogenous growth framework can also be supported by the data, we include the growth rate of R&D workers ($\Delta \ln X_{it}$), the growth rate of education attainment ($\Delta \ln SCH_{it}$) and their interaction with distance to the frontier [$(\Delta \ln X_{it}) \ln(A^{\max} / A_i)_{t-1}$ and $(\Delta \ln SCH_{it}) \ln(A^{\max} / A_i)_{t-1}$)] in the regressions. Against the predictions of the semi-endogenous growth models, the results reported in Table A14 indicate that only in very few cases are the coefficients of these variables significantly positive. Hence, we can conclude that the Schumpeterian model is the appropriate framework in our context.

(O10) Alternative specification of the TFP growth regressions

In this section, we provide an alternative set of specifications for the TFP regressions reported in Table 2 in order to more systematically examine the direct and indirect effects of research intensity and human capital on productivity growth. We first examine the individual effects of technology transfer and R&D intensity by entering them separately in the regressions (see columns 1 and 2 in Table A15). Their direct effects on TFP growth are considered simultaneously in column (3). Both their direct and indirect effects are jointly examined in columns (4) and (5). The same exercise is repeated for human capital (see columns 6 to 9). Column (10) reports the direct and indirect effects of research intensity while controlling for the role of educational attainment whereas column (11) considers these effects by controlling for the role of R&D intensity.

As is evident, we find a direct significant and positive effect of technology transfer and research intensity (see columns 1 and 2). The estimates in column (3) suggest that the results are consistent when these variables are included simultaneously in the same specification. Their direct effects, however, diminish significantly when the interaction term is included in columns (4) and (5). On the other hand, the coefficients of the interaction between research intensity and technology transfer are found to be significantly positive in all cases, suggesting that a country's ability to absorb foreign technology plays a more important role than autonomous technology transfers and direct R&D spending in boosting productivity growth. Thus, consistent with the results in the main text, we have only found partial support for the model in Eq. (4).

In line with the earlier results, a significant positive role of human capital is found in the full and developing countries samples but not the OECD sample (see columns 6 and 7). Similar to the findings of R&D intensity and the findings in the main text, we find a more important role for human capital-based absorptive capacity on growth compared to the direct effects of educational attainment or technology transfer (see columns 8 and 9). The last two columns provide mixed results regarding the effects of these determinants on productivity growth, but the results are by and large consistent with the results reported in Table 2 in the main text. It is also important to note that while this approach of examining the roles human capital and research intensity is more systematic, a number of these specifications are subject to omitted variable bias. It is therefore not adopted as our main empirical strategy and the results are reported here only as a robustness check.

(O11) Measuring absorptive capacity in a double-log form

While our measures of absorptive capacity for both research intensity and human capital [$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$ and $SCH_{it}\ln(A^{\max}/A_i)_{t-1}$] are consistent with the theoretical derivations of Nelson and Phelps (1966), Howitt (2000) and Griffith *et al.* (2003), these variables can also be expressed in a double-log form [$\ln(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$ and $\ln SCH_{it}\ln(A^{\max}/A_i)_{t-1}$]. The estimates reported in Table A16 show that the effect of R&D-based absorptive capacity is relatively weaker in the sub-samples, but other estimates are broadly in line with the earlier results.

(O12) The roles of trade openness and foreign direct investment

Keller (2004) argues that openness to international trade and FDI may work effectively as channels of international technology transfer. This is because countries that are more open to international trade and foreign direct investment are better equipped to take advantage of the technology that is developed at the frontier countries. Thus, international trade and FDI both affect the speed at which the technological gap is closed. The implications of the interaction between international trade or FDI and distance to the frontier for TFP growth can be derived using the following simple approach.

According to Bernard and Jones (1996a, b), TFP growth is a function of technological catch-up given that countries which are relatively backward can grow faster by utilizing technologies developed in the leading country. Thus, we can assume that TFP growth depends on:

$$\Delta \ln A_{it} = \alpha_i + \beta_i \ln\left(\frac{A_{t-1}^{\max}}{A_{i,t-1}}\right) + \gamma' X_{it} + \varepsilon_{it}, \quad \alpha_i, \beta_i \geq 0 \tag{A7}$$

where α_i is the rate of innovation growth, β_i parameterizes the rate of technological catch up, $A_{t-1}^{\max} / A_{i,t-1}$ is a variable measuring the technology gap between the frontier and the domestic economy (or distance to the frontier), X is a vector of control variables (which may include the rate of inflation, financial development, the terms of trade, the quality of institutions, and distance from the equator, as discussed in section A1), and ε_{it} is the stochastic error term.

A number of studies have emphasized the importance of R&D, human capital, international trade and foreign direct investment in facilitating innovation and technology transfer (see, e.g., Griffith *et al.*, 2004; Keller, 2004). We therefore follow the approach of Griffith *et al.* (2000) and Cameron *et al.* (2005) by allowing both innovation (α_i) and the rate of technology transfer (β_i) to be functions of R&D, human capital, international trade and foreign direct investment, as follows:

$$\alpha_i = a_i + b' F_{it}, \quad \beta_i = c + d' F_{it} \tag{A8}$$

where F is a vector including R&D, human capital, international trade and foreign direct investment. Thus, Eq. (A7) becomes:

$$\Delta \ln A_{it} = a_i + b' F_{it} + c \ln\left(\frac{A_{t-1}^{\max}}{A_{i,t-1}}\right) + d' F_{it} \ln\left(\frac{A_{t-1}^{\max}}{A_{i,t-1}}\right) + \gamma' X_{it} + \varepsilon_{it} \tag{A9}$$

where $b' F_{it}$ captures the direct effect on TFP growth and $d' F_{it} \ln(A_{t-1}^{\max} / A_{i,t-1})$ captures the indirect effects on TFP growth.

To conserve the degrees of freedom, Eq. (A9) is estimated without control variables. Our results in Table A17 reveal that a significant positive role of the interaction between trade openness and distance to the frontier is only found in the OECD sample. Moreover, the estimated coefficients of the interaction between FDI and distance to the frontier are only positive and significant in the developing country sample in 2 out of 10 cases. The estimated coefficients of other variables are qualitatively very similar to the base case, suggesting that the benefits of technological backwardness can best be exploited through enhancing domestic R&D intensity and investment in education for developing countries.

Our results thus far suggest that the inflows of FDI have permanent positive effects on TFP growth while trade openness does not. To examine the possibility that trade openness and FDI have temporary growth effects, we enter these variables in first differences (rather than in levels) in the base specification (Eq. (4)). In this case, we continue to find little support for the hypothesis that trade openness has a positive impact on productivity growth (see Table A18). FDI is found to have some temporary growth effects in the full sample and some weak evidence of this is also found in the OECD sample. Importantly, our core results remain largely unaltered.

Table A1: Controlling for institutional, geographical and other macroeconomic effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.04**			0.06***	0.04*	0.05***	0.08**	0.03**	0.07**
		(2.22)			(3.12)	(1.97)	(3.79)	(2.50)	(2.28)	(2.49)
$\ln(A^{\max}/A_i)_{t-1}$	0.17***	0.19***		0.18***	0.22***		0.17***		0.19***	0.22**
	(5.59)	(6.83)		(4.25)	(4.39)		(4.00)		(4.03)	(2.40)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.03**	0.02*	-0.01					-0.001
			(2.27)	(1.93)	(-0.93)					(-0.03)
$\ln SCH_{it}$	0.08**	0.04	-0.01	0.09*	0.03			-0.12	0.03	-0.003
	(2.22)	(1.12)	(-0.27)	(1.81)	(0.75)			(-1.40)	(0.74)	(-0.03)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.03***	0.003	0.03***	-0.004	0.01
						(3.01)	(0.55)	(3.92)	(-0.63)	(0.38)
$\Delta\ln TO_{it}$	-0.01	-0.01	0.05	-0.003	-0.004	-0.01	0.01	0.04	0.04	0.05
	(-0.23)	(-0.16)	(0.64)	(-0.04)	(-0.06)	(-0.14)	(0.19)	(0.37)	(0.67)	(0.54)
ΔFY_{it}	1.02*	1.19*	1.09*	1.02*	1.38**	1.72***	1.17*	1.46**	1.13**	1.04*
	(1.72)	(1.93)	(1.98)	(1.78)	(2.69)	(2.76)	(1.84)	(2.73)	(2.05)	(1.74)
ΔINF_{it}	-0.03	-0.03	-0.04	-0.05	-0.05	-0.05	-0.04	-0.06	-0.05	-0.04
	(-0.76)	(-0.63)	(-0.78)	(-0.98)	(-0.82)	(-1.09)	(-0.90)	(-1.03)	(-1.15)	(-0.70)
$\Delta\ln FD_{it}$	0.01	0.0003	0.01	-0.001	0.05	0.05	0.01	0.06	0.004	0.01
	(0.31)	(0.01)	(0.39)	(-0.02)	(1.52)	(1.06)	(0.42)	(1.27)	(0.16)	(0.23)
$\Delta\ln TOT_{it}$	0.01	0.01	-0.02	0.02	0.01	0.01	0.006	0.02	-0.003	0.02
	(0.24)	(0.45)	(-1.01)	(0.74)	(0.60)	(0.41)	(0.29)	(0.68)	(-0.14)	(0.77)
INS_{it}	0.002**	0.001*	-0.0001	0.001	0.0004	-0.0002	0.001	0.001	0.002**	0.001
	(2.36)	(1.75)	(-0.06)	(0.74)	(0.44)	(-0.18)	(1.47)	(0.62)	(2.64)	(1.34)
DE_{it}	0.06	-0.02	-0.08	0.04	-0.04	-0.15	-0.004	-0.18	-0.02	-0.01
	(1.04)	(-0.27)	(-1.18)	(0.57)	(-0.61)	(-1.40)	(-0.08)	(-1.20)	(-0.42)	(-0.09)
Hansen (p-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
AR(2) (p-value)	0.84	0.79	0.97	0.78	0.74	0.65	0.73	0.51	0.88	0.49
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.07**			0.12*	0.01	0.10**	0.07*	0.05*	0.09
		(2.01)			(1.74)	(0.32)	(2.43)	(1.82)	(1.92)	(1.54)
$\ln(A^{\max}/A_i)_{t-1}$	0.14**	0.34***		0.22*	0.39**		0.48*		0.78**	0.77*
	(2.21)	(2.88)		(1.89)	(2.20)		(1.85)		(1.96)	(1.74)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.03**	0.03	-0.03					-0.005
			(2.21)	(1.39)	(-0.92)					(-0.15)
$\ln SCH_{it}$	0.01	-0.01	0.002	-0.04	-0.06			-0.03	0.11	0.09
	(0.32)	(-0.08)	(0.02)	(-0.44)	(-0.59)			(-0.40)	(0.86)	(0.54)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01***	-0.02	0.02***	-0.06	-0.05
						(2.84)	(-1.13)	(2.88)	(-1.42)	(-1.12)
$\Delta\ln TO_{it}$	-0.01	-0.05	-0.18	-0.07	-0.03	-0.0004	-0.01	-0.09	-0.02	-0.01
	(-0.05)	(-0.41)	(-1.44)	(-1.19)	(-0.34)	(-0.01)	(-0.09)	(-1.00)	(-0.19)	(-0.09)
ΔFY_{it}	0.91	0.85*	0.55	0.75***	0.75	0.96*	1.18	0.83	0.63	0.97*
	(1.65)	(1.85)	(0.85)	(2.90)	(1.26)	(1.77)	(1.24)	(0.90)	(0.89)	(1.69)
ΔINF_{it}	0.06	0.17	0.92	0.23	0.24	0.02	0.34	0.25	0.21	0.18
	(0.40)	(1.01)	(1.22)	(1.31)	(1.28)	(0.16)	(1.50)	(1.55)	(1.33)	(1.38)
$\Delta\ln FD_{it}$	-0.02	-0.01	0.004	-0.005	-0.02	-0.003	0.01	0.02	-0.03	-0.02
	(-0.55)	(-0.34)	(0.10)	(-0.16)	(-0.65)	(-0.10)	(0.23)	(0.53)	(-0.88)	(-0.46)
$\Delta\ln TOT_{it}$	0.08	0.16**	0.19	0.16**	0.07	0.15***	0.13*	0.12	0.16***	0.07
	(1.62)	(2.35)	(1.15)	(2.52)	(0.77)	(2.92)	(1.79)	(1.30)	(2.94)	(0.77)
INS_{it}	0.002	0.002	-0.003	0.004*	0.002	0.0004	-0.0005	-0.001	0.0006	0.003
	(1.32)	(0.49)	(-0.83)	(1.85)	(0.99)	(0.29)	(-0.22)	(-0.32)	(0.25)	(1.09)
DE_{it}	0.01	0.07	0.10	0.06	-0.01	-0.01	-0.12	-0.06	0.07	-0.02
	(0.24)	(0.34)	(0.56)	(0.21)	(-0.06)	(-0.13)	(-0.98)	(-0.44)	(0.57)	(-0.08)
Hansen (p-value)	0.99	0.99	0.92	0.99	0.99	0.99	0.99	0.99	0.99	0.99
AR(2) (p-value)	0.15	0.35	0.55	0.69	0.20	0.28	0.65	0.30	0.26	0.27
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.04*			0.01	0.03	0.04	0.05	0.04*	0.18*
		(1.66)			(0.05)	(1.03)	(1.33)	(1.41)	(1.90)	(1.78)
$\ln(A^{\max}/A_i)_{t-1}$	0.16***	0.16***		0.13*	0.22*		0.15**		0.06	-0.15
	(3.95)	(3.11)		(1.84)	(1.78)		(2.33)		(0.24)	(-0.50)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.26**	0.08	0.12					-0.30
			(2.35)	(1.19)	(0.23)					(-1.13)
$\ln SCH_{it}$	0.06	0.005	-0.08	0.07	0.21			-0.11	-0.12	-0.37
	(1.02)	(0.08)	(-0.95)	(0.85)	(1.16)			(-1.41)	(-0.50)	(-1.18)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.02*	0.004	0.02*	0.02	0.08

						(1.71)	(0.33)	(1.69)	(0.49)	(1.10)
$\Delta \ln TO_{it}$	0.04	0.06	0.08	0.01	-0.03	0.09	0.05	0.06	0.10	0.17
	(0.42)	(0.76)	(0.76)	(0.31)	(-0.19)	(0.70)	(0.69)	(0.65)	(1.28)	(1.30)
ΔFY_{it}	-1.01	-0.51	-0.03	1.41	1.88	1.40	-0.31	-1.02	0.02	1.59
	(-0.37)	(-0.16)	(-0.01)	(0.49)	(0.68)	(0.41)	(-0.09)	(-0.39)	(0.01)	(0.46)
ΔINF_{it}	-0.18***	-0.13*	-0.05	-0.09*	-0.02	-0.10*	-0.12**	-0.11**	-0.14**	-0.24**
	(-3.06)	(-1.91)	(-0.72)	(-1.90)	(-0.12)	(-1.74)	(-2.08)	(-2.65)	(-2.61)	(-2.71)
$\Delta \ln FD_{it}$	0.11***	0.12***	0.18**	0.16***	0.13*	0.14**	0.11**	0.14***	0.14***	0.25**
	(3.71)	(2.91)	(2.70)	(3.59)	(1.91)	(2.53)	(2.73)	(5.16)	(3.45)	(2.61)
$\Delta \ln TOT_{it}$	-0.002	-0.007	0.0005	0.01	0.03	0.02	-0.003	-0.01	0.002	0.002
	(-0.12)	(-0.35)	(0.01)	(0.52)	(0.65)	(1.20)	(-0.16)	(-0.52)	(0.09)	(0.09)
INS_{it}	0.001	0.001	0.003	0.0005	0.001	-0.0005	0.001	0.003	0.001	-0.002
	(0.43)	(0.69)	(0.58)	(0.15)	(0.14)	(-0.01)	(0.50)	(0.96)	(0.36)	(-0.39)
DE_{it}	-0.01	-0.09	-0.32	-0.03	0.06	-0.11	-0.07	-0.18	-0.08	-0.34
	(-0.05)	(-0.61)	(-1.27)	(-0.16)	(0.17)	(-0.57)	(-0.37)	(-0.81)	(-0.37)	(-1.23)
Hansen (p-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
AR(2) (p-value)	0.50	0.25	0.20	0.25	0.16	0.18	0.25	0.12	0.26	0.23

Notes: all results satisfy the AR(1) test for 1st order serial correlation and *F*-test for joint significance but they are not reported to conserve space. Constants, time and country dummies are not reported due to space consideration. Research intensity (X/Q) is measured as number of R&D workers divided by the total labor force (N/L). *SCH* = educational attainment; $A^{\max} / A_i$ = technology gap between US and country *i*; *TO* = trade openness; *FY* = foreign direct investment inflows as a percentage of nominal GDP; *INF* = the rate of inflation; *FD* = financial development; *TOT* = the terms of trade; *INS* = the quality of institutions; and *DE* = distance from the equator. Robust standard errors are used. Figures in parenthesis are *t*-statistics. *, ** and *** denote 10%, 5% and 1% significance levels, respectively.

Table A2: TFP growth estimates – correcting for the endogeneity of R&D intensity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.03**			0.03**	0.02***	0.04***	0.03***	0.03***	0.02
		(2.64)			(2.33)	(3.63)	(4.04)	(3.24)	(2.93)	(0.67)
$\ln(A^{\max}/A_i)_{t-1}$	0.11**	0.13**		0.11**	0.11**		0.05*		0.13**	0.32***
	(2.03)	(2.42)		(2.13)	(2.64)		(1.70)		(1.96)	(3.73)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.02**	0.03***	-0.01					0.06**
			(2.53)	(2.81)	(-0.04)					(2.05)
$\ln SCH_{it}$	0.08**	0.04	-0.01	0.07**	0.04			-0.03	-0.01	0.06
	(2.19)	(1.36)	(-0.37)	(2.03)	(1.60)			(-1.25)	(-0.70)	(0.85)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01**	0.01**	0.01***	0.05	0.01
						(2.20)	(2.06)	(2.80)	(0.93)	(0.71)
$\ln TO_{it}$	0.03	0.06**	0.05	0.06*	0.01	0.01	0.02	0.01	0.04	0.02
	(0.75)	(1.96)	(1.42)	(1.80)	(0.67)	(0.29)	(1.22)	(0.45)	(1.50)	(0.36)
FY_{it}	0.69	0.53	0.79	0.44	0.26	0.43	0.15	0.42	0.37	1.23**
	(0.92)	(1.00)	(1.24)	(0.66)	(0.49)	(0.79)	(0.27)	(0.83)	(0.87)	(2.27)
Hansen (p-value)	0.35	0.49	0.26	0.73	0.99	0.88	0.98	0.99	0.99	0.87
AR(2) (p-value)	0.32	0.42	0.30	0.39	0.46	0.41	0.60	0.50	0.50	0.14
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.09**			0.01	0.01	0.06**	0.03	0.10***	0.07
		(2.43)			(0.26)	(0.67)	(2.39)	(1.29)	(2.89)	(1.36)
$\ln(A^{\max}/A_i)_{t-1}$	0.20***	0.38***		0.37***	0.34***		0.35**		0.58**	0.58**
	(4.09)	(4.30)		(4.19)	(4.01)		(2.67)		(2.23)	(2.03)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.01*	0.04***	0.04**					0.01
			(1.87)	(2.89)	(2.18)					(0.80)
$\ln SCH_{it}$	0.03	-0.17	-0.04	-0.01	-0.01			-0.06	0.05	0.08
	(0.82)	(-1.03)	(-1.08)	(-0.10)	(-0.08)			(-1.19)	(0.46)	(0.51)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01***	-0.02	0.02**	-0.03	-0.03
						(4.00)	(-1.37)	(2.75)	(-0.96)	(-0.89)
$\ln TO_{it}$	0.01	-0.01	0.01	0.06	0.03	-0.01	-0.01	0.01	-0.01	0.01
	(0.32)	(-0.12)	(0.46)	(1.06)	(0.71)	(-0.35)	(-0.34)	(0.10)	(-0.05)	(0.22)
FY_{it}	0.76	1.32***	0.32	1.07*	1.06**	0.80	1.17**	0.67	1.16**	1.06**
	(1.22)	(2.78)	(0.69)	(1.88)	(2.32)	(1.58)	(2.66)	(1.58)	(2.74)	(2.55)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00
AR(2) (*p*-value)	0.14	0.37	0.18	0.11	0.07	0.11	0.11	0.11	0.13	0.16
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.04*			-0.03	0.03	0.04**	0.05	0.05	-0.05
		(1.87)			(-0.90)	(0.91)	(2.66)	(1.29)	(1.19)	(-1.03)
$\ln(A^{\max}/A_i)_{t-1}$	0.13**	0.12**		0.10*	0.07		0.08**		0.65***	0.08
	(2.08)	(1.96)		(1.72)	(1.48)		(2.72)		(2.98)	(1.10)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.09***	0.10**	0.14*					0.16*
			(4.65)	(3.30)	(1.90)					(1.85)
$\ln SCH_{it}$	0.08**	0.06	-0.01	0.07**	0.08*			-0.09	-0.15	0.09
	(2.52)	(1.62)	(-0.55)	(2.06)	(1.91)			(-0.54)	(-0.88)	(1.39)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.02*	-0.03	0.06**	0.01	-0.01
						(1.76)	(-0.13)	(2.50)	(0.26)	(-0.79)
$\ln TO_{it}$	-0.01	0.04	0.03	0.05*	0.03	0.01	0.03	-0.03	0.02	0.03
	(-0.33)	(1.63)	(1.40)	(1.70)	(1.28)	(0.12)	(1.17)	(-0.60)	(0.20)	(1.30)
FY_{it}	0.41	0.55	0.93	0.60	0.72	-1.73	0.30	-0.19	0.33	0.34
	(0.58)	(0.89)	(1.16)	(0.81)	(1.25)	(-1.09)	(0.47)	(-0.17)	(0.36)	(0.39)
Hansen (*p*-value)	0.99	0.99	0.99	0.35	0.99	0.90	0.99	0.99	0.99	0.99
AR(2) (*p*-value)	0.11	0.15	0.14	0.16	0.11	0.11	0.20	0.25	0.90	0.12

Notes: see notes to Table 2.

Table A3: TFP growth estimates under the assumption of 0.35 capital's income share

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.03^{***}			0.03^{**}	0.02^{***}	0.03^{***}	0.03^{***}	0.03^{***}	0.02
		(2.68)			(2.48)	(3.50)	(4.62)	(3.16)	(2.78)	(0.59)
$\ln(A^{\max}/A_i)_{t-1}$	0.14^{**}	0.13^{**}		0.12^{**}	0.11^{***}		0.06^{**}		0.14^{**}	0.34^{***}
	(2.12)	(2.51)		(2.29)	(2.80)		(2.01)		(2.08)	(5.23)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.02^{**}	0.03^{***}	-0.01					0.06^{**}
			(2.62)	(2.93)	(-0.42)					(2.01)
$\ln SCH_{it}$	0.09^{**}	0.04	-0.01	0.07^{**}	0.04			-0.02	0.05	0.10
	(2.37)	(1.43)	(-0.25)	(2.27)	(1.47)			(-1.07)	(1.00)	(1.36)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01^{**}	0.01^{*}	0.01^{***}	-0.01	0.01
						(2.21)	(1.80)	(2.87)	(-0.94)	(0.01)
$\ln TO_{it}$	0.02	0.03	0.03	0.03	0.01	0.01	0.02	0.01	0.02	0.06
	(0.50)	(1.10)	(0.81)	(1.00)	(0.38)	(0.03)	(1.01)	(0.32)	(1.17)	(1.09)
FY_{it}	0.73	0.70	0.95	0.61	0.47	0.55	0.41	0.55	0.65	1.03^{**}
	(0.95)	(1.19)	(1.26)	(0.81)	(0.89)	(0.97)	(0.76)	(1.04)	(1.50)	(2.03)
Hansen (p-value)	0.38	0.56	0.35	0.73	0.99	0.90	0.99	0.99	0.99	0.87
AR(2) (p-value)	0.32	0.45	0.37	0.44	0.46	0.47	0.63	0.54	0.50	0.12
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.08^{**}			0.01	0.01	0.06^{**}	0.03	0.10^{***}	0.05
		(2.42)			(0.27)	(0.80)	(2.43)	(1.45)	(3.11)	(0.95)
$\ln(A^{\max}/A_i)_{t-1}$	0.20^{***}	0.42^{***}		0.40^{***}	0.36^{***}		0.34^{**}		0.69^{**}	0.71^{**}
	(3.77)	(4.13)		(4.05)	(3.89)		(2.73)		(2.40)	(2.28)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.01^{**}	0.04^{***}	0.04^{**}					0.02
			(2.06)	(3.00)	(2.24)					(1.38)
$\ln SCH_{it}$	0.03	-0.16	-0.03	-0.02	-0.02			-0.06	0.09	0.15
	(0.73)	(-0.96)	(-1.07)	(-0.20)	(-0.16)			(-1.31)	(0.74)	(0.92)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01^{***}	-0.02	0.02^{**}	-0.04	-0.06
						(3.83)	(-1.46)	(2.63)	(-1.28)	(-1.32)
$\ln TO_{it}$	0.01	-0.01	0.01	0.06	0.03	-0.01	-0.01	0.01	0.01	0.02
	(0.28)	(-0.10)	(0.44)	(1.14)	(0.50)	(-0.31)	(-0.39)	(0.17)	(0.08)	(0.45)
FY_{it}	0.82	1.35^{***}	0.39	1.12^{**}	1.05^{**}	0.79^{*}	1.20^{**}	0.72^{*}	1.21^{***}	1.07^{**}
	(1.36)	(2.77)	(0.85)	(2.04)	(2.24)	(1.66)	(2.76)	(1.70)	(3.03)	(2.70)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00
AR(2) (*p*-value)	0.16	0.57	0.23	0.19	0.11	0.11	0.13	0.14	0.14	0.15
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.03^{*}			-0.03	0.04	0.04^{**}	0.06	0.05	-0.05
		(1.78)			(-0.92)	(1.09)	(2.72)	(1.33)	(0.97)	(-1.17)
$\ln(A^{\max}/A_i)_{t-1}$	0.12^{**}	0.13^{**}		0.08^{**}	0.09		0.09^{***}		0.65^{***}	0.09
	(2.01)	(2.30)		(2.64)	(1.55)		(3.21)		(2.92)	(1.12)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.07^{**}	0.09^{***}	0.15^{*}					0.18^{*}
			(2.35)	(4.57)	(1.89)					(1.89)
$\ln SCH_{it}$	0.07^{**}	0.05	-0.02	0.04	0.08^{*}			-0.15	-0.17	0.09
	(2.26)	(1.61)	(-0.63)	(1.55)	(1.92)			(-0.86)	(-0.84)	(1.57)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.03^{*}	-0.03	0.07^{**}	0.01	-0.01
						(1.90)	(-0.68)	(1.96)	(0.39)	(-1.18)
$\ln TO_{it}$	-0.01	0.01	0.02	0.02	0.02	-0.03	0.04	-0.11	-0.01	0.03
	(-0.42)	(0.06)	(0.59)	(0.71)	(0.95)	(-0.38)	(1.48)	(-1.62)	(-0.07)	(1.56)
FY_{it}	-0.26	0.41	0.90	0.23	0.84^{*}	-1.86	0.28	0.48	0.12	0.58
	(-0.38)	(0.61)	(1.21)	(0.42)	(1.80)	(-1.12)	(0.43)	(0.47)	(0.15)	(0.76)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.81	0.99	0.95	0.99	0.99
AR(2) (*p*-value)	0.11	0.21	0.11	0.20	0.12	0.13	0.18	0.45	0.73	0.14

Notes: see notes to Table 2.

Table A4: TFP growth estimates under the assumption of 0.40 capital's income share

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.02**			0.03**	0.02***	0.03***	0.02***	0.03***	0.02
		(2.48)			(2.46)	(3.50)	(4.88)	(3.03)	(2.69)	(0.73)
$\ln(A^{\max}/A_i)_{t-1}$	0.16**	0.13**		0.13**	0.11***		0.06**		0.14**	0.38***
	(2.44)	(2.56)		(2.40)	(2.99)		(2.20)		(2.15)	(6.07)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.02**	0.03***	-0.01					0.05*
			(2.53)	(3.00)	(-0.62)					(1.77)
$\ln SCH_{it}$	0.09***	0.04	-0.01	0.07**	0.04			-0.02	0.05	0.09
	(2.84)	(1.38)	(-0.20)	(2.43)	(1.57)			(-0.85)	(1.04)	(1.28)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01**	0.01*	0.01***	-0.01	0.001
						(2.55)	(1.77)	(3.04)	(-0.96)	(0.04)
$\ln TO_{it}$	0.01	0.01	0.02	0.02	0.01	-0.01	0.01	0.01	0.02	0.06
	(0.13)	(0.51)	(0.54)	(0.45)	(0.18)	(-0.22)	(0.66)	(0.14)	(0.74)	(1.01)
FY_{it}	-0.01	0.59	1.03	0.52	0.16	0.36	0.45	0.38	0.59	0.87
	(-0.02)	(1.08)	(1.30)	(0.75)	(0.31)	(0.71)	(1.06)	(0.81)	(1.41)	(1.57)
Hansen (p-value)	0.44	0.71	0.44	0.58	0.99	0.90	0.98	0.99	0.99	0.86
AR(2) (p-value)	0.28	0.37	0.39	0.36	0.38	0.41	0.54	0.49	0.43	0.11
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.07**			-0.01	0.01	0.05**	0.01	0.04***	0.03
		(2.03)			(-0.20)	(1.07)	(2.41)	(0.69)	(3.11)	(0.65)
$\ln(A^{\max}/A_i)_{t-1}$	0.21***	0.59***		0.58***	0.54***		0.30**		0.40**	0.45**
	(3.48)	(5.98)		(5.14)	(5.67)		(2.70)		(2.06)	(2.23)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.01**	0.04***	0.04**					0.01
			(2.46)	(3.77)	(2.79)					(1.04)
$\ln SCH_{it}$	0.03	-0.07	-0.02	0.02	0.09			-0.04	0.02	0.10
	(0.85)	(-0.50)	(-1.11)	(0.24)	(0.56)			(-0.78)	(0.34)	(0.96)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01***	-0.01	0.02**	-0.03	-0.03
						(4.46)	(-1.50)	(2.58)	(-1.27)	(-1.03)
$\ln TO_{it}$	0.001	-0.04	0.01	0.03	0.01	0.002	-0.01	-0.02	0.01	0.01
	(0.02)	(-0.68)	(0.49)	(0.45)	(0.26)	(0.16)	(-0.39)	(-0.57)	(0.99)	(0.29)
FY_{it}	0.21	0.65	0.29	0.26	0.44	0.14	0.56	0.41	0.54	0.58
	(0.32)	(1.53)	(0.71)	(0.59)	(1.11)	(0.36)	(1.60)	(1.32)	(1.42)	(1.46)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00
AR(2) (*p*-value)	0.56	0.73	0.12	0.80	0.28	0.20	0.47	0.42	0.17	0.23
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.03*			-0.02	0.04	0.04**	0.06	0.04	-0.04
		(1.79)			(-0.82)	(1.04)	(2.61)	(1.37)	(0.97)	(-1.10)
$\ln(A^{\max}/A_i)_{t-1}$	0.13**	0.12**		0.09***	0.08		0.10***		0.67***	0.11
	(2.08)	(2.42)		(2.73)	(1.69)		(3.38)		(3.08)	(1.54)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.08**	0.10***	0.15*					0.17*
			(2.55)	(4.10)	(1.90)					(1.98)
$\ln SCH_{it}$	0.06**	0.04	-0.02	0.04	0.06			-0.17	-0.17	0.10*
	(2.24)	(1.39)	(-0.62)	(1.49)	(1.62)			(-0.91)	(-0.81)	(1.87)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.02*	-0.01	0.07**	0.01	-0.02
						(1.92)	(-0.82)	(2.10)	(0.40)	(-1.60)
$\ln TO_{it}$	-0.01	-0.001	0.02	0.02	0.02	-0.04	0.04	-0.11	-0.01	0.03
	(-0.45)	(-0.04)	(0.64)	(0.68)	(0.86)	(-0.65)	(1.34)	(-1.68)	(-0.12)	(1.69)
FY_{it}	-0.42	0.27	0.86	0.32	0.74	-1.97	0.30	0.26	0.001	0.63
	(-0.62)	(0.42)	(1.18)	(0.53)	(1.66)	(-1.18)	(0.48)	(0.26)	(0.01)	(0.86)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.76	0.99	0.96	0.99	0.99
AR(2) (*p*-value)	0.11	0.21	0.11	0.20	0.12	0.14	0.17	0.56	0.81	0.13

Notes: see notes to Table 2.

Table A5: TFP (with quality adjusted workforce) growth estimates ($A = Y / [K^{\alpha} (HL)^{1-\alpha}]$)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.04***			0.03**	0.02***	0.04***	0.03***	0.04***	-0.01
		(2.98)			(2.15)	(3.18)	(3.69)	(2.95)	(2.89)	(-0.18)
$\ln(A^{\max}/A_i)_{t-1}$	0.10**	0.15***		0.12**	0.11***		0.06**		0.13**	0.27***
	(2.15)	(2.75)		(2.28)	(2.83)		(2.19)		(2.35)	(3.74)
$(X/Q)_{it} \ln(A^{\max}/A_i)_{t-1}$			0.02***	0.03***	0.01					0.09***
			(2.58)	(3.06)	(0.16)					(2.92)
$\ln SCH_{it}$	0.09**	0.08**	-0.01	0.10**	0.06*			-0.03	0.06	0.13*
	(2.37)	(2.10)	(-0.09)	(2.41)	(1.93)			(-1.27)	(1.18)	(1.80)
$SCH_{it} \ln(A^{\max}/A_i)_{t-1}$						0.01**	0.01	0.01***	-0.01	0.01
						(2.25)	(1.38)	(2.87)	(-0.67)	(0.77)
$\ln TO_{it}$	0.03	0.03	0.01	0.02	0.01	-0.01	0.01	-0.01	0.02	0.06
	(0.77)	(1.14)	(0.31)	(0.72)	(0.22)	(-0.32)	(0.52)	(-0.07)	(0.88)	(1.18)
FY_{it}	0.51	0.92	1.11	0.99	0.66	0.40	0.48	0.47	0.62	1.13*
	(0.64)	(1.55)	(1.47)	(1.38)	(1.25)	(0.67)	(0.89)	(0.92)	(1.29)	(1.97)
Hansen (p-value)	0.48	0.70	0.37	0.64	0.99	0.88	0.99	0.99	0.99	0.80
AR(2) (p-value)	0.29	0.67	0.66	0.63	0.87	0.82	0.94	0.92	0.79	0.20
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.06*			-0.01	0.06*	0.09**	0.08*	0.12***	0.13**
		(1.81)			(-0.21)	(1.95)	(2.04)	(1.97)	(4.22)	(2.65)
$\ln(A^{\max}/A_i)_{t-1}$	0.33***	0.33***		0.87***	0.64***		0.27**		0.75**	0.67*
	(4.38)	(4.62)		(3.73)	(4.40)		(2.21)		(2.12)	(1.93)
$(X/Q)_{it} \ln(A^{\max}/A_i)_{t-1}$			0.02**	0.06**	0.06***					-0.01
			(2.50)	(2.50)	(2.97)					(-1.04)
$\ln SCH_{it}$	0.19**	0.15*	0.01	0.58**	0.55***			-0.10	0.24	0.19
	(2.59)	(1.81)	(0.37)	(2.23)	(3.09)			(-1.29)	(1.29)	(0.94)
$SCH_{it} \ln(A^{\max}/A_i)_{t-1}$						0.03**	0.01	0.03***	-0.04	-0.03
						(2.73)	(0.67)	(4.20)	(-1.17)	(-0.76)
$\ln TO_{it}$	0.01	0.03	0.04	-0.08	-0.07	0.02	-0.01	-0.02	0.02	0.01
	(0.04)	(0.73)	(1.09)	(-0.92)	(-0.95)	(0.49)	(-0.35)	(-0.54)	(0.55)	(0.23)
FY_{it}	0.98	1.09*	0.33	0.48	1.01*	0.66	1.12**	1.04*	1.08**	1.12***
	(1.30)	(1.73)	(0.79)	(0.73)	(1.72)	(1.65)	(2.38)	(1.94)	(2.74)	(3.20)
Hansen (*p*-value)	0.99	0.99	0.99	0.84	0.99	0.99	0.99	0.99	0.99	0.99
AR(2) (*p*-value)	0.15	0.11	0.11	0.25	0.30	0.82	0.11	0.61	0.21	0.31
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.03*			-0.03	0.09	0.05***	0.07	0.06	-0.04
		(1.86)			(-1.05)	(1.39)	(3.34)	(1.59)	(1.61)	(-1.57)
$\ln(A^{\max}/A_i)_{t-1}$	0.12**	0.13**		0.08**	0.06		0.08***		0.57***	0.11**
	(2.10)	(2.38)		(2.56)	(1.63)		(3.24)		(2.86)	(2.03)
$(X/Q)_{it} \ln(A^{\max}/A_i)_{t-1}$			0.04**	0.06***	0.11**					0.10**
			(2.17)	(5.11)	(2.11)					(2.47)
$\ln SCH_{it}$	0.10**	0.08**	-0.01	0.06*	0.09**			-0.26	-0.18	0.15**
	(2.50)	(2.04)	(-0.49)	(1.78)	(2.56)			(-1.00)	(-0.94)	(2.25)
$SCH_{it} \ln(A^{\max}/A_i)_{t-1}$						0.09*	-0.01	0.08**	0.03	-0.02
						(2.00)	(-0.27)	(2.60)	(0.85)	(-1.63)
$\ln TO_{it}$	-0.02	0.01	0.01	0.02	0.03*	-0.11	0.04	-0.08	-0.01	0.02
	(-0.54)	(0.09)	(0.36)	(0.64)	(1.82)	(-1.05)	(1.57)	(-0.92)	(-0.16)	(1.54)
FY_{it}	-0.11	0.64	0.95	0.40	0.68	2.51	0.23	1.05	0.63	0.56
	(-0.15)	(0.98)	(1.18)	(0.58)	(1.48)	(1.13)	(0.32)	(1.14)	(0.79)	(1.21)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.35	0.99	0.96	0.96	0.99
AR(2) (*p*-value)	0.14	0.27	0.17	0.40	0.18	0.44	0.27	0.85	0.16	0.19

Notes: see notes to Table 2.

Table A6: Estimates of output per labor growth ($A = Y / L$)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.04**			0.05*	0.04***	0.05**	0.03***	0.03**	-0.01
		(2.30)			(1.83)	(3.78)	(2.11)	(2.66)	(2.58)	(-0.20)
$\ln(A^{\max}/A_i)_{t-1}$	0.10*	0.12*		0.12*	0.12*		0.30***		0.07	0.31***
	(1.72)	(1.70)		(1.89)	(1.81)		(3.87)		(0.89)	(3.94)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.02**	0.06***	-0.01					0.07*
			(2.47)	(2.89)	(-0.41)					(1.81)
$\ln SCH_{it}$	0.06*	0.03	-0.01	0.08*	0.01			-0.03	0.01	0.04
	(1.89)	(0.91)	(-0.45)	(1.92)	(0.29)			(-1.22)	(0.15)	(0.45)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01*	-0.01	0.01	0.01	0.01
						(1.66)	(-0.15)	(1.45)	(0.23)	(0.11)
$\ln TO_{it}$	0.09	0.08*	0.05	-0.01	0.04	0.05	0.04	0.01	0.02	0.07
	(1.56)	(1.94)	(1.08)	(-0.04)	(0.92)	(1.12)	(0.67)	(0.43)	(0.98)	(0.95)
FY_{it}	0.12	1.16*	1.08	2.57***	1.86**	1.31	2.83***	1.34**	1.24	2.23***
	(0.17)	(1.79)	(1.24)	(2.70)	(2.30)	(1.42)	(3.83)	(2.44)	(2.79)	(3.53)
Hansen (p-value)	0.42	0.72	0.47	0.38	0.49	0.17	0.53	0.99	0.99	0.96
AR(2) (p-value)	0.38	0.40	0.44	0.70	0.43	0.28	0.18	0.72	0.71	0.16
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.10**			0.05	0.01	0.11**	0.07**	0.12***	0.10
		(2.62)			(0.71)	(0.10)	(2.45)	(2.22)	(2.96)	(1.50)
$\ln(A^{\max}/A_i)_{t-1}$	0.37***	0.47***		0.46***	0.61***		0.55***		0.86***	0.82**
	(5.20)	(4.46)		(4.13)	(4.83)		(2.96)		(2.92)	(2.66)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.04**	0.04**	0.02					0.01
			(2.14)	(2.60)	(0.64)					(0.20)
$\ln SCH_{it}$	0.10	-0.19	0.01	-0.01	0.07			-0.08	0.11	0.11
	(1.54)	(-1.14)	(0.31)	(-0.05)	(0.28)			(-1.13)	(0.81)	(0.68)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.07**	-0.02	0.03**	-0.04	-0.04
						(2.43)	(-0.74)	(2.49)	(-1.30)	(-1.03)
$\ln TO_{it}$	0.01	-0.01	0.05	0.05	0.04	0.03	-0.03	0.01	-0.02	-0.01
	(0.02)	(-0.13)	(1.09)	(0.72)	(0.61)	(0.24)	(-0.77)	(0.10)	(-0.54)	(-0.13)
FY_{it}	0.88	1.33**	0.58*	1.14*	1.25*	1.03*	1.15*	0.67*	1.17**	1.13**
	(1.09)	(2.49)	(1.75)	(1.78)	(1.72)	(1.69)	(1.71)	(1.68)	(2.12)	(2.09)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00
AR(2) (*p*-value)	0.14	0.30	0.76	0.28	0.46	0.30	0.92	0.94	0.65	0.66
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.06**			-0.04	0.01	0.03*	0.05	0.05	-0.05
		(2.23)			(-1.08)	(0.08)	(1.75)	(0.93)	(0.82)	(-1.63)
$\ln(A^{\max}/A_i)_{t-1}$	0.10*	0.15*		0.09	0.06		0.07*		0.61**	0.07
	(1.80)	(1.93)		(1.25)	(0.77)		(1.67)		(2.48)	(0.71)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.07**	0.09***	0.14*					0.14**
			(2.44)	(2.70)	(1.78)					(2.22)
$\ln SCH_{it}$	0.05*	0.10	0.01	0.07	0.08*			-0.08	-0.11	0.10
	(1.67)	(1.41)	(0.13)	(1.59)	(1.86)			(-0.47)	(-0.70)	(1.34)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.07*	-0.01	0.08*	0.03	-0.01
						(1.87)	(-0.90)	(1.94)	(0.73)	(-0.95)
$\ln TO_{it}$	-0.01	0.01	0.01	0.04	0.04*	-0.11	0.04	-0.09	-0.05	0.03
	(-0.49)	(0.03)	(0.27)	(1.40)	(1.69)	(-1.40)	(1.53)	(-1.14)	(-0.60)	(1.23)
FY_{it}	0.21	1.18	-0.17	1.54**	1.03*	1.19	1.20	1.90*	2.42**	1.00*
	(0.31)	(0.91)	(-0.12)	(2.09)	(1.68)	(0.92)	(1.54)	(1.99)	(2.32)	(1.69)
Hansen (*p*-value)	0.99	0.74	0.68	0.99	0.99	0.90	0.99	0.96	0.99	0.99
AR(2) (*p*-value)	0.20	0.58	0.61	0.24	0.15	0.58	0.28	0.19	0.49	0.19

Notes: see notes to Table 2.

Table A7: TFP estimates using 10-year intervals data (system GMM)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.12***			0.14***	0.08**	0.14***	0.14**	0.17***	0.20***
		(2.96)			(2.81)	(2.17)	(3.45)	(2.35)	(3.41)	(2.76)
$\ln(A^{\max}/A_i)_{t-1}$	0.22*	0.36***		0.22**	0.34***		0.18		0.05	0.03
	(1.67)	(3.07)		(2.62)	(3.23)		(1.62)		(0.31)	(0.27)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.06*	0.08*	-0.05					-0.07
			(1.72)	(1.86)	(-1.49)					(-1.64)
$\ln SCH_{it}$	0.17*	0.07	0.01	0.17**	0.04			-0.09	0.06*	0.06*
	(1.70)	(1.01)	(0.23)	(2.62)	(0.59)			(-0.69)	(1.71)	(1.78)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.06**	0.03	0.04*	-0.22	-0.27
						(2.32)	(1.47)	(1.81)	(-1.59)	(-1.66)
$\ln TO_{it}$	0.16	0.19**	0.12	0.13	0.13	-0.11	0.02	0.03	0.08	0.09
	(1.06)	(2.06)	(1.05)	(1.18)	(1.54)	(-0.57)	(0.21)	(0.23)	(0.83)	(1.04)
FY_{it}	-1.39	-0.47	1.14	-1.03	0.75	-0.19	-1.03	5.95	-0.57	0.71
	(-0.69)	(-0.29)	(0.65)	(-0.68)	(0.49)	(-0.09)	(-0.60)	(1.60)	(-0.35)	(0.49)
Hansen (p-value)	0.14	0.08	0.11	0.11	0.15	0.11	0.13	0.32	0.19	0.41
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.17**			0.07	0.01	0.09*	0.07	0.10*	0.13*
		(2.18)			(0.72)	(0.14)	(1.70)	(1.10)	(1.94)	(1.67)
$\ln(A^{\max}/A_i)_{t-1}$	0.38**	0.64***		0.35**	0.47**		0.69**		0.93*	0.93**
	(2.13)	(3.71)		(2.19)	(2.67)		(2.45)		(1.93)	(2.17)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.06*	0.03	-0.01					-0.04
			(1.72)	(0.86)	(-0.07)					(-0.96)
$\ln SCH_{it}$	-0.08	-0.17	-0.24	-0.11	-0.08			-0.18	0.07	0.07
	(-0.61)	(-0.99)	(-1.41)	(-0.82)	(-0.62)			(-1.58)	(0.49)	(0.40)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.04**	-0.03	0.05***	-0.07	-0.04
						(2.83)	(-1.03)	(3.46)	(-1.06)	(-0.87)
$\ln TO_{it}$	-0.13	0.01	-0.09	-0.09	-0.06	-0.09	-0.05	-0.08	-0.04	-0.01
	(-0.93)	(0.04)	(-0.93)	(-1.19)	(-1.13)	(-1.59)	(-1.08)	(-1.44)	(-0.90)	(-0.02)
FY_{it}	3.38	3.49	2.64	2.65	1.98	2.17	1.77	2.41	1.78	0.94
	(1.07)	(1.13)	(1.32)	(1.62)	(1.31)	(1.12)	(1.10)	(1.43)	(1.09)	(0.81)
Hansen (*p*-value)	0.76	0.23	0.27	0.40	0.63	0.35	0.17	0.52	0.56	0.88
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.23***			-0.02	0.31	0.22**	-0.05	0.22***	-0.01
		(2.90)			(-0.18)	(1.34)	(2.68)	(-0.52)	(3.01)	(-0.16)
$\ln(A^{\max}/A_i)_{t-1}$	0.64*	0.34***		0.27***	0.19*		0.29**		0.26	0.21
	(1.80)	(2.77)		(2.74)	(1.85)		(2.26)		(1.38)	(1.19)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.41***	0.45***	0.34*					0.36
			(3.50)	(3.84)	(1.78)					(1.51)
$\ln SCH_{it}$	0.24*	0.01	-0.01	0.17*	0.15			0.24	-0.01	-0.03
	(1.83)	(0.11)	(-1.10)	(1.76)	(1.52)			(0.52)	(-0.59)	(-0.97)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.05	-0.02	0.11*	-0.01	0.13
						(1.29)	(-0.80)	(1.81)	(-0.18)	(1.00)
$\ln TO_{it}$	0.26*	0.12	-0.11	0.14	0.10	-0.24	0.11	-0.04	0.12	0.14*
	(1.82)	(1.22)	(-0.10)	(1.42)	(1.43)	(-0.98)	(1.00)	(-0.30)	(1.16)	(1.83)
FY_{it}	-3.49	1.34	2.68	-0.90	0.84	8.85	5.54*	0.35	3.54*	2.75
	(-0.97)	(0.54)	(1.14)	(-0.29)	(0.34)	(0.83)	(1.77)	(0.07)	(1.79)	(1.56)
Hansen (*p*-value)	0.38	0.31	0.21	0.50	0.25	0.94	0.57	0.39	0.30	0.23

Notes: AR(2) is not available since the estimation here involves a mush shorter time horizon. See also notes to Table 2.

Table A8: TFP growth estimates based on the pure cross-sectional estimator

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X_i/Q_i)$		0.003***			0.003**	0.002***	0.004***	0.004***	0.003***	0.003*
		(2.83)			(1.96)	(4.83)	(3.85)	(3.20)	(3.03)	(1.81)
$\ln(A^{\max}/A_i)_{1970}$	0.10***	0.01***		0.01***	0.01***		0.007*		0.009	0.009
	(4.32)	(3.89)		(3.01)	(3.34)		(1.65)		(1.27)	(1.15)
$(X_i/Q_i)\ln(A^{\max}/A_i)_{1970}$			0.002***	0.002**	0.001					0.001
			(2.78)	(2.34)	(0.82)					(0.09)
$\ln SCH_i$	0.01***	0.01*	0.002	0.01***	0.01*			-0.004	0.002	0.002
	(4.93)	(1.91)	(0.92)	(3.24)	(1.91)			(-1.26)	(0.45)	(0.38)
$SCH_i \ln(A^{\max}/A_i)_{1970}$						0.002***	0.001**	0.003***	0.001	0.001
						(4.94)	(2.13)	(4.88)	(0.84)	(0.56)
$\ln TO_i$	0.005**	0.004**	0.005*	0.004*	0.004*	0.003	0.003	0.003	0.004*	0.004
	(2.06)	(2.07)	(1.94)	(1.94)	(1.99)	(1.43)	(1.59)	(1.27)	(1.67)	(1.60)
FY_i	-0.18	-0.11	-0.06	-0.09	-0.09	-0.09	-0.05	-0.03	-0.08	-0.07
	(-1.55)	(-0.99)	(-0.57)	(-0.93)	(-0.83)	(-0.96)	(-0.54)	(-0.32)	(-0.70)	(-0.69)
R-Squared	0.40	0.50	0.26	0.46	0.50	0.45	0.50	0.47	0.50	0.50
Observations	55	55	55	55	55	55	55	55	55	55
OECD Countries (23)										
$\ln(X_i/Q_i)$		0.001			0.006*	-0.001	0.001	0.001	0.001	0.008***
		(1.29)			(1.86)	(-0.46)	(0.97)	(0.84)	(0.80)	(3.61)
$\ln(A^{\max}/A_i)_{1970}$	0.01***	0.01***		0.01***	0.02***		0.01		-0.001	-0.01
	(6.78)	(5.85)		(4.95)	(3.59)		(1.61)		(-0.03)	(-1.12)
$(X_i/Q_i)\ln(A^{\max}/A_i)_{1970}$			0.001**	0.001	-0.002					-0.003
			(2.39)	(0.32)	(-1.48)					(-4.50)
$\ln SCH_i$	0.002	-0.001	-0.004	0.001	-0.002			-0.005	-0.005	-0.02***
	(0.98)	(-0.08)	(-1.31)	(0.70)	(-0.56)			(-1.59)	(-0.58)	(-3.45)
$SCH_i \ln(A^{\max}/A_i)_{1970}$						0.001***	0.002	0.002***	0.002	0.005***
						(6.18)	(0.26)	(4.80)	(0.61)	(3.14)
$\ln TO_i$	0.001	0.001	0.003*	0.001	0.001	0.001	0.002	0.001	0.001	-0.001
	(1.10)	(0.97)	(1.70)	(1.04)	(0.77)	(0.92)	(0.94)	(0.72)	(0.61)	(-0.42)
FY_i	-0.13	-0.11	-0.24**	-0.12	-0.10	-0.13	-0.11	-0.10	-0.10	-0.06
	(-1.28)	(-1.15)	(-2.17)	(-1.23)	(-1.13)	(-1.31)	(-1.14)	(-1.07)	(-0.99)	(-0.57)
R-Squared	0.74	0.75	0.56	0.74	0.79	0.72	0.76	0.77	0.76	0.83
Observations	23	23	23	23	23	23	23	23	23	23
Developing Countries (32)										
$\ln(X_i/Q_i)$		0.003*			-0.002	0.002	0.004**	0.004*	0.003	-0.002
		(1.71)			(-0.79)	(1.64)	(2.25)	(2.00)	(1.33)	(-1.30)
$\ln(A^{\max}/A_i)_{1970}$	0.01***	0.01***		0.01**	0.008*		0.007		0.02	0.01
	(2.72)	(3.16)		(2.52)	(1.74)		(1.59)		(1.07)	(0.90)
$(X_i/Q_i)\ln(A^{\max}/A_i)_{1970}$			0.01***	0.01***	0.02**					0.02***
			(5.49)	(3.59)	(2.45)					(2.73)
$\ln SCH_i$	0.008***	0.006	0.003	0.008***	0.009**			-0.005	0.007	0.013
	(2.72)	(1.63)	(1.08)	(2.89)	(2.50)			(-1.30)	(0.63)	(1.35)
$SCH_i \ln(A^{\max}/A_i)_{1970}$						0.002***	0.001	0.003***	-0.001	-0.01
						(3.34)	(1.45)	(3.43)	(-0.14)	(-0.35)
$\ln TO_i$	0.004	0.005	0.007*	0.006*	0.006	0.004	0.005	0.004	0.006	0.006
	(1.34)	(1.50)	(1.88)	(1.67)	(1.63)	(1.11)	(1.26)	(1.04)	(1.35)	(1.57)
FY_i	-0.07	-0.05	-0.04	-0.08	-0.10	-0.09	-0.03	-0.04	-0.06	-0.11
	(-0.50)	(-0.39)	(-0.29)	(-0.61)	(-0.70)	(-0.71)	(-0.25)	(-0.24)	(-0.39)	(-0.73)
R-Squared	0.41	0.46	0.31	0.51	0.52	0.39	0.45	0.42	0.46	0.52
Observations	32	32	32	32	32	32	32	32	32	32

Notes: the standard errors are corrected using the Newey-West procedure.

Table A9: TFP (excluding the pro-cyclical components) growth estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.01^{***}			0.01^{***}	0.01^{***}	0.01^{***}	0.004^{***}	0.01^{***}	-0.02
		(2.86)			(3.88)	(3.14)	(4.06)	(2.67)	(2.94)	(-0.34)
$\ln(A^{\max}/A_i)_{t-1}$	0.03^{**}	0.02^{**}		0.01	0.02^{***}		0.01^{**}		0.02^{***}	0.04^{***}
	(2.02)	(2.01)		(1.09)	(3.11)		(2.29)		(2.69)	(3.66)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.002	0.01^{*}	-0.01					0.003
			(1.41)	(1.76)	(-1.19)					(0.51)
$\ln SCH_{it}$	0.03^{**}	0.01	0.003^{*}	0.01^{**}	0.01			-0.003	0.01^{*}	-0.01
	(2.51)	(1.10)	(1.68)	(2.02)	(1.09)			(-0.98)	(1.67)	(-0.71)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.001	0.001	0.001	-0.002	-0.001
						(0.47)	(0.91)	(1.06)	(-1.55)	(-0.59)
$\ln TO_{it}$	0.002	0.02	-0.001	0.001	0.01	0.002	0.01^{*}	0.01	0.01^{*}	-0.01
	(0.38)	(3.38)	(-0.27)	(0.19)	(1.40)	(0.45)	(1.67)	(0.92)	(1.91)	(-1.10)
FY_{it}	-0.21	-0.13	0.11	-0.003	0.02	0.02	-0.03	0.01	-0.07	-0.02
	(-1.60)	(-1.51)	(1.04)	(-0.04)	(0.27)	(0.19)	(-0.29)	(0.05)	(-0.95)	(-0.25)
Hansen (p-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98
AR(2) (p-value)	0.18	0.61	0.03	0.11	0.11	0.11	0.11	0.03	0.13	0.18
OECD Countries (23)										
$\ln(X/Q)_{it}$		-0.01			0.01^{**}	-0.001	0.01^{*}	-0.01	0.01	0.01
		(-0.32)			(2.23)	(-0.10)	(1.68)	(-0.42)	(0.84)	(0.02)
$\ln(A^{\max}/A_i)_{t-1}$	0.01^{**}	0.01		0.02^{**}	0.04^{***}		0.13^{**}		0.03	0.07^{*}
	(2.01)	(1.20)		(2.69)	(3.56)		(2.32)		(0.36)	(1.80)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.01^{*}	0.01^{*}	-0.01					-0.01
			(1.93)	(1.71)	(-1.46)					(-0.57)
$\ln SCH_{it}$	0.003	0.004	-0.001	0.005	-0.001			0.001	-0.04	0.03
	(0.54)	(0.79)	(-0.25)	(0.88)	(-0.19)			(0.16)	(-1.19)	(1.46)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						-0.001	-0.01	0.001	-0.002	-0.01
						(-0.76)	(-1.49)	(0.16)	(-0.23)	(-1.21)
$\ln TO_{it}$	0.01^{***}	0.01^{**}	0.01^{*}	0.01	0.01^{*}	0.01^{*}	-0.002	0.01^{***}	0.03^{**}	0.004
	(2.95)	(2.44)	(1.88)	(1.47)	(1.86)	(1.75)	(-0.13)	(3.12)	(2.04)	(0.86)
FY_{it}	-0.11	-0.09	-0.14	-0.06	-0.04	-0.07	0.10	-0.08	-0.05	-0.16
	(-1.56)	(-1.28)	(-1.42)	(-0.68)	(-0.40)	(-0.72)	(0.31)	(-0.90)	(-0.27)	(-1.57)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
AR(2) (*p*-value)	0.59	0.74	0.56	0.60	0.66	0.85	0.63	0.58	0.46	0.83
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.01^{***}			-0.01	0.01^{***}	0.01^{***}	0.01	0.01^{***}	0.01
		(2.99)			(-0.10)	(3.16)	(3.17)	(1.05)	(2.73)	(1.51)
$\ln(A^{\max}/A_i)_{t-1}$	0.02^{*}	0.02^{***}		0.01^{*}	0.01^{*}		0.01^{**}		0.04^{**}	0.02^{**}
	(1.70)	(3.11)		(2.00)	(2.01)		(2.63)		(2.10)	(2.09)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.01^{***}	0.02^{***}	0.02					-0.01
			(3.10)	(3.42)	(1.09)					(-0.32)
$\ln SCH_{it}$	0.02^{**}	0.01^{*}	-0.01	0.01^{**}	0.01			0.02^{*}	0.02	0.01
	(2.04)	(1.72)	(-0.11)	(2.36)	(1.63)			(1.83)	(1.23)	(0.90)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01^{*}	-0.01	0.01^{**}	-0.01	-0.01
						(1.77)	(-0.67)	(2.57)	(-1.15)	(-1.03)
$\ln TO_{it}$	-0.01	0.01	0.01	0.01^{*}	0.01	0.01	0.01^{*}	-0.01	0.01^{*}	0.01^{*}
	(-0.05)	(1.00)	(0.22)	(1.69)	(1.11)	(1.41)	(1.68)	(-1.15)	(2.01)	(1.98)
FY_{it}	-0.11	0.01	0.15	0.05	0.02	0.08	0.09	0.16	0.06	0.07
	(-0.74)	(0.01)	(1.38)	(0.43)	(0.14)	(0.80)	(0.95)	(1.19)	(0.37)	(0.90)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
AR(2) (*p*-value)	0.60	0.72	0.72	0.92	0.72	0.93	0.80	0.17	0.47	0.62

Notes: see notes to Table 2. TFP is estimated using Equation (A4).

Table A10: TFP growth estimates based on the Cohen-Soto human capital data

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.03**			0.03**	0.03***	0.04***	0.03***	0.03***	0.01
		(2.30)			(2.18)	(3.49)	(4.09)	(2.84)	(3.04)	(0.29)
$\ln(A^{\max}/A_i)_{t-1}$	0.06*	0.10**		0.07**	0.08***		0.06**		0.10*	0.43***
	(1.77)	(2.36)		(2.03)	(2.77)		(2.12)		(1.90)	(3.64)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.02**	0.03***	0.01					0.07**
			(2.41)	(3.02)	(0.37)					(2.28)
$\ln SCH_{it}$	0.05**	0.03	0.01	0.05**	0.02			-0.03	0.02	-0.06
	(2.45)	(1.29)	(0.35)	(2.04)	(1.11)			(-1.20)	(0.48)	(-0.80)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01**	0.01*	0.01**	-0.01	0.02
						(2.49)	(1.65)	(2.46)	(-0.05)	(1.43)
$\ln TO_{it}$	0.08***	0.05**	0.07**	0.04**	0.02	0.01	0.02	0.02	0.04**	-0.04
	(3.20)	(2.32)	(2.24)	(2.10)	(1.25)	(0.39)	(1.02)	(1.14)	(2.46)	(-0.72)
FY_{it}	0.51	0.50	0.77	0.65	0.54	0.38	0.47	0.60	0.79*	0.98
	(0.89)	(0.96)	(1.13)	(1.07)	(1.20)	(0.64)	(0.83)	(1.26)	(1.70)	(1.26)
Hansen (p-value)	0.38	0.71	0.47	0.88	0.99	0.95	0.99	0.99	0.99	0.91
AR(2) (p-value)	0.20	0.41	0.14	0.32	0.45	0.46	0.60	0.46	0.45	0.27
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.09**			0.03	0.01	0.05**	0.11**	0.12***	0.09*
		(2.63)			(0.83)	(1.10)	(2.29)	(2.47)	(3.31)	(1.69)
$\ln(A^{\max}/A_i)_{t-1}$	0.22***	0.37***		0.36***	0.22*		0.30**		0.68*	0.73*
	(4.88)	(3.08)		(3.32)	(1.93)		(2.62)		(1.90)	(1.82)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.01	0.04***	0.04**					0.02
			(1.40)	(3.17)	(2.49)					(0.96)
$\ln SCH_{it}$	0.07	-0.21	-0.07	-0.04	-0.27			-0.50	-0.02	0.05
	(1.56)	(-0.85)	(-1.20)	(-0.21)	(-1.15)			(-1.50)	(-0.10)	(0.22)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01***	-0.01	0.04**	-0.03	-0.04
						(3.82)	(-1.44)	(2.76)	(-1.00)	(-1.05)
$\ln TO_{it}$	-0.01	0.01	0.02	0.06	0.07	-0.01	0.01	-0.06	-0.02	0.01
	(-0.21)	(0.06)	(0.87)	(1.08)	(1.47)	(-0.07)	(0.03)	(-1.14)	(-0.59)	(0.05)
FY_{it}	1.02	1.11**	0.44	1.08*	1.03**	0.84*	0.95**	1.10***	1.09**	1.02**
	(1.50)	(2.09)	(1.04)	(1.91)	(2.32)	(1.91)	(2.15)	(2.97)	(2.28)	(2.18)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
AR(2) (*p*-value)	0.19	0.81	0.32	0.21	0.11	0.11	0.11	0.11	0.07	0.11
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.02*			-0.05	0.04	0.02	0.08*	0.10**	-0.03
		(1.72)			(-1.42)	(1.21)	(1.46)	(1.70)	(2.15)	(-0.81)
$\ln(A^{\max}/A_i)_{t-1}$	0.08**	0.06**		0.04*	0.01		0.08**		0.55**	0.07
	(2.16)	(2.13)		(1.68)	(0.13)		(2.63)		(2.55)	(1.02)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.07**	0.06***	0.15**					0.13*
			(2.27)	(2.83)	(2.06)					(1.71)
$\ln SCH_{it}$	0.02	0.02	-0.02	0.02	0.05*			0.01	-0.04	0.07
	(0.43)	(0.76)	(-0.75)	(1.44)	(1.90)			(0.08)	(-0.36)	(1.65)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.02**	-0.01	0.06***	0.04*	-0.01
						(2.03)	(-0.24)	(3.22)	(1.94)	(-0.77)
$\ln TO_{it}$	0.06*	0.02	0.04	0.02	0.03	-0.01	0.04**	-0.04	-0.02	0.03
	(1.88)	(0.82)	(1.52)	(1.33)	(1.48)	(-0.28)	(2.10)	(-0.63)	(-0.23)	(1.49)
FY_{it}	0.80	0.88	2.07***	0.84	0.58	-2.31	1.31**	1.11	2.02**	1.11*
	(1.05)	(1.47)	(3.19)	(1.58)	(1.28)	(-1.34)	(2.36)	(1.21)	(2.06)	(1.87)
Hansen (*p*-value)	0.93	0.99	0.99	0.99	0.99	0.93	0.99	0.98	0.99	0.99
AR(2) (*p*-value)	0.11	0.29	0.12	0.28	0.17	0.36	0.20	0.54	0.90	0.18

Notes: the human capital data in Cohen and Soto (2007) are in 10-year intervals. We have interpolated the data to obtain the 5-year estimates. See also notes to Table 2.

Table A11: TFP growth estimates based on alternative measure of capital stock

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.03^{***}			0.03^{**}	0.02^{***}	0.03^{***}	0.03^{***}	0.03^{**}	-0.01
		(2.83)			(2.41)	(3.66)	(4.58)	(3.13)	(2.34)	(-0.27)
$\ln(A^{\max}/A_i)_{t-1}$	0.14^{**}	0.15^{***}		0.13^{**}	0.12^{***}		0.06^{**}		0.17^{***}	0.37^{***}
	(2.39)	(2.70)		(2.51)	(3.15)		(2.61)		(2.82)	(4.05)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.03^{***}	0.03^{***}	-0.01					0.07^{**}
			(2.91)	(3.16)	(-0.19)					(2.58)
$\ln SCH_{it}$	0.11^{**}	0.06^{*}	-0.01	0.08^{**}	0.06^{**}			-0.02	0.08^{*}	0.07
	(2.63)	(1.82)	(-0.45)	(2.40)	(2.24)			(-1.25)	(1.68)	(1.05)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01^{***}	0.01	0.01^{***}	-0.01	0.01
						(2.92)	(1.26)	(2.78)	(-1.41)	(0.25)
$\ln TO_{it}$	0.02	0.04	0.05	0.06^{*}	0.01	0.01	0.03^{**}	0.02	0.04^{*}	0.05
	(0.42)	(1.41)	(1.42)	(1.73)	(0.55)	(0.76)	(2.06)	(1.15)	(1.77)	(0.96)
FY_{it}	0.77	0.53	0.76	0.04	0.67	0.29	0.44	0.50	0.26	0.89
	(0.95)	(0.85)	(1.03)	(0.54)	(1.47)	(0.53)	(0.86)	(1.09)	(0.58)	(1.56)
Hansen (p-value)	0.32	0.62	0.26	0.60	0.99	0.88	0.98	0.99	0.99	0.76
AR(2) (p-value)	0.36	0.63	0.30	0.32	0.76	0.72	0.83	0.73	0.67	0.20
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.08^{***}			0.01	0.02^{*}	0.05^{**}	0.01	0.08^{***}	0.03
		(2.72)			(0.06)	(1.70)	(2.48)	(0.49)	(2.96)	(0.53)
$\ln(A^{\max}/A_i)_{t-1}$	0.36^{***}	0.33^{***}		0.38^{***}	0.34^{***}		0.31^{**}		0.36	0.48^{**}
	(4.15)	(3.17)		(3.16)	(3.29)		(2.62)		(1.08)	(2.43)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.03^{**}	0.04^{***}	0.04^{***}					-0.01
			(2.27)	(4.27)	(3.31)					(-0.37)
$\ln SCH_{it}$	0.08	-0.11	-0.01	0.05	0.04			-0.03	-0.02	0.10
	(1.20)	(-0.56)	(-0.21)	(0.53)	(0.26)			(-0.54)	(-0.19)	(0.90)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01^{**}	-0.01	0.02^{***}	-0.01	-0.03
						(2.17)	(-1.35)	(3.74)	(-0.07)	(-1.06)
$\ln TO_{it}$	0.02	0.01	0.01	0.11	0.12^{**}	0.01	0.01	0.01	-0.01	0.01
	(0.54)	(0.19)	(0.86)	(1.51)	(2.33)	(0.40)	(0.08)	(0.36)	(-0.23)	(0.73)
FY_{it}	0.92^{**}	1.16^{**}	0.65^{**}	1.01^{**}	1.01^{**}	0.55	0.88^{**}	0.57	1.07^{**}	0.59
	(2.12)	(2.68)	(2.52)	(2.22)	(2.50)	(1.34)	(1.96)	(1.33)	(2.68)	(1.40)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00
AR(2) (*p*-value)	0.27	0.11	0.72	0.18	0.15	0.11	0.11	0.11	0.11	0.12
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.04^{*}			-0.04	0.04	0.05^{***}	0.04	0.04	0.04
		(1.91)			(-0.87)	(0.92)	(3.28)	(0.86)	(0.76)	(0.87)
$\ln(A^{\max}/A_i)_{t-1}$	0.16^{**}	0.13^{*}		0.08^{***}	0.08		0.08^{***}		0.56^{**}	0.17^{**}
	(2.11)	(1.99)		(2.70)	(1.24)		(3.42)		(2.13)	(2.51)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.07^{***}	0.08^{***}	0.17^{*}					-0.02
			(3.13)	(3.26)	(1.81)					(-0.17)
$\ln SCH_{it}$	0.09^{**}	0.07^{*}	-0.01	0.04	0.12^{**}			-0.19	-0.18	0.06
	(2.46)	(1.86)	(-0.16)	(1.61)	(2.41)			(-0.80)	(-0.63)	(1.15)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.03^{*}	-0.01	0.09^{**}	0.02	-0.01
						(1.91)	(-0.26)	(2.59)	(0.50)	(-1.30)
$\ln TO_{it}$	-0.01	0.02	0.01	0.03	0.01	-0.03	0.03	-0.11	-0.05	0.02
	(-0.11)	(0.65)	(0.37)	(0.86)	(0.10)	(-0.49)	(1.31)	(-1.20)	(-0.63)	(0.95)
FY_{it}	0.01	0.76	1.16	0.45	1.00	-2.23	0.40	0.67	0.32	-0.09
	(0.01)	(1.21)	(1.63)	(0.75)	(1.62)	(-1.30)	(0.66)	(0.58)	(0.34)	(-0.12)
Hansen (*p*-value)	0.99	0.99	0.99	0.40	0.99	0.99	0.99	0.96	0.99	1.00
AR(2) (*p*-value)	0.11	0.23	0.11	0.25	0.17	0.23	0.19	0.92	0.78	0.12

Notes: see notes to Table 2.

Table A12: TFP growth estimates based on alternative measure of distance to the frontier

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.03***			0.04***	0.04***	0.04***	0.04***	0.04***	0.01
		(2.85)			(2.81)	(3.38)	(4.57)	(2.98)	(3.72)	(0.32)
$\ln(A^{\max}/A_i)_{t-1}$	0.12**	0.13**		0.11**	0.11***		0.07**		0.12*	0.33***
	(2.07)	(2.38)		(2.01)	(2.76)		(2.68)		(1.78)	(4.31)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.02**	0.03***	-0.02					0.07**
			(2.36)	(2.79)	(-0.32)					(2.14)
$\ln SCH_{it}$	0.09**	0.04	-0.01	0.08**	0.04			-0.05	0.02	0.03
	(2.23)	(1.10)	(-0.38)	(2.04)	(1.46)			(-1.42)	(0.39)	(0.35)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01**	0.01	0.02**	-0.01	0.01
						(2.36)	(1.15)	(2.52)	(-0.30)	(0.57)
$\ln TO_{it}$	0.03	0.05**	0.05	0.04	0.12	0.03	0.02	0.04	0.04*	0.06
	(0.69)	(1.96)	(1.40)	(1.12)	(0.64)	(0.79)	(1.47)	(1.39)	(1.90)	(1.05)
FY_{it}	0.04	0.59	0.96	0.69	0.51	0.87	0.57	0.61	0.53	0.91
	(0.06)	(1.29)	(1.46)	(1.12)	(1.23)	(1.56)	(1.49)	(1.16)	(1.49)	(1.58)
Hansen (p-value)	0.34	0.59	0.25	0.62	0.99	0.82	0.98	0.99	0.99	0.83
AR(2) (p-value)	0.37	0.42	0.36	0.48	0.53	0.13	0.70	0.16	0.42	0.17
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.09**			0.01	0.01	0.06***	0.03	0.10***	0.06
		(2.54)			(0.34)	(0.56)	(2.90)	(1.27)	(3.23)	(1.20)
$\ln(A^{\max}/A_i)_{t-1}$	0.21***	0.32***		0.27***	0.28***		0.33***		0.61**	0.61**
	(4.13)	(4.10)		(3.05)	(2.92)		(3.04)		(2.20)	(2.06)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.02**	0.04***	0.04**					0.02
			(2.15)	(2.88)	(2.18)					(1.05)
$\ln SCH_{it}$	0.03	-0.20	-0.05	-0.06	-0.06			-0.07	0.07	0.11
	(0.77)	(-1.21)	(-1.28)	(-0.61)	(-0.35)			(-1.32)	(0.60)	(0.72)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01***	-0.02	0.02**	-0.03	-0.04
						(3.83)	(-1.55)	(2.71)	(-1.06)	(-1.06)
$\ln TO_{it}$	0.01	0.01	0.01	0.09*	0.05	-0.01	-0.01	-0.01	0.01	0.02
	(0.40)	(0.10)	(0.25)	(1.78)	(1.09)	(-0.39)	(-0.20)	(-0.03)	(0.28)	(0.60)
FY_{it}	0.81	1.47***	0.58	1.26**	1.03**	0.86*	1.03**	0.86**	1.21***	1.08**
	(1.28)	(3.12)	(1.43)	(2.46)	(2.25)	(2.01)	(2.47)	(2.30)	(2.91)	(2.60)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	1.00
AR(2) (*p*-value)	0.17	0.47	0.13	0.11	0.11	0.11	0.11	0.11	0.24	0.23
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.04**			-0.02	0.04	0.04**	0.08	0.08	-0.06
		(2.31)			(-0.65)	(1.23)	(2.63)	(1.40)	(1.50)	(-1.03)
$\ln(A^{\max}/A_i)_{t-1}$	0.13*	0.14**		0.11*	0.09		0.08***		0.63***	0.07
	(1.80)	(2.20)		(1.78)	(1.43)		(3.31)		(2.93)	(0.96)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.07**	0.10***	0.13*					0.16*
			(2.26)	(3.48)	(1.77)					(1.67)
$\ln SCH_{it}$	0.08*	0.05	-0.03	0.08**	0.07			-0.15	-0.22	0.09
	(1.69)	(1.18)	(-0.95)	(2.04)	(1.55)			(-0.73)	(-1.34)	(1.25)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.02*	-0.01	0.07*	0.01	-0.01
						(1.68)	(-0.41)	(1.93)	(0.42)	(-0.91)
$\ln TO_{it}$	0.01	0.01	0.03	0.03	0.03	0.02	0.04*	-0.08	0.01	0.04*
	(0.29)	(0.48)	(0.96)	(0.97)	(1.24)	(0.27)	(1.67)	(-1.07)	(0.12)	(1.78)
FY_{it}	0.27	0.60	0.80	1.19	1.12**	-1.19	0.45	0.97	0.71	0.57
	(0.35)	(0.86)	(1.28)	(1.64)	(2.29)	(-0.69)	(0.74)	(1.02)	(0.92)	(0.69)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.71	0.99	0.96	0.98	0.99
AR(2) (*p*-value)	0.11	0.22	0.13	0.22	0.12	0.11	0.28	0.25	0.85	0.17

Notes: see notes to Table 2.

Table A13: OLS estimates with country and time dummies

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.05***			0.03	0.03**	0.05***	0.03**	0.05***	0.03
		(3.07)			(1.33)	(1.98)	(3.16)	(1.96)	(3.11)	(1.37)
$\ln(A^{\max}/A_i)_{t-1}$	0.29***	0.31***		0.28***	0.30***		0.31***		0.31***	0.30***
	(4.95)	(5.43)		(5.12)	(5.00)		(3.90)		(4.26)	(4.05)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.03***	0.04***	0.03**					0.03**
			(3.83)	(4.12)	(2.31)					(2.36)
$\ln SCH_{it}$	0.03	0.01	0.04	0.02	0.02			-0.05	0.03	0.02
	(0.54)	(0.17)	(1.18)	(0.49)	(0.34)			(-0.84)	(0.07)	(0.30)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.03***	0.01	0.03***	0.02	0.01
						(3.52)	(0.33)	(3.47)	(0.32)	(0.11)
$\ln TO_{it}$	0.08**	0.07**	0.03	0.08**	0.08**	0.04	0.07*	0.03	0.07*	0.07**
	(2.20)	(2.06)	(1.46)	(2.18)	(2.14)	(1.21)	(1.97)	(1.18)	(2.00)	(2.10)
FY_{it}	1.12***	1.51***	1.53***	1.32***	1.43***	1.52***	1.50***	1.45***	1.51***	1.43***
	(3.79)	(5.31)	(4.68)	(4.18)	(4.60)	(4.27)	(5.09)	(3.99)	(5.55)	(4.45)
R-Squared	0.30	0.35	0.23	0.35	0.36	0.26	0.35	0.26	0.35	0.36
F-test (p-value)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.06**			0.02	0.02	0.04**	0.04	0.04**	0.02
		(2.16)			(0.83)	(0.99)	(2.28)	(1.51)	(2.18)	(0.85)
$\ln(A^{\max}/A_i)_{t-1}$	0.43***	0.42***		0.34***	0.35***		0.22		0.17	0.23
	(4.97)	(5.07)		(3.91)	(4.36)		(1.06)		(0.68)	(0.87)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.04***	0.03***	0.02**					0.17*
			(3.90)	(2.88)	(2.09)					(1.94)
$\ln SCH_{it}$	0.13	0.01	-0.13	0.05	0.02			-0.11	-0.06	-0.02
	(1.34)	(0.13)	(-1.52)	(0.61)	(0.21)			(-1.18)	(-0.49)	(-0.14)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.05***	0.03	0.05***	0.03	0.02
						(5.63)	(1.01)	(5.67)	(1.09)	(0.52)
$\ln TO_{it}$	0.06	0.04	0.09*	0.05	0.05	0.06	0.05	0.05	0.05	0.05
	(1.11)	(0.68)	(1.93)	(1.05)	(0.89)	(1.08)	(0.83)	(0.97)	(0.83)	(0.91)
FY_{it}	1.02**	1.08**	0.84**	0.96**	0.99**	1.09**	1.10**	1.10**	1.10**	1.02**
	(2.47)	(2.74)	(2.65)	(2.13)	(2.22)	(2.44)	(2.53)	(2.61)	(2.59)	(2.21)
R-Squared	0.51	0.54	0.47	0.55	0.56	0.54	0.55	0.55	0.55	0.56
F-test (p-value)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.04*			0.03	0.03	0.04**	0.02	0.04**	0.04
		(1.98)			(0.84)	(1.13)	(2.11)	(1.01)	(1.96)	(0.89)
$\ln(A^{\max}/A_i)_{t-1}$	0.31***	0.30***		0.26***	0.30***		0.27***		0.28***	0.28***
	(4.19)	(4.25)		(3.95)	(3.67)		(3.01)		(3.46)	(3.12)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.09*	0.07**	0.01					0.01
			(1.85)	(2.25)	(0.26)					(0.20)
$\ln SCH_{it}$	0.11*	0.08	0.06	0.07	0.08			0.04	0.08	0.07
	(1.72)	(1.22)	(1.21)	(1.09)	(1.15)			(0.68)	(1.13)	(1.06)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.03***	0.01	0.03**	0.01	0.01
						(2.81)	(0.98)	(2.62)	(0.65)	(0.64)
$\ln TO_{it}$	0.09*	0.07*	0.01	0.07*	0.07*	0.02	0.06	0.02	0.06*	0.07*
	(1.97)	(1.67)	(0.46)	(1.72)	(1.69)	(0.77)	(1.50)	(0.91)	(1.67)	(1.68)
FY_{it}	1.04**	1.80***	2.18***	1.71***	1.80***	1.48**	1.62***	1.54**	1.74***	1.74***
	(2.28)	(3.72)	(3.79)	(3.54)	(3.71)	(2.43)	(3.08)	(2.54)	(3.28)	(3.26)
R-Squared	0.31	0.36	0.25	0.36	0.36	0.28	0.35	0.28	0.36	0.36
F-test (p-value)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: see notes to Table 2.

Table A14: TFP growth estimates – incorporating the implications of semi-endogenous theory

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.04***			0.03**	0.03***	0.04***	0.04***	0.03***	0.03*
		(3.10)			(2.41)	(3.25)	(4.48)	(3.28)	(3.44)	(1.88)
$\Delta \ln X_{it}$		0.04			-0.06	0.01	0.01	-0.03	-0.01	-0.05
		(1.12)			(-1.13)	(0.28)	(0.49)	(-0.95)	(-0.05)	(-0.97)
$\ln(A^{\max}/A_i)_{t-1}$	0.11*	0.13**		0.09*	0.07**		0.09***		0.15***	0.17***
	(1.95)	(2.57)		(1.84)	(2.01)		(3.52)		(2.93)	(2.90)
$(X/Q)_{it} \ln(A^{\max}/A_i)_{t-1}$			0.02**	0.03***	0.01					0.01
			(2.50)	(2.90)	(1.15)					(1.29)
$(\Delta \ln X_{it}) \ln(A^{\max}/A_i)_{t-1}$			0.04	0.05	0.07					0.06
			(0.83)	(1.30)	(1.19)					1.01
$\ln SCH_{it}$	0.11**	0.04	0.01	0.07**	0.02			-0.08	0.04	0.05
	(2.47)	(1.56)	(0.34)	(2.27)	(0.84)			(-1.58)	(1.05)	(1.02)
$\Delta \ln SCH_{it}$	0.26	0.09	0.04	0.07	-0.07			0.21	0.27	0.19
	(1.27)	(0.53)	(0.23)	(0.37)	(-0.56)			(0.70)	(1.36)	(0.95)
$SCH_{it} \ln(A^{\max}/A_i)_{t-1}$						0.01***	0.01	0.01***	-0.01	-0.01
						(2.70)	(0.78)	(2.88)	(-0.70)	(-1.07)
$(\Delta \ln SCH_{it}) \ln(A^{\max}/A_i)_{t-1}$						0.08	-0.10	-0.18	-0.27**	-0.30***
						(0.69)	(-1.28)	(-0.65)	(-2.32)	(-2.78)
$\ln TO_{it}$	0.03	0.03	0.04	0.02	0.02	0.01	0.01	0.01	0.03	0.02
	(1.10)	(1.38)	(1.34)	(0.85)	(1.34)	(0.48)	(1.02)	(0.02)	(1.31)	(1.39)
FY_{it}	0.61	1.13**	0.74	1.19**	0.61	0.83*	0.54	0.48	0.55	0.66
	(0.87)	(2.32)	(1.26)	(1.97)	(1.28)	(1.70)	(1.06)	(0.97)	(1.21)	(1.57)
Hansen (p-value)	0.79	0.98	0.88	0.98	0.99	0.99	0.99	0.90	0.99	0.99
AR(2) (p-value)	0.19	0.42	0.35	0.26	0.47	0.40	0.86	0.43	0.63	0.43
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.04**			0.01	0.05*	0.04***	0.08***	0.04**	0.06*
		(2.18)			(0.30)	(1.94)	(2.83)	(3.45)	(2.07)	(1.84)
$\Delta \ln X_{it}$		0.03			0.02	0.03	0.02	0.01	0.05	0.05
		(0.84)			(0.37)	(1.01)	(0.79)	(0.14)	(1.47)	(0.85)
$\ln(A^{\max}/A_i)_{t-1}$	0.11***	0.13*		0.35*	0.33***		0.14		-0.06	-0.22
	(3.04)	(1.71)		(1.81)	(2.44)		(0.92)		(-0.12)	(-0.67)
$(X/Q)_{it} \ln(A^{\max}/A_i)_{t-1}$			0.01**	0.04***	0.03**					-0.01
			(2.09)	(3.17)	(2.50)					(-0.70)
$(\Delta \ln X_{it}) \ln(A^{\max}/A_i)_{t-1}$			0.08	0.03	0.01					-0.04
			(0.92)	(0.38)	(0.04)					(-0.21)
$\ln SCH_{it}$	0.02	0.05	0.06*	0.15	0.09			-0.08*	-0.01	-0.13
	(0.53)	(1.17)	(1.94)	(1.31)	(0.61)			(-1.77)	(-0.08)	(-1.39)
$\Delta \ln SCH_{it}$	0.24	0.58		0.31	0.24			0.53	-0.51	-0.30
	(0.97)	(1.61)		(0.98)	(0.82)			(1.12)	(-0.94)	(-1.31)
$SCH_{it} \ln(A^{\max}/A_i)_{t-1}$						0.04***	-0.01	0.02*	0.01	0.03
						(2.84)	(-0.48)	(1.84)	(0.07)	(1.12)
$(\Delta \ln SCH_{it}) \ln(A^{\max}/A_i)_{t-1}$						0.82*	0.49	-0.04	0.25*	0.13
						(1.88)	(1.03)	(-0.05)	(1.88)	(1.37)
$\ln TO_{it}$	-0.01	0.01	0.02	0.11*	0.09	0.05	0.01	0.02	0.02	0.01
	(-0.05)	(0.97)	(0.98)	(1.77)	(1.50)	(0.62)	(0.88)	(0.90)	(0.96)	(0.11)
FY_{it}	0.80	0.95*	0.43	1.21***	1.40***	1.35***	0.77*	0.65*	0.83	0.94*
	(1.54)	(1.76)	(0.91)	(2.99)	(3.70)	(3.83)	(1.85)	(1.69)	(1.59)	(1.81)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
AR(2) (*p*-value)	0.23	0.45	0.41	0.52	0.50	0.28	0.14	0.12	0.54	0.15
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.04***			-0.01	0.01	0.04***	0.03	0.02	0.01
		(3.10)			(-0.35)	(1.04)	(4.71)	(0.77)	(0.54)	(0.09)
$\Delta \ln X_{it}$		-0.02			-0.06	-0.01	-0.02	-0.03	-0.01	0.04
		(-0.83)			(-1.28)	(-0.04)	(-0.75)	(-0.96)	(-0.64)	(0.63)
$\ln(A^{\max}/A_i)_{t-1}$	0.10**	0.11***		0.09**	0.04		0.12***		0.66***	0.44***
	(2.08)	(2.68)		(2.41)	(1.26)		(5.98)		(3.30)	(3.37)
$(X/Q)_{it} \ln(A^{\max}/A_i)_{t-1}$			0.09***	0.10***	0.11*					0.04
			(3.60)	(4.13)	(1.72)					(0.45)
$(\Delta \ln X_{it}) \ln(A^{\max}/A_i)_{t-1}$			-0.02	-0.02	0.05					-0.08
			(-0.56)	(-0.84)	(0.85)					(-0.96)
$\ln SCH_{it}$	0.08**	0.02	-0.02	0.03	0.01			-0.23	0.01	-0.02
	(2.68)	(0.71)	(-0.47)	(1.22)	(0.35)			(-0.90)	(0.11)	(-1.52)
$\Delta \ln SCH_{it}$	0.09	-0.19	-0.17	-0.23	-0.27**			0.08	0.03	

	(0.52)	(-1.55)	(-1.01)	(-1.65)	(-2.27)			(0.24)	(0.13)	
$SCH_{it} \ln(A^{\max} / A_i)_{t-1}$						0.01*	-0.01	0.07**	0.01	0.05
						(1.67)	(-0.65)	(2.36)	(0.30)	(0.60)
$(\Delta \ln SCH_{it}) \ln(A^{\max} / A_i)_{t-1}$						-0.02	-0.21***	-0.14	-0.20	-0.12
						(-0.19)	(-2.96)	(-0.62)	(-1.24)	(-0.60)
$\ln TO_{it}$	0.01	0.02	0.03	0.03	0.03**	-0.01	0.04**	-0.08	0.07	0.06
	(0.02)	(1.12)	(1.42)	(1.23)	(2.08)	(-0.14)	(2.38)	(-1.33)	(0.98)	(1.41)
FY_{it}	-0.19	0.42	0.63	0.35	0.60	0.49	0.72*	0.44	0.68	0.89
	(-0.23)	(0.67)	(1.32)	(0.67)	(1.38)	(0.72)	(1.73)	(0.51)	(1.14)	(1.49)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
AR(2) (*p*-value)	0.11	0.30	0.20	0.25	0.30	0.30	0.57	0.17	0.08	0.11

Notes: see notes to Table 2.

Table A15: TFP growth estimates based on alternative specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
ALL Countries (55)											
$\ln(X/Q)_{it}$		0.02**	0.03***	0.002						0.03**	0.03***
		(2.06)	(3.53)	(0.12)						(2.22)	(2.78)
$\ln(A^{\max}/A_i)_{t-1}$	0.07*		0.07**		0.03		0.11**		0.03	0.11***	0.13**
	(1.83)		(2.19)		(1.60)		(2.03)		(0.51)	(2.67)	(2.01)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$				0.02*	0.03***					0.02	
				(1.87)	(3.12)					(0.20)	
$\ln SCH_{it}$						0.02*	0.08**	0.03**		0.05*	0.05
						(1.71)	(2.19)	(2.28)		(1.68)	(0.98)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$								0.01	0.02*		-0.01
								(1.57)	(1.76)		(-0.81)
$\ln TO_{it}$	0.11**	0.06	0.05**	0.06**	0.04*	0.01	0.03	0.001	0.18***	0.01	0.03
	(2.60)	(1.27)	(2.09)	(2.12)	(1.80)	(0.22)	(0.75)	(0.05)	(3.79)	(0.41)	(1.31)
FY_{it}	-0.72	1.14	0.51	1.08**	0.22	0.88**	0.69	0.41	0.24	0.45	0.55
	(-0.73)	(1.40)	(0.83)	(2.61)	(0.32)	(2.18)	(0.92)	(0.87)	(0.36)	(0.82)	(1.21)
Hansen (p-value)	0.81	0.12	0.77	0.98	0.80	0.98	0.35	0.99	0.98	0.99	0.99
AR(2) (p-value)	0.24	0.20	0.51	0.11	0.59	0.13	0.32	0.24	0.11	0.47	0.50
OECD Countries (23)											
$\ln(X/Q)_{it}$		0.10**	0.08***	0.01						0.01	0.10***
		(2.36)	(3.35)	(0.32)						(0.25)	(3.21)
$\ln(A^{\max}/A_i)_{t-1}$	0.13***		0.26***		0.30*		0.20***		0.06	0.32***	0.58**
	(4.73)		(3.30)		(1.73)		(4.09)		(0.83)	(3.73)	(2.08)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$				0.05***	0.06***					0.04**	
				(3.13)	(5.50)					(2.20)	
$\ln SCH_{it}$						-0.06	0.03	-0.04		-0.03	0.05
						(-0.41)	(0.82)	(-0.89)		(-0.20)	(0.43)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$								0.02***	0.01*		-0.03
								(3.08)	(1.82)		(-0.92)
$\ln TO_{it}$	-0.01	0.19*	0.04	0.12*	0.08	0.09	0.01	-0.01	-0.01	0.03	-0.01
	(-0.44)	(1.76)	(0.93)	(1.70)	(0.96)	(0.60)	(0.32)	(-0.46)	(-0.36)	(0.68)	(-0.07)
FY_{it}	0.91*	0.72**	0.71*	0.84**	0.85**	0.94**	0.76	1.17**	0.88*	1.01**	1.19***
	(1.70)	(2.69)	(1.99)	(2.51)	(2.47)	(2.57)	(1.22)	(1.96)	(1.84)	(2.12)	(2.80)
Hansen (*p*-value)	0.99	0.98	0.99	0.99	0.99	0.98	0.99	0.99	0.99	0.99	0.99
AR(2) (*p*-value)	0.12	0.81	0.74	0.20	0.39	0.44	0.14	0.27	0.14	0.11	0.18
Developing Countries (32)											
$\ln(X/Q)_{it}$		0.03*	0.03*	-0.03						-0.03	0.07
		(1.95)	(1.88)	(-0.99)						(-0.84)	(1.28)
$\ln(A^{\max}/A_i)_{t-1}$	0.07*		0.08*		0.04		0.13**		0.46**	0.08	0.66***
	(2.01)		(1.87)		(1.61)		(2.08)		(2.02)	(1.47)	(2.77)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$				0.16**	0.07**					0.13*	
				(2.21)	(2.64)					(1.78)	
$\ln SCH_{it}$						0.09*	0.08**	-0.01		0.08**	-0.16
						(1.88)	(2.52)	(-0.40)		(2.03)	(-0.91)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$								0.01*	0.04*		0.01
								(1.87)	(1.73)		(0.40)
$\ln TO_{it}$	0.04	0.003	0.02	0.08***	0.03*	-0.22	-0.01	-0.02	-0.01	0.02	0.01
	(1.54)	(0.11)	(1.04)	(2.74)	(1.86)	(-1.38)	(-0.33)	(-0.70)	(-0.22)	(0.99)	(0.01)
FY_{it}	0.64	0.30	1.04	0.88	0.48	2.26	0.41	-0.83	-0.10	0.99**	0.49
	(0.86)	(0.31)	(1.24)	(0.98)	(0.65)	(0.50)	(0.58)	(-0.94)	(-0.10)	(2.03)	(0.57)
Hansen (*p*-value)	0.99	0.91	0.99	0.99	0.99	0.85	0.99	0.99	0.96	0.99	0.96
AR(2) (*p*-value)	0.11	0.13	0.25	0.11	0.36	0.18	0.11	0.14	0.71	0.11	0.83

Notes: see notes to Table 2.

Table A16: TFP growth estimates based on a double-log specification for absorptive capacity measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.03^{***}			0.03^{***}	0.02^{***}	0.04^{***}	0.03^{***}	0.04^{***}	0.04^{**}
		(2.69)			(3.03)	(3.46)	(4.08)	(3.31)	(3.60)	(2.18)
$\ln(A^{\max}/A_i)_{t-1}$	0.11^{**}	0.13^{**}		0.11^{***}	0.10^{***}		0.06^{*}		0.08	0.04
	(2.03)	(2.48)		(2.98)	(3.18)		(1.68)		(1.18)	(0.46)
$\ln(X/Q)_{it}\ \ln(A^{\max}/A_i)_{t-1}$			0.02^{*}	0.02^{**}	-0.01					0.01
			(1.90)	(2.27)	(-0.14)					(0.22)
$\ln SCH_{it}$	0.08^{**}	0.05	-0.01	0.05	0.04			-0.03	0.01	-0.03
	(2.19)	(1.53)	(-0.67)	(1.55)	(1.46)			(-1.42)	(0.24)	(-0.31)
$\ln SCH_{it}\ \ln(A^{\max}/A_i)_{t-1}$						0.02^{*}	0.03^{*}	0.04^{**}	0.01	0.03
						(1.71)	(1.70)	(2.64)	(0.11)	(0.63)
$\ln TO_{it}$	0.03	0.03	0.01	0.04	0.01	-0.01	0.01	0.01	0.03^{*}	0.04^{**}
	(0.75)	(1.27)	(0.41)	(1.28)	(0.75)	(-0.11)	(0.51)	(0.48)	(1.73)	(2.37)
FY_{it}	0.69	0.76	0.43	0.66	0.79^{*}	0.67	0.70	0.48	0.44	0.50
	(0.92)	(1.32)	(0.74)	(0.87)	(1.72)	(1.14)	(1.16)	(0.87)	(0.96)	(0.94)
Hansen (p-value)	0.35	0.51	0.90	0.67	0.99	0.88	0.70	0.98	0.99	0.99
AR(2) (p-value)	0.32	0.48	0.54	0.30	0.53	0.56	0.52	0.47	0.41	0.24
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.09^{**}			0.01	0.02	0.06^{**}	0.03^{*}	0.10^{***}	0.04
		(2.53)			(0.05)	(1.62)	(2.31)	(1.71)	(3.20)	(0.46)
$\ln(A^{\max}/A_i)_{t-1}$	0.20^{***}	0.37^{***}		0.32^{**}	0.29^{**}		0.41^{**}		0.75	1.07
	(4.09)	(3.92)		(2.72)	(2.74)		(2.29)		(1.52)	(1.30)
$\ln(X/Q)_{it}\ \ln(A^{\max}/A_i)_{t-1}$			0.06^{*}	0.16^{*}	0.15					0.12
			(2.00)	(2.03)	(1.21)					(0.64)
$\ln SCH_{it}$	0.03	-0.17	-0.04	-0.21	-0.21			-0.05	0.04	0.15
	(0.82)	(-1.09)	(-1.14)	(-1.62)	(-1.50)			(-1.07)	(0.33)	(0.65)
$\ln SCH_{it}\ \ln(A^{\max}/A_i)_{t-1}$						0.07^{***}	-0.09	0.08^{***}	-0.19	-0.41
						(4.52)	(-1.31)	(2.93)	(-0.83)	(-0.85)
$\ln TO_{it}$	0.01	-0.01	0.01	0.01	0.01	-0.01	-0.01	-0.01	0.01	0.02
	(0.32)	(-0.12)	(0.35)	(0.18)	(0.11)	(-0.18)	(-0.55)	(-0.02)	(0.04)	(0.61)
FY_{it}	0.76	1.31^{***}	0.44	1.44^{**}	1.37^{***}	0.80^{*}	1.18^{**}	0.73^{*}	1.18^{**}	1.11^{**}
	(1.22)	(2.70)	(1.00)	(2.75)	(2.96)	(1.70)	(2.53)	(1.71)	(2.73)	(2.55)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
AR(2) (*p*-value)	0.14	0.45	0.12	0.17	0.28	0.11	0.12	0.13	0.17	0.51
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.03^{*}			0.05	-0.01	0.04^{***}	0.02^{**}	0.03^{***}	0.01
		(1.80)			(1.30)	(-0.25)	(3.10)	(1.96)	(3.15)	(0.24)
$\ln(A^{\max}/A_i)_{t-1}$	0.13^{**}	0.12^{**}		0.13^{**}	0.09^{**}		0.07^{***}		0.09^{**}	0.10^{*}
	(2.08)	(2.10)		(2.67)	(2.20)		(3.04)		(2.03)	(1.81)
$\ln(X/Q)_{it}\ \ln(A^{\max}/A_i)_{t-1}$			0.01	0.02^{*}	-0.01					0.02
			(1.48)	(1.84)	(-0.30)					(0.88)
$\ln SCH_{it}$	0.08^{**}	0.06^{*}	-0.03	0.05	0.04			-0.03	-0.01	0.02
	(2.52)	(1.67)	(-1.08)	(1.21)	(1.39)			(-1.22)	(-0.34)	(0.39)
$\ln SCH_{it}\ \ln(A^{\max}/A_i)_{t-1}$						0.03^{*}	0.01	0.03^{*}	0.03	-0.01
						(1.72)	(0.19)	(1.75)	(0.45)	(-0.26)
$\ln TO_{it}$	-0.01	0.01	0.01	0.01	0.04	-0.01	0.04^{*}	0.01	0.03^{**}	0.04^{**}
	(-0.33)	(0.09)	(0.04)	(0.49)	(1.57)	(-0.44)	(1.68)	(0.30)	(2.04)	(2.43)
FY_{it}	0.41	0.76	0.63	0.44	1.09^{*}	0.08	0.33	0.65	0.46	0.80
	(0.58)	(1.12)	(0.90)	(0.69)	(1.73)	(0.10)	(0.57)	(1.50)	(0.71)	(1.46)
Hansen (*p*-value)	0.99	0.99	0.97	0.99	0.99	0.99	0.99	0.99	0.99	0.99
AR(2) (*p*-value)	0.11	0.21	0.39	0.17	0.14	0.31	0.26	0.15	0.25	0.31

Notes: see notes to Table 2.

Table A17: TFP growth estimates – incorporating the effects of trade openness and FDI-based absorptive capacities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.03^{**}			0.03^{**}	0.03^{***}	0.04^{***}	0.03^{***}	0.03^{***}	0.02
		(2.42)			(2.02)	(3.50)	(4.05)	(2.83)	(3.41)	(0.54)
$\ln(A^{\max}/A_i)_{t-1}$	0.08^{*}	0.11^{**}		0.06^{*}	0.10^{**}		0.04		0.13^{*}	0.34^{***}
	(1.75)	(2.13)		(1.81)	(2.13)		(1.13)		(1.73)	(2.70)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.02^{***}	0.03^{**}	0.01					0.10^{***}
			(2.88)	(2.47)	(0.58)					(2.68)
$\ln SCH_{it}$	0.09^{***}	0.04	0.02	0.05^{**}	0.04			-0.02	0.05	0.03
	(2.76)	(1.37)	(1.04)	(2.01)	(1.55)			(-0.48)	(1.00)	(0.41)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01^{*}	0.01^{**}	0.01^{**}	-0.01	0.02
						(1.97)	(2.35)	(2.12)	(-0.38)	(0.91)
$\ln TO_{it}\ln(A^{\max}/A_i)_{t-1}$	-0.03	0.01	-0.02	0.01	0.01	-0.02	-0.01	-0.02	0.01	-0.03
	(-0.84)	(0.01)	(-0.95)	(0.12)	(0.08)	(-1.30)	(-0.47)	(-0.99)	(0.19)	(-0.69)
$FY_{it}\ln(A^{\max}/A_i)_{t-1}$	-0.97	-0.07	0.53	0.06	-0.22	-0.13	-0.25	-0.07	-0.31	0.98
	(-1.08)	(-0.14)	(1.62)	(0.45)	(-0.62)	(-0.21)	(-0.55)	(-0.18)	(-0.87)	(1.50)
Hansen (*p*-value)	0.25	0.65	0.58	0.72	0.99	0.88	0.97	0.98	0.93	0.88
AR(2) (*p*-value)	0.77	0.55	0.48	0.77	0.47	0.51	0.69	0.49	0.45	0.17
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.05^{**}			0.06^{**}	0.01	0.05^{***}	0.03	0.04^{**}	0.05
		(2.26)			(2.08)	(0.47)	(2.79)	(1.40)	(2.61)	(1.10)
$\ln(A^{\max}/A_i)_{t-1}$	0.22^{***}	0.24^{***}		0.14^{***}	0.23^{***}		0.32^{**}		0.29^{*}	0.66^{**}
	(5.01)	(4.98)		(6.33)	(4.31)		(2.73)		(1.91)	(2.50)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.02^{**}	0.01^{*}	-0.01					-0.01
			(2.04)	(1.85)	(-1.12)					(-0.37)
$\ln SCH_{it}$	0.05	-0.04	-0.02	0.01	-0.04			-0.07	-0.01	0.14
	(1.32)	(-0.76)	(-0.70)	(0.12)	(-1.00)			(-1.38)	(-0.09)	(0.93)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01^{***}	-0.01	0.02^{***}	-0.01	-0.05
						(3.16)	(-1.22)	(4.14)	(-0.68)	(-1.33)
$\ln TO_{it}\ln(A^{\max}/A_i)_{t-1}$	0.12^{*}	0.09^{**}	0.05	0.09^{**}	0.06^{**}	0.03	0.09^{**}	0.11^{*}	0.07^{*}	0.07^{*}
	(1.91)	(2.29)	(0.63)	(2.59)	(2.26)	(1.30)	(2.63)	(1.92)	(1.87)	(1.67)
$FY_{it}\ln(A^{\max}/A_i)_{t-1}$	0.68	1.82	2.69	1.03	1.84	2.03	1.90	1.73	1.88	1.74
	(0.33)	(1.01)	(1.68)	(0.63)	(1.25)	(1.48)	(1.20)	(0.96)	(1.34)	(1.05)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
AR(2) (*p*-value)	0.14	0.13	0.11	0.11	0.11	0.12	0.16	0.11	0.11	0.21
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.03^{*}			-0.05	0.03^{**}	0.07	0.03^{**}	0.03^{***}	-0.04
		(1.81)			(-1.40)	(2.58)	(1.26)	(2.51)	(3.12)	(-1.33)
$\ln(A^{\max}/A_i)_{t-1}$	0.10^{*}	0.09^{*}		0.04	0.02		0.50^{**}		0.07	0.11
	(1.83)	(1.67)		(0.83)	(0.52)		(2.39)		(0.75)	(1.21)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.07^{***}	0.09^{***}	0.15^{**}					0.13^{**}
			(3.64)	(3.30)	(2.11)					(2.07)
$\ln SCH_{it}$	0.10^{***}	0.05^{*}	0.03	0.06^{*}	0.08^{*}			-0.05	-0.01	0.13^{*}
	(3.05)	(1.82)	(1.19)	(1.85)	(1.91)			(-1.38)	(-0.14)	(1.95)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01	0.01	0.02^{**}	0.01	-0.02
						(1.29)	(0.56)	(2.03)	(0.30)	(-1.29)
$\ln TO_{it}\ln(A^{\max}/A_i)_{t-1}$	-0.03	-0.01	-0.02	-0.01	-0.02	-0.02	-0.05	-0.01	0.01	0.01
	(-1.14)	(-0.37)	(-0.73)	(-0.48)	(-0.88)	(-0.89)	(-0.77)	(-0.30)	(0.26)	(0.13)
$FY_{it}\ln(A^{\max}/A_i)_{t-1}$	-0.46	0.10	0.84^{**}	0.44	0.39	0.11	1.14^{**}	-0.01	-0.12	0.33
	(-1.31)	(0.27)	(2.62)	(0.99)	(0.99)	(0.18)	(2.35)	(-0.01)	(-0.26)	(1.18)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
AR(2) (*p*-value)	0.12	0.23	0.18	0.36	0.19	0.34	0.34	0.40	0.30	0.23

Notes: see notes to Table 2.

Table A18: TFP growth estimates – temporary growth effects of trade and FDI

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ALL Countries (55)										
$\ln(X/Q)_{it}$		0.03***			0.03**	0.02***	0.04***	0.03***	0.03***	-0.02
		(2.65)			(2.15)	(3.18)	(4.19)	(2.89)	(3.08)	(-0.68)
$\ln(A^{\max}/A_i)_{t-1}$	0.10*	0.11**		0.08*	0.08**		0.05**		0.12*	0.32***
	(1.70)	(2.17)		(1.68)	(2.50)		(2.26)		(1.97)	(3.74)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.02*	0.03***	0.01					0.05**
			(1.90)	(3.05)	(0.15)					(2.30)
$\ln SCH_{it}$	0.08*	0.04	-0.01	0.06	0.03			-0.03	0.04	-0.10
	(1.81)	(1.13)	(-0.16)	(1.47)	(1.19)			(-1.33)	(0.83)	(-1.39)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01**	0.01*	0.01**	-0.01	0.02
						(2.09)	(1.66)	(2.31)	(-0.46)	(1.24)
$\Delta\ln TO_{it}$	0.04	-0.04	-0.01	0.01	-0.01	-0.01	-0.01	0.02	-0.02	-0.04
	(0.74)	(-0.93)	(-0.08)	(0.09)	(-0.35)	(-0.15)	(-0.30)	(0.73)	(-0.45)	(-1.24)
ΔFY_{it}	1.40**	1.19**	1.25**	1.14*	0.79	0.83	0.80	0.95**	0.71	0.82*
	(2.13)	(2.26)	(1.96)	(1.90)	(1.55)	(1.62)	(1.62)	(2.64)	(1.57)	(1.79)
Hansen (p-value)	0.26	0.40	0.22	0.49	0.99	0.81	0.95	0.99	0.99	0.98
AR(2) (p-value)	0.33	0.50	0.45	0.56	0.54	0.45	0.66	0.25	0.39	0.11
OECD Countries (23)										
$\ln(X/Q)_{it}$		0.07*			0.06	0.01	0.05**	0.02	0.06**	0.09***
		(1.70)			(1.20)	(0.40)	(2.27)	(0.84)	(2.12)	(3.02)
$\ln(A^{\max}/A_i)_{t-1}$	0.16**	0.37***		0.43**	0.40***		0.21*		0.57***	0.35***
	(2.47)	(3.72)		(2.31)	(3.77)		(1.99)		(3.98)	(2.88)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.03***	0.04***	0.02					-0.02
			(2.70)	(2.83)	(1.60)					(-1.57)
$\ln SCH_{it}$	0.03	-0.03	-0.05	0.04	-0.07			-0.02	0.07	-0.01
	(0.84)	(-0.17)	(-1.50)	(0.30)	(-0.41)			(-0.47)	(0.76)	(-0.14)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.07***	-0.01	0.01**	-0.04	-0.01
						(3.31)	(-0.78)	(2.64)	(-1.23)	(-0.47)
$\Delta\ln TO_{it}$	-0.01	0.01	-0.09	0.11	0.21*	-0.10	0.06	-0.03	-0.07	0.07
	(-0.11)	(0.88)	(-1.15)	(0.85)	(1.75)	(-1.21)	(0.62)	(-0.26)	(-0.84)	(0.90)
ΔFY_{it}	0.74	0.53	0.26	0.33	0.66*	0.64	1.12*	0.70	0.50	1.10**
	(1.12)	(1.21)	(0.43)	(0.93)	(1.76)	(1.34)	(2.01)	(1.11)	(1.06)	(2.07)
Hansen (*p*-value)	0.99	0.99	0.99	0.96	0.99	0.99	0.99	0.99	0.99	1.00
AR(2) (*p*-value)	0.11	0.53	0.78	0.45	0.48	0.21	0.11	0.12	0.66	0.12
Developing Countries (32)										
$\ln(X/Q)_{it}$		0.02*			-0.04	0.02	0.04**	0.09*	0.02	-0.03
		(1.74)			(-1.45)	(0.74)	(2.67)	(1.95)	(1.25)	(-1.24)
$\ln(A^{\max}/A_i)_{t-1}$	0.07*	0.08**		0.08**	0.06*		0.06**		0.14**	0.11*
	(1.68)	(2.19)		(1.96)	(1.67)		(2.51)		(2.05)	(1.73)
$(X/Q)_{it}\ln(A^{\max}/A_i)_{t-1}$			0.08***	0.05**	0.14**					0.10**
			(3.09)	(2.13)	(2.10)					(2.08)
$\ln SCH_{it}$	0.05	0.03	-0.01	0.05	0.08*			-0.14	0.08	0.12*
	(1.50)	(1.06)	(-0.47)	(1.47)	(1.82)			(-0.68)	(1.29)	(1.68)
$SCH_{it}\ln(A^{\max}/A_i)_{t-1}$						0.01*	0.01	0.07*	-0.01	-0.01
						(1.91)	(0.92)	(1.71)	(-1.16)	(-1.14)
$\Delta\ln TO_{it}$	0.01	0.05	-0.05	0.03	0.06	0.05	-0.04	-0.01	0.06	0.04
	(0.22)	(0.90)	(-0.58)	(0.63)	(1.21)	(0.45)	(-0.49)	(-0.01)	(1.29)	(0.81)
ΔFY_{it}	0.72	0.47	0.51	0.81	0.46	-0.04	-0.09	1.44*	0.17	0.17
	(0.86)	(0.74)	(0.58)	(1.22)	(0.79)	(-0.06)	(-0.14)	(1.79)	(0.34)	(0.30)
Hansen (*p*-value)	0.99	0.99	0.99	0.99	0.99	0.40	0.99	0.88	0.99	0.99
AR(2) (*p*-value)	0.14	0.40	0.22	0.40	0.15	0.14	0.52	0.13	0.25	0.14

Notes: see notes to Table 2.

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