Financial Constraints and Firm Dynamics in the Great Recession

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Abstract:

Recessions are conventionally considered as times when low-productivity firms are driven out of the market. However, in the aftermath of the Great Recession, economic growth in most advanced economies has been unusually anaemic. In an attempt to explain this poor economic performance, we highlight the reduced efficiency in resource reallocation process during deep recessions. The suspect is financial constraints faced by firms. In this study we build a model in which recessions tend to be cleansing only in the absence of strong financial constraints. Since the best projects are deemed to require a higher level of investment, there is a bias towards the funding of projects that are less productive and less financially demanding if times are tight. Using Portuguese longitudinal data for manufacturing, construction and services industries, we do find a spike in firm exit in 2008–2012 vis-à-vis the 2004–2007 pre-recession period. We also found a considerable fraction of high-productivity firms shutting down. Our selected proxies for strictness in credit markets reveal that in deep recessions they are highly associated with increased firm exit and lower employment creation. Our results show that credit market stringency in conjunction with an unfavourable economic cycle is likely to generate a long-lasting destructive process.

Keywords: Entry and exit; firm's productivity; aggregate productivity growth; financial constraints; great recession.

JEL Classifications: D24 · L11 · L25 · L26 · L60.

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1 Introduction

Recessions are conventionally considered as times when low-productivity firms are driven out of the market at a more accelerated pace so that resources are freed to more productive uses. However, in the aftermath of the Great Recession began in 2008, economic growth in most advanced economies has been unusually anaemic. This recession is maybe different from previous recessions in the sense that recessions that are associated with financial crises not only tend to be both deeper and longer lasting in terms of output losses, but also take several years to make a full recovery (Cerra and Saxena, 2008). Although researchers have documented that there are a number of channels, both cyclical and structural, through which a weakened financial system spills over unfavourably into the economy, in this paper we highlight the reduced efficiency in resource allocation process during the Great Recession, possibly due to financial constraints faced by firms (Foster et al., 2016; Benmelech et al., 2017).

Why severe recessions associated with financial crises result in permanent losses of output is probably less well understood. The economic theory offers conflicting predictions on how demand downturn and strict financial constraints affect firm behaviour. The Schumpeterian theory of creative destruction claims that recessions are times of "cleansing", when outdated or relatively unprofitable techniques and products are more likely to be driven out of the market, so that the productivity-enhancing reallocation becomes countercyclical (Caballero and Hammour, 1994, 1996). But the cleansing effect can be reversed by other effects, such as financial or labour market frictions (Barlevy, 2002, 2003; Caballero and Hammour, 2005). Barlevy (2003), for example, has pointed out that crises can impair the cleansing process by exacerbating credit market frictions, which may hurt more productive firms disproportionately as such firms are likely to have higher financing constraints.

In this paper, we investigate how the market selection mechanism works in deep recessions, especially whether credit frictions can reverse the cleansing effect due to resource misallocation between surviving firms and a lack of creative destruction. Our central hypothesis is that during financial crises resource allocation are mainly driven by financial constraints rather than by market fundamentals such as productivity, demand or costs (Giroud and Mueller, 2017). When access to bank loans is constrained, not only potentially profitable projects of financially constrained firms are not undertaken, but also banks may be tempted to fund "zombie" firms in an effort to protect their own balance sheets, delaying the death of inefficient firms (Peek and Rosengren, 2005; Caballero et al., 2008).

Our theoretical framework builds upon Cooper and Haltiwanger (2006)'s model, modified to allow for invest in different projects as in Barlevy (2003), financial frictions and for macroeconomic fluctuations. In particular, the 2008–2013 Great Recession in Portugal, for its nature and length, provides a useful testing ground for examining the linkage between financial crises, resource reallocation and productivity gains.

The remainder of the paper is organized as follows. Section 2 briefly surveys the literature on the effect of deep recessions on firm dynamics. Section 3 analyses the resource reallocation and productivity growth during the Portuguese Great Recession. It also serves as a motivation to our modelling strategy in section 4, which discusses a framework where financially constrained firms decide to continue or exit the industry and then whether to invest or not. Section 5 presents main empirical results and their discussion, while Section 7 concludes.

2 What do we know about cleansing effects of deep recessions?

The empirical literature has documented several stylized facts on firm dynamics using micro firm-level data, but no pattern has been established in deep recessions, simply because they are a rare event (Geroski, 1995; Caves 1998). Hallward-Driemeier and Rijkers (2013) evaluated the effect of the 1997 Asian crisis using plant-level data from Indonesia. Despite a spike in firm exit and an increased employment reallocation rate, no evidence supporting the cleansing effect hypothesis was found. Productivity was indeed less critical for firm survival during the crisis, while the risk of exit increased for those firms financially constrained. Giroud and Mueller (2017), in turn, found that U.S. establishments of more highly levered firms exhibit during the

Great Recession both significantly larger declines in employment and increased risk of shutting down. The results are not driven by either firms being less productive or having expanded too much prior to the Great Recession. Similar results were found by Carneiro et al. (2014) and Carreira and Teixeira (2016) for the 2008–2013 Great Recession that hit the Portuguese economy after the 2008 financial crisis. These authors observe that financially constrained firms are more vulnerable to severe credit restrictions generated by the crisis and that firms facing higher financial constraints destroyed jobs and exited at higher rates than those not financially constrained. Carneiro et al. (2014) and Carreira and Teixeira (2016) also provided evidence showing that it was on the "catastrophic" job destruction flows, with nearly half of these flows being due to firm exit, that the Great Recession differed the most from the past business cycle downturns.

Firm mobility is expected to have an impact on aggregate productivity growth, with changes in industry-level productivity arising either from within-firm productivity growth or resource reallocation. Griffin and Odaki (2009), using data on large manufacturing firms between 1969 and 1996, found that the weak Japanese productivity growth during the long 1990s stagnation was due to a significant reduction in the within-firm effect rather than to an absence of cleansing. Foster et al. (2016) found that the 2007–2009 Great Recession of the U.S. has been less productivity enhancing in comparison with previous recessions and, in particular, that the extent of the cleansing effect among manufacturing firms was less pronounced than it was expected.

3 Reallocation during the Portuguese Great Recession

3.1 The Portuguese crisis

In the late 2000s, the Portuguese economy was taken by the financial storm that broke out in September 2008 in the U.S. and spread with strong shock waves throughout Europe, with the banking system and the economy at large suffering heavy losses. In particular, over 2008–2013, the Portuguese real gross domestic product (GDP) decreased, on average, by 1.5 percentage points annually, with a peak in 2012, at -3.3%, after austerity measures implemented by the 2011 IMF Memorandum of Understanding. Furthermore, the financial-sovereign debt crisis and the subsequent measures of the Memorandum triggered both a dramatic increase in the unemployment rate that more than doubled the pre-crisis level and propelled a significant reduction in the number of firms as shown in Figure 1.

[Figure 1 near here]

The Great Recession also brought severe credit restrictions for the Portuguese non-financial firms. Loans to non-financial firms dropped by 25% between 2008 and 2009, then maintaining that level unchanged over the crisis period (in Figure 2). Moreover, in order to avoid having to report impaired loans as nonperforming, during the Great Recession banks often followed a policy of forbearance with their problem borrowers, engaging in sham loan restructurings that kept credit flowing to otherwise insolvent borrowers.

[Figure 2 near here]

3.2 Entry and exit patterns

Figure 3 shows how the number of firms evolves differently across industries.[1] There are two industries that present a strong downward trend over 2004-2012 period: *Manufacturing* and *Transportation*. During the Great Recession, the number of firms only rises in three industries: *Accommodation*, *Communication* and *Other services*.

[Figure 3 near here]

The sample is divided into two sub-periods: pre-recession (2004–2007) and Great Recession (2008–2012). Table 1 reports the average entry and exit rates by industry, while Figure 4 plots their evolution for the entire economy. As it is apparent, there is quite a substantial firm mobility: on average, 9.9% of the firms operating in year *t* were not producing in *t*-1, while 10.1% of firms operating in *t*-1 do not produce at all in *t*, which implies a turnover rate of 20.0%. The annual entry and exit rates vary considerably across industries. In particular,

[1] The description of our data is given in Appendix A.1.

Real estate presents the highest average entry rate, at 18.4%, while the lowest entry rate is in *Transportation*, at 5.0%. These industries also have the highest and the lowest average exit rates, at 19.2 and 7.3%, respectively. These figures are much in line with those found for other European countries (e.g. Caves 1998; Bartelsman et al. 2005).

[Table 1 and Figure 4 near here]

Comparing the two selected periods, the main picture that emerges is that while the Great Recession seems to have no obvious impact on the average entry rate, the average exit rate is about 1.3 percentage points higher than in the crisis period, with a peak in 2011, at 12.7%. One explanation for this pattern of entry can be that up to the financial crisis was a time of stagnation and poor growth in the Portuguese economy. Looking across industries, *Real Estate* and *Construction* show the highest exit rate difference between the two sub-periods, 2.7 and 2.6 percentage points, respectively.

Panel (a) of Table 2 contains the survival rate for each entry cohort, that is, the ratio of the number of surviving firms to the corresponding number of entering firms by entry cohort, while panel (b) reports the hazard rate or the ratio of the number of deaths each year to the number of surviving firms in previous year by entry cohort. There are three notable results. First, survival rates at birth are low: on average, around 30% of entrants fail within the two subsequent years and only approximately half of the entrants in a given year survive beyond the fifth year. This pattern is robust to sector disaggregation, but with seemingly differences: in *Real Estate* industry only one third of entrants in a given year survive beyond the fifth year, while in the case of *Transportation* the corresponding rate is 58% (in Table A3). Second, the hazard rate for entrants decreases slightly with age. Hazard rates in panel (b) of the table indicate that entrants exit in the first (fifth) year of life at an approximately rate of 16.8% (12.7%). This pattern is highly consistent across industries. Finally, the crisis seems to have an impact on the survival probability of new firms, with the corresponding survival rate in the first year life decreasing 3.9 percentage points. The hazard rate increasing in 2011 by a notorious 4.1 percentage points for all entry cohorts.

[Table 2 near here]

3.3 The productivity level of entering and exiting firms

Given the observed resource reallocation process, the issue is whether the crisis generates productive cleansing or counterproductive destruction. Due to large differences in TFP measures across industries, we need to control for industry heterogeneity in any comparison exercise across industries. Figure 5 shows the normalized productivity gap among continuing, entering and exiting firms. As can be seen, the productivity of both continuing and entering firms is higher than that of exiting firms. In other words, less productive firms have been replaced by more productive units. Furthermore, the productivity gap between new firms and exiting firms seems to be higher in the Great Recession. The productivity level required for entry during the crisis is even higher than that of continuing firms. As suggested by Aghion et al. (2007), it seems therefore that due to stringent financial constraints, the financial crisis may have inhibited potentially good investment projects to flourish, thus reducing aggregate productivity growth.

[Figure 5 near here]

Table 6 shows the average productivity for entering/exiting firms relative to continuing firms of the relevant size group—following the European Commission enterprise size classification, we have micro firms (i.e. firms with less than 10 employees), small firms (10 to 49 employees), medium firms (50 to 249 employees) and large firms (250 or more employees). On this occasion, the TFP measures should be interpreted as the deviation from the TFP of continuing firms of the same size group (industry-year-size average). One interesting finding is that the average productivity of exiting microenterprises is lower than that of continuing firms, while in the case of medium/large firms there is a positive productivity gap in a significant number of sectors, suggesting a failure of the market selection mechanism. Indeed, according to the cleansing argument, increased selection created by falling demand is supposed to eliminate low-productivity firms, while high-productivity firms should be expected to engage in productivity-enhancing investments to maintain their competitive position. As suggested by Barlevy (2003), one plausible explanation can be that the largest (and eventually most productive) projects face tighter financial constraints, since in recessions it is hard to find lenders willing to provide large amounts of credit, and so projects that require less credit might have a higher chance of survival regardless of their underlying efficiency.

[Tables 3 near here]

3.4 The impact of firm dynamics on aggregate productivity growth

To assess whether productive cleansing or counterproductive destruction is dominant, we decompose the aggregate productivity growth using an extended version of the Olley and Pakes (1996) decomposition method proposed by Melitz and Polanec (2015)—the dynamic Olley-Pakes decomposition hereafter:

$$\Delta P_t = \Delta \overline{P}_{Ct} + \Delta cov_{Ct}(\theta_{it}, p_{it}) + \theta_{Et}(P_{Et} - P_{Ct}) + \theta_{X(t-\tau)}(P_{C(t-\tau)} - P_{X(t-\tau)}), \tag{3.1}$$

where P_t represents the industry productivity level in year t; Δ denotes changes between $t-\tau$ and t; and C, E, and X denote the group of continuing, entering, and exiting firms (the group of continuing firms comprises all existing firms in the beginning of the year that remain active throughout the year). θ_{it} is the market share (i.e. the real gross output share) of the i^{th} firm in year t and p_{it} is the corresponding productivity level (i.e. firm-level total factor productivity, as explained in section 3.4 below); θ_{gt} is the share of group g and P_{gt} and $\overline{P}_{gt}$ are the corresponding weighted and unweighted average productivity (g = C, E, X). The first term on the right-hand-side of Equation (3.1)—the "within" term—captures the contribution of within-firm productivity changes of continuing firms. The second term—the "covariance" term—reflects the inter-firm resource reallocation towards more productive continuing firms. The last two terms capture the contribution of entering and exiting firms, respectively. The entry (exit) contribution is positive if the productivity level of entering (exiting) firms is higher (smaller) than the productivity level of continuing firms in the corresponding year.

Since the process of creative destruction may take time, the decomposition was conducted using two four-year periods, that is, 2004–2008 and 2008–2012. The result of the dynamic Olley-Pakes decomposition exercise for the aggregate manufacturing sector is given in Figure 6. The aggregate TFP growth rate remained more or less constant across the two periods, at 1.2% and 1.1%, respectively. Note that according to the cleansing paradigm one should expect a countercyclical productivity growth as a result of the presumably dominant contribution in recessions of the covariance and exit terms, on the one hand, and a reduced impact of the within and entry terms, on the other. The results in Figure 6 are, however, only partially consistent with the cleansing hypothesis. The strong increase in the covariance term during the crisis suggests that firms with a large decline in productivity have a higher contraction in output as well. In turn, the (large) negative within term indicates that the crisis does generate a sizeable counterproductive destruction. However, the exit term is negative, which suggests that exiting firms were relatively more productive than continuing firms.

[Figure 6]

Overall, the data do not seem to clearly support the cleansing effect. Even if low-productivity continuing firms contract market shares and new firms are relatively more productive than continuing firms, a result that is favourable to the cleansing hypothesis, there is a non-negligible number of high-productivity firms that do actually exit, which is a rather clear confirmation of counterproductive destruction hypothesis. These results are also in line with those reported by Hallward-Driemeier and Rijkers (2013) for the 1997 Indonesian crisis.

4 A model of financial frictions and resources allocation

This section presents our theoretical model of an entrepreneur/firm that has many projects (Caballero et al., 2008). Our goal is to analyse how financial frictions interact with the firm's optimal allocation of capital across projects. The model builds upon that of Cooper and Haltiwanger (2006), but it differs in that a firm can invest in different projects. (We interpret the projects as alternative techniques of producing a single good.) As in Barlevy (2003), we assume that more productive projects require more funds and generate less collateral to borrow money. Given that collateral correlates negatively with the reliance on external funding, financial market frictions disproportionately benefits high collateral/low productivity projects. For example, in a context of tighter financial constraints, R&D-intensive projects are disproportionately harmed. In contrast, projects which have low R&D intensity should not be adversely affected.

Consider a monopolistically competitive firm with N different types of projects, indexed by $n \in \{1, \ldots, N\}$, with each project requiring a distinct amount of investment and consequently of borrowing. Investment decisions are made on a project-by-project basis, without any interaction between them. Projects that require more investment are also more productive and able to generate more profits. In every period new and more productive projects arrive. At any period t, t = 1, 2, …, T, firms maximize the present value of net cash flows, V. (For better readability, in the remainder of the section, we omit time subscripts and denote variables in $t + 1$ by a prime, except if clarity requires otherwise.) In the case of an incumbent, state the (revenue) productivity shock and the capital stock of each project, denoted by z_n and K_n, respectively, it must decide whether to continue or to exit the industry in the next period. Then the firm decides whether or not to invest in a project and how much to invest and borrow. Firm re-entry is not allowed.

Every period there is a constant mass $E>0$ of prospective entrants who observe aggregate productivity shocks A. Then they receive a signal about their productivity draw z. Entrepreneurs that decide to enter the industry pay an entry cost $c_e \geq 0$. The timing in period t is summarized in Figure 7.

[Figure 7]

4.2 The incumbent's problem

Each project n is characterized by a time-invariant TFP shock, denoted A_n, which could include a firm-specific component that is common to all projects. Given the beginning-of-period capital stock K_n, the operating profits of project n, $\Pi(z_n, K_n)$, are given by:

$$\Pi(A_n, K_n) = \max_{L_n, M_n} \{R(A_n, K_n, L_n, M_n) - w_L L_n - w_M M_n\}, \tag{4.1}$$

where $R(A_n, K_n, L_n, M_n)$ denotes revenues given capital, and variable labour and materials inputs (L_n and M_n, respectively) optimally chosen. The prices of labour and materials inputs (w_L and w_M respectively) are assumed to be constant. The formulation for total variable cost clearly assumes there are no costs of adjusting variable inputs. Assuming a constant returns to scale (CRS) Cobb-Douglas production function and a constant-elasticity output demand function, the maximization of profits with respect to the variable inputs leads to the following reduced form profit equation (the formal proof is given in Appendix B):[2]

$$\Pi(z_n, K_n) = z_n K_n^{\theta}, \tag{4.2}$$

where the revenue productivity shock z_n is the scaled project TFP given by the Equation (B.8) in Appendix B and θ is the scaled production elasticity of capital given by (B.9).

Capital depreciates at the rate $\delta \in (0, 1)$. The capital stock of project n evolves over time according to the equation $K_n' = (1-\delta)K_n + I_n$, where I_n denotes the current level of investment in the project n. Adjusting the capital stock by I_n implies an additional cost of $C(I_n, K_n)$. Indeed, firms face various non-financial costs when adjusting its capital stock. For example, investment activity disrupts current business operations as a result of the need for firm restructuring, worker retraining and organizational restructuring. We assume that the capital adjustment cost function has both a fixed term, which represents the foregone production during an investment, and a convex term, which in turn replicate the fact that larger investments are more disruptive than smaller ones (Cooper and Haltiwanger, 2006):[3]

[2] The constant returns to scale is the prevalent regime in our estimates.

[3] Since Lucas (1967), convex adjustment costs have been standard in dynamic investment models.

$$C(I_n, K_n) = \left[c_f F(I_n) + c_v \left(\frac{I_n}{K_n} \right)^2 \right] K_n, \tag{4.3}$$

where $c_f > 0$ is the fixed cost and $F(I_n)$ is an indicator function equal to 0 if $I_n = 0$ and 1 otherwise (i.e. the fixed term is paid if and only if gross investment is different from zero). $c_v > 0$ is a parameter determining the curvature of the variable cost. The higher is c_v, the higher is the marginal cost of investing and the lower is the responsiveness of investment to variations in the underlying profitability of capital. Notice that costs are scaled by capital stock K_n in order to eliminate any size effect.

The firm can finance investment out of internal funds or by rising funds in the capital markets. By definition, if the investment in any period is greater than the funds generated from operations (after paying for adjustment and financial costs), then external financing is required. We assume that the only source of external financing is through debt.[4] The budget constraints can be written as:

$$\Pi(z, K) + \Delta B = I + C(I, K) + H(B, K), \tag{4.4}$$

where Π, I and $C(I, K)$ denote aggregate value of the corresponding variable at the project-level, $H(B, K)$ represents the external financial cost and B the corresponding amount of external financing. The left hand side of Equation (4.4) represents sources of funds (i.e. cash inflow from current operations and net borrowing), while the right hand side represents uses of funds (i.e. direct investment costs, indirect capital adjustment costs and interest expense on the debt stock borrowed).

The current debt stock borrowed is the sum of the stock borrowed last period and the new contracts, that is, $B' = B + \Delta B'$. We assume that capital is the only collateral. As a result, firms can only borrow up to a level proportional to its current capital stock:

$$B \le L(\varphi) K. \tag{4.5}$$

[4] Debt is the primary source of financing for most European firms (ECB, 2007).

We let $L(\varphi) \in [0,1]$ depend on the state of the industry and the business cycle. If $B > L(\varphi)K$, there is no new loan. If $\Pi > I + C(I,K) + H(B,K)$, old loans are repaid ($\Delta B < 0$).

The external financing premium will depend on firm's financial health, which may be captured by the leverage ratio (i.e. the ratio of debt to the value of capital, B/K). We assign the following functional form to the external financing cost function:

$$H(B,K) = \left[\vartheta \left(\frac{B}{K} \right)^2 F(B) + r \right] B, \tag{4.6}$$

where $F(B)$ is an indicator function equal to 1 if $B > 0$, 0 otherwise, $\vartheta > 0$ is a parameter determining the curvature, and r is the risk-free interest rate

In the presence of financial market frictions, internal funds have a cost advantage over external funds, so firms with free cash flow have an incentive retain funds to invest in future projects. To accommodate such firm's strategy, the variable B is allowed to be negative and the earnings retained will be invested in assets yielding a return of r.

Upon exit, a firm obtains a value equal to the undepreciated portion of its capital stock, net of the adjustment cost it incurs in order to dismantle it, that is:

$$V_X(K) = (1-\delta)K - C[-(1-\delta)K, K], \tag{4.7}$$

Then, the incumbent firm's problem can be written in recursive form as follows:

$$\begin{aligned} V(z,K,B) = \max_{I_n} \; & \Pi(z,K) - I - C(I,K) - H(B,K) + \beta \max \left\{ V_X(K), E\left[V(z',K') | \Phi \right] \right\} \\ s.t. \quad & K'_n = (1-\delta)K_n + I_n \\ & \Pi(z,K) + \Delta B = I + C(I,K) + H(B,K) \\ & \Delta B' = B' - B \\ & B \le L(\varphi)K \end{aligned} \quad , \tag{4.8}$$

where $\beta = 1/(1+r)$ denotes the discount factor; and Φ represents information available in period t.

4.3 Entry

For an aggregate state of technology, the value of a prospective entrant that obtains a signal z about her productivity is given by:

$$V_E(z,K) = \max_{K'} -K' + \beta E[V(z',K') | \Phi] \quad (4.9)$$

An entrepreneur will invest and start operating if and only if $V_E(z,K) \geq c_e$.

4.4 Solving the model and empirical implications (work in progress)

While the intuition that only the most efficient projects survive seems almost tautological, it follows from equation (4.8) that may be not true once there is limited enforceability of loan contracts as in the case of Great Recessions. Since the risk to default on loans rise with the amount of firm's borrows, it will be the projects that require less borrowing that will get financed, regardless of the surplus they offer. Thus, the model predicts that high productivity/low collateral projects, which have high R&D intensity, will be disproportionately harmed in deep recessions.

The first empirical test of the model is to observe whether incumbents continue or exit. Given equation (4.8), the probability of exit is a function of the set of variables $\left\{z, \Pi, \frac{K}{B}, E(V)\right\}$. The expected value of future net cash flows depends on investment opportunities. Empirically, we will use firm's sales growth as a proxy for investment opportunities.

In a second step, if an incumbent firm stays in the market, we will perceive whether it decide to invest or not. As we stated in Equation (4.8), this decision model is a function of the same set of variables of exit model.

5 Estimation Results

5.1 The determinants of firm exit

In order to analyse the role of productivity and financial constraints faced by firms as determinants of exit, we estimate a logit model in which the binary dependent variable, $Exit_{i(t+1)}$, is a function of firm *productivity* (z_{it}), *operating cash-flow* (cf_{it}), *leverage* (lev_{it}), *sales growth* (Δs_{it}) and firm and industry control variables (x_{it} and z_j, respectively). Additionally, and in order to assess the effect of the recession on the selected outcome, we generated the interaction terms $GR*p_{it}$, and $GR*fc_{it}$, where *GR* is a dummy variable equal to 1 if year *t* belongs to 2008–2012, 0 otherwise. The model can be written as:

$$Pr\left(Exit_{i(t+1)} = 1\right) = \Phi\Big(\beta_z z_{it} + \beta_{GR*z} GR \times z_{it} + \beta_{cf} cf_{it} + \beta_{GR*cf} GR \times cf_{it} + \beta_{lev} lev_{it} + \beta_{GR*lev} GR \times lev_{it} + \beta_{\Delta s} \Delta s_{it} + \beta_{GR*\Delta s} GR \times \Delta s_{it} + \beta_x x_{it} + \beta_z z_j + u_{it}\Big), \tag{5.1}$$

where Φ is the cumulative density function and u_{it} is a standard error term. β_z is expected to be negative, that is, the higher is the productivity level, the lower is the risk of exiting; and under the hypothesis that a crisis intensifies the creative destruction process, we expect $\beta_{GR*z} > 0$. We also expect that firms with a higher sales growth or a higher operating cash-flow have a reduced risk of exiting, which implies $\beta_{\Delta s} < 0$ and $\beta_{cf} < 0$. In turn, a higher leverage ratio implies a higher risk of failure, $\beta_{lev} > 0$. Additionally, financially constrained firms are more vulnerable to credit market restrictions during the Great Recession, and therefore we should expect a negative sign in the case of the interaction between *GR* and both *Δsales* and *operating cash-flow*, $\beta_{GR*\Delta s} < 0$ and $\beta_{GR*\mathrm{cf}} < 0$, respectively; and a positive sign in the case of the interaction with *leverage*, ($\beta_{GR*\mathrm{lev}} > 0$).

Model specification (5.1) includes firm size, measured as the natural logarithm of the number of employees, and the entry rate, the latter being introduced in order to capture the competitive effect of new firms. We also control for other (non-observed) differences across industries by including a set of industry dummies.

The regression results of empirical model (5.1) are presented in column (1) of Table 4. As our dependent variable is the hazard rate, a negative coefficient implies that the corresponding variable reduces the instantaneous likelihood of exit. The null that the parameters are jointly equal to zero is rejected at the 0.01 level.

[Table 4 near here]

The productivity coefficient is negatively signed and it is statistically significant at the 0.01 level, a confirmation that a higher productivity level does reduce the hazard rate. The magnitude of the productivity effect is nevertheless quite distinct across the two periods. The recession seems to intensify the creative destruction process: in the pre-recession period, a 1% increase in the (log) TFP implies a 1% fall in the hazard rate, all else constant; in 2008-2012, the corresponding reduction in the hazard rate is only 0.17% ($\beta_z + \beta_{GR*z} = -1.00 + 0.83 = -0.17\%$). This is in accordance with the cleansing hypothesis, since firms with a lower productivity level have an increased risk of failure in the crisis period.

All else constant, the negative sign of the *Δsales* and *operating cash-flow* coefficients indicate that good opportunities of investment and capacity to generate internal funds, respectively, reduce the risk of exiting, while the positive sign of *leverage* suggests that higher dependence on external financing increases this risk (the three variables, *Δsales*, *operating cash-flow* and *leverage*, are statistically significant at the 0.01 level). But the impact of these variables on the hazard seems to be different during the recession. Indeed, good opportunities of investment seem to have a significant impact on the probability of shutting-down in the Great Recession, the role of the capacity to generate funds internally seems to seems to be less important now (*recession*Δsales* and *recession*operating cash-flow* coefficients are negative and positive, respectively, both statistically significant). Typically, recessions put additional pressure on firm liquidity and, as a consequence, firms may hold their available liquidity rather than investing. In turn, the coefficient of *leverage* and its interaction term show that if the leverage increases by 1%, then the hazard rises by 0.61%, which compare with 0.01% in the pre-recession period.

The analysis in Section 3 revealed that a non-negligible number of large, high-productivity firms actually exit. To test whether credit constraints are bidding in the case of large firms, column (2) of Table 4 presents a regression that includes *leverage* variable interacted with firm size dummies. As can be seen, the *leverage* variable is now only statistically significant in the recession period (except in the case of microenterprises). Moreover, the coefficient of the interaction term (i.e. *large*recession*leverage*) shows that the risk of death increases with the size. The hazard rate of large firms is even more than twice that of medium firms. In other words, high leverage may cause serious cash flow problems in large firms in deep recessions because there may not be enough revenues to cover the relatively higher borrowing costs.

As expected, the *entry rate* seems to have an impact on the risk of exit, which mirrors the indirect effect through competitive pressure of entry. All else constant, the risk of exit decreases with firm size, proxied by the log of employment.

5.2 The determinants of job creation

If an incumbent firm decides to stay, there is then the decision to invest or not. Given (4.1), firms will hire more workers if they invest. For simplicity of discussion, we will use the following model:

$$Pr(JC_{it}=1)=\Phi\Big(\beta_z z_{it}+\beta_{GR*z}GR\times z_{it}+\beta_{cf}cf_{it}+\beta_{GR*cf}GR\times cf_{it}+\beta_{lev}lev_{it}+ \\ \beta_{GR*lev}GR\times lev_{it}+\beta_{\Delta s}\Delta s_{it}+\beta_{GR*\Delta s}GR\times\Delta s_{it}+\beta_x x_{it}+\beta_z z_j+u_{it}\Big), \quad (5.2)$$

where JC is a binary variable that equals 1 if employment change between *t* and *t*+1 is positive (i.e. if net job creation has been positive). The results are presented in Table 5.

As can be seen, there is a negative and statistically significant effect of productivity on the probability of job creation. Two opposite effects connecting productivity and employment may be at stake: on the one hand, it can be expected that through a higher productivity level, firms generate higher profits, which may in turn induce more investment and job creation; on the other, as argued by Gali (1999), a positive technology shock can reduce employment.

[Table 5 near here]

A higher level of both *sales growth* and *operating cash-flow* is associated with job creation, an effect that was attenuated in the Great Recession (the coefficients of respective interaction terms are negative and statistically significant). The leverage variable only has a significantly positive impact on job creation of medium-sized firms. On the contrary, it has a negative impact on job creation of large firms during the recession: the coefficient of the *recession*leverage* is negative and statistically significant at the 0.01 level; the variable leverage alone is not. Apparently, deep recessions may cause relatively higher difficulties to large and highly leveraged firms.

From Tables 4 and 5, we can then conclude that in great recessions credit market conditions are an important determinant of firm exit and job creation, as conjectured in our theoretical model.

6 Conclusion

Great recessions are primarily periods of “counterproductive” destruction rather than periods of productive cleansing. We use in this study the Portuguese 2008–2013 Great Recession as a motivating device to develop a model on firm dynamics with financial frictions and endogenous entry/exit. The goal was to investigate whether credit frictions may reverse the cleansing effect of recessions.

Based on a longitudinal panel of firms over 2004–2012, our empirical findings seem to partially support the cleansing hypothesis; and as predicted by the cleansing hypothesis, the decomposition of aggregate productivity growth reveals that low-productivity continuing firms have their market shares reduced during the crisis, thus enhancing productivity growth. But great recessions can also be counterproductive, with the premature exit of large/highly productive firms. And we do actually observe this result in the data. Thus, although we confirm that low-productivity firms have a higher probability of exit, credit market conditions seemingly play a role in firm exiting, especially in the case of large firms. High external funding dependence during the recession has also seemed to be adversarial to job creation by large-sized firms. Our results show therefore that in great recessions very harsh credit market conditions may entail the disadvantage of throwing out promising projects, thus impairing the postrecession economic recovery. Countercyclical policies to ensure adequate access to external funding are in this context of special relevance.

Appendix

Appendix A. Data and measurement issues

A.1 The dataset

The raw data is extracted from *Sistema de Contas Integradas das Empresas* (SCIE), a mandatory annual business survey administered by INE–Instituto Nacional de Estatística, the Portuguese Statistical Office. The SCIE covers the 2004-2012 interval and includes all registered enterprises in Portugal operating in any economic activity with the exception of the financial sector, insurance and not-for-profit organizations.

Each firm in the SCIE database has a fixed identification number, which enables us to follow individuals longitudinally. New firms can be then identified from each new identification number. Prior to the beginning of production, there is in general an initial investment period, which may extend beyond the first year of life. Since we are only concerned with active firms, for any unit created in t, if there is no production recorded between t and $t+\tau$, then $t+\tau$ is defined as the birth year. In turn, all the exits from the database are flagged as firm deaths. If a given unit ceases production before the year of the registered death, say t, and no production is observed between $t-\tau$ and t, $t-\tau$ is coded as the year of death.

Even though SCIE covers all firms, the register of individual proprietorships and self-employed professionals contains quite limited information: economic activity, location and number of employees. Thus, we exclude these firms from our dataset—on average, 93% of individual proprietorships and self-employed professionals have just one employee, the owner, while only 0.2% of those have more than 10 employees. Due to confidentiality restrictions, the raw data from highly concentrated industries (i.e. *tobacco products*, and *coke and refined petroleum products*) are not available. We also excluded from the dataset regulated industries (i.e. *electricity* and *water supply*). Firms with missing observations or unreasonable values (e.g. a negative value of *total net assets*, *cost of materials* or *services purchased*) were also ignored.

Table A.1 presents the lists of industries covered by the present study and the corresponding number of firms. Our estimation sample comprises an unbalanced panel of 467,345 firms or 2,518,361 year-firm observations.

[Table A1 near here]

A.2 Measurement of productivity

Firm-level total factor productivity (TFP) is our selected productivity measure. To compute the TFP, we firstly estimate the factor elasticity parameters of a Cobb-Douglas production function for each industry (at two-digit level), to allow for sector heterogeneity:

$$y_{it} = \alpha_0 + \alpha_K k_{it} + \alpha_L l_{it} + \alpha_M m_{it} + u_{it}, \qquad \text{(A.1)}$$

where y_{it} is the real gross output of the *i*th firm in year *t*, and k_{it}, l_{it} and m_{it} are capital, labour and material (intermediate) inputs, respectively (all variables in logarithms); and α_f denotes factor elasticities, $f = K, L, M$. Note that we do not impose any restriction on the sum of the three factor elasticities.

The *gross output* is given by the sum of total revenues from sales and services rendered, self-consumption of own production and production subsidies. It is deflated by the producer price index at the three-digit industry level (or two-digit level when the former is unavailable). The *labour* input is a 12-month employment average. *Materials* include the cost of materials and services purchased and were deflated by the intermediate consumption price index at the two-digit level (or the GDP deflator index when unavailable). *Capital* is measured as the book-value of total net assets, that is, it includes not only tangible and intangible assets but also all other elements of the asset side of the balance sheet, including accounts receivable and inventory investment, all important to the operation of the firm. For the first year in the time-series of a firm, we have deflated all the assets by the GDP deflator index of that year (2004 base-year), in order to derive the capital stock K_t. For subsequent years, if the book-value of assets rises, then the increment is deflated by GDP deflator index of the current year and added to the K_{t-1} to yield K_t. If it declines, K_t is reduced proportionately. Output and input variables are measured in constant 2004 Euros.

To estimate equation (A.1), we assume $u_{it} = \omega_{it} + \eta_{it}$, with ω_{it} denoting a firm-specific unobserved component and η_{it} a residual term uncorrelated with input choices. Ordinary least-squares estimation produces inconsistent estimates due to the likely presence of simultaneity and selection biases. The simultaneity bias arises because input demand functions are also determined by firm's knowledge of its productivity level. The selection bias is generated by endogenous exit, as smaller firms, with lower capital intensity, are more likely to exit. Assuming that ω_{it} is time invariant, equation (A.1) can be estimated using the least square dummy variable approach or the within transformation.[5] Consistency of the fixed effect model requires, however, strict exogeneity of the included regressors, which is a non-realistic assumption. To overcome this problem, we estimate equation (4) using the semi-parametric estimation method proposed by Olley and Pakes (1996).[6] This method accounts for the endogeneity of input demand and the selection bias problem, thus improving the quality of the estimation.

Finally, the (log) TFP is defined as the difference between firms' output and the weighted sum of inputs:

$$\hat{p}_{it} = y_{it} - \hat{\alpha}_K k_{it} - \hat{\alpha}_L l_{it} - \hat{\alpha}_M m_{it} . \qquad \text{(A.2)}$$

[5] The random effects model is rejected in favour of fixed effects model by the Hausman test at the 1% significance level.

[6] Estimation was performed using the Stata *opreg* command developed by Yasar et al. (2008).

Appendix B. Proof of equation (4.2)

The firm produces in a monopolistic competitive market and faces a Dixit-Stiglitz demand function for its variety *n* at time *t*:

$$Y_{nt}^{D} = D_t P_{nt}^{-\sigma}, \text{ with } D_t = M_t \, P_t^{\sigma-1} \tag{B.1}$$

where $\sigma = \dfrac{1}{1-\rho} > 1$ is the constant elasticity of substitution (CES) and $0 < \rho < 1$ is the measure of substitutability, D_t is the market demand index that is consist of the CES aggregate of differentiated varieties Y_t^D and the price P_t, and M_t is the consumers' expenditure on all varieties (i.e. the revenue).

The firm's revenue is given by:

$$R(Y_{nt}) = Y_{nt}^{\ \rho} \tag{B.2}$$

with $\rho = \dfrac{\sigma - 1}{\sigma}$. (For simplicity, the market demand index was assumed to be equal to 1.) Considering the CRS Cobb-Douglas production function (A.1), the firm's operating profits of project *n* state the productivity shock and the capital stock (A_n and K_{nt}, respectively) are given by:

$$\Pi(A_n, K_{nt}, L_{nt}, M_{nt}, w_L, w_M) = \max_{L_{nt}, M_{nt}} \left(A_n K_{nt}^{\ \alpha_K} L_{nt}^{\ \alpha_L} M_{nt}^{\ \alpha_M}\right)^{\rho} - w_L L_{nt} - w_M M_{nt}, \tag{B.3}$$

At given input prices, w_L and w_M, the maximization of profits with respect to the variable inputs yields the following variable factor demand and profit functions, respectively:

$$L(A_n, K_{nt}, w_L, w_M) = \left[A_n^{\ \rho} K_{nt}^{\ \rho\alpha_K} \left(\frac{\rho\alpha_L}{w_L}\right)^{1-\rho\alpha_M} \left(\frac{\rho\alpha_M}{w_M}\right)^{\rho\alpha_M} \right]^{\frac{1}{1-\rho\alpha_L-\rho\alpha_M}}, \tag{B.4}$$

$$M(A_n, K_{nt}, w_M, w_L) = \left[A_n^{\ \rho} K_{nt}^{\ \rho\alpha_K} \left(\frac{\rho\alpha_M}{w_M}\right)^{1-\rho\alpha_L} \left(\frac{\rho\alpha_L}{w_L}\right)^{\rho\alpha_L} \right]^{\frac{1}{1-\rho(1-\alpha_K)}}, \tag{B.5}$$

$$\Pi(A_n, K_{nt}) = \left[(1-\rho+\rho\alpha_K)\, A_n{}^{\rho} \left(\frac{\rho\alpha_M}{w_M}\right)^{\rho\alpha_M} \left(\frac{\rho\alpha_L}{w_L}\right)^{\rho\alpha_L} K_{nt}{}^{\rho\alpha_K} \right]^{\frac{1}{1-\rho(1-\alpha_K)}}, \tag{B.6}$$

Simplifying, we obtain equation (4.3) in the text:

$$\Pi(z_n, K_{nt}) = z_n K_{nt}{}^{\theta}, \tag{B.7}$$

where $z_n = \left[(1-\rho+\rho\alpha_K)\, \rho^{\rho(1-\alpha_K)} A_n{}^{\rho}\, (\alpha_M/w_M)^{\rho\alpha_M} (\alpha_L/w_L)^{\rho\alpha_L}\right]^{1/(1-\rho+\rho\alpha_K)}$ (B.8)

and $\theta = \rho\alpha_K/(1-\rho+\rho\alpha_K)$. (B.9)

Appendix C.

[Table A2 to A5 near here]

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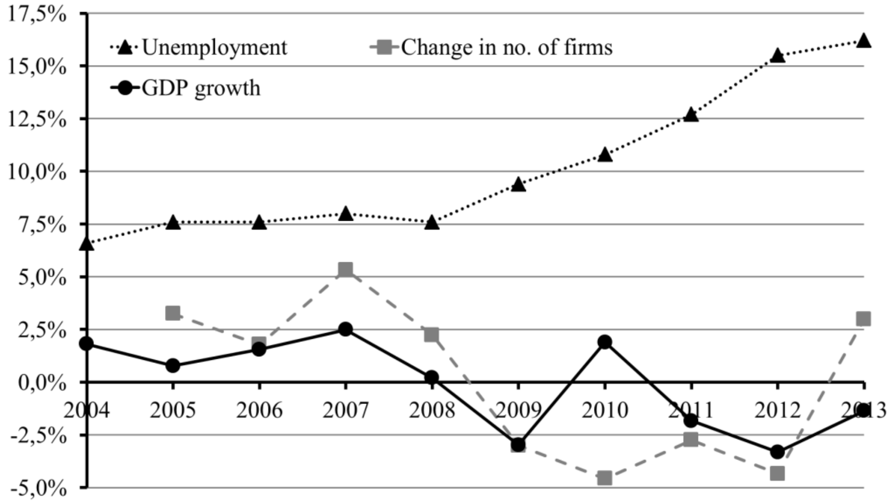
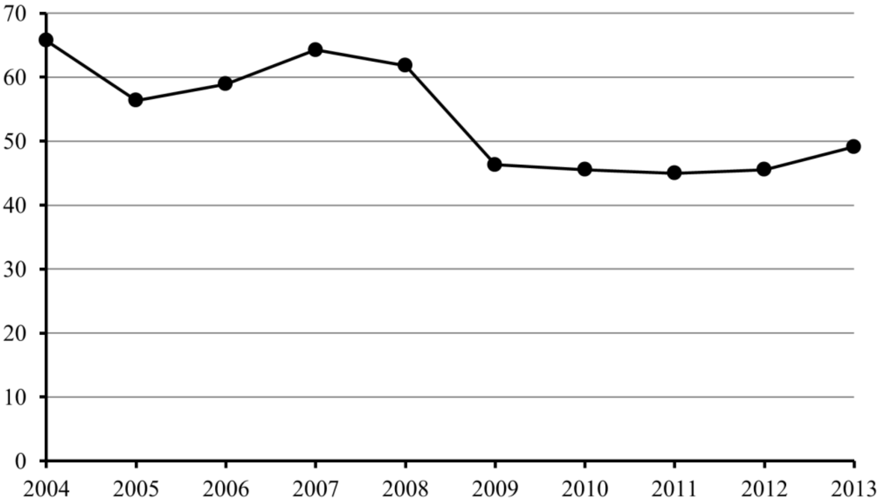
Figure 1 Real GDP growth, unemployment rate and change in the number of firms



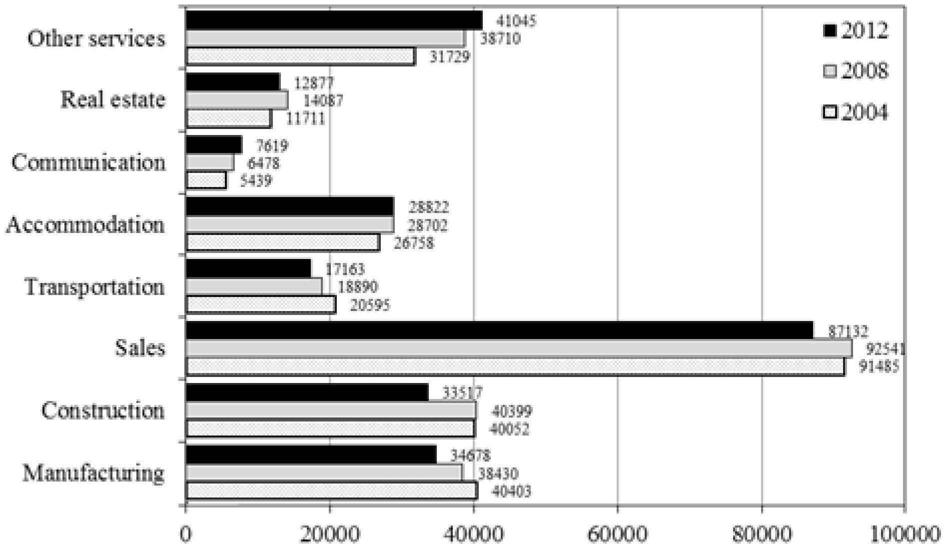
Source: INE.

Figure 2 Loans to non-financial firms (10^9 Euros)



Source: Banco de Portugal.

Figure 3 Number of firms in 2004, 2008 and 2012 by industry



Note: Industry classification is given in Table A1.

Figure 4 Firm entry and exit

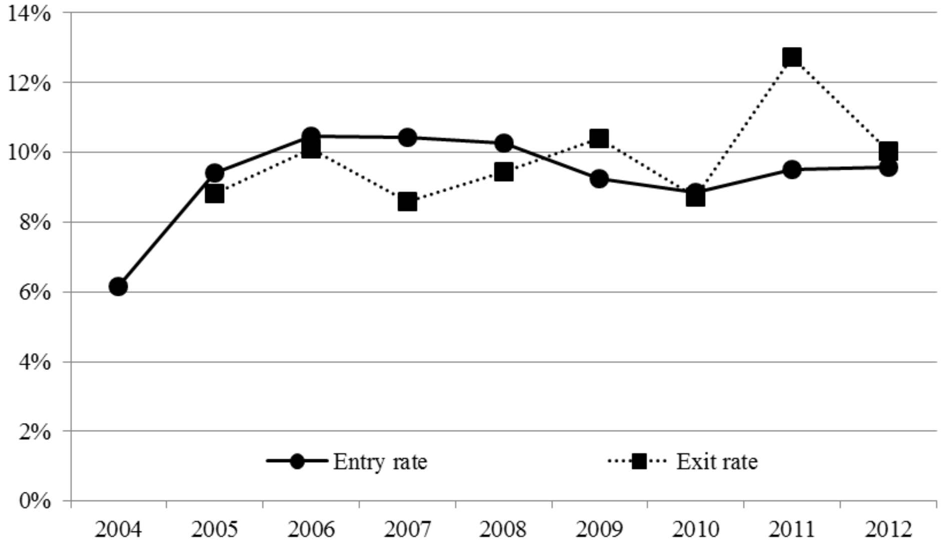
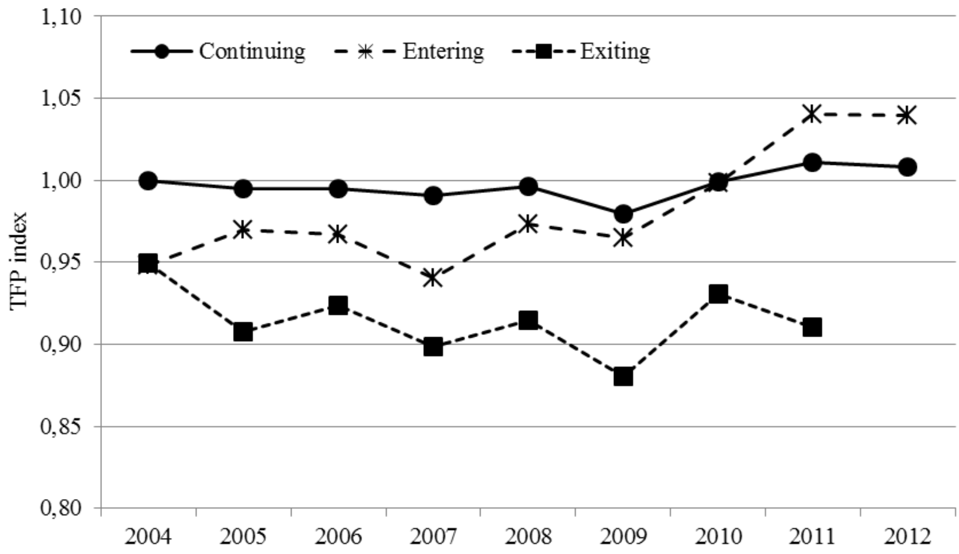


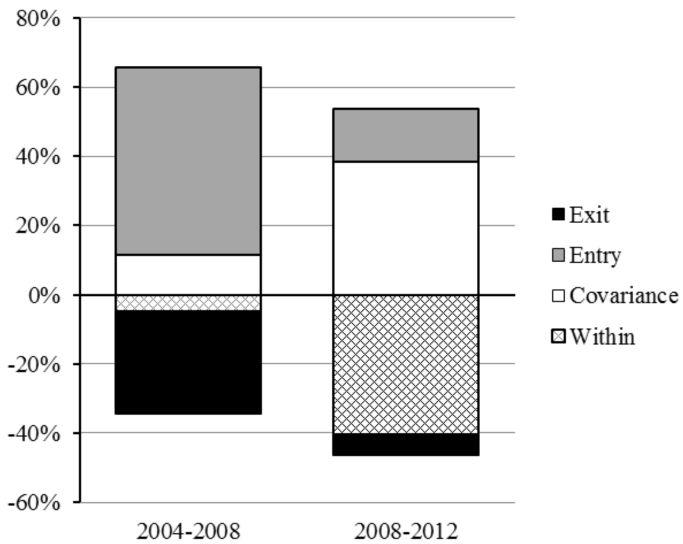
Figure 5 Productivity of continuing, entering, and exiting firms



Notes:

Notes: TFP normalized by the average productivity of continuing firms over the sample period at industry-level. Aggregation weighted over 61 two-digit industries by output. The productivity index is set to 1 for continuing firms (in 2004).

Figure 6 Productivity growth decomposition for manufacturing sector (in percentage)



Notes: Output-weighted (total factor) productivity growth decomposition at the two-digit industry level using the dynamic Olley–Pakes method. Aggregation weighted by firm's output.

Figure 7 Timing in period *t*

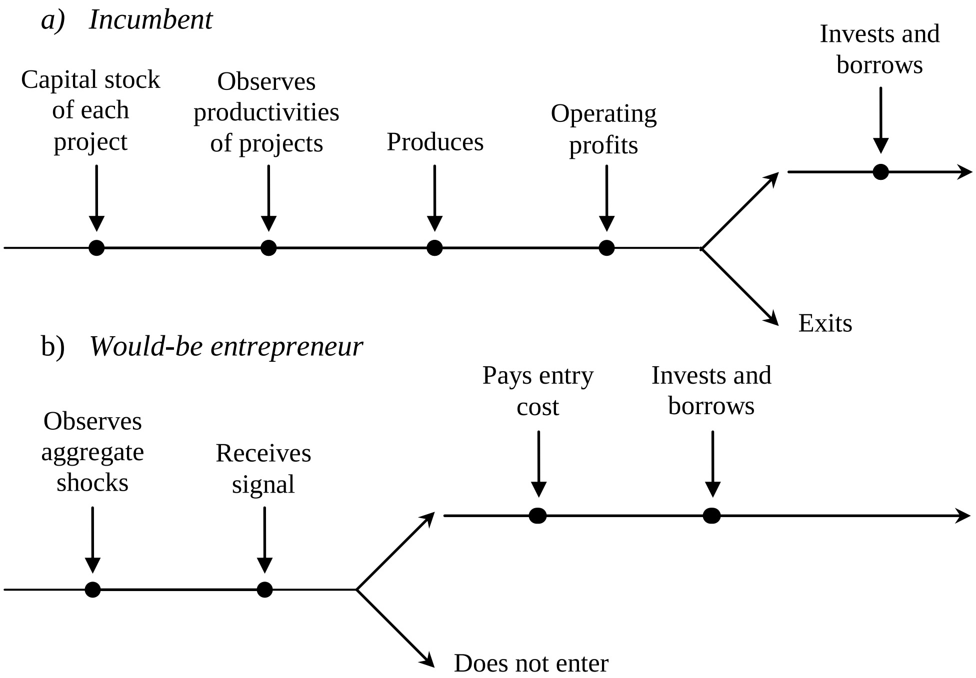


Table 1 Entry and exit rates by sector of activity (in percentage)

	Pre-crisis period		Crisis period	
	Entry rate	Exit rate	Entry rate	Exit rate
Manufacturing	5.7	7.4	6.1	8.1
Construction	11.1	12.2	11.3	14.7
Sales	8.3	8.4	8.1	9.2
Transportation	5.4	8.1	4.7	6.8
Accommodation	8.9	8.2	10.0	9.7
Communication	12.8	10.6	14.4	10.6
Real estate	17.8	17.6	18.9	20.2
Other services	11.3	8.0	11.5	9.4

Notes: The reported entry (exit) rate is calculated as the ratio of entering (exiting) firms to the total number of firms in *t* (*t*–1), as suggested by Dunne et al. (1988). The pre-crisis (crisis) period is defined as 2004–2007 (2008–2012). See disaggregation for the manufacturing sector in Table A2.

Table 2 Survival and hazard rates by entry cohort (in percentage)

	2004	2005	2006	2007	2008	2009	2010	2011	2012
a) Survival rates									
2004 Entry Cohort	100	90.9	78.4	69.8	62.5	55.1	50.2	43.6	39.6
2005 Entry Cohort		100	82.4	71.0	62.2	54.0	48.3	41.3	36.9
2006 Entry Cohort			100	83.6	70.9	60.5	53.5	45.0	39.9
2007 Entry Cohort				100	81.9	67.7	59.3	48.5	42.6
2008 Entry Cohort					100	81.2	69.6	56.6	49.2
2009 Entry Cohort						100	84.0	65.6	56.5
2010 Entry Cohort							100	79.4	67.2
2011 Entry Cohort								100	82.1
b) Hazard rates									
2004 Entry Cohort		9.1	13.8	10.9	10.5	11.8	9.0	13.1	9.2
2005 Entry Cohort			17.6	13.8	12.4	13.2	10.5	14.6	10.6
2006 Entry Cohort				16.4	15.1	14.7	11.5	16.0	11.2
2007 Entry Cohort					18.1	17.4	12.4	18.1	12.3
2008 Entry Cohort						18.8	14.3	18.7	12.9
2009 Entry Cohort							16.0	21.9	13.9
2010 Entry Cohort								20.6	15.4
2011 Entry Cohort									17.9

Notes: The reported survival rates for each entry cohort are the ratio of the number of surviving firms to the respective number of entering firms. The hazard rates for each entry cohort are the ratio of the number of deaths each year to the number of surviving firms in previous year. The corresponding values by sector of activity are given in Tables A3 and A4.

Table 3 Productivity gap relative to continuing firms by firm size

	Pre-crisis				Crisis			
	Micro	Small	Medium	Large	Micro	Small	Medium	Large
a) Entering firms								
Manufacturing	0.906	1.098	1.078	1.068	0.921	1.145	1.049	0.657
Construction	0.607	0.725	0.828	1.437	0.653	0.868	1.007	1.226
Sales	1.005	1.091	1.083	1.058	1.036	1.097	1.023	1.277
Transportation	0.873	1.008	1.410		0.923	0.953	1.320	1.251
Accommodation	0.851	0.868	0.802		0.826	0.905	0.823	0.993
Communication	0.867	0.980	1.431		0.915	0.993	1.325	1.668
Real estate	0.399	0.863	0.806	0.784	0.473	0.678	0.810	
Other services	0.911	1.133	1.325	1.351	0.839	1.060	1.036	0.903
b) Exiting firms								
Manufacturing	0.868	0.966	0.963	0.991	0.839	1.045	0.991	1.184
Construction	0.624	0.613	0.660	0.699	0.610	0.711	0.761	1.041
Sales	0.974	1.036	1.089	1.116	0.959	1.015	1.045	1.172
Transportation	0.929	0.929	0.903	0.826	0.872	0.922	0.981	0.678
Accommodation	0.867	0.855	0.897	1.160	0.850	0.888	0.882	0.727
Communication	0.810	0.979	1.048	1.270	0.796	1.045	1.030	0.909
Real estate	0.495	0.686	0.808	1.322	0.533	0.627	0.952	
Other services	0.856	0.935	0.935	0.529	0.740	0.955	0.865	1.237

Notes: Unweighted averages. For each size group and by industry-year, the productivity of entering (exiting) firms is expressed relatively to continuing firms. Micro, small, medium and large enterprises are those with less than 10, 10–49, 50–249 and 250 or more employees, respectively. Shaded areas indicate that the TFP of entering (exiting) firms is greater than that of continuing firms. See disaggregation for the manufacturing sector in Table A5.

Table 4 Determinants of firm exit

Variables	(1)	(2)
Log *TFP*	-1.000*** (0.066)	-1.058*** (0.066)
Recession × Log *TFP*	0.827*** (0.070)	0.892*** (0.071)
Δ Log *Sales*	-0. 144*** (0.030)	-0.127*** (0.030)
Recession ×Δ Log *Sales*	-0.579*** (0.040)	-0.585*** (0.040)
Log *Operating cash-flow*	-0.183*** (0.006)	-0.176*** (0.006)
Recession × Log *Operating cash-flow*	0.193*** (0.006)	0.183*** (0.006)
Log *Leverage*	0.005*** (0.002)	
Micro × Log *Leverage*		0.006*** (0.002)
Small × Log *Leverage*		0.007 (0.024)
Medium × Log *Leverage*		0.054 (0.057)
Large × Log *Leverage*		-2.023 (1.669)
Recession × Log *Leverage*	0.608*** (0.023)	
Micro × Recession × Log *Leverage*		0.498*** (0.022)
Small × Recession × Log *Leverage*		1.188*** (0.057)
Medium × Recession × Log *Leverage*		1.456*** (0.153)
Large × Recession × Log *Leverage*		3.257* (1.694)
Entry rate	9.147*** (1.586)	8.291*** (1.596)
Log *Employment*	-1.904*** (0.045)	-1.990*** (0.046)
Log likelihood	-10 494.166	-10 391.386
LR test	14 849.90***	15 055.46***
No. of observations	55 470	55 470

Notes: The logistic regression with fixed-effects ($Exit_{t+1}$=1) is given by model (5.1) in the text. The Log*TFP* is normalized by the weighted average total factor productivity by industry. "Recession" is a dummy for the period 2008–2012. "Micro", "small", "medium", and "large" are dummies for firms with less than 10, 10–49, 50–249, and 250 or more employees, respectively. The regression includes two-digit industry dummies. ***, **, and * denote statistical significance at the 0.01, 0.05 and 0.10 levels, respectively.

Table 5 Determinants of (net) job creation

Variables	(1)	(2)
Log *TFP*	-1.343*** (0.049)	-1.321*** (0.050)
Recession × Log *TFP*	0.101*** (0.039)	0.066 (0.042)
Δ Log *Sales*	1.428*** (0.028)	1.428*** (0.028)
Recession × Δ Log *Sales*	-0.315*** (0.036)	-0.313*** (0.036)
Log *Operating cash-flow*	0.024*** (0.026)	0.024*** (0.003)
Recession × Log *Operating cash-flow*	-0.012*** (0.029)	-0.011*** (0.003)
Log *Leverage*	-0.007* (0.039)	
Micro × Log *Leverage*		-0.007* (0.004)
Small × Log *Leverage*		0.006 (0.026)
Medium × Log *Leverage*		0.162*** (0.063)
Large × Log *Leverage*		-0.0867 (0.237)
Recession × Log *Leverage*	0.004 (0.063)	
Micro × Recession × Log *Leverage*		-0.008 (0.009)
Small × Recession × Log *Leverage*		-0.005 (0.026)
Medium × Recession × Log *Leverage*		-0.083 (0.058)
Large × Recession × Log *Leverage*		-0.595*** (0.192)
Entry rate	4.131*** (0.837)	4.092*** (0.837)
Log *Employment*	4.336*** (0.037)	4.329*** (0.037)
Log likelihood	-55 596.985	-55 583.568
LR test	40 701.49***	40 728.32***
No. of observations	193 196	193 196

Notes: The logistic regression with fixed-effects (*Job creation*=1, if variation of employment > 0) is given by model (5.2). The Log*TFP* is normalized by the weighted average total factor productivity by industry. “Recession” is a dummy for the period 2008–2012. “Micro”, “small”, “medium”, and “large” are dummies for firms with less than 10, 10–49, 50–249, and 250 or more employees, respectively. The regression includes two-digit industry dummies and year dummies. ***, **, and * denote statistical significance at the 0.01, 0.05 and 0.10 levels, respectively.

Table A1. Number of firms by sector of activity

Code		Industry	Shortcut	Mean	SD
C	10–33	Manufacturing	Manufacturing	37 781	1 912.4
F	41–43	Construction	Construction	38 716	2 393.3
G	45–47	Wholesale and retail trade; repair of motor vehicles	Sales	90 686	1 891.0
H	49–53	Transportation and storage	Transportation	18 676	1 022.5
I	55–56	Accommodation and food service activities	Accommodation	28 153	758.5
J	58–63	Information and communication activities	Communication	6 420	694.7
L	68	Real estate activities	Real estate	13 222	797.6
M-N	69–82	Consultancy, technical and administrative activities	Other services	37 394	3 365.5

Notes: The decomposition uses the two-digit level of the Portuguese Classification of Economic Activities (CAE-Rev.3). At least at this disaggregation level there is a direct correspondence between this classification and the classifications of both the European Community (NACE-Rev.2) and the United Nations (CITA-Rev.4). Mean and standard deviation (SD) of the number of firms are computed over the period 2004–2012.

Table A2 Entry and exit rates in manufacturing industry (in percentage)

	Pre-crisis		Crisis	
	Entry rate	Exit rate	Entry rate	Exit rate
Food	6.5	4.9	6.1	6.1
Beverages	5.7	3.0	6.5	4.0
Textiles	6.2	8.5	5.5	9.9
Apparel	7.1	10.9	7.9	12.7
Leather	8.1	10.3	8.6	8.0
Wood	5.6	8.2	5.9	8.9
Paper	5.2	7.0	5.5	7.7
Printing	6.9	7.3	5.2	8.3
Chemicals	5.7	6.4	5.4	7.1
Pharmaceutical	8.5	4.7	5.9	5.2
Rubber	4.8	5.1	4.9	6.3
Other non-metallic	4.7	6.7	3.9	8.0
Basic metals	5.2	6.9	5.9	7.1
Metals	6.1	6.8	5.3	6.7
Computer	7.8	11.0	7.2	8.2
Electrical	5.4	8.6	5.4	7.1
Machinery	5.3	7.5	4.5	7.0
Motor vehicles	5.5	5.7	4.5	6.3
Other transport	8.7	11.5	8.0	9.5
Furniture	6.2	7.6	6.2	9.6
Other manufacturing	6.8	7.9	5.9	7.7
Repair	7.8	3.3	9.5	7.1

Note: See notes to Table 1.

Table A3 Survival rate by sector of activity (in percentage)

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Entry Cohort:					Manufacturing				
2004	100	90.7	79.3	71.5	65.2	58.0	52.5	46.6	43.0
2005		100	85.3	75.0	67.6	59.5	54.3	47.4	43.4
2006			100	87.6	77.5	67.7	60.4	50.4	45.8
2007				100	86.1	72.8	65.5	54.5	48.5
2008					100	85.9	75.6	64.4	57.8
2009						100	90.3	75.7	67.7
2010							100	85.8	77.3
2011								100	89.0
Entry Cohort:					Construction				
2004	100.0	87.7	75.7	66.2	58.8	50.6	45.4	38.0	33.0
2005		100.0	75.5	63.2	52.9	43.5	38.4	31.1	26.6
2006			100.0	76.4	62.1	51.0	44.0	34.6	29.2
2007				100.0	74.1	57.8	49.4	37.6	31.3
2008					100.0	74.1	60.8	45.9	37.9
2009						100.0	77.2	55.1	44.6
2010							100.0	70.1	55.2
2011								100.0	72.6
Entry Cohort:					Sales				
2004	100.0	92.2	78.5	69.3	61.4	54.5	49.7	43.2	39.1
2005		100.0	86.5	75.1	66.1	58.0	51.7	44.3	39.7
2006			100.0	87.4	74.8	64.2	57.2	48.5	43.4
2007				100.0	86.3	72.5	63.8	52.5	46.3
2008					100.0	85.0	74.3	60.9	53.0
2009						100.0	89.0	70.8	62.0
2010							100.0	84.8	73.2
2011								100.0	86.5
Entry Cohort:					Transportation				
2004	100	91.6	82.3	75.2	66.4	58.6	53.8	47.1	42.7
2005		100	89.2	81.7	74.1	65.8	59.6	51.1	45.6
2006			100	88.5	79.2	70.4	64.7	55.6	49.8
2007				100	89.5	77.0	70.5	62.2	56.6
2008					100	88.8	81.6	68.9	63.7
2009						100	92.0	76.3	69.1
2010							100	85.4	77.3
2011								100	89.3
Entry Cohort:					Accommodation				
2004	100	90.8	74.8	64.8	57.7	50.1	44.8	38.6	35.4
2005		100	85.4	74.1	64.0	56.4	51.2	44.1	39.7
2006			100	87.0	73.6	62.2	55.4	47.2	41.9
2007				100	84.4	67.8	58.4	46.9	41.1
2008					100	84.2	70.6	56.3	49.1
2009						100	87.2	66.0	56.8
2010							100	83.0	68.3
2011								100	83.9

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Entry Cohort:					Communication				
2004	100	91.8	78.0	70.4	63.0	57.2	50.8	45.1	42.0
2005		100	85.0	70.9	61.9	54.2	48.0	42.3	38.6
2006			100	86.9	73.4	62.3	56.0	48.3	43.4
2007				100	86.9	72.8	65.6	55.2	49.8
2008					100	85.3	75.8	62.0	54.5
2009						100	89.8	71.5	62.6
2010							100	86.1	75.5
2011								100	88.4
Entry Cohort:					Real estate				
2004	100	77.2	66.6	59.8	54.2	47.2	42.8	37.4	33.4
2005		100	65.7	51.0	43.2	36.4	31.5	25.9	22.9
2006			100	67.5	50.4	40.8	34.2	27.4	23.0
2007				100	63.6	48.8	40.1	31.6	27.3
2008					100	60.8	46.6	35.9	29.7
2009						100	60.8	41.0	32.3
2010							100	57.6	42.9
2011								100	57.0
Entry Cohort:					Other services				
2004	100	93.9	83.4	76.1	69.2	61.2	56.2	49.1	45.2
2005		100	89.2	79.3	71.5	62.7	56.2	48.9	44.2
2006			100	88.2	77.5	67.2	59.9	51.8	46.2
2007				100	88.2	75.8	67.3	57.1	50.3
2008					100	86.5	75.6	62.5	54.7
2009						100	89.4	72.9	62.9
2010							100	85.8	74.9
2011								100	87.9

Note: See notes to Table 2.

Table A4 Hazard rate by sector of activity (in percentage)

	2005	2006	2007	2008	2009	2010	2011	2012
Entry Cohort:				Manufacturing				
2004	9.3	12.6	9.9	8.8	10.9	9.5	11.3	7.7
2005		14.7	12.1	9.9	12.0	8.7	12.7	8.4
2006			12.4	11.5	12.7	10.8	16.5	9.2
2007				13.9	15.5	10.0	16.8	11.0
2008					14.1	12.0	14.9	10.2
2009						9.7	16.2	10.6
2010							14.2	9.9
2011								11.0
Entry Cohort:				Construction				
2004	12.3	13.7	12.5	11.3	13.8	10.3	16.4	13.2
2005		24.5	16.3	16.3	17.8	11.7	18.9	14.6
2006			23.6	18.7	18.0	13.7	21.3	15.6
2007				25.9	22.0	14.5	23.8	16.8
2008					25.9	17.9	24.6	17.3
2009						22.8	28.6	19.1
2010							29.9	21.2
2011								27.4
Entry Cohort:				Sales				
2004	7.8	14.8	11.7	11.4	11.3	8.7	13.1	9.5
2005		13.5	13.1	12.0	12.3	10.7	14.4	10.4
2006			12.6	14.3	14.2	11.0	15.2	10.4
2007				13.7	16.0	11.9	17.8	11.7
2008					15.0	12.7	18.0	13.0
2009						11.0	20.4	12.5
2010							15.2	13.7
2011								13.5
Entry Cohort:				Transportation				
2004	8.4	10.3	8.6	11.7	11.7	8.1	12.5	9.4
2005		10.8	8.3	9.3	11.3	9.4	14.2	10.8
2006			11.5	10.4	11.1	8.1	14.1	10.4
2007				10.5	14.0	8.5	11.7	9.1
2008					11.2	8.2	15.5	7.5
2009						8.0	17.1	9.3
2010							14.6	9.6
2011								10.7
Entry Cohort:				Accommodation				
2004	9.2	17.6	13.4	10.9	13.1	10.5	13.9	8.2
2005		14.6	13.2	13.6	12.0	9.2	13.8	10.1
2006			13.0	15.4	15.6	10.9	14.7	11.2
2007				15.6	19.6	13.9	19.6	12.5
2008					15.8	16.1	20.3	12.8
2009						12.8	24.2	14.0
2010							17.0	17.8
2011								16.1

	2005	2006	2007	2008	2009	2010	2011	2012
Entry Cohort:				Communication				
2004	8.2	15.0	9.7	10.5	9.3	11.2	11.1	6.9
2005		15.0	16.6	12.6	12.5	11.5	11.9	8.7
2006			13.1	15.5	15.1	10.1	13.9	10.1
2007				13.1	16.3	9.9	15.8	9.8
2008					14.7	11.2	18.2	12.2
2009						10.2	20.4	12.4
2010							13.9	12.3
2011								11.6
Entry Cohort:				Real estate				
2004	22.8	13.7	10.2	9.5	12.8	9.4	12.6	10.7
2005		34.3	22.4	15.2	15.9	13.3	17.7	11.7
2006			32.5	25.3	19.0	16.4	19.8	16.0
2007				36.4	23.4	17.7	21.3	13.7
2008					39.2	23.3	22.9	17.2
2009						39.2	32.5	21.2
2010							42.4	25.6
2011								43.0
Entry Cohort:				Other services				
2004	6.1	11.2	8.8	9.0	11.7	8.1	12.7	7.8
2005		10.8	11.1	9.8	12.3	10.4	12.9	9.7
2006			11.8	12.2	13.2	10.9	13.6	10.7
2007				11.8	14.1	11.3	15.2	11.9
2008					13.5	12.6	17.3	12.5
2009						10.6	18.4	13.8
2010							14.2	12.7
2011								12.1

Note: See notes to Table 2.

Table A5 Productivity gap relative to continuing firms by firm size (manufacturing sector)

	Pre-crisis				Crisis			
	Micro	Small	Medium	Large	Micro	Small	Medium	Large
a) Entering firms								
Food	0.838	0.894	0.791	0.931	0.859	0.934	0.919	
Beverages	0.756	0.715			0.849	0.834	1.032	
Textiles	0.936	1.190	0.960		0.965	1.170	0.867	
Apparel	0.856	0.998	1.063		0.953	1.015	0.758	
Leather	0.958	1.068	1.155		0.999	1.025	1.064	
Wood	0.938	0.990	1.047		1.013	0.869		0.690
Paper	0.826	1.053	0.960		0.921	0.910	0.930	
Printing	0.859	0.918	0.786		0.912	0.938	0.678	
Chemicals	0.933	1.101		2.049	0.905	0.775	0.826	
Pharmaceutical	0.954	0.931	0.920		0.645	0.760	0.721	
Rubber	0.934	0.962	1.119		0.953	0.925	0.734	
Other non-metallic	0.916	0.911	0.680		0.976	0.929	0.557	
Basic metals	0.889	0.730	2.448	0.942	0.973	1.264		
Metals	0.946	1.025	1.148		0.973	1.109	1.312	
Computer	0.589	0.993	1.206		0.824	0.677	0.824	
Electrical	1.022	0.812	0.530		0.895	1.092	2.374	
Machinery	0.947	0.864			0.954	1.027	1.635	
Motor vehicles	0.833	1.232	0.754		0.908	1.128	0.388	
Other transport	0.930	1.154	1.985		0.942	1.388	1.550	
Furniture	0.897	0.907	1.032	1.077	0.965	1.061	0.835	0.148
Other manufacturing	0.858	0.912	0.158		0.988	0.957	0.607	
Repair	0.963	1.022			1.064	1.152	1.022	
b) Exiting firms								
Food	0.880	0.836	0.861	1.005	0.842	0.901	0.906	0.878
Beverages	0.836	1.045	1.439	1.207	0.936	0.798	0.388	
Textiles	0.841	0.898	0.926	0.703	0.817	0.918	0.821	0.957
Apparel	0.823	0.878	0.854	0.785	0.852	0.977	0.888	0.821
Leather	0.796	0.853	0.883		0.800	0.924	1.170	1.340
Wood	0.933	1.033	0.760		0.904	0.853	0.901	
Paper	0.833	0.876	1.026		0.809	0.942	0.909	
Printing	0.866	0.780	0.749		0.840	0.932	0.866	
Chemicals	0.803	0.918			0.808	0.880	1.014	
Pharmaceutical	0.851	0.862	1.148		0.745	0.892	0.563	
Rubber	0.808	0.831	0.907	0.814	0.909	0.884	0.833	
Other non-metallic	0.864	0.812	1.048	1.110	0.849	0.867	0.801	1.043
Basic metals	0.854	0.896			0.970	0.869	0.823	
Metals	0.893	0.950	0.742		0.869	0.933	1.003	0.726
Computer	0.689	0.934	0.859	0.812	0.790	0.917	1.119	
Electrical	0.864	0.787	0.895		0.844	1.140	0.865	
Machinery	0.893	0.827	0.983		0.834	0.939	0.987	
Motor vehicles	0.840	0.978	0.805		0.830	0.929	0.793	1.226
Other transport	0.799	1.232	0.893		0.820	0.720	1.167	2.558
Furniture	0.885	0.878	1.189	0.997	0.873	0.882	1.094	
Other manufacturing	0.866	0.819	1.342		0.858	0.818	1.262	0.779
Repair	0.865	0.969	1.149		0.918	0.859	0.939	

Note: See notes to Table 3.