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# Essays in Labor and Public Economics

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by Simon Jäger

This dissertation consists of three independent essays in labor and public economics. Chapter 1, the main chapter, presents evidence on the substitutability between workers within a firm, and between incumbent workers and outsiders, which matter for understanding the operation of internal labor markets and the consequences of worker turnover. To assess the substitutability of workers, I estimate how exogenous worker exits affect a firm's demand for incumbent workers and new hires. Using matched employer-employee data based on the universe of German social security records, I analyze the effects of 34,000 unexpected worker deaths and show that these worker exits on average raise the remaining workers' wages and retention probabilities for a period of several years. These findings are difficult to reconcile with frictionless labor markets and perfect substitutability between incumbent workers and outsiders. The average effect masks substantial heterogeneity: coworkers in the same occupation as the deceased see positive wage effects; coworkers in other occupations instead experience wage decreases when a high-skilled worker or manager dies. Thus, coworkers in the same occupation appear to be substitutes, while high-skilled workers and managers appear to be complements to coworkers in other occupations. Finally, when the external labor market in the deceased's occupation is thin, incumbents' wages respond more and external hiring responds less to a worker death. The results suggest that thin external markets for skills lead to higher firm-specificity of human capital and lower replaceability of incumbents.

Chapter 2, which is joint work with Peter Ganong, proposes a permutation test for the Regression Kink (RK) design—an increasingly popular empirical method for causal inference. Analogous to the Regression Discontinuity design, which evaluates discontinuous changes in the *level* of an outcome variable with respect to the running variable at a point at which the *level* of a policy changes, the RK design evaluates discontinuous changes in the *slope* of an outcome variable with respect to the running variable at a kink point at which the *slope* of a policy with respect to the running variable changes. Using simulation studies based on data from existing RK designs, we document empirically that the statistical significance of RK estimators based on conventional standard errors can be spurious. In the simulations, false positives arise as a consequence of nonlinearities in the underlying relationship between the outcome and the assignment variable. As a complement to standard RK inference, we propose that researchers construct a distribution of placebo estimates in regions with and without a policy kink and use this distribution to gauge statistical significance.

Under the assumption that the location of the kink point is random, this permutation test has exact size in finite samples for testing a sharp null hypothesis of no effect of the policy on the outcome. We document using simulations that our method improves on the size of standard approaches.

Chapter 3, which is joint work with Johannes Abeler and published in Abeler and Jäger (2015), analyzes a laboratory experiment to study how tax complexity affects people's reactions to tax changes. In the experiment, subjects work for a piece rate and face taxes. One treatment features a simple tax system, the other is complex. The payoff-maximizing output level and the incentives around this optimum are, however, identical across treatments. We introduce the same sequence of additional taxes in both treatments. Subjects in the complex treatment underreact to new taxes; some ignore new taxes entirely. The underreaction is stronger for subjects with lower cognitive ability. Contrary to predictions from models of rational inattention, subjects are equally likely to ignore large or small incentive changes.

## Summary of Chapter 1: How Substitutable Are Workers? Evidence from Worker Deaths

The fluidity of labor markets depends on the ease with which the two sides of the market can switch trading partners: workers finding alternative employment suitable for their skills and firms finding adequate substitutes for their current workers. An extensive body of empirical literature sheds light on the workers' perspective and finds that workers who are displaced from their jobs suffer persistent earnings losses—consistent with Becker's (1962) idea that human capital has firm-specific components.<sup>1</sup> However, much less is known about the other side of the market: firms' ability to find substitutes for their workers, in particular ones with specific human capital. When a worker leaves a firm, how easily can the firm replace the worker externally through hiring, and how do such worker exits affect the firm's demand for its remaining workers? Several debates—ranging from the role of labor pooling as a source of agglomeration (Marshall 1890) to the importance of intrafirm bargaining (Stole and Zwiebel 1996a,b)—hinge directly on the answer to this question.

I offer an empirical answer to this question by estimating the effects of exogenous worker exits on hiring, and on the firm's demand for the labor of the remaining workers. I then use the results to adjudicate between different models of the labor market—in particular, different assumptions about the substitutability of workers. I illustrate the intuition underlying my approach in a simple conceptual framework that demonstrates how different assumptions about worker substitutability alter the predictions for the sign and magnitude of the effects of worker exits. The competitive labor market model assumes that outside workers are perfect substitutes for incumbent workers and thus predicts that the

effect of worker exits on the firm's labor demand for the remaining insiders is zero: the firm can simply hire a suitable new worker in response to a worker exit so that its demand for the labor of the remaining workers remains unchanged. In contrast, when outsiders are only imperfect substitutes for insiders—for instance, because the firm's production process relies on specific human capital—worker exits can affect the firm's labor demand for incumbent workers. In bargaining models that incorporate such imperfect substitutability (see, e.g., Stole and Zwiebel [1996a,b]), the sign of the effect identifies the substitutability of the exiting worker's skills with those of the remaining workers: the firm's labor demand rises for substitutes and, in contrast, falls for complements of the worker who exited.

To test these predictions, I implement a quasi-experimental research design and estimate the causal effect of unexpected worker deaths on hiring and on the remaining workers' wages and retention rates based on the universe of German Social Security records.<sup>2</sup> In a dynamic difference-in-differences design, I compare roughly 34,000 small firms that experienced the death of a worker in a given year to a comparison group of firms with similar characteristics that did not experience a worker death that year. The research design relies on deaths as a source of variation to circumvent the endogeneity of worker exits. The sample excludes the deaths of workers who experienced a hospitalization or longer sickness spell in the five years before their death in order to exclude deaths preceded by debilitating diseases. The outcomes in the treatment and comparison group follow parallel trends in the years prior to the death of a worker in treatment group firms, suggesting that outcomes in comparison group firms can be used to gauge what would have happened to workers in treatment group firms in the absence of a worker death.

Based on almost 7 million worker-year observations, I show that worker deaths affect firms' demand for the labor of their remaining workers. On average, incumbent workers in the treatment group experience a highly statistically significant earnings increase of about 0.6 percent in the year after the death.<sup>3</sup> Over the course of the five years after the death, the average cumulative effect on the earnings of all incumbent workers in a treatment group firm is close to 6,000 EUR (2010 CPI), corresponding to about 18 percent of an average deceased worker's annual earnings. Moreover, incumbent workers in the treatment group are more likely to retain employment at the same firm and are less likely to be employed at other firms; their probability of (any) employment does not change in response to a worker death. Worker deaths do not affect incumbents' working hours at the part-time versus full-time margin.<sup>4</sup>

In a next step, I leverage the research design to estimate within-firm heterogeneity across occupation and skill groups and find substantial heterogeneity, shedding light on the interdependencies between workers and the sources of frictions in replacing workers. The positive wage effects of

worker exits are concentrated among incumbent workers in the same occupation group as the deceased.<sup>5</sup> For deaths of workers in high-skilled occupations, I estimate statistically significant, *negative* effects on the wages of incumbent workers in other occupations. Similarly, wage effects on incumbent workers in other occupations are negative in the case of deaths of managers.<sup>6</sup> Turning the focus to measures of human capital specificity of the deceased, I find evidence suggesting that longer-tenured workers and workers in specialized occupations are harder to replace with outsiders.<sup>7</sup>

Since the evidence indicates that worker exits affect firms' demand for incumbents, my findings are hard to reconcile with frictionless labor markets and perfect substitutability between incumbents and outsiders and instead point to a set of models in which firms face frictions in replacing workers externally. In particular, the findings accord with Becker's (1964) conjecture that firms share rents with workers to keep workers with specific human capital from quitting.<sup>8</sup> The finding of positive wage effects on coworkers in the same occupation as the deceased supports this view, because workers in the same occupation are arguably closer substitutes than workers in different occupations and therefore become more valuable to the firm as a consequence of a coworker exit. The finding of negative wage effects of deaths of workers in high-skilled occupations on incumbents in other occupations indicates imperfect substitutability between high- and low-skilled labor. My findings thereby support a key assumption of models positing that skilled workers raise the productivity of other workers at the same firm (see, e.g., Lucas [1978]; Murphy, Shleifer, and Vishny [1991]; Rosen [1982]), and constitute firm-level evidence consistent with studies of how marketwide labor supply shocks—for example, due to immigration or changes in the college graduation rate—affect the wage structure (see, e.g., Card [2009]; Dustmann, Ludsteck, and Schönberg [2009]; Goldin and Katz [2008]; and Katz and Murphy [1992]).<sup>9</sup>

The validity of my interpretation of the empirical results as evidence regarding the substitutability of workers depends on whether alternative mechanisms can account for my findings. I consider three alternative explanations and evaluate them in light of the evidence: 1) changes in the remaining workers' compensating differential for working at the firm, 2) job assignment purely based on seniority, and 3) search frictions without human capital specificity. None of the alternative mechanisms matches all of the evidence. The first alternative explanation, for instance, builds on the hypothesis that incumbent worker wages may have gone up as a result of a worker death increasing the compensating differential for working at the firm—for example, due to decreased utility of interacting with colleagues or increases in the perception of job hazards. While such labor supply-driven explanations could explain why wages increase, they would simultaneously predict that workers' probability of staying with the firm should decrease. The data, however, reject this

explanation as both wages and the probability of staying at the firm go up. Therefore, positive shifts in firms' labor demand dominate any negative shocks to incumbent workers' labor supply. Several results are in conflict with the other alternative explanations. For example, the second explanation posits that workers may be perfect substitutes but rise through the ranks purely based on seniority. However, this explanation cannot account for the finding that wage effects of high-skilled worker deaths are negative. In contrast, models in which insiders and outsiders as well as high- and low-skilled workers are imperfect substitutes are consistent with the evidence.

To shed light on the sources of frictions in replacing workers, I study heterogeneity by external labor market conditions and find that firms in thicker markets for specialized skills change incumbent wages by less and hire more externally in response to a worker death. The investigation is motivated by Marshall's (1890) conjecture that firms and workers in thicker, more agglomerated labor markets face fewer frictions in finding a suitable match and tests Lazear's (2009) theory according to which the specificity of human capital depends on the thickness of the market.<sup>10</sup> I investigate the role of market thickness by estimating heterogeneity across labor markets which vary in the relative agglomeration of workers in the deceased's occupation.<sup>11</sup> Wage effects are smaller in labor markets with a higher concentration of workers in the relevant occupation. Consistent with a labor market thickness mechanism, the difference between thick and thin labor markets is larger for occupations with a high degree of specialization. Additional evidence shows that firms in thicker labor markets are more likely to hire a new worker externally when a worker in a specialized occupation dies. Taken together, my findings support Lazear's (2009) theory of firm-specific human capital and suggest that frictions in replacing workers are larger in thin markets, in which workers' skills are more firm-specific.

This paper contributes to several additional strands of the literature. Its results provide direct evidence supporting the key assumption of intrafirm bargaining models (Stole and Zwiebel 1996a,b)—imperfect substitutability between incumbent workers and outsiders—and thereby resolve an open debate in the literature.<sup>12</sup> By shedding light on the frictions that firms face in replacing workers externally, my study adds to a literature—going back to Slichter (1919) and Oi (1962)—that estimates the costs of worker turnover.<sup>13</sup> While this literature focuses on gauging firms' expenditure for recruiting, hiring, and training, my research design provides a complementary perspective by providing evidence on how turnover affects firms' labor demand for incumbent workers and by showing that workers are harder to replace when their human capital is firm-specific. In doing so, my research design complements the extensive literature that assesses how firms' profitability affects wages (see, e.g., Blanchflower, Oswald, and Sanfey 1996; Card, Devicienti,

and Maida 2013; Dickens and Katz [1987]; Slichter [1950]; and Van Reenen, 1996), as it provides direct evidence for a mechanism—human capital specificity leading to imperfect substitutability between insiders and outsiders—that gives rise to such rent sharing. Finally, my research design provides new evidence for the importance of internal labor markets (Doeringer and Piore 1971) by showing how idiosyncratic shocks to firm-specific labor supply—that is, internal market forces—shape wages.<sup>14</sup>

## Notes

1. See Davis and von Wachter (2011); Dustmann and Meghir (2005); Farber, Hall, and Pencavel (1993); Gibbons and Katz (1991); Jacobson, LaLonde, and Sullivan (1993); and Topel (1991). Additional evidence accords with extensions of Becker's model in Gibbons and Waldman (2004) and Lazear (2009) that can account for occupation, industry, and firm specificity of human capital (see Gathmann and Schönberg 2010; Gibbons and Katz 1992; Kambourov and Manovskii 2009; Neal 1995; Nedelkoska, Neffke, and Wiederhold 2015; Parent 2000; and Poletaev and Robinson 2008).
2. The use of deaths as a source of variation builds on previous work in Azoulay, Wang, and Zivin (2010); Becker and Hvide (2013); Bennedsen, Pérez-González, and Wolfenzon (2006); Bennedsen et al. (2007); Fadlon and Nielsen (2015); Isen (2013); Jaravel, Petkova, and Bell (2015); Jones and Olken (2005); and Oettl (2012).
3. The average firm in my sample has 14.5 employees in the year before a worker death.
4. Even if in part due to changes in working hours, nonzero wage effects of worker exits indicate that the firm cannot costlessly hire perfect replacements for incumbents. The data contain information on the part-time and full-time status of workers, but not more fine-grained measures of working hours, such as overtime. My analysis of treatment effects on the intensive margin is therefore limited to the part-time versus full-time margin. I analyze this effect in several samples, including incumbent workers who were part-time employed at the time of the worker death, and find no evidence for intensive-margin effects.
5. In my main specifications, I consider workers in the same one-digit group of the 2010 Classification of Occupations (*Klassifikation der Berufe 2010*) as being in the same occupation group and define workers in other occupations as the complement of that group.
6. I classify workers as managers if they work in an occupation characterized by managerial, planning, and control activities, such as operation and work scheduling, supply management, and quality control and assurance.
7. I proxy for specialization with a measure used in Bleakley and Lin (2012), who classify occupations as relying on more specific skills when the returns to experience are high, which can be thought of as capturing the importance of occupation-specific capital (see, e.g., Kambourov and Manovskii [2009] and Shaw [1984, 1987]).
8. My results provide support for ex post rent sharing. It would in principle still be possible that workers do not earn ex ante rents



if labor markets are competitive at the stage when workers enter firms.

9. Katz and Murphy (1992), for example, provide evidence that college- and high school-educated workers are imperfect substitutes and show that changes in the aggregate supply of college graduates are associated with in opposite-signed changes the college premium.
10. See Marshall (1890, p. 156):

[A] localized industry gains a great advantage from the fact that it offers a constant market for skill. Employers are apt to resort to any place where they are likely to find a good choice of workers with the special skill which they require; while men seeking employment naturally go to places where there are many employers who need such skill as theirs and where therefore it is likely to find a good market. The owner of an isolated factory, even if he has access to a plentiful supply of general labour, is often put to great shifts for want of some special skilled labour; and a skilled workman, when thrown out of employment in it, has no easy refuge.

Lazear (2009) develops a model in which human capital is a combination of general skills and becomes more firm-specific in firms with more idiosyncratic skill requirements compared to the external market. This view of human capital specificity contrasts with a dichotomous distinction of purely firm-specific and purely general skills.
11. I measure thickness at the 5-digit occupation  $\times$  commuting zone level as the share of employment in the relevant occupation in that commuting zone relative to the nationwide share of employment in that occupation. I then classify 5-digit occupation  $\times$  commuting zone cells as a thin or thick labor market based on a median split. As an intuitive example, the labor market for mechanical engineers in Munich will be described as thick based on this measure if Munich has a high share of mechanical engineers relative to the overall share of mechanical engineers in the German labor market.
12. The canonical intrafirm bargaining model of Stole and Zwiebel (1996a,b) relies crucially on the assumption that firms face frictions in replacing their workers externally (see applications in trade and macroeconomics in, e.g., Acemoglu and Hawkins [2014] and Helpman, Itskhoki, and Redding [2010]). Under the converse assumption that firms can hire perfectly substitutable replacement workers in the external labor market, the key result of overemployment in Stole and Zwiebel is overturned (de Fontenay and Gans 2003). Stole and Zwiebel (2003) themselves note that “empirical work is needed to make a compelling case for one approach over the other” (p. 457). More recently, Elsby and Michaels (2013) assess that the “empirical validity of the Stole and Zwiebel bargaining solution has yet to be assessed.”
13. See also the overview of estimates of hiring costs in Manning (2011).
14. In an influential contribution, Doeringer and Piore (1971) describe hiring, wage, and career dynamics in internal labor markets in which the hiring of new workers is limited to lower-level “ports of entry,” higher-level vacancies are filled through internal promotions and wages are “shielded from the direct influences of competitive forces in the external market.”

For existing tests of internal labor markets see, e.g., Baker, Gibbs, and Holmstrom (1994a,b); Lazear (1992); and Lazear and Oyer (2004a,b). Relatedly, Bertrand (2004) provides evidence on the relationship between import competition and the shielding of wages from external labor market conditions. A related literature tests empirically between contract and spot market models of the labor market by estimating the effect of past unemployment on wages (see, e.g., Beaudry and DiNardo [1991]). For overviews, see the surveys in Gibbons and Waldman (1999); Lazear and Oyer (2013); Oyer and Scott (2011); and Waldman (2013).

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