ON ENTRY AND GROWTH: THEORY AND EVIDENCE

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This paper analyzes the relationship between the entry of new firms and the innovation and productivity growth within existing firms. In particular, we argue that liberalizing entry has a boosting effect on innovation and growth in those existing enterprises that are the most productive prior to the liberalisation, whereas it discourages them in the least productive firms. This prediction is confronted to firm-level panel data from the UK, India and especially Russia over the period 1996-2002.

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1. Introduction

This paper surveys recent contributions on product market liberalization and productivity growth. It then uses Russian firm-level data to analyze the effect of (foreign) entry on innovation and productivity growth across domestic sectors in Russia. In particular, we are interested in the extent to which the effect of liberalizing entry on innovation and productivity growth depends upon the technological distance between the domestic incumbent and the world technology frontier.

Our main finding is that, as for the UK (see Aghion-Blundell-Griffith-Howitt-Prantl, 2005, and Section 3 below) and for India (see Aghion-Burgess-Redding-Zilibotti (2004) and Section 4 below), reducing barriers to entry to foreign products and firms in Russia, has a more positive effect on economic performance for firms and industries that are initially closer to the technological frontier. In contrast, performance in firms and industries that are initially far from the frontier may actually be damaged by liberalization. As a result, liberalization magnifies the initial differences in productivity. The reason is that incumbent firms that are sufficiently close to the technological frontier can survive and deter entry by innovating. An increased entry threat, thus, results in higher innovation intensity aimed at escaping that threat. In contrast, firms and sectors that are far below the frontier are in a weaker position to fight external entry. For these firms, an increase in the entry threat reduces the expected payoff from innovating, since their expected life horizon has become shorter.

The paper is organized as follows. Section 2 sketches a theoretical framework which links liberalization and entry to industrial performance across heterogeneous industries and summarizes its main implications. Section 3 shows the impact of increased foreign entry on productivity growth in the UK. Section 4 reports similar results by Aghion-Burgess-Redding-Zilibotti (2004) on the impact of the Indian liberalization experiment of 1991 using a 3-digit state-industry panel for the period 1980-1997. Section 5 reports the findings on entry and growth in Russia. Section 6 concludes.

2. A simple growth model with entry

2.1. The argument

More formally developed below[1] , the idea here is that increased entry, and increased threat of entry, enhance innovation and productivity growth,

1. See Aghion, Blundell, Griffith, Howitt and Prantl (2004) and Aghion, Burgess, Redding and Zilibotti (2005a).

not just because these are the direct result of quality-improving innovations from new entrants, but also because the threat of being driven out by a potential entrant gives incumbent firms an incentive to innovate in order to escape entry, through an effect that works much like the escape-competition effect described above. Note that it is important here that new entrants replace incumbent firms, in other words that entry be associated with firm turnover. Moreover, it will be shown that when innovations are step-by-step (that is, an innovation cannot increase productivity in any sector by more than some factor $\gamma > 1$) then the entry threat effect is stronger the closer an economy or sector is to the world technology frontier. This result is analogous to the result discussed above concerning the effect of product-market competition on growth. Specifically, for firms or sectors that lie initially far behind the frontier, an increased threat of entry acts to discourage innovation by incumbents because there is no way for those firms and sectors to catch up with the quality offered by a potential entrant even if they succeed in innovating; however, firms already close to the frontier have a chance to beat a potential entrant if they successfully innovate. That is, an incumbent firm near the frontier can escape entry by innovating, because by innovating it can match the potential entrant's quality of product without having to pay the entry cost that would face the potential entrant.

This idea and its formalization generate the following predictions:

– Entry (therefore, turnover) and entry threat are growth-enhancing overall;

– Entry and entry threat enhance average productivity growth even among incumbent firms provided the cost-benefit ratio of innovation is sufficiently large;

– Entry and entry threat enhance innovation and productivity growth among incumbents in sectors or countries that are initially close to the technological frontier, as the escape entry effect dominates in that case;

– Entry and entry threat discourages innovation and productivity growth among incumbents in sectors or countries that are far below the frontier, as the discouragement effect dominates in that case.

That entry may be growth-enhancing is also predicted by the product variety model. However, that model does not predict that growth in sectors or countries that are further below the frontier should react less positively or even negatively to increased entry, nor that productivity growth should react positively to turnover and exit.

2.2. The theory

This subsection illustrates how the Schumpeterian apparatus outlined in the previous section is naturally suited to talk about entry and its effects on average productivity growth in the overall economy and on innovation and

growth among incumbent firms. Final output is produced by each intermediate product i according to the production function (?) described in the previous section. There are two intermediate producers in each sector, engaged in Bertrand competition. Each producers lives for only one period, which allows us to express the equilibrium payoff to an innovation in sector i as the one-period monopoly profit, which is easily shown to be proportional to the sector's productivity parameter:

$$\pi_{it} = \delta A_{it}.$$

The frontier technology $\bar{A}_t$ grows at the exogenous rate $\bar{g} = \gamma - 1 > 0$. At the *beginning* of period t intermediate firms can be of three types. Firms of type 1 operate at the current frontier, with a productivity level $A_{it-1} = \bar{A}_{it-1}$. Type 2 firms are one step behind the frontier, with $A_{it-1} = \bar{A}_{t-2}$, and type-3 firms are two steps behind, with $A_{it-1} = \bar{A}_{t-3}$.

Innovation allows an incumbent firm to increase its productivity by the constant factor γ and thereby to keep up with growth of the frontier. The cost of innovating with probability z is:

$$c_{jt} = c \cdot (z^2/2)\bar{A}_{t-j},\ c > 0$$

With probability $1 - z$ the incumbent's productivity does not increase, and lags by $j + 1$ steps behind the new frontier. The most backward (type-3) firms are automatically upgraded by the factor γ, on the grounds that upgrading is almost costless for sufficiently mature technologies.

In each period and intermediate sector, there is one outside producer that can pay for an entry opportunity. We focus on technologically advanced entry; thus when entry occurs it takes place at the *new* frontier $\bar{A}_t$. An entrant will become the new leading firm unless the incumbent leader also acquires the frontier technology $\bar{A}_t$ by innovating, in which case the incumbent retains his monopoly.

Equilibrium Innovation

Denote by p the probability that a potential entrant arrives. A firm that lags its rival in a sector never innovates because even if successful it would at best catch up to its rival and would earn no profit in Bertrand competition. A type-2 incumbent leader chooses its R&D investment z to maximize the expected net payoff from innovation:

$$\max_z \{\delta z(1-p)\bar{A}_{t-1} - c(z^2/2)\bar{A}_{t-2}\}$$

from which the first order condition yields:

$$z = (\delta/c)(1-p)\gamma = z_2.$$

In words, the type-2 incumbent only retains the market if it successfully innovates and there is no entry (i.e. with probability $z(1-p_2)$). If it does not innovate then its automatically upgraded type-3 rival catches up with it, and Bertrand competition dissipates all its profits.

A type-1 leader chooses its innovative investment to:

$$\max_z \{ \delta[z\bar{A}_t + (1-z)(1-p)\bar{A}_{t-1}] - c(z^2/2)\bar{A}_{t-1} \}$$

Hence, from the first order condition we get:

$$z = (\delta/c)(\gamma - 1 + p) = z_1$$

In words, the type-1 leader retains the market when: (i) it successfully innovates or (ii) it does not successfully innovate and there is no entry.

The "escape entry" and "discouragement" effects

Consider the effects on innovative activity and expected productivity growth at the industry level from increasing entry threat, modeled as an increase in the probability.

– An increase in entry threat reduces the expected payoff from innovating to an incumbent firm two steps behind the frontier, and therefore reduces its innovation effort. This is because a firm this far behind the frontier know that it cannot survive entry even if it innovates. That is:

$$\frac{\partial z_2}{\partial p} = -(\delta/c)\gamma < 0$$

– This *discouragement effect* is similar to the Schumpeterian appropriability effect of product market competition, among incumbents. It implies that entry threat reduces expected productivity growth among incumbent type-2 leaders.

– An increase in entry threat fosters innovation by an incumbent firm just one step behind the frontier, by increasing the likelihood that the firm will lose out to an entrant if it fails to innovate, thus increasing the firm's incentive to "escape entry" by innovating:

$$\frac{\partial z_1}{\partial_p} = (\delta/c) > 0$$

– This *escape entry effect* is similar to the escape-competition effect described above. It implies that entry threat increases expected productivity growth among incumbent type-1 leaders.

Aggregate productivity growth

In the long run there will just be three kinds of industry, depending on whether the leader is one, two or three steps behind the frontier at the

beginning of the period. Denote by q_i the steady-state proportion of industries that are i steps behind. In a steady state, the country's average productivity level relative to the frontier, $a_t = A_t/\bar{A}_t$ will be a constant:

$$\hat{a} = q_1 + (1/\gamma)q_2 + (1/\gamma^2)q_3$$

Consider the effect on long-run average productivity growth from increasing entry threat, again modeled as an increase in the probability p.

– An increase in entry threat will not change the long-run growth rate of aggregate productivity, which always equals the growth rate $\bar{g}$ of the frontier, because the economy's average distance to the frontier a converges to the constant $\hat{a}$. However, increased entry threat will result in a transitory increase in aggregate productivity growth because it moves the country permanently closer to the frontier. That is, as we show formally in Appendix A below:

$$d\hat{a}/dp = (1-\gamma^{-1})dq_1/dp - (\gamma^{-1}-\gamma^{-2})dq_3/dp > 0$$

– The reason why entry raises aggregate productivity is that even in those sectors where incumbent innovation is discouraged by the threat of entry, the entrants themselves will raise productivity by implementing a frontier technology.

– An increase in entry threat will however raise the long-run average productivity growth rate among incumbents, at least when the profit/cost ratio is sufficiently small, as shown in ABGHP. That is, in the long run the dominant effect overall will be the escape-entry effect working on firms near the frontier, rather than the discouragement effect working on firms further from the frontier.

2.3. Main theoretical predictions

Let us conclude this section by summarizing our main findings:

– Liberalization (as measured by an increase in the threat of entry) encourages innovation in industries that are close to the frontier and discourages innovation in industries that are far from it. Productivity, output, and profits, should thus be higher in industries and firms that are initially more advanced.

– When the R&D cost is sufficiently large, liberalization increases average productivity growth among incumbent firms.

3. Entry and growth in the UK

ABGHP look at the effect of entry on performance and productivity growth in the UK. As discussed in Chapter 1 the UK is a good place to study these issues becuase there was a sustantial liberalization of markets, including opening up to foreign direct investment. In addition, there is

availability of rich micro data on productivity growth, patenting activity, and actual entry.

Following the theory outlined above, ABGHP look at the relationship between foreign firm entry and growth in total factor productivity, and how this relationship varies with the industries distance to the technological frontier. The main equation of interest is of the form

$$Y_{ijt} = f(E_{jt}, F_{jt}, X_{ijt}) \tag{1}$$

where i indexes (incumbent) firms, j indexes industries (4-digit), and t indexes years, Y is a measure of incumbent firm growth in total factor productivity or innovative performance, E is the actual entry rate of foreign firms, F is the industries distance to the technological frontier and X is a vector of other firm and/or industry covariates that control for other economic processes that may affect the innovative performance of domestic incumbent firms.

One of the main concerns in estimating this relationship is the likelihood that entry is endogenous – entry is more attractive in industries where expectuations about future productivity growth are high. In order to control for this ABGHP instrument actual entry using a large set of policy instruments, in particular: (a) 53 investigations and decisions by the Monopoly and Merger Commission; (b) 11 privatization cases of large publicly owned companies; (c) 41 indicators for 3-digit industries expected to be highly affected by the EU single market programme. Thus ABGHP specifies the following reduced form equation for entry:

$$E_{jt} = Z'_{jt}\Pi + F_{jt}\psi + X_{ijt}\phi + v_{jt}, \tag{2}$$

with

$$E[v_{jt} | Z_{jt}, F_{jt}, X_{ijt}] = 0 \tag{3}$$

where Z_{it} denote the instruments.

To control for unobservable industry characteristics and common macro shocks ABGHP including dummies. However, these may not be sufficient to remove all spurious correlation between entry and the growth in TFP (or patent count). In particular, relative changes in the entry rate across industries may be indirectly caused by shocks to UK TFP growth (or patenting). The approach take to remove this temporal correlations is to use policy and foreign technology variables as excluded instruments that determine entry but have no direct effect on the growth in TFP (or patenting).

Innovative performance is measured in two ways: first, by growth in total factor productivity, using data on output and factor inputs at the plant level for the population of UK manufacturing enterprises. Second, by patent counts: these data are available for only a subset of firms (those

listed on the UK Stock Market). Entry is measured either by the actual number of employees in new foreign plants or by entry rates on 4-digit industries in the previous periods. Distance to frontier is measured by the relative labor productivity index between UK and US industry on a 4-digit level, and to limit the high variation of a distance measure over time ABGHP use a three year moving average.

The empirical models specified above are estimated using micro-level data on productivity growth and patenting activity of British firms between 1987 and 1993. Data is combined two main sources. First, data from the Annual Respondents Database (ARD) is used. This covers the manufacturing sector and contains the micro data underlying the Annual Census of Production. It is collected by the British Office for National Statistics under the 1947 Statistical Trade Act and response is mandatory. Second, data from the IFS-Leverhulme database which links patent data from the NBER/Case Western Patent database with firm level accounting data from DataStream. The patent database contains all patents granted by the United States PTO between 1968 and 1999. This patent data is linked to DataStream data on 415 firms listed on the London Stock Exchange (LSE) during the time period 1968-1996.

The main sample used by ABGHP for estimating productivity growth models is a panel of 17,741 observations on 2,944 domestic incumbent establishments in the ARD between 1987 and 1993. The main firm panel for estimating innovation models consists of 1,101 observations on 179 firms in the IFS-Leverhume database. All firms in this sample are considered to be incumbent firms since firms listed on the LSE are all large and old. About 60 percent of the firms in the sample are patenting firms between 1987 and 1993.

Table 1 in Aghion-Griffith (chapter 5), henceforth AG, shows a significant effect of the entry measure on *aggregate* productivity growth of domestic, incumbent firms in the OLS regression without instrumentation. The size of the coefficient is reasonably high. When using an IV approach and instruments indicating industries expected to be affected by the Single Market Program and those affected by major privatization events in the UK we find confirmation for a positive entry effect on productivity growth. The coefficient gets (reasonably) larger which indicates a negative endogeneity bias. The last column in table 1 shows our preferred specification since the Sargan test displayed at the end of the table indicates no rejection of over-identification. This result was achieved by controlling for the direct effect of some Single Market indicators and privatization indicators in the second stage regression (see table for F-test results).

We can now interact entry with the incumbent's distance to the technology frontier. The first column of Table 2 in AG, chapter 5, shows a significant effect of foreign entry rate on productivity growth only after we instrument for entry as specified above. We also find a negative effect

of closeness to the frontier (this variable is misleadingly referred to as the "distance to frontier" variable), and positive effects of competition and import penetration. More importantly, we see that the interaction between entry and distance to frontier is positive and significant at the 1% level. In other words, the regression vindicates our conjecture that the effect of entry on TFP growth is all the more positive when an industry is closer to the technological frontier.

The second column displays similar results, but with patent count as the dependant variable. Once again, the entry rate of foreign firms, import penetration, and competition, all have a positive and significant effect on patenting; moreover the interaction term between entry and distance to frontier is positive and highly significant (at the 1% level), so that the closer an industry initially is to the corresponding frontier, the more entry enhances patenting in that industry.

Table 2 also shows that for low values of the distance to frontier variable an increase in entry can have an overall negative effect on patenting, which in turn confirms the existence of a discouragement effect of entry for firms far below the frontier.

4. The Indian liberalization experiment

In India up to the mid eighties central government control over industrial development was maintained through public ownership, licensing and high tariff, non-tariff barriers and controls on foreign investment. The New Industrial Policy, introduced in 1991, involved:

(i) *Trade liberalization* – across the 1990-97 period we find that there was a 51% reduction in tariffs with 97% of products experiencing tariff reductions. Quantitative controls on imports of intermediate products were also largely eliminated.

(ii) *Foreign investment* – approval of foreign technology agreements and of foreign investment of up to 51% of equity was made automatic in a large number of industries.

(iii) *Deregulation* – the requirement to obtain a license to start up a new production unit, expand production levels by more than 25% or to manufacture a new product were removed in the majority of industrial sectors. The number of industrial sectors reserved for the public sector was also dramatically reduced.

The empirical strategy pursued in ABRZ is straightforward. They track 3-digit state-industries across pre- and post-reform periods and examine whether being closer to the Indian technological frontier or having more pro-employer labor institutions pre-reform affects post-reform performance. ABRZ focus attention on the registered or organized manufacturing sector.

ABRZ run panel regressions of the form:

$$y_{ist} = \alpha_{is} + \beta_t + \gamma_i t + \delta(x_{is})(d_t) + \eta r_{st} + \theta(r_s)(d_t) + u_{ist} \qquad (4)$$

where i indexes a 3-digit industries, s indexes the Indian state in which the industry is located and t indexes years. y_{ist} is a 3-digit state-industry manufacturing performance outcome expressed in logs. x_{is} is pre-reform distance to the Indian technological frontier defined as labor productivity in a 3-digit state-industry in 1990 divided by labor productivity in the most productive 3-digit state-industry in that year. This measure equals l for the frontier and is less than 1 for non-frontier state-industries. A higher x_{is} therefore corresponds to being closer to the technological frontier. The liberalization reform is captured with a dummy d_t which takes a value of before 1991 and a value of 1 after. The coefficient on the interaction between pre-reform distance to frontier and the reform dummy (δ) tells us whether 3-digit state-industries closer to the frontier grew more quickly in the post-liberalization period relative to state-industries further from frontier.

The key results from ABRZ are that 3-digit state-industries close to the most productive state-industry in India pre-reform experienced faster post-reform total factor productivity growth relative to state industries far from the frontier. A common liberalization reform is thus having a heterogenous impact on industries (located in different states) within the same 3-digit industrial sector. ABRZ then obtain that, as predicted by the theory, the rate of technological progress is slower in states moving a pro-worker direction. This is evidence that institutional environment in which firms are embedded affected productivity growth across the 1980-1997 period. What is more striking is the evidence that liberalization magnifies the negative impact of pro-worker regulations on productivity growth. This shows how greater rent extraction by workers blunts the incentives of firms to make innovative investments in order to fight entry. State specific regulatory policies therefore have a central bearing on whether or not the same 3-digit industries located in different parts of India benefit from liberalization.

5. Entry and Growth in Russia

In this last section of the paper, we analyze the effect of increased entry by foreign firms on productivity growth in Russian enterprises.

5.1. Data

We combined several micro-level sources. Data on domestic firms were taken from the Registry of Russian Industrial Firms and data on foreign firms came from the Registry of Joint Ventures. Both of these

datasets are collected by Rosstat. Import-export data were taken from publications by the State Customs Committee.

The data on domestic firms consists of key balance-sheet statistics (sales, employment, fixed assets, costs and wage bill) for about 15 000 large enterprises in the years 1996-2002. It covers about 70% of total industrial output and employment in Russia. Unfortunately, the biggest companies in the extractive industries do not provide balance-sheet data to Rosstat. So firms (particularly oil and gas producers) which tend to be more profitable are substantially under-represented.

Product structure of output in 6- or 9-digit HS classification is also available for the firms in the Registry. We combined these data with import data from the State Customs Committee to get a measure of firm-specific import penetration ratios.

Sales and wage bills were deflated by industry-specific deflators calculated on the basis of monthly PPI weighted by monthly industrial output. Capital deflators were obtained in a different way. The value of a Russian firm's capital stock is subject to revaluation every year as of 1 January, so reported end-of-year and start-of-year capital stocks differ by the revaluation coefficient. We computed these revaluation coefficients and used them as deflators for capital stock.

Rosstat's Registry of Joint Ventures collects information on shareholders as well as balance-sheet information: the dataset contains information on the size of the foreign stake and country of origin of the foreign investor. Until 1997 all enterprises with foreign ownership over 10% had to provide data to the Registry of Joint Ventures, but since 1998 Rosstat only collects data from large and medium-size firms. This reduces the sample size from about 5000 firms in 1996-1997 to 2000 firms in 1998-2002. The criteria that Rosstat uses to define large and medium-size firms are unclear and study of the data shows that many small enterprises with foreign ownership continue to report. We use output data of all firms presented in the Registry of Joint Ventures. The dynamic of the shares of FDI in various industries is quite stable before and after 1998.

The Joint Ventures data were cleaned to eliminate off-shore companies set up by Russian businessmen, but we encountered difficulties when we tried to separate genuine foreign investments from off-shore schemes in the extractive industries. Off-shores relating to the extractive industries tend to be better disguised. In particular, investments from these off-shores often make a detour via European countries instead of coming directly to Russia. It was therefore hard to avoid overestimating entry shares of foreign firms in the extractive industries.

5.2. Empirical specification

The model predicts that the threat of increasing competition from foreign firms will have different impact on firms, which are close to their production possibility frontier, and on those, which are far from this frontier. We expect that firms close to the frontier react to increased foreign competition by innovating more, thus improving their efficiency even further. By contrast, less efficient firms do not innovate and the efficiency gap increases.

We estimate the following equation

$$E_{it} = \beta_1 EntSh_{jt} + \beta_2 D_{it} + \beta_3 D_{it} \times EntSh_{jt} + X_{it}\gamma + v_t + u_i + \varepsilon_{it}$$

where E_{it} is the productivity growth of firm i at date t;

D_{it} is the firm's distance to the production possibility frontier;

$EntSh_{jt}$ is the lagged sales share of foreign firms in sector j; and

X_{it} is the vector of controls (Herfindalh Index, import penetration ratios); and

v_t is time effect, u_i is firm-specific effect and ε_{it} is error term.

We expect that the share of entering foreign firms, which we use as a proxy for entry threat, will have a positive effect on productivity growth due to increased competition. We expect catch-up behavior by lagging firms: a larger productivity gap is associated with faster efficiency growth. So we expect a positive coefficient on distance to the frontier.

In our sample foreign firms entering the market have, on average, higher employment and output than domestic firms, and they are often characterized by higher labor productivity than domestic firms. Threat of entry by foreign firms destroys the motivation of less efficient domestic firms to innovate and forces them to leave the market. By contrast, threat of entry by foreign firms encourages the most efficient domestic firms to innovate more in order to discourage such entry. We therefore expect a negative coefficient for the cross-term of distance and foreign entry.

We use TFP as our measure of productivity. Quite often in transition economies production factor prices are not determined by market mechanisms and we cannot set them as equal to marginal costs. We therefore estimate TFP growth using two approaches. One approach (Jorgenson method) requires estimation of production functions, but does not assume marginal cost pricing. The other method, suggested by Harberger, is simpler to implement, since there is no need to estimate production functions or to calculate different deflators for output and capital in different industries. But the Harberger method does require assumptions about shares of labor and capital at a national level of aggregation (see Appendix A for details of TFP estimations). The TFP

growth estimates, which result from these two approaches, are highly correlated, but TFP growth rates obtained by the Harberger method show more variability.

Entry of foreign firms was calculated as the output share of all firms with some foreign ownership at the region-industry level[2]. Efficiency growth of individual firms could not affect entry decisions of a potential entrant, so we do not believe that the construction has a serious endogeneity problem.

We calculate distance to the production possibility frontier as the gap between labor productivity of a given firm and labor productivity of the firm, which is the best in the industry by this criterion. We use a three-year average of the labor productivity gap to smooth oscillations in productivity.

We use the Herfindalh Index and import penetration ratios to control for competitive pressure. We lagged these variables to avoid endogeneity.

5.3. Regression results

The regression results are presented in Table 2, which offers separate estimates for all industrial firms and for manufacturing enterprises (i.e. excluding extractive industries). In all regressions we control for year and firm fixed effects.

In the first case (i.e. when extractive industries are included) the coefficients have signs, which are predicted by the model, but are not always significant. The Russian extractive sectors tend to be highly concentrated and the state has kept a substantial share of ownership in some of them, using the pretext of 'strategic interests'. We do not have data on ownership structure of domestic firms, so we cannot control for state ownership in the regressions. Concentration and the role of the state result in various formal and informal restrictions on entry by foreign firms, and it is therefore often impossible to separate economic factors from political ones when studying what determines foreign entry to the Russian electricity, oil and gas or metallurgy industries. We also made estimates excluding extractive industries in order to ensure that political factors not covered by the model's construction would not seriously distort the results.

If we limit our sample to manufacturing firms the coefficients of interest become significant. The coefficients for competition measures (import penetration ratios and Herfindalh Index) enter the regressions with the signs, which one would expect, and they are significant. It is particularly interesting that the coefficient for the cross-term of distance to the frontier

2. 3-digit Russian industry classification (OKONKH)

and foreign entry is negative and significant for both TFP measures. So increasing competition from foreign firms has different effect on manufacturing enterprises, which are close to and far from the frontier.

6. Conclusion

In this paper, we have analyzed the relationship between entry (and entry threat) and incumbent innovation and productivity growth. The main theoretical finding is that increased entry threat stimulates innovation by incumbent firms that are already close to the technological frontier, whereas it discourages innovation by firms that are far below the frontier. We then reported on supporting evidence, both from UK firm-level panel data and from the recent liberalization experience in India. We then explored Russian firm-level panel data to test the prediction that increased (foreign) entry has differential effects on incumbent firms' productivity growth rates, with those firms that are initially more closer to the technological frontier in their industry, reacting more positively to entry than firms that are further away from their industry frontier. The evidence summarized in Table 2 confirms this prediction for the case of Russian manufacturing firms.

References

ACEMOGLU D., P. AGHION and F. ZILIBOTTI 2002: "Distance to Frontier, Selection, and Economic Growth", NBER Working Paper No 9066.

AGHION P. and Rachel GRIFFITH 2005: *Competition and Growth,* MIT Press.

AGHION P., R. BLUNDELL, Rachel GRIFFITH, P. HOWITT and Susanne PRANTL 2004: "Entry and Productivity Growth: Evidence from Micro-Level Panel Data", *Journal of the European Economic Association, Papers and Proceedings,* 2: 265-276.

AGHION P., R. BLUNDELL, Rachel GRIFFITH, P. HOWITT and Susanne PRANTL 2005: "Entry, Innovation, and Growth: Theory and Evidence from UK Firm-Level Data", mimeo Harvard-UCL.

AGHION P., R. BURGESS, S. REDDING and F. ZILIBOTTI 2005a: "Entry Liberalization and Inequality in Industrial Performance", *Journal of the European Economic Association, Papers and Proceedings*.

AGHION P., R. BURGESS, S. REDDING and F. ZILIBOTTI 2005b: "On the Unequal Effects of Liberalization: Theory and Evidence from Indian Delicensing Data", mimeo LSE-Harvard-IIES.

AGHION P. and P. HOWITT 1992: "A Model of Growth through Creative Destruction", *Econometrica,* 60: 323-351.

AGHION P. and P. HOWITT 1998: *Endogenous Growth Theory,* MIT Press.

BLUNDELL R., Rachel GRIFFITH and J. VAN REENEN 1995: "Dynamic Count Data Models of Technological Innovation", *Economic Journal,* 105: 333-344.

HELPMAN E. 1993: "Innovation, Imitation, and Intellectual Property Rights", *Econometrica,* 61: 1247-80.

NICKELL S. 1996: "Competition and Corporate Performance", *Journal of Political Economy,* 104: 724-46.

NICOLETTI G. and S. SCARPETTA 2003: "Regulation, Productivity and Growth", *Economic Policy,* 36: 11-72.

APPENDIX A

TFP estimations

1. TFP – Jorgenson method

We estimate production functions separately for 83 industries. We use a translog specification for estimating production functions.

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$$\ln VA_t = \alpha_0 + \alpha_L \ln L_t + \alpha_K \ln K_t + \alpha_t t + \alpha_{KK}(\ln K_t)^2 + \alpha_{LL}(\ln L_t)^2 + \alpha_{tt} t^2 + \alpha_{LK} \ln L_t \ln K_t + \alpha_{Lt} \ln L_t \cdot t + \alpha_{Kt} \ln K_t \cdot t$$

where VA is value added of a firm;

L is employment;

K is average capital stock; and

t is a time variable.

The TFP growth rates were calculated using the procedure suggested in Jorgenson (1995). One important feature of this method is that TFP can be estimated without assuming that factor prices are equal to marginal products, which is not always true in a transition economy. The TFP growth rate is obtained as the difference between the value-added growth rate and input growth rates multiplied by corresponding elasticities.

$$\ln(A_{t+1}/A_t) = \ln(VA_{t+1}/VA_t) - \bar{\eta}_K \ln(K_{t+1}/K_t) - \bar{\eta}_L \ln(L_{t+1}/L_t)$$

where $\bar{\eta}_K = (\eta_{K,t+1} + \eta_{K,t})/2, \bar{\eta}_L = (\eta_{L,t+1} + \eta_{L,t})/2$,

$$\eta_{K,t} = \frac{\partial \ln VA_t}{\partial \ln K_t} = \hat{\alpha}_K + 2\hat{\alpha}_{KK} \ln K_t + \hat{\alpha}_{LK} \ln L_t + \hat{\alpha}_{Kt} t,$$

$$\eta_{L,t} = \frac{\partial \ln VA_t}{\partial \ln L_t} = \hat{\alpha}_L + 2\hat{\alpha}_{LL} \ln L_t + \hat{\alpha}_{LK} \ln K_t + \hat{\alpha}_{Lt} t.$$

2. TFP – Harberger method

We also use an alternative method of computing TFP without estimating production functions. The method was suggested by Harberger (1998). TFP growth rate is calculated as the difference between value-added growth rate and input growth rate multiplied by factor prices. Following Harberger, we first deflate all the variables (value added, wage bill, capital) by a GDP deflator and then adjust TFP growth rates by

differences in inflation for different industries. In order to make growth of different types of employees comparable, we calculate the number of 'standard workers' by dividing the wage bill by the 'standard wage'. The standard wage is the wage of a 'representative worker', which can be estimated based on the part of GDP paid to labor. We assume that the labor share is 2/3 of GDP at an aggregated level and calculate the standard wage as $\frac{2/3 \times real\ GDP}{population}$. Return to capital is difficult to evaluate in a transition economy with underdeveloped financial markets. We therefore estimated return to capital for given enterprises by using their balance sheet data: we calculated implied return to capital as the ratio of total sales, minus the wage bill and material costs, to the average capital stock for a given year.

Thus TFP growth is calculated using the following expression:

$$\frac{\Delta TFP}{TFP} = \frac{\Delta RVA}{RVA} - s_L \frac{\Delta L^*}{L^*} - s_K \frac{\Delta RK}{RK} - \frac{\Delta P}{P} = \frac{\Delta RVA}{RVA} - w^* \frac{L^*}{RVA} \frac{\Delta L^*}{L^*}$$

$$-(\rho + \delta) \frac{RK}{RVA} \frac{\Delta RK}{RK} - \frac{\Delta P}{P}$$

where

RVA is real value added deflated by GDP deflator;

RK is average capital stock deflated by GDP deflator;

L^* is the number of standard workers;

w^* is the real standard wage;

$\rho+\delta$ is implied return to capital; and

$P=p_j/p_{GDPdef}$ is the ratio of the industry price index to the GDP deflator.

APPENDIX B

Summary statistics

1.1. Efficiency dynamics

TFP growth rates		1996	1997	1998	1999	2000	2001	2002
Jorgenson method	*means*	-0.48	-0.07	-0.08	0.18	-0.04	0.10	0.03
	st. dev.	0.73	0.74	0.94	0.96	0.70	0.69	0.68
	min	-2.99	-2.99	-2.99	-2.99	-2.96	-3.00	-3.00
	max	2.95	2.97	2.98	2.99	2.97	3.00	2.97
Harberger method	*mean*	-0.27	-0.02	-0.20	0.41	0.03	0.09	-0.08
	st. dev.	0.73	0.78	1.09	1.03	0.75	0.74	0.74
	min	-4.34	-4.33	-4.29	-4.28	-4.34	-4.10	-4.27
	max	3.65	3.64	3.64	3.68	3.54	3.67	3.68

1.2. Output shares of entering foreign firms in 3-digit industries

		1996	1997	1998	1999	2000	2001	2002
Electricity & Fuel	*mean*	0.002	0.000	0.032	0.005	0.007	0.006	0.003
	st. dev.	0.009	0.000	0.144	0.065	0.084	0.059	0.022
	min	0	0	0	0	0	0	0
	max	0.125	0.001	1.000	0.945	0.974	0.878	0.395
Metallurgy	*mean*	0.012	0.010	0.042	0.010	0.075	0.032	0.030
	st. dev.	0.076	0.069	0.133	0.035	0.187	0.104	0.144
	min	0	0	0	0	0	0	0
	max	0.671	0.998	1.000	0.152	1.000	0.935	0.918
Chemical & Petro-chemical	*mean*	0.007	0.004	0.077	0.010	0.034	0.014	0.023
	st. dev.	0.028	0.035	0.174	0.084	0.111	0.072	0.112
	min	0	0	0	0	0	0	0
	max	0.175	0.774	0.988	0.998	0.996	0.862	0.917
Machine-building	*mean*	0.004	0.001	0.011	0.013	0.010	0.009	0.009
	st. dev.	0.022	0.008	0.050	0.061	0.051	0.037	0.048
	min	0	0	0	0	0	0	0
	max	0.931	0.087	1.000	0.652	0.0989	0.650	0.796
Timber, Paper and Woodworking	*mean*	0.017	0.006	0.026	0.006	0.014	0.009	0.013
	st. dev.	0.072	0.033	0.108	0.023	0.060	0.027	0.042
	min	0	0	0	0	0	0	0
	max	0.523	0.582	1.000	0.198	0.981	0.227	0.277

1.2. Output shares of entering foreign firms in 3-digit industries

		1996	1997	1998	1999	2000	2001	2002
Construction Materials	*mean*	0.002	0.006	0.018	0.011	0.015	0.013	0.003
	st. dev.	0.021	0.044	0.050	0.070	0.092	0.065	0.018
	min	0	0	0	0	0	0	0
	max	0.794	0.768	0.281	0.979	0.959	0.623	0.160
Light Industry	*mean*	0.005	0.007	0.004	0.008	0.006	0.009	0.007
	st. dev.	0.025	0.050	0.019	0.046	0.041	0.049	0.026
	min	0	0	0	0	0	0	0
	max	0.262	0.693	0.124	0.983	0.828	0.883	0.460
Food Industry	*mean*	0.007	0.003	0.020	0.010	0.018	0.013	0.014
	st. dev.	0.032	0.014	0.069	0.047	0.053	0.049	0.047
	min	0	0	0	0	0	0	0
	max	0.385	0.127	0.418	0.467	0.633	0.320	0.291
Other Industries	*mean*	0.007	0.004	0.013	0.008	0.008	0.009	0.002
	st. dev.	0.034	0.039	0.077	0.063	0.048	0.071	0.014
	min	0	0	0	0	0	0	0
	max	0.372	0.861	0.893	0.914	0.738	0.789	0.131

1.3. Average employment and output of domestic and foreign firms

	1996	1997	1998	1999	2000	2001	2002
Average employment, number of workers							
domestic firms	759	525	462	388	377	471	390
foreign firms	660	994	435	1090	985	2758	1305
Average real output, thousands of rubles							
domestic firms	10765	9548	9168	8179	9397	12800	9567
foreign firms	3706	3774	18412	43336	29173	93776	30370

2. Efficiency regressions

	All industries		Manufacturing industries	
	TFP growth, Jorgenson (1)	TFP growth, Harberger (2)	TFP growth, Jorgenson (3)	TFP growth, Harberger (4)
Foreign entry$_{t-1}$ * distance$_{t-1}$	-0.115	-0.176*	-0.182*	-0.224**
	(1.58)	*(2.30)*	*(2.43)*	*(2.84)*
Foreign entry$_{t-1}$	0.393*	0.563**	0.589**	0.727**
	(2.14)	*(2.95)*	*(3.08)*	*(3.63)*
Distance$_{t-1}$	0.223**	0.145**	0.220**	0.143**
	(21.31)	*(13.49)*	*(20.64)*	*(13.09)*
Import penetration$_{t-1}$	0.120	0.488**	0.118	0.448**
	(1.73)	*(6.77)*	*(1.68)*	*(6.18)*
Herfindalh Index$_{t-1}$	-0.117	-0.583**	0.011	-0.501**
	(0.79)	*(3.81)*	*(0.07)*	*(3.09)*
Constant	-0.910**	-0.648**	-0.918**	-0.646**
	(34.15)	*(23.67)*	*(33.27)*	*(22.86)*
Year dummies	yes	yes	yes	yes
Number of observations	54076	55513	51684	53021
Number of firms	14586	14872	13954	14192
R^2	0.07	0.07	0.07	0.07

Fixed effects estimations
Absolute value of t-statistics in parenthesis
* significant at 5% level; ** significant at 1% level