Teams and Bankruptcy

Finance Working Paper N° 626/2019
August 2019

Ramin P. Baghai
Stockholm School of Economics, CEPR and ECGI

Rui C. Silva
London Business School

Luofu Ye
London Business School

ECGI Working Paper Series in Finance

Teams and Bankruptcy

Working Paper N° 626/2019

August 2019

Ramin P. Baghai
Rui C. Silva
Luofu Ye

We thank Effi Benmelech, Andrea Caggese, Emanuele Colonnelli, Sasha Indarte, Julian Franks, Laurent Frésard, Paolo Fulghieri, Hyunseob Kim, Vojislav Maksimovic, Janet Gao, Marco Ghitti, Ben Iverson, Kaveh Majlesi, David Matsa, Paige Ouimet, Luigi Pistaferri, Ronan Powell, Chenyu Shan, Jason Sturgess, Joacim Tåg, Vikrant Vig, Woody Wu, and Zili Zhuang, seminar participants at Cass Business School, Copenhagen Business School, London Business School, Nova SBE, University of Lugano (SFI), University of Milano-Bicocca, and conference participants at the Labor and Finance Working Group meeting at the University of Colorado Boulder (2016), SITE Labor and Finance Workshop (2017), Oslo Summer Finance Workshop (2017), EFA Annual Meeting (2017), 6th International Moscow Finance and Economics Conference (2017), AFA Annual Meeting (2018), Review of Corporate Finance Studies Conference (2018), LBS IIE Research Symposium (2018), Lancaster University Corporate Finance Workshop (2018), NICE conference (2018), 3rd Annual CEPR Symposium (2018), Corporate Finance: Beyond Public Companies conference (2018), The Society of Labor Economists Annual Meeting (2018), 4 Nations Cup (2018), FIRS (2018), PFN (2018), Antwerp Corporate Finance Day (2018), CEPR European Summer Symposium in Financial Markets, World Finance Conference, EEA Annual Meeting (2018), Duke/ UNC Entrepreneurship Research Conference (2019), City University of Hong Kong International Finance Conference on Corporate Finance and Financial Markets (2019), and the China International Conference in Finance (2019) for helpful discussions. Financial support from the Deloitte Institute for Innovation and Entrepreneurship at the London Business School is gratefully acknowledged.

Abstract

We study how the human capital embedded in teams is reallocated in corporate bankruptcies using data on US inventors. We find that bankruptcies reduce team stability. After a bankruptcy, team-dependent inventors produce fewer and less impactful patents. This points to the loss of teamspecific human capital as a cost of resource reallocation through bankruptcy. However, this cost is limited by the ability of the labor market and the market for corporate control to preserve teams. Inventors with past collaboration are likely to move jointly to a new firm after bankruptcy, and the productivity of team inventors that relocate together increases.

Keywords: Teams, teamwork, team-specific human capital, bankruptcy, labour productivity, innovation

JEL Classifications: J24, J63, G33, O31, O32,

Ramin P. Baghai*
Associate Professor
Stockholm School of Economics, Department of Finance
Sveavägen 65
113 83 Stockholm, Sweden
phone: +46 873 692 96
e-mail: Ramin.Baghai@hhs.se

Rui C. Silva
Assistant Professor of Finance
London Business School, Finance Department
Regent's Park
London, NW1 4SA, United Kingdom
phone: +44 207 000 8263
e-mail: rsilva@london.edu

Luofu Ye
Researcher
London Business School
Regent's Park
London, NW1 4SA, United Kingdom
phone:
e-mail: lye@london.edu

*Corresponding Author

Teams and Bankruptcy

Ramin P. Baghai, Rui C. Silva, and Luofu Ye*

July 2019

JEL: J24, J63, G33, O31, O32,

Keywords: Teams, teamwork, team-specific human capital, bankruptcy, labor productivity, innovation.

---

* This paper was previously circulated as: "Bankruptcy, team-specific human capital, and productivity: evidence from US inventors." Baghai (ramin.baghai@hhs.se): Stockholm School of Economics, CEPR, and ECGI. Silva (rsilva@london.edu) and Ye (lye@london.edu): London Business School. We thank Effi Benmelech, Andrea Caggese, Emanuele Colonnelli, Sasha Indarte, Julian Franks, Laurent Frésard, Paolo Fulghieri, Hyunseob Kim, Vojislav Maksimovic, Janet Gao, Marco Ghitti, Ben Iverson, Kaveh Majlesi, David Matsa, Paige Ouimet, Luigi Pistaferri, Ronan Powell, Chenyu Shan, Jason Sturgess, Joacim Tåg, Vikrant Vig, Woody Wu, and Zili Zhuang, seminar participants at Cass Business School, Copenhagen Business School, London Business School, Nova SBE, University of Lugano (SFI), University of Milano-Bicocca, and conference participants at the Labor and Finance Working Group meeting at the University of Colorado Boulder (2016), SITE Labor and Finance Workshop (2017), Oslo Summer Finance Workshop (2017), EFA Annual Meeting (2017), 6th International Moscow Finance and Economics Conference (2017), AFA Annual Meeting (2018), Review of Corporate Finance Studies Conference (2018), LBS IIE Research Symposium (2018), Lancaster University Corporate Finance Workshop (2018), NICE conference (2018), 3rd Annual CEPR Symposium (2018), Corporate Finance: Beyond Public Companies conference (2018), The Society of Labor Economists Annual Meeting (2018), 4 Nations Cup (2018), FIRS (2018), PFN (2018), Antwerp Corporate Finance Day (2018), CEPR European Summer Symposium in Financial Markets, World Finance Conference, EEA Annual Meeting (2018), Duke/ UNC Entrepreneurship Research Conference (2019), City University of Hong Kong International Finance Conference on Corporate Finance and Financial Markets (2019), and the China International Conference in Finance (2019) for helpful discussions. Financial support from the Deloitte Institute for Innovation and Entrepreneurship at the London Business School is gratefully acknowledged.

Teams and Bankruptcy

ABSTRACT

We study how the human capital embedded in teams is reallocated in corporate bankruptcies using data on US inventors. We find that bankruptcies reduce team stability. After a bankruptcy, team-dependent inventors produce fewer and less impactful patents. This points to the loss of team-specific human capital as a cost of resource reallocation through bankruptcy. However, this cost is limited by the ability of the labor market and the market for corporate control to preserve teams. Inventors with past collaboration are likely to move jointly to a new firm after bankruptcy, and the productivity of team inventors that relocate together increases.

1. Introduction

> *"Teams possess value over and above the value that each worker brings to the enterprise. […] From the animators at Walt Disney in the 1940s to the engineers at NASA in the 1960s to the software writers at Microsoft in the 1990s, one can identify teams across a large range of activities. The histories of most successful enterprises tell of the group of individuals crucial to their successes. Often these individuals will have had little success in earlier or later ventures with other people. […] A robust law of corporate reorganizations must focus on firms that have valuable teams yet face financial distress."*
>
> (Baird, Douglas G. and Rasmussen, Robert K., 2002. The End of Bankruptcy. Stanford Law Review 55, p.775)

Corporate bankruptcies constitute an important mechanism through which the economy rids itself of obsolete firms and allocates their constituent parts to alternative and potentially more productive uses. However, the restructuring process involves various imperfections. In addition to the potential loss in value to the firm's redeployable physical capital stock (e.g., due to asset fire sales), bankruptcy may involve some deterioration of organizational and human capital.[1] While prior work has focused primarily on the reallocation of physical capital and individual workers, we are the first to systematically study how the human capital embedded in teams is affected by corporate bankruptcies.

Teamwork has become a prevalent way of organizing production in science, in patenting, and, more broadly, in the corporate sector. There is evidence, in a variety of settings, that

[1] For example, the failure of a firm may result in ongoing R&D projects to be halted and the knowledge accumulated thus far to be lost; workers that invested in organizational or other firm-specific human capital will see the value of those skills diminish (e.g., Graham, Kim, Li, and Qiu 2016). Further, frictions in the post-bankruptcy reallocation of resources may lead capital and labor to be idle for some time or even result in protracted sub-optimal uses. In the case of workers, unemployment spells could also accelerate the depreciation of skills (e.g., Ljungqvist and Sargent 1998). Bankrupt firms may also impose negative externalities on non-bankrupt peers (e.g., Bernstein, Colonnelli, Giroud, and Iverson 2018, Benmelech, Bergman, Milanez, and Mukharlyamov 2019; Benmelech and Bergman 2011; Birge, Parker, and Yang 2015).

teamwork has substantial benefits compared to work in hierarchical environments, in particular when complex tasks are involved. Venture capitalists view the entrepreneurial management team as more important for success than the product or technology of the business. Despite the importance of teamwork, there is little systematic evidence on the economic drivers affecting the creation, stability, and dissolution of productive team configurations. Understanding these forces is crucial for the design of corporate and public policies that maximize productivity.[2]

The impact of bankruptcies on the productivity of the average employee is theoretically ambiguous. Despite frictions, the bankruptcy process may result in an efficient reallocation of many workers. However, team-specific human capital (defined as an intangible asset consisting of common knowledge related to communication, coordination, and problem-solving which is not easily codified or transferable across different groups of workers; e.g., Bartel, Beaulieu, Phibbs, and Stone 2014) is likely to be adversely affected by bankruptcy if well-established worker teams are broken up. The restructuring process that occurs during bankruptcy may disrupt the stability of teams within the financially distressed firm. It may be difficult for workers that are used to collaborating in teams to move jointly to a different firm after bankruptcy, because few firms may have the financial slack to hire entire groups of employees of the distressed firm. This problem may be further aggravated due to common industry shocks. Furthermore, the joint relocation of former team-members to new firms may be rendered onerous by transaction and coordination costs.[3] The resulting shock to the structure of teams, or, at the extreme, their outright dissolution, may have negative consequences for the productivity of its members. This would be especially relevant for employees that have built up significant team-specific human capital in the past.

---

[2] Card and DelaVigna (2013), Azoulay, Zivin, and Wang (2010), Azoulay, Fons-Rosen, and Zivin (2018), and Jaravel, Petkova, and Bell (2018) study teamwork in science and corporate innovation. The value of teamwork has been demonstrated in a variety of other settings ranging from garment plants (Hamilton, Nickerson, and Owan 2003) to steel mills (Boning, Ichniowski, and Shaw 2007) and healthcare (Bartel, Beaulieu, Phibbs, and Stone 2014). Lazear and Shaw (2007) report that the share of large firms that employ teams has increased. Gompers, Gornall, Kaplan, and Strebulaev (forthcoming) provide evidence on the importance of the entrepreneurial team for startup success. While these prior studies are informative for the quantification of the importance of teamwork, additional work is required to inform the design of public and corporate policies that aim to nurture or preserve human capital that is specific to teams.

[3] For example, individuals may have different geographic preferences, or family circumstances may make it difficult to coordinate a joint relocation. Furthermore, depressed housing markets may impede workers' ability to move to other regions (Brown and Matsa 2017).

To study the impact of corporate bankruptcies on team stability and productivity of team-dependent workers, we face several challenges. First, bankruptcies are not exogenous events, and neither is the matching of workers to firms. In fact, endogenous responses to financial distress—by employees, the labor market, and the market for corporate control—are economic effects that we investigate. Our paper suggests a plausible narrative related to the reallocation of team-specific human-capital through corporate bankruptcies, but we also entertain possible alternative explanations. In addition, we conduct a comprehensive series of tests that alleviate concerns that our results are driven by selection and that thus support the notion that team-specific capital helps explain the post-bankruptcy productivity of workers.

Second, to identify the effect of bankruptcies on team-specific human capital, we must overcome a series of data challenges. We need to observe a panel of workers that are matched to their employers. Further, we require metrics of individual worker productivity. Finally, we must be able to measure the extent to which workers collaborate in teams and are endowed with team-specific human capital. To overcome these challenges, we use an employer-employee matched dataset of inventors in the United States spanning the years 1980 to 2010. While inventors tend to work in teams, there is substantial variation in the extent to which they do so, allowing us to study teamwork and team-specific human capital. Because we can trace the composition of teams within and across firms, we can distinguish the role of team-specific human capital from that of firm-specific human capital. This setting also allows us to construct patent-based productivity measures which have been shown to be economically meaningful in a large body of prior work. We can measure inventors' individual output, both in terms of quantity (patent counts) and quality (citation-based innovation measures, as well as market estimates of the monetary value of patents). Finally, inventors are an important category of workers due to their central role in the production of innovation and technological progress, which ultimately drives economic growth (e.g., Romer 1990; Grossman and Helpman 1991; and Aghion and Howitt 1992). As such, it is economically important to understand whether corporate bankruptcies affect productive human capital that is embedded in inventor teams.

We have three main findings. First, bankruptcies lead to the loss of team-specific human capital. Corporate bankruptcies are associated with a disruption in team structure: team stability is reduced by about a third in the year of the bankruptcy filing and the year thereafter. Furthermore, inventors that tend to work in teams—those that have co-authored a significant share of patents with other inventors in the financially distressed firm—experience more negative effects on their productivity post-bankruptcy than inventors that rely less on team production. Indeed, we show that an inventor who used to co-author all patents with colleagues at the firm filing for bankruptcy experiences a 15 percent reduction in citations post-bankruptcy, relative to an inventor with no co-authorships within the bankrupt firm. We confirm that this drop in productivity occurs after the bankruptcy, not before. Moreover, there is no evidence that team-dependent inventors are of lower quality than their colleagues, as prior to bankruptcy, team-dependent inventors have higher productivity. We also document that team-dependent inventors are three percent less likely to remain active as inventors (by filing patents) after bankruptcy than those that rely less on teamwork. This suggests that team dissolution is an important, yet previously undocumented, cost associated with the process of resource reallocation through bankruptcies.

Second, we find that both the labor market and the market for corporate control appear to value team-specific human capital and encourage its preservation after bankruptcy. Specifically, inventors that tend to work in teams are more likely to co-locate with their team members post-bankruptcy, in particular if the inventors have collaborated in the production of valuable innovation. Moreover, firms where production is more dependent on teamwork pre-bankruptcy are more likely to be acquired (in whole or part) during bankruptcy, perhaps because doing so facilitates the preservation of human capital that is specific to teams.

Third, we find that inventors that co-locate with their team members after the bankruptcy innovate more, both compared to before the bankruptcy and relative to inventors that do not end up working at the same firm as their teammates. This increase in productivity may arise because teams that are more successful tend to survive. It is also conceivable that the new employer is less financially constrained and can direct more resources to the team than the previous employer.

Our results paint a nuanced picture of the reallocation of human capital through bankruptcy. Team dissolution increases around bankruptcy and team inventors become less productive than their less team-dependent colleagues. However, the labor market and the market for corporate control promote the preservation of team-specific human capital. Therefore, on balance, the productivity losses associated with bankruptcy are modest for team-dependent inventors. In addition, inventors who do not work in teams may even experience an increase in their post-bankruptcy productivity (although these effects have limited statistical significance). This suggests that bankruptcies have the capacity to release resources to more productive uses (e.g., Hotchkiss and Mooradian 1998). Overall, we conclude that frictions that limit the efficiency of asset reallocation through bankruptcy (e.g., Gertner and Scharfstein 1991; Aghion, Hart and Moore 1992; Shleifer and Vishny 1992) may be limited in the case of highly skilled labor.

We conduct a series of tests to alleviate the concern that the inventors in our sample are a non-randomly selected group; after all, bankruptcies are not exogenous. First, we redo our analysis on a subset of inventors whose employers are not R&D-intensive, that is, the firms' primary activity is not innovation. This reduces the reverse causality concern that bad inventor performance is the driver of the bankruptcy in the first place. Second, we restrict the sample to include only "star" inventors (defined as the top decile of all inventors by total number of patents filed during our sample period). This test alleviates the concern that our findings are driven by unproductive inventors being adversely affected by the bankruptcy-induced separation from highly productive team-members. Furthermore, because "star" inventors file patents frequently, this test also reduces concerns related to measurement error in the timing of recorded firm transitions of inventors (we infer inventors' careers from their patenting activity). Third, we confirm that our results are not driven by the selection of inventors that remain in the firm during financial distress. Note that our baseline tests define as "treated" those inventors that worked at the firm three years prior to the bankruptcy filing; strategic departures are significantly less common three years prior to the bankruptcy than in subsequent years (see Baghai, Silva, Thell, and Vig 2018). Despite this, we perform an additional test using a subsample of US states where courts strongly enforce non-compete clauses in labor contracts. In such states, high-skill workers are restricted in their ability to strategically time their exit prior to the bankruptcy event. We confirm our results in this setting. Overall, these tests alleviate the concern that our findings are purely driven by unobservable differences in the quality of inventors.

We perform several ancillary tests to assess the robustness of our findings. First, we show that the results are robust to different ways of constructing the sample. The main sample consists of inventors that experience a corporate bankruptcy at some point during the sample period (in the spirit of the analysis in Bertrand and Mullainathan 2003 and Giroud and Mueller 2015). Thus, inventors that are not encountering a bankruptcy yet act as a counterfactual for those that are currently experiencing a bankruptcy. The results also hold when, instead, we additionally include in the comparison group inventors that never experience a corporate bankruptcy during our sample period. Second, the results are unaffected when we restrict the sample to end in 2006, to avoid possible effects of the financial crisis. This also reduces concerns related to the mismeasurement of citations due to truncation (patents applied for and granted towards the end of the sample period have fewer opportunities to be cited). Finally, we perform several variations of our estimation, for example, by using alternative industry definitions and by clustering standard errors at the inventor (instead of the firm) level. In all cases, our main finding that bankruptcies have a negative impact on the productivity of team-dependent inventors relative to their non-team-dependent colleagues, remains statistically and economically significant.

Our study primarily contributes to the literature that studies the allocation of resources through bankruptcy. Most of this literature focuses on the reallocation of physical capital and (non-human) intangible assets in the economy.[4] Our paper is most closely related to two recent studies that shed light on the reallocation of general human capital through bankruptcy. Eckbo, Thorburn, and Wang (2016) analyze the careers of CEOs of firms that file for bankruptcy; they find that a large fraction of such CEOs leaves the executive labor market and suffer a large drop in their future compensation. Graham, Kim, Li, and Qiu (2016) document that manufacturing workers' earnings fall after a firm files for bankruptcy and that affected employees are likely to subsequently work less and leave the firm, industry, and local labor market. We contribute to this

[4] Studies examining the reallocation of physical capital and patents during bankruptcies include Gertner and Scharfstein (1991), Aghion, Hart, and Moore (1992), Shleifer and Vishny (1992), Benmelech and Bergman (2011), Birge, Parker, and Yang (2015), Bernstein, Colonnelli, Giroud, and Iverson (2018), Bernstein, Colonnelli, and Iverson (2019), Iverson (2017), and Ma and Wang (2017). Other work has highlighted bankruptcy externalities (Benmelech, Bergman, Milanez, and Mukharlyamov 2019; Babina 2015; Hacamo and Kleiner 2016).

literature by documenting the impact of bankruptcies on teamwork and human capital that is specific to collaborative relationships.

We also contribute to the body of research on innovation and its determinants. Previous work has identified several macroeconomic drivers of innovation.[5] We contribute to this literature by providing micro-level evidence of a specific channel—bankruptcy and the subsequent redeployment of team-specific human capital—through which corporate innovation and the process of creative destruction take place.

2. Data and variables

2.1 Main data sources

We combine several data sources containing patent data, information on individual inventors' careers, and data on firms' financials (including bankruptcy filings). The NBER patent database contains the application dates of granted patents, as well as information on the technology classes of patents. It also includes information on the assignee of the patent, which is typically the firm or subsidiary at which the research is conducted; the identifier corresponding to an assignee is unique and time-invariant. The NBER patent dataset also includes a link to Compustat for patent applications between 1975 and 2006 which enables us to link patent assignees to their corporate parents. For the years 2007 – 2010, we employ the Compustat link provided in Kogan, Papanikolaou, Seru, and Stoffman (2017). Citations to patents are from Lai, D'Amour, Yu, Sun, and Fleming (2011). In addition to citations-based measures of patent quality, we employ a measure of the economic value of patents based on the stock price reaction to the announcement of new patent grants; we obtain these data from Kogan, Papanikolaou, Seru, and Stoffman (2017).

The data on individual inventors are from Lai, D'Amour, Yu, Sun, and Fleming (2011). These data are based on information from the United States Patent and Trademark Office (USPTO)

[5] Prior studies have examined the role of patent law (Moser 2005), labor laws (Acharya, Baghai, and Subramanian 2013), bankruptcy codes (Acharya and Subramanian 2009), and the quality of institutions (Donges, Meier, and Silva 2016) for innovation. At the micro-level, access to finance (e.g., Kortum and Lerner 2000; Gompers and Lerner 2001; Kerr, Lerner, and Schoar 2014; Bernstein 2015; Hombert and Matray 2017), investors' tolerance for failure (Tian and Wang 2014), and the organizational structure of firms (Seru 2014) have also been shown to affect innovation. In a recent working paper, Liu, Mao, and Tian (2016) quantify the value added by individuals versus that of firms as drivers of innovation.

and encompass around 4.2 million patent records and 3.1 million inventors between 1975 and 2010. The dataset contains disambiguated inventor names and permits us to track the careers of inventors across firms. We define the place of employment of the inventor as the firm that a patent assignee belongs to. For example, an inventor that files a patent with firm A in 1999 and one with firm B in 2000 is designated as an employee of firm A in 1999 and as an employee of firm B in 2000. If more than one year passes between two patent filings, we assume that the employment transition between the two firms occurs at the midpoint between the patent application years.[6] Inventors are included in the sample for their entire active career, defined as the years between their first and last patent filings.

Information on bankruptcy filings is from the New Generation Research bankruptcy database and the UCLA-LoPucki Bankruptcy Research Database.[7] These databases contain, among other information, all bankruptcy filings of public US firms and asset sales occurring during the bankruptcy. We match the bankruptcies to Compustat and the NBER patent data using the name and EIN/Tax ID. Our source of corporate financial data is Compustat. We collect data on R&D spending, total assets, cash holdings, earnings, and leverage.

The final sample covers the period 1980 to 2010 and contains 300 public firms that file for Chapter 11 bankruptcy during this sample period. These firms employ 12,081 inventors three years prior to the bankruptcy. Figure 1 depicts the frequency of bankruptcy filings by year. We observe that the early 1990s, the early 2000s, and 2009 are the periods with the largest number of bankruptcy filings. This suggests that resource reallocation through bankruptcies primarily occurs during economic downturns. In Figure 2, we tabulate the bankruptcies by industry. Manufacturing is the industry with the largest number of bankruptcies, followed by transportation, communications, electricity and gas, and by the service industries. Within manufacturing, the top five sectors with the largest number of bankruptcies are (in descending order): electronic and other electrical equipment and components; industrial and commercial

[6] For example, if an inventor has a patent with firm A in 1995 and one with firm B in 2000 and no patents in between, we assume that the inventor is with firm A until 1997 and with firm B from 1998 onwards.

[7] The New Generation Research bankruptcy database covers bankruptcies from 1990 onwards, while the UCLA-LoPucki Bankruptcy Research Database starts in 1980. We combine information from both databases and use information for the years 1980 to 1989 from the UCLA-LoPucki Bankruptcy Research Database.

machinery and computer equipment; chemicals and allied products; measuring, analyzing and controlling instruments, photographic, medical, and optical goods; and transportation equipment.

2.2 Main variables

To conduct our analysis, we first identify the set of inventors that are directly affected by corporate bankruptcies. With a slight abuse of terminology (given the non-random nature of bankruptcies), we occasionally refer to such inventors as "treated." That is, if an inventor is present in a financially distressed firm three years prior to the bankruptcy filing, the inventor is permanently categorized as being in the "treatment" group.[8] The variable *Post bankruptcy* is a dummy variable that takes the value of one in the years after the bankruptcy filing for inventors in the bankruptcy group. It takes the value of zero in the year of the bankruptcy filing and before; it is also zero for inventors that were never employed by a bankrupt firm three years prior to bankruptcy (this latter group of inventors is used in robustness tests, see Section 3.4.3).

We employ several patent-based proxies to measure inventor productivity.[9] For a given inventor in a given year, the variable *Ln(Citations)* is defined as the natural logarithm of one plus the total number of citations (until 2010) obtained on all patents that the inventor applies for in that year. In addition, we also employ the variable *Ln(Patents)*, the natural logarithm of one plus the number of patents applied for by a given inventor in a given year. Citations, our main measure of innovation, reflect the importance of an invention, while the simple count of patents does not distinguish between important and less significant technological discoveries. Our final patent-based measure of innovation is *Ln(Citations per patent)*, the natural logarithm of one plus the average number of citations per patent for all patents that a given inventor applies for in a given year. As an additional way to measure the economic value of innovation, we employ the variable *Ln(Dollar value of patents)*, defined as the natural logarithm of one plus the cumulative dollar value of patents (in millions of nominal US dollars) that an inventor applies for in a given year; the

---

[8] In robustness tests, reported in Section 3.3.4, we define an inventor as "treated" when he or she is an employee of a financially distressed firm one year (instead of three) prior to the bankruptcy filing.

[9] There is a long tradition of using patents as proxies for innovative activity (e.g., Griliches 1981, Pakes and Griliches 1980, and Griliches 1990). Measures using information on citations are particularly well suited to capture the economic importance of an invention (e.g., Hall, Jaffe, and Trajtenberg 2005).

dollar value of each patent is obtained from Kogan, Papanikolaou, Seru, and Stoffman (2017). Following the literature, the year refers to the patent application year, and we only consider patents that are eventually granted (e.g., Hall, Jaffe, and Trajtenberg 2001). Citations are naturally censored because patents applied for in later sample years receive on average fewer citations than patents applied for in earlier years. This concern is addressed in two ways. First, we employ year-by-industry fixed effects in our tests (industry is defined at the four-digit SIC level). Second, the variable *Ln(Dollar value of patents)* does not suffer from the truncation problem.[10]

In this study, we are interested not only in the evolution of the productivity of team-dependent inventors following a bankruptcy, but, more generally, also in the impact of bankruptcies on their careers. For this purpose, we construct the variable *Stop inventing*, an indicator that takes the value of one in the year of the last patent application filed by a given inventor. For each pair of "treated" inventors that are employed at the same firm three years prior to bankruptcy, we also create the variable *Move together*, an indicator that takes the value of one if both inventors in the pair jointly move to the same new firm following the bankruptcy. The variable takes the value of zero if both inventors remain at the bankrupt (restructured) firm, or if they move to different firms post-bankruptcy, or if one of them stops inventing. Finally, to study the effect of bankruptcies on the likelihood that inventor teams break up, we construct the following variable. For each inventor *i* in year *t*, we determine the set of patents filed until year *t-4* and the identity of the co-authors of those patents that also worked with that inventor in the same firm in year *t-4*. The variable *Remain together* is defined as the fraction of the inventors that were both co-authors and coworkers of inventor *i* in year *t-4* that are still at the same firm in year *t*. This variable is a measure of team stability across inventors and over time.[11]

---

[10] In robustness tests, we perform tests in a sample that ends in 2006, which also alleviates concerns related to the data truncation in our main sample, which ends in 2010 (see Section 3.4.4). We also perform a robustness test on the industry definition and document that our results are qualitatively similar if we use individual inventors' primary technology classes to define industries (see Section 3.4.2).

[11] A priori, it is not clear what the best way to measure team stability is. In particular, it is unclear what the length of collaboration is that best describes a stable effective team. We choose four years because it strikes a balance between being long enough to plausibly capture meaningful team-specific human capital, while being short enough to not limit our sample period considerably. We note, however, that the pattern of team stability around bankruptcies that we obtain if we use a three-year period (instead of four years) to define this variable, is similar to that documented in Section 3.1.

In terms of explanatory variables, the focus of our analysis is on the role of team-specific human capital and how its evolution during bankruptcy subsequently relates to the productivity of inventors. We construct two measures that capture different aspects of team-specific human capital. First, *Team dependence* measures the extent to which an inventor collaborates with others at the firm before its bankruptcy. For an inventor that works at a financially distressed firm three years prior to its bankruptcy filing, this variable measures the share of that inventor's patents that are co-authored with other inventors that are also employed at that firm in that year; all co-authorships up to year three before the bankruptcy filing are considered in this calculation. For inventors that are not employed at a financially distressed firm three years prior to bankruptcy (this group of inventors is used in robustness tests, see Section 3.4.3), this variable takes the value of zero. *Team dependence* is constant within an inventor across time and ranges from zero to one. A value of zero indicates that none of the patents of an inventor are co-authored with other inventors that are also present at the bankrupt firm three years prior to the bankruptcy filing. In contrast, a value of one denotes that all patents of the inventor are produced with other inventors from the bankrupt firm. Therefore, a higher value of *Team dependence* indicates a higher level of team-specific human capital in an inventor's production function.

Our second measure of the importance of team production is *Stable team share*; this variable captures the stability of inventor teams that are affected by bankruptcy. For each inventor that works at the bankrupt firm three years prior to bankruptcy, this variable measures the fraction of other inventors employed by the same firm three years prior to bankruptcy that work together with that inventor at the same firm post-bankruptcy. Because simply having worked at the same firm is unlikely to be informative about the intensity of collaboration, we assign more weight to bankruptcy inventors that patented together. For inventors that are not employed by a bankrupt firm three years prior to its bankruptcy, this variable takes the value of zero. *Stable team share* thus captures both an intensive and an extensive margin of team stability and team-specific human capital. Formally, this variable is constructed as follows:

$$Stable\ team\ share_i = \frac{\sum_{j=1,i\neq j}^{N_f} Move\ together_{ij} \times Pair\ co-dependence_{ij}}{\sum_{j=1,i\neq j}^{N_f} Pair\ co-dependence_{ij}}$$

where N_f is the set of inventors that were at the financially distressed firm *f* in year three prior to bankruptcy. For two inventors *i* and *j* who were at a bankrupt firm in year three prior to the bankruptcy, *Pair co-dependence$_{ij}$* is defined as the share of patents of inventors *i* and *j* that are co-authored by both inventors *i* and *j*; it includes all patents of both inventors up to year three before the bankruptcy filing. *Move together$_{ij}$* is an indicator variable that takes the value of one if after the bankruptcy, inventors *i* and *j* are employed by the same new firm.

We create several additional measures of the economic value of collaborations at the level of inventor pairs. For each pair of inventors, the variable *Pair average citations* is defined as the natural logarithm of one plus the average number of citations obtained by the patents (filed until year three prior to bankruptcy) coauthored by the inventors in the pair. The variable *Pair total citations* captures the total number of forward citations obtained by all joint patents filed by the inventor pair until year three before bankruptcy. Similarly, the variables *Pair average dollar value of patents* and *Pair total dollar value of patents*, use the dollar value of patents to measure the average quality and total output of patents produced by each pair of inventors.

To measure work experience generally and an inventor's experience with patenting more specifically, we calculate the number of years between the current year and the year of the first patent filed by a given inventor. In our regressions, we include a set of fixed effects for years of experience as a way to capture possible non-linearities in the relationship between inventor productivity and experience (e.g., Bell, Chetty, Jaravel, Petkova, and Van Reenen 2019). In addition, in robustness tests we also employ the variable *Tenure at bankrupt firm,* which, for an inventor experiencing a corporate bankruptcy, is the number of years between the year the inventor joined the firm and year three prior to the bankruptcy filing.

We measure firm-level reliance on teamwork with the variables *Average team dependence*, the average of *Team dependence* at the firm level; and *Share of team-dependent inventors*, which is the share of all inventors at a firm that have above median *Team dependence*. Finally, to control for time-varying factors at the firm level that affect innovation, our main tests include a set of firm-by-year fixed effects. Moreover, in the firm-level regressions where we analyze the likelihood of asset sales under Section 363 of the Bankruptcy Code (Section 4.4), we control for the following firm characteristics. *Ln(Number of inventors)* is the natural logarithm of the number of inventors at the firm. *Firm size* is the natural logarithm of total assets; *ROA*, is defined as net income divided by total assets; *R&D intensity* denotes expenditures on research and development divided by total assets; *Cash ratio* is defined as cash and short term marketable securities divided by total assets; and, finally, *Leverage* is the sum of long term debt and debt in current liabilities divided by total assets. These firm-level control variables are winsorized at the 1st and 99th percentiles. We report summary statistics of these variables in Table 1. A summary of the variable definitions is provided in the Appendix.

3. Bankruptcies, team-dependence, and productivity

3.1 The impact of bankruptcies on team stability

We first examine how the stability of inventor teams evolves around bankruptcies. Many tasks, in particular knowledge-intensive tasks, do not happen in isolation. For example, Figure 3 shows that team production is an important aspect of patenting; indeed, the average number of inventors per patent has increased from 1.5 in 1975 to 2.3 in 2010. A bankruptcy is an event that is likely to impact the stability of teams: it may be difficult to retain the composition of a team in the restructuring firm or to transfer all of its members to a new firm post-bankruptcy. Instead, some teams may be dissolved in the event of bankruptcy. Although team dissolution may be an optimal outcome in cases where teams are not productive (e.g., Cornelli, Simintzi, and Vig 2016), frictions in the labor market and inefficiencies in the bankruptcy process may result in significant losses of team-specific human capital. For example, the new employer of some of the team members may be financially constrained and may not have the necessary resources to hire the entire team. Furthermore, a joint relocation of several inventors to a new firm requires considerable coordination, which may not be feasible due to individual inventors' idiosyncratic constraints. In that case, a bankruptcy event may lead to the destruction of team-specific human capital and, consequently, to a decline in the productivity of the affected inventors.

We focus on Chapter 11 bankruptcies in our analysis.[12] It is not clear ex ante to which extent this type of reorganization leads to the dissolution of teams. On the one hand, in a frictionless labor market, productive team configurations should be kept intact; on the other hand,

[12] Only 35 of the Chapter 11 bankruptcies in the sample eventually transition into Chapter 7, too few for a systematic analysis of the differences in outcomes between reorganizations and liquidations.

search and coordination costs together with financial constraints of the hiring firms may make it difficult for inventors to remain together. First, we document that Chapter 11 bankruptcies and the associated financial distress are severe events that are associated with deep changes in the operations of the firms in our sample. In Figure 4, we observe that as firms approach bankruptcy, their profitability decreases (Panel A) and their leverage increases (Panel B).[13] In addition, these firms tend to downsize, in terms of both physical assets (Panel C) and number of inventors (Panel D). In fact, the largest drop in the number of inventors employed by bankrupt firms occurs after year *t-1*, suggesting that bankruptcies may indeed lead to disruptions in the composition of production teams.

To shed light on the effect of bankruptcies on team-specific human capital, we test whether they are associated with an increase in the likelihood of team break-ups. Specifically, we study the variable *Remain together* around the time of bankruptcy; this variable measures the share of an inventor's co-authors from four years prior to any given year *t*, i.e., at *t-4*, that are still employed together in year *t*. A decrease in *Remain together* would suggest that bankruptcies negatively affect team stability.

The results are presented in Table 2. We find that the disruptive effect of bankruptcies on team composition is concentrated in the year of the bankruptcy and the year thereafter. Two years after the bankruptcy, inventors start forming new teams which are as stable as the (baseline) period prior to bankruptcy. In terms of magnitudes, the coefficients suggest that the fraction of past team members that remain together is lower by about 24 percentage points in the year of the bankruptcy and the following year, which constitutes a 27% reduction in team stability relative to the average fraction of team members that remain together in a typical year. Note that our estimation in Table 2 likely underestimates the effect of bankruptcy on team stability: these estimates condition on inventors remaining active in patenting. However, we show in Section 4.1 that there is an increased likelihood that inventors cease patenting after bankruptcy, especially if those inventors have high levels of *Team dependence*.

---

[13] Due to the reorganization and renegotiations that take place during bankruptcy, leverage decreases substantially following the bankruptcy filing date.

The results reported in Table 2 imply that bankruptcies have a negative impact on team stability. This effect is temporary and takes place in the years around the bankruptcy filing, suggesting that inventors may be able to join new teams soon after the bankruptcy event. However, the impact of the bankruptcy on their productivity may be long-lasting, especially if team-specific human capital takes time to build in newly formed teams. We investigate this issue in the next subsection.

3.2 The impact of bankruptcies on the productivity of team-reliant inventors

Do bankruptcies affect the post-bankruptcy productivity of inventors? In particular, does the organization of production in teams correlate with the productivity of inventors after a bankruptcy event? Corporate bankruptcies may be an important stimulant of creative destruction in the economy, as new ideas and ventures displace obsolete firms. Whether this process leads to an increase or a decrease in the productivity of individual inventors depends on whether the negative effects due to the bankruptcy (such as work disruption and loss of firm- and team-specific human capital) are outweighed by the gains from allocating the production inputs (labor and capital) to their new uses.

We study the evolution of the productivity of inventors that are directly affected by a bankruptcy. Corporate bankruptcies are staggered in time and occur in most of the sample years (see Figure 1); we can thus use inventors of firms that have not gone bankrupt *yet* as a control group for inventors of firms that are currently filing for bankruptcy. Because all inventors in this sample will at some point experience a bankruptcy event, we are comparing similar firms and inventors to each other.[14] The presence of a comparison group in our analysis allows us to account for industry-level and macroeconomic dynamics in the evolution of inventor productivity that occur in the absence of bankruptcy. Our main variable of interest is *Team dependence*, which measures the degree to which an inventor's innovation output depends on colleagues in the bankrupt firm (see Section 2 for details). A low value of *Team dependence* indicates that only a small amount of team-specific human capital is likely to be lost in the event of bankruptcy. In contrast, a high value of *Team dependence* implies high interdependence between the inventors of the

---

[14] In robustness tests, we also include in the sample inventors that never experience a bankruptcy event (see Section 3.4.3).

bankrupt firm, suggesting that team complementarities may be an important element of inventor productivity.

We first examine this issue graphically in Figure 5. This figure shows the role of team-specific human capital in explaining innovation around the time of bankruptcy. On the y-axis, the figure measures changes in *Ln(Citations)* per inventor relative to year *t-5* (five years prior to the bankruptcy filing), and on the x-axis, it plots the time relative to the bankruptcy filing year. The two horizontal lines show the average changes for the pre- and post-bankruptcy periods, respectively. We observe that from year four before, up to the year of the bankruptcy, inventors with many co-authors in the bankrupt firm are just as productive as they were five years prior to bankruptcy. However, after the bankruptcy, the productivity of inventors with many co-authors at the financially distressed firm diminishes significantly relative to the benchmark.

To investigate the role of team-specific human capital for post-bankruptcy inventor productivity in a regression framework, we use the following specification:

$$Ln(Citations)_{ift} = \alpha + \beta_1 \cdot Post\ bankruptcy_{it} + \beta_2 \cdot Post\ bankruptcy_{it} \times Team\ dependence_i\ + \\ +\ X_{ift}^{'}\gamma + \Psi_{ft} + \mu_i + \varepsilon_{ift}, \qquad (1)$$

where $Ln(Citations)_{ift}$ is the natural logarithm of one plus the number of forward citations of all new patents filed in year *t* by inventor *i* in firm *f*. *Post bankruptcy* is an indicator variable that takes the value of one in the years after the bankruptcy, and zero in the years prior to bankruptcy. The regression described by equation (1) further includes the following control variables: Ψ is a vector of firm-by-year fixed effects, which account for any time-varying, potentially unobservable firm characteristics that may affect innovation (such as a deterioration in the amount or quality of resources made available for research). μ are inventor fixed effects, which we include as a way to control for (time-invariant) differences in inventor characteristics that are unobservable to us. Finally, the matrix X contains dummies for the number of active years of an inventor, to account for any life-cycle related changes in inventor productivity. X also contains detailed 4-digit SIC industry–by–year fixed effects, which control for a variety of other potential confounding factors, such as the possibility that the incidence of bankruptcies may be higher in industries that are in decline, that the redeployability of human capital after bankruptcy may vary across industries and time, or that the value of inventor skills may be affected by industry dynamics.[15] Standard errors are clustered at the firm level to account for any correlation in error terms within firms.

The coefficient of interest is β_2; it is associated with the interaction between *Team dependence* and *Post bankruptcy* and measures whether the change in inventor productivity associated with bankruptcy depends on the implied loss of team-specific human capital. If such human capital were irrelevant for productivity or such human capital was not affected by bankruptcy, one would expect to find a coefficient of zero associated with this interaction term. On the other hand, if team-specific human capital is important and bankruptcy affects team stability (as documented in Table 2), then inventors whose work relies more on co-authorships within the financially distressed firm will be more negatively affected by the bankruptcy event.

We report results from this analysis in Table 3. Consistent with the view that team-specific human capital is a key determinant of post-bankruptcy inventor productivity, in column 1 we find a significantly negative coefficient associated with the interaction term *Post bankruptcy* × *Team dependence*. In terms of economic magnitude, an inventor who used to co-author all patents with colleagues at the firm filing for bankruptcy (for whom *Team dependence* takes the value of one) experiences a 15 percent reduction in citations post-bankruptcy, relative to an inventor with no co-authorships within the bankrupt firm. For an inventor with average team-dependence, however, the productivity loss amounts to a modest 1.2 percent. Another important result in column 1 of Table 3 is that the coefficient on the variable *Post bankruptcy* is not statistically significant. This suggests that on average, inventors without significant team-specific human capital do not experience a reduction in their innovation productivity after the bankruptcy.

The variable *Ln(Citations)* used in the specification reported in column 1 captures both the importance and quality of an innovation, as well as the quantity of patents produced.[16] It is

[15] In our main tests, industry is defined based on the SIC classification of the firm. This implies that firm-by-year fixed effects capture the information embedded in industry-by-year fixed effects. Even though industry-by-year fixed effects are redundant in these tests, we use equation (1) as our general regression formulation because its flexible form allows us to apply the same regression equation when conducting robustness tests, including those in Section 3.4.2 when industry will not correlate perfectly with the firm.

[16] For example, suppose that an inventor's output changes from one patent per year that receives two citations, to either three patents per year that each receive one citation, or, alternatively, one patent per year that receives three citations. Based on the measure *Ln(Citations)* employed in the regressions reported in column 1 of Table 3, both of these cases would suggest an equivalent increase in productivity.

possible, however, that a bankruptcy event affects the quality and quantity of subsequent innovation activity in different ways. For example, inventors may continue to produce patents, but these patents may turn out to be less cited, that is, economically less valuable, when team-specific human capital is lost due to the bankruptcy.

In columns 2 and 3 of Table 3, we examine whether bankruptcy affects the quantity and quality of innovation produced by inventors in different ways. We employ the same regression specification as in column 1 (corresponding to equation (1) above), but we consider a different set of dependent variables: *Ln(Patents)*, as a measure of the quantity of innovation output, and *Ln(Citations per patent)*, which measures the quality of patents produced. The coefficients reported in columns 2 and 3 imply that both the quantity as well as the quality of innovation significantly decrease for inventors for whom team complementarities are important, relative to inventors who do not work in teams. Based on the number of patent filings (column 2) and citations per patent (column 3), an inventor who exclusively patented with co-workers at the bankrupt firm experiences a drop in productivity of 6 and 12 percent, respectively. For the average inventor, the productivity loss amounts to less than one percent. As in column 1, we also find a statistically insignificant coefficient associated with the variable *Post bankruptcy* in columns 2 and 3, suggesting that inventors who did not work in teams in the bankrupt firm do not experience a change in their post-bankruptcy productivity.

In the regressions so far, we focused on patent-based measures of innovation productivity. As an alternative way to capture the impact of bankruptcies on the economic value of innovation produced by team inventors, we employ the variable *Ln(Dollar value of patents)* in the specification reported in column 4. This measure is based on the stock market reaction to the announcement of new patent grants (see Section 2 for details). In this specification, we observe similar effects as before, although the coefficient of interest is estimated less precisely.

The findings reported in Table 3 complement prior evidence on the effect of bankruptcies on worker human capital. Graham, Kim, Li, and Qiu (2016) report that after bankruptcy, workers experience a large decline in wages. While we do not study compensation, our results are indicative of more modest losses to human capital in the setting we consider. An important difference is that while we focus on highly skilled, highly mobile workers, Graham et al. study blue-collar workers for whom job loss may have more severe consequences. Our results also contrast with the findings in the literature that uses inventor deaths to study the impact of a destruction of team-specific human capital (Jaravel, Petkova, and Bell 2018). The smaller losses faced by team-dependent inventors in the aftermath of bankruptcy suggest that, unlike in the case of deaths, the labor market may play an important role in maintaining productive team configurations. We return to this point in Section 4, where we explicitly study the post-bankruptcy joint reallocation of inventor teams.

3.3 Inventor selection

A possible concern with our analysis is that firms that go bankrupt may employ inventors that are very different from inventors in firms that do not experience a bankruptcy. If, for example, inventors in firms that file for bankruptcy are of worse quality than inventors in firms that are not (yet) financially distressed, then what is interpreted as a "bankruptcy effect" should instead be attributed to selection. While bankruptcy events are not exogenous, there are several reasons why selection alone is unlikely to be driving our results. First, the regressions reported in Table 3 include inventor fixed effects, which control for any time-invariant unobservable characteristics of inventors, including differences in the ability of inventors employed by different firms. Second, we include 4-digit SIC industry-by-year fixed effects to account for the possibility that the value of inventor skills varies across industries and time. This implies that we are not simply capturing the effect of an industry in decline, which may be associated with a reduction in productivity that would occur independently of bankruptcy events. Third, firm-by-year fixed effects in our regressions alleviate concerns that firms that go bankrupt and those that are currently still viable are fundamentally different from each other, and that these differences are driving our results. Fourth, we focus on a sample of "eventually treated" inventors; that is, all inventors in our sample experience a bankruptcy at some point in their career, and they are thus similar along this dimension. Fifth, we do not observe a pre-trend in the productivity of team-dependent inventors until the year of the bankruptcy. The relative drop in productivity of team-inventors occurs after the bankruptcy filing year, but not before (Figure 5). Finally, to explain our findings, any inventor selection mechanism would have to take a rather specific and intricate form. For example, non-team inventors in firms currently going through bankruptcy would have to be of better quality (not worse) than those in firms not yet bankrupt. To further alleviate the concern that our results are being driven by selection considerations, we now conduct a series of additional tests.

3.3.1 Firms' innovation-intensity

In our setting, it is conceivable that the quality of inventors could be an important determinant of bankruptcy, especially for firms that rely on innovation. In that case, a bankruptcy event would be the result of low inventor quality and productivity. To alleviate this reverse causality concern, we focus on a subset of firms that have below median inventors per total assets in our sample. For these low innovation intensity firms, it is unlikely that poor inventor performance was responsible for the financial distress of the firm. The results, which employ *Ln(Citations)* as the measure of productivity, are presented in column 1 of Table 4; they show a similar pattern to those in Table 3, suggesting that this effect is unlikely to be driving our findings.

In addition, in column 2 of Table 4, we test whether in the absence of bankruptcy, team-dependent inventors are of worse quality than inventors who rely less on collaboration within the firm. If that were the case, it could explain their worse performance after bankruptcy. However, the results show that when we restrict the sample to the years prior to the bankruptcy filing, team-reliant inventors are on average more productive than non-team inventors.

3.3.2 Star inventors

To further address the concern that inventors at firms going through bankruptcy could be different, and, in particular, of worse quality than inventors of firms not yet in bankruptcy, we consider a sample of "star inventors." We define such inventors as follows. For all inventors in the dataset (including inventors that never experience a bankruptcy), we calculate the total number of patents granted over the period 1980 – 2010. We then define "star inventors" as those that belong to the top decile of inventors in terms of number of granted patents. If low quality inventors drove some of the previously discussed effects, we would not expect our results to hold when we restrict the sample to the set of the most productive inventors. On the other hand, if our results apply equally to all inventors (including star inventors), then we are more likely capturing a general "bankruptcy effect" rather than an effect attributable to heterogeneity in inventor quality.[17] The results are reported in column 3 of Table 4 and confirm our findings from earlier tests. Star inventors who have co-authored a large share of their patent portfolio with other inventors from the bankrupt firm experience a significant decrease in their innovation productivity post-bankruptcy relative to inventors that are less dependent on team production.

This test also alleviates the concern that our results may be affected by the way we infer inventor careers from their patenting activity. In particular, our methodology could be adding statistical noise to the estimates through the assumption that inventors switch firms at the midpoint of two consecutive patent filings in different firms. Because "star" inventors effectively file patents annually, this problem does not arise here.

3.3.3 Non-compete clauses

An additional selection concern in our setting is that some of the best individual inventors as well as the best teams of inventors may have left by the time the firm files for bankruptcy (Baghai, Silva, Thell, and Vig 2018). In that case, what we interpret as an impact of bankruptcies and team dissolution on inventor productivity may instead be driven by the type of teams that decide to remain in the firm until close to the bankruptcy filing date.[18]

In column 4 of Table 4, we test whether our results hold when we focus on a subsample of inventors that are employed in US states whose courts strongly enforce non-compete clauses in labor contracts.[19] In this subsample of inventors, the concern that the best may have endogenously chosen to abandon the firm early is diminished, as the best inventors and the best teams are

---

[17] We note that "star inventors" are over-represented in the sample as they tend to have long careers.

[18] Note that this effect would likely lead us to *underestimate* the "true" effect of team-specific human capital on post-bankruptcy productivity. If good inventors abandon the sinking ship early, yet team-specific human capital is valuable, then good team-reliant inventors would be more likely to stay than good non-team inventors. This would imply that our tests in Table 3 would be comparing good team-reliant inventors (who may suffer less from team breakup than the average inventor) to bad non-team reliant inventors, suggesting that the actual effect from team dissolution may be bigger absent this selection issue.

[19] Non-compete clauses (also called covenants not to compete) are contractual restrictions in employment contracts aimed at limiting an employee's ability to work for a competing firm or to start a competing business. The extent to which these clauses are enforceable differs across US states (for a recent discussion, see Jeffers 2017). In this test, we employ a time-varying state-level index measuring the extent to which non-compete clauses are enforced by courts in a given US state. The index is from Bird and Knopf (2015), who apply the same methodology to the index construction as Garmaise (2011) and extend his index from 1992 back to 1976; the index is available up to 2004, which means that the sample in column 4 of Table 4 covers the years 1980 – 2004. High enforceability states are those where the index is above the sample median, 4.

precisely the type of employees that are likely to have a non-compete clause in their employment contract. Our main result that *Team dependence* is negatively associated with post-bankruptcy productivity remains statistically and economically significant in this subsample. The fact that our results hold in the case of inventors that have contractual impediments to leaving the firm increases our confidence that our findings are not driven by selection.[20]

3.3.4 Alternative definition of "treated" inventors

To further establish that our results are not being driven by the selection of teams, we perform an additional variation of our estimation. We define as "treated" those inventors that were at the firm one year prior to bankruptcy. We confirm that our results are robust to this variation in column 5 of Table 4. When we use this alternative "treatment" group (defined at *t-1*, instead of *t-3* as in our main tests), the interaction between *Post bankruptcy* and *Team dependence* remains negative and economically and statistically significant, as in our main tests.

3.3.5 Discussion

Altogether, the evidence in this section suggests that the selection of inventor teams is unlikely to be driving our main finding that team dissolution following the bankruptcy is associated with a drop in productivity. However, we concede that we do not have a mechanism to observe exogenous bankruptcies nor to assign inventors randomly to firms. While we acknowledge that our interpretation may not be the only possible interpretation of the results, we believe that it represents the most plausible way to rationalize the full set of findings that we document.

3.4 Additional robustness tests

3.4.1 Team-specific human capital versus firm-specific human capital

As we have seen in Table 2, bankruptcies are associated with a change in the structure of research and development teams. Because this shock affects not only team stability but also other aspects of the firm, a concern that may arise is that what we attribute to team-specific human capital may instead be driven by firm-specific human capital. That is, while a bankruptcy may indeed result in the breaking up of successful innovator teams, the reduction in inventor productivity post-

[20] An additional indication that non-compete clauses are important in this setting is given by the positive coefficient on the variable *Post bankruptcy*. When non-compete clauses are binding, pre-bankruptcy reallocation is limited, thus, efficiency-enhancing employee departures concentrate after the bankruptcy.

bankruptcy may primarily stem from a loss of firm-specific human capital experienced by such inventors (e.g., the familiarity with firm-specific software or other complementarities between the inventor and the organization's assets). Moreover, because bankruptcies may lead to the dissolution of the firm, any organizational capital may also be lost around the time of the bankruptcy filing (e.g., Eisfeldt and Papanikolau 2013).

We believe that our tests effectively separate the impact of the bankruptcy-induced disruption to firm-specific human capital from the role played by team-specific human capital. The average effect on innovation attributable to firm-specific human capital and organizational capital is captured by the variable *Post bankruptcy* in our regressions. Furthermore, firm-specific human capital or organizational capital that is shared by all inventors within the firm should not affect our team variable, *Team dependence*. With this measure of team-specific human capital, we are identifying the differential effect of team dissolution on productivity that is incremental to the average effect of the bankruptcy-induced separation, which is captured by *Post bankruptcy*.

However, one may raise the concern that a higher value of *Team dependence* may itself proxy for the amount of firm-specific human capital: inventors with longer tenure at a firm may be more likely to co-author more with people at that firm; at the same time, those inventors may build up firm-specific human capital. To ensure that *Team dependence* is indeed a proxy for team-specific human capital and is not capturing firm-specific human capital, we implement an additional variation of our tests. We add to our regressions the variable *Tenure at bankrupt firm* as a proxy for firm-specific human capital, as well as its interaction with *Post bankruptcy*.[21]

The coefficient estimate on the term *Post bankruptcy* × *Tenure at bankrupt firm* is negative and statistically significant (column 1 of Table 5) suggesting that workers who have accumulated more firm-specific human capital may experience a larger reduction in their productivity post-bankruptcy. Importantly, *Post bankruptcy* × *Team dependence* remains statistically significant, with a magnitude similar to our baseline test in Table 3. It is also worth noting that in this specification the coefficient on the variable *Post bankruptcy* is economically large, positive, and statistically significant. This suggests that inventors that (i) do not have co-authorships at the bankrupt firm

[21] Note that our main specification already includes fixed effects for inventor experience to account for the (possibly non-linear) impact of inventor life cycle effects on productivity.

and that (ii) have not been at that firm for a long time (the average inventor tenure in our sample is eight years) tend to experience significant increases in productivity following the bankruptcy.

3.4.2 Alternative industry definition

In the results in Table 3, we use 4-digit SIC industry-by-year fixed effects to control for various unobservable factors that drive the evolution of inventor productivity at the industry level. A possible concern with this approach is that in some cases, the industry of the firm may not be a good representation of the technology in which different groups of inventors specialize in. For example, it could be that some inventors are working on technologies that are well-represented by the current industry definition of the firm, while other inventors within the same firm may be exploring new lines of research that could be more promising in the future. Assigning the same industry to such a diverse group of inventors could lead to biases.

To address this concern, we create measures of the technology class that best represent the innovation activity of each individual inventor. We do so by identifying the technology class (as defined by the Cooperative Patent Classification System) in which the inventor has produced the most patents until the current year. We then control for individual inventor technology class-by-year fixed effects. The results, presented in column 2 of Table 5, remain virtually unchanged when we perform this additional robustness test, suggesting that measurement error related to the industry definition is unlikely to drive our findings.

3.4.3 "Never-treated" inventors as comparison group

In our tests, we restrict the sample to inventors that experienced a bankruptcy at some point during the period 1980 to 2010. This serves to alleviate concerns that firms that file for bankruptcy and the inventors that work at these firms are fundamentally different from inventors that never experience bankruptcy. We now report estimates obtained when we use the entire population of inventors as a comparison group. Because this group now includes all inventors that were never employed by a firm three years prior to bankruptcy ("never-treated inventors"), the number of observations increases from about 105,000 to more than four million. The findings remain unchanged: the estimates in column 3 of Table 5 show that after bankruptcy, the decline in inventor productivity is concentrated among the group of inventors that had more team-specific human capital. Inventors without substantial team-specific human capital tend to experience a (statistically insignificant) productivity increase.

3.4.4 Shortened sample (1980 – 2006)

The NBER patent data, which we employ in our tests, end in 2010. Patent grants and citations are thus censored: the latter sample years may understate the productivity of inventors (patenting innovation takes time and patents granted towards the end of the sample have less opportunity to be cited). We address this issue in two ways: (i) by including time fixed effects in all regressions; and (ii) by studying the *Dollar value of patents*, which is a forward-looking measure not affected by censoring. We now perform an additional test that further addresses this concern.[22] We drop the last four years of the sample and end the analysis in 2006. Since most successful patent applications are granted within four years, patent applications that are made until 2006 (and approved by 2010) should provide an accurate representation of the innovation activity until 2006. In addition, by eliminating the years after 2006 we also ensure that our findings are not driven by the recent financial crisis and the recession that accompanied it. The estimates, presented in column 4 of Table 5, are similar to the ones obtained with the main sample.

3.4.5 Clustering of standard errors

In our main tests, we cluster standard errors at the firm level to account for any potential correlation between different workers of the same firm. In column 5 of Table 5, we show that our results also hold if instead we cluster standard errors at the individual inventor level.

4. Labor mobility and inventor careers after a bankruptcy

4.1 Inventor career terminations in the shadow of bankruptcy

The results in the previous section conditioned on inventors continuing to innovate post-bankruptcy: an inventor is included in the sample only from the year of the first patent filing to the year of the last patent filed. Yet, after a bankruptcy, some inventors may cease patenting altogether. Our previous tests did not specifically take this into account. For example, if an inventor's productivity relies on firm-specific human capital, a corporate bankruptcy may, in the

[22] Despite this robustness test, we note that it is difficult to envisage a reason for any potential bias to affect inventors with different levels of team-dependence differentially.

extreme, lead inventors to terminate their patenting career. In addition, if valuable team-specific human capital is destroyed due to the bankruptcy, inventors that are more dependent on teams may be especially prone to leave the profession. We study these questions in this section.

We analyze whether inventors that were employed at a bankrupt firm in year *t-3* relative to its bankruptcy filing ("treated" inventors) experience a reduction in the length of their careers as inventors; we employ a linear probability regression framework. The sample encompasses both "treated" inventors as well as inventors that never experience a corporate bankruptcy. The outcome variable is *Stop inventing*, a dummy variable which takes the value of one in a given year if an inventor ceases to invent (i.e., stops filing patents) after that year. As before, the regressions include firm-year fixed effects as well as 4-digit SIC industry-year fixed effects.[23] Further, we include fixed effects for the number of an inventor's active years, which account for the fact that older inventors may be more likely to stop inventing than young inventors. In these regressions, in the case of inventors in the bankruptcy group, we consider only observations for the period after the bankruptcy filing year: by construction, inventors that worked at a bankrupt firm prior to its bankruptcy filing could not have ended their careers before that.

We report the results in Table 6. In column 1, we find that inventors exposed to bankruptcy are not more likely to end their career compared to inventors with similar characteristics at similar firms that do not experience bankruptcy. In column 2, we test whether inventors that are more dependent on team production are more likely to cease patenting. Indeed, our estimates suggest that inventors who produced most of their patents with other inventors at the bankrupt firm are more likely to exit the profession following the bankruptcy. On average, the probability of stopping inventing in a given year is 13%. The estimates in column 2 imply that very team reliant inventors (who have produced all their patents with other co-authors at the bankrupt firm) experience a three percentage point increase ((-0.012+0.016)/0.131 = 3% relative to the sample average) in the likelihood of stopping inventing after the bankruptcy.

These findings confirm the importance of team-specific human capital for the post-bankruptcy careers of inventors: the share of patents co-authored with other inventors at the

[23] In these specifications, we do not control for inventor fixed effects because such variables would absorb the cross-sectional variation of interest, and we would instead capture a within-inventor *time-series* effect.

bankrupt firm positively affects the probability that the inventor stops inventing post-bankruptcy. As a caveat, it should be noted that patenting activity may not be a sufficient statistic for the productivity of inventors. That is, it is possible that inventors affected by bankruptcy do not stop inventing, but only stop patenting, choosing to protect their innovation with secrecy instead. While this is in principle consistent with the tests reported in Table 6, it is not obvious why the patenting-secrecy trade-off should be affected by the bankruptcy of the employer or by the level of an inventor's pre-bankruptcy team dependence.

4.2 Division sales and post-bankruptcy productivity

During the bankruptcy process, some firms may choose to sell entire divisions or even all substantial assets of the firm. Consequently, some of the respective inventor teams may stay together in the process. A common way for companies to sell entire operations during bankruptcy is through a "363 sale." This is the sale of the assets of an organization under Section 363 of the US Bankruptcy Code. In light of the previous results, we conjecture that the negative impact of bankruptcies for team players is more pronounced in the subsample of inventors whose division was not sold as a single unit. On the other hand, inventors whose entire team was acquired by another firm in the course of a "363 sale" may experience only small disruptions to their productivity, if any at all.

In Table 7, we divide the sample into inventors whose division was sold through a 363 sale process (columns 2, 4, 6, and 8) and inventors whose division was not acquired during the bankruptcy proceedings (columns 1, 3, 5, and 7). Out of 300 bankruptcies in our sample, 47 involve 363 sales. Reassuringly, and in line with previous results, we observe that when the entire division is acquired there is, on average, no significant drop in the post-bankruptcy productivity of inventors that depend on teams relative to those that do not. Instead, team-dependence and the negative effects of team dissolution on productivity are only substantial when divisions are not acquired as a whole.[24]

---

[24] This result is consistent with the findings in Maksimovic and Phillips (1998, 2001), who document the existence of an active and efficient market for the physical assets of manufacturing firms. Instead of focusing on physical capital, we complement these findings by studying human capital, in particular the redeployability of team-specific human capital.

It is plausible that team dissolutions are rarer and less severe in the case of 363 sales (in fact, a division may be acquired primarily with a view to hiring its staff; see section 4.4 below, and, e.g., Ouimet and Zarutskie 2016). However, it is also possible that even when an entire division is sold, many of the division's inventors may be dismissed in the course of its subsequent restructuring and integration within the new corporate owner. In the next subsections, we explicitly study whether past collaboration affects the likelihood of inventors moving together to a new firm, and how such team stability affects the post-bankruptcy productivity of inventors.

4.3 Inventor co-location and post-bankruptcy productivity

The reduction in innovation resulting from the dissolution of teams due to bankruptcy may be limited if inventors jointly move to a new firm. In that case, any team-specific human capital accumulated at the bankrupt firm will continue to be valuable in the new firm. Moreover, because the new employer may direct inventors' efforts to more promising technologies or alleviate financial constraints that may have limited R&D activity at the financially distressed firm, the reallocation of teams may in fact lead to an overall increase in efficiency and productivity.

To assess how team stability affects inventors' productivity after the bankruptcy of the employer, we test whether the productivity loss experienced by inventors that relied more on team production in the bankrupt firm is mitigated in cases where such inventors move together to a new employer. To this end, we employ the variable *Stable team share*, which measures the share of inventors of the bankrupt firm that move jointly to a new firm, weighed by their co-authorships. We first examine this question graphically. Figure 6 plots annual inventor productivity (as measured by number of citations) relative to the year *t-5*. The figure shows that inventors whose team-members co-locate after the bankruptcy experience an increase in productivity (compared to their output five years prior to the bankruptcy filing), relative to inventors whose team is dissolved.

Next, we examine this question in a regression setting. To do this, we additionally interact *Post bankruptcy* in equation (1) with the variable *Stable team share*. Table 8 reports the results. As in the previous section, we use four different measures of innovation output: *Ln(Citations)* in columns 1 and 2, *Ln(Patents)* in columns 3 and 4, *Ln(Citations per patent)* in columns 5 and 6, and *Ln(Dollar value of patents)* in columns 7 and 8.

Consistent with Figure 6, in column 1, we find that when team-specific human capital is preserved because inventors jointly move to new firms post-bankruptcy, productivity subsequently increases (relative to inventors whose co-authors do not co-locate with them). In column 2, we include both the interactions of *Post bankruptcy* with *Team dependence* and with *Stable team share*, respectively. As in Table 3, the interaction of *Post bankruptcy* with *Team dependence* is negative. Furthermore, the interaction of *Post bankruptcy* with *Stable team share* is positive (albeit not statistically significant). The coefficient estimates (taking into account both interaction terms) suggest that the net effect on innovation for team-reliant inventors of bankrupt firms is positive when a large share of team members co-locates after the bankruptcy. We find a similar pattern when we analyze the number of patents (in columns 3 and 4), citations per patent (in columns 5 and 6), and dollar value of patents (in columns 7 and 8). The estimates in column 8, for example, suggest that very team-reliant inventors (for whom the measure *Team dependence* is one) will experience an increase in productivity (as measured by the dollar value of patents) of 3.6% (-0.104 - 0.028 + 0.168) if their entire teams move together to a new firm. We note, however, that this is not the case for the average team-reliant inventor, whose productivity decreases.

Post-bankruptcy co-location is an endogenous decision, as is the decision to acquire an entire division. If only successful teams consisting of prolific inventors remain together after a bankruptcy, then the concern may arise that what we are capturing in Table 8 is a comparison of the productivity of good inventors (after the bankruptcy) to the productivity of average inventors in the pre-bankruptcy firm. This alternative explanation based on selection on time-invariant ability of inventors in bankrupt and non-bankrupt firms cannot account for the findings due to the inclusion of inventor fixed effects in the regressions. However, one can ask whether teams whose productivity is likely to increase in the future are more likely to remain together, while dysfunctional teams may be more likely to be dismantled. In other words, it is conceivable that time-varying unobservables may be the reason that the most valuable teams remain together. Investigating the ability of the labor market to identify and preserve productive teams is precisely what we are interested in, in this section. To analyze this issue further, in the next subsection, we directly examine the selection of inventors that move together post-bankruptcy.

4.4 Are well-established and productive inventor teams more likely to co-locate post-bankruptcy?

In light of the role played by team-specific human capital for the post-bankruptcy productivity of inventors, we ask whether the labor market recognizes the value of teams in the sense that more productive team configurations tend to be retained post-bankruptcy. Because inventor productivity is enhanced in the case of joint mobility, one may expect the labor market to attempt to preserve the valuable team-specific human capital, resulting in inventors being hired in groups, instead of individually.

To shed light on this question, we proceed as follows. First, for each bankruptcy event, we create all possible pairs of inventors that are employed by the firm in year *t-3* relative to bankruptcy, and that remain active post-bankruptcy.[25] We then construct the variable *Pair co-dependence*, a pairwise measure of team-specific human capital, by calculating the share of patents of the pair that is co-authored by its constituent members up to year three prior to the bankruptcy. We use this measure to test whether inventors that work closely together in the firm pre-bankruptcy are more likely to move together to a new employer post-bankruptcy. In this test, each inventor pair enters the sample once and the dependent variable of interest, *Move together*, is an indicator that takes the value of one if the firm to which the two inventors move after the bankruptcy is the same for both inventors in the pair.

Results are reported in Panel A of Table 9. Column 1 reports the coefficients from a regression specification without any controls, and the specification reproduced in column 2 includes fixed effects for each bankrupt firm. Consistent with the conjecture that the labor market recognizes the importance of team-specific human capital, we find that in cases where co-authorships are important, inventors are indeed more likely to move together to the same firm after the bankruptcy. In terms of magnitude, the coefficient reported in column 1 implies that an inventor pair that has produced all patents together pre-bankruptcy is 10% more likely to co-locate than a pair that has no co-authored patents and for whom separation is likely to have a negligent impact on productivity (according to our previous analyses in Table 3).

[25] For example, a firm with four inventors has six possible inventor pairs.

It may not be possible to record joint-location decisions of workers involved in bankruptcies close to the end of the sample, as those career switches may occur after 2010. In that case, we could be biasing our estimates by falsely assuming that team-dependent inventors do not move together, even if they eventually do. To address this possibility, in columns 3 and 4 of Table 9, we redo the analysis of columns 1 and 2, but consider only inventors whose firm filed for bankruptcy before the year 2000, giving us at least 10 years of subsequent data to identify joint mobility. The results confirm the findings of columns 1 and 2.

The variable *Pair co-dependence* primarily measures team stability but may not capture team productivity. Two inventors that patent all their patents together will be assigned the highest value of *Pair co-dependence*, even if the patents they produce are of little value. To better capture the ability of the labor market to maintain productive team configurations, we create several additional measures of pairwise productivity. In Panel B of Table 9, instead of *Pair co-dependence* we use the variable *Pair average citations*, which measures the average quality of the patents jointly produced by each inventor pair (using citations). Panel C employs *Pair total citations*, which is similar to the measure employed in Panel B but uses the total citations of an inventor pair rather than the average. Finally, in panels D and E of Table 9, we create similar measures of innovation quality and quantity at the level of inventor pair using dollar value of patents instead of citations. In all panels, we find a positive correlation between measures of value of team production and joint relocation.

The results in columns 1 to 4 of Panels A to E of Table 9 could be driven by two non-mutually exclusive mechanisms. On the one hand, corporate acquirers may understand the value of team production and acquire entire divisions through a 363 sale. On the other hand, teams of inventors may be able to relocate jointly, even in the absence of a division sale, if the labor market values team-specific human capital and is able to preserve it. To disentangle these alternative mechanisms, we do an additional test in columns 5 and 6 of each panel. We exclude from the sample all pairs of inventors whose firm was involved in a "363 sale." We find that the probability of joint relocation is positively correlated with joint output, even in the absence of an acquisition; the point estimates are similar in magnitude to those in the full sample. This suggests that the continuation of past collaboration is facilitated not only through the market for corporate control, but also through matching in the labor market.

To understand the role that the market for corporate control plays in the preservation of team-specific human capital, in Table 10, we test whether firms that rely more on team collaborations at the time of bankruptcy are more likely to be acquired via a 363 sale. We construct two measures of team-intensity in production at the firm level: *Average team dependence*, the average of the variable *Team dependence* across all inventors of the firm at *t-3*; and *Share of team-dependent inventors*, the share of inventors of the firm at *t-3* that are above the median of *Team dependence* for all "treated" inventors in the sample. Across the various specifications reported in Table 10, we find a positive association between the degree to which a firm relies on team production and the probability of a 363 sale. In sum, based on the evidence in Tables 9 and 10, we conclude that both the market for corporate control, as well as the labor market, play an important role in preserving valuable team-specific human capital.

5. Conclusion

In this paper, we analyze the impact of corporate bankruptcies on the allocation of resources and the organization of production by tracking the careers and productivity of inventors employed by firms that file for bankruptcy. Many economists highlight the role of general and firm-specific human capital as determinants of productivity (e.g., Becker 1975; Topel 1991). Our study provides evidence that another important aspect to consider in the context of knowledge-intensive tasks, such as innovation, is the existence of complementarities that do not span the entire firm, but that occur at the team level, giving rise to team-specific human capital. We find that team stability (or lack thereof) is a crucial factor in determining whether there is more knowledge creation than destruction when human capital is reallocated through bankruptcy. When teams are dissolved and inventors that had previously worked together part ways, innovation decreases. This effect is mitigated when inventors that have active working relations move together to a different firm post-bankruptcy. In fact, our estimates imply that full preservation of team-specific human capital through joint mobility of the whole inventor team is associated with a subsequent increase in inventor productivity.

A key finding of our paper is that the labor market for inventors takes the importance of teams into account: inventors with strong complementarities (as measured by the quantity and quality of their past joint output) are more likely to be hired together, and firms (or divisions) are more likely to be sold as a unit during the bankruptcy proceedings if teamwork is a prominent feature of the organization. This points to the existence of market forces that promote and preserve the stability of productive teams. Our results highlight the importance of team-specific human capital for the production of knowledge and suggest that the market for corporate control and the labor market promote the efficient continuation of well-attuned inventor teams.

References

Acharya, V., Baghai, R., Subramanian, K., 2013. Labor laws and innovation. Journal of Law and Economics 56, 997-1037.

Acharya, V., Subramanian, K., 2009. Bankruptcy codes and innovation. Review of Financial Studies 22, 4949–4988.

Aghion, P., Hart, O., Moore, J., 1992. The economics of bankruptcy reform. Journal of Law, Economics and Organization 8 (3), 523-546.

Aghion, P., Howitt, P. 1992. A model of growth through creative destruction. Econometrica 60, 323–351.

Azoulay, P., Zivin, J., Wang, J., 2010. Superstar extinction. Quarterly Journal of Economics 125, 549-589.

Azoulay, P., Fons-Rosen, C., Zivin, J., 2018. Does science advance one funeral at a time? American Economic Review, forthcoming.

Babina, T., 2015. Destructive creation at work: How financial distress spurs entrepreneurship. Working paper.

Baghai, R., Silva, R., Thell, V., Vig, V., 2018. Talent in distressed firms: Investigating the labor costs of financial distress. Working paper.

Bartel, A., Beaulieu, N., Phibbs, C., Stone, P., 2014. Human capital and productivity in a team environment: evidence from the healthcare sector. American Economic Journal, Applied Economics 6, 231.

Becker, G., 1975. Human capital: A theoretical and empirical analysis, with special reference to education, Second Edition. NBER.

Bell, A., Chetty, R., Jaravel, X., Petkova, N., Van Reenen, J., 2019. Who becomes an inventor in America? The importance of exposure to innovation. The Quarterly Journal of Economics, 134, 647-713

Benmelech, E., Bergman, N., 2011. Bankruptcy and the collateral channel. Journal of Finance 66, 337-378.

Benmelech, E., Bergman, N., Milanez, A., Mukharlyamov, V., 2019. The agglomeration of bankruptcy. Review of Financial Studies, forthcoming.

Berman, S., Down, J., Hill, C., 2002. Tacit knowledge as a source of competitive advantage in the National Basketball Association. Academy of Management Journal 45, 13-31.

Bernstein, S., 2015. Does going public affect innovation? Journal of Finance 70, 1365-1403.

Bernstein, S., Colonnelli, E., Giroud, X., Iverson, B., 2018. Bankruptcy spillovers. Journal of Financial Economics, forthcoming.

Bernstein, S., Colonnelli, E., Iverson, B., 2019. Asset allocation in bankruptcy. Journal of Finance, 74, 5-53.

Bertrand, M., Mullainathan, S., 2003. Enjoying the quiet life? Corporate governance and managerial preferences. Journal of Political Economy 111, 1043-1075.

Bird, R., Knopf, J., 2015. The impact of local knowledge on banking. Journal of Financial Services Research 48, 1-20.

Birge, J., Parker, R., Yang, S., 2015. The supply chain effects of bankruptcy. Management Science 61, 2320-2338.

Bloom, N., Draca, M., Van Reenen, J., 2016. Trade induced technical change? The impact of Chinese imports on innovation, IT and productivity. The Review of Economic Studies, 83(1), 87-117.

Boning, B., Ichniowski, C., Shaw, K., 2007. Opportunity counts: Teams and the effectiveness of production incentives. Journal of Labor Economics 25, 613-650.

Brown, J., Matsa, D., 2016. Boarding a sinking ship? An investigation of job applications to distressed firms. Journal of Finance 71, 507–550.

Brown, J., Matsa, D., 2017. Locked in by leverage: Job search during the housing crisis. Working paper.

Card, D., DellaVigna, S., 2013. Nine facts about top journals in economics. Journal of Economic Literature, 51(1), pp.144-161.

Cornelli, F., Simintzi, E., Vig, V., 2016. Team stability and performance: Evidence from private equity. Working paper.

Donges, A., Meier, J.-M., Silva, R., 2016. The impact of institutions on innovation. Working paper.
Eckbo, B., Thorburn, K., Wang, W., 2016. How costly is corporate bankruptcy for the CEO?. Journal of Financial Economics, 121(1), pp.210-229.
Eisfeldt, A., Papanikolaou, D., 2013. Organization capital and the cross-section of expected returns. Journal of Finance 68, 1365-1406.
Feng, J., Jaravel, X., 2017. Crafting intellectual property rights: Implications for patent assertion entities, litigation, and innovation. Working Paper.
Galasso, A., Schankerman, M. (2015). Patents and cumulative innovation: Causal evidence from the courts. The Quarterly Journal of Economics, 130(1), 317–369.
Garmaise, M., 2011. Ties that truly bind: Noncompetition agreements, executive compensation, and firm investment. Journal of Law, Economics, & Organization 27, 376-425.
Gertner, R., Scharfstein, D., 1991. A theory of workouts and the effects of reorganization law. The Journal of Finance 46(4), 1189-1222.
Giroud, X., Mueller, H., 2015. Capital and labor reallocation within firms. The Journal of Finance, 70(4), 1767-1804.
Gompers, P., Lerner, J., 2001. The venture capital revolution. Journal of Economic Perspectives 15, 145-168.
Gompers, P., Gornall, W., Kaplan, S., Strebulaev, I. How Do Venture Capitalists Make Decisions? Journal of Financial Economics, forthcoming.
Graham, J., Kim, H., Li, S., Qiu, J., 2016. Employee costs of corporate bankruptcy. Working paper.
Griliches, Z., 1981. Market value, R&D, and patents. Economics Letters 7, 183–187.
Griliches, Z., 1990. Patent statistics as economic indicators: A survey. Journal of Economic Literature 28, 1661–1707.
Grossman, G., Helpman, E. 1991. Innovation and growth in the global economy. Cambridge: MIT Press.
Hacamo, I., Kleiner, K., 2016. Finding success in tragedy: Forced entrepreneurs after corporate bankruptcy. Working paper.
Hall, B., Jaffe, A., Trajtenberg, M., 2001. The NBER patent citations data file: Lessons, insights and methodological tools. Working paper, NBER.
Hall, B., Jaffe, A., Trajtenberg, M., 2005. Market value and patent citations. RAND Journal of Economics 36, 16–38.
Hamilton, B., Nickerson, J., Owan, H., 2003. Team incentives and worker heterogeneity: An empirical analysis of the impact of teams on productivity and participation. Journal of Political Economy 111, 465-497.
Hombert, J., Matray, A., 2017. The real effects of lending relationships on innovative firms and inventor mobility. Review of Financial Studies, 30, 2413-2445.
Hortaçsu, A., Matvos, G., Syverson, C., Venkataraman, S., 2013. Indirect costs of financial distress in durable goods industries: The case of auto manufacturers. Review of Financial Studies 26, 1248-1290.
Hotchkiss, E., Mooradian, R., 1998. Acquisitions as a means of restructuring firms in Chapter 11. Journal of Financial Intermediation 7, 240-262.
Iverson, B., 2017. Get in line: Chapter 11 restructuring in crowded bankruptcy courts. Management Science.
Jaravel, X., Petkova, N., Bell, A., 2018. Team-specific capital and innovation. American Economic Review, 108(4-5), pp.1034-73.
Jeffers, J., 2017. The impact of restricting labor mobility on corporate investment and entrepreneurship. Working paper.
Kerr, W., Lerner, J., Schoar, A., 2014. The consequences of entrepreneurial finance: Evidence from angel financings. Review of Financial Studies 27, 20-55.
Kogan, L., Papanikolaou, D., Seru, A., Stoffman, N., 2017. Technological innovation, resource allocation, and growth. The Quarterly Journal of Economics, 132(2), pp.665-712.

Kortum, S., Lerner, J., 2000. Assessing the contribution of venture capital to innovation. RAND Journal of Economics 31, 674-692.

Lai, R., D'Amour, A., Yu, A., Sun, Y., Fleming, L., 2011. Disambiguation and co-authorship networks of the U.S. patent inventor database (1975 - 2010). Working paper, Harvard Dataverse, V5.

Lazear, E., Shaw, K., 2007. Personnel economics: The economist's view of human resources. Journal of Economic Perspectives 21, 91-114.

Liu, T., Mao, Y., Tian, X., 2016. The role of human capital: The case of patent generation. Working paper.

Ljungqvist, L., Sargent, T., 1998. The European unemployment dilemma. Journal of Political Economy 106, 514-550.

Ma, S., Wang, W., 2017. Selling innovation in bankruptcy. Working paper.

Maksimovic, V., Phillips, G., 1998. Asset efficiency and reallocation decisions of bankrupt firms. The Journal of Finance 53, 1495-1532.

Maksimovic, V., Phillips, G., 2001. The market for corporate assets: Who engages in mergers and asset sales and are there efficiency gains? The Journal of Finance, 56(6), pp.2019-2065.

Moser, P., 2005. How do patent laws influence innovation? Evidence from nineteenth-century world's fairs. American Economic Review 95, 1214-1236.

Ouimet, P., Zarutskie, R., 2016. Acquiring labor. Working paper.

Pakes, A., Griliches, Z., 1980. Patents and R&D at the firm level: A first report. Economics Letters 5, 377–381.

Romer, P., 1990. Endogenous technological change. Journal of Political Economy 98, 71–102.

Seru, A., 2014. Firm boundaries matter: Evidence from conglomerates and R&D activity. Journal of Financial Economics 111, 381-405.

Shleifer, A., Vishny, R., 1992. Liquidation values and debt capacity: A market equilibrium approach. The Journal of Finance 47(4), 1343-1366.

Tian, X., Wang, T., 2014. Tolerance for failure and corporate innovation. Review of Financial Studies 27, 211-255.

Topel, R., 1991. Specific capital, mobility, and wages: Wages rise with job seniority. Journal of Political Economy 99, 145-176.

White, M., 1989. The corporate bankruptcy decision. Journal of Economic Perspectives 3, 129-151.

Table 1: Summary statistics

This table presents summary statistics. *Remain together* is the fraction of the inventors that were both co-authors and co-workers of a given inventor in year $t-4$ that are still at the same firm in year t. *Ln(Citations)* is the natural logarithm of one plus the total number of citations (until 2010) obtained on all patents that a given inventor files in a given year. *Ln(Patents)* is the natural logarithm of one plus the sum of patents applied for (and ultimately granted) by a given inventor in a given year. *Ln(Citations per patent)* is the natural logarithm of one plus the average number of citations per patent for all patents that an inventor applies for in a given year. *Ln(Dollar value of patents)* is the natural logarithm of one plus the cumulative dollar value of patents (in millions of nominal U.S. dollars) that an inventor applies for in a given year (Kogan, Papanikolaou, Seru, and Stoffman 2017). *Experience* is the number of years between the current year and the year of the first patent filing by a given inventor. *Post bankruptcy* is an indicator variable that takes the value of one in the years after bankruptcy, and zero in the years prior to bankruptcy. *Team dependence* is the share of an inventor's patents that are co-authored with other inventors that were also at the bankrupt firm in year three before bankruptcy. *Stable team share* measures the stability of innovation teams post-bankruptcy. *Tenure at bankrupt firm* counts the number of years between year three prior to bankruptcy and the year an inventor first joins the bankrupt firm. For each pair of inventors, *Move together* is a dummy variable that takes the value of one if the two inventors in the pair move to the same new firm after bankruptcy. For each pair of inventors who were at the same firm in year three prior to the bankruptcy filing we define the following variables: *Pair co-dependence* is the share of patents that the two inventors have co-authored until year three prior to the bankruptcy; *Pair average citations* is the natural logarithm of one plus the average citations of the patents co-authored by the pair of inventors until year three prior to the bankruptcy; *Pair total citations* is the natural logarithm of one plus the total citations of the patents co-authored by the pair of inventors until year three prior to the bankruptcy; *Pair average dollar value of patents* is the natural logarithm of one plus the average dollar value of the patents co-authored by the pair of inventors until year three prior to the bankruptcy; *Pair total dollar value of patents* is the natural logarithm of one plus the total dollar value of the patents co-authored by the pair of inventors until year three prior to the bankruptcy. *363 sale* is a dummy variable which takes the value of one if the firm sold assets under Section 363 of the US Bankruptcy Code. *Average team dependence* is the average of *Team dependence* across all inventors of the firm three years prior to bankruptcy. *Share of team-dependent inventors* is the share of inventors of the firm in the year three prior to bankruptcy that have a value of *Team dependence* above the sample median. *Ln(Number of inventors)* is the natural logarithm of number of inventors at the firm. *Firm size* is the natural logarithm of total assets. *ROA* is net income divided by total assets. *R&D intensity* is expenditures on research and development divided by total assets. *Cash ratio* is cash and short term investments divided by total assets. *Leverage* is the sum of short and long term debt divided by total assets. The sample spans the period 1980 to 2010. The sample construction and variables are described in detail in Section 2 of the paper and Appendix A.

Variable	Obs.	Mean	SD
Remain together	58,714	0.911	0.165
Ln(Citations)	105,277	0.571	1.151
Ln(Patents)	105,277	0.314	0.486
Ln(Citations per patent)	105,277	0.486	0.988
Ln(Dollar value of patents)	105,277	0.372	0.898
Experience	105,277	8.594	7.212
Post bankruptcy	105,277	0.115	0.319
Team dependence	105,277	0.077	0.256
Stable team share	105,277	0.009	0.082
Tenure at bankrupt firm	105,277	7.803	6.867
Move together	1,188,919	0.003	0.056
Pair co-dependence	1,188,919	0.002	0.029
Pair average citations	1,188,919	0.011	0.165
Pair total citations	1,188,919	0.013	0.196
Pair average dollar value of patents	1,188,919	0.006	0.100
Pair total dollar value of patents	1,188,919	0.007	0.128
363 sale	247	0.162	0.369
Average team dependence	247	0.399	0.424
Share of team-dependent inventors	247	0.363	0.403
Ln(Number of inventors)	247	2.328	1.276
Firm size	247	5.601	1.999
ROA	247	-0.148	0.228
R&D intensity	247	0.079	0.108
Cash ratio	247	0.156	0.206
Leverage	247	0.358	0.212

Table 2: Team dissolution around corporate bankruptcies

This table shows the impact of corporate bankruptcies on team stability. The dependent variable is *Remain together*, which is the share of an inventor's co-authors from four years ago ($t-4$) that are still employed at the same firm today (t). *t_0 to t+1* is a dummy variable that takes the value of one during the year of the bankruptcy filing (t_0) and the year after (t+1). *t+2 and after* is a dummy variable that takes the value of one two years post bankruptcy and thereafter. The t-statistics in parentheses are calculated based on standard errors clustered at the firm level. Statistical significance at 1%, 5%, and 10% is market with ***, **, and * respectively.

	Remain together
t_0 to t+1	-0.241***
	(-9.5)
t+2 and after	0.005
	(0.2)
Inventor F.E.	Y
Firm × Year F.E.	Y
Industry × Year F.E.	Y
Experience F.E.	Y
Adjusted R^2	0.945
Observations	58,714

Table 3: The impact of team dependence on the post-bankruptcy productivity of inventors

This table shows the impact of team dependence on inventor productivity after bankruptcy. Productivity is measured using *Ln(Citations)* in column 1, *Ln(Patents)* in column 2, *Ln(Citations per patent)* in column 3, and *Ln(Dollar value of patents)* in column 4. *Post bankruptcy* is an indicator variable that takes the value of one in the years after bankruptcy, and zero in the years prior to bankruptcy. *Team dependence* is a measure of the team-specific human capital accumulated at the financially distressed firm by a given inventor. All variables and the sample construction are detailed in Section 2 of the paper and in Appendix A. The t-statistics in parentheses are calculated based on standard errors clustered at the firm level. Statistical significance at 1%, 5%, and 10% is market with ***, **, and *, respectively.

	(1) Ln(Citations)	(2) Ln(Patents)	(3) Ln(Citations per patent)	(4) Ln(Dollar value of patents)
Post bankruptcy	0.129	0.045	0.104	-0.072
	(1.3)	(1.5)	(1.3)	(-0.9)
Post bankruptcy × Team dependence	-0.150***	-0.059***	-0.120***	-0.048*
	(-4.5)	(-5.2)	(-4.2)	(-1.9)
Inventor F.E.	Y	Y	Y	Y
Firm × Year F.E.	Y	Y	Y	Y
Industry × Year F.E.	Y	Y	Y	Y
Experience F.E.	Y	Y	Y	Y
Adjusted R^2	0.318	0.362	0.310	0.308
Observations	105,277	105,277	105,277	105,277

Table 4: Team dependence and the post-bankruptcy productivity of inventors: inventor selection

This table presents additional results on the impact of team dependence on inventor-level productivity after bankruptcy. *Post bankruptcy* is an indicator variable that takes the value of one in the years after the bankruptcy filing, and zero in the years prior to bankruptcy. *Team dependence* is a measure of the team-specific human capital accumulated at the financially distressed firm. In column 1, we focus on a subset of firms whose main activity is not innovation, which are defined with below median inventors per total assets. In column 2, we test whether team-dependent inventors are less productive in the period preceding the year of the bankruptcy filing. In column 3, we restrict the sample to "star inventors," defined as those that are in the top 10% of U.S. inventors in terms of number of filed patents in our sample time frame. In column 4, we focus on the sub-sample of inventors who are located in US states that have high enforcement of non-compete clauses in labor contracts. In column 5, we define as "treated" those inventors that were at the firm one year prior to bankruptcy. The t-statistics in parentheses are calculated based on standard errors clustered at the firm level. Statistical significance at 1%, 5%, and 10% is market with ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)
			Ln(Citations)		
Post bankruptcy	0.047		0.141	0.354***	0.069
	(0.4)		(0.9)	(3.2)	(0.7)
Post bankruptcy × Team dependence	-0.123***		-0.139**	-0.180***	-0.133**
	(-3.4)		(-2.4)	(-5.6)	(-2.1)
Team dependence		0.058***			
		(2.9)			
Inventor F.E.	Y	N	Y	Y	Y
Firm × Year F.E.	Y	Y	Y	Y	Y
Industry × Year F.E.	Y	Y	Y	Y	Y
Experience F.E.	Y	Y	Y	Y	Y
Adjusted R^2	0.323	0.263	0.292	0.309	0.305
Observations	74,780	88,258	45,926	91,450	69,525

Table 5: Team dependence and the post-bankruptcy productivity of inventors: robustness tests

This table examines the robustness of the impact of team dependence on inventor-level productivity after bankruptcy. *Post bankruptcy* is an indicator variable that takes the value of one in the years post bankruptcy, and zero in the years prior to bankruptcy; it takes the value of zero for inventors that never experienced bankruptcy (column 3). *Team dependence* is a measure of the team-specific human capital accumulated at the financially distressed firm. In column 1, we add inventor's tenure at the bankrupt firm and its interaction with *Post bankruptcy* to our regression specification. In column 2, we control for individual inventor technology class-by-year fixed effects, where technology class is defined by sorting inventors into the categories of the Cooperative Patent Classification. In column 3, we include in the control group all the inventors who have not experienced bankruptcy during the sample period. In column 4, the sample is restricted to end in 2006. In column 5, we cluster the standard errors at the individual inventor level rather than at the firm level. All variables and sample construction are detailed in Section 2 of the paper and Appendix A. The t-statistics in parentheses are calculated based on standard errors clustered at the firm level in columns 1 to 4, and at the individual inventor level in column 5. Statistical significance at 1%, 5%, and 10% is market with ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)
			Ln(Citations)		
Post bankruptcy	0.224**	0.158*	0.045	0.118	0.129
	(2.0)	(1.7)	(1.2)	(1.1)	(1.6)
Post bankruptcy × Team dependence	-0.163***	-0.124***	-0.149***	-0.146***	-0.150***
	(-4.8)	(-3.9)	(-4.1)	(-4.1)	(-3.1)
Post bankruptcy × Tenure at bankrupt firm	-0.013**				
	(-2.4)				
Inventor F.E.	Y	Y	Y	Y	Y
Firm × Year F.E.	Y	Y	Y	Y	Y
Industry × Year F.E.	Y	N	Y	Y	Y
Technology Class × Year F.E.	N	Y	N	N	N
Experience F.E.	Y	Y	Y	Y	Y
Adjusted R^2	0.318	0.336	0.328	0.320	0.335
Observations	105,277	105,629	4,351,942	96,537	105,277

Table 6: The impact of corporate bankruptcies and team dependence on the likelihood that an inventor stops inventing

This table examines the impact of bankruptcies and team dependence on the likelihood that an inventor stops inventing. *Stop inventing* is a dummy variable that takes the value of one in the last year that a given inventor files a patent. *Post bankruptcy* is an indicator variable that is one in the years post bankruptcy, and zero in the years prior to bankruptcy; it always takes the value of zero for inventors that never experienced bankruptcy. *Team dependence* is a measure of the team-specific human capital accumulated at the financially distressed firm. All variables and sample construction are detailed in Section 2 of the paper and Appendix A. In these regressions, in the case of inventors in the "treatment" group, we consider only observations for the period after the bankruptcy filing year. The t-statistics in parentheses are calculated based on standard errors clustered at the firm level. Statistical significance at 1%, 5%, and 10% is market with ***, **, and *, respectively.

	(1)	(2)
	Stop inventing	
Post bankruptcy	-0.002	-0.012**
	(-0.4)	(-2.1)
Post bankruptcy × Team dependence		0.016**
		(2.2)
Firm × Year F.E.	Y	Y
Industry × Year F.E.	Y	Y
Experience F.E.	Y	Y
Adjusted R^2	0.384	0.384
Observations	4,262,062	4,262,062

Table 7: Team dependence and the productivity of inventors: the role of "363 sales"

This table shows the impact of team dependence on inventor-level productivity after bankruptcy; we report results separately for firms that sold entire divisions and firms that did not. Productivity is measured using *Ln(Citations)* in columns 1 and 2, *Ln(Patents)* in columns 3 and 4, *Ln(Citations per patent)* in columns 5 and 6, and *Ln(Dollar value of patents)* in columns 7 and 8. *Post bankruptcy* is an indicator variable that takes the value of one in the years after bankruptcy, and zero in the years prior to bankruptcy. *Team dependence* is a measure of the team-specific human capital accumulated at the financially distressed firm. The sample in columns 1, 3, 5, and 7 is restricted to inventors whose entire division was not sold through Section 363 of the US Bankruptcy Code, while the sample in columns 2, 4, 6, and 8 is restricted to inventors whose division was sold through a 363 sale. All variables and the sample construction are detailed in Section 2 of the paper and in Appendix A. The t-statistics in parentheses are calculated based on standard errors clustered at the firm level. Statistical significance at 1%, 5%, and 10% is market with ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ln(Citations)		Ln(Patents)		Ln(Citations per patent)		Ln(Dollar value of patents)	
	No sale	Sale	No sale	Sale	No sale	Sale	No sale	Sale
Post bankruptcy	0.105	0.322	0.079**	-0.167	0.087	0.302	-0.046	0.243
	(0.8)	(0.9)	(2.0)	(-0.7)	(0.8)	(1.0)	(-0.5)	(0.5)
Post bankruptcy × Team dependence	-0.176***	0.232*	-0.073***	0.094	-0.141***	0.191*	-0.059**	0.187**
	(-5.4)	(1.8)	(-6.2)	(1.4)	(-5.0)	(1.8)	(-2.3)	(2.3)
Inventor F.E.	Y	Y	Y	Y	Y	Y	Y	Y
Firm × Year F.E.	Y	Y	Y	Y	Y	Y	Y	Y
Industry × Year F.E.	Y	Y	Y	Y	Y	Y	Y	Y
Experience F.E.	Y	Y	Y	Y	Y	Y	Y	Y
Adjusted R^2	0.325	0.294	0.340	0.424	0.321	0.279	0.302	0.328
Observations	76,713	27,675	76,713	27,675	76,713	27,675	76,713	27,675

Table 8: Team stability and the productivity of inventors

This table studies the impact of team stability on inventor-level productivity after bankruptcy. Productivity is measured using *Ln(Citations)* in columns 1 and 2, *Ln(Patents)* in columns 3 and 4, *Ln(Citations per patent)* in columns 5 and 6, and *Ln(Dollar value of patents)* in columns 7 and 8. *Post bankruptcy* is an indicator variable that takes the value of one in the years after bankruptcy, and zero in the years prior to bankruptcy. *Team dependence* is a measure of the team-specific human capital accumulated at the financially distressed firm. *Stable team share* is a measure of team stability post-bankruptcy. All variables and the sample construction are detailed in Section 2 of the paper and in Appendix A. The t-statistics in parentheses are calculated based on standard errors clustered at the firm level. Statistical significance at 1%, 5%, and 10% is market with ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ln(Citations)		Ln(Patents)		Ln(Citations per patent)		Ln(Dollar value of patents)	
Post bankruptcy	0.034	0.105	-0.003	0.020	0.031	0.089	-0.119	-0.104
	(0.3)	(1.1)	(-0.1)	(0.6)	(0.4)	(1.1)	(-1.6)	(-1.3)
Post bankruptcy × Team dependence		-0.135***		-0.044***		-0.110***		-0.028
		(-4.4)		(-3.3)		(-4.2)		(-1.1)
Post bankruptcy × Stable team share	0.167**	0.128	0.143***	0.130***	0.112	0.080	0.177***	0.168***
	(2.0)	(1.6)	(4.0)	(3.6)	(1.6)	(1.2)	(3.2)	(3.1)
Inventor F.E.	Y	Y	Y	Y	Y	Y	Y	Y
Firm × Year F.E.	Y	Y	Y	Y	Y	Y	Y	Y
Industry × Year F.E.	Y	Y	Y	Y	Y	Y	Y	Y
Experience F.E.	Y	Y	Y	Y	Y	Y	Y	Y
Adjusted R^2	0.318	0.318	0.362	0.362	0.310	0.310	0.308	0.308
Observations	105,277	105,277	105,277	105,277	105,277	105,277	105,277	105,277

Table 9: Team-specific human capital and joint mobility of inventors post bankruptcy

This table reports coefficients from regressions studying the impact of team-specific human capital on the probability of joint mobility after bankruptcy. *Move together* is a dummy variable that is one if two inventors move to the same new firm after bankruptcy, zero otherwise. For each pair of "treated" inventors who were at the same firm in year three prior to bankruptcy, we define the following variables: *Pair co-dependence* is the share of patents that the two inventors have co-authored until year three prior to the bankruptcy; *Pair average(/total) citations* is the natural logarithm of one plus the average(/total) citations of the patents co-authored by the pair of inventors until year three prior to the bankruptcy; *Pair average(/total) dollar value of patents* is the natural logarithm of one plus the average(/total) dollar value of the patents co-authored by the pair of inventors until year three prior to the bankruptcy. In columns 1 and 2, the full set of "treated" inventor pairs is included; in columns 3 and 4, the sample includes pairs of inventors whose firm went bankrupt between 1980 and 2000; in columns 5 and 6, we exclude from the sample inventors whose division was sold through Section 363 of the US Bankruptcy Code. The regression specifications reported in columns 2, 4, and 6, include bankruptcy firm fixed effects. All variables and the sample construction are detailed in Section 2 of the paper and in Appendix A. The t-statistics in parentheses are calculated based on standard errors clustered at the firm level. Statistical significance at 1%, 5%, and 10%, is market with ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample		Until 2000		No sale	
			Move together			
Panel A: Pair co-dependence						
Pair co-dependence	0.104***	0.086***	0.063***	0.050***	0.094***	0.081***
	(12.1)	(10.3)	(6.1)	(5.2)	(10.7)	(9.2)
Firm F.E.	N	Y	N	Y	N	Y
Adjusted R^2	0.003	0.027	0.002	0.056	0.002	0.016
Observations	1,188,919	1,188,919	183,752	183,752	1,165,181	1,165,181
Panel B: Pair average citations						
Pair average citations	0.016***	0.013***	0.013***	0.011***	0.013***	0.011***
	(13.0)	(11.1)	(7.6)	(6.8)	(11.3)	(9.9)
Firm F.E.	N	Y	N	Y	N	Y
Adjusted R^2	0.002	0.026	0.002	0.054	0.001	0.016
Observations	1,188,919	1,188,919	220,198	220,198	1,352,707	1,352,707
Panel C: Pair total citations						
Pair total citations	0.014***	0.011***	0.011***	0.010***	0.012***	0.010***
	(13.2)	(11.3)	(7.7)	(6.8)	(11.5)	(10.2)
Firm F.E.	N	Y	N	Y	N	Y
Adjusted R^2	0.002	0.026	0.002	0.054	0.002	0.017
Observations	1,188,919	1,188,919	220,198	220,198	1,352,707	1,352,707
Panel D: Pair average dollar value of patents						
Pair average dollar value of patents	0.011***	0.010***	0.010***	0.010***	0.009***	0.008***
	(8.1)	(7.0)	(5.3)	(5.2)	(6.7)	(5.9)
Firm F.E.	N	Y	N	Y	N	Y
Adjusted R^2	0.000	0.025	0.001	0.053	0.000	0.016
Observations	1,188,919	1,188,919	220,198	220,198	1,352,707	1,352,707
Panel E: Pair total dollar value of patents						
Pair total dollar value of patents	0.010***	0.008***	0.009***	0.009***	0.009***	0.007***
	(8.3)	(7.0)	(5.3)	(5.1)	(7.0)	(6.1)
Firm F.E.	N	Y	N	Y	N	Y
Adjusted R^2	0.001	0.025	0.001	0.053	0.000	0.016
Observations	1,188,919	1,188,919	220,198	220,198	1,352,707	1,352,707

Table 10: Inventor team collaborations and probability of 363 sales

This table shows the impact of inventor team collaborations on the probability of acquisitions via a 363 sale during bankruptcy. *363 Sale* is a dummy variable that takes the value of one if all or substantially all of the assets are acquired by another firm under Section 363 of the US Bankruptcy Code. *Average team dependence* is the firm-level average of the variable *Team dependence* for all inventors who were at the firm three years prior to bankruptcy. *Share of team-dependent inventors* is the firm-level share of the "treated" inventors with *Team dependence* above the sample median. All explanatory variables are measured in year three prior to bankruptcy. All variables and the sample construction are detailed in Section 2 of the paper and in Appendix A. The t-statistics in parentheses are calculated based on heteroskedasticity robust standard errors. Statistical significance at 1%, 5%, and 10%, is market with ***, **, and *, respectively.

	(1)	(2)	(3)	(4)
	363 Sale			
Average team dependence	0.220***	0.218**		
	(4.6)	(2.3)		
Share of team-dependent inventors			0.237***	0.221**
			(4.7)	(2.3)
Ln(Number of inventors)		0.001		0.000
		(0.0)		(0.0)
Firm size		-0.011		-0.009
		(-0.5)		(-0.4)
ROA		-0.051		-0.052
		(-0.4)		(-0.4)
Cash ratio		-0.115		-0.111
		(-0.8)		(-0.8)
Leverage		-0.213		-0.207
		(-1.6)		(-1.6)
Year F.E.	N	Y	N	Y
Adjusted R^2	0.062	-0.006	0.066	-0.006
Observations	300	247	300	247

Figure 1: Corporate bankruptcies over time

This figure shows the distribution of corporate bankruptcies by year during our sample period (1980 to 2010). Information on bankruptcy filings is from the UCLA-LoPucki Bankruptcy Research Database and New Generation Research bankruptcy database.

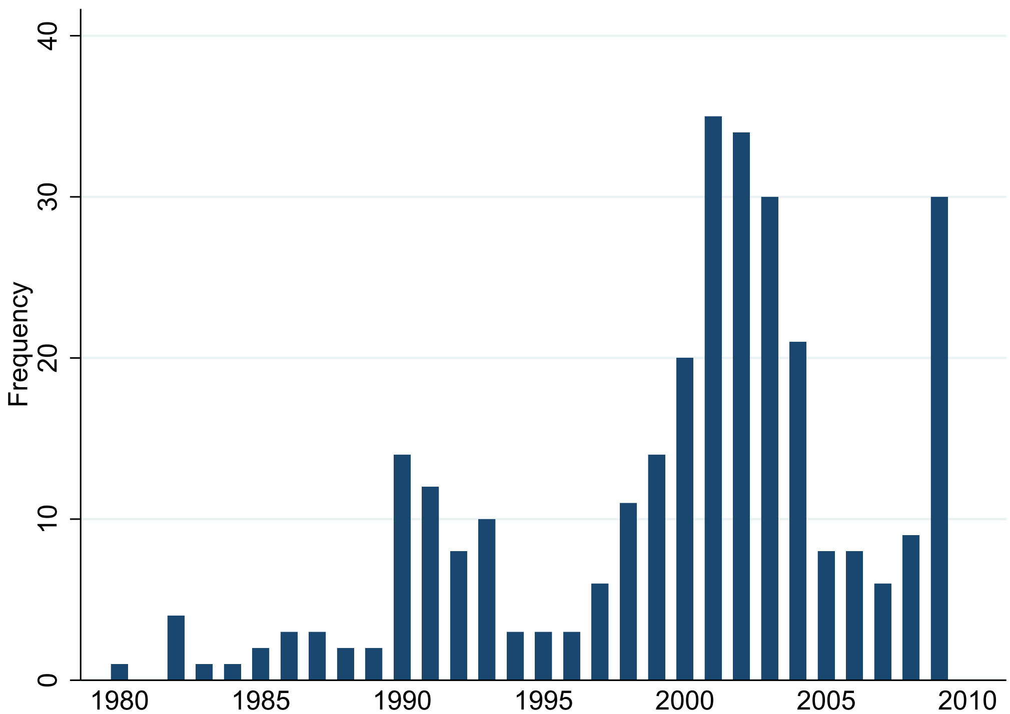


Figure 2: Corporate bankruptcies across industries

This figure shows the distribution of corporate bankruptcies by industry during the sample period (1980 to 2010). Information on bankruptcy filings is from the UCLA-LoPucki Bankruptcy Research Database and the New Generation Research bankruptcy database. The top five sub-divisions of industries under manufacturing are electronic and other electrical equipment and components; industrial and commercial machinery and computer equipment; chemicals and allied products; measuring, analyzing and controlling instruments, photographic, medical, and optical goods; and transportation equipment.

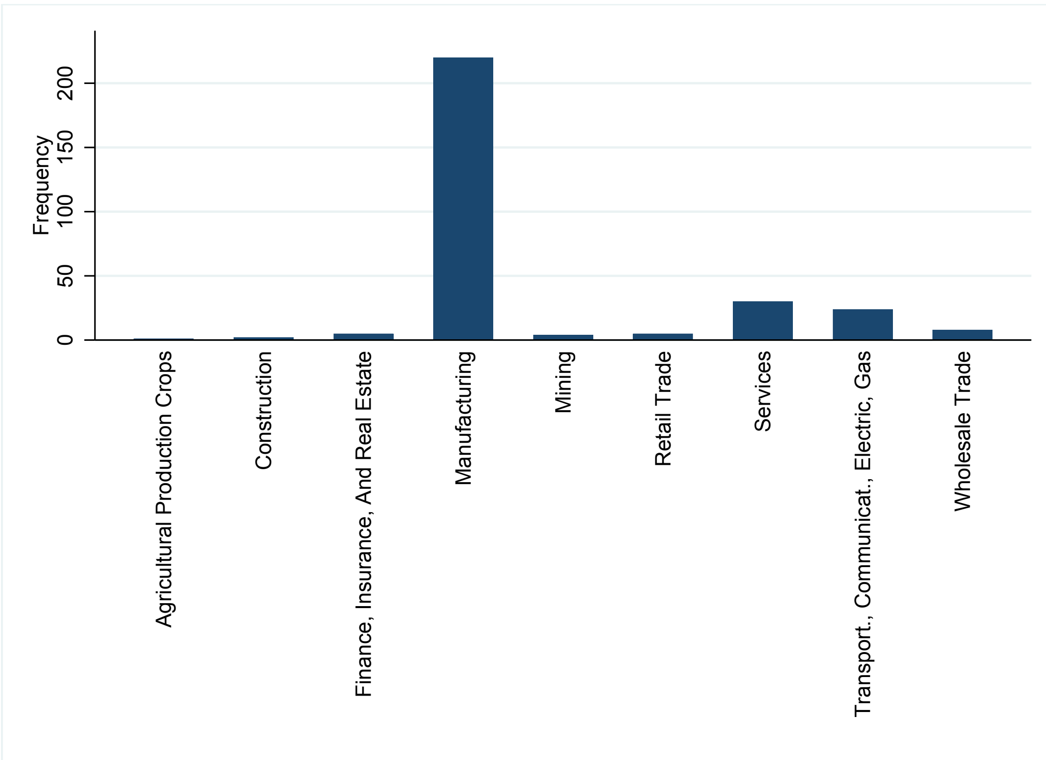


Figure 3: Team production in corporate innovation over time

This figure shows the evolution of the average number of co-authors per patent between 1975 and 2010. The data are from the NBER Patent Dataset.

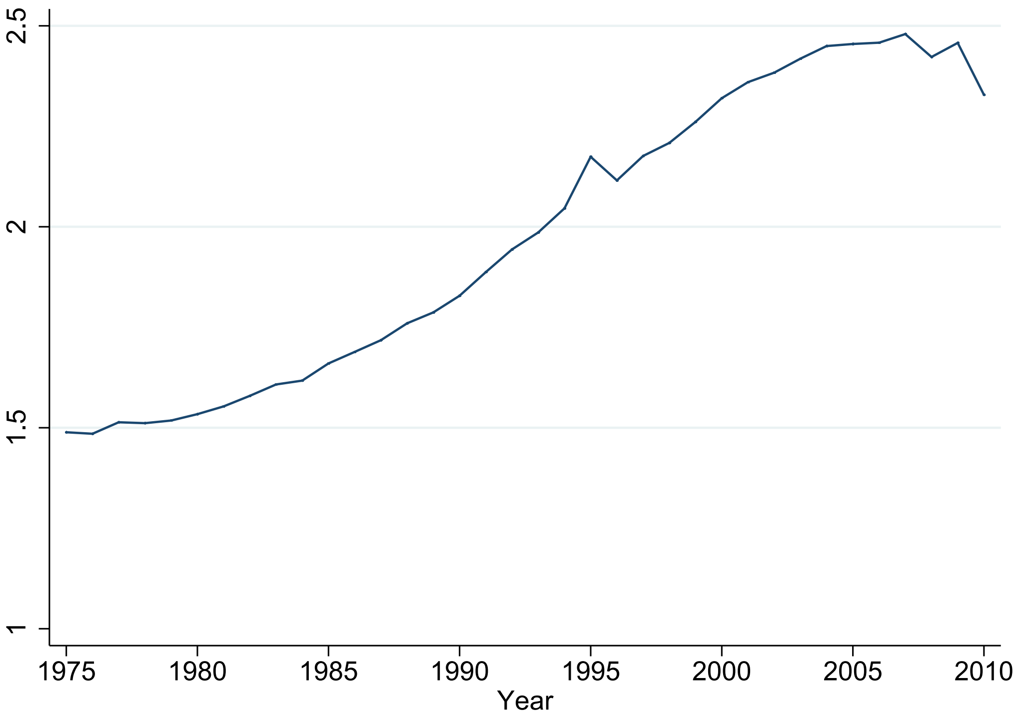


Figure 4: Firm characteristics as firms approach bankruptcy

This figure shows the impact of bankruptcies on firm characteristics. We first estimate the following OLS regression model:

$$Y_{ft} = \alpha + \mathit{Treated}_f \cdot T_f' \beta + X_{ft}' \gamma + \epsilon_{ft}$$

We then plot the coefficients β associated with the interaction between *Treated* (a dummy variable taking the value of one for firms that file for bankruptcy between 1980 and 2010) and the event-time dummies included in matrix T; we include dummies for the years t-4, t-3, t-2, t-1, 0 (bankruptcy year) relative to the bankruptcy event. These event-time dummies always take the value of zero for firms that do not file for bankruptcy during the period 1980-2010. We require "treated" firms to be present in the sample at time t-5 and exclude any observations after year 0. Y is *ROA* in Panel A, *Leverage* in Panel B, *Firm size* in Panel C, and *Number of inventors*, the total number of inventors employed by a given firm in a given year, in Panel D. The matrix of controls X includes firm fixed effects and industry × year fixed effects. All variables and the sample construction are detailed in Section 2 of the paper and in Appendix A. The 95% confidence bounds are calculated based on standard errors clustered at the firm level.

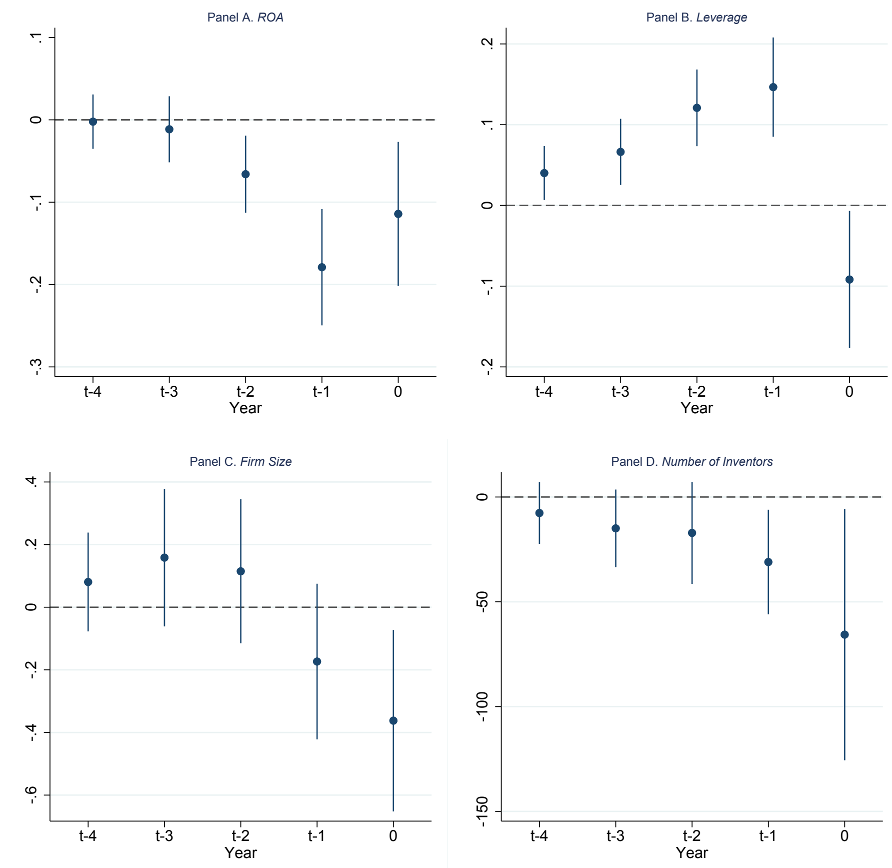


Figure 5: Team-dependence and innovation output around corporate bankruptcies

This figure shows the impact of disruptions to team-specific human capital on the evolution of inventors' productivity around bankruptcy events. We first estimate the following OLS regression model:

$$Ln(Citations)_{ift} = \alpha + T_i'\beta + Team\ dependence_i \cdot T_i'\theta + X_{ift}'\gamma + \epsilon_{ift}$$

We then plot the coefficients θ associated with the interaction between *Team dependence* and the event-time dummies included in matrix T; we include dummies for the years t-4, t-3, t-2, t-1, 0 (bankruptcy year), t+1, t+2, t+3, and t+4 relative to the bankruptcy event. The sample is restricted to "treated" inventors. We require inventors to be present in the sample at time t-5 and exclude any observations after year t+4. The matrix of controls X includes inventor fixed effects, firm $\times$ year fixed effects, industry $\times$ year fixed effects, and inventor experience fixed effects. The solid horizontal lines (in red) are the average of the estimated θs in the periods before and after bankruptcy, respectively. All variables and the sample construction are detailed in Section 2 of the paper and in Appendix A.

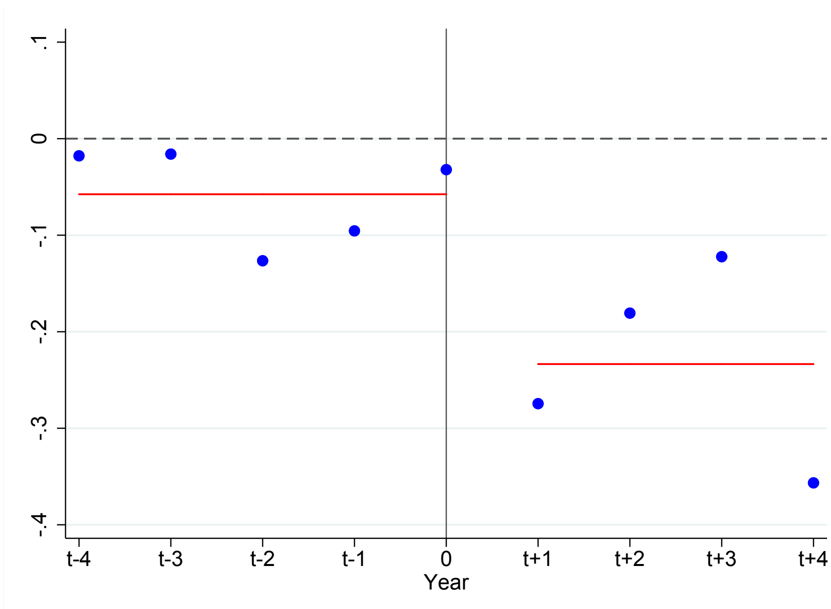
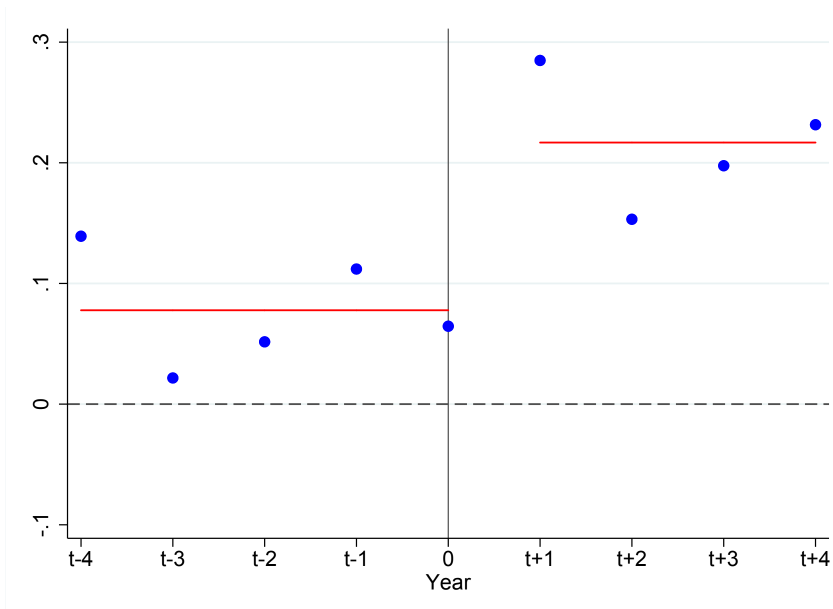


Figure 6: Team stability and innovation output around corporate bankruptcies

This figure shows the impact of team stability on the evolution of inventors' productivity around bankruptcy events. We first estimate the following OLS regression model:

$$Ln(Citations)_{ift} = \alpha + T_i' \beta + Stable\ team\ share_i \cdot T_i' \theta + X_{ift}' \gamma + \epsilon_{ift}$$

We then plot the coefficients θ associated with the interaction between *Stable team share* and the event-time dummies included in matrix T; we include dummies for the years t-4, t-3, t-2, t-1, 0 (bankruptcy year), t+1, t+2, t+3, and t+4 relative to the bankruptcy event. The sample is restricted to "treated" inventors. We require inventors to be present in the sample at time t-5 and exclude any observations after year t+4. The matrix of controls X includes inventor fixed effects, firm $\times$ year fixed effects, industry $\times$ year fixed effects, and inventor experience fixed effects. The solid horizontal lines (in red) are the average of the estimated θs in the periods before and after bankruptcy, respectively. All variables and the sample construction are detailed in Section 2 of the paper and in Appendix A.



Appendix A. Variable definitions

A.1. Dependent variables

Remain together —This variable measures the stability of team production over a four year horizon. It is defined as the share of the co-authors of an inventor that were at the same firm four years ago (at $t-4$), that remain together in the same firm today (in year t).

Ln(Citations) —This variable is our main measure of individual inventor innovation productivity. It is defined as the natural logarithm of one plus the total number of citations (until 2010) obtained on all patents that the inventor applies for (and that are subsequently granted) in a given year.

Ln(Patents) —This variable measures the quantity of innovation output produced by individual inventors. It is defined as the natural logarithm of one plus the total number of patents that the inventor applies for (and that are subsequently granted) in a given year.

Ln(Citations per patent) —This variable measures the quality of innovation output produced by individual inventors. It is defined as the natural logarithm of one plus the average number of citations per patent for all patents that a given inventor applies for (and that are subsequently granted) in a given year.

Ln(Dollar value of patents) —This variable is defined as the natural logarithm of one plus the cumulative dollar value of patents (in millions of nominal U.S. dollars) that an inventor applies for (and that are subsequently granted) in a given year; the dollar value of each patent is obtained from Kogan, Papanikolaou, Seru, and Stoffman (2017) and is based on the stock market reaction to the announcement of new patent grants.

Stop inventing —This variable captures the end of an innovation career. It is an indicator that takes the value of one in the year of the last patent application filed by a given inventor.

Move together —This variable captures joint relocation. For each pair of treated inventors that are employed at the same firm in year three prior to bankruptcy, this variable is an indicator that takes the value of one if both inventors in the pair jointly move to the same new firm following the bankruptcy.

363 Sale —This is a dummy variable that takes the value of one if all or substantially all of the assets of a firm in bankruptcy are acquired by another firm under Section 363 of the US Bankruptcy Code. More specifically, it takes the value of one if the outcome of the bankruptcy procedure includes an acquisition event according to the New Generation Research bankruptcy database, or if a 363 sale is recorded in the UCLA-LoPucki Bankruptcy Research Database.

A.2. Main explanatory variables

Treated —Dummy variable which takes the value of one if an inventor is employed by a firm that files for bankruptcy, in year three prior to the bankruptcy filing. For inventors that are never employed by a firm in year three before it files for bankruptcy, it takes the value of zero.

Post bankruptcy —Dummy variable that takes the value of one in the years after the bankruptcy filing for inventors in the treatment group. This variable takes the value of zero for years prior to bankruptcy and for inventors that were never employed by a bankrupt firm in year three prior to bankruptcy.

Team dependence —This variable measures the extent to which an inventor collaborates with others at the firm before its bankruptcy. For an inventor that works at a financially distressed firm in year three prior to its bankruptcy filing, this variable measures the total share of that inventor's patents that are co-authored with other inventors that are also employed at that firm in year three before bankruptcy; all co-authorships up to year three before the bankruptcy filing are considered in this calculation. For inventors that are never employed by a financially distressed firm in year three prior to bankruptcy, this variable takes the value of zero.

Stable team share —This variable captures the stability of inventor teams affected by bankruptcy. For each inventor that works at the bankrupt firm in year three prior to bankruptcy, this variable measures the fraction of other inventors employed by the same firm in year three prior to bankruptcy that move jointly with that inventor to the same new firm post-bankruptcy. Because simply working at the same firm is unlikely to be informative about the intensity of collaboration, we assign more weight to inventors that tend to patent together. For inventors that are not employed by a bankrupt firm in year three prior to its bankruptcy, this variable takes the value of zero. Formally defined as:

$$Stable\ team\ share_i = \frac{\sum_{j=1,i\neq j}^{N_f} Move\ together_{ij} \times Pair\ co\text{-}dependece_{ij}}{\sum_{j=1,i\neq j}^{N_f} Pair\ co\text{-}dependece_{ij}},$$

where *Pair co-dependence* is defined below, and *Move together* is defined above.

Pair co-dependence —For a pair of inventors i and j who both worked at the same firm in year three prior to bankruptcy, this variable is the share of patents of inventors i and j that are co-authored by both inventors until year three prior to the bankruptcy.

Pair average citations —For a pair of inventors i and j who both worked at the same firm in year three prior to bankruptcy, this variable is defined as the natural logarithm of one plus the average citations of the patents co-authored by the inventor pair i and j until year three prior to the bankruptcy.

Pair total citations —For a pair of inventors i and j who both worked at the same firm in year three prior to bankruptcy, this variable is defined as the natural logarithm of one plus the total citations of the patents co-authored by the inventor pair i and j until year three prior to the bankruptcy.

Pair average dollar value of patents —For a pair of inventors i and j who both worked at the same firm in year three prior to bankruptcy, this variable is defined as the natural logarithm of one plus the average dollar value (in millions of nominal U.S. dollars) of the patents co-authored by the inventor pair i and j until year three prior to the bankruptcy.

Pair total dollar value of patents —For a pair of inventors i and j who both worked at the same firm in year three prior to bankruptcy, this variable is defined as the natural logarithm of one plus the total dollar value (in millions of nominal U.S. dollars) of the patents co-authored by the inventor pair i and j until year three prior to the bankruptcy.

Average team dependence —This variable measures the reliance of a firm on team production. It is defined as the average of the variable *Team dependence* across all inventors of the firm at time t-3 relative to bankruptcy.

Share of team-dependent inventors —This variable measures the reliance of a firm on team production. It is defined as the share of inventors of the firm in the year three prior to bankruptcy that have a value of *Team dependence* that is higher than the median *Team dependence* across all "treated" inventors.

A.3. Inventor- and firm-level control variables

Experience —The number of years between the current year and the year of the first patent filed by a given inventor.

Tenure at bankrupt firm —For a treated inventor, this variable is defined as the number of years between the year the inventor joined the firm and year three prior to the bankruptcy filing.

Ln(Number of inventors) —The natural logarithm of the number of inventors at the firm.

Firm size —Defined as the natural logarithm of total assets.

ROA —Defined as net income divided by total assets.

R&D intensity —Defined as expenditures on research and development divided by total assets.

Cash ratio —Defined as cash and short term marketable securities divided by total assets.

Leverage —Defined as the sum of long term debt and debt in current liabilities divided by total assets.

about ECGI

The European Corporate Governance Institute has been established to improve *corporate governance through fostering independent scientific research and related activities.*

The ECGI will produce and disseminate high quality research while remaining close to the concerns and interests of corporate, financial and public policy makers. It will draw on the expertise of scholars from numerous countries and bring together a critical mass of expertise and interest to bear on this important subject.

The views expressed in this working paper are those of the authors, not those of the ECGI or its members.

Electronic Access to the Working Paper Series

The full set of ECGI working papers can be accessed through the Institute's Web-site (www.ecgi.global/content/working-papers) or SSRN:

Finance Paper Series	http://www.ssrn.com/link/ECGI-Fin.html
Law Paper Series	http://www.ssrn.com/link/ECGI-Law.html