

R&D Decisions During the Crisis: Firm-Level Evidence for Selected Eastern Countries

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Recent empirical work finds that R&D expenditures, particularly from the business sector, tend to move in parallel with gross domestic product (GDP).¹ Comin and Gertler (2006) and Barlevy (2007) provide recent documentation on the procyclicality of R&D. In the Eastern Europe and Central Asia (ECA) region, the region most negatively affected by the recent financial crisis according to World Bank (2010), the evidence suggests that the crisis has already affected the economic performance of R&D performers.² Correa and Iooty (2011) focus on sales as a particular measure of firm's economic performance and use a panel data—from the World Bank's Financial Crisis Survey (FCS)—to investigate the differential impact of the global economic crisis on sales performance of R&D (versus non-R&D performers) firms in selected Eastern European countries. The authors show that the decline in sales growth of R&D performers was significantly larger when compared to non-R&D performers, even when controlling for different idiosyncratic firm characteristics.³

Data from the same FCS showed that R&D spending declined in some ECA countries in 2009. On the other hand, the same data also pointed out that, surprisingly, other firms have increased their R&D efforts during the recent economic slowdown. What could then explain R&D decisions during the crisis? This note uses FCS data and tries to shed light on the determinants of R&D spending in Eastern Europe (Bulgaria, Hungary, Latvia, Lithuania, Romania and Turkey) in 2009.

Literature review

A number of theories have been developed to explain why R&D spending is procyclical. The most common view is that R&D declines during economic downturns: first, because it is mainly financed from cash flow, which contracts in recessions, and, second, because firms face difficulties in tapping into external sources of funding to support their investments in general and their R&D spending, particularly. As a result, firms tend to first cut long-term and high-risk innovation while reorienting their R&D efforts toward short-term and low-risk innovations (OECD 2009). When trying to explain the procyclicality of R&D, Aghion et al. (2005) follow the same idea but go further, constructing a model focusing on the cyclical

behavior of the composition of investment. The authors argue that with imperfect credit markets, long-term investments, such as R&D investment, become procyclical. This is not so much because borrowing constraints limit the ability to invest, but because tighter constraints imply a higher risk that long-term investments can be interrupted by some ex-post liquidity shock. This would, in turn, reduce a firm's willingness to engage in long-term investment ex ante, and all the more so in recessions, when scarce liquidity becomes an additional problem. The authors confront these predictions with a cross-country panel and find evidence that tighter financial constraints make R&D investment and growth more sensitive to shocks.

Barlevy (2007) documents that R&D remains procyclical even for firms that are relatively financially unconstrained, and shows evidence that other investments in productivity that are just as vulnerable to credit constraints (such as training and machine investments) do not appear to be procyclical. Therefore, there must be something about R&D that makes it particularly prone to being procyclical independent of credit market conditions. The author then develops a stochastic Schumpeterian growth model in which (though it is socially optimal for R&D to be concentrated during downturns when R&D tends to be

less costly) the short-term behavior of innovators leads to a procyclical allocation of resources to R&D. To be more specific, as the incentives to engage in R&D depend on the short-term benefits of successful innovation, and as profits are highly procyclical, innovators chasing short-term profits would develop more R&D in booms than is socially optimal. Barlevy (2007) then explores the welfare implications of such inefficiently procyclical R&D and argues that the distorted timing of R&D increases the cost of achieving productivity growth.

In Francois and Lloyd-Ellis (2009) the authors develop a model to explain why R&D inherently evolves in a procyclical manner without relying on either the existence of tightening credit conditions during downturns or on the short-term behavior of innovators. The authors decompose the innovation process as comprising three phases: R&D, commercialization and implementation. R&D is modeled as a costly process that generates potentially productive ideas whose application and timing are uncertain. Commercialization is the next phase when the process of matching those ideas with particular applications takes place; it is modeled as a costly search by entrepreneurs who intend to obtain a share of the expected profit. The last phase is implementation, when commercially viable ideas are implemented in production. According to the model, by treating the R&D phase distinctly from the commercial application phase and by allowing the implementation of commercially ready products to be another strategic choice of firms, the recurring pattern that emerges is that commercialization is concentrated during downturns while the incentive to undertake R&D evolves in the opposite way. This model is then compatible with Schumpeterian models in the sense that downturns induce innovative activities, but only in the form of commercialization. R&D investment, however, is procyclical.

Data Analysis

For this analysis, we combine the World Bank's Enterprise Survey (ES) of 2008 and the second round of the World Bank's Financial Crisis Survey (FCS) covering Bulgaria, Hungary, Kazakhstan, Latvia, Lithuania, Romania and Turkey.

The ES 2008 is a comprehensive database of 3,363 firms from manufacturing, retail and other service sectors in the above countries that provides information on firm characteristics, various performance measures and the business environment, most of which refer to fiscal year 2007. The ES 2008 sample in each country is stratified by firm size, sector and region and is representative of the private non-agricultural formal economy in that year.⁴ The FCS constitutes a panel of longitudinal respondents originally from the ES 2008, who were interviewed in three rounds: June 2009, January 2010 and June 2010.⁵ From the FCS, we used only the second round because

	ES 2008 (wave 0)	FCS Jan. 2010 (wave 2)
Turkey	1,152	606
Romania	541	304
Kazakhstan	544	233
Hungary	291	152
Latvia	271	221
Lithuania	276	224
Bulgaria	288	152
Total Obs.	3,363	1,892

Source: Enterprise Survey and Financial Crisis Survey

it is the first one to include questions on R&D spending referenced to a whole year (2009).⁶ Table 1 shows the number of firms included in the sample of ES 2008 (the pre-crisis scenario) for each country and the number of firms included in the second wave of FCS.

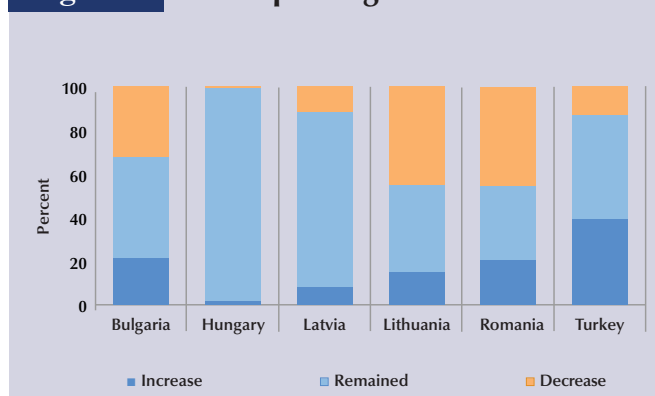
In order to assure that the FCS wave of the panel is representative of the population in the according period, inverse probability weights were estimated in each country through the adjustment of the ES 2008 weights for non-response. With these adjusted weights, it is then possible to estimate statistics that are representative for the non-agricultural private economy within each country for the according period.

The January 2010 FCS asked firms if their R&D spending had increased, decreased or remained constant in 2009. Data suggest that the lingering uncertainties in credit markets seemed to have shaken some firms' commitments to R&D in most of surveyed countries. It showed that among the firms that were performing R&D before the crisis, the proportion of firms that reduced their R&D spending over the period under review was higher than the proportion of firms expanding R&D. On the other hand, in Turkey and Hungary the opposite happened: the likelihood of firms having increased R&D efforts was higher than the likelihood of firms having decreased R&D efforts (figure 1).

Overall, the fact that in some countries the likelihood of decreasing R&D efforts is higher than the likelihood of increasing R&D is not surprising. At first sight, the decreasing R&D trend confirms the procyclical bias of R&D. On the other hand, the fact that firms managed to expand their R&D activities, particularly in Turkey and Hungary, is somewhat unexpected in the context of the economic downturn, and it could suggest that firms in these countries are pressing an anticyclical R&D path. In order to solve this R&D puzzle, we model the answers of firms to the question of change in R&D spending using an ordered probit model.⁷

Using data from the second round of FCS and from ES

Figure 1 R&D spending in 2009



Source: Financial Crisis Survey

2008, two separate models were run: one focusing only on firms from FCS that used to perform R&D before the crisis (according to ES) and the other relying on all surveyed firms in FCS. We account for the following pre-crisis firm characteristics as controls: size (small, medium and large),⁸ age (young and older),⁹ trade orientation (exporter and nonexporter),¹⁰ ownership status (foreign owned and nonforeign owned)¹¹ and a quality certification dummy. To control for differences across firms in their access to finance before the crisis, we consider two alternative measures: if a firm has a line of credit or a loan; and the share of investment financed externally.

The overall results show that there is no difference between the two samples of firms, which basically points out that there is no differential impact of the crisis on R&D decision among firms that performed R&D before the crisis and those that decided to do R&D after 2008. Concerning the specific variables, we first see that export-oriented firms were more likely to increase their R&D efforts in 2009, a result that was robust to the group of firms considered, and to the measure of access to finance considered. There is also evidence that firms with quality certification were inclined to increase R&D during the crisis. This was valid for both samples of firms, and in two out of the four regressions, the variable has showed to be statistically significant. The explanation for this anticyclical behavior might be related, first, to a reorientation of R&D efforts toward short-term and low-risk innovations. Second, it might be related to the way these two particular groups of firms (export-oriented firms and firms with quality certification) value R&D and how they use the strategy of increasing their R&D as a way to gain a competitive advantage later on.

The literature suggests that the decision to export is often accompanied by R&D investments, as exporting firms, once acting in a larger market, are in a better position to reap the benefits from potential gains from productivity growth resulting from technical change (see for instance, Aw, Roberts and Xu 2008). Therefore, as R&D is usually

strategic to export-oriented firms, it might be even more important under a crisis context when they must keep the high intrinsic value of the goods they supply in a tight international market. By the same token, for firms that have quality certification, which proxy technology innovation, spending in R&D might be an important strategy to compete in the market, so these firms might have used the fact that opportunity cost of R&D decreases during a downturn to reinforce their R&D spending in order to gather the benefits in the upswing to come.

Results also indicated that large firms were more inclined to reduce R&D efforts during the crisis when compared to small firms. This variable was statistically significant when considering only the firms that used to perform R&D before the crisis. Two stylized facts in the literature on innovation can help to understand this result. First, larger firms are more likely to engage in R&D, and among firms engaged in R&D, the amount spent on innovative activities increases with firm size (Cohen and Klepper 1996). Second, studies that estimate the productivity of R&D, such as Acs and Audretsch (1991), suggest that innovations produced per dollar of R&D are higher in smaller firms. Hence, that larger firms were more inclined to reduce R&D spending might be because the amount they spend in R&D is normally higher than small firms, so even if they cut R&D expenditures as a way to reorient their portfolio toward low-risk innovation projects, they will be still performing some R&D. Small firms might be less inclined to reduce R&D because they are reluctant to affect their higher productivity of R&D.

Finally, we find that firms that had access to credit before the crisis were more inclined to reduce their R&D efforts during the economic downturn, a result that was robust to the measure of access to finance used (access to credit or share of investments financed from external funds). For these firms, the recourse to external sources of finance during the crisis might have had possible effects on the funding of R&D. As argued by Hall and Lerner (2009), it is certainly the case that firms—especially the established and large ones—prefer to use internally generated funds for financing R&D investment, as this kind of venture often faces high financing costs due to information asymmetry and/or agency problems. This said, even though R&D tends to be financed more by retained earnings than by external sources, the credit crunch occasioned by the financial crisis might have forced firms to reallocate the use of cash flow—also contracted in recessions—to support other investments than R&D activities. Therefore, the exogenous changes in the supply of external finance might have led to changes in R&D. These results confirm the literature on the timing of R&D because it shows that R&D decline during the crisis is related to, among other factors, financial constraints.

Conclusions

Recent empirical work finds that R&D expenditures, particularly from the business sector, tend to move in parallel with GDP. Data from the World Bank's Financial Crisis Survey showed that R&D spending declined in some countries of the ECA region in 2009. On the other hand, surprisingly, the same data revealed that firms in Turkey and Hungary have increased their R&D efforts during the recent economic slowdown. What could then explain R&D decisions during the crisis? In this note we used data from this survey and also from the World Bank's Enterprise Survey and tried to shed light on R&D spending in Eastern Europe (Bulgaria, Hungary, Latvia, Lithuania, Romania and Turkey) in 2009. Results show that firms that increased their R&D spending during the crisis were export oriented and had quality certification. On the other hand, large firms and those with access to credit were inclined to reduce their R&D efforts in the same period.

Notes

1. As defined by the *Frascati Manual 2002* (OECD Publishing, 30), R&D "comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge and the use of this stock of knowledge to devise new applications." Once resulting in new goods, new processes and new knowledge, R&D can be considered a major source of technical change if one assumes that it is difficult for substantial advances in technology to occur without this systematic activity, even though theorists acknowledged that R&D is not the only source of new technology in modern industrial economies.
2. R&D performers are those firms that have engaged in R&D activities before the crisis (during the 2005-2007 period) according to Enterprise Survey data.
3. These results were robust to the estimator applied and to the way used to measure innovation (introduction of new product/process or R&D activities).
4. Detailed information on the Enterprise Surveys can be obtained at <http://www.enterprisesurveys.org>.
5. Participation in FCS was voluntary and the entire original sample of the ES 2008 was contacted to determine whether these firms were still in existence or if they had failed and/or become inactive in each FCS wave.
6. The third round of the FCS (conducted in July 2010) also included R&D questions, but they refer not to the whole previous year but to the first half of 2010, and so the answers could be biased.

7. In this case, though the outcome is discrete, multinomial logit or probit models would fail to account for the ordinal nature of the dependent variable. In the order probit model, standard errors were clustered to allow for possible correlations in R&D decisions within the same country, and all of the models' specifications control for two-digit ISIC sector fixed effects to account for differences across sectors in the incentives of firms to perform R&D.
8. Small (≥ 5 and ≤ 19 employees), medium (≥ 20 and ≤ 99) and large (≥ 100). The omitted category is Small
9. It is a dummy controlling for firms with less than or equal to 5 years old, as in 2007.
10. Export orientation is defined as having over 10 percent of sales as direct exports, as in 2007.
11. Foreign ownership is defined as having over 10 percent of share in firm ownership, according to information from 2007.

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