

Barriers to Exit, Experimentation and Comparative Advantage

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Abstract

The delay in the EU in embracing new technology, relative to the US, is often thought to result from higher entry and expansion costs for more innovative firms. Yet, the choice of firms to experiment with new technologies may be more vulnerable to exit than to entry costs, as innovative entrants fail more often and fail earlier. This paper argues that more innovative strategies, especially near the technological frontier, are affected by exit costs, because such strategies entail exploring novel combinations with a higher failure rate than follower strategies tracing established products and processes. High exit costs lead to more entrants choosing stable follower strategies, thus starting on a larger scale. They also lead to higher delay to exit, so that resources remain trapped longer in existing firms. The model in the paper is consistent with stylized facts relating to differences in firm-level patterns of entry, exit, and productivity between the US and the EU. The empirical results confirm testable implications of the model, namely that employment protection interacted with a distance-to-frontier measure reduces total factor productivity. Further, employment protection reduces observable patterns of firm behavior associated with experimentation and, as expected, reduces firm-level employment volatility.

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1. Introduction

This paper explores empirical variation in industry and firm-level performance within and across countries for clues to explain differences in innovative strategies chosen by firms in the USA versus EU countries. The fact of firm heterogeneity, even within narrowly-defined industries or markets, has now been well documented (see e.g. Bartelsman and Doms, 2000). The role of reallocation among firms in determining aggregate or industry outcomes is becoming evident (e.g. Bartelsman, Halitwanger, and Scarpetta 2004, 2007; Melitz and Canut 2007). Aggregate productivity is boosted by the expansion of more productive firms, and the scaling down and exit of less efficient ones within and across sectors, in response to successful innovation. The process of new entry and resource reallocation across firms also is seen to be important for economic renewal and growth. More recently, selection is receiving increased attention: how do institutional features and technology interact with firm-level choices and market selection in determining the characteristics of firms that are observed to produce (see e.g. Acemoglu et al. 2006; Koeniger and Prat, 2007).

Individual firm growth and exit patterns are posited to depend on a firm-level choice between experimental innovation which leads to a high chance of temporary or complete failure, and incremental adaptation which has less variable outcomes.¹ Experimentation requires sequential testing of alternative combinations of technologies and resource inputs, and leads to more variable outcomes than strategies that replicate tried and tested combinations of technology and resource inputs. While an innovation may succeed and deliver high growth, it is subject to significant risk of failure, as logistic, technological and marketing assumptions may fail. Overall, *experimentation* is a dynamic process which increases the diversity of performance within the population of firms, in principle increasing the average, the standard deviation and even the skewness of the distribution of firm productivity. It is associated with smaller entrants, faster scaling up and down of the better and worse firms, and a high rate of resource reallocation.

¹ Innovative strategies are here broadly defined to include new technology, novel market approach, and changes in organizational structure.

We start to explore the importance of experimentation by illustrating a broad range of empirical evidence on the differences in firm and industry characteristics in the EU compared to the United States. Our key data source contains cross sectional and time series information on the distribution of firm-level characteristics. We compare in particular the different features of entrant and exiting firms, their size at entry and exit, and the resource reallocation rates and the distribution of productivity across firms.

We offer a theoretical model where entrant firms choose their technology, factor input, and market strategy to aid in explaining the features of the data. More innovative choices are riskier, but hold promise for larger profit and growth. Experimentation offers high rewards in case of success, but also imposes financial losses in case of failure, as well as costs on various stakeholders (workers, suppliers, consumers, local communities). Thus, political preferences aiming at protecting these groups induce a policy of large exit costs on firms to compensate all affected parties.²

High exit costs discourage innovative entrants more than conventional entrants. High entry costs are not a likely candidate to explain the differential entry rates of firms with experimentation versus adoption as innovative strategy as the entry costs are sunk before the choice of innovation strategy is taken. While all firms incur entry costs³, most often conventional entrants invest immediately at a higher scale than experimental ventures. In contrast, exit costs, and more generally any assets that are lost in failure, hit harder those firms with the strategy of experimentally seeking for new products and processes, because their chance of failure is higher.

The model provides testable implications. In particular, exit costs discourage experimentation more in sectors close to the technological frontier. In sectors where there is less scope for an entrant to gain a drastic improvement over incumbents, experimentation may not be affected by entry costs at all. A measurable implication is that the pace at which resources and market share may shift towards more productive

² Some exit costs have a cultural component. An example is the “stigma of failure”, a negative social judgment on the quality of entrepreneurs which suffer bankruptcy. Landier (2003) show how it may be self reinforcing, and how severely it undermines the incentives of talented individuals to start an own firm.

³ There may be specific financial constraints which make external financing harder for novel concepts. In that case it is essential to understand how the US and EU financial systems differ in resolving the problem of early stage financing.

firms is indirectly influenced by exit costs. The intuition is that the stock of productive resources available for reallocation across firms depends on the strategies chosen by firms. The growth ability of better firms depends on the availability of high quality, redeployable resources released by downsizing and exiting firms. Higher experimentation rates produces more rapid entry as well as faster exit, so resources remain on average shorter in the same firm. As resources become specialized to firms over time, a process of more frequent exit frees up resources at a stage of easier redeployment. This creates an externality across firm strategies. In a low exit cost environment, many exiting firms are innovative ventures which have been unlucky. In a high exit cost environment, more of them are conventional firms which have reached obsolescence. To the extent that resources released by the latter are harder to reallocate, the average quality of resources released depends on the fraction of experimenting firms. The quality of available resources is critical for strategies requiring speed, such as the ability of a successful innovator to capture the value generated by the innovation before the rents are dissipated by imitating followers.

Overall, the evidence we review is consistent with two postulates. *Experimentation*, in combination with productivity enhancing reallocation is a crucial factor in achieving high productivity. Second, exit costs matter significantly for productivity, both because they lower productivity enhancing reallocation and because they lower experimentation. Our paper complements the literature on the barriers to innovation from entry costs, but also provides a clear contrast. Entry costs discourage both innovative and conventional entry, yet as long as innovative ventures are more valuable, entry costs should not create a greater relative obstacle for innovative firms. Here we argue that the nature of experimentation with frequent failures makes exit costs even more critical, especially for sectors close to the technological frontier.⁴ Understanding the differential implications of entry costs and exit frictions may change political considerations that are at the heart of their existence.⁵

⁴ Aghion and Blundell (200?) show that the relationship between innovation and competition is U shaped, and attribute it to different benefits of innovation in sectors near and far from the technological frontier.

⁵ Djankov et al. (2004) document remarkable variation in entry costs across countries, and highlight how high entry barriers are more common in corrupt countries. Klapper, Laeven and Rajan (2006) show how

The paper is organized as follows. The next section presents some existing evidence and some new stylized facts concerning firm demographics and productivity. The following section offers a model of experimentation choice under exit costs. The fourth section presents our preliminary results of the testable implications of the model, using a combination of statistical sources: a panel dataset on output and factor inputs (EUKLEMS), two datasets on institutional indicators (OECD Employment Protection data and World Bank Cost of Doing Business data), and a new panel of indicators built up from longitudinal firm-level datasets (ONS/Eurostat). The conclusions conclude the paper.

2. Recent observations on heterogeneity, churn, and productivity dispersion

The stylized facts presented in this section are drawn from recent firm-level studies and from a harmonized database of indicators built up from firm-level data for a sample of OECD countries over the past decade.⁶ The indicators for the OECD countries are generally limited to manufacturing industries and cover periods that vary by country but generally contain most of the 1990s. The reported facts relate to the size distribution of firms, the magnitude of firm entry and exit, the survival and post-entry growth of firms, and to the dispersion of productivity of entrants and incumbents. We start with a selection of indicators from the literature that portray the heterogeneity in firm characteristics and the amount of churn in employment and the population of firms.

entry costs reduce entry rates, and are not justified as efficient public policy. Rajan and Zingales (2003) include finance barriers as deliberate obstacles created to favor insiders and established producers. Perotti and Volpin (2007) show evidence that weak investor protection reduces entry rates in countries where the capacity of insiders to block entry is strongest.

⁶ The firm-level database collected indicators for 24 countries (Canada, Denmark, Germany, Finland, France, Italy, the Netherlands, Portugal, United Kingdom and United States Estonia, Hungary, Latvia, Romania, Slovenia; Argentina, Brazil, Chile, Colombia, Mexico, Venezuela, Indonesia, South Korea and Taiwan (Turkey, China coming)). These indicators are based on a process that involved the harmonization of key concepts (e.g. entry, exit, or the definition of the unit of measurement) as well as the definition of common methodologies for studying firm-level data. The methodology for collecting the country/industry/time panel dataset built up from underlying micro-level datasets has been referred to as 'distributed micro-data analysis' (Bartelsman 2004). A detailed technical description of the dataset may be found in Bartelsman, Haltiwanger and Scarpetta (2004).

Firm and worker turnover rates are sizable in all countries. Clear evidence for this is presented in Bartelsman, Haltiwanger and Scarpetta (2004) and Bartelsman, Scarpetta and Schivardi (2004). Over the first-half of the 1990s, firm turnover rates (entry plus exit rates) in OECD countries were in the range of 15 to more than 20 per cent in the business sector: *i.e.* a fifth of firms is either recent entrants, or will close down within a year. The process of entry and exit of firms involves a proportionally low number of workers: *i.e.* only about 10 per cent of employment is involved in firm turnover. In a decomposition of variance of turnover rates, industry effects are far more important than country effects. In Haltiwanger, Scarpetta, and Schweiger (2006), the turnover rates are seen to be somewhat related to the regulatory and institutional environment, with lower turnover rates associated with higher firing costs particularly in those industries where turnover is high on average across countries.

Market selection is harsh in all countries. Only about 60-70 per cent of entering firms survive the first two years in the countries reviewed. Having overcome the initial years, the prospects of firms improve further: those that remain in business after the first two years have a 50 to 80 per cent chance of surviving for five more years. Nevertheless, in the countries considered, only about 40 to 50 per cent of firms entering in a given year survive on average beyond the seventh year. Failure rates in the early years of activity are highly skewed towards small units, while surviving firms are not only larger, but also tend to grow rapidly.

In the U.S. successful new firms expand rapidly compared with the EU. Bartelsman, Scarpetta and Schivardi (2004) show that the average size of surviving firms increases rapidly to approach that of incumbents in the market in which they operate. However, in the United States, surviving firms on average increase their employment by 60% by their seventh year, while employment gains amongst surviving firms in Europe are in the order of 10 to 20 per cent (Figure 3).⁷ Firms in ICT-related industries (*office accounting and computing machinery and radio, TV and communication equipment*) generally experience rapid post entry growth in all countries for which data are available. However, even in

⁷ The results for the United States are consistent with the evidence in Audretsch (1995a,b). He found that the four-year employment growth rate amongst surviving firms was about 90 per cent.

these highly dynamic industries, surviving US firms show a considerably stronger employment expansion, compared with those in the EU countries.

There is larger variation in the productivity levels of new firms in the U.S. than in Europe. The coefficient of variation (standard deviation divided by the mean) of the distribution of productivity levels of entrants varies across countries and manufacturing sectors. Results are reported in Bartelsman and Scarpetta (2004). They show the country fixed effects for a regression of the coefficient of variation of the productivity of a cohort of entrants on country, industry, and time dummies. Controlled for industry composition, the distribution of productivity of entrants is seen to be wider in the USA than in EU countries, more so for the TFP measure than for labor productivity. This finding is consistent with the notion that entrants in the USA may not have settled on a known technology, but are trying to find out their ability to survive in the market. Interestingly, there is a wider dispersion in the productivity of entrants in high- and low-tech sectors for each country. As discussed, in the US the difference in dispersion between high and low-tech is significantly higher than in other countries. This latter finding points to the possibility that the relative attractiveness of experimental versus follower strategy may vary by industry.

Firm-level indicators by technology grouping

Taking a queue from the last finding on differences-in-differences of entrants productivity variation between high and low tech in the US and EU, we try to extract a collection of stylized facts for a wider set of the indicators built up from micro data (BHS 2004) for the manufacturing sector. The classification scheme for assigning individual industries to technology groups is based on IT production or use intensity, and has been developed by van Ark et al., (see e.g. find original ref.). We display results for manufacturing as a whole and for ICT-producing and non-ICT industries (the intermediate group, ICT-using industries, is reported). The industry list is provided in the appendix. Results for this table are generally consistent with the OECD grouping of manufacturing industries in High, Medium, and Low technology groups.

The job destruction by incumbents versus jobs lost through firm exit varies across groupings and between the US and EU countries. Job destruction rates in the OECD countries hover around 10 percent.⁸ This process frees up labor resources needed for entrants and expanding firms. Differences across countries in firing costs and impediments to exit affect the share of job destruction that takes place at incumbent firms versus exiting firms. The first row of Table 2 shows the percentage of job destruction occurring through the exit of firms rather than shedding of workers at continuing firms. Overall, this share is lower in the US than in the EU.⁹ Most striking is the sizable difference in this rate in moving from the low to the high technology group in the U.S. In the high group in the US less than 7 percent of job losses occur through firm exit, while in the EU a third of the losses occur through firm exit. As a consequence, the high technology group releases a large quantity of employment at firms that continue to search for a fit in the market. These resources may be precisely those that are scarce at the more successful experimenting firms. By contrast, in the EU these resources remain attached to the firm, until the firm finally exits the market altogether. A similar pattern of job creation at entering firms versus total job creation emerges between the US and the EU and across technology groupings.

Table 2. Firm-level indicators by ICT-Technology Group

(percent)	US Average Manuf	EU	US ICT Producing	EU	US Non-ICT	EU
Exit share of Job Destr.	24.7	34.3	10.7	24.1	24.9	37.4
Entrant Size rel. to incumbent	21.0	38.6	6.3	35.7	24.0	40.8
Productivity Gap of Exitters	10.0	15.4	1.2	9.1	7.9	17.7
Employment Share of Exitters*	18.9	23.1	20.2	31.8	19.8	22.3
Employment growth, top qrt.	68.6	50.1	91.8	65.1	70.8	45.0

The ICT-using industry is omitted from table. *The employment share of exitters is for 5-year window.

Entering and Exiting firms in the US tend to be smaller relative to industry average than in the EU. The relatively small size of entering and exiting firms in the US, especially in the high technology grouping, point towards the relative ease with which the mostly young firms can adjust their workforce to market circumstances. Further, as

⁸ We follow the Davis and Haltiwanger (1999) definitions of jobs creation, destruction, and gross flows, as described in BHS (2004).

⁹ The EU countries used to compute these moments vary across indicators. The overall dataset includes information for Denmark, France, Finland, Germany, Italy, the Netherlands, Portugal, Sweden, and the United Kingdom.

described in BSS (2004) and Aghion, Fally, and Scarpetta (2007), financial conditions and social safety nets may be such that firms with less certain ‘business models’ enter smaller in the US but then face a more vigorous selection process over time.

The productivity threshold for exit is lower in the EU than in the US. The gap in productivity between exiting firms and incumbents is fifty percent larger in the EU than in the US. The ‘shadow of death’ (Griliches and Regev 1995) of firms documented in the US is likely more pronounced in the US than in the EU. As firms face difficulty matching their production process to market demand, they shrink. This shrinking, all else equal, raises their measured productivity, but maybe not enough to remain competitive in the market. Conditional on exit, firms are seen to have a recent history of downsizing, but downsizing firms do have a higher chance of regaining productivity and market share.

Fewer resources are held in exiting firms in the US than in the EU. The share of employment taken up by firms that exit is lower in the US than in the EU, and lower for high technology firms. The measure presented here is the employment in year t-5 of firms that exit between year t-5 and t, as a share of total employment in year t-5.

Fast growing firms grow faster (and shrinking firms shrink faster) in the US. Over five-year periods, the average employment growth of high-tech firms in the quartile with the highest growth in employment in the US was 90 percent. This is higher than in the other technology groupings and higher than in the EU. The employment declines for the firms in the bottom quartile by employment growth over five years are a near perfect mirror image of the increases in the top quartile, both by country and technology groups.

Interpretation

We interpret this evidence as consistent with a higher rate of experimentation in US relative to EU firms. Entrants and exiting firms in the U.S. are smaller, consistent with a greater ease of entry and exit. In addition, more entry and exit of smaller firms in the US may reflect a higher rate of innovative strategies, while larger entrants and exiting firms in the EU may reflect more cautious entry strategies, which target more established markets. While smaller size of entrants is often seen as a sign of dynamisms, the same

may be true for the size of exiting firms. Smaller exiting firms may reflect unlucky risky ventures, while large exits concern established firms which become less productive.¹⁰

These stylized facts further are consistent with related findings in previous years. First, empirical work has formed a link between observed differences in IT adoption in the US and the EU and differences in firm dynamics related to regulatory environment (Gust and Marquez (2004), Bartelsman and Hinloopen (2004). Similarly, Koeniger (2005) finds that R&D expenditures are lower in countries with less labor flexibility.

Recently, modeling effort has been undertaken to link employment protection to innovative activity (Saint-Paul 2002; Samaniego 2006; Koeniger 2007; Melitz and Canut 2007). However, the empirical link between employment protection and productivity (growth) remains tenuous. Simple correlations between TFP and a country index of employment protection show a weak negative relationship (e.g. Lagos 2006). Missing in the work is a link between employment protection and firm-level innovative choices on the one hand, and innovative choices, resource flexibility and aggregate productivity on the other hand.

We present next a model which illustrates how experimenting firms suffer more from high exit costs. Experimentation is interpreted as the process of searching for novel combinations (Schumpeter, 1929). Testing new concepts and adapting them to concrete applications, with concomitant use of capital and labor inputs, necessarily requires frequent failures, and even sequential failures,¹¹ requiring partial divestitures and often leading to an early exit. The main result is that higher exit costs hurts innovative strategies more severely than conventional strategies.

We also show that a rapid process of resource reallocation facilitate growth of successful innovators. Finally, a large degree of experimentation, together with fluid resource reallocation leads to high aggregate productivity.

¹⁰ This process of greater firm dynamics appears more pronounced in high-tech and emerging sectors, precisely where the necessity of, or benefit from, experimentation is largest.

¹¹ The term is perhaps unnecessarily negative, as any combination which proves unprofitable represents a learning experience which opens the door to a narrower set of promising options.

3. The model

Consider the choice for a firm to pursue either an experimental innovation or a follower strategy. We at first focus on the case of full scale entry for all firms. We ignore any strategic interaction among firm choices.

Firms undertake experimental innovation by trying new combinations of technologies and established factor inputs. If one combination fails, a firm may try another configuration of resources and a new set of skills. When this occurs a firm needs to dismiss resources, and it incurs exit costs.¹²

If the innovation is successful, i.e., a particular combination of production factors and technology succeeds, other firms may follow it. A follower strategy earns π with certainty, which is less than the profit for successful innovation, denoted by Π . The ratio of π/Π depends on how innovative is the experimenting strategy: The less likely is the success of experimentation, the higher the resulting earnings stream and the lower is π/Π .

Firms pursuing experimental innovation can choose from a set of combinations of factor inputs and technologies, say a set of two possible combinations $\{A,B\}$. Suppose that either choice may be successful with independent probability p , and the firm stops experimenting as soon as a choice is successful.¹³ Each failed combination requires dismissing some resources at a partial exit cost denoted by P_X . If neither of the two strategies is found valuable, the firm incurs a cost of total exit equal to T_X .

If the experimenting firm chooses first for A, there are three possible outcomes. The firm succeeds with probability p . If it fails in its first choice, with probability $1-p$, it faces some partial exit cost P_X . It will then attempt the second choice B, which also has a p chance of success. With chance $(1-p)^2$, the firm fails again and faces total exit costs equal to T_X . P_X and T_X are political choices and reflect preferences which we treat as exogenous. The expected marginal return for an innovating firm V_I after incurring the sunk investment (entry) cost I equals

¹² Later we study how successful innovators needs to expand rapidly to capture the maximum gain from innovation, before other firms imitate.

¹³ We assume that p is exogenous to each firm, and not a choice variable.

$$V_I = p \Pi + (1 - p) [-P_X + p \Pi - (1-p) T_X]$$

$$= p (2-p) \Pi - (1-p) P_X - (1-p)^2 T_X$$

The first term is the return from an immediately successful attempt at combining resources and technology, the second term is the profit when the first choice fails and there is a partial exit cost, in which case a second combination may succeed or may fail causing the firm to incur the total exit cost. After successful innovation, the firm earns Π .

For simplicity we assume that partial exit costs are half as large as total exit costs.¹⁴ Let $P_X = k$ so that $T_X = 2k$. In this case, a follower firm earns more when

$$\pi > p (2-p) \Pi - k (1-p) - 2k (1-p)^2$$

The immediate result is that as the follower strategy does not risk bankruptcy, its relative payoff increases with exit costs.

We next assume that the relative profit gain enjoyed by a leader is negatively related to the ex ante chance of success. Intuitively, an ex ante less likely combination offers a greater potential gain. In particular, let $\pi/\Pi = p$. This implies that potential profits are very high for successful innovations, the closer they are to the technological frontier, while their chance of success increases with distance from the frontier.

So the condition to prefer a follower strategy becomes

$$\pi / \Pi > p (2-p) - [3p - 2p^2 - 1] k$$

and since $\pi/\Pi = p$:

$$p (1-p) > k - 3pk + 2p^2k$$

Thus an innovative strategy is optimal only for firms facing exit costs k less than

$$k^* \equiv p (1-p)/(1 - 3 p + 2 p^2)$$

¹⁴ If partial exits were as expensive as final exits, our results would be considerably strengthened, as experimentation would be lower for any level of exit costs.

which is always positive for $p < 1$. This produces our main result:

Proposition I: *the threshold level of exit costs which discourages innovation is decreasing in p .*

This equation, described in graph 1, shows that when p is low, that is for very innovative ventures close to the frontier, an innovative strategy is better than a follower strategy only when exit costs are low. In other word, higher exit costs decrease the range of industries close to the frontier at which innovative strategies will be pursued. Graph 2 illustrates the effect of changes in exit costs k on the threshold for firm choice of an innovative strategy across industries, by comparing expected gains and expected costs along distance from the technological frontier.

In the next section we offer two extensions. The first introduces a choice on the scale of entry and looks at implication for the distribution of firm entry and exit. The second looks at the external effect of more diffused experimentation.

Scale at Entry and Exit

We allow here two variations. First, we study the long term value of firm strategies. Second, we allow firms to choose a lower scale of operation. Experimental firms succeed in the first period as before with probability $p + p(1-p)$. After successful innovation, they keep earning Π in each period until exit, which occurs with hazard rate x . A follower strategy earns π with certainty in the first period, and continues to earn it till exit, which also occurs with hazard rate x . As before, the ratio of π/Π depends on p , the initial chance of experimental success. Entry and exit costs are proportional to scale of operation, and are the same for each strategy. Entry may be on small scale, at a cost I_0 or full scale at a cost I , where $I_0 < I$.

The scale of entry is indicated by s , on a scale from 0 to 1. There are constant return to scale, so that for instance a successful innovator earns $s\Pi$. Also exit costs are proportional to scale, so that

$$sT_X = 2sP_X = ks\Pi$$

We assume that exit costs are large enough to exceed one period profitability for either strategy π and Π (e.g $T_X > \Pi$), while the capitalized value of either strategy, π/rx and Π/rx , are both larger than $T_X = k\Pi$ (implying that $k < 1/rx$).

This reasonable assumption has as consequence that experimenting firms will enter at a lower scale than firms choosing for conventional entry.

The expected profit of an experimenting strategy in the first period is now

$$\begin{aligned} & p(2-p)\Pi - (1-p)sP_X - (1-p)^2sT_X \\ & = (1-p)sk\Pi + 2(1-p)^2sk\Pi \end{aligned}$$

When the first period produces an expected loss (as $T_X > \Pi$), experimenting firms enter at a lower size $s < 1$, so that any exit loss is reduced by a smaller scale.

So riskier firms enter at a smaller scale to avoid exit costs on early stage failures, and expand only upon success.¹⁵

This expected one period loss can be seen as a learning cost granting access to a valuable option, producing a stream of profits of value Π/rx .

In contrast, an innovating firm faces no chance of immediate exit. Thus a follower firm earns more when¹⁶

$$\pi/rx > p(2-p)\Pi/rx + (1-p)sP_X + (1-p)^2sT_X$$

After the first period, future profits equal π or Π in all periods before exit. So the value of a follower firm is $\pi/rx - I$, minus an expected exit cost. The value of a successful

¹⁵ An alternative cause of differential entry size is that followers enter at later stage of market development, which requires a larger initial capital.

¹⁶ Exit costs for both strategies after the first period are equal, so they drop out of the equation. Note that exit always occurs, and discounted expected exit costs depend on the expected timing of exit.

innovating firm is $p(2-p)(\Pi - T_X)/rx - I$, minus an identical expected exit cost. Thus a follower firm earns more when¹⁷

$$\pi > p(2-p)\Pi + (1-p)sP_X + (1-p)^2sT_X$$

Note that average age of an experimental firm at exit is $(2p-p^2)/x$, and is $1/x$ for a follower firm. Firms pursuing experimental strategies also have on average a smaller size at entry and exit.

Quality of Resources for Reallocation

We model here in reduced form strategic choices for a continuum of firms on $[0,1]$ which are heterogeneous in their cost of experimentation. Thus the fraction of firms choosing for experimentation (denoted by n) is increasing in its profitability relative to conventional entry, so that $n = n(\Pi/\pi)$, with $n' > 0$.

The gain from successful experimentation Π/π depends now also on the ability of successful innovators to rapidly expand to seize the opportunity created. Here the redeployability of available resources is critical for the ability to capture the value generated by the innovation before imitation by followers.

Let our measure of redeployability be denoted by q . So the profitability of innovative strategies depends on both redeployability q and its distance from the frontier p :

$\Pi = f(p)g(q)$ where $g' > 0$ and $g'' < 0$. As before, profitability upon success also depends on the distance from frontier p , so $f' > 0$ and $f'' < 0$.

Resources available for redeployment come from exit. Firm exit occurs in two cases: an innovative firm may fail in one of its experimentations, which occurs with probability $(1-p)$, or an established firm producing at full scale is forced out of business from competition, which as before occurs with probability x . As ventures are riskier, we assume that $x < 1-p$.

¹⁷ The capitalization factor for first period profits for both strategies is $1/xr$, where r is the discount rate. Note that the ratio is independent of r .

We take the view that resources employed in a firm become progressively “dedicated” to the firm, as they accumulate firm specificity.¹⁸ Let q be a function of the length in time a resource has been in the previous firm. This latter equals $1/e$ in the exit of conventional firms and $1/(1-p)$ in the exit of innovative firms whose productive experiment failed. Clearly, the second term is smaller, so resources released by failed experimenting firms are more easily redeployable.

Thus, q is higher when the fraction of experimenting firms is higher, and so is the extra profit from innovative strategies, as the ratio of Π to π increases with q .

In conclusion, we can now state

Proposition The redeployability of resources increases in the proportion of experimenting firms. This produces a reinforcing effect on the profitability of innovative strategies.

4. Empirical results

The main testable implication of the setup discussed above is that nearer to the frontier exit costs are more of an impediment to experimentation. When experimentation does take place, we should observe various distinct features in the data. The main feature is that the productivity (or profitability) of successful experimentation is much higher than for follower firms. Next, we should see a higher level of resource reallocation at experimenting firms. Finally, successful experimentation and proper resource reallocation should lead to high average industry-level productivity.

To cut directly to the chase, we will test whether industry productivity is negatively affected employment protection, and whether the effect is stronger for industries where the potential benefits to experimentation are larger, owing to negative selection of experimenting firms within the industry (industries near the frontier). Next, we will see whether measures of resource reallocation are larger in industries close to the frontier and

¹⁸ Reasons why redeployability decreases with the duration of employment in the previous firm may be that the sunk investment in firm specific skills increases over time and interferes with new incentives, or that capacity to adapt decreases with a prolonged involvement in the same organization.

whether these are, differentially, harmed by employment protection. Finally, we will look across industries to determine whether employment protection leads to a selection of firms away from industries close to the frontier or, more generally, away from industries requiring more resource reallocation.

Data

Table 3 provides an overview of the data used for this exercise. The EUKLEMS database (Timmer, O'Mahoney and van Ark 2007) provides measures of output, factor inputs, prices and industry purchasing power parities for EU countries and for US, for disaggregated industries covering the whole economy from 1970 through 2004. The employment protection indicators (EPL) come from a country-time panel dataset collected at the OECD (Nicolleti, et al. 1999), with an indicator of the stringency of overall employment protection and indicators of protection for regular contracts and temporary employment contracts. The time dimension of this dataset may contain interpolations between actual component level information collected from OECD member countries. A complementary dataset of indicators of 'Costs of doing business' (CDB), including entry and exit costs has been compiled by the World Bank (see Djankov et al. 2002). Current indicators on, for example, hiring and firing costs, or time to start a business, are available for many countries from 2004 to the present.

Finally, the paper makes use of two datasets collected using the method of 'distributed micro data research' (Bartelsman 2004). These sets include information of the underlying distributions in confidential micro datasets available at national statistical offices. First, for the 1990s data has been collected for a selection of OECD countries, mostly for firms in manufacturing. Next, an ongoing project, coordinated by the UK Office of National Statistics (ONS), and funded by Eurostat, is compiling information from linked longitudinal business registers, production surveys, and e-commerce surveys for 13 EU countries for firms in all sectors of the economy for the years 2001 to the present. Numerical results using this dataset are not shown pending release of the study, but qualitative results will be given [to be update June 2008].

Table 3. Data sources

Source	Periods	Countries	Coverage	Variables
EUKLEMS	1970-2004	EU+US	All industries	Output, factor inputs, prices
OECD-EPL	1985-2003	OECD	---	EPL indicators
WB-CDB	2004-2007	World	--	Entry costs, firing costs, rigidities
BHS	1990s	Selection of OECD, Asia, Lat. Am.	30 industries, mostly manufacturing	Moments and correlations from underlying firm-level business surveys
ONS/Eurostat	2001-2004	13 EU countries	Industries covering the market economy	Moments and correlations from underlying linked firm-level datasets

The empirical evidence combines information from these datasets into two main samples. First, we have a sample from 1991-2004 with the largest available set of countries from EUKLEMS combined with the OECD-EPL data. This consists of eighteen countries, including most Euro countries, some new EU countries, and the US. In the tables below this sample is listed as ‘All’. Next, we have a subset of eleven countries from the EU (thus without the US), that is labeled ‘ONS’.

EPL and productivity

While we have no direct way to measure the actual degree of experimentation undertaken in an industry, we do have information on the productivity distribution of firms, in particular the productivity of the best quartile of firms relative to mean firm-level productivity. Further, we know some moments of the distribution of employment and output growth rates. Of course, the measures are endogenous, and in particular may be affected by the employment protection rules in each country. For our empirical work, we therefore use, as a proxy for the ‘distance to frontier’ indicators related to experimentation at the frontier in countries with lax employment protection, namely the

US or the UK.¹⁹ These indicators are pulled from the BHS or the ONS dataset and are averaged over time. Next, these are turned into an ordinal index across industries, providing the ‘distance to frontier’ measure. The measure considered follow quite naturally from our idea of what it is about the frontier industries that make them require experimentation in order for firms to really succeed. First, we look at how far ahead the best firms in an industry are from average firm-level productivity. Another measure is simply the standard deviation of the industry level productivity distribution. Finally, in some specifications, consistent with work by Samaniego, Gust and Marques, and Bartelsman and Hinloopen, but also fitting nicely in new results by Brynjolffson, we look at adoption and intensity of use of broadband internet by firms in each industry in the U.K.

The first results are presented for a standard production function regression of the following general form:

$$V_{c,i,t} = \alpha + \beta_1 L_{c,i,t} + \beta_2 K_{c,i,t}^x + \beta_3 K_{c,i,t}^{IT} + \gamma I_{c,t} \times F_i + \sum \delta_j D_j + \varepsilon_{c,i,t}$$

where $I_{c,t} = EPL_{c,t}$ or CDB_c

Where V is (log) real, ppp-adjusted, value added, L is (log) of hours worked, K is (log) non-IT and IT capital service flows, respectively, I is the regulatory indicator and F is the proxy for industry distance to frontier. The parameter γ measures the effect of the regulatory environment (interacted with frontier indicator) on TFP. Depending on specification, fixed effects in various dimensions are swept out with dummy variables, D. The subscripts denote whether the variable varies by country, c, industry, i, and time, t.

In table 4, column (1) shows the results where the EPL index for regular contracts is not interacted. The dataset used is the ‘All’ sample for the period 1991 through 2004, while fixed effects for industry, country, and time are controlled for. The coefficients for the primary factors labor and capital are similar to those seen in previous work with similar

¹⁹ Since firm-level productivity indicators in the US only are available for manufacturing industries, we also use these proxy indicators from the UK, which has the least restrictive employment protection in the EU.

datasets. Possibly, the coefficient for capital is downwardly biased owing to its pre-determined nature and to endogeneity through unobserved productivity shocks, even

Table 4

Dependent Variable: Log real value added

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log hours	0.50 (44.2)	0.50 (42.4)	0.67 (34.4)	0.67 (34.5)	0.54 (31.7)	0.77 (29.0)	0.54 (17.2)
Log cap.l svcs (non-IT)	0.25 (40.2)	0.25 (38.7)	0.21 (18.0)	0.21 (18.0)	0.23 (26.6)	0.18 (12.4)	0.25 (14.1)
Log IT-capital svcs	0.12 (21.0)	0.12 (20.4)	0.13 (11.4)	0.13 (11.3)	0.15 (18.5)	0.12 (7.8)	0.18 (11.0)
Employment protection	0.02 (0.9)	-0.03 (3.48)	-0.03 (2.25)	-0.02 (1.68)	-0.05 (3.92)	-0.10 (4.85)	-0.09 (3.42)
interacted with:	---	p4/p	p4/p	p4/p- USA	p4/p	p4/p	p4/p
R-sq	0.97	0.97	0.97	0.95	0.94	0.97	0.96
Deg.F.	5034	4704	2173	2173	2861	1320	836
Fixed effects	c,i,t	c,i,t	c,i,t	c,i,t	c,i,t	c,i,t	c,i,t
Sample	ALL	ALL	ALL-mfg	ALL-mfg	ONS	ONS-mfg	ONS
Start year	1991	1991	1991	1991	1991	1991	2001

(t-stats in parenthesis).

after controlling with fixed industry effects. However, it would be difficult to imagine how the EPL indicator could be endogenous through the channel of unobserved, non-fixed-effect, productivity shocks, so no such bias is expected. The coefficient on EPL is insignificant. This, also is in line with the inconclusive results from regressions using a variety of specifications (see, e.g., Bassanini and Venn, 2007). Further, a priori theoretical considerations of possible effects could lead to a positive correlation (worker training, effort) or a negative one (shirking, firm and worker selection, lowering of exit threshold). A rich literature on these effects may be found in e.g., Acemoglu and Shimer (2000), Aghion and Saint-Paul (1998), Bertola (1992), Chari et al. (2007), Micco and Pages (2006).

The next column, (2), follows the logic of our storyline, and interacts the EPL indicator with a distance indicator. The indicator used shows the average (labor) productivity of the top quartile of firms in the UK, relative to the unweighted mean firm-level productivity. This measure is averaged over the years available for each industry (2001-2004) after which an ordinal rank is computed for each industry, with a higher rank going to industries where the most productive quartile is further removed from the mean. The estimates for the primary factors are little changed, while the EPL effect now becomes

significantly negative. Column (4) uses a similar measure, but for US manufacturing sectors for the year 1997. Because the sample shifts to manufacturing the specification of column (2) is replicated in column (3) for the manufacturing sub-sample. In both (3) and (4), the effect of EPL on total factor productivity remains significantly negative.

In the ‘all’ sample, the US is a clear outlier in terms of the EPL index. Further, various timevarying indicators of interest for later tests only are available for the ‘ONS’ sample. In order to improve comparability across specifications, columns (5) through (7) show results for the full ONS sample, the ONS manufacturing sub-sample, and the ONS sub-sample for 2001 through 2004. The EPL effect becomes numerically larger, albeit less precisely estimated.

Table 5 continues with the ONS sample, and compares results with different frontier indicators (none, top productivity, and standard deviation of productivity distribution), and using country, industry, and time fixed effects (columns 1-3), and country interacted with industry, and time fixed effects (columns 4-6). The effect of EPL without interactions is significantly negative in the ONS sample and the two frontier indicators provide similar coefficients for EPL. With the interacted country-industry fixed effects all EPL effects remain significantly negative, but the estimation of the capital output elasticities becomes problematic, as is usually the case in such ‘within’ specifications.

Table 5
Dependent Variable: Log real value added

	(1)	(2)	(3)	(4)	(5)	(6)
Log hours	0.53 (32.5)	0.54 (31.7)	0.53 (32.7)	0.69 (20.7)	0.69 (20.2)	0.70 (21.1)
Log capital svcs (non-IT)	0.23 (27.9)	0.23 (27.9)	0.23 (26.6)	0.08 (3.2)	0.09 (3.2)	0.09 (3.2)
Log IT-capital svcs	0.12 (19.2)	0.12 (18.5)	0.13 (19.1)	0.00 (0.3)	0.00 (0.4)	0.00 (0.30)
Employment protection	-0.34 (3.80)	-0.06 (3.91)	-0.04 (2.96)	-0.19 (3.44)	-0.21 (4.22)	-0.16 (3.40)
interacted with:	---	p4/p	std(p)	---	p4/p	std(p)
R-sq	0.96	0.96	0.96	0.99	0.99	0.99
Deg.F.	3059	2861	3059	2860	2675	2860
Fixed effects	c,i,t	c,i,t	c,i,t	cXi,t	cXi,t	cXi,t
Sample	ONS	ONS	ONS	ONS	ONS	ONS
Start year	1991	1991	1991	1991	1991	1991

A final check of results is done by looking at ‘long differences’. In table 6, the average EPL indicator for the years 1995 through 1997 is used to examine the effect on the growth of productivity for the ensuing years through 2004. To avoid biases resulting from initial period noise, the output and factor input measures are averaged for the period 1995-1997, and for the period 2002-2004, and the growth rates computed for the smoothed data. The first 3 columns do not take out fixed effect, while the last 3 columns control for country effects. Without interactions, EPL is insignificant, while with either frontier measure, EPL significantly lowers TFP growth.

Table 6

Dependent Variable: Long-Difference of averaged Log real value added

	(1)	(2)	(3)	(4)	(5)	(6)
LD hours	0.68 (9.1)	0.67 (9.1)	0.69 (9.4)	0.67 (8.5)	0.65 (8.3)	0.67 (8.8)
LD capital svcs	0.19 (2.8)	0.18 (2.8)	0.18 (2.7)	0.27 (3.9)	0.29 (4.2)	0.28 (4.1)
Empl. prot. (1996)	-0.01 (.51)	-0.02 (2.12)	-0.03 (3.55)	0.27 (1.06)	-0.04 (3.20)	-0.05 (4.95)
interacted with:	---	p4/p	std(p)	---	p4/p	std(p)
R-sq	0.96	0.96	0.96	0.99	0.99	0.99
Deg.F.	411	411	411	397	397	397
Fixed effects	---	---	---	c	c	c
Sample	ALL	ALL	ALL	ALL	ALL	ALL
LONG-Diff	1996- 2003	1996- 2003	1996- 2003	1996- 2003	1996- 2003	1996- 2003
LD(X) = X ₁ -X ₀ , where X ₁ is average of log(x) for 2002-04 and X ₀ is average log(x) for 1995-97						
Countries	Aut, Bel, Cze, Dnk, Esp, Fin, Fra, Gbr, Hun, Ita, Jpn, Nld, Pol, Swe, USA					
robustness:	drop Cze, Hun, Pol, and USA: EPL -.04(1.86) only Aut, Bel, Esp, Fra, Ita, Nld (High EPL countries): EPL -.04 (2.08)					

EPL and Experimentation

While the significantly negative effect of EPL on productivity, especially for industries requiring experimentation, has to our knowledge not yet been shown, it remains the result of a reduced-form, black-box regression. The link from EPL to productivity through its negative effect on experimentation could be tested directly: do industries in countries with higher EPL exhibit fewer features related to experimentation and is this reduction larger in industries closer to the frontier? Table 7 shows the effects of EPL on the standard deviation of the firm-level productivity distribution, on the productivity of firms in the top-quartile of the productivity distribution, relative to mean productivity, and on

the interquartile range of the within-firm employment growth distribution. The underlying moments from the firm-level distributions are computed for each country, industry and year (generally available for 2001-2005).

[The results in Table 7 are suppressed pending release by NSIs, June 2008]

Table 7.

Even though the interacted indicator, denoting which industry is closest to the frontier, is based on firm-level data in the US or the UK, the 'industry' component may make the indicator endogenous to the independent variables in the cross-country panel regressions. To reduce the problem, the frontier indicators (from the US or UK) are never the same

'concept' as the indicator of experimentation used on the left-hand side. So, when the standard deviation of the productivity distribution is on the left hand side, we use the top-quartile-to-mean as frontier indicator, and add the broadband penetration (DSL) as a robustness check. When the top-quartile-to-mean is on the left-hand side, we use the corresponding indicator from the US on the right hand side (thus only allowing the manufacturing sub-sample).

The results for the top two panels of table 7 show that as the 'need' for experimentation gets larger, so does the negative effect of EPL.

The bottom panel of table 7 shows the correlations between the interquartile range of the firm-level employment growth distribution. Here the significant negative effect of EPL on the reallocation of labor, even in the non-interacted case, is as expected and does not by itself point towards a reduction in experimentation. It just means that firms are less able to adjust the workforce to shocks, regardless of industry. When interacted, the negative EPL effect remains, pointing towards a reduction in experimentation as well.

Conclusions

We argue that when political preferences for stability impose exit costs, they particularly discourage firms from choosing innovative approaches which cause more frequent failures, even more than entry costs. What may explain different choices in exit costs ?

A classic interpretation of the difference in firm behavior across the Atlantic is that European institutions created since World War II aimed at promoting a stable economic environment, even at the cost of reducing dynamism. In particular, demand for stability and social insurance has led to less flexible labor market, hindering labor dismissal and the rapid scaling down of operations. Exit costs have discouraged experimenting strategies, and European firms have chosen to follow the technological lead established abroad, usually in the US.²⁰

EU firms have specialized in implementing best practices once established elsewhere, licensing technologies or adopting follower strategies after non-EU industry leaders have trail blazed a path to innovation. EU firms did well in this strategy: by some measures, European manufacturing firms are often as productive or even more so than their US counterpart in established market segments.²¹ Anecdotal evidence suggests that in Europe the best resources may be located in established firms which focus at being good followers; EU firms are often more productive than US firms in established sectors.

Yet two recent trends seriously undermine this model and its economic advantages. First, the recent acceleration in the process of globalization has increased access for developing country firms to knowledge and capital. New producers in emerging low cost countries with greater factor flexibility have significantly cut down their technological delay, and now benchmark their practices directly to the global leader in many sectors in which Europe has a relative specialization. In this race, Europe cannot maintain its relative

²⁰ The picture is somewhat different in sectors where innovation is generally led by incumbent, such as in the automobile aerospace or heavy chemical industry. Here the EU technological delay is distinctively lower or even insignificant, although these sectors still suffer from higher costs, reduced labor flexibility and less experimentation at the

²¹ The service sector lags considerably behind due to limited use of general application technologies, which may reflect political constraints as much as different adoption strategies.

position as a producing area, although its consumers may benefit from this process. Second, the spread of the information and communication technology (ICT) as a general purpose technology has opened up much potential for market experimentation and process innovation, most recently also in mature sectors.

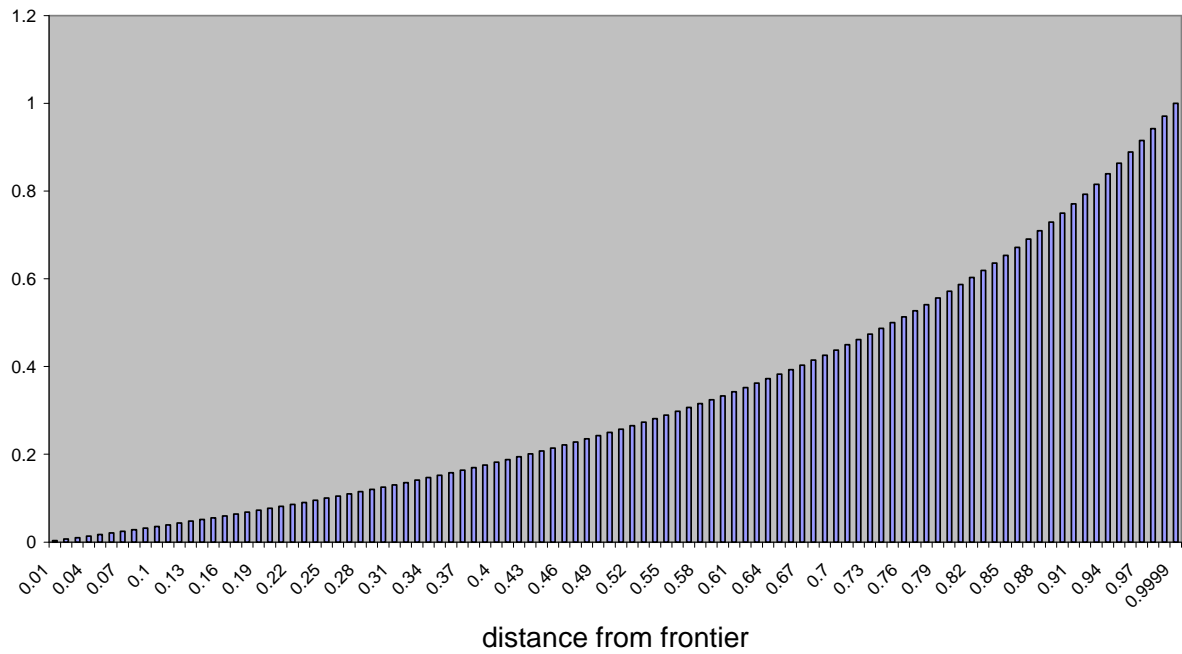
This paper does not seek to explain the causes of the European preference for stable and predictable corporate strategies; these reflect historical circumstances and preferences arising from its historical experiences. Rajan and Zingales (2003) and Perotti and von Thadden (2006) have offered political interpretations; LaPorta et al 2008 offer a legal interpretation). Entry requirements and barriers in Europe have been historically higher than in the US (Lamoreaux and Rosenthal, 2005; Sokoloff and Khan, 2006).

Yet it stresses that institutional rigidities may not be the best form of stability or job protection, as they particularly affect the relative value of innovative versus follower strategies. Thus the comparative high costs of experimentation in Europe, as measure by its exit costs, may condemn its firms to a steady relative decline. A less redistributive system and more labor flexibility may also enable firms to reward high talent better.

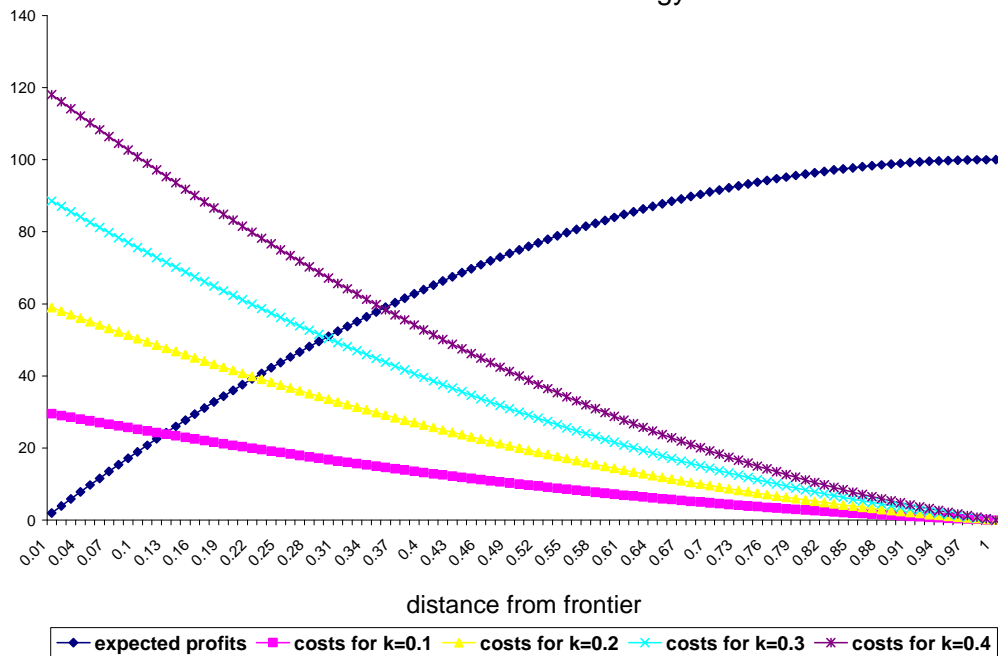
At present, the evidence is that EU firms are specialized in medium innovative sectors, lose gradually high labor skills, and are losing ground relative to emerging countries.

A future goal of ours is to estimate the impact on economic growth rates in Europe relative to the US due to the current difference in experimentation rates. The goal of this effort is to quantify the potential medium term impact of regulatory changes aimed at fostering more experimentation. We calibrate our estimates by simulating a model which describes the dynamic consequences in terms of productivity and economic growth of a slower rate of reallocation across European firms due to lower experimentation rates in product, process and market innovation. This allows assessing the potential difference of an EC wide agenda on this matter, and more generally at engaging a debate in the policymaking arena on structural obstacles to productivity growth and innovation. Our conclusions call for a policy initiative across different aspects of European regulation which hinder experimentation by punishing unlucky attempts at innovation. We include in this list EU-wide educational and research policy, labor markets, competition policy and financial regulation.

Threshold exit cost (normalized by innovator's profits)



Expected profits and costs of innovative strategy



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