european corporate governance institute

Teams and Bankruptcy

Finance Working Paper N° 626/2019
March 2023

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ECGI Working Paper Series in Finance

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We thank Holger Mueller (the editor), two anonymous referees, 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 MilanoBicocca, 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), 3 rd 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 comments and discussions. Silva gratefully acknowledges financial support from the Deloitte Institute for Innovation and Entrepreneurship at the London Business School. Ye thanks the DFG Center for Advanced Studies on the Foundations of Law and Finance for their support (project FOR 2774).

Abstract

We study how the human capital embedded in teams is affected by, and reallocated through, corporate bankruptcies. After a bankruptcy, U.S. inventors produce fewer and less impactful patents. Moreover, teams become less stable. Consequently, compared to inventors that rely less on teamwork, the performance of team inventors deteriorates more. These findings point to the loss of team-specific human capital as a cost of resource reallocation through bankruptcy. Acquisitions by industrial firms and joint mobility of inventors with past collaborations limit these losses, suggesting that the labor market and the market for corporate control help preserve team-specific human capital in bankruptcies.

Keywords: Teams, Teamwork, Team-specific human capital, Bankruptcy, Labor productivity, Innovation

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

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LawFin Working Paper No. 46

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* 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 (rui.silva@novasbe.pt): Nova School of Business and Economics and CEPR, and Ye (lye@london.edu): London Business School. We thank Holger Mueller (the editor), two anonymous referees, 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 comments and discussions. Silva gratefully acknowledges financial support from the Deloitte Institute for Innovation and Entrepreneurship at the London Business School. Ye thanks the DFG Center for Advanced Studies on the Foundations of Law and Finance for their support (project FOR 2774).

Teams and Bankruptcy

ABSTRACT

We study how the human capital embedded in teams is affected by, and reallocated through, corporate bankruptcies. We observe that after a bankruptcy, U.S. inventors produce fewer and less impactful patents. Compared to inventors that rely less on teamwork, the performance of team inventors deteriorates significantly more. We also find that bankruptcies reduce team stability. These findings point to the loss of team-specific human capital as a cost of resource reallocation through bankruptcy. Team inventors of bankrupt firms that are acquired by other industrial firms perform relatively better after bankruptcy than other team inventors. Inventors with past collaborations are also more likely to move jointly to a new employer after bankruptcy. This suggests that the labor market and the market for corporate control play important roles in preserving team-specific human capital.

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."*
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> (Baird, Douglas G. and Rasmussen, Robert K., 2002. The End of Bankruptcy. Stanford Law Review 55, p.775)

Corporate bankruptcies are 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] Prior research 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 innovation, and, more broadly, in the corporate sector. There is evidence, in a variety of settings, that teamwork has substantial benefits compared to work in hierarchical environments, in particular

[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 2022). Further, frictions in the post-bankruptcy reallocation of resources may lead to capital and labor being idle for some time or even result in protracted sub-optimal uses. In the case of workers, unemployment spells could accelerate the depreciation of skills (e.g., Ljungqvist and Sargent 1998).

when complex tasks are involved. 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.

In this paper, we study how the human capital embedded in teams is affected by and reallocated through corporate bankruptcies. Team-specific human capital can be 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). The restructuring process that occurs during bankruptcy may disrupt the stability of teams within the financially distressed firm. Moreover, it may be difficult for workers who 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: individuals may have different geographic preferences, or family circumstances may make it difficult to coordinate a joint relocation. Depressed housing markets may also impede workers' ability to move to other regions (Brown and Matsa 2020). 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.

We face several challenges when studying the impact of corporate bankruptcies on team stability and the productivity of team-dependent workers. First, bankruptcies are not exogenous events, and neither is the matching of workers to teams and 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 presents a plausible narrative related to the reallocation of team-specific human-capital during corporate bankruptcies, but we also entertain possible alternative explanations. To alleviate concerns that our results are driven by selection, we conduct a comprehensive series of tests that support the notion that team-specific capital helps explain the post-bankruptcy productivity of workers. Second, we require panel data of workers matched to their respective employers; the data should permit to measure the extent to which workers collaborate in teams and are endowed with team-specific human capital. Finally, to be able to quantify the importance of team-specific human capital in the reallocation process that takes place during bankruptcies, we require metrics of individual worker productivity.

In our analysis, we use an employer-employee matched dataset of inventors in the United States spanning the years 1980 to 2015. 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). Another advantage of focusing on inventors is that they constitute an important category of workers due to their central role in the production of innovation and technological progress, which ultimately drives economic growth. 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 sets of findings. First, inventors employed at a firm that files for bankruptcy experience a subsequent drop in productivity by four to five percent, on average, in the ten-year period after the bankruptcy relative to the ten-year pre-bankruptcy period. The decline in productivity is largest in the first three to five years after the bankruptcy. Second, bankruptcies lead to the loss of team-specific human capital. We show that corporate bankruptcies are associated with a disruption in team structure: the probability of the break-up of teams significantly increases in the year of the bankruptcy filing and the year thereafter. Furthermore, inventors that tend to work in teams—those who 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 co-authored all patents with colleagues at the firm filing for bankruptcy experiences a six percent larger reduction in patents filed post-bankruptcy, relative to an inventor with no co-authorships within the bankrupt firm. In terms of quality, such team-reliant inventors suffer a twelve percent larger reduction in citations per patent than inventors that work alone. The magnitude of this change is economically significant but smaller than the decrease in inventor productivity documented in the case of co-inventor deaths (Jaravel, Petkova, and Bell 2018).

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; in fact, prior to the bankruptcy, team-dependent inventors are, on average, more productive. We also document that team-dependent inventors are significantly less likely to remain active as inventors (by filing patents) after bankruptcy than those that rely less on teamwork. For example, two years after the bankruptcy, inventors that only patent in teams are twelve percentage points less likely to remain active; relative to the average inventor affected by the bankruptcy, this constitutes an 18 percent lower two-year survival rate. This suggests that the loss of team specific capital is an important, yet previously undocumented, cost associated with the process of resource reallocation through bankruptcies.

Third, we find that both the labor market and the market for corporate control play a significant role in preserving team capital after bankruptcy. 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. We also find that labor market frictions in the form of non-compete agreements reduce the likelihood that team inventors co-locate post-bankruptcy: team inventors in states that enforce such agreements display larger reductions in their post-bankruptcy productivity. Finally, team inventors of firms that are acquired by other industrial firms during or after bankruptcy perform relatively better than team inventors of firms that are not acquired after the bankruptcy. In particular, team inventors in liquidated firms perform significantly worse after bankruptcy than those in firms experiencing more favorable bankruptcy outcomes.

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, limiting the productivity losses associated with bankruptcy.

Among other robustness tests, we address the concern that the selection of inventors that work for financially distressed firms or the selection of inventors who work in teams could drive our results. First, we conduct a test in which 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.[2] Second, we confirm that our results are not driven by the selection of inventors that remain in the firm during financial distress. We perform a test using a subsample of U.S. states where courts strongly enforce non-compete clauses in labor contracts. In such states, high-skill workers are typically restricted in their ability to strategically time their exit prior to the bankruptcy event. We confirm our results in this setting. Third, 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. Finally, we show that the results are robust to different ways of constructing the sample. The main sample consists of inventors who experience a corporate bankruptcy at some point during the sample period (in the spirit of the analysis in, e.g., Giroud and Mueller 2015). Thus, inventors who are not encountering a bankruptcy yet serve as a counterfactual for those who 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 the sample period. Overall, these tests alleviate the concern that our findings are purely driven by the selection of inventors included in our sample or the selection of inventors who work in teams.

Our study contributes to several strands of the literature in Economics and Finance. First, we contribute to the literature on the allocation of resources through bankruptcy. Most of this

[2] 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).

work focuses on the reallocation of physical capital and (non-human) intangible assets.[3] In contrast, our focus is on human capital. Our paper is most closely related to two 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, finding that many such CEOs leave the executive labor market and suffer future compensation losses. Graham, Kim, Li, and Qiu (2022) document that manufacturing workers' earnings fall after a firm files for bankruptcy and that affected employees tend to subsequently work less and leave the firm, industry, and local labor market. A related set of papers study displaced workers (e.g., Fallick, 1996; Couch and Placzek, 2010; Andersson et al., 2018; Schmieder, von Wachter, and Heining, 2022). Even though these studies often focus on plant closures, not bankruptcies, they present related evidence on the post-displacement earnings dynamics of workers.

Our contribution to the literature on factor reallocation in bankruptcy is twofold. First, while we study (patent-based) measures of productivity, past research focussed on compensation. This is an important distinction as pay may be driven not only by productivity, but also by bargaining power, perks, riskiness of the employment relationship, etc. Second, and perhaps more importantly, the focus of our paper is on teamwork, a key determinant of productivity in high-skill tasks. In contrast, Graham et al. and Eckbo et al. have no discussion or analysis along this dimension, and neither does the literature studying worker displacement. Given the importance that collaborative work arrangements have for the creation of value, we believe our work fills an important gap in the literature.

Second, our paper contributes to the literature on teamwork more generally. The value of teamwork has been demonstrated in a variety of settings such as garment plants (Hamilton, Nickerson, and Owan 2003), steel mills (Boning, Ichniowski, and Shaw 2007), academia (Card and DelaVigna, 2013), and healthcare (Bartel, Beaulieu, Phibbs, and Stone 2014). Lazear and Shaw

[3] 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 (2019), Bernstein, Colonnelli, and Iverson (2019), Iverson (2018), and Ma, Tong and Wang (2022). Other work has highlighted bankruptcy externalities (e.g., Benmelech, Bergman, Milanez, and Mukharlyamov 2019; Babina 2020; Hacamo and Kleiner 2022).

(2007) report that the share of large firms that employ teams has increased. Gompers, Gornall, Kaplan, and Strebulaev (2020) provide evidence on the importance of the entrepreneurial team for startup success. Closest to our paper is the work of Azoulay, Zivin, and Wang (2010), Azoulay, Fons-Rosen, and Zivin (2019), and Jaravel, Petkova, and Bell (2018) who use the deaths of co-authors to study teamwork in science and corporate innovation. While deaths are a good setting to quantify the value of team-specific human capital in general, it is not suitable to test whether corporate events, like bankruptcies, M&As, or IPOs, lead to significant losses (gains) in productivity because of a destruction (creation) of team-specific human capital. The reason is that, unlike death events, most of the shocks that firms face still allow inventors to continue to collaborate. For example, because firms may be especially careful at preserving team-specific human capital after a bankruptcy, bankruptcy judges may pay close attention to and be protective of valuable collaborative arrangements, or labor markets may value such human capital and attempt to preserve it by hiring inventors in teams rather than individually. The extent to which these mechanisms occur cannot be learned or extrapolated from empirical designs that rely on deaths for identification, because there is no market mechanism that can preserve the stability of a team when one of its members dies. Because most of the shocks that affect collaborative work arrangements are not as extreme as worker deaths, we see our work as an important contribution to the understanding of whether and how market forces promote team stability and productive teamwork.

Finally, we contribute to the body of research on innovation and its determinants. Previous work has identified several macroeconomic drivers of innovation.[4] 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.

[4] 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 2022) 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.

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). We consider public and private firm bankruptcies up to and including the year 2015; similarly, we consider patents filed until 2015 (counting forward citations received until 2020).[5] To track inventor moves across both private and public firms, we combine several data sources. The PatentsView database is a USPTO platform of intellectual property data, including all patents granted by the USPTO from 1976. It contains information on application date, Cooperative Patent Classification (CPC) technology class, patent citing link, and initial application assignee of the patent (typically the firm or subsidiary at which the research is conducted). PatentsView also 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. Inventors are included in the sample for their entire active career, defined as the years between their first and last patent filings.

To link these patents to public firms, we combine PatentsView with the Compustat link for patent application assignees in the NBER patent database for the years 1980 – 2006 and in Kogan, Papanikolaou, Seru, and Stoffman (2017) for the years 2007 – 2015. To link patents to private firms, we follow the routines employed by the NBER. In addition to citations-based measures of patent quality, in robustness tests, 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).

[5] We consider patents applied for and granted until 2015 because later years are sparsely populated in the database. There is a delay of observations being added into the patent database because only granted patents are included, and the grant year is up to five years after the original application year.

Information on bankruptcy filings is from the New Generation Research bankruptcy database and the UCLA-LoPucki Bankruptcy Research Database. 2,066 public firms and more than 400,000 private firms filed for Chapter 11 and Chapter 7 between 1980 and 2015. We match the public and private bankruptcies to Compustat and patent data using the EIN/Tax ID and firm name. Among the 2,066 public bankruptcy firms, 626 (30%) have at least one patent filed with the USPTO during the 1980 – 2015 period, [6] and 588 have at least one active inventor during the period from one to three years before bankruptcy (which we require for the firms to enter our sample). Among the more than 400,000 private bankruptcy firms, few are matched to the inventor database. This is to be expected as most private firms that file for bankruptcy do not have any patents at all. We perform a fuzzy name matching between patent assignee names and bankruptcy firm names, focusing on exact and close to exact matches. In addition, we require the state of assignee location (where the patent was filed) to match with the bankruptcy state and the patenting period to match with the private firm's operating period. We then perform further manual checks using Capital IQ and online information searches to ensure that we have matched the correct bankrupt private firms with their patents. The resulting sample of private innovation-active firms that eventually file for bankruptcy encompasses 430 firms; 363 of these have at least one active inventor during the period from one to three years before bankruptcy and enter our sample.

Focusing on initial Chapter 11 filers, we collect information on bankruptcy outcomes from a variety of sources, including the Capital IQ database and news searches. We classify these outcomes into four categories: company liquidates (178 cases), company bought by industrial firm (91 cases), company bought by financial firm (36 cases), and company exits as independent entity (221 cases). We can determine the bankruptcy outcomes for 526 Chapter 11 bankruptcy filers (public and private) in our sample.

Figure 1 depicts the frequency of bankruptcy filings in our sample, by year; the early 2000s and 2009 are the periods with the largest number of bankruptcy filings. This suggests that resource

[6] The fraction of patenting firms is similar when considering the whole Compustat universe (active and inactive firms). That is, out of 35,535 U.S. firms that existed in the Compustat North America database during the 1980 – 2015 period, 8,730 firms (25%) filed at least one patent during that same period.

reallocation through bankruptcies primarily occurs during economic downturns. Figure 2 reports the bankruptcies by CPC "industry," in our sample. Because information on traditional industry classifications (like SIC or NAICS codes) is unavailable for private firms, we construct industry classifications based on the modal patent class for each bankrupt firm. Most bankruptcies occur among firms that file most patents in the "physics" (covering, e.g., instruments, optics, and computing) and "electricity" (covering, e.g., generation, conversion, distribution of electric power; electronic circuitry, electrical communication systems) categories.

2.2 Main variables

In this section, we discuss the main variables used in our tests. 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." If an inventor is present in a financially distressed firm in at least one of the three years prior to the bankruptcy filing, the inventor is permanently categorized as being in the "treatment" group. This definition of the set of inventors affected by bankruptcy enables us to consider inventors that depart prior to the actual bankruptcy filing (see, e.g., Baghai, Silva, Thell, and Vig 2021), which would not be possible had we defined the year of the bankruptcy filing as the reference year. Further, we still avoid selecting workers that may be unaffected by the bankruptcy because they left long before the filing.[7] In the regressions, we include each inventor for a maximum window of ten years before to ten years after the bankruptcy (our results are robust to using a shorter [-5, +5] window in the regressions).

Post bankruptcy is an indicator 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 during the three years prior to bankruptcy (this latter group of inventors is only considered in robustness tests, see Section 4.5). In some tests, we use the variables *t0*, *t1*, *t2*, *t3*, and *t4*, which are event time dummy variables that identify, respectively, the year of the bankruptcy,

[7] In robustness tests, reported in Section 4.5, we define an inventor as "treated" when he or she is an employee of a financially distressed firm one year prior to the bankruptcy filing (rather than in one of the three years preceding the bankruptcy).

the year after the bankruptcy, year two after the bankruptcy, year three after the bankruptcy, and year four after the bankruptcy. Furthermore, *t3plus* and *t5plus* are event time dummies that identify the period of year three (respectively, year five) post bankruptcy and beyond.

We employ two main patent-based proxies to measure inventor productivity. The variable *Ln(Patents)* is the natural logarithm of one plus the number of patents applied for by a given inventor in a given year. 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). As an alternative measure which also reflects the importance of an invention, we use the variable *Ln(Citations per patent)*, the natural logarithm of one plus the average number of forward citations (counted until 2020) per patent for all patents that a given inventor applies for in a given year.

We also consider two additional productivity measures in robustness tests. *Ln(Citations)* is defined as the natural logarithm of one plus the total number of citations obtained on all patents that the 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)*, which 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; the dollar value of each patent is obtained from Kogan, Papanikolaou, Seru, and Stoffman (2017). This measure is only available for public firms. We report a selected set of regression specifications with these measures in the robustness section (Section 4.5).

In this study, we are interested not only in the evolution of inventor productivity following a bankruptcy, but, more generally, also in the impact of bankruptcies on inventor careers. To measure how long an inventor remains active following a bankruptcy, and how this may be affected by the team-specific human capital lost during bankruptcy, we construct the variables *Still inventing (x)*, which are indicator variables taking the value of one if an inventor continues to file patents *x* years after the bankruptcy filing. For each pair of "treated" inventors that are employed at the same firm one to 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, if they move to different firms post-bankruptcy, or if one of them stops inventing. To capture team collaborations at the pair level, we define the variable *Pair co-dependence.* For two inventors *i* and *j* who were at a bankrupt firm in at least one of the three years prior to the bankruptcy, *Pair co-dependence* 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 one before the bankruptcy filing. We also create a measure 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 average number of citations obtained by the patents (filed until year one prior to bankruptcy) co-authored by the inventors in the pair.

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 any 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*. We then calculate the percentage 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.* The variable *Remain together* is a dummy variable equal to one if that percentage is larger than 75%, that is, if more than three quarters of the team remains in place. This variable is a measure of team stability across inventors and over time.[8]

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 relates to the productivity of inventors. *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 in at least one of the 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 during that period; all co-authorships up to the year before the bankruptcy filing are considered in this calculation. For inventors that are not employed at a financially distressed firm between years

[8] 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 if we use a three-year period (instead of four years) to define this variable, the pattern of team stability around bankruptcies that we obtain is similar to that documented in Section 4.2.

three and one prior to bankruptcy, this variable takes the value of zero (this group of inventors is only used in robustness tests reported in Section 4.5). *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 in years three, two, or one 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.

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 sample. In our regressions, we include a set of fixed effects for years of experience to capture possible non-linearities in the relationship between inventor productivity and experience (e.g., Bell, Chetty, Jaravel, Petkova, and Van Reenen 2019). We also include fixed effects for the modal patent class of the patents filed by an inventor in a given year, based on CPC technology classes (discussed in Section 2.1). In robustness tests we also employ the variable *Tenure,* which, for an inventor experiencing a corporate bankruptcy, is the number of years between the year the inventor joined the firm and the last year prior to the bankruptcy filing. In Table 1, we present summary statistics of the variables employed in the empirical analyses of this paper. We report a summary of the variable definitions in the Appendix.

3. Empirical setting and identification

We aim to quantify the role of team-specific human capital as a determinant of the productivity of inventors following corporate bankruptcies. Doing so is challenging because bankruptcies are not random events, and neither is the matching of inventors with (bankrupt) firms, nor the formation of production teams. In this section, we discuss the main endogeneity concerns present in our empirical setting and the ways we address them.

When studying corporate bankruptcies, one initial concern relates to selection at the broad industry level. Industries where bankruptcies are most prevalent may be declining industries with obsolete technologies. We account for this possibility in two ways. First, we include technology class-by-year fixed effects, defined at the inventor level. These fixed effects account for industry dynamics that could determine the evolution of productivity of inventors in the absence of a bankruptcy. We consider the modal technology class of the patents filed by each inventor in a given year; thus, the technology class assignment potentially varies over time for a given firm, but also potentially for each inventor. Second, we include bankrupt firm-by-year fixed effects in most of our regression specifications, which absorb any industry trends that are common to all inventors of a given financially distressed firm.

Next, considering selection concerns at the firm level, the firms that file for bankruptcy within a given industry may be those with worse prospects. Thus, finding that productivity falls after bankruptcy could be simply a manifestation of inferior technology and outdated products in those specific firms. We account for this possibility by including bankrupt firm-by-year fixed effects in our regression specifications, which absorb any firm-level trends. This permits us to compare cohorts of inventors who experienced bankruptcy at the same firm but that differ in the extent to which they relied on teams when innovating prior to the bankruptcy.

Given our empirical setting and the fixed effects we employ in our regressions, perhaps the most relevant concern relates to the endogenous formation of inventor teams. Collaborations are not random, and it is possible that inventors who work in teams are fundamentally different from inventors who work alone. It could be, for example, that the most productive inventors can produce individually, while less productive inventors need the support of a team. We address this concern in several ways. First, our tests include inventor fixed effects. This means that time-invariant differences in skills between inventors who work in teams and inventors who work alone are absorbed by our regression specification. One would need to argue that this selection of collaborators only leads to productivity differences after the bankruptcy, but not before, which we view as implausible. Furthermore, if inventors who work in teams are of lower quality than those who work alone, and this was driving our findings, one would expect team-dependence to not matter for post-bankruptcy productivity once accounting for inventor quality. Contrary to the view that team dependent inventors experience a reduction in productivity post-bankruptcy because they are of worse quality, we observe that on average, team-inventors appear to be at least as productive as non-team inventors (see Table 5, Panel A), suggesting that they are unlikely to be low quality inventors. Moreover, when we restrict our sample to a group of highly productive "star" inventors, our findings remain, which further supports the view that our results are not driven by the possibility that the quality of team inventors is low (we discuss these tests in Section 4.4).

One may be also concerned about reverse causality, as low inventor productivity or quality may be the cause of the bankruptcy, and not vice versa. We address this concern in two ways. First, in Table 2, we compare the pre-bankruptcy characteristics of inventors who experience bankruptcy between 1980 and 2015 ("treated" inventors) and inventors who do not experience bankruptcy during the same period ("never treated" inventors).[9] Panel A of Table 2 reports the distribution of technology classes in which the two groups of inventors publish. Overall, treated and never-treated inventors publish in similar patent classes, although treated inventors appear to have a somewhat lower fraction of patents published in "human necessities" (including areas such as foodstuffs, agriculture, health) and a higher fraction in "mechanical engineering; lighting; heating; weapons; blasting." Panel B reports that both treated and never-treated inventors file patents with similar frequency: on average, about one patent every 16 months in the case of treated inventors, and every 18 months in the case of never-treated inventors. However, treated inventors appear to be more enduring in their patenting efforts: treated inventors' careers span 15 years on average, while it is 10 years on average for never-treated inventors. Further, treated inventors publish around 12 patents on average in their lifetime compared to seven patents for never-treated inventors. Finally, the patents of treated inventors are more impactful: while the patents of treated inventors receive about 19 forward citations on average, never-treated inventors receive around 15; lifetime citations are 229 on average for treated inventors and 157 on average for their never-treated peers. In sum, there are indeed differences between inventors experiencing bankruptcy and those that never experience one.

[9] In Table 2, the set of "never treated" inventors encompasses all inventors that file patents in at least *two* years during the 1980 to 2015 period. We impose this requirement because the treated inventors that contribute to the estimation of our regression coefficients also patent in at least two sample years, given that we employ inventor fixed effects in most specifications. However, the conclusions we draw from the comparison are very similar when we relax this sample selection criterion of having at least two patenting years and compare treated inventors to never-treated inventors that have a minimum of one patenting year during the 1980 to 2015 period.

While this may raise some concerns about external validity, it also reduces the concern that (bad) inventor quality causes the firms that we study to go bankrupt, as treated inventors appear to be overall more prolific and to produce more impactful patents than never-treated ones. We address the reverse causality concern in a second way, in robustness tests presented in Section 4.5. In these tests, we restrict the sample to firms with low innovation intensity and observe similar results as in our main sample. Because these firms are unlikely to rely on innovation as their main business driver, the reverse causality argument that firms go bankrupt due to the bad quality or performance of their inventors appears to be less plausible.

In sum, even though we do not have randomly assigned bankruptcies or exogenous assignment of inventors to teams, we employ a battery of fixed effects and robustness tests (discussed in detail in Sections 4.4 and 4.5) to address key identification challenges. We believe that these precautions, taken together, significantly reduce the impact of endogeneity problems inherent in this type of analysis.

4. Bankruptcies, team-dependence, and productivity

4.1 How do bankruptcies affect inventor productivity, on average?

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.[10] 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. We start our empirical analysis by studying the evolution of inventor productivity around corporate bankruptcies. We test whether inventors who were employed by a bankrupt firm experience a change in productivity in the aftermath of the bankruptcy. We use the following regression specification:

$$Productivity_{ift} = \alpha + \beta \cdot Post\ bankruptcy_{it} + X_{ift}^{'}\gamma + \Psi_i + \varepsilon_{ift}, \qquad (1)$$

where $Productivity_{ift}$ is, in different specifications, either the natural logarithm of one plus the number of patents filed in year *t* by inventor *i* in firm *f*; or 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* divided by the corresponding number of patents. These two variables are used to capture distinct aspects of the innovation process, because a bankruptcy event may affect 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.

Post bankruptcy is an indicator variable that takes the value of one in the years after the bankruptcy, and zero before that. The regression described by equation (1) further includes the following control variables: Ψ is a vector of inventor fixed effects, which control for (time-invariant) differences in inventor characteristics that are unobservable to us. Because each inventor is assigned to a single bankrupt firm, these fixed effects also account for any time-invariant, potentially unobservable, firm characteristics that may affect the innovation of inventors employed by the firm filing for bankruptcy. Further, 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, as well as technology class–by–year fixed effects. The latter control for a variety of other potential confounding factors, such as the possibility that the incidence of bankruptcies may be higher in firms that develop technologies that are in decline, that the redeployability of human capital after bankruptcy may vary across technology classes and time, or that the value of inventor skills may be affected by industry dynamics. Standard errors are clustered at the bankrupt firm

[10] In robustness tests, we also include in the sample inventors that never experience a bankruptcy event (see Section 4.5).

level to account for any correlation in error terms within these firms. The coefficient of interest is β which measures changes in the post-bankruptcy productivity of inventors, relative to the period before.

Column 1 of Table 3 reports that, on average, inventors experience a four percent reduction in their innovation productivity, as measured by a patent count, after a corporate bankruptcy, relative to before. Furthermore, the patents filed are of lower quality as measured by citations per patent (column 2 of Table 3). To explore the timing of the effects, we replace the variable *Post bankruptcy* in equation (1) with a set of dummy variables that take the value of one only in one specific year relative to the bankruptcy event. For example, *t0* takes the value of one in the bankruptcy filing year, and is zero otherwise, while *t1* takes the value of one in the year after the bankruptcy filing. Columns 3 and 4 of Table 3 show that innovation output drops immediately in the year of the bankruptcy (*t0*)[11] and continues to drop further until 3 years after the bankruptcy. Patent filings (column 3) are lower by four percent in the year after the bankruptcy filing, and down by six percent three years after the bankruptcy; the effects on citations per patent are quantitatively even larger (column 4). After year 3, the magnitude of the decline in patenting appears to stabilize, and the coefficients are statistically indistinguishable from zero; in the case of patent quality, the effects appear to persist beyond five years. This suggests that inventors who remain active post-bankruptcy suffer longer-term negative effects on their productivity.

4.2 Bankruptcies and team stability

Many tasks, in particular knowledge-intensive tasks, do not happen in isolation. Figure 3 shows that team production is an important aspect of patenting; indeed, the average number of inventors per patent has increased from 1.4 in 1975 to 2.6 in 2015.[12] A corporate 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 its members to a new firm post-bankruptcy. Instead, some

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[11] The drop in productivity in year *t0* is unsurprising, given that firms typically experience challenges related to their financial distress even before the bankruptcy filing. Our examination of firm characteristics before bankruptcy (reported in Figure 4) suggests that profitability decreases in *t-1*, and firm assets gradually decrease starting in *t-3*. These negative developments inside the firms are likely to affect inventor productivity and are likely to explain why there is an effect on patenting already in year *t0*.

[12] In this figure, we consider all patents in the PatentsView database, not only patents filed by inventors in firms (ultimately) experiencing bankruptcy.

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 2019), 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 those cases, a bankruptcy event may lead to the destruction of valuable team-specific human capital and, consequently, to a decline in the productivity of the affected inventors.

It is not clear ex ante to which extent reorganization through bankruptcy 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, 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 corporate 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 this analysis, in which we rely on data from Compustat, we focus on the public 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). 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 in the bankruptcy filing year, 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 employ the variable *Remain together*, a measure of team stability across inventors and over time. This dummy variable is equal to one if the percentage 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,* is larger than 75%; that is, the dummy is one if more than three quarters of the team remains in place.

The results are presented in column 1 of Table 4. 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 in the (baseline) period prior to bankruptcy. In terms of magnitudes, the coefficients suggest that the likelihood of inventors remaining together with at least 75% of their team from four years prior is lower by about 20 percentage points in the year of the bankruptcy and the following year, which constitutes a reduction in team stability by 33 percent relative to the pre-bankruptcy period.

The results reported in Table 4 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, or if the new teams are of worse quality. We investigate this issue in the next subsection.

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

In the previous sections, we documented that inventors become less productive after bankruptcy. They also experience an increased likelihood of being separated from their teammates. A natural next step is to investigate whether the organization of production in teams correlates with the productivity of inventors after a bankruptcy event. Our main explanatory variable of interest is *Team dependence*, which measures the degree to which an inventor's innovation output depends on collaborators 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 bankrupt firm, suggesting that team complementarities may be an important element of inventor productivity.

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

$$Productivity_{ift} = \alpha + \beta_1 \cdot Post\ bankruptcy_{it} + \beta_2 \cdot Post\ bankruptcy_{it} \times Team\ dependence_i\ + X'_{ift}\gamma + \Psi_f + \varepsilon_{ift}, \qquad (2)$$

where $Productivity_{ift}$ is, in different specifications, *Ln(Patents)*, a measure of the quantity of innovation output, and *Ln(Citations per patent)*, a measures of the quality of patents produced. *Post bankruptcy* is an indicator variable that takes the value of one in the years after the bankruptcy, and zero before that. The regression described by equation (2) further includes the following control variables: Ψ is a vector of bankrupt firm fixed effects, while the matrix X contains dummies for the number of active years of an inventor, as well as technology class–by–year fixed effects. Standard errors are clustered at the bankrupt firm level to account for any correlation in error terms within firms.

The coefficient of interest in equation (2) 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 4), then inventors whose work relies more on co-authorships within the financially distressed firm may be more negatively affected by the bankruptcy event.

We report results from this analysis in Table 5, Panel A. First, in columns 1 and 2, we report specifications in which we do not interact the variables *Team dependence* and *Post bankruptcy.* These specifications permit us to compare the productivity of team and non-team inventors. We find that team inventors are at least as productive as non-team inventors. Specifically, based on the coefficient estimates in columns 1 and 2, we find that inventors that only work in teams are three to eight percent more productive than inventors that patent alone; the first of these point estimates is statistically insignificant, while the second is statistically significant at the five percent level. As in Table 3, we also observe that inventor productivity diminishes after the bankruptcy. Next, we report results from regressions in which we interact the variables *Team dependence* and *Post bankruptcy.* Consistent with the view that team-specific human capital is a key determinant of post-bankruptcy inventor productivity, in columns 3 and 4 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 six percent reduction in patenting post-bankruptcy (column 3) and a 12 percent reduction in citations per patents (column 4), relative to an inventor with no co-authorships within the bankrupt firm. For an inventor with average team-dependence, the productivity loss amounts to three percent if the estimate in specification 3 is considered, or six percent based on the estimate in specification 4.[13] We also observe in columns 3 and 4 of Table 5, Panel A, that the coefficient on the variable *Post bankruptcy* is negative but not statistically significant. This suggests that, on average, inventors without significant team-specific human capital do not experience a substantial reduction in their innovation productivity after the bankruptcy.

In Panel B of Table 5, we enhance the regression model (2) with an additional set of fixed effects. These regressions include bankrupt firm-by-year fixed effects, which account for any time-varying, potentially unobservable firm characteristics that may affect the innovation of inventors employed by the firm filing for bankruptcy (such as a deterioration in the amount or quality of resources made available for research). This set of fixed effects permits us to compare cohorts of inventors who experienced bankruptcy at the same firm but that differ in the extent to which they relied on teams when innovating prior to the bankruptcy. In addition, we employ inventor fixed effects, which we include to control for (time-invariant) differences in inventor characteristics that are unobservable to us. The coefficient estimates on the interaction term on the variables *Team dependence* and *Post bankruptcy* in columns 1 and 2 of Panel B are similar to the coefficients from the less saturated model reported in Panel A, implying a decrease in the post-bankruptcy productivity of team inventors compared to less team reliant inventors. Based on the coefficient estimates reported in columns 3 and 4, we observe that team inventors suffer longer-lasting productivity losses compared to other inventors, with the productivity declines extending to at least five years after the bankruptcy filing. Given the evidence in Table 4 that new teams form relatively quickly, this suggests that, on average, team-specific capital is destroyed through bankruptcy. Even if new teams are relatively quickly formed, these appear to be of worse quality than before.

[13] Average *Team dependence* in the sample is 0.5 (Table 1).

In sum, the evidence presented in Table 5 suggests that the productivity of team inventors is particularly negatively affected by the bankruptcy. While the quantity of patents produced decreases, it is particularly the quality of these patents that diminishes.[14]

In Figure 5, we analyze the dynamic evolution of different inventor productivity measures around bankruptcy events. This figure plots coefficients from a regression model similar to equation (2); however, in this figure, we replace the variable *Post bankruptcy* with dummy variables indicating specific years around the bankruptcy filing year. We interact these dummies with the variable *Team dependence* and plot the coefficients and 95% confidence intervals around the point estimates. The interaction between *Team dependence* and the dummy variable indicating the year prior to the bankruptcy filing is omitted. On the y-axis, the figure measures changes in productivity per inventor relative to year *t-1* (one year prior to the bankruptcy filing), and on the x-axis, it plots the time relative to the bankruptcy filing year. In Panel A, we employ as the productivity measure *Ln(Patents)*, while we measure inventor productivity using *Ln(Citations per patent)* in Panel B and using *Ln(Citations)* in Panel C. Finally, Panel D uses *Ln(Dollar value of patents)* as the dependent variable (which is only available for public firms). We observe that up to the year of the bankruptcy, the productivity of inventors with many co-authors in the bankrupt firm evolves in parallel with that of inventors who do not rely on teamwork. However, after the bankruptcy, the productivity of inventors with many co-authors at the financially distressed firm diminishes significantly relative to the benchmark. It is also evident from Figure 5 that most of the negative productivity effects of bankruptcies for team inventors subside five to six years after the bankruptcy filing and then revert to pre-bankruptcy levels.

The findings reported in Tables 3 – 5, and in Figure 5, complement prior evidence on the effect of bankruptcies on human capital. Graham, Kim, Li, and Qiu (2022) report that after a bankruptcy, manufacturing workers experience a large decline in wages. While we do not study

[14] 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 a specification discussed in Section 4.5. This measure is based on the stock market reaction to the announcement of new patent grants and is therefore only available for publicly traded firms (see Kogan et al., 2017, for details). Despite the differences in the sample, we observe effects that are qualitatively similar to our main tests reported in Table 5.

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. A more fundamental difference between our findings and those of Graham, Kim, Li, and Qiu (2022) is that we show that the losses are magnified for team-dependent workers, while collaborative work is not analyzed in Graham et al. Our results also contrast with the findings in the literature that uses co-inventor deaths to study the impact of a destruction of team-specific human capital. Jaravel, Petkova, and Bell (2018) report that an inventor's productivity is still lower by 15 percent eight years after the death of a co-inventor. We find that inventor productivity is significantly and persistently reduced after a bankruptcy; the magnitudes are economically significant but smaller than in the case of the death of a co-inventor. The smaller losses faced by team-dependent inventors in the aftermath of a bankruptcy suggest that, unlike in the case of deaths, the labor market may play an important role in preserving productive team configurations. We return to this point in Section 5, where we explicitly study the post-bankruptcy joint reallocation of inventor teams.

4.4 Addressing 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. For example, inventors in firms that file for bankruptcy may be of worse quality than inventors in firms that are not (yet) financially distressed; in that case, 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, as discussed in Section 3, inventors exposed to bankruptcy are on average more productive than "never treated" inventors (see Table 2), which is contrary to the view that inventors in bankrupt firms are simply of worse quality. Further, regression estimates presented in Table 5, Panel A, also show that—within the sample of inventors experiencing bankruptcy—team inventors are more productive than inventors that tend to work alone. Second, the regressions reported in Table 5, Panel B, include inventor fixed effects; these control for any time-invariant unobservable characteristics of inventors, including differences in the ability of inventors employed by different firms or differences in the ability of inventors with different levels of team-dependence. Third, we include technology class-by-year fixed effects to account for the possibility that the value of inventor skills varies across technology classes and time. This implies that we are not simply capturing the effect of technological obsolescence, which may be associated with a reduction in productivity that would occur independently of bankruptcy. Fourth, bankrupt firm-by-year fixed effects in our regressions in Table 5, Panel B, 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. When we employ this set of fixed effects, we are performing comparisons among cohorts of inventors who were employed by the *same* bankrupt firm. Fifth, 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. Sixth, 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). Therefore, to explain our findings, any inventor selection mechanism would have to take a rather specific and intricate form. Nevertheless, to further alleviate the concern that the results might be driven by selection considerations, we conduct two additional tests which we report below. While we report the results only for the variable *Ln(Patents)*, to conserve space, we obtain similar results using the variable *Ln(Citations per patent)*.

To help rule out the concern that the (low) quality of inventors at firms going through bankruptcy and that of inventors who work in teams could be biasing our estimates, 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 – 2015. "Star inventors" are then defined 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 the most productive inventors), then we are more likely capturing a general "bankruptcy effect" rather than an effect attributable to heterogeneity in inventor quality.[15] The results are reported in column 1 of Table 6 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 star inventors that are less dependent on team production.[16] This test also alleviates the concern that our results may be affected by the way we infer inventor careers from their patenting activity. That is, 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.

We also conduct a test to address reverse causality concerns. It is conceivable that in our setting 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 set of firms for which innovation may be relatively less important: we select a subset of firms that have below median R&D per total assets, measured three years prior to the bankruptcy filing, in our sample (the sample median is 0.050). For these low innovation intensity firms, it is unlikely that poor inventor performance was responsible for the financial distress of the firm. The results are presented in column 2 of Table 6; they show a similar pattern to those in Table 5, suggesting that this effect is unlikely to be driving our findings.[17]

In sum, we believe that the evidence presented 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 or teams. While we

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

[16] When estimating specification 1 with *Ln(Citations per patent)* as the dependent variable, we observe that star inventors experience a reduction in productivity after the bankruptcy; however, the coefficient on the interaction between *Post bankruptcy* and *Team dependence*, while negative, is not significantly different from zero. When defining star inventors as inventors in the top 50% of granted patents, however, we observe statistically significant reductions in post-bankruptcy productivity using both productivity measures, *Ln(Patents)* and *Ln(Citations per patent)*.

[17] Because we employ the variable assets (*at*) and R&D expenditure (*xrd*) from Compustat to select firms for this sample, the firms included in these tests are public firms; thus, the sample size is reduced.

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.

4.5 Additional robustness tests

In the main tests, we report coefficients of regression specifications that employ *Ln(Patents)* and *Ln(Citations per patent)* as the dependent variables. These variables measure the quantity and quality of inventor innovation, respectively. However, our results are robust to using other measures of innovation output, such as *Ln(Citations)*, defined as the natural logarithm of one plus the total number of forward citations, and *Ln(Dollar value of patents)*, 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 in a given year. We report specifications using these two alternative productivity measures in columns 3 and 4 of Table 6.

As we have seen in Table 5, 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, the concern may arise 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-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, 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 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. Indeed, the correlation between *Team dependence* and the years of tenure of inventors up to three years prior to the bankruptcy (variable *Tenure*) is small but positive (the correlation coefficient is 0.10). 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* as a proxy for firm-specific human capital, as well as its interaction with *Post bankruptcy*.[18]

The coefficient estimate on the term *Post bankruptcy* × *Tenure* is negative (column 5 of Table 6), suggesting that workers who have accumulated more firm-specific human capital may experience a larger reduction in their productivity post-bankruptcy; however, the relevant coefficient is not statistically significantly different from zero at conventional levels. Importantly, the coefficient on *Post bankruptcy* × *Team dependence* remains statistically significant, with a magnitude similar to our baseline test in Table 5.

In our main tests, we restrict the sample to inventors that experienced a bankruptcy at some point during the period 1980 to 2015. 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 a bankruptcy. To show that our results are not driven by this choice of sample, we also report estimates obtained when we use the entire population of inventors as a comparison group. Because this group includes all inventors that were never employed by a firm in the runup to bankruptcy ("never-treated inventors"), the number of observations increases from about 160,000 to more than five million. The findings remain unchanged: the estimates in column 6 of Table 6 show that after bankruptcy, the decline in inventor productivity is concentrated among the group of inventors that had more team-specific human capital.

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

In our main sample, we define an inventor as "treated" when he or she is an employee of a financially distressed firm in at least one of the three years preceding the bankruptcy (we provide arguments for this sample selection procedure in Section 2.2). However, the results do not appear to be sensitive to variations of this procedure. For example, in column 7 of Table 6, we report a regression for our main test using an alternative procedure in which we define inventors as "treated" if they are at the bankrupt firm one year prior to the bankruptcy filing.

Finally, we address the concern that our results are driven by the choice of regression model (e.g., Cohn, Liu, and Wardlaw 2022). To address this concern, instead of a linear regression model with a log-transformed outcome variable, we estimate a Poisson model. The results are similar to our linear regression estimates and are reported in column 8 of Table 6.[19]

5. Inventor careers after a bankruptcy

5.1 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 take this into account, and they may thus underestimate the effect that bankruptcies have on inventors. 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 this question in this section.

We estimate a linear probability model in which each inventor is only included in the sample once; the sample focusses on "treated" inventors. The outcome variable is *Still inventing*, a dummy variable that takes the value of one if an inventor continues to invent (i.e., continues to file patents) within a certain number of years after the bankruptcy filing. The regressions include bankruptcy firm fixed effects as well as technology class fixed effects. Further, we include fixed effects for the number of an inventor's active years at the time of the bankruptcy filing, which

[19] We note that all other specifications reported in Tables 3, 5, 8, and 9 are also robust to being estimated with a Poisson model using a simple patent count as the dependent variable.

account for the fact that older inventors may be more likely to stop inventing than young inventors.[20] We report the results in Table 7.

We find that more team-reliant inventors are less likely to continue to invent after bankruptcy than less team reliant inventors. The magnitude of this effect diminishes the more time passes after the bankruptcy, perhaps because team breakup occurs soon after bankruptcy (see Table 4) and new team capital from new work relationships is built up over time. The economic magnitude of this effect is considerable. For example, two years after the bankruptcy, inventors that only patent in teams are twelve percentage points less likely to remain active; relative to the average inventor affected by the bankruptcy, this constitutes an 18 percent lower two-year survival rate. 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 bankrupt firm positively affects the probability that the inventor stops inventing post-bankruptcy.[21]

5.2 Bankruptcy outcomes, team stability, and post-bankruptcy productivity

In the analysis presented so far, we have grouped together all bankruptcy events. However, the preservation of collaborative arrangements and the productivity of inventors may depend on the outcome of the bankruptcy. In this section, we investigate whether different bankruptcy resolutions affect the stability of inventor teams as well as their post-bankruptcy output. In these tests we focus on a sample that includes all initial Chapter 11 filers for whom we can find conclusive information on the outcome of the bankruptcy. We distinguish the following outcomes: exit as an independent firm; acquisition by an industrial firm; acquisition by a financial firm (that is, a private equity deal); and liquidation. To examine whether different bankruptcy outcomes affect team stability differently, we enhance the specifications reported in Table 4 with interactions with dummy variables that capture these different bankruptcy outcomes. Similarly,

[20] In these specifications, we do not control for inventor fixed effects because such variables would absorb the cross-sectional variation of interest.

[21] 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 7, 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.

to measure whether different outcomes affect the post-bankruptcy productivity of team inventors differently, we enhance the specifications reported in Panel B of Table 5 by interacting *Team dependence * Post bankruptcy* with dummy variables that capture the bankruptcy outcomes; we report these tests in Table 8.

First, we test whether inventors whose firms are eventually liquidated because of the bankruptcy experience a more severe disruption to their teams and their innovation activity. Because liquidations may lead to an abrupt stoppage of all firm activities, the productivity of inventors may be most negatively affected in those cases, especially when their output is dependent on tightly-knit collaborations. To assess the extent to which liquidations affect team stability, in column 2 of Table 4, we examine whether the probability of being employed in the same firm as the coauthors from four years before is lower in the case of liquidation. Overall, the estimates suggest that liquidations are indeed associated with a considerably higher likelihood of team break-up than other outcomes of the bankruptcy. An inventor of a liquidated firm is about 30 percentage points less likely to be working with at least 75% of the team from four years prior than when a bankruptcy does not result in a liquidation. This negative effect on team stability is more than twice as large as in the case of other bankruptcy outcomes. In turn, team-dependent inventors of liquidated firms experience roughly double the average productivity losses following the bankruptcy (see columns 1 and 2 in Table 8).

When firms are not liquidated as a result of a bankruptcy there are several potential continuation outcomes. After reorganizing itself, the firm may re-emerge as an independent corporation, or it may be acquired by a financial or a strategic buyer. These outcomes may also influence the degree to which inventors continue to collaborate with their colleagues and, ultimately, their productivity. We test whether different continuation outcomes affect the stability of inventor teams, in columns 3 to 5 of Table 4. Being acquired by a strategic buyer is associated with a lower likelihood of team break-up (column 5). Consistent with the view that team stability is a key determinant of post-bankruptcy productivity of team-reliant inventors, in Table 8, we observe that the negative consequences of the bankruptcy for inventors that work in teams are non-existent when the bankruptcy-filing firm is acquired by a strategic buyer (columns 7 and 8 in Table 8). This suggests that acquisitions facilitate the preservation of human capital that is specific to teams. There appears to be no differential effect on team stability and post-bankruptcy productivity when firms emerge as independent entities after restructuring or when they are acquired by a financial buyer (columns 3 and 4 in Table 4, and columns 3 to 6 in Table 8).

5.3 Mobility restrictions and productivity: evidence from non-compete clauses

Contractual restrictions that make it difficult for inventors to move freely across firms may prevent productive combinations of inventors to continue to collaborate in the aftermath of the bankruptcy event. One important type of mobility restrictions, which are prevalent in labor contracts, is non-compete clauses. These clauses 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 U.S. states (for a recent discussion, see Jeffers 2022).[22] This allows us to exploit variation in the degree of enforceability of non-compete clauses across U.S. states.

We employ a time-varying state-level index measuring the extent to which non-compete clauses are enforced by courts in each U.S. state. To cover our whole sample period, we combine three sources which construct indices using the same methodology. Garmaise (2011) pioneered the construction of an index of the state-level enforceability of non-compete agreements (NCA); that index covered the years from 1992 to 2004. Bird and Knopf (2015) extend his index from 1992 back to 1976, while Kini, Williams, and Yin (2021) extend the index from 2004 to 2014. The index ranges from zero in states where noncompetition clauses are not enforced at all (e.g., California), to nine in states that exhibit the strongest enforceability of such clauses (e.g., Florida). Because we

[22] How are non-compete agreements handled in bankruptcy? Employment contracts are so-called "executory contracts" that can be assumed or rejected by the debtor in a bankruptcy case, subject to bankruptcy court approval and certain other conditions. If the employment contract is assumed, then the employee is still bound by the conditions in the contract, including covenants not to compete. However, noncompetition agreements (NCA) may also "survive" rejection of the contract; whether they do is subject to bankruptcy court ruling. The court will have to consider that a failure to enforce such clauses, even in a rejected contract, may adversely affect a debtor's ability to reorganize or sell the business. However, bankruptcy courts—as courts of equity—may choose to protect the employees, then voiding the NCA in rejected employment contracts. While in Chapter 11 cases NCA are often still enforced even when the employment contract is rejected by the debtor, in Chapter 7 cases, noncompetition clauses are less likely to survive rejection. In sum, whether NCA are still binding in bankruptcy depends on several factors. Despite this, in our view, the idiosyncratic treatment of NCA will not bias our results, but it may make some of the estimates less precise. Please see Gretchko and Todhunter (2012) for more details on the treatment of NCA in bankruptcy.

are primarily interested in a comparison of effects between high and low enforcement U.S. states (rather than in the effect of marginal changes in NCA enforcement), we compare effects in states above and below the sample median of the index. We construct the indicator variable *Strong NCA enforcement*, which is a dummy variable taking the value of one in states in which the non-compete enforcement index takes a value greater or equal than five (the sample median).

First, we study how the enforceability of NCA affects team stability. We enhance the baseline specification in Table 4 with interactions with the variable *Strong NCA enforcement*. A priori, it is not clear how NCA should affect team stability. While they reduce individual inventor mobility (e.g., Marx, Strumsky, and Fleming 2009), resulting in inventor teams being kept together by being "stuck" at the restructuring firm, such agreements also hinder the ability of productive teams to move to different employers. The coefficients are reported in column 6 of Table 4. We find that strong enforcement of NCA results in a significant reduction in the stability of teams around bankruptcy events, compared to states with weaker non-compete enforcement.

In Table 9, we test whether the productivity of team-dependent inventors is more negatively affected by a bankruptcy when the inventor is employed in a state with high enforceability of non-compete clauses at the time of bankruptcy. In columns 1 and 2, we focus on inventors located in states with below median enforcement, while in columns 3 and 4, the sample includes inventors located in states with above median enforcement. The picture that emerges is stark. Across both measures of inventor productivity, restrictions to inventor mobility are associated with deeper drops in productivity after a bankruptcy. The point estimates on the coefficient *Post bankruptcy* × *Team dependence* are statistically significantly different from each other across the two labor market regimes, as can be seen in columns 5 and 6 of Table 9. In particular, in the specifications reported in columns 5 and 6, we interact our measure of team-dependence with the dummy variable *Strong NCA enforcement*; the coefficient on this interaction term is negative and statistically significant.

These tests also help to address the concern that some of the best individual inventors as well as the best teams of inventors may have left the financially distressed firm by the time it files for bankruptcy (Baghai, Silva, Thell, and Vig 2021). 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.[23] The concern that the best may have endogenously chosen to abandon the firm early is diminished in the sample of inventors located in states where non-compete clauses are enforced, because the best inventors and the best teams are precisely the type of employees that are likely to have a non-compete clause in their employment contract. The fact that our results hold in the case of inventors who have contractual impediments to leaving the firm increases our confidence that our findings are not driven by selection.

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

Considering the role played by team-specific human capital as a determinant of the post-bankruptcy productivity of inventors, it is natural to 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 (i) are employed by the firm in years *t-3* to *t-1* relative to the bankruptcy and that (ii) remain active post-bankruptcy.[24] 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 also create an alternative measure of the economic value of collaborations at the

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[23] 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 5 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.

[24] For example, a firm with four inventors has six possible inventor pairs. The dataset we construct is thus at the pair level with one observation for each inventor pair. Each inventor may have several pairings with other inventors, but each pair only appears once in our data. For example, if A-B is in the dataset, then B-A will be excluded from our data (but inventor A may be in other pairings which are included in the data, such as A-C and A-D).

level of inventor pairs: *Pair average citations* is the average number of citations obtained by the patents (filed until year three prior to bankruptcy) coauthored by the inventor pair. We use these measures to test whether inventors who work closely together in the firm pre-bankruptcy are more likely to move together to a new employer post-bankruptcy. In these tests, 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.

Consistent with the conjecture that the labor market recognizes the importance of team-specific human capital, in Table 10, 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 a one-standard deviation increase in *Pair co-dependence* for the average inventor pair would result in a 40% increase in the co-location likelihood, relative to the sample mean. Columns 2 to 4 enhance the regression specification with additional explanatory variables: the dummy variable *Strong NCA enforcement*, in specification 2; a dummy variable indicating that a given inventor pair worked in a firm that is acquired by an industrial firm post-bankruptcy in specification 3; and a dummy variable indicating that a given inventor pair worked in a firm that is later liquidated post-bankruptcy in specification 4.[25] Consistent with non-compete agreements limiting inventor mobility, we find that stricter enforcement of non-compete agreements in a given state reduces the likelihood of inventors co-locating to a different firm post-bankruptcy. The regressions reported in Table 10 (specifically, coefficients in columns 3 and 4) also show that an acquisition by an industrial buyer increases the likelihood of inventor colocation, while a liquidation of the bankrupt firm reduces the chance of inventors working together post-bankruptcy. In all specifications, the coefficient on the variable *Pair co-dependence* is positive and significant, suggesting that team inventors are more likely to co-locate.

[25] The dataset underlying the tests in Table 10 has as its unit of observation an inventor pair. Inventors that work for the same firm may be subject to different enforceability of non-compete agreements, depending on the state where their work unit is located. That is, in our data, two inventors of the same firm may work at different subsidiaries (patent assignees) which are located in different states; if they do, we assign to the inventor pair the highest of the two non-compete enforcement indices in a given year.

The variable *Pair co-dependence* primarily measures the extent of teamwork by a pair of inventors, but it may not capture well the importance and impact of that work. 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 employ an alternative measure of pairwise productivity. In columns 5 – 8 of Table 10, instead of *Pair co-dependence*, we use the variable *Pair average citations*, which uses patent citations to measure the average quality of the patents jointly produced by each inventor pair. The results are qualitatively similar to those reported in columns 1 – 4. In sum, the tests in Table 10 show that the likelihood of two inventors moving together to a new employer post-bankruptcy is increasing in the intensity and importance of the pre-bankruptcy collaborations of these inventors.

6. Conclusion

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. Our findings also point to the existence of market forces that promote and preserve the stability of productive teams. We document 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. However, contractual restrictions on employee mobility constitute labor market frictions that hinder the reallocation of productive teams. We also find that acquisitions play an important role in maintaining productive team constellations. 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 after bankruptcies.

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Figure 1: Corporate bankruptcies over time

This figure reports the frequency of corporate bankruptcies by year from 1980 to 2015, as they occur in our sample. Information on bankruptcy filings is from the UCLA-LoPucki Bankruptcy Research Database and the New Generation Research bankruptcy database.

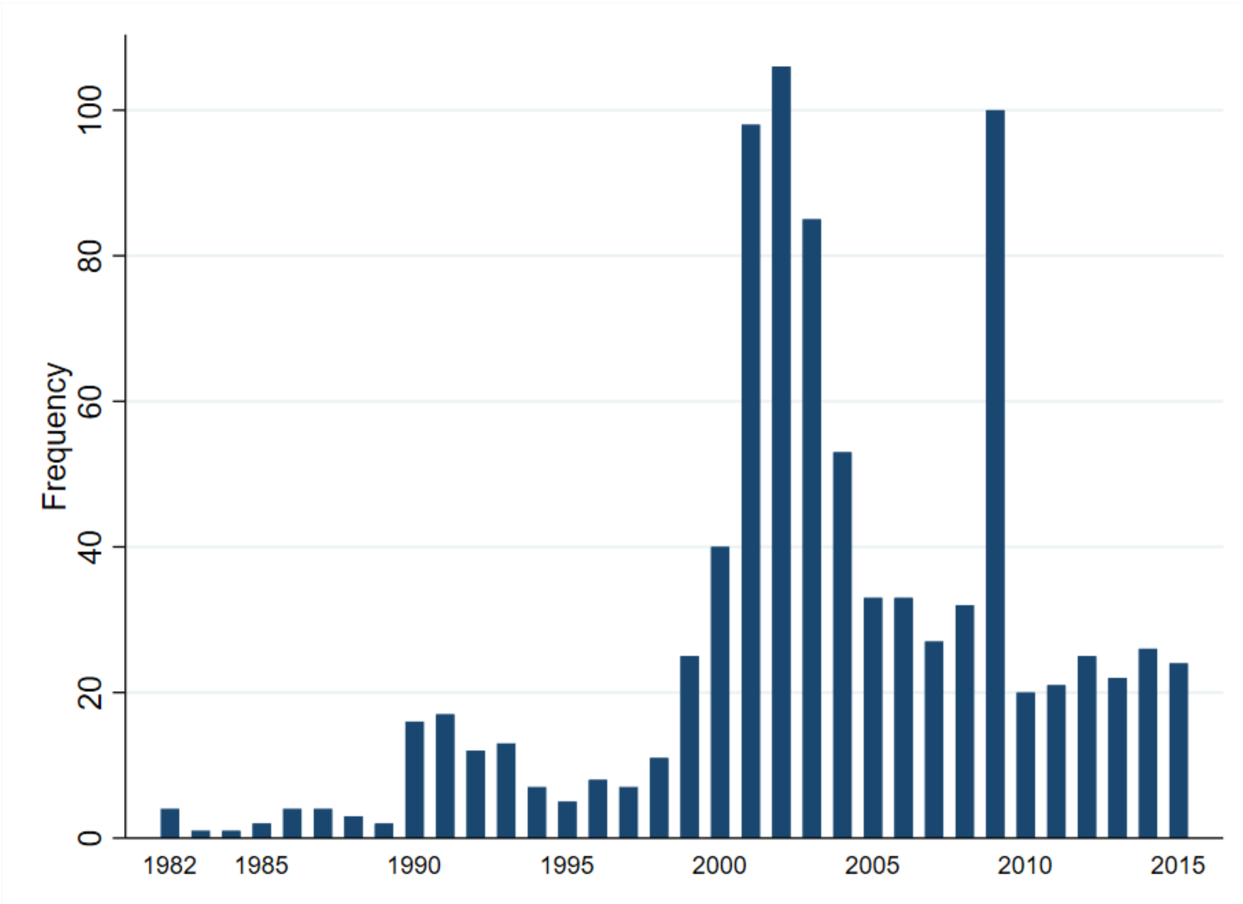

Figure 2: Corporate bankruptcies across industries

This figure shows the distribution of corporate bankruptcies by industry between 1980 and 2015, as they occur in our sample. The industry classification reflects the Cooperative Patent Classification (CPC) technology class and is based on the modal patent class for each bankrupt firm. Information on bankruptcy filings is from the UCLA-LoPucki Bankruptcy Research Database and the New Generation Research bankruptcy database.

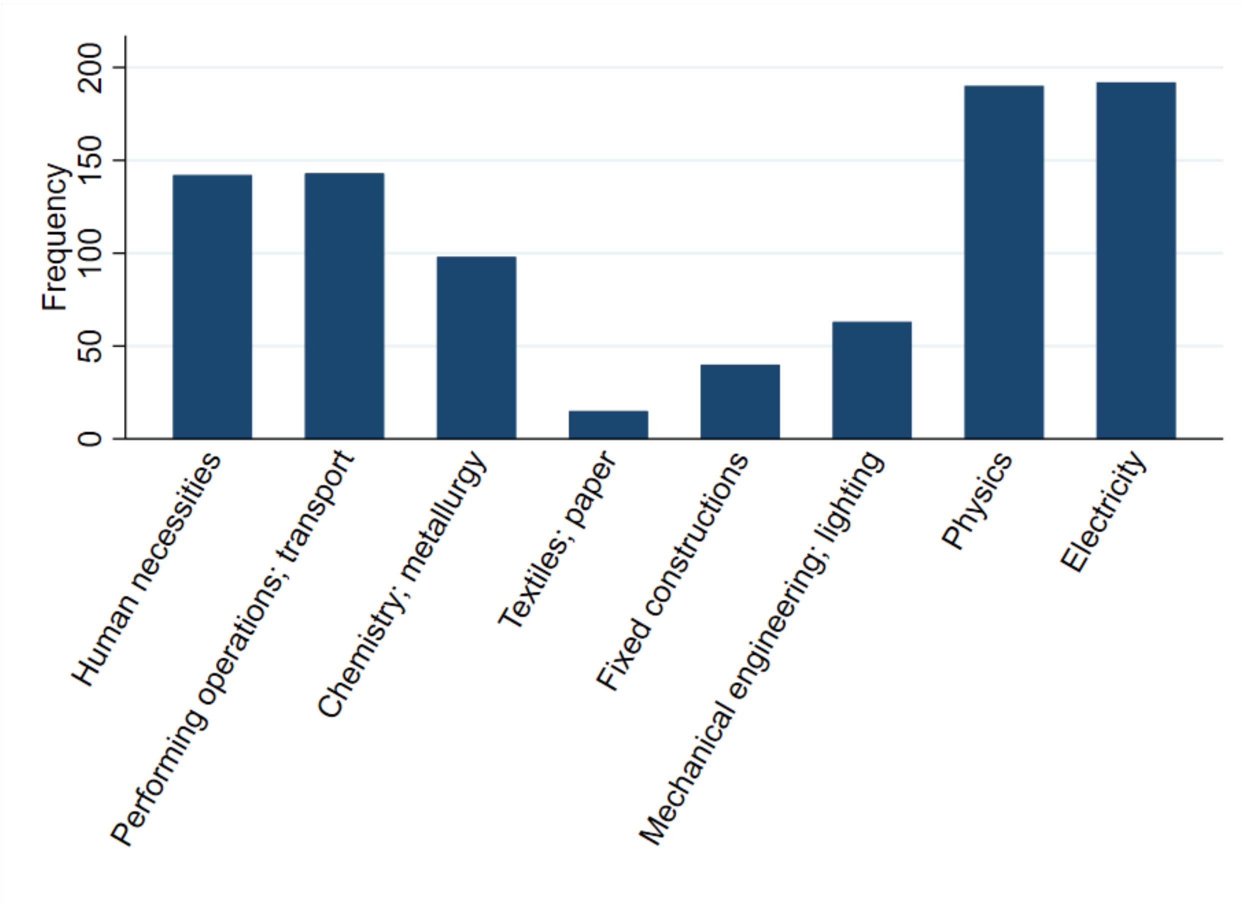

Figure 3: Team production in corporate innovation over time

This figure shows the evolution of the average number of co-authors per patent between 1976 and 2020. The data are from the PatentsView database.

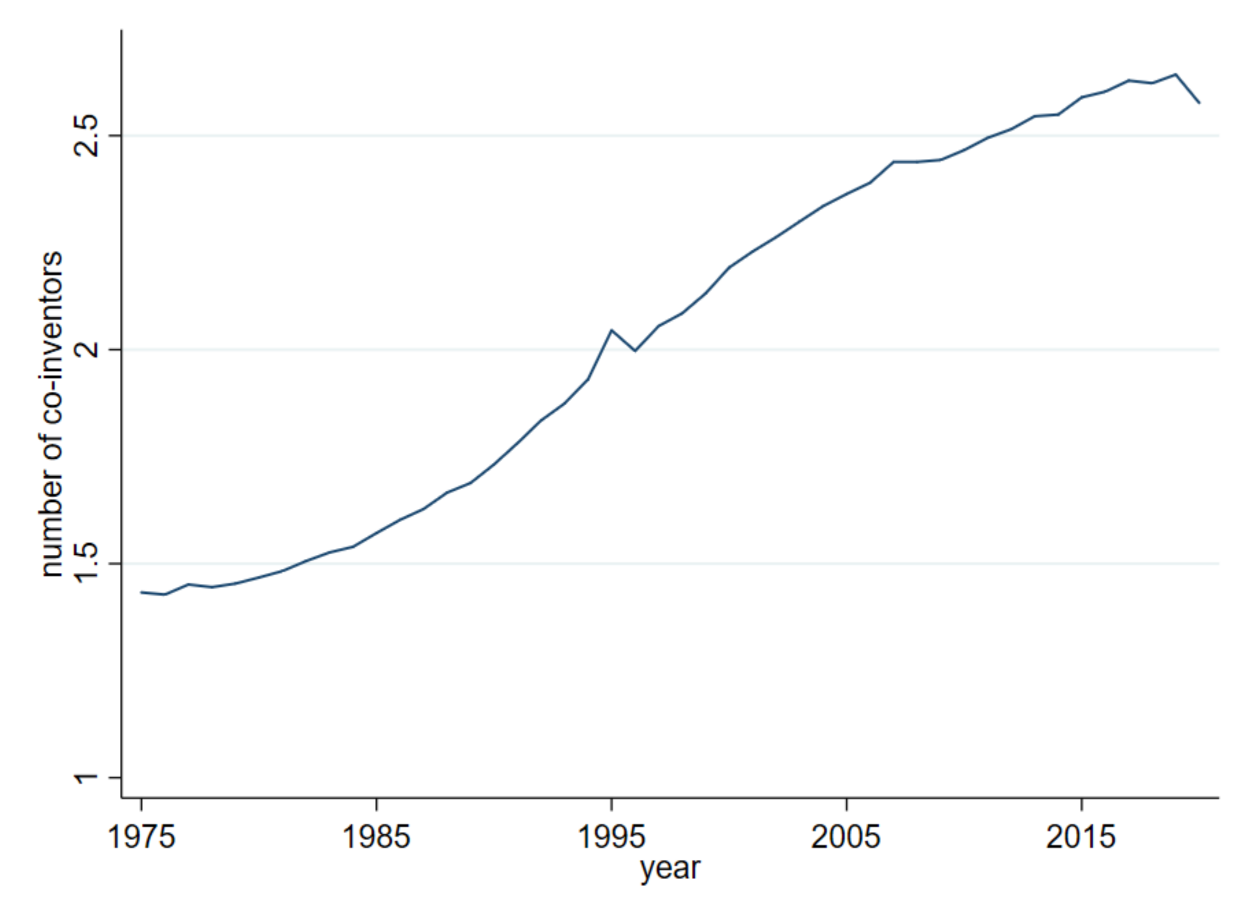

Figure 4: Firm characteristics as firms approach bankruptcy

This figure shows how firm characteristics evolve prior to the bankruptcy filing. We first estimate the following OLS regression model:

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

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 2015) and the event-time dummies included in matrix *T*; we include dummies for the years *t-4*, *t-3*, *t-2*, *t-1*, *t0* (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 – 2015. We require "treated" firms to be present in the sample at time *t-5* and exclude any observations after year *t0*. *Y* is the return on assets (Compustat items *ebitda* divided by *at*) in Panel A; *Leverage* (defined using Compustat items (*dltt* + *dlc*)/*at*) in Panel B; *Firm size* in Panel C (measured as the log of total assets, Compustat item *at*); 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 (SIC 4-digit)-by-year fixed effects. The sample of non-treated firms consists of all listed companies in Compustat that have patented at least one patent during 1980 to 2015 (our sample period). The 95% confidence bounds are calculated using standard errors clustered at the firm level.

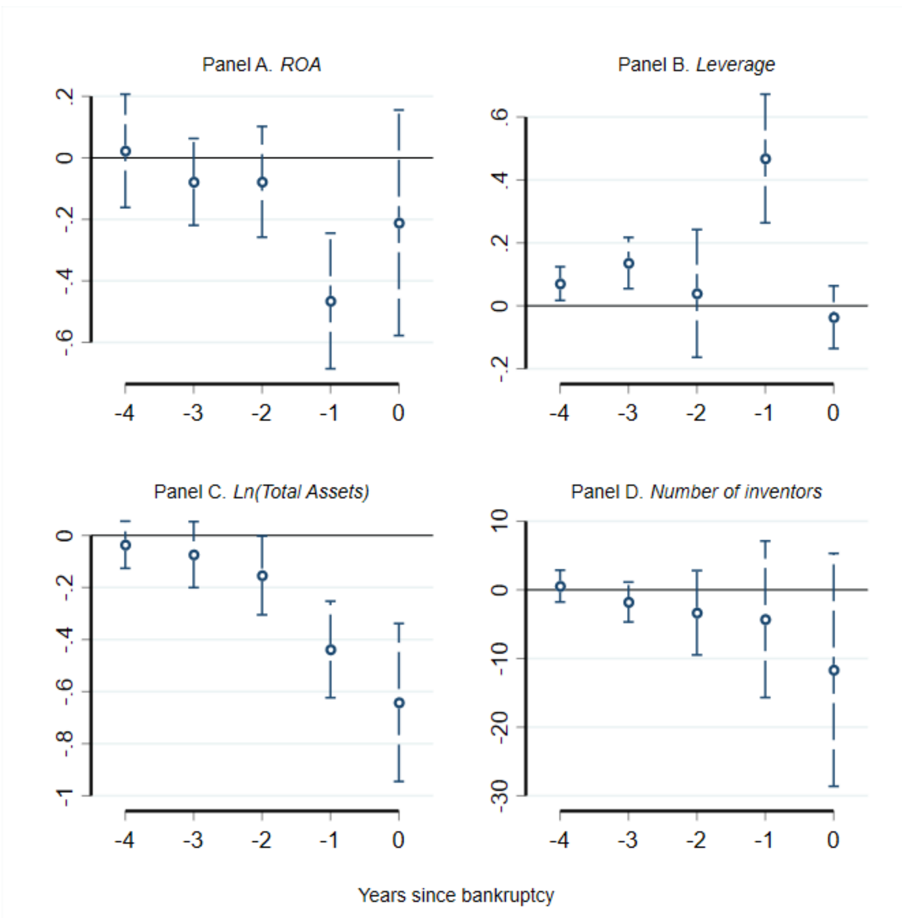

Figure 5: Team-dependence and inventor productivity around corporate bankruptcies

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:

$$Y_{ft} = \alpha + T_i'\beta + Team\ dependence_i \cdot T_i'\theta + X_{ift}'\gamma + \epsilon_{ift}$$

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-10, t-9, …t-3, t-2, t0* (the bankruptcy filing year), *t+1, t+2, t+3, …t+10* relative to the bankruptcy event. The dummy for the year prior to the bankruptcy filing year, *t-1*, is the baseline and omitted from the specification (interaction). As dependent variables, *Y*, we employ *Ln(Patents)* in Panel A, *Ln(Citations per patent)* in Panel B, *Ln(Citations)* in Panel C, and *Ln(Dollar value of patents)* in Panel D. The sample is restricted to "treated" inventors. We require inventors to be present in the sample at time *t-10* and exclude any observations after year *t+10*. The matrix of controls *X* includes inventor fixed effects, bankruptcy firm-by-year fixed effects, technology class-by-year fixed effects, and inventor experience fixed effects. The 95% confidence bounds are calculated using standard errors clustered at the bankruptcy firm level.

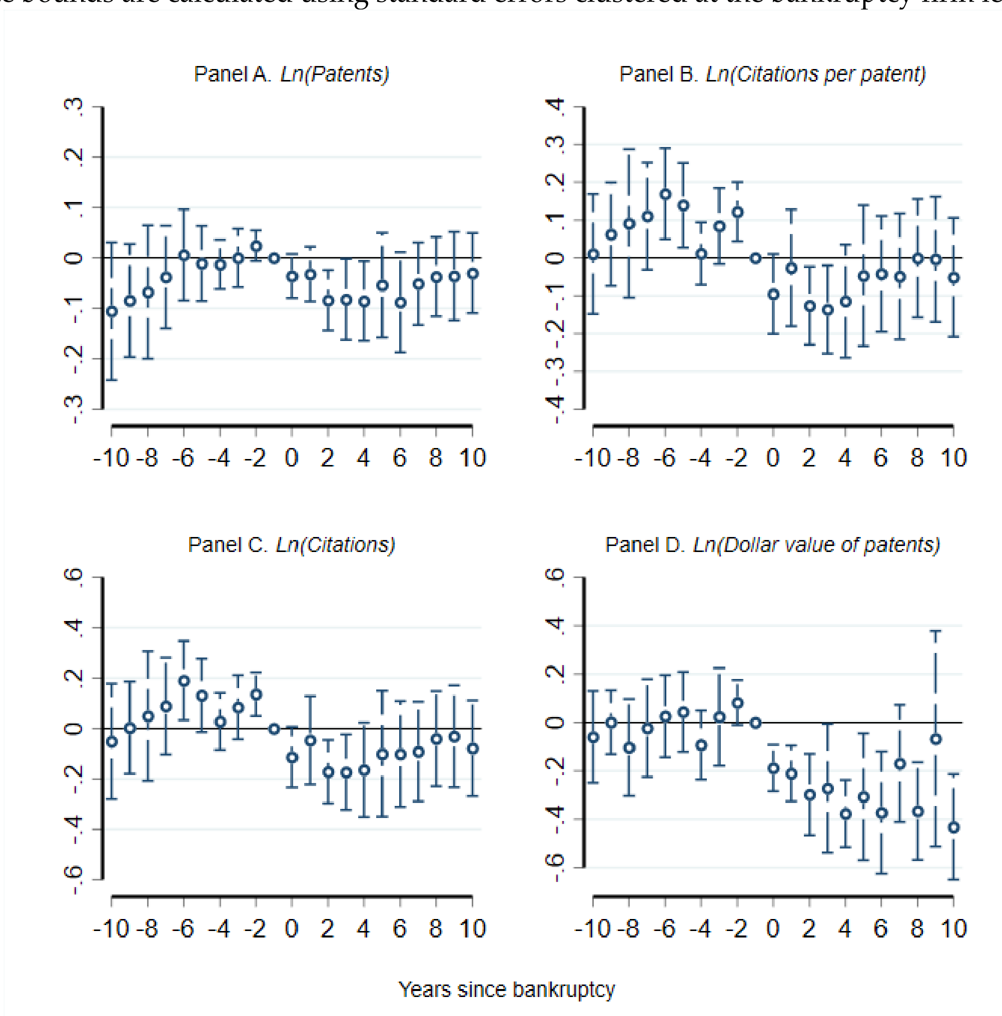

Table 1: Summary statistics

This table shows summary statistics for the variables used in the regressions reported in Tables 3 to 10. The variable definitions are reported in the Appendix.

Panel A: Summary statistics for variables used in Tables 3, 4, 5, 6, 8, and 9

	Obs.	Mean	Std. dev.
Ln(Patents)	162,338	0.390	0.549
Ln(Citations per patent)	162,338	0.765	1.264
Ln(Citations)	162,338	0.907	1.483
Ln(Dollar value of patents)	81,276	0.772	1.284
Post bankruptcy	162,338	0.361	0.480
Team dependence	162,338	0.486	0.425
t0	162,338	0.065	0.247
t1	162,338	0.060	0.237
t2	162,338	0.054	0.226
t3	162,338	0.049	0.216
t4	162,338	0.043	0.203
t5plus	162,338	0.155	0.362
t3plus	162,338	0.247	0.431
Noncompete enforcement index	158,063	3.932	2.020
Strong NCA enforcement	158,063	0.595	0.491
Independent exit	140,424	0.602	0.489
Acquisition by financial buyer	140,424	0.048	0.214
Acquisition by strategic buyer	140,424	0.112	0.315
Liquidation	140,424	0.275	0.446
Tenure	162,338	2.091	3.864
Remain together	127,983	0.546	0.498

Panel B: Summary statistics for variables used in Table 7

	Obs.	Mean	Std. dev.
Still inventing (1)	12,089	0.729	0.444
Still inventing (2)	12,089	0.668	0.471
Still inventing (3)	12,089	0.608	0.488
Still inventing (4)	12,089	0.551	0.497
Still inventing (5)	12,089	0.498	0.5
Team dependence	12,089	0.497	0.441

Panel C: Summary statistics for variables used in Table 10

	Obs.	Mean	Std. dev.
Move together	4,444,997	0.007	0.083
Pair co-dependence	4,444,997	0.001	0.074
Pair average citations	4,444,997	0.109	2.963
Strong NCA enforcement	4,438,449	0.925	0.263
Acquisition by strategic buyer	4,388,532	0.016	0.125
Liquidation	4,381,363	0.602	0.490

Table 2: Comparing inventors in bankruptcy firms to other inventors

In this table, we compare the pre-bankruptcy characteristics of "treated" inventors (those employed at a firm in one of the three years prior to the bankruptcy filing year) and the characteristics of "never treated" inventors (inventors that are never employed at a firm in one of the three years prior to the bankruptcy year) with at least two years of patenting experience between 1980 and 2015. Panel A reports the distribution of CPC technology classes in which the two groups of inventors file patents (observations are at the inventor-year level). Patents are assigned to eight CPC classes: (i) human necessities; (ii) performing operations, transporting; (iii) chemistry, metallurgy; (iv) textiles, paper; (v) fixed constructions; (vi) mechanical engineering, lighting, heating, weapons, blasting engines or pumps; (vii) physics; and (viii) electricity. We classify patenting activity by technology class for each inventor and year (if an inventor patents in different classes in a year, we consider the modal class of the patents in that year). Panel B reports characteristics of the two groups of inventors. *Patents*, *Citations*, *Citations per patent* measure productivity at the inventor-year level; they correspond, respectively, to the number of patents filed by an inventor (until 2015), the number of forward citations received by these patents (until 2020), and the average number of forward citations divided by the number of patents filed in a year. The other variables are constructed at the inventor level. *Lifetime patents* is the total sum of patents filed by an inventor between 1980 and 2015; *Lifetime citations* is the total number of forward citations (until 2020) generated by these patents filed until 2015; *Inventor ranking (patents)* and *Inventor ranking (citations)* are, respectively, the percentile ranking of an inventor by number of patents filed, and a ranking by the number of citations received by these patents (citations are considered until 2020). *Active years* is the number of years that an inventor has patent filings (between 1980 and 2015). *Inventors per patent* is the average number of inventors per patent for each inventor across sample years (a measure of team size).

Panel A: Technology classes

	Never-treated		Treated	
	Observations	Percentage	Observations	Percentage
Necessities	1,306,626	16.4%	10,484	7.9%
Transport	1,200,585	15.1%	28,556	21.5%
Chem./Metal.	999,554	12.6%	16,908	12.7%
Textiles	67,323	0.8%	2,041	1.5%
Construction	277,627	3.5%	3,705	2.8%
Mech. Engineering	574,309	7.2%	17,521	13.2%
Physics	2,032,280	25.5%	28,224	21.2%
Electricity	1,497,094	18.8%	25,648	19.3%

Panel B: Inventor characteristics

	Never-treated			Treated		
	Observations	Mean	Std. Dev.	Observations	Mean	Std. Dev.
Patents	7,957,055	0.673	1.641	133,087	0.753	1.815
Citations	7,957,055	14.661	97.572	133,087	18.621	101.105
Citations per patent	7,957,055	8.251	36.154	133,087	9.724	37.079
Lifetime patents	658,187	7.332	14.228	12,147	11.694	19.294
Lifetime citations	658,187	156.634	819.62	12,147	229.055	938.693
Inventor ranking (patents)	658,187	68.971	21.965	12,147	79.505	17.178
Inventor ranking (citations)	658,187	63.399	27.149	12,147	73.952	21.611
Active years	658,187	10.096	7.597	12,147	14.931	8.252
Inventors per patent	658,187	3.323	1.982	12,147	3.230	1.411

Table 3: Post-bankruptcy productivity of inventors

This table reports coefficients from regression models examining how individual inventor productivity evolves after bankruptcy. Inventor productivity is measured using *Ln(Patents)* in columns 1 and 3, and *Ln(Citations per patent)* in columns 2 and 4. *Post bankruptcy* is an indicator variable that takes the value of one in the years after the bankruptcy, and zero otherwise. *t0, t1, t2, t3, t4,* and *t5plus* are event time dummy variables that identify, respectively, the year of the bankruptcy, the year after the bankruptcy, year two after the bankruptcy, year three after the bankruptcy, year four after the bankruptcy, and the period of year five post-bankruptcy and beyond. All variables and the sample construction are detailed in Section 2 of the paper and in the Appendix. Standard errors are clustered at the bankruptcy firm level. Statistical significance at 1%, 5%, and 10% is market with ***, **, and *, respectively.

	(1) Ln(Patents)	(2) Ln(Citations per patent)	(3) Ln(Patents)	(4) Ln(Citations per patent)
Post bankruptcy	-0.039**	-0.054**		
	(0.017)	(0.023)		
t0			-0.030***	-0.075***
			(0.010)	(0.023)
t1			-0.043***	-0.074***
			(0.013)	(0.023)
t2			-0.048***	-0.087***
			(0.015)	(0.026)
t3			-0.064**	-0.101***
			(0.026)	(0.033)
t4			-0.061	-0.090*
			(0.037)	(0.054)
t5plus			-0.074	-0.140**
			(0.047)	(0.065)
Inventor F.E.	Yes	Yes	Yes	Yes
Technology class-by-year F.E.	Yes	Yes	Yes	Yes
Years of experience F.E.	Yes	Yes	Yes	Yes
Observations	162,338	162,338	162,338	162,338
Adjusted R^2	0.322	0.276	0.322	0.276

Table 4: Team stability after bankruptcies

This table reports coefficients from regressions that study team stability after corporate bankruptcies. The dependent variable is *Remain together*, a measure of team stability across inventors and over time. This dummy variable is equal to one if the percentage 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*, is larger than 75%; that is, the dummy is one if more than three quarters of the team remains in place. *t0, t1, t2,* and *t3plus* are event time dummy variables that identify, respectively, the year of the bankruptcy, the year after the bankruptcy, year two after the bankruptcy, and the period of year three post-bankruptcy and beyond. In columns 2 – 5, the event time dummies are interacted with the following dummy variables that indicate the post-bankruptcy outcomes: *Liquidation* (a firm that files for Chapter 11 is subsequently liquidated), *Independent exit* (a firm that files for Chapter 11 subsequently exits bankruptcy as an independent firm), *Acquisition by strategic buyer* (a firm that files for Chapter 11 is subsequently acquired by an industrial (non-financial) firm); and *Acquisition by financial buyer* (a firm that files for Chapter 11 is subsequently acquired by a financial (private equity) firm). In specification 6, the event time dummies are interacted with *Strong NCA enforcement*, a dummy variable taking the value of one in U.S. states in which the non-compete enforcement index takes a value greater or equal than five (the sample median); for a more detailed description of this variable see Table 9 and Section 5.3. All variables and the sample construction are detailed in Section 2 of the paper and in the Appendix. Standard errors are clustered at the bankruptcy firm level. Statistical significance at 1%, 5%, and 10% is market with ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Remain together					
t0	-0.202**	-0.136*	-0.331**	-0.218**	-0.235**	-0.123**
	(0.084)	(0.070)	(0.151)	(0.097)	(0.100)	(0.055)
t1	-0.247***	-0.198***	-0.386**	-0.283***	-0.306***	-0.146**
	(0.090)	(0.065)	(0.160)	(0.100)	(0.102)	(0.063)
t2	-0.149	-0.107	-0.249	-0.199*	-0.211*	-0.041
	(0.103)	(0.081)	(0.195)	(0.116)	(0.120)	(0.074)
t3plus	0.040	0.096	-0.065	0.009	-0.011	0.119*
	(0.097)	(0.082)	(0.195)	(0.112)	(0.115)	(0.071)
t0 * Liquidation		-0.317*				
		(0.164)				
t1 * Liquidation		-0.314*				
		(0.166)				
t2 * Liquidation		-0.298				
		(0.199)				
t3plus * Liquidation		-0.340*				
		(0.187)				

Table continued on next page

Table continued from previous page

t0 * Independent exit			0.182			
			(0.159)			
t1 * Independent exit			0.172			
			(0.158)			
t2 * Independent exit			0.104			
			(0.189)			
t3plus * Indenpedent exit			0.131			
			(0.181)			
t0 * Acquisition by financial buyer				-0.010		
				(0.118)		
t1 * Acquisition by financial buyer				0.038		
				(0.128)		
t2 * Acquisition by financial buyer				0.224		
				(0.177)		
t3plus * Acquisition by financial buyer				0.139		
				(0.145)		
t0 * Acquisition by strategic buyer					0.145	
					(0.129)	
t1 * Acquisition by strategic buyer					0.234*	
					(0.124)	
t2 * Acquisition by strategic buyer					0.218	
					(0.133)	
t3plus * Acquisition by strategic buyer					0.225**	
					(0.110)	
t0 * Strong NCA enforcement						-0.137*
						(0.082)
t1 * Strong NCA enforcement						-0.169**
						(0.077)
t2 * Strong NCA enforcement						-0.190**
						(0.082)
t3plus * Strong NCA enforcement						-0.129*
						(0.066)
Inventor F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Technology class-by-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Years of experience F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Observations	127,465	108,956	108,956	108,956	108,956	121,730
Adjusted R^2	0.349	0.372	0.363	0.360	0.362	0.348

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

This table reports coefficients from regressions that examine the impact of team dependence on inventor productivity after bankruptcy; productivity is measured using *Ln(Patents)* and *Ln(Citations per patent)*. *Post bankruptcy* is an indicator variable that takes the value of one in the years after bankruptcy, and zero otherwise. *Team dependence* is a measure of the team-specific human capital accumulated at the financially distressed firm by a given inventor. *t0, t1, t2, t3, t4,* and *t5plus* are event time dummy variables that identify, respectively, the year of the bankruptcy, the year after the bankruptcy, year two after the bankruptcy, year three after the bankruptcy, year four after the bankruptcy, and the period of year five post-bankruptcy and beyond. All variables and the sample construction are detailed in Section 2 of the paper and in the Appendix. Standard errors are clustered at the bankruptcy firm level. Statistical significance at 1%, 5%, and 10% is market with ***, **, and *, respectively.

Panel A

	(1) Ln(Patents)	(2) Ln(Citations per patent)	(3) Ln(Patents)	(4) Ln(Citations per patent)
Post bankruptcy	-0.045***	-0.072***	-0.016	-0.017
	(0.016)	(0.023)	(0.014)	(0.024)
Team dependence	0.029	0.075**	0.053**	0.121***
	(0.022)	(0.034)	(0.024)	(0.042)
Post bankruptcy * Team dependence			-0.061***	-0.118***
			(0.013)	(0.031)
Bankruptcy firm F.E.	Yes	Yes	Yes	Yes
Technology class-by-year F.E.	Yes	Yes	Yes	Yes
Years of experience F.E.	Yes	Yes	Yes	Yes
Observations	164,456	164,456	164,456	164,456
Adjusted R^2	0.111	0.173	0.112	0.174

Panel B

	(1) Ln(Patents)	(2) Ln(Citations per patent)	(3) Ln(Patents)	(4) Ln(Citations per patent)
Post bankruptcy * Team dependence	-0.047***	-0.119***		
	(0.015)	(0.041)		
t0 * Team dependence			-0.024*	-0.168***
			(0.014)	(0.036)
t1 * Team dependence			-0.020	-0.101*
			(0.014)	(0.055)
t2 * Team dependence			-0.072***	-0.201***
			(0.013)	(0.043)
t3 * Team dependence			-0.070***	-0.211***
			(0.020)	(0.046)
t4 * Team dependence			-0.074***	-0.189***
			(0.021)	(0.055)
t5plus * Team dependence			-0.044*	-0.111**
			(0.024)	(0.054)
Bankruptcy firm-by-year F.E.	Yes	Yes	Yes	Yes
Inventor F.E.	Yes	Yes	Yes	Yes
Technology class-by-year F.E.	Yes	Yes	Yes	Yes
Years of experience F.E.	Yes	Yes	Yes	Yes
Observations	157,950	157,950	157,950	157,950
Adjusted R^2	0.355	0.340	0.355	0.341

Table 6: 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 otherwise; it also takes the value of zero for inventors that never experienced bankruptcy (column 6). *Team dependence* is a measure of the team-specific human capital accumulated at the financially distressed firm. In specification 1, the sample focusses on "star inventors," that is, inventors that belong to the top decile of inventors in terms of number of granted patents during the 1980 to 2015 period. In specification 2, the sample focusses on a subset of public firms that have below median R&D per total assets (Compustat items *xrd/at*), measured three years prior to the bankruptcy filing. The regression specifications 3 and 4 employ as dependent variables *Ln(Citations)* and *Ln(Dollar value of patents)*, respectively. In specification 5, an inventor's tenure (in years) at the bankrupt firm and its interaction with *Post bankruptcy* is added to the regression model. In specification 6, we include in the control group all inventors who have not experienced bankruptcy during the sample period. The sample underlying specification 7 consists of all inventors that worked at a bankrupt firm in the year prior to the bankruptcy filing. Finally, column 8 reports coefficients from a Poisson regression model. All variables and the sample construction are detailed in Section 2 of the paper and in the Appendix. Standard errors are clustered at the bankruptcy firm level. Statistical significance at 1%, 5%, and 10% is market with ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ln(Patents)	Ln(Patents)	Ln(Citations)	Ln(Dollar value of patents)	Ln(Patents)	Ln(Patents)	Ln(Patents)	Patents
Post bankruptcy * Team dependence	-0.076***	-0.054***	-0.152***	-0.240***	-0.045***	-0.045***	-0.085***	-0.295***
	(0.031)	(0.016)	(0.049)	(0.056)	(0.015)	(0.017)	(0.013)	(0.079)
Post bankruptcy * Tenure					-0.001			
					(0.001)			
Bankruptcy firm-by-year F.E.	Yes	Yes	Yes	Yes				
Inventor F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Technology class-by-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Years of experience F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	68,708	58,054	157,950	79,090	157,950	5,495,403	157,950	146,604
Adjusted R^2	0.299	0.367	0.353	0.3701	0.355	0.379	0.356	

Table 7: Corporate bankruptcies, team dependence, and the likelihood that an inventor continues to invent

This table reports coefficients from regressions that study if team dependent inventors experience a reduction in the length of their careers as inventors following the bankruptcy event. We estimate a linear probability model in which each inventor is only included in the sample once; the sample focusses on "treated" inventors. The outcome variable is *Still inventing (x)*, a dummy variable that takes the value of one if an inventor continues to invent (i.e., continues to file patents) within a certain number of years (*x*) after the bankruptcy filing. All variables and the sample construction are detailed in Section 2 of the paper and in the Appendix. Standard errors are clustered at the bankruptcy firm level. Statistical significance at 1%, 5%, and 10% is market with ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)
	Still inventing (1)	Still inventing (2)	Still inventing (3)	Still inventing (4)	Still inventing (5)
Team dependence	-0.128***	-0.115***	-0.089***	-0.067**	-0.048*
	(0.022)	(0.023)	(0.028)	(0.027)	(0.026)
Bankruptcy firm F.E.	Yes	Yes	Yes	Yes	Yes
Technology class F.E.	Yes	Yes	Yes	Yes	Yes
Years of experience F.E.	Yes	Yes	Yes	Yes	Yes
Observations	12,089	12,089	12,089	12,089	12,089
Adjusted R^2	0.354	0.375	0.387	0.398	0.397

Table 8: Bankruptcy outcomes, team dependence, and post-bankruptcy productivity

The regression models reported in this table examine whether post-bankruptcy team inventor productivity differs by bankruptcy outcome; productivity is measured using *Ln(Patents)* and *Ln(Citations per patent)*. *Post bankruptcy* is an indicator variable that takes the value of one in the years after bankruptcy, and zero otherwise. *Team dependence* is a measure of the team-specific human capital accumulated at the financially distressed firm by a given inventor. The following dummy variables indicate the post-bankruptcy outcomes: *Liquidation* (a firm that files for Chapter 11 is subsequently liquidated), *Independent exit* (a firm that files for Chapter 11 subsequently exits bankruptcy as an independent firm), *Acquisition by strategic buyer* (a firm that files for Chapter 11 is subsequently acquired by an industrial (non-financial) firm); and *Acquisition by financial buyer* (a firm that files for Chapter 11 is subsequently acquired by a financial (private equity) firm). All variables and the sample construction are detailed in Section 2 of the paper and in the Appendix. Standard errors are clustered at the bankruptcy firm level. Statistical significance at 1%, 5%, and 10% is market with ***, **, and *, respectively.

	(1) Ln(Patents)	(2) Ln(Citations per patent)	(3) Ln(Patents)	(4) Ln(Citations per patent)	(5) Ln(Patents)	(6) Ln(Citations per patent)	(7) Ln(Patents)	(8) Ln(Citations per patent)
Post bankruptcy * Team dependence	-0.040**	-0.099*	-0.070***	-0.204***	-0.049***	-0.114***	-0.062***	-0.149***
	(0.018)	(0.051)	(0.020)	(0.056)	(0.016)	(0.043)	(0.014)	(0.042)
Post bankruptcy * Team dependence	-0.046*	-0.112*						
* Liquidation	(0.024)	(0.065)						
Post bankruptcy * Team dependence			0.028	0.119				
* Independent exit			(0.029)	(0.077)				
Post bankruptcy * Team dependence					-0.084*	-0.383		
* Acquisition by financial buyer					(0.051)	(0.305)		
Post bankruptcy * Team dependence							0.103***	0.188**
* Acquisition by strategic buyer							(0.024)	(0.076)
Bankruptcy firm-by-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Inventor F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Technology class-by-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Years of experience F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	137,551	137,551	137,551	137,551	137,551	137,551	137,551	137,551
Adjusted R^2	0.351	0.322	0.351	0.322	0.351	0.322	0.351	0.322

Table 9: Post-bankruptcy productivity and restrictions on inventor mobility

This table examines how contractual restrictions in employment contracts aimed at limiting an employee's ability to work for a competing firm or to start a competing business affect the post-bankruptcy productivity of (team) inventors. We employ a time-varying state-level index measuring the extent to which non-compete clauses are enforced by courts in each U.S. state. The index ranges from zero in states where noncompetition clauses are not enforced at all (e.g., California), to nine in states that exhibit the strongest enforceability of such clauses (e.g., Florida). We construct the indicator variable *Strong NCA enforcement*, which is a dummy variable taking the value of one in states in which the non-compete enforcement index takes a value greater or equal than five (the sample median); the relevant state is the state in which the inventor worked when they were "treated," that is, experienced the corporate bankruptcy. In specifications 1 and 2 we focus on inventors that worked at bankruptcy firms located in states with a NCA enforcement index below the value of five; in specifications 3 and 4 we limit the sample to inventors that worked at bankruptcy firms located in states with an NCA enforcement index taking the value of five or higher. The other variables are identical to those employed in Tables 5 and 8. All variables and the sample construction are detailed in Section 2 of the paper and in the Appendix. Standard errors are clustered at the bankruptcy firm level. Statistical significance at 1%, 5%, and 10% is market with ***, **, and *, respectively.

	(1) Ln(Patents)	(2) Ln(Citations per patent)	(3) Ln(Patents)	(4) Ln(Citations per patent)	(5) Ln(Patents)	(6) Ln(Citations per patent)
Post bankruptcy * Team dependence	-0.028	-0.049	-0.074***	-0.183***	-0.020	-0.035
	(0.023)	(0.054)	(0.011)	(0.037)	(0.025)	(0.054)
Post bankruptcy * Strong NCA enforcement					0.053**	0.132***
					(0.021)	(0.049)
Post bankruptcy * Team dependence * Strong NCA enforcement					-0.044*	-0.137***
					(0.023)	(0.048)
Bankruptcy firm-by-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Inventor F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Technology class-by-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Years of experience F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Observations	60,333	60,333	90,559	90,559	153,836	153,836
Adjusted R^2	0.374	0.366	0.330	0.319	0.350	0.338

Table 10: Team-specific human capital and joint mobility of inventors post-bankruptcy

The regression models reported in this table test whether well-established and productive inventor teams are more likely to co-locate to a new firm post-bankruptcy. For each bankruptcy event, we create all possible pairs of inventors that (i) are employed by the same firm in years *t-3* to *t-1* relative to the bankruptcy and that (ii) remain active post-bankruptcy. In these tests, each inventor pair enters the sample once. *Pair co-dependence* is a pairwise measure of team-specific human capital, calculated as the share of patents of the pair that is co-authored by its constituent members up to year one prior to the bankruptcy. *Pair average citations* is the average number of citations obtained by the patents (filed until year one prior to bankruptcy) coauthored by the inventor pair. The dependent variable is *Move together*, an indicator variable 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. *Strong NCA enforcement* is a dummy variable taking the value of one in states in which the non-compete enforcement index takes a value greater than or equal to five (the sample median); if two inventors in a pair who work at the same firm prior to bankruptcy work in different states (for example, different subsidiaries of the same firm), we consider the state with the higher non-compete enforcement index. *Liquidation* is a dummy variable that takes the value of one if a firm that files for Chapter 11 is subsequently liquidated. *Acquisition by strategic buyer* is a dummy variable that takes the value of one if a firm that files for Chapter 11 is subsequently acquired by an industrial (non-financial) firm. Standard errors are clustered at the bankruptcy firm level. Statistical significance at 1%, 5%, and 10% is market with ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Move together							
Pair co-dependence	0.038***	0.036***	0.036**	0.038**				
	(0.014)	(0.014)	(0.016)	(0.017)				
Pair average citations					0.002***	0.002***	0.002***	0.002***
					(0.000)	(0.000)	(0.000)	(0.000)
Strong NCA enforcement		-0.021**	-0.020**	-0.016		-0.020**	-0.019**	-0.015
		(0.010)	(0.009)	(0.009)		(0.009)	(0.009)	(0.009)
Acquisition by strategic buyer			0.017***	0.012*			0.017***	0.012*
			(0.005)	(0.007)			(0.005)	(0.006)
Liquidation				-0.009**				-0.009**
				(0.004)				(0.004)
Constant	0.007*	0.026***	0.024**	0.026***	0.007*	0.025**	0.024**	0.025**
	(0.003)	(0.010)	(0.010)	(0.010)	(0.003)	(0.010)	(0.010)	(0.010)
Observations	4,444,997	4,438,449	4,383,995	4,376,687	4,444,997	4,438,449	4,383,995	4,376,687
Adjusted R^2	0.001	0.005	0.006	0.009	0.006	0.009	0.009	0.012

Appendix. Variable definitions

A.1 Dependent variables

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(Citations)—This variable is defined as the natural logarithm of one plus the total number of citations obtained on all patents that the 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.

Move together—an indicator variable that takes the value of one if the firm to which two inventors move after the bankruptcy is the same for both inventors in the pair.

Remain together—measures team stability across inventors and over time. This dummy variable is equal to one if the percentage 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*, is larger than 75%; that is, the dummy is one if more than three quarters of the team remains in place.

Still inventing (x)—a dummy variable that takes the value of one if an inventor continues to invent (i.e., continues to file patents) for at least *x* more years after the bankruptcy filing.

A.2 Explanatory variables

Acquisition by financial buyer—dummy variable that takes the value of one if a firm that files for Chapter 11 is subsequently acquired by a financial (private equity) firm.

Acquisition by strategic buyer—dummy variable that takes the value of one if a firm that files for Chapter 11 is subsequently acquired by an industrial (non-financial) firm.

Independent exit—dummy variable that takes the value of one if a firm that files for Chapter 11 subsequently exits bankruptcy as an independent firm.

Liquidation—dummy variable that takes the value of one if a firm that files for Chapter 11 is subsequently liquidated.

Pair average citations—the average number of citations obtained by the patents (filed until year one prior to bankruptcy) co-authored by an inventor pair.

Pair co-dependence—the share of patents that is co-authored by an inventor pair until one year prior to the bankruptcy.

Post bankruptcy—a dummy variable that takes the value of one in the years after the bankruptcy filing for inventors in the "treatment" group.

t0, t1, t2, t3, t4—event time dummy variables that identify, respectively, the year of the bankruptcy, the year after the bankruptcy, year two after the bankruptcy, year three after the bankruptcy, and year four after the bankruptcy.

t3plus, t5plus—event time dummy variables that take the value of one in year three (respectively, year five) post-bankruptcy and in subsequent years.

Strong NCA enforcement—a dummy variable taking the value of one in states in which the non-compete enforcement index (see Kini, Williams, and Yin 2021) takes a value greater than or equal to five (the sample median). The relevant state is the state in which the inventor worked when they were "treated," that is, experienced the corporate bankruptcy.

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 one to three years prior to its bankruptcy filing, it measures the share of that inventor's patents that are co-authored with other inventors that are also employed at that firm during that period; all co-authorships up to year one before the bankruptcy filing are considered in this calculation.

Tenure—number of years an inventor has worked at the bankrupt firm until the bankruptcy filing year.

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