

Research Statement

Bastian Schulz

I am an applied economist with research interests at the intersection of macro, labor, and family economics. My specialty is the empirical and theoretical analysis of matching markets with and without search frictions. The assignment in matching markets with two-sided heterogeneity is commonly referred to as *sorting*. The classical question about sorting, first posed by Gary Becker, is “who marries whom?” (Becker, 1973, 1974). Empirically, positive sorting (or positive assortative matching, PAM) manifests itself as a positive association of rankable types in the cross-section. Two seminal papers in the sorting literature that my work builds upon are Shimer and Smith (2000), who show under which conditions PAM arises in the presence of search frictions, and Choo and Siow (2006), who show how frictionless matching models can be estimated.

The literature shows that marriage market sorting affects the within-household allocation of resources, labor supply, and consumption, as well as inequality between-households (Goussé et al., 2017; Chiappori et al., 2018; Eika et al., 2019). Moreover, economic policy affects marriage formation and stability (Gayle and Shephard, 2019; Persson, 2020; Schulz and Siuda, forthcoming). In the context of the labor market, the extent of sorting between heterogeneous workers and heterogeneous firms matters for wage dispersion, the cyclical properties of unemployment, and skill mismatch (Card et al., 2013; Lise and Robin, 2017; Baley et al., 2022). Worker mobility is central for labor market sorting to take shape and underlies the most common identification strategies (Abowd et al., 1999; Taber and Vejlin, 2020; Bagger and Lentz, 2019; Bonhomme et al., 2019).

In eight research papers, I have built on these lines of work. I summarize these papers under three common topics.¹

1. **Sorting and Labor Market Dynamics**

(Lochner and Schulz, forthcoming; Schulz, forthcoming)

2. **The Measurement of Sorting**

(Lochner and Schulz, forthcoming; Foerster et al., 2022; Almar et al., 2023b; Almar and Schulz, 2023)

3. **Joint Household Decisions, Sorting, and Policy**

(Schulz and Siuda, forthcoming; Foerster et al., 2022; Holzner and Schulz, 2023; Almar et al., 2023a)

¹Some papers belong to multiple topics.

1 Sorting and Labor Market Dynamics

Recent work on the macroeconomics of labor markets shows that the extent of sorting, which reflects the allocation of workers to firms, is important for our understanding of labor market dynamics and aggregate productivity. As evidenced by the changing composition of the pool of unemployed workers over the business cycle ([Mueller, 2017](#); [Lise and Robin, 2017](#); [Baley et al., 2022](#)), macroeconomic conditions affect the (re)allocation of workers to the most productive worker-firm matches.

The results in [Lochner and Schulz \(forthcoming\)](#) shed new light on this reallocation process. We develop a search-matching model of multi-worker firms, intra-firm bargaining (following [Stole and Zwiebel, 1996](#); [Cahuc et al., 2008](#)), two-sided heterogeneity and worker-firm complementarities. The model shows how firms can be ranked based on their estimated productivity, which we are able to separate from wages by taking into account the types of workers that a firm employs (see section 2 for details). By separating the wages that firms pay from their productivity, we can study to what extent worker sorting along wage and productivity ladders is aligned.

We find that the empirical relationship between wages and firm productivity is hump-shaped: the most productive firms pay lower wages than somewhat less productive firms, and this tendency has become more pronounced over time. Worker mobility is primarily guided by wages, so transitions from high- to medium-productivity firms are on average associated with wage gains, despite that fact that workers move to less productive firms. Consistently, the sorting of high-type workers into high-productivity firms (productivity sorting) is much less pronounced than the sorting into high-wage firms (wage sorting). We know that the extent of wage sorting has increased in recent decades ([Card et al., 2013](#); [Song et al., 2019](#)). Combined with our findings, this trend implies that the allocation mechanism that matches worker and firms over the business cycle has become less efficient. High-type workers are increasingly matched with firms that pay high wages—a development that also affects wage inequality—and not with high-productivity firms that could employ their skills more effectively.

Another interesting question is to what extent sorting itself contributes to the dynamics of the labor market, i.e., the observed volatility of the unemployment rate, vacancies, wages, etc. over the business cycle. To explore this, I develop a dynamic search-and-matching model with free entry of firms, two-sided heterogeneity, sorting, and aggregate shocks in [Schulz \(forthcoming\)](#). In this framework, firms face a dynamic job-creation problem that includes an expectation over the endogenous distribution of unemployed worker types. In response to shocks, the match surplus adjusts instantaneously and disproportionately for high-skill workers and high-productivity firms due to the assumed production complementarity. The distribution of unemployment worker types adjusts slowly due to both search frictions and the fact that not all meetings lead to matches.

Both mechanisms lead to a strong vacancy-posting response of firms. Thus, the sorting model solves the unemployment-volatility puzzle (Shimer, 2005) without making the wages of new hires sticky (the common solution, see Hagedorn and Manovskii, 2008; Hall and Milgrom, 2008; Pissarides, 2009). Furthermore, the model produces realistic degrees of cross-sectional wage dispersion and (relatively low) productivity sorting (similar to what we find in Lochner and Schulz, forthcoming).

2 The Measurement of Sorting

In the context of the labor market, the key challenge for the measurement of sorting is the unobserved heterogeneity of both workers and firms. In standard matched-employer-employee data, we observe how workers move between firms along with the wages that they receive. The key identification challenge is that one data point, the wage, reflects both worker and firm heterogeneity. In a seminal paper, Abowd et al. (1999) show how worker and firm heterogeneity can be captured by in a two-way fixed-effects model by exploiting the fact that workers move between firms. Based on the estimated fixed effects, workers and firms can be ranked in terms of wages received and paid, respectively, and a measure of sorting between high-wage workers and high-wage firms can be computed. Most of the literature that builds on Abowd et al. (1999) keeps this focus on *wage sorting* (e.g., Hagedorn et al., 2017; Bonhomme et al., 2019; Kline et al., 2020).

The theoretical literature assumes that labor market sorting arises because workers' heterogeneous ability and firms' heterogeneous productivities are complements in production (Becker, 1973). While the wages that firms pay are most likely related to their productivity, the mapping from productivity to wages is far from obvious. Highly productive firms may share profits with their workers and pay high wages. Conversely, the wages these firms pay could be reduced by labor market imperfections or compensating differentials. Therefore, measures of *wage sorting* do not necessarily reflect the underlying production complementarity and, thus, the efficiency of the allocation in terms of output.

In Lochner and Schulz (forthcoming), we develop a strategy to measure *productivity sorting*, i.e., the sorting between workers' unobserved ability and firms' unobserved productivity. Guided by a search-matching model with large firms and worker-firm complementarities, we combine two empirical models: (i) the two-way fixed effects model of Abowd et al. (1999); (ii) the production function estimation of Akerberg et al. (2015). First, we estimate the Abowd et al. (1999) model for all private sector employees in Germany and merge their estimated wage components with detailed establishment survey data. Second, we estimate establishment-level production functions and calculate firm productivity following Akerberg et al. (2015). Importantly, we are able to separate firm productivity from the effect of heterogeneous worker ability on output because we can flexibly control for estimated wage components of all workers.

To compute a measure of productivity sorting, we correlate worker ranks based on wage fixed-effects and firm ranks based on estimated productivity. Productivity sorting is muted relative to wage sorting, and this is consistent with our finding that high-type workers are willing to move down the productivity ladder to increase their wages. It is quite common in this literature to implicitly or explicitly interpret wage-based firm effects as measures of firm productivity. Our results show that this is erroneous.

In the context of the marriage market, the discussion about the measurement of sorting has a different focus. Commonly, the classifications of types relies on an observable characteristic, which is most often educational attainment. The measurement debate in this literature does not revolve around unobserved heterogeneity but, instead, around marginal type distributions, which are known to shift over time as the average educational attainment in the population rises. Due to this challenge, the literature has struggled to establish whether marriage market sorting is increasing or not (e.g., [Greenwood et al., 2016](#); [Eika et al., 2019](#)). In [Almar and Schulz \(2023\)](#), we find that the fact that female educational attainment has increased relatively more in recent decades is important in this context. We show how a common measure of marriage market sorting, a weighted sum of observed matching probabilities relative to random matching, can take this into account through appropriate weights. We derive optimal weights that minimize the effect of changing type distributions and find that education-based marriage market sorting increases in Danish data, while the same measure with naive weights exhibits no trend.

In [Almar et al. \(2023b\)](#), we construct a new classification of marriage market types that takes into account the heterogeneity that is hidden by the level of educational attainment (e.g., primary, secondary, tertiary). Using Danish data, we categorize individuals based on the starting wages and wage growth of peers at the educational-program level. Based on this categorization, we find that sorting increases over time and explains more than 40% of increasing inequality since 1980. In contrast, sorting trends are flat using the level of education. The mapping between education and marriage-market types matters crucially for conclusions about the role of sorting for rising income inequality.

In [Foerster et al. \(2022\)](#), we study income-based marriage market sorting. Similar to educational attainment, the correlation of spousal labor incomes is positive in the cross-section. Theoretically, it is not clear whether spousal incomes are complements or substitutes ([Becker, 1974, 1981](#)). We exploit plant closures ([Jacobson et al., 1993](#)) to shed light on the apparent contradiction between household specialization and the positive correlation that seems to suggest PAM. We find that men who are displaced from their job have persistently lower labor income and higher chances to get divorced. Divorcees who re-marry, however, find new partners that outearn their previous partners. This implies that sorting in the income dimension must be negative. Using a multi-dimensional sorting model, we show that the positive income correlation is likely spurious.

3 Joint Household Decisions, Sorting, and Policy

Most papers that study the role of joint household decisions for, e.g., labor market dynamics (Guler et al., 2012), gender pay gaps (Flabbi and Mabili, 2018), health insurance coverage (Dey and Flinn, 2008; Fang and Shephard, 2019), and marital wage premia (Pilossoph and Wee, 2021) keep the marriage market fixed. That is, they take household formation as given and do not consider the possibility of divorce.

The main contribution of my research to this literature is the development and estimation of models in which the marriage market and the labor market are in joint equilibrium (Holzner and Schulz, 2023; Almar et al., 2023a). This implies that choices in the marriage market (e.g., whom to marry or whether to get a divorce) and in the labor market (e.g., labor supply or search intensity) affect one another. Based on this interaction, the second contribution to this literature concerns the role of economic policy. I show that labor market, tax, and family policies can have significant repercussions on households' choices and the marriage market, which can either reinforce or dampen their effects (Schulz and Siuda, forthcoming; Holzner and Schulz, 2023; Foerster et al., 2022; Almar et al., 2023a).

In Schulz and Siuda (forthcoming) and Almar et al. (2023a), we use frictionless matching models in the spirit of Choo and Siow (2006). In Foerster et al. (2022) and Holzner and Schulz (2023), we use search-matching models in the spirit of Shimer and Smith (2000). The natural approach to study marriage formation integrates frictions. The reason is that search models naturally generate the sluggishness that seems to be a general characteristic of many matching markets, including the marriage market. However, frictionless matching models have important advantages in terms of tractability and estimation.

In Holzner and Schulz (2023), we combine an on-the-job-search model with endogenous search intensity with a search-matching model of the marriage market that features transferable utility and ex-ante heterogeneous men and women (Shimer and Smith, 2000; Goussé et al., 2017). The key innovation is that we allow endogenous job-finding rates to depend on marriage: men and women bargain over transfers, domestic time inputs, and labor search intensity based on current and future marital surplus. For singles, reservation wages depend on current income, home production, and the marriage market option value. For couples, reservation wages additionally depend on the surplus change that occurs if working hours change. Less time for home production negatively affects the household's public good and, thus, marital surplus.

In this framework, labor market transitions can lead to an endogenous divorce, and married individuals incorporate this into their search intensity choice. Our paper is the first in the literature on joint job search of couples to consider the possibility of divorce. Using German household-survey data, we quantify the relative importance of these "labor market transition divorces". Depending on the couple-type, between 0–80% of divorces are associated with job loss or job finding.

Using our estimated model, we study marriage market effects of recent developments in the German labor market. A series of labor market reforms from 2003–2005 lowered the generosity of the unemployment insurance system but also increased matching efficiency and labor demand. This development is associated with higher participation rates of females (Burda and Seele, 2017). In a counterfactual exercise, we fix the estimated labor market parameters at levels from the 1990s and find that the labor market policy changes were not neutral with respect to marriage. More married women entering employment led to more divorces, but the decrease in divorces caused by less job loss among married men was greater, resulting in a net decrease in the overall divorce rate.

In Schulz and Siuda (forthcoming), we use a single reform element—tighter means testing—that specifically affected couples as a laboratory to study insurance within the household. The idea is simple: social insurance and within-household insurance are substitutes. When unemployment insurance benefits are generous and not means-tested at the household level, the dependence on the partner’s income upon job loss is low. But as means-testing thresholds get tighter, potential partners that are exposed to unemployment risk become less attractive in the marriage market. We estimate marital surplus based on the Choo and Siow (2006) model and proxy unemployment risk with nationality. We find that the labor market reform had a sizable negative effect on the formation of intermarriages in Germany. At the same time, marital stability increased, which is consistent with a better selection of couples.

In Almar et al. (2023a), we consider the joint equilibrium of families’ career investment and firms’ training and promotion decisions. In this paper, the marriage market is frictionless (Choo and Siow, 2006) and the labor market competitive. However, firms make endogenous training decisions and promote workers subject to a capacity constraint, taking into account heterogeneous career investments of men and women of different types. At the same time, families base their joint labor supply choices, which affect human capital accumulation, on expected promotion probabilities that vary by gender and type. We use the estimated model to analyze the effectiveness and distributional consequences of parental leave policies and diversity, equity, and inclusion initiatives to promote families’ and firms’ investments in women. For example, we find that parental leave policies and board quotas have significant repercussions on households’ joint labor supply choices, transfers within the household, and the marriage market equilibrium.

In Foerster et al. (2022), we construct a multidimensional sorting model to show that negative assortative matching in the income dimension is compatible with a positive correlation of spousal labor income in the cross section. We calibrate this model using Danish register data and illustrate the significance of our finding—sorting in the income dimension is negative, see the measurement discussion in section 2—by means of simulated tax reforms. Specifically, we consider an increase in the progressiveness of the Danish tax system and find that the limiting effect that such a reform has on between-household

inequality is dampened by the marriage market. The reason is that more progressive taxes compress the support of the net-income distribution. With search frictions and income-NAM, this implies that high-income singles become more likely to marry another high-income individual because they are more similar to low-income individuals after the tax reform. This tends to increase between-household inequality. The finding that tax policies and marriage market sorting interact to determine the effect of tax progression on inequality is a novel finding in the literature on household taxation.

References

- Abowd, John M., Francis Kramarz, and David N. Margolis (1999) “High Wage Workers and High Wage Firms,” *Econometrica*, Vol. 67, pp. 251 – 333.
- Akerberg, Daniel A., Kevin Caves, and Garth Frazer (2015) “Identification Properties of Recent Production Function Estimators.,” *Econometrica*, Vol. 83, pp. 2411–2451.
- Almar, Frederik, Ana Reynoso, Benjamin Friedrich, Bastian Schulz, and Rune Vejlin (2023a) “Families’ Career Investments and Firms’ Promotion Decisions,” in progress.
- (2023b) “Marital Sorting and Inequality: How Educational Categorization Matters,” IZA Discussion Paper No. 15912.
- Almar, Frederik and Bastian Schulz (2023) “Optimal Weights for Marital Sorting Measures,” IZA Discussion Paper No. 16368, IZA Institute of Labor Economics.
- Bagger, Jesper and Rasmus Lentz (2019) “An Empirical Model of Wage Dispersion with Sorting.,” *Review of Economic Studies*, Vol. 86, pp. 153–190.
- Baley, Isaac, Ana Figueiredo, and Robert Ulbricht (2022) “Mismatch Cycles,” *Journal of Political Economy*, Vol. 130, pp. 2943–2984.
- Becker, Gary S. (1973) “A Theory of Marriage: Part I,” *Journal of Political Economy*, Vol. 81, pp. 813–846.
- (1974) “A Theory of Social Interactions,” *Journal of Political Economy*, Vol. 82, pp. 1063–1093.
- (1981) *A Treatise on the Family*: National Bureau of Economic Research.
- Bertrand, Marianne, Emir Kamenica, and Jessica Pan (2015) “Gender identity and relative income within households,” *The Quarterly Journal of Economics*, Vol. 130, pp. 571–614.

- Bonhomme, Stéphane, Thibaut Lamadon, and Elena Manresa (2019) “A Distributional Framework for Matched Employer Employee Data,” *Econometrica*, Vol. 87, pp. 699–739.
- Burda, Michael C. and Stefanie Seele (2017) “Das deutsche Arbeitsmarktwunder: Eine Bilanz,” *Perspektiven der Wirtschaftspolitik*, Vol. 18, pp. 179–204.
- Cahuc, Pierre, Francois Marque, and Etienne Wasmer (2008) “A Theory of Wages and Labor Demand With Intra-Firm Bargaining and Matching Frictions.,” *International Economic Review*, Vol. 49, pp. 943–972.
- Card, David, Jörg Heining, and Patrick Kline (2013) “Workplace Heterogeneity and the Rise of West German Wage Inequality,” *Quarterly Journal of Economics*, Vol. 128, pp. 967–1015.
- Chaumont, Gaston and Shouyong Shi (2022) “Wealth accumulation, on-the-job search and inequality,” *Journal of Monetary Economics*, Vol. 128, pp. 51–71.
- Chiappori, Pierre-André, Monica Costa Dias, and Costas Meghir (2018) “The Marriage Market, Labor Supply, and Education Choice,” *Journal of Political Economy*, Vol. 126, pp. S26–S72.
- Choo, Eugene and Aloysius Siow (2006) “Who Marries Whom and Why,” *Journal of Political Economy*, Vol. 114, pp. 175–201.
- Ciscato, Edoardo, Bastian Schulz, and Andrew Shephard (in progress) “Marriage market impact of the Danish ART reform,” in progress.
- Denderski, Piotr, Leo Kaas, Bastian Schulz, and Nawid Siassi (in progress) “Joint Labor Search and the Taxation of Couples,” in progress.
- Dey, Matthew and Christopher Flinn (2008) “Household search and health insurance coverage,” *Journal of Econometrics*, Vol. 145, pp. 43–63.
- Eika, Lasse, Magne Mogstad, and Basit Zafar (2019) “Educational Assortative Mating and Household Income Inequality,” *Journal of Political Economy*, Vol. 127, pp. 2795–2835.
- Fang, Hanming and Andrew J Shephard (2019) “Household labor search, spousal insurance, and health care reform,” NBER Working Paper No. 26350.
- Flabbi, Luca and James Mabli (2018) “Household search or individual search: Does it matter?” *Journal of Labor Economics*, Vol. 36, pp. 1–46.

- Foerster, Hanno, Tim Obermeier, Bastian Schulz, and Alexander Paul (2022) “Job Displacement, Remarriage, and Marital Sorting,” unpublished.
- Folke, Olle and Johanna Rickne (2020) “All the Single Ladies: Job Promotions and the Durability of Marriage,” *American Economic Journal: Applied Economics*, Vol. 12, pp. 260–87.
- Gayle, George-Levi and Andrew Shephard (2019) “Optimal Taxation, Marriage, Home Production, and Family Labor Supply,” *Econometrica*, Vol. 87, pp. 291–326.
- Goussé, Marion, Nicolas Jacquemet, and Jean-Marc Robin (2017) “Marriage, Labor Supply, and Home Production,” *Econometrica*, Vol. 85, pp. 1873–1919.
- Greenwood, Jeremy, Nezih Guner, Georgi Kocharkov, and Cezar Santos (2016) “Technology and the Changing Family: A Unified Model of Marriage, Divorce, Educational Attainment, and Married Female Labor-Force Participation,” *American Economic Journal: Macroeconomics*, Vol. 8, pp. 1–41.
- Guler, Bulent, Fatih Guvenen, and Giovanni L Violante (2012) “Joint-search theory: New opportunities and new frictions,” *Journal of Monetary Economics*, Vol. 59, pp. 352–369.
- Hagedorn, Marcus, Tzuo Hann Law, and Iourii Manovskii (2017) “Identifying Equilibrium Models of Labor Market Sorting,” *Econometrica*, Vol. 85, pp. 29 – 65.
- Hagedorn, Marcus and Iourii Manovskii (2008) “The Cyclical Behavior of Equilibrium Unemployment and Vacancies Revisited,” *American Economic Review*, Vol. 98, pp. 1692 – 1706.
- Hall, Robert E. and Paul R. Milgrom (2008) “The Limited Influence of Unemployment on the Wage Bargain,” *American Economic Review*, Vol. 98, pp. 1653 – 1674.
- Holzner, Christian and Bastian Schulz (2023) “Marriage and Divorce under Labor Market Uncertainty,” unpublished.
- (in progress) “Marriage Market Sorting with Endogenous Divorces,” in progress.
- Jacobson, Louis S., Robert J. LaLonde, and Daniel G. Sullivan (1993) “Earnings Losses of Displaced Workers,” *The American Economic Review*, Vol. 83, pp. 685–709.
- Kline, Patrick, Raffaele Saggio, and Mikkel Sølvsten (2020) “Leave-Out Estimation of Variance Components,” *Econometrica*, Vol. 88, pp. 1859–1898.
- Lise, Jeremy and Jean-Marc Robin (2017) “The Macrodynamics of Sorting between Workers and Firms,” *American Economic Review*, Vol. 107, pp. 1104–35.

- Lochner, Benjamin and Bastian Schulz (forthcoming) “Firm Productivity, Wages, and Sorting,” *Journal of Labor Economics*, URL: <https://doi.org/10.1086/722564>.
- Mueller, Andreas I. (2017) “Separations, Sorting, and Cyclical Unemployment,” *American Economic Review*, Vol. 107, pp. 2081–2107.
- Persson, Petra (2020) “Social Insurance and the Marriage Market,” *Journal of Political Economy*, Vol. 128, pp. 252–300.
- Pilosoph, Laura and Shu Lin Wee (2021) “Household search and the marital wage premium,” *American Economic Journal: Macroeconomics*, Vol. 13, pp. 55–109.
- Pissarides, Christopher A. (2009) “The Unemployment Volatility Puzzle: Is Wage Stickiness the Answer?” *Econometrica*, Vol. 77, pp. 1339–1369.
- Schulz, Bastian (forthcoming) “Labor Market Dynamics with Sorting,” *Journal of Economic Dynamics and Control*, URL: <https://doi.org/10.1016/j.jedc.2023.104776>.
- Schulz, Bastian and Fabian Siuda (forthcoming) “Marriage and Divorce: the Role of Unemployment Insurance,” *Journal of Population Economics*, URL: <https://doi.org/10.1007/s00148-023-00961-1>.
- Shimer, Robert (2005) “The Cyclical Behavior of Equilibrium Unemployment and Vacancies,” *American Economic Review*, Vol. 95, pp. 25 – 49.
- Shimer, Robert and Lones Smith (2000) “Assortative Matching and Search,” *Econometrica*, Vol. 68, pp. 343 – 369.
- Song, Jae, David J Price, Fatih Guvenen, Nicholas Bloom, and Till von Wachter (2019) “Firming Up Inequality,” *The Quarterly Journal of Economics*, Vol. 134, pp. 1–50.
- Stole, Lars A. and Jeffrey Zwiebel (1996) “Intra-firm Bargaining under Non-binding Contracts,” *The Review of Economic Studies*, Vol. 63, pp. 375–410.
- Taber, Christopher and Rune Vejlin (2020) “Estimation of a Roy/Search/Compensating Differential Model of the Labor Market,” *Econometrica*, Vol. 88, pp. 1031–1069.