Job Displacement, Remarriage, and Marital Sorting*

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Abstract

We investigate how job displacement affects whom men marry, and study implications for marriage market matching theory. Leveraging quasi-experimental variation from Danish establishment closures, we show that job displacement leads men to match with higher earning women. We use a general marriage market search and matching model as conceptual framework, to derive several implications of our empirical findings: (i) husband's and wife's earnings are substitutes, rather than complements on the marriage market (ii) our findings are challenging to reconcile with one-dimensional matching, while consistent with multidimensional matching (iii) a substantial part of the measured correlation in spouses' incomes arises spuriously from sorting on unobserved characteristics. We highlight the policy relevance of our results, by contrasting the impact of simulated tax reforms on marital sorting and income inequality in one-dimensional versus multidimensional specifications of our framework.

Keywords: Marriage Market, Sorting, Search and Matching, Job Displacement, Taxation

JEL classification: D10, J12, J63, J65

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1 Introduction

Who marries whom contributes to economic inequality. This idea, which goes back to Becker (1973), has motivated an extensive body of literature that studies empirical patterns of marriage market sorting, and to what extent they contribute to trends in income inequality (see, e.g., Greenwood, Guner, Kocharkov and Santos, 2015; Eika, Mogstad and Zafar, 2019). A wide range of studies document strong correlations between spouses' characteristics such as income and education (see, e.g., Becker, 1973), personality traits (Becker, 1973; Dupuy and Galichon, 2014), measures of health (Chiappori, Oreffice and Quintana-Domeque, 2017a; Guner, Kulikova and Llull, 2018) or physical attractiveness (Oreffice and Quintana-Domeque, 2010; Chiappori, Oreffice and Quintana-Domeque, 2012). However, much less is known about the underlying causes of these correlations. Consider the case of income. Do individuals directly value the earnings potential of their partners, and make marriage decisions based thereon? Or does the positive income correlation arise through other channels, for example because marriage decisions are based on other (potentially unobserved) characteristics that correlate with income?

In this paper, we offer empirical answers to these questions by estimating the effect of exogenous job displacements on whom displaced men marry (or enter a committed relationship with). To this end we leverage variation from establishment closures in Denmark. Our research design allows us to study how quasi-exogenous changes in a person's employment status and earnings potential affect the characteristics (such as earnings potential, age, and education) of the person they match with on the marriage market. While a wide range of studies have used establishment closures as a source of quasi-exogenous variation, we are the first to exploit this source of variation to analyze marriage market sorting.[1] Based on our findings, we derive implications for marriage market matching theory.

Our empirical design leverages quasi-experimental variation from establishment closures in Denmark between 1980 and 2007. In a difference-in-differences analysis, we compare over 75,000 displaced male workers to a non-displaced control group. We follow treatment and control group over time and compare the evolution in their relationship status, as well as their spouses' (or cohabiting partners') characteristics, such as income, age, and education. We find that displaced men are more likely to separate from their partners, relative to a non-displaced control group. Two thirds of this effect is due to men who stay single, while one third is driven by men who remarry or cohabit with a new partner. Moreover, we find that displaced men who separate from their female partners on average re-match with higher earning new partners, relative to the control group. This effect is not driven by partners' labor supply choices, but is due to men matching with new partners who earn higher hourly wages.[2] We do not find notable effects on other partner characteristics, such as, age, education,

[1] The wide range of studies, spanning several fields within economics, that uses establishment closures as a source of quasi-exogenous variation goes back to Jacobson, LaLonde and Sullivan (1993). See, e.g., Gathmann, Helm and Schönberg (2018), Heining, Schmieder and von Wachter (2019), and Braxton, Herkenhoff and Phillips (2020) for recent contributions.

[2] In our data we do not find significant evidence of an added worker effect following job loss. This finding is in

or number of children. Robustness checks reveal that our results are not driven by displaced men moving to new firms or municipalities, in which women have a higher average income, or where the sex ratio is skewed towards women. Furthermore we argue that equilibrium effects of plant closures on the marriage market can plausibly be expected to be negligible, based on back-of-the-envelope calculations.

We use our empirical results to reexamine marriage market sorting and the underlying mechanisms that give rise to it. Since Becker (1973) it has been known that marriage market sorting can be explained by complementarities in the utility derived from marriage. Intuitively, likes mate if spouses' characteristics are complements, whereas unlikes mate if spouses' characteristics are substitutes.[3] Following this reasoning, different mechanisms have been proposed to explain why couples tend to be sorted positively on income and education empirically. Examples include complementarities in education (highly educated people value education in their spouse more), complementarities in home production (people who intent to spent similar hours on home production match), or complementarities in raising children.[4] Other mechanisms push towards substitutability of spouses' characteristics and thus negative sorting, such as, substitutability in home production hours (leading to household specialization) or risk sharing (Chiappori et al., 2018; Pilossoph and Wee, 2021). In simple (one-dimensional) models of marriage market matching, there is thus a tight link between complementarities in spouses' characteristics and marriage market sorting.[5]

While much of the literature focuses on one-dimensional matching, recently multimensional environments, in which people face trade-offs between different characteristics they value in their spouse, have gained attention (Dupuy and Galichon, 2014; Chiappori, McCann and Pass, 2016; Chiappori et al., 2017a). Under multidimensional matching, the link between complementarities in spouses' characteristics and marriage market sorting becomes more complex. For example, a positive correlation between husband's and wife's incomes reflects not only sorting on income, but also sorting on other characteristics that correlate with income (potentially including unobservables). As a consequence, the positive correlation in spouses' incomes may arise due to sorting on correlates of income, even if sorting on income itself is negative (i.e., even if husband's and wife's incomes are substitutes, as predicted by Becker, 1981).[6] Evidence based on exogenous variation is thus needed to disentangle sorting on income from sorting on other characteristics, and to uncover whether

accord with several papers that document a small added worker effect following job displacement, e.g., Stephens (2002), Eliason (2011), Birinci (2019), Halla, Schmieder and Weber (2020).

[3]In more technical terms, marriage market sorting depends on the supermodularity or submodularity of the household production function in the spouses' characteristics.

[4]See Chiappori, Costa-Dias and Meghir (2018), Chiappori, Iyigun and Weiss (2009) for models featuring complementarity in education. In Goussé, Jacquemet and Robin (2017) and Calvo, Lindenlaub and Reynoso (2021) complementarity in home production hours gives rise to positive sorting. Chiappori, Salanié and Weiss (2017b) model investments in children's human capital as complements giving rise to positive sorting in the marriage market. These mechanisms are not mutually exclusive and some of the cited studies feature more than one of the described mechanisms.

[5]For example, Calvo et al. (2021) note that a strong role for household specialization is hard to reconcile with positive assortative matching.

[6]Becker (1981) regards this as a possible reason for the lack of empirical evidence for negative sorting on earnings:

husband's and wife's incomes are complements or substitutes on the marriage market.

As conceptual framework we consider a general one-dimensional marriage market search and matching model, which builds on Shimer and Smith (2000) (for applications to marriage markets see, e.g., Jacquemet and Robin, 2013; Goussé et al., 2017; Holzner and Schulz, 2019; Ciscato, 2020). We show that within this framework, it is challenging to reconcile two empirical facts: 1. our empirical finding that displaced men on average match with higher earning women, relative to a non-displaced control group, and 2. the widely documented positive correlation between spouses' incomes. Intuitively, if spouses' incomes are complements the model generates a positive correlation in spouses' incomes but predicts that upon job loss men on average match with lower earning women (at odds with our empirical evidence). By contrast, if spouses' incomes are substitutes the model predicts that upon job loss men on average to match with higher earning women (consistent with our empirical evidence) but generates a negative correlation between spouses' incomes, at odds with the data. We formally show that, under one-dimensional matching, the two empirical facts can neither be reconciled under positive assortative matching (PAM) nor negative assortative matching (NAM).

To realign theory and evidence, we propose a multidimensional extension of the Shimer and Smith (2000) framework. The distinguishing model feature vis-à-vis the one-dimensional framework is that agents consider several characteristics (such as income, age, or physical attractiveness) in their matching decisions, and face trade-offs between them. We define a notion of PAM and NAM in this framework, under which sorting is defined dimension by dimension. PAM can thus arise in one dimension, while NAM arises in another.[7] We show that the proposed framework is consistent with both empirical regularities: the positive correlation between spouses' incomes and our finding that displaced men on average match with higher earning women. Our proposed specification features negative sorting on income and positive sorting on other characteristics, generating the two regularities by the following simple logic: under negative sorting on income (holding other characteristics constant), agents who experience job loss (and thus lose income) tend to match with higher-income partners. At the same time, positive sorting on other characteristics that are positively correlated with income gives rise to a positive correlation between spouses' incomes. The correlation between spouses' incomes is thus spuriously driven by characteristics that are correlated with income. Based on our empirical results we demonstrate that the positive correlation between spouses' incomes cannot be explained purely by sorting on variables observable in our data (specifically, income, age, and education). We show, based on a simple regression analysis, that a substantial share

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"The positive correlation between wage rates of husbands and wives [...] may really be measuring the predicted positive correlation between a husband's wage rate (or his non-market productivity) and his wife's non-market productivity. Many unobserved variables, like intelligence, raise both wage rates and non-market productivity." Lam (1988) offers an alternative explanation for the observed positive correlations despite theoretically-predicted negative sorting on income: the presence of public goods in married households.

[7] See Lindenlaub and Postel-Vinay (2016), who define sorting dimension by dimension in a multidimensional search model of the labor market. The main differences between frictional labor market and marriage market models is that in the latter matching is one-to-one and there is no entry.

of the measured correlation in spouses' incomes is due to sorting on unobserved characteristics.

Finally, to highlight the policy relevance of our results, we calibrate a one-dimensional as well as a two-dimensional specification of our framework to Denmark. We show that the two-dimensional model aligns with the data while the one-dimensional model is at odds with our empirical findings. We then simulate tax reforms in each calibrated model version. The two model versions make markedly different predictions: Under one-dimensional matching, the marriage market amplifies the effect of tax progressivity on inequality. By contrast, under two-dimensional matching the impact of tax progressivity on inequality is dampened by the marriage market. Our simulations thereby reveal, that whether matching is one-dimensional (at odds with our empirical results) or two-dimensional (consistently with our evidence) make a quantitatively important difference for how the marriage market shapes the long run effects of policy.

The contribution of this paper is threefold. First, we contribute to the literature that documents empirical patterns of marriage market sorting. A wide range of previous work analyzes empirical sorting on wages or labor income (Becker, 1973; Lam, 1988; Wong, 2003) as well as a range of other characteristics, including education, age, health, BMI, and personality traits (Becker, 1973; Oreffice and Quintana-Domeque, 2010; Chiappori et al., 2012; Dupuy and Galichon, 2014; Chiappori et al., 2017a; Guner et al., 2018). Several papers in this literature have studied how the evolution of marital sorting shapes income inequality over time (e.g., Greenwood et al., 2015; Eika et al., 2019).[8] Generally, this literature documents positive correlations between spouses' wages (as well as labor incomes).[9] In this paper, we take a different route by leveraging quasi-experimental variation from job displacements. Our estimates reveal that own income losses lead men to match with higher earning women. These results point towards substitutability between husband's and wife's incomes, rather than complementarity. The measured positive correlation between spouses' incomes, according to our evidence, is driven spuriously by unobserved variables. These findings complement the existing correlational evidence from previous work.

Second, we contribute on the modeling front, by proposing an extension of the Shimer and Smith (2000) marriage market search-and-matching model to multidimensional settings. We thereby contribute to a set of studies that explore multidimensional marriage market matching. E.g., Chiappori et al. (2012) and Dupuy and Galichon (2014) model matching on multiple observed characteristics.[10] Our extended framework adds to this literature as it accounts for multidimensional matching on

[8] See also the methodological contribution by Chiappori et al. (2012), who develop criteria for the suitability of different measures of marriage market sorting, for measuring changes in sorting over time.

[9] Several studies document that not only the raw correlations between spouses' wages (and labor incomes) are positive, but also the respective partial correlations, when various other observed characteristics are held constant (see, e.g., Becker, 1973).

[10] Our framework differs from Chiappori et al. (2012) and Dupuy and Galichon (2014) in several ways. By contrast to ours, preferences in their models are specified over a one-dimensional index which combines the various characteristics. Moreover, the matching processes in their models are frictionless while ours is frictional. Importantly, both these papers assume that observed characteristics are independent from unobservables.

observed as well as unobserved characteristics, without restricting the distributions of observed and unobserved characteristics to be independent. We show that our empirical results are hard to reconcile with one-dimensional matching, while consistent with multidimensional matching. Moreover, we argue that our empirical findings suggest that sorting on unobserved characteristics (from the researchers perspective) plays an important role. Our proposed extension of the Shimer and Smith (2000) framework captures both these aspects. We show that the extended model is capable of reconciling our empirical findings with theory.

Third, we contribute to a growing literature that takes into account the role of the family in shaping the outcomes of economic policy. A range of papers investigates how household formation and dissolution interact with economic policy, such as taxation (see, e.g., Guner, Kaygusuz and Ventura, 2012; Bronson and Mazzocco, 2018; Holter, Krueger and Stepanchuk, 2019; Gayle and Shephard, 2019; Siassi, 2019; Obermeier, 2019), social insurance (Low, Meghir, Pistaferri and Voena, 2018; Persson, 2020; Schulz and Siuda, 2020), and education policy (Anderberg, Bagger, Bhaskar and Willson, 2020). Our policy simulations complement these papers, by underscoring the relevance of accounting for marriage market sorting when evaluating policy reforms. Furthermore, our results demonstrate that policy simulations based on models that only match the raw correlation between spouses' labor incomes can be misleading. As shown by our analysis, requiring a model to be consistent with quasi-experimental evidence can alter and, in our case, overturn policy simulation results.

The remainder of our paper is structured as follows: in section 2, we introduce the marriage market matching model with one-dimensional heterogeneity and derive predictions regarding the implications of job displacement for marital sorting. Section 3 describes our data sources and empirical strategy. In section 4, we present our empirical results and show that they are in disagreement with the predictions of the one-dimensional sorting model. We explore multidimensional sorting as a possible avenue to reconcile theory and data in section 5. Section 6 presents the policy experiments and Section 7 concludes.

2 Conceptual Framework

This section introduces a search-and-matching model of the marriage market, which we use as a conceptual framework to guide our empirical analysis. We build on the frictional version of the classical Beckerian assignment model developed by Shimer and Smith (2000), which features two-sided (but one-dimensional) heterogeneity, and transferable utility.[11] Following these authours, we characterize PAM and NAM equilibria in our environment. We highlight a number of predictions that emerge from this framework, which we subsequently confront with the data in our empirical analysis (section 4). Ultimately, this allow us to adjudicate on the explanatory power of one-dimensional and multidimensional models of marriage market matching.

[11] Versions of the Shimer and Smith (2000) model have been applied to study marriage markets, e.g., in Goussé et al. (2017), Jacquemet and Robin (2013), Ciscato (2020), and Holzner and Schulz (2019).

2.1 Setup

We consider a two-sided market, in which women and men match with each other. Time is continuous, and discounted at rate r. Women and men are characterized by their types, $q_f \in Q_f$ and $q_m \in Q_m$. Throughout this section, we maintain that agents' types are one-dimensional, assuming $Q_f = [\underline{q}, \overline{q}]$ and $Q_m = [\underline{q}, \overline{q}]$. We connect our framework to the context of our empirical analysis by interpreting agent types, q_f and q_m, as agents' labor incomes.[12,13] In section 5 we extend our framework to settings in which agents match on several characteristics (i.e., vector valued agent types).

Search is assumed to be random. Denote the income distributions of single women and men by G_f and G_m, respectively.[14] At rate λ_f, a single woman meets a man drawn from the distribution of single men, G_m. Likewise, at rate λ_m, a single man meets a single woman, drawn from G_f. We follow Shimer and Smith (2000) in assuming that meeting rates are proportional to the mass of singles, $\lambda_f = \alpha \int dG_m(q_m)$ and $\lambda_m = \alpha \int dG_f(q_f)$. Upon meeting, female and male agents observe each others' types (i.e., each others' labor incomes), and both decide whether to accept and form a match, or to reject and continue searching.

2.2 Flow Utilities

We assume that single agents' flow value depends on their type q_g ($g \in \{f, m\}$), and is given by the flow utility function $u_g^S(q_g)$. Matched couples of type (q_f, q_m) enjoy flow match value, $f(q_f, q_m)$, which equals the sum of the matched partners' individual flow utilities,

$$f(q_f, q_m) = u_f^C(q_f, q_m) + u_m^C(q_f, q_m), \tag{1}$$

where $u_f^C(q_f, q_m)$ is the flow utility of a type q_f woman matched with a type q_m man (and vice versa for men). Throughout, superscript C refers to utility or value functions in couples, whereas superscript S refers to singles.

2.3 Bellman Equations and Matching

A model agent's decision problem can be summarized by two Bellman equations. Denote by $\mathcal{M}(q_g)$ the matching set of a model agent of type q_g. That is, $q_f \in \mathcal{M}(q_m)$ if a type q_f woman and a type q_m

[12]Note that this setup does not rule out that agents' consider other characteristics than income in their matching decisions if these characteristics are linked to q_f or q_m by a one-to-one mapping. A typical assumption in the literature is that agents match on income and education, which are linked by a one-to-one mapping.

[13]Our framework does not account for endogenous work hours choices. This is consistent with our empirical results (discussed in section 4) which are exclusively driven by changes in partner wages, not work hours.

[14]Note that G_f and G_m are equilibrium outcomes, i.e., are endogenous in the described framework.

man bilaterally accept to match upon meeting. The value of being a type q_m single man is given by[15]

$$rV_m^S(q_m) = u_m^S(q_m) + \lambda_m \int_{\mathcal{M}(q_m)} (1-\mu_f)S(q_f, q_m)dG_f(q_f), \tag{2}$$

where $(1-\mu_f)S(q_f, q_m)$ is the the share of marital surplus that q_m receives upon matching with q_f. The Bellman equation states that the value of being single is given by the flow utility of singlehood and the option value of matching with a partner. The value being matched with a type q_f woman for a type q_m man is given by the Bellman equation

$$rV_m^C(q_f, q_m) = u_m^C(q_f, q_m) + \delta(V_m^S(q_m) - V_m^C(q_f, q_m)), \tag{3}$$

where δ denotes the exogenous separation rate and $f(q_m, q_f)$ the flow value for a type q_m man of being matched with type q_f. Given these Bellman equations, the marital surplus is defined as

$$S(q_f, q_m) = V_m^C(q_f, q_m) + V_f^C(q_f, q_m) - V_m^S(q_m) - V_f^S(q_f) \tag{4}$$

The transferable utility assumption entails that the flow match value can be distributed between matched spouses without frictions. Couples therefore match upon meeting if (and only if) the marital surplus is weakly positive (i.e. $S(q_f, q_m) \geq 0$), and can thus be distributed such that each spouse benefits relative to remaining single. The model is closed by assuming that matched spouses share the marital surplus by Nash bargaining. Given female bargaining power μ_f Nash Bargaining entails in a matched couple (q_f, q_m) the f receives a share $\mu_f S(q_f, q_m)$ of the marital surplus while m receives $(1-\mu_f)S(q_f, q_m)$. For a formal description of the Nash Bargaining solution see C.1.

2.4 Equilibrium and Sorting

For the described search-and-matching environment, Shimer and Smith (2000) prove the existence of an equilibrium which satisfies: 1. *individually optimal behavior:* every agent maximizes her expected payoff, taking all other agents' strategies as given. 2. *steady state:* match creation equals match destruction for each agent type (i.e., for all q_f and all q_m). Shimer and Smith (2000) further define the following notion of PAM and NAM, which generalizes the frictionless definition by Becker (1973).[16]

Definition 1. *Consider $q'_f < q''_f$, $q'_m < q''_m$.*

There is PAM if: $q''_f \in \mathcal{M}(q'_m)$ and $q'_f \in \mathcal{M}(q''_m) \Rightarrow q'_f \in \mathcal{M}(q'_m)$ and $q''_f \in \mathcal{M}(q''_m)$

There is NAM if: $q'_f \in \mathcal{M}(q'_m)$ and $q''_f \in \mathcal{M}(q''_m) \Rightarrow q''_f \in \mathcal{M}(q'_m)$ and $q'_f \in \mathcal{M}(q''_m)$.

[15]The value of being a type q_f single woman and a type q_f woman matched with a type q_m man are defined analogously.

[16]Note that as matching is symmetric, $q_f \in \mathcal{M}(q_m)$ is equivalent to $q_m \in \mathcal{M}(q_f)$. The definition of PAM and NAM thus implies that the respective relationships with q_m and q_f interchanged hold as well.

Intuitively, under PAM, whenever there are two couples, (q'_f, q''_m) and (q''_f, q'_m), that could form more equal matches by switching partners, the involved individuals would be willing to do so. An implication of this definition is that if there is PAM, higher earning men will match on average with higher earning women in equilibrium (i.e., $\mathbb{E}[q_f|q_m]$ is weakly increasing in q_m). As a conequence, matched partners' incomes are positively correlated. By contrast, if there is NAM, higher earning men will match on average with lower earning women in equilibrium (i.e., $\mathbb{E}[q_f|q_m]$ is weakly decreasing in q_m). This implies that matched partners' incomes are negatively correlated. Taken together, it holds that

$$\text{PAM} \Rightarrow Corr(q_f, q_m) > 0, \tag{5}$$

$$\text{NAM} \Rightarrow Corr(q_f, q_m) < 0. \tag{6}$$

According to relationships (5) and (6), one could directly use the observed correlations between matched spouses' incomes to make inference about marital sorting patterns. Specifically relationships (5) and (6) show that in the one-dimensional search and matching environment, $Corr(q_f, q_m) < 0$ is inconsistent with PAM, while $Corr(q_f, q_m) > 0$ is inconsistent with NAM.

2.5 Job Loss and Marriage Market Matching

Next, we use our framework to derive predictions of how job displacement affects marriage market sorting. We model job loss as a permanent reduction in labor income.[17] Formally, we assume that a man with income q_m, who is displaced from his job, suffers a permanent income reduction to $\tilde{q}_m = q_m - d$, where $d > 0$. To conform with our empirical context, consider two groups of men, a treatment and a control group, observed at two points in time, $t = 0$ and $t = \tau > 0$. Suppose all men in the treatment group are displaced from their jobs at some point in time between $t = 0$ and $t = \tau > 0$, while men in the control group are not displaced. Formally, we thus have $\tilde{q}_{m\tau} = q_{m0} - d$ for the treated and $\tilde{q}_{m\tau} = q_{m0}$ for the control group.

We denote by $R_m^{0;\tau}$ a dummy variable that indicates a switch to a new partner between $t = 0$ and $t = \tau > 0$ (i.e., $R_m^{0;\tau} = 1$ for men who, between $t = 0$ and $t = \tau$, seperated from the partner they were matched with in $t = 0$ and formed a new match with a new partner). In our empirical analysis, we identify the following treatment effect:

$$\gamma = \mathbb{E}\left[q_{f\tau} - q_{f0} | q_{m\tau} = q_{m0} - d, R_m^{0;\tau} = 1\right] - \mathbb{E}\left[q_{f\tau} - q_{f0} | q_{m\tau} = q_{m0}, R_m^{0;\tau} = 1\right], \tag{7}$$

i.e., the impact of job displacement on partner income for those who switch partners between $t = 0$ and $t = \tau$, relative to a non-displaced control group. This treatment effect is identified by individuals

[17] This in line with our own empirical evidence (see section 4) as well as previous studies (see,e.g., Jacobson et al., 1993; Sullivan and von Wachter, 2009), showing that job displacement leads to a long lasting losses in earnings power.

who switch to a new partner between $t = 0$ and $t = \tau$ (mechanically $q_{f\tau} - q_{f0} = 0$, for individuals who do not switch to a new partner). Two margins contribute to the treatment effect γ. The first margin is a selection effect, by which job displacement affects which types of men seperate and re-match (i.e., for which types of men $R_m^{0,\tau} = 1$). The second margin is a causal effect, by which job displacement for a given man changes which female type he matches with in expectation. Our framework allows us to derive predictions about the direction of each of these margins, and, in sum, about the sign of the treatment effect, γ. Specifically, we show that the following relationships between marriage market sorting and the sign of the treatment effect hold:

Proposition 1. *(1) Under PAM, job displacement leads men to match with lower earning women. (2) Under NAM, job displacement leads men to match with higher earning women. Formally,*

$$PAM \Rightarrow \gamma \leq 0, \tag{8}$$

$$NAM \Rightarrow \gamma \geq 0. \tag{9}$$

Implications (8) and (9) show that marriage market sorting (PAM or NAM) pins down the sign of the treatment effect γ in our one-dimensional search and matching framework. Taken together with implications (5) and (6), marriage market sorting thus determines both the sign of the within-couple earnings correlation as well as the sign of the treatment effect γ. The model specifications most commonly used in applied work exhibit PAM (see,e.g., Goussé et al., 2017), and thus are consistent with a positive within-couple earnings correlation by (5), and predict that job displacement leads men to match with lower earning women (i.e., $\gamma \leq 0$) by (8).

In sections 3–4 we present quasi-experimental estimates of γ and use the derived implications to confront the presented marriage market framework with our empirical results.

3 Empirical Strategy

Our empirical strategy compares roughly 77,000 workers who lose their job due to an establishment closure to a control group of workers who have similar observable characteristics but are unaffected by establishment closures during our sample period. The following subsections describe our data sources, how we identify establishment closures in the data, the empirical matching technique used to define treatment and control group, and the empirical design including regression specifications.

3.1 Data

Our empirical analysis is based on Danish register data, which include the full population of men and women living in Denmark between 1980 and 2007. The data are drawn from tax and social security records and include information about employment status, labor income, occupation, work hours as well as marital status and children. The data allow us to analyze both married and unmarried cohabiting couples. Cohabiting couples are defined as two opposite-sex individuals who share the same address, exhibit an age difference of less than 15 years, have no family relationship, and do not share their accommodation with other adults.[18] For employed individuals, the data further identify the establishment a person works at and the number of workers employed at the establishment, among other things.

3.2 Establishment Closures

On the firm side, we rely on the Integrated Database for Labor Market Research (IDA), a register that links workers to firms. To identify establishment closures, we consider establishments that stop operating, i.e., completely shed their workforce. To define the *closure year* we consider the last three years of establishment operation and pick the first among these years with a workforce reduction of 10% or more. The idea behind this strategy is that the first wave of layoffs can be interpreted as an exogenous shock that this the affected workers. Layoffs that occur later, i.e. closer to the final closure date, are likely anticipated by the workers. In our main analysis, we exclude establishments with less than 5 employees in the last period prior to the closure year. These criteria broadly follow the definition of establishment closures in Browning and Heinesen (2012).

3.3 Treatment and Control Group

Based on this definition of establishment closure, we define our group of treated, that is, laid-off workers. Our treatment group consists of men who are employed at a closing establishment in the year of their layoff. To focus on men who are strongly attached to the labor market, we only include men with at least three years of tenure at the closing establishment and who are of age 25–45 in the closure year. The time window we consider extends from five years prior to ten years after establishment closure, so ten years after the establishment closure the considered men between 35–55 years old.

Next, we draw a control group. We rely on matched sampling to obtain a group of men who resemble our treatment group in terms of observable characteristics, but who were not laid off as part of an establishment closure during our sample period. More specifically, we draw our control group from all men in our data with tenure of at least three years at establishments that did not close during our observation period. We perform coarse and exact matching (**?**) to ensure the similarity between treatment and control group in terms of observables. The matching approach discretizes continuous matching variables into bins and then matches each displaced individual with a control individual in the same bin. This method has favorable statistical properties in small samples (see Iacus, King and Porro, 2012), as well as the appeal of being straightforward to interpret.

[18] This is the official definition of cohabiting couples that Statistics Denmark uses to define family types. Many other studies of couples' behavior that use Danish data rely on it (e.g., Svarer, 2004; Datta Gupta and Larsen, 2007; Datta Gupta and Larsen, 2010; Bruze, Svarer and Weiss, 2015).

Table 1: Summary statistics in year $t = -3$, treatment vs. control group

	Treatment	Control	P-value
Labor income (in DKK)	313,040	311,687	0.005
Partner's labor income (in DKK)	168,728	169,659	0.079
Partner's age	34.19	34.23	0.203
Education (years)	12.55	12.60	0.000
Partner's education (years)	12.10	12.15	0.000
Tenure (years)	4.43	4.39	0.101
No. of children	1.51	1.52	0.146
No. observations	77,084	77,084	

Notes: This table reports summary statistics for treatment and control group in year $t = -3$ relative to job displacement.

The variables that we perform our exact matching algorithm on are marital status (single, cohabiting, married, divorced), (exact) age, children (binary indicator), calendar year, occupation (6 categories), industry (9 groups), establishment size quintiles, and tenure quintiles. We match treatment and control group with respect to each of these variables three years before establishment closure. In the end, we have 77,084 individuals in both the treatment and the control group.

To assess to what extent our matching approach has created balanced treatment and control groups, we compare summary statistics between the groups. To this end, Table 1 displays sample means for a range of observables three years before the establishment closure. The sample means are very close in all cases. The largest percentage difference is approximately 0.7% (for tenure years and number of children). Some of the displayed sample means are significantly different between treatment and control group. Statistical significance arises as a consequence of the large sample size and high precision of the administrative data that leads to very small standard errors. Given the small magnitudes of these differences, we take them to be economically insignificant and conclude that treatment and control groups are balanced in terms of observables.

3.4 Regression Specification

To study how job displacement affects marriage market matching, we estimate the following regression specification, using a set of different outcome variables Y_{it} (described below):

$$Y_{it} = \sum_{\tau=-3}^{10} \alpha_\tau \mathbf{1}\{t = \tau\} + \sum_{\tau=-3}^{10} D_i \beta_\tau \mathbf{1}\{t = \tau\} + e_{it}, \tag{10}$$

where i is an individual index and t is time relative to the year of displacement of the treated individuals. D_i is a dummy variable indicating whether an individual is in the treatment group and e_{it} is the residual error term. The coefficients of interest are β_τ, which correspond to the effect of the displacement on the treatment group relative to the control group in the year of displacement and subsequent years. The key assumption to identify β_τ is that the trend in Y_{it} would have been parallel across treatment and control group in the absence of job displacement.

4 Empirical Results

This section presents our main empirical results. We first report the long-run effect of job displacement on employment and earnings, documenting that displacement is associated with persistent earnings losses. We then turn to analyzing the impact of job displacement on a range of marriage market outcomes, including relationship status, and whom men match with measured in terms of several partner characteristics, including earnings, education, age, and number of children. We show that our results on partner earnings are not driven by endogenous work hours choices. Additionally, we support our estimation results with several robustness checks, ruling out that our results reflect moves to firms or municipalities with favorable marriage market conditions or are driven by marriage market equilibrium effects.

4.1 Labor Income, Employment, Hourly Wages, and Work Hours

Figure 1 plots estimates of β_τ from estimating equation (10). As outcome variables, Y_{it}, we consider employment (Panel A), labor income (Panel B), hourly wages (Panel C), and work hours (Panel D). In the regressions for labor income and work hours we include zeros for non-employed individuals, while we run the regression for wages conditional on employment.

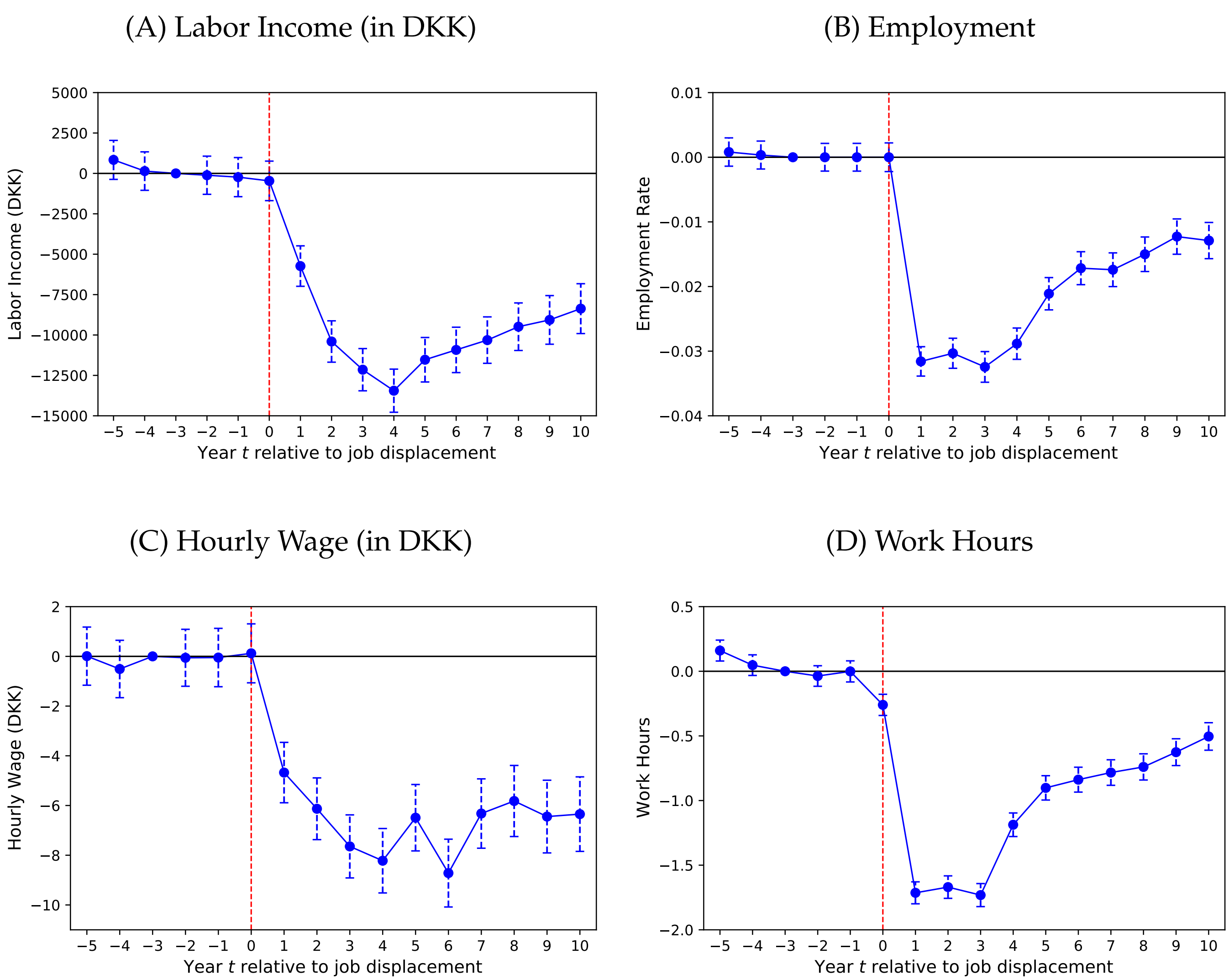
Panel A shows that job displacement has a negative impact on labor income that builds up to around -13,000 DKK in the first four years post displacement and persists at around -8,000 DKK ten years after displacement (around -3% of treated men's pre-displacement income). The remaining graphs decompose this effect on labor income into the employment, work hours, and hourly wage margin. Panel B shows that displacement initialy reduces the probability of employment by 3 percentage points, implying that a large share of displaced men find a new job within the first year after displacement. This effect persists at around -1 percentage point 10 years after displacement. Panel C shows that displacement reduces hourly wages by around 6 DKK (around 3% of treated men's pre-displacement wage), revealing that while most men find a new job after displacement, these jobs pay significantly lower wages. Panel D shows that displacement also reduces work hours, by around 1.5 weekly hours initially. This effect persists at around -0.5 weekly hours. In sum we find that displaced men experience a persistent reduction in labor income by 3% which is largely driven by displaced men finding new jobs that pay lower hourly wages.

4.2 Relationship Status

Figure 2 plots estimates of β_τ from estimating equation (10), where we use measures of individual's relationship status as outcome variables. Specifically, Panel A uses as outcome variable, Y_{it}, an indicator of whether i is separated from his period $t = -3$ partner.

Our results in Panel A show that 10 years after displacement, displaced men are 1.3 percentage points more likely to have separated from their pre-displacement ($t = -3$) partner. Relative to the control group of which TBA% separate over this 10 year horizon this is a sizable, TBA%, effect. Panel B and C decompose this effect into men staying single and men matching with a new partner. Panel B considers an indicator of whether i is single (i.e., not cohabiting and unmarried). Panel C considers an indicator of whether i is matched with a new partner (different from his $t = -3$ partner). The displayed results show that 10 years after displacement, displaced men are TBA percentage points more likely to be single, and TBA percentage points more likely to be matched with a new partner, relative to the control group. Roughly two thirds of the displacement effect on separations thus result in an increase in single hood, while one third leads to matches with new partners.

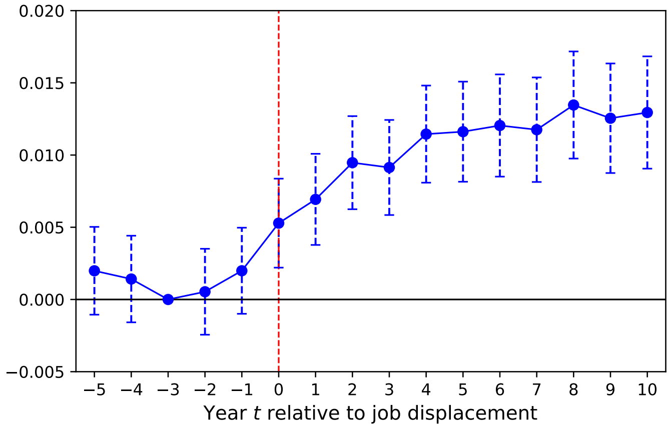
Figure 1: Labor Market Effects of Job Displacement



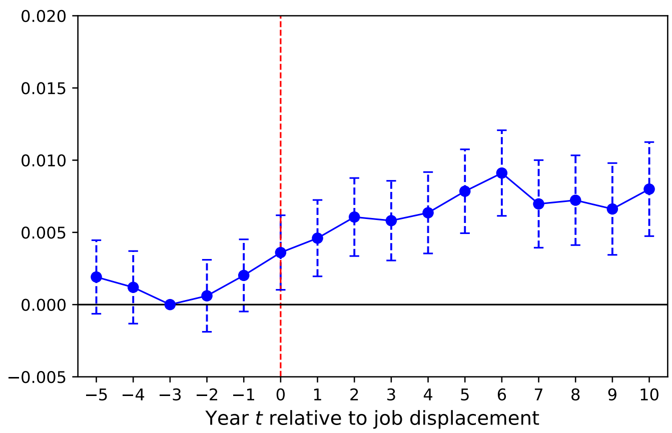
<u>*Notes*</u>: The figure shows the effect of establishment closure on different labor market outcomes. Point estimates measure the impact of experiencing establishment closure on labor income (in DKK), employment, hourly wages (in DKK), and weekly work hours (including zeros for non-employed). The estimates correspond to estimates of β_τ from equation (10). All estimates are based on a sample of men who experienced an establishment closure between 1980-2007, and the same number of control individuals selected by exact matching. The sample selection criteria and matching algorithm are described in subsection 3.3.

Figure 2: Impact of Job Displacement on Relationship Status

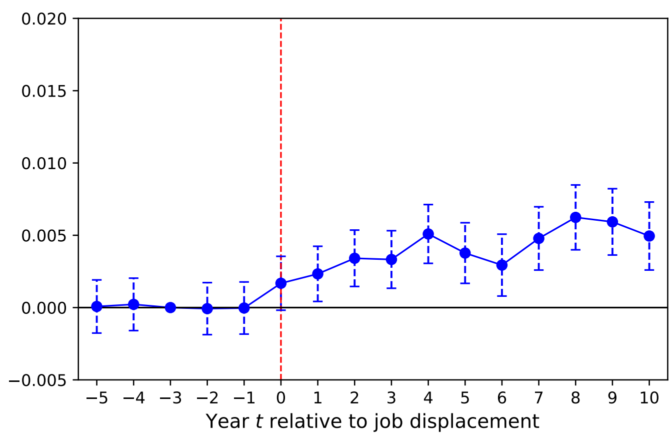
(A) Separated



(B) Single



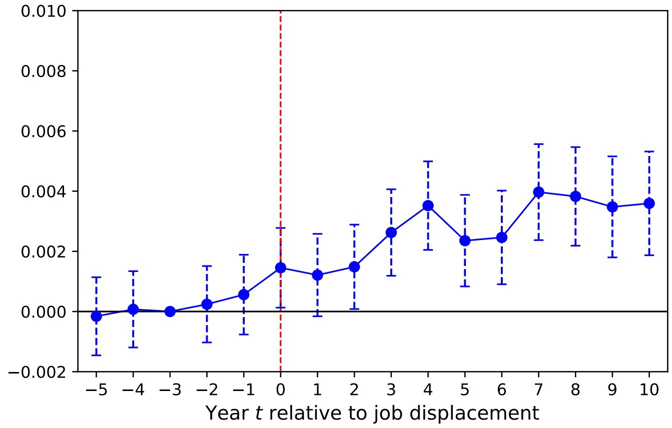
(C) New partner



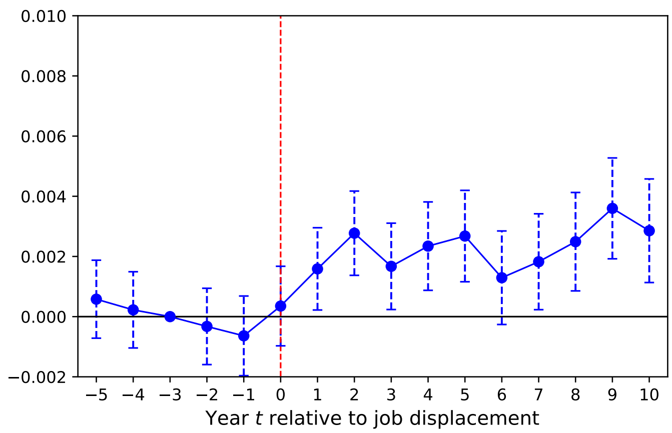
Notes: The figure shows the effect of establishment closure on different measures of relationship status. Point estimates measure the impact of experiencing establishment closure on the probability to be (a) separated from the initial partner (defined as the partner at $\tau = -3$), (b) single (i.e., *not* married *and not* cohabiting) or (c) matched (i.e., married or cohabiting) with a new partner who is distinct from the initial partner. (d), (e), (f), relative to initial partner. The estimates correspond to estimates of β_τ in equation (10). All estimates are based on a sample of men who experienced an establishment closure between 1980-2007, and the same number of control individuals selected by exact matching. The sample selection criteria and matching algorithm are described in subsection 3.3.

Figure 3: Impact of Job Displacement on Partner Income

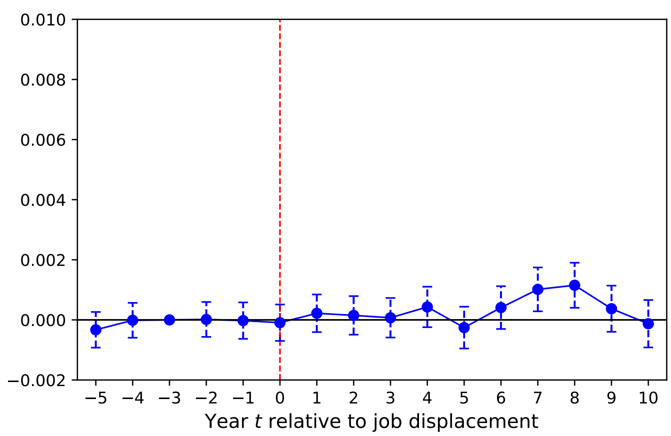
(A) New partner, income higher by $> 5\%$



(B) New partner, income within $\pm 5\%$ range



(C) New partner, income lower by $< 5\%$



Notes: The figure shows the effect of establishment closure on different measures of relationship status. Point estimates measure the impact of experiencing establishment closure on the probability to be (a) separated from the initial partner (defined as the partner at $\tau = -3$), (b) single (i.e., *not* married *and not* cohabiting) or (c) matched (i.e., married or cohabiting) with a new partner who is distinct from the initial partner. (d), (e), (f), relative to initial partner. The estimates correspond to estimates of β_τ in equation (10). All estimates are based on a sample of men who experienced an establishment closure between 1980-2007, and the same number of control individuals selected by exact matching. The sample selection criteria and matching algorithm are described in subsection 3.3.

4.3 Partner Earnings

We now turn to analyzing how job loss affects whom men match with on the marriage market. To start with, we study if job displacement induces men to match with women of systematically different earnings.

To this end we estimate our empirical specification (given by equation (10)) using outcome variables of the form

$$\begin{aligned} Y_{it}^{+} &= \mathbf{1}\{Q_{it} > (1+\rho)\widetilde{Q}_{it}\}, \\ Y_{it}^{0} &= \mathbf{1}\{(1-\rho)\widetilde{Q}_{it} < Q_{it} < (1+\rho)\widetilde{Q}_{it}\}, \\ Y_{it}^{-} &= \mathbf{1}\{Q_{it} < (1-\rho)\widetilde{Q}_{it}\}. \end{aligned}$$

where Q_{it} is a measure of the earnings of $i's$ period t partner, $\widetilde{Q}_{it}$ is a measure of the earnings of $i's$ pre-displacement partner, and ρ is a pre-specified threshold value. I.e., Y_{it}^{+} indicates wether $i's$ period t partner outearns $i's$ pre-displacement partner by more than $\rho \cdot 100\%$. Y_{it}^{-} indicates wether $i's$ period t partner is outearned by $i's$ pre-displacement partner by more than $\rho \cdot 100\%$. Y_{it}^{0} indicates wether $i's$ period t partner earns within a $\pm\rho \cdot 100\%$ range of $i's$ pre-displacement partner.

For our main regression specifications we fix $\rho = 0.05$ and consider annual labor incomes as well as hourly wages as earnings measures. Figure 3 plots estimates of β_τ from estimating equation (10), for Y_{it}^{+} (in Panel A), Y_{it}^{0} (in Panel B), and Y_{it}^{-} (in Panel C), as outcome variables.

Table 2: Treatment Effects, Conditional on Re-matching with a New Partner

	Income	Wage	Hours
Treatment	3185.2*	4.073***	0.139
	(2.47)	(3.49)	(0.79)
Constant	-1639.1	-8.429***	0.291*
	(-1.77)	(-10.03)	(2.31)
N	65046	62753	49930

Notes: The table reports the results of regressions of differences in labor income, wages and work hours between new partner and initial partner (defined as the partner at event time $\tau = -3$) on a constant and an indicator variable that equals 1 for individuals in the treatment group and 0 for control group individuals. t-statistics are reported in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The figure reveals that most of the difference in partner switching is driven by a higher propensity of the displaced group to switch to a partner with a *higher* income. In this case, the estimated coefficients are positive significant at the 5% level at all post-displacement event times. For switching to a partner with the same income, the coefficients are smaller and not always statistically significant. Finally, for switching to lower income partners, there is almost no difference between treatment and control group. The coefficients are almost always close to 0 and insignificant.

In table 2, we summarize these estimates in a single coefficient. We pool all post-displacement event times and regress partner income on a constant and a dummy for the displacement group. The highly significant coefficient on the displaced dummy is 7806.9, capturing that displaced men on average switch to a partner with higher earnings. To investigate the drivers behind the increase in partner earnings, we also conducted the regression separately for hours and wages of the new partner. The table shows that the increase in partner income is primarily driven by wages. For hours, the displacement effect is small and insignificant. Note that this result rules out changes in intra-household specialization as a driver of the increase in partner income. In principle, it could be that the (new) partners of displaced men increase their work hours somewhat in order to make up for the displacement. However, our finding of no significant change in hours is evidence against such a channel.

Table 3: Treatment Effects, Conditional on Re-matching with a New Partner

	Age	Education	No. of children
Treatment	-0.140**	-0.0127	0.0306**
	(-2.59)	(-0.91)	(2.95)
Constant	6.454***	0.344***	-0.233***
	(165.90)	(34.32)	(-31.17)
N	71090	67999	71090

Notes: The table reports the results of regressions of differences in age, years of schooling and number of children between new partner and initial partner (defined as the partner at event time $\tau = -3$) on a constant and an indicator variable that equals 1 for individuals in the treatment group and 0 for control group individuals. t-statistics are reported in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

4.4 Other Partner Characteristics

4.5 Robustness

Finally, we rule out a number of alternative explanations for our findings which are unrelated to the channels highlighted by the theoretical model.

Moves Across Local Marriage Markets. First, we look at the role of geographical moves. Figure **??** how the displacement affects the propensity to move by estimating our previous specification with an indicator variable for whether the individual has moved to a different region. The figure shows that the impact of displacement on the likelihood of having moved to a different municipality is significantly positive and stabilizes at 1.5 p.p. 3 years after displacement.

Since the figure shows that displaced workers adjust their mobility behavior, it is also important to check whether the regions they move to differ from the choices of the control group. For example, if displaced workers were, for whatever reasons, moving to regions in which women on average earn more than in their previous region, this would partially explain why they find a better partner after their displacement. However, it turns out that there is hardly any difference between the regional earnings of women between the treatment and control group. The difference is very small and not statistically different from zero.

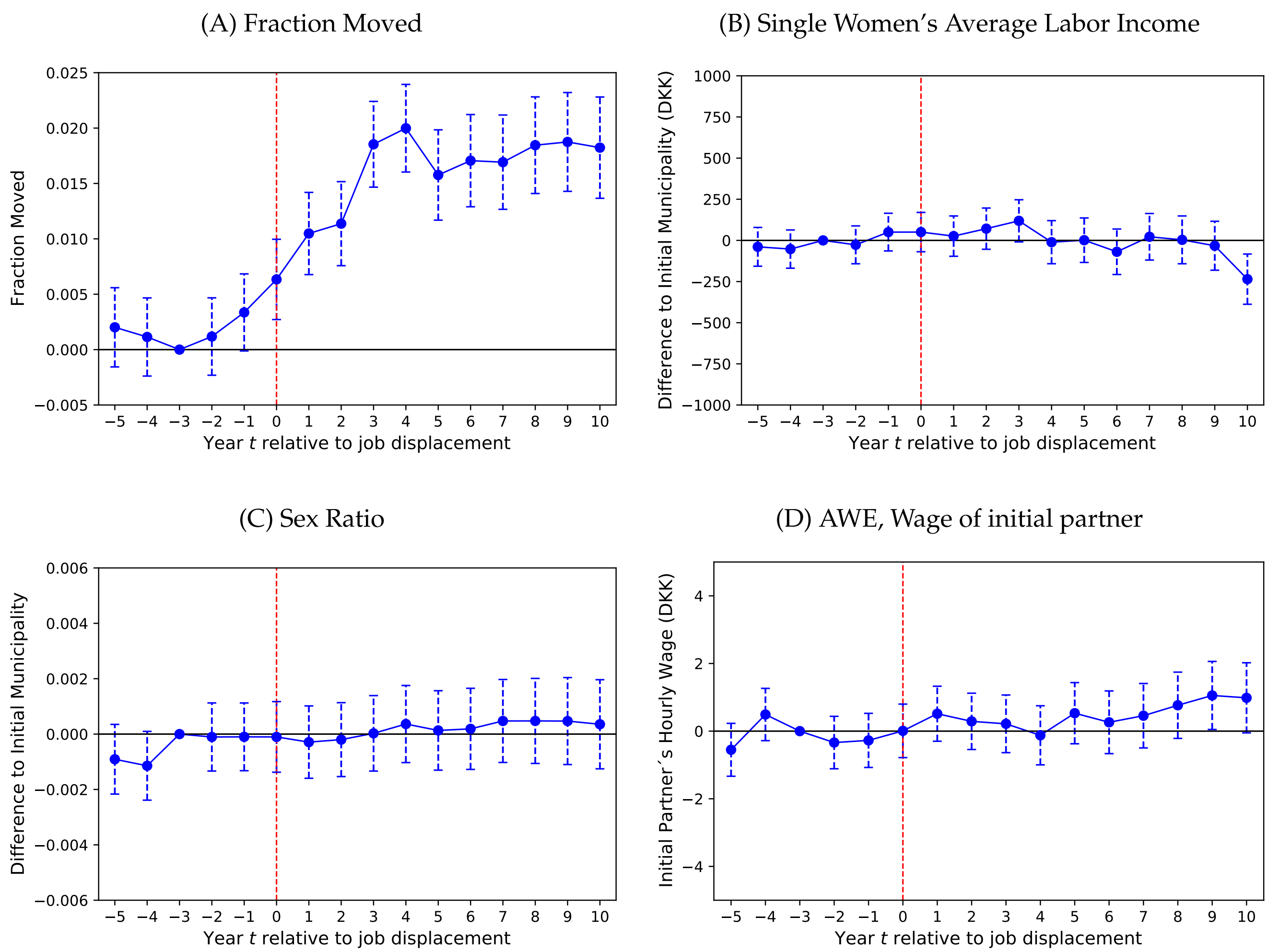
A related issue is that the new regions might differ in the sex ratio. In regions in which there are many women relative to men, it would also be easier to find a better partner than previously. To exclude this explanation, we also ran an event study with the sex ratio of the region as an dependent variable. To capture common age differences between spouses, we construct age-specific sex ratios which compute the ratio of women relative to men in a 10-year window around the individuals own age.[19] As with the regional earnings, however, there is no difference in the regional sex ratio between treatment and control group after displacement.

Marriage Market Equilibrium Effects of Establishment Closures. A potential challenge to identification is that establishment closures might exert equilibrium effects on the marriage market. Our previous empirical analysis rests on the assumption that establishment closures affect displaced men directly, but do not change the overall composition of the pool of singles on the marriage market. We provide a back of the envelope calculation to demonstrate that we can reasonably expect such equilibrium effects to be small: The workforce of the average closing establishment in our sample is 270 workers. The raw rate at which displaced workers separate from their partners in the 10 years following establishment closure is 0.2. The average inflow of singles into the marriage market over 10 years in the aftermath of an establishment closure hence is approximately $0.2 \times 270 = 54$. This amounts to an influx of 1.4% relative to the average number of singles living in the municipality where the establishment closes (which is 3897).[20] We view this number as a conservative approximation, given the long time horizon (10 years) we consider and given that we look at the number of singles in the municipality of the closing establishment, arguably a lower bound for the size of the local marriage market.

[19]For example, for a 40 year old worker, the age-region-specific sex ratio is the ratio between the number of single women between 35 and 45.

[20]We arrive at a similarly small number (0.89%) if we use the median instead of the mean establishment size and number of singles in the municipality.

Figure 4: Robustness Plots



Notes: The figure shows the effect of establishment closure on (a) the probability of moving to a different municipality, (b) the difference between single women's average labor income in the municipality an individual lives in to the average single women's labor income in the municipality where the individual lived in $\tau = -3$, and (c) the difference between the sex ratio ($\frac{\#women}{\#men}$) in the municipality an individual lives in to the average sex ratio in the municipality where the individual lived in $\tau = -3$. The estimates correspond to estimates of β_τ in equation (10). All estimates are based on a sample of men who experienced an establishment closure between 1980-2007, and the same number of control individuals selected by exact matching. The sample selection criteria and matching algorithm are described in subsection 3.3. (d) is the AWE expressed in terms of the initial partner's hourly wage, to be moved.

5 Reconciling Theory and Data: Multidimensional Matching

In this section we extend the marriage market search and matching model described in section 2 to multidimensional settings. We define notions of PAM and NAM in this environment and derive a relationship between sorting patterns and matching sets for the multidimensional case. Finally, we derive conditions under which our empirical results that challenge the one-dimensional framework can be reconciled with theory. In particular, we provide conditions under which the multidimenstional framework is consistent with: 1. men switching to higher earning spouses upon job loss and 2. the widely documented positive correlation between matched spouses' incomes.

5.1 Multidimensional Setup

The model fundamentals, the timing and the search protocol are identical to the one-dimensional case presented in section 2. We extend the framework by allowing for n-dimensional male and female types summarized in vectors, v_f and v_m. Upon meeting, model agents take into account all dimensions of v_f and v_m, in deciding whether to accept or reject a potential partner. A matched couple of type (v_f, v_m) enjoys flow marital surplus $f(v_f, v_m)$. Analogous to the one-dimensional case it can be shown that a match is formed if and only if a type v_f woman and type v_m men meet and the marital surplus is positive, $S(v_f, v_m) = V_m^C(v_f, v_m) + V_f^C(v_f, v_m) - V_m^S(v_m) - V_f^S(v_f) \geq 0$.

5.2 Multidimensional Sorting

We extend the defintion of PAM and NAM presented in section 2 to capture sorting in multidimensional settings. Denote by $\mathcal{M}(v_m)$ the matching set of men of type v_m. In the following, it will be useful to occasionally denote v_f as (v_{fi}, v_f^{-i}), where v_{fi} denotes the i-th component and v_f^{-i} denotes all but the i-th components of vector v_f. We define positive and negative assortative mating in dimension (i, j) (write PAM (i,j) and NAM (i,j)) as follows.

Definition 2. *Consider $v'_{fi} < v''_{fi}$, $v'_{mj} < v''_{mj}$.*

There is PAM (i,j) if:

$$\left.\begin{matrix} (v''_{fi}, v_f^{-i}) \in \mathcal{M}(v'_{mj}, v_m^{-j}) \\ (v'_{fi}, v_f^{-i}) \in \mathcal{M}(v''_{mj}, v_m^{-j}) \end{matrix}\right\} \Rightarrow \begin{cases} (v'_{fi}, v_f^{-i}) \in \mathcal{M}(v'_{mj}, v_m^{-j}) \\ (v''_{fi}, v_f^{-i}) \in \mathcal{M}(v''_{mj}, v_m^{-j}) \end{cases}$$

There is NAM (i,j) if:

$$\left.\begin{matrix} (v''_{fi}, v_f^{-i}) \in \mathcal{M}(v'_{mj}, v_m^{-j}) \\ (v'_{fi}, v_f^{-i}) \in \mathcal{M}(v''_{mj}, v_m^{-j}) \end{matrix}\right\} \Rightarrow \begin{cases} (v'_{fi}, v_f^{-i}) \in \mathcal{M}(v'_{mj}, v_m^{-j}) \\ (v''_{fi}, v_f^{-i}) \in \mathcal{M}(v''_{mj}, v_m^{-j}) \end{cases}$$

Definition 3. *Consider $v'_{fi} < v''_{fi}$, $v'_{mj} < v''_{mj}$.*

There is PAM(i,j) if: $(v''_{fi}, v_f^{-i}) \in \mathcal{M}(v'_{mj}, v_m^{-j})$ *and* $(v'_{fi}, v_f^{-i}) \in \mathcal{M}(v''_{mj}, v_m^{-j})$ $\Rightarrow (v'_{fi}, v_f^{-i}) \in \mathcal{M}(v'_{mj}, v_m^{-j})$ *and* $(v''_{fi}, v_f^{-i}) \in \mathcal{M}(v''_{mj}, v_m^{-j})$

There is NAM(i,j) if: $(v''_{fi}, v_f^{-i}) \in \mathcal{M}(v'_{mj}, v_m^{-j})$ *and* $(v'_{fi}, v_f^{-i}) \in \mathcal{M}(v''_{mj}, v_m^{-j}) \Rightarrow (v'_{fi}, v_f^{-i}) \in \mathcal{M}(v'_{mj}, v_m^{-j})$ *and* $(v''_{fi}, v_f^{-i}) \in \mathcal{M}(v''_{mj}, v_m^{-j})$.

Definition 4. *Consider* $v'_{fi} < v''_{fi}$, $v'_{mj} < v''_{mj}$.

There is PAM(i,j) if:

$$\begin{aligned} & (v''_{fi}, v_f^{-i}) \in \mathcal{M}(v'_{mj}, v_m^{-j}) \text{ and } (v'_{fi}, v_f^{-i}) \in \mathcal{M}(v''_{mj}, v_m^{-j}) \\ \Rightarrow \quad & (v'_{fi}, v_f^{-i}) \in \mathcal{M}(v'_{mj}, v_m^{-j}) \text{ and } (v''_{fi}, v_f^{-i}) \in \mathcal{M}(v''_{mj}, v_m^{-j}) \end{aligned}$$

There is NAM(i,j) if:

$$\begin{aligned} & (v''_{fi}, v_f^{-i}) \in \mathcal{M}(v'_{mj}, v_m^{-j}) \text{ and } (v'_{fi}, v_f^{-i}) \in \mathcal{M}(v''_{mj}, v_m^{-j}) \\ \Rightarrow \quad & (v'_{fi}, v_f^{-i}) \in \mathcal{M}(v'_{mj}, v_m^{-j}) \text{ and } (v''_{fi}, v_f^{-i}) \in \mathcal{M}(v''_{mj}, v_m^{-j}). \end{aligned}$$

To obtain similar results on the relationship of sorting and matching sets as in the one-dimensional case, we furthermore need to make an assumption that ensures for given v_f and v_m^{-i} matching sets are non-empty (and likewise for given v_m and v_f^{-i}).

Assumption 1. *For all* v_f, v_m^{-i} *there is a* v_{mi}, *such that* $(v_{mi}, v_m^{-i}) \in \mathcal{M}(v_m)$. *For all* v_m, v_f^{-i} *there is a* v_{fi}, *such that* $(v_{fi}, v_f^{-i}) \in \mathcal{M}(v_m)$.

Intuitively, under assumption 1 even a man who is unfavorable in all but the i-th dimension is able to match with women of any type v_f if he is favorable enough in dimension i (and analogously for women).

5.3 Two-Dimensional Sorting in Equilibrium

In the following we focus on a two-dimensional specification, the simplest case of a multidimensional model in which theory can be reconciled with our quasi-experimental evidence. Consider female and male types, $v_f = (q_f, x_f)$ and $v_m = (q_m, x_m)$, where q_f and q_m are female and male labor income, while x_f and x_m are indices of other individual characteristics. We will argue in section that while part of x_f, x_m is arguably captured by observables, it is unlikely that x_f, x_m are fully observed in our data. The relationship between sorting and matching sets in the two-dimensional case is established in the following proposition.

Proposition 2. *Under assumption 1, and given PAM (1,1) or NAM (1,1), then* $(q_f, x_f) \in \mathcal{M}(q_m, x_m)$ *if and only if* $q_f \in [a(q_m, x_m, x_f), b(q_m, x_m, x_f)]$, *where* a *and* b *are* *(i) increasing in q_m under PAM (1,1),*

(ii) decreasing in q_m under NAM (1,1).

Conditional on the second dimension x_f (or x_m), matching sets are increasing in income under PAM (1,1) and decreasing in income under NAM (1,1). This result allows us to explore how sorting on income affects matching after job loss.

5.4 Job Loss and Two-Dimensional Matching

Analogous to the one-dimensional case, we model job loss as a persistent reduction in labor income, i.e., if a type (q_m, x_m) man loses his job, his labor income is reduced to $\tilde{q}_m = q_m - d < q_m$. As in section 2, we denote by $D_m = 1$ a treatment group of men who lose their job between period $t = 0$ and $\tau > 0$ and by $D_m = 0$, a control group of men who are not displaced from their jobs.

The following proposition establishes that whether men who are displaced from their jobs (on average) switch to weakly lower earning or weakly higher earning female partners is determined by sorting on income (i.e., whether sorting is PAM(1,1) or NAM(1,1)).

Proposition 3. *Under PAM (1,1) displaced men who switch to a new partner on average match with partners of weakly lower income relative to non-displaced men who switch to a new partner. Under NAM (1,1) displaced men who switch to a new partner on average match with partners with weakly higher income relative to non-displaced men who switch to a new partner:*

$$\begin{aligned}
&\textit{PAM (1,1)} \Rightarrow \mathbb{E}[q_{f\tau} - q_{f0} | S_m = 1, R_m = 1, D_m = 1] \leq \mathbb{E}[q_{f\tau} - q_{f0} | S_m = 1, R_m = 1, D_m = 0], \\
&\textit{NAM (1,1)} \Rightarrow \mathbb{E}[q_{f\tau} - q_{f0} | S_m = 1, R_m = 1, D_m = 1] \geq \mathbb{E}[q_{f\tau} - q_{f0} | S_m = 1, R_m = 1, D_m = 0].
\end{aligned}$$

Proposition 3 establishes that the relationship between marital sorting on income and job loss derived in Proposition 1 holds up in the two-dimensional case. We thus conclude that our quasi-experimental evidence, showing that displaced men switch to higher earning new partners, relative to a control group, is consistent with negative sorting on income (NAM (1,1)) and inconsistent with positive sorting on income (PAM (1,1)).

5.5 Cross-Sectional Correlations under Two-Dimensional Matching

Next, we provide conditions under which two-dimensional matching is consistent with the observed positive correlation between matched partners' labor incomes. In particular we show that partners' incomes can be positively correlated even if sorting on income is negative. In this case the positive correlation between matched spouses' labor incomes arises spuriously and is driven by the second agent type dimension, x_f and x_m.

Formally, we provide conditions under which, the conditional expectation of female labor income, conditional on male labor income for matched couples, $\mathbb{E}[q_f|q_m]$, is increasing (decreasing) q_m, which implies a positive (negative) correlation between q_f and q_m.

To this end we decompose the effect of increased male labor income on $\mathbb{E}[q_f|q_m]$ into a direct effect (DE), capturing the impact of ceteris paribus increasing q_m, holding x_m constant, and an indirect effect (IE), that captures the association between q_m and x_m in the population of single men. We then sign DE and IE under conditions on sorting, and on the association between q_m and x_m.

Proposition 4. *Consider the following decomposition for $q''_m > q'_m$*

$$\begin{aligned}\mathbb{E}[q_f|q''_m] - \mathbb{E}[q_f|q'_m] &= \underbrace{\int \mathbb{E}[q_f|q''_m, x_m] - \mathbb{E}[q_f|q'_m, x_m] dG(x_m|q''_m)}_{:=\textbf{DE (Direct effect)}} \\ &+ \underbrace{\int \mathbb{E}[q_f|q'_m, x_m] dG(x_m|q''_m) - \int \mathbb{E}[q_f|q'_m, x_m] dG(x_m|q'_m)}_{:=\textbf{IE (Indirect effect)}}.\end{aligned}$$

In a two-dimensional steady state matching equilibrium the following implications hold:

$$\begin{aligned} PAM(1,1) &\Rightarrow \textit{DE} \geq 0, \\ NAM(1,1) &\Rightarrow \textit{DE} \leq 0, \\ PAM(1,2) \textit{ and } G(x_m|q_m) \textit{ is increasing in } q_m &\Rightarrow \textit{IE} \geq 0, \\ NAM(1,2) \textit{ and } G(x_m|q_m) \textit{ is increasing in } q_m &\Rightarrow \textit{IE} \leq 0, \\ PAM(1,2) \textit{ and } G(x_m|q_m) \textit{ is decreasing in } q_m &\Rightarrow \textit{IE} \leq 0, \\ NAM(1,2) \textit{ and } G(x_m|q_m) \textit{ is decreasing in } q_m &\Rightarrow \textit{IE} \geq 0. \end{aligned}$$

By proposition 4 the two-dimensional model is consistent with the observed positive correlation between matched spouses' incomes. Specifically the model can generate a positive correlation between matched spouses' incomes, even when sorting on income is negative, if soting if there is positive sorting on other attributes and income and and other attributes are positively associated. Note that assuming $Corr(q_m, x_m) > 0$ is not sufficient. Instead we assume $G(x_m|q_m)$ is increasing, a stronger condition on the association of male income and other attributes, which implies $Corr(q_m, x_m) > 0$. Note that in these cases matched partners' income correlation does not reflect a causal relationship, but arises spuriously. The impact of ceteris paribus changing q_m on marriage market matching is captured by DE, while IE captures the spurious association of matched partners' labor income that is driven by (unobserved) attractiveness.

Altogether the two-dimensional model is thus consistent with our empirical results if 1. sorting on income is negative, $NAM(1,1)$, which generates that displaced men switch to higher earning female partners relative, to an untreated control group, and 2. sorting on other attributes is positive, $PAM(2,2)$, and $G(x_m|q_m)$ is increasing in q_m, which is consisten with a positive correlation between matched spouses' incomes.

6 Policy Simulations

The empirical results we present in section 4 are inconsistent with one-dimensional matching, but are reconciled with theory under two-dimensional matching, as our theoretical considerations (in section 2 and 5) show. More specifically we conclude that individuals in the marriage market sort negatively on income, and positively on other attributes that are correlated with income. These attributes may include attributes unobserved to us (such as physical attractiveness or personality traits). To highlight the policy relevance of these findings, we contrast the impact of hypothetical tax reforms on income inequality in a one-dimensional versus a two-dimensional marriage market search and matching model.

6.1 Model Specification

Based on our general conceptual framework that is outlined in section 2, we specify a quantitative 1D as well as a 2D marriage market search and matching model. We then calibrate each specification using Danish administrative data.

For the flow match value and the flow value of singles we specify the following functional forms

$$\text{1D-Model:} \qquad \begin{aligned} f_{1D}(q_f, q_m) &= \ln(\tfrac{q_f+q_m}{2}) + \gamma_{1D} q_f q_m \\ u_s^S(q_s) &= \tfrac{1}{2}\ln(q_s), \quad s \in \{f, m\} \end{aligned} \tag{11}$$

$$\text{2D-Model:} \qquad \begin{aligned} f_{2D}(q_f, x_f, q_m, x_m) &= \ln(\tfrac{q_f+q_m}{2}) + \gamma_{2D} q_f q_m - \kappa_{2D}(x_f - x_m)^2 \\ u_s^S(q_s) &= \tfrac{1}{2}\ln(q_s), \quad s \in \{f, m\} \end{aligned} \tag{12}$$

These functional forms of the flow values are sufficiently flexible to yield positive or negative sorting on income, depending on the parameterization of $(\gamma_{1D}, \gamma_{2D})$. Intuitively, for low γ_{1D} or γ_{2D}, respectively, a substitutability in spouses' incomes is introduced through $\ln(q_m + q_f)$ pushes towards negative marital sorting on income. As γ_{1D} is increased a complementarity in spouses' incomes, pushing towards positive sorting on incomes is introduced in the 1D specification of our model. Similarly as γ_{2D} is increased a force pushing towards positive sorting on other attributes, x_f and x_m, is introduced in the 2D specification.[21] We solve the model numerically by iterating on the distributions of single types and the values of being single, (G_f, G_m, V_f^S, V_m^S).

[21]See also Gautier, Teulings and Van Vuuren (2010), who rely on a similar functional form to analyze sorting in the labor market.

Every couple draws an idiosyncratic "love shock" z upon meeting. Let $G(z)$, denote the CDF, μ_z the mean, and σ_z the standard deviation of z. Given $G(z)$, the function $\alpha(x, y) \in [0, 1]$ determines the probability that a single man of type x and a single woman of type y get married conditional on meeting. The match-specific love shock ensures that our model can match moments of the empirical joint distribution of married couples, particularly in the 1D case.[22]

6.2 Tax Schedule

We assume that model agents match on net income. For the purpose of simulating changes in tax policy it becomes relevant to specify the relationship between gross and net income. We denote gross incomes by $\tilde{q}_f$ and $\tilde{q}_m$. Net income equals $q_s = \tilde{q}_s - T(q_s)$, where

$$T(\tilde{q}_s) = \max\left((1 - \psi_1 \tilde{q}_s^{-\psi_2}) \cdot \tilde{q}_s, 0\right)$$

is the tax schedule. The parametrization of the tax schedule follows Heathcote, Storesletten and Violante (2017). ψ_2 controls the progressivity of the tax system and ψ_1 shifts the level of taxation. As Denmark is a country with individual taxation of partners, we assume that the tax function is applied to each partner individually.[23]

6.3 Calibration

We calibrate a 1D as well as a 2D specification our model to Denmark. We fix the discount rate at 0.97. The separation rate, δ, is estimated directly to match mean rate at which singles match with new partners in our data. The remaining model parameters are calibrated by targeting empirical moments computed from Danish adminstrative data.[24]

We set the population type distribution in the first dimension equal to the empirical distribution functions of female and male net income, respectively.[25] These densities form the type space in the 1D model. For the 2D model, we additionally assume that other attributes (x_f and x_m) follow a (truncated) normal distribution. We use a copula to compute the joint distributions of labor income and other attributes for males and females and treat the correlation between the two dimensions as a parameter to be calibrated.

[22] The match-specific shock leads to continuous marriage probabilities. In the basic Shimer and Smith (2000) model, matching probabilities are either zero or one due to the discontinuity at the boundary of the matching set.

[23] Note that we abstract from the transfer system by ruling out negative values of the tax function, as transfers are typically means-tested and based on *family* rather than *individual* income, which would complicate the model.

[24] We compute these moments from pooled longitudinal data, spanning the time window of our main empirical analysis, 1980-2007.

[25] More specifically, we estimate densities between the 5th and 95th percentile of the empirical income distribution. implying that our income space reaches from 46,000 to 484,000 DKK.

Table 4: Calibrated parameter values

Parameter	Symbol	Value 1D	Value 2D	Comment
Discount rate	r	0.050	0.050	fixed
Bargaining power	β	0.500	0.500	fixed
Separation rate	δ	0.120	0.120	data estimate
Meeting rate	λ	0.937	2.000	calibrated
Love shock mean	μ_z	0.000	0.000	calibrated
Love shock standard deviation	σ_z	2859.784	393058.800	calibrated
Home production NAM income	γ_1	0.967	0.376	normalized
Home production PAM income	γ_2	1.892	–	calibrated
Home production PAM attractiveness	γ_3	–	73026.831	calibrated
Correlation Income/Attractiveness	ρ	–	0.415	calibrated

We target moments that reflect the mariage market equilibrium, as well as the variance of log-gross household income among married couples, as a measure of economic inequality.[26] Our calibration procedure selects values for the free parameters of our model that minimize the euclidian distance between model moments and empirical moments. Table 4 presents the calibrated parameter values and Table 5 displays the model fit, for the 1D as well as the 2D specification of our model.

Note that, in the 2D model, we calibrate five parameters using four data moments. Our calibration procedure handles this lack of discipline by setting the standard deviation of the love shock to zero. This suggests that the extra flexibility of the match-specific shock, which is needed in the 1D model to match the data, is not necessary in the 2D model due to the additional dimension of heterogeneity. That is, the love shock is merely a constant in the 2D model, while the 1D model needs a certain amount of dispersion.

Both the 1D as well as the 2D model specification provide a good fit to the selected empirical moments. We closely match the empirical correlation between matched spouses' incomes. Our measure of inequality, the simulated variance of log gross income, is slightly lower than in the data. Both models match the fraction of people who are matched with a spouse, while the rate at which matches are formed in the 2D specification is slightly lower than in the data.

6.4 Simulation Results

We now turn to the results from several counterfactual policy simulations. In particular, we consider the impact of changes in tax progressivity on income inequality. Increasing tax progressivity is a

[26] In using this measure of income inequality we follow, e.g., Blundell, Pistaferri and Preston (2008).

Table 5: Target moments and fit

Moment	Value 1D	Value 2D	Target
Dislacement effect on partner income	-1333.4029	11086.1094	11086.809
Income Correlation	0.1198	0.1217	0.1198
Attractiveness Correlation	-	0.8236	-
Variance of log gross income of couples	0.2762	0.2592	0.2762
Marriage rate	0.7813	0.7759	0.7811
Marriage inflow	0.0896	0.0890	0.0916

common tool for counteracting income inequality (see, e.g., Heathcote et al. (2017)). In this context our simulations are aimed at contrasting policy effects in the 2D model that is consistent with our empirical results, and the 1D model, that is refuted by our data. Our simulation results show that our findings are relevant for understanding the link between tax progressivity, income inequality and marital sorting.

We study several hypothetical tax reforms through the lense of the calibrated versions of the 1D as well as the 2D specification of our marriage market search and matching framework. We start from a status quo scenario, in which the tax schedule is fixed at an approximation of the real world tax system in Denmark (this tax schedule is given by $\psi_1 = 0.65$ and $\psi_2 = 0.15$., i.e., the same parameters that we use in our calibration). We simulate moving from the Danish tax schedule to an approximation of the U.S. tax system.

Intuitively, under positive marital sorting we expect that disproportionately taxing high income individuals, induces these individuals to match with individuals earning less, i.e. the impact of taxation is amplified by the marriage market. Under negative marital sorting on income by contrast, highly taxed individuals are induced to match with individuals earning more, i.e., the impact of taxation is counteracted by the marriage market. Our simulations allow us to study if this intuition holds up in the presence of equilibrium effects and to obtain quantitative results.

Table 6 contrasts the impact of each simulated tax reform on economic inequality in the 1D specification versus the 2D specification of our model. Moreover we use our model to isolate the effect of taxes on income inequality that is mediated via the marriage market. Specifically, by simulating tax reforms while keeping marital sorting fixed, we quantify the impact of the considered tax reforms on income inequality, if the marriage market was unresponsive.

Indeed, the results displayed in Table 6 confirm the described intuition. As expected, increasing tax progressivity generally reduces income inequality (in the 1D as well as the 2D specification of our model). The magnitudes and contribution of the marriage market to this effect, however, differ

Table 6: Policy Simulations: Impact of Tax Reforms on Inequality

	$\text{Var}[\log(q_f^{\text{net}} + q_m^{\text{net}})]$	
	1D model	2D Model
(1) Danish Tax Schedule	0.033	0.031
(2) U.S. Tax Schedule, marital sorting fixed	0.043	0.039
(2) U.S. Tax Schedule	0.045	0.039
Fraction due to marital sorting	0.11	-0.08

substantially between the 1D model which is refuted by our empirical results and the 2D model which is consistent with our data.

We can isolate the impact of this reduction on inequality by introducing the progressive tax while holding the distribution of married couples fixed. This also leads to a reduction in inequality, as shown in table 6, but the reduction is not as strong as in the full model, where we allow the distribution to adjust. We can compute the relative importance of the marriage market adjustment by dividing the difference in inequality between the two policy experiments (column (2) - (3)) by the difference in inequality between no taxation and a progressive tax (column (3) - (1)). The interpretation of this number is fraction of reduction in inequality which is due to the marriage market, which turns out to be sizable in the 1D model.

7 Conclusion

In this paper, we have investigated the impact of job displacement on the remarriage outcomes of workers. Leveraging quasi-experimental variation from establishment closures in Denmark, we find that workers who experience a displacement shock are more likely to separate from their current partner and on average find a new partner with *higher* earnings than their previous partner, relative to an untreated control group. This finding is hard to reconcile with a large class of matching models which generate positive assortative matching on income in the cross-section. These view marriage as matching on a single attribute (income) and predict that the effect of shocks to earnings should be the same as the effect of initial earnings differences in the beginning of life. As a way of reconciling theory and data, we propose multidimensional matching, in which there is a second attribute, which we call "general attractiveness" and which is positively correlated with income. If there is positive assortative matching on general attractiveness, this can generate a positive correlation between the incomes of partners even if matching on income (conditional on general attractiveness) exhibits negative assortative matching.

These findings suggest caution in interpreting the positive correlation between partners' earnings as evidence of causal positive assortative mating on earnings. Through the lens of our multidimensional model, the underlying matching patterns on earnings are in fact negatively assortative, while unobserved variables lead to a positive earnings correlation. Whether marriage market matching is positively assortative on income has important implications for a range of policy questions, particularly those related to redistribution and the tax and benefit system. If matching is positively assortative on income, one would expect policies which reduce inequality, such as the tax and transfer system, to indirectly reduce PAM, which would result in an additional reduction of inequality. Under NAM, the marriage market impact of such policies would *amplify* inequality, which would mitigate the intended effect of reducing inequality.

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A Derivations and Proofs

Proof of proposition 1: We prove the implication for PAM. The result for NAM follows by analogous steps.

We use that under PAM matching sets are intervals with bounds that are weakly increasing in agent type. E.g., a man of type q_m matches with women of type $q_f \in [a(q_m), a(q_m)]$ with a, b weakly increasing in q_m.[27] It follows that

$$\mathbb{E}[q_f|q_m] = \mathbb{E}[q_f|a(q_m) \leq q_f \leq b(q_m)] \tag{13}$$

with a, b weakly increasing in q_m.

We start by considering the control group. In the control group all separations are exogenous, i.e., occur independent of agent types. We thus have

$$\mathbb{E}[q_{ft}|S_m = 1, D_m = 0] = \mathbb{E}[q_{ft}|D_m = 0]. \tag{14}$$

By the law of iterated expectations

$$\mathbb{E}[q_{ft}|D_m = 0] = \mathbb{E}[\mathbb{E}[q_{ft}|q_{mt}, D_m = 0]D_m = 0]. \tag{15}$$

In the control a given men's type does not change between the initial match in period $t = 0$ and the new match that we observe in τ. We thus have

$$\mathbb{E}[q_{f\tau}|q_{m\tau}, D_m = 0] = \mathbb{E}[q_{f\tau}|q_{m0}, D_m = 0] \tag{16}$$

and by stationarity of the distribution of single women, G_f, and (13):

$$\mathbb{E}[q_{f\tau}|q_{m0}, D_m = 0] = \mathbb{E}[q_{f0}|q_{m0}, D_m = 0] = \mathbb{E}[q_{f0}|a(q_{m0}) \leq q_{f0} \leq b(q_{m0}), D_m = 0] \tag{17}$$

By (14) - (17) it follows that

$$\mathbb{E}[q_{f\tau}|S_m = 1, D_m = 0] - \mathbb{E}[q_{f0}|S_m = 1, D_m = 0] = 0. \tag{18}$$

Next, we consider the treatment group. We start with $\mathbb{E}[q_{f0}|S_m = 1, D_m = 1]$. By the law of

[27] This is proved by Shimer and Smith (2000). Under NAM the same holds with a, b weakly decreasing.

iterated expectations

$$\mathbb{E}[q_{f0}|S_m = 1, D_m = 1] = \mathbb{E}[\mathbb{E}[q_{f0}|q_{m0}, S_m = 1, D_m = 1]S_m = 1, D_m = 1]$$

For the treatment group, as both exogenous and endogenous separations occur, conditioning on $S_m = 1$ is not innocuous. More precisely, endogenous separations occur for couples who have matched in $t = 0$, but who would not match after the men loses his job. These are couples for which $q_{f0} \in [a(q_{m0}), b(q_{m0})]$ and $q_{f0} \notin [a(q_{m0} - d), b(q_{m0} - d)]$ or equivalently $q_{f0} \in [b(q_{m0} - d), b(q_{m0})]$ (as a, b are weakly increasing under PAM).

Note that the probability of an exogenous separation between time $t = 0$ and $t = \tau$ is $1 - e^{-\delta\tau}$. The probability of an endogenous separation, conditional on having matched in $t = 0$ is

$$\frac{G_f(b(q_{m0})) - G_f(\max\{b(q_{m0} - d), a(q_{m0})\})}{G_f(b(q_{m0})) - G_f(a(q_{m0}))}.$$

$\mathbb{E}[q_{f0}|q_{m0}, S_m = 1, D_m = 1]$ is a weighted sum of the expectation of q_{f0} conditional on exogenous and endogenous separation, respectively:

$$\begin{aligned}
\mathbb{E}[q_{f0}|q_{m0}, S_m = 1, D_m = 1] \quad = \quad & \frac{1}{1 - e^{-\delta\tau} + e^{-\delta\tau}\frac{G_f(b(q_{m0})) - G_f(\max\{b(q_{m0}-d), a(q_{m0})\})}{G_f(b(q_{m0})) - G_f(a(q_{m0}))}} \\
& \Bigg[(1 - e^{-\delta\tau})\mathbb{E}[q_{f0}|a(q_{m0}) \leq q_{f0} \leq b(q_{m0})] \\
& + e^{-\delta\tau}\frac{G_f(b(q_{m0})) - G_f(\max\{b(q_{m0} - d), a(q_{m0})\})}{G_f(b(q_{m0})) - G_f(a(q_{m0}))} \\
& \mathbb{E}[q_{f0}|\max\{b(q_{m0} - d), a(q_{m0})\} \leq q_{f0} \leq b(q_{m0})]\Bigg]. \qquad (19)
\end{aligned}$$

Now consider $\mathbb{E}[q_{f\tau}|S_m = 1, D_m = 1]$. By the law of iterated expectations

$$\mathbb{E}[q_{f\tau}|S_m = 1, D_m = 1] = \mathbb{E}[\mathbb{E}[q_{f\tau}|q_{m\tau}, S_m = 1, D_m = 1]|S_m = 1, D_m = 1]$$

As the control group is laid off between $t = 0$ and $t = \tau$ we have $q_{m\tau} = q_{m0} - d$. Moreover note that conditional on a man's type that he separated is independent from the type of is next partner, and thus

$$\mathbb{E}[q_{f\tau}|q_{m\tau}, S_m = 1, D_m = 1] \quad = \quad \mathbb{E}[q_{f\tau}|q_{m0} - d, D_m = 1]$$

$$= \mathbb{E}[q_{f\tau}|a(q_{m0}-d) \leq q_{f\tau} \leq b(q_{m0}-d)].$$

Note that in general for a random variable X, and $b \leq b'$, $a \leq a'$:

$$\mathbb{E}[X|a \leq X \leq b] \leq \mathbb{E}[X|a' \leq X \leq b']. \tag{20}$$

By (20)

$$\mathbb{E}[q_{f0}|a(q_{m0}) \leq q_{f\tau} \leq b(q_{m0})] \leq \mathbb{E}[q_{f\tau}|\max\{b(q_{m0}-d), a(q_{m0})\} \leq q_{f\tau} \leq b(q_{m0})], \tag{21}$$

and thus

$$\begin{aligned}
\mathbb{E}[q_{f0}|q_{m0}, S_m = 1, D_m = 1] &\geq \mathbb{E}[q_{f0}|a(q_{m0}) \leq q_{f\tau} \leq b(q_{m0})] \\
&\geq \mathbb{E}[q_{f0}|a(q_{m0}-d) \leq q_{f\tau} \leq b(q_{m0}-d)] \\
&= \mathbb{E}[q_{f\tau}|q_{m0}, S_m = 1, D_m = 1].
\end{aligned}$$

We thus have established

$$\mathbb{E}[q_{f0}|q_{m0}, S_m = 1, D_m = 1] - \mathbb{E}[q_{f\tau}|q_{m0}, S_m = 1, D_m = 1] \geq 0.$$

Together with (18) we get

$$\mathbb{E}[q_{f\tau} - q_{f0}|S_m = 1, D_m = 1] - \mathbb{E}[q_{f\tau} - q_{f0}|S_m = 1, D_m = 0] \geq 0.$$

$\square$

Proof of proposition 2: Define $\mathcal{M}_{(1,1)}(q_m, x_m, x_f) := \{q_f : (q_f, x_f) \in \mathcal{M}(q_m, x_m)\}$. We proceed by first proving that $\mathcal{M}_{(1,1)}$ is a convex set and then show that its bounds are weakly increasing under PAM(1,1).

1. $\mathcal{M}_{(1,1)}(q_m, x_m, x_f)$ is convex:

Consider $q'_f < q''_f < q'''_f$, with q'_f and q'''_f in $\mathcal{M}_{(1,1)}(q_m, x_m, x_f)$, i.e.,

$$(q'_f, x_f) \in \mathcal{M}(q_m, x_m), \tag{22}$$

$$(q'''_f, x_f) \in \mathcal{M}(q_m, x_m). \tag{23}$$

Consider $\mathcal{M}(q_f, x_f)$, by (A1) this set is nonempty and by (A2) there is a $\hat{q}_m$ such that $(\hat{q}_m, x_m) \in \mathcal{M}(q''_f, x_f)$. Equivalently

$$(q''_f, x_f) \in \mathcal{M}(\hat{q}_m, x_m). \tag{24}$$

If $\hat{q}_m = q_m$, (24) entails convexity of $\mathcal{M}_{(1,1)}$. Suppose $\hat{q}_m < q_m$ then PAM(1,1) together with (22) and (24) implies $(q''_f, x_f) \in \mathcal{M}(q_m, x_m)$. If $\hat{q}_m > q_m$ the same follows from PAM(1,1), together with (23) and (24). We thus have shown $\mathcal{M}_{(1,1)}(q_m, x_m, x_f)$ is convex. Note that given q_m, x_m, x_f, $\mathcal{M}_{(1,1)}(q_m, x_m, x_f)$ is thus described by interval bounds $a(q_m, x_m, x_f)$, $b(q_m, x_m, x_f)$.

2. $a(q_m, x_m, x_f)$ and $b(q_m, x_m, x_f)$ are weakly increasing in q_m under $PAM(1,1)$:

b is weakly increasing in q_m: If not, $b(q'_m, x_m, x_f) > b(q''_m, x_m, x_f)$ for some $q'_m < q''_m$. As matching sets are closed $b(q'_m, x_m, x_f) \in \mathcal{M}(q'_m, x_m, x_f)$ and $b(q''_m, x_m, x_f) \in \mathcal{M}(q''_m, x_m, x_f)$. Equivalently $(b(q'_m, x_m, x_f), x_f) \in \mathcal{M}(q'_m, x_m)$ and $(b(q''_m, x_m, x_f), x_f) \in \mathcal{M}(q''_m, x_{mx})$. By PAM(1,1) this constellation implies $(b(q'_m, x_m, x_f), x_f) \in \mathcal{M}(q''_m, x_m)$. Equivalently, $b(q'_m, x_m, x_f) \in \mathcal{M}_{(1,1)}(q''_m, x_m, x_f)$, in contradiction with $b(q''_m, x_m, x_f)$ being the upper bound of $\mathcal{M}_{(1,1)}(q''_m, x_m, x_f)$.

That a is weakly increasing in q_m follows by similar steps that yield, $a(q''_m, x_m, x_f) \in \mathcal{M}_{(1,1)}(q'_m, x_m, x_f)$, in contradiction with $a(q'_m, x_m, x_f)$ being the lower bound of $\mathcal{M}_{(1,1)}(q'_m, x_m, x_f)$.

The proof that $a(q_m, x_m, x_f)$ and $b(q_m, x_m, x_f)$ are weakly decreasing in q_m under $NAM(1,1)$ proceeds analogously.

Proof of proposition 3: We prove the implication for PAM(1,1). The result for NAM(1,1) follows by analogous steps.

From proposition 2 it follows that

$$\mathbb{E}[q_f | q_m, x_m] = \mathbb{E}[q_f | a(q_m, x_m, x_f) \leq q_f \leq b(q_m, x_m, x_f)] \tag{25}$$

with a, b weakly increasing in q_m. Note that the expectation in is taken over the joint distribution $G(q_f, x_f)$.

Consider the control group first. By analogous steps as in the proof of proposition 1 it follows that

$$\mathbb{E}[q_{f\tau} | q_{m0}, D_m = 0] = \mathbb{E}[q_{f0} | q_{m0}, D_m = 0] = \mathbb{E}[q_{f0} | a(q_{m0}, x_{m0}, x_{f0}) \leq q_{f0} \leq b(q_{m0}, x_{m0}, x_{f0}), D_m = 0],$$

and

$$\mathbb{E}[q_{f\tau}|S_m = 1, D_m = 0] - \mathbb{E}[q_{f0}|S_m = 1, D_m = 0] = 0. \tag{26}$$

Next, we consider the treatment group. By the law of iterated expectations

$$\mathbb{E}[q_{f0}|S_m = 1, D_m = 1] = \mathbb{E}[\mathbb{E}[q_{f0}|q_{m0}, x_{m0}, S_m = 1, D_m = 1]S_m = 1, D_m = 1]$$

The treatment group in $t = 0$ matches given their types (q_{m0}, x_{m0}) while in later periods $t > 0$ (after layoff) matches that are formed given their new types $(q_{m0} - d, x_{m0})$. For the treatment group endogenous separations occur for couples, where $q_{f0} \in [a(q_{m0}, x_{m0}, x_{f0}), b(q_{m0}, x_{m0}, x_{f0}))]$ and $q_{f0} \notin [a(q_{m0}-d, x_{m0}, x_{f0}), b(q_{m0}-d, x_{m0}, x_{f0}))]$, or equivalently $q_{f0} \notin [b(q_{m0}-d, x_{m0}, x_{f0}), b(q_{m0}, x_{m0}, x_{f0}))]$.

The probability of endogenous separation, conditional on (q_{m0}, x_{m0}, x_{f0}) thus is

$$\frac{G(b(q_{m0}, x_{m0}, x_{f0})) - G(\max\{b(q_{m0} - d, x_{m0}, x_{f0}), a(q_{m0}, x_{m0}, x_{f0}))\})}{G(b(q_{m0}, x_{m0}, x_{f0})) - G(a(q_{m0}, x_{m0}, x_{f0}))}$$

and we get for the separation probability, conditional on (q_{m0}, x_{m0})

$$\begin{aligned}
&P(S_m = 1|q_{m0}, x_{m0}, D_m = 0) = 1 - e^{-\delta\tau} \\
&+e^{-\delta\tau} \int \frac{G(b(q_{m0}, x_{m0}, x_{f0})) - G(\max\{b(q_{m0} - d, x_{m0}, x_{f0}), a(q_{m0}, x_{m0}, x_{f0}))\})}{G(b(q_{m0}, x_{m0}, x_{f0})) - G(a(q_{m0}, x_{m0}, x_{f0}))} dG(x_{f0}).
\end{aligned}$$

$\mathbb{E}[q_{f0}|q_{m0}, S_m = 1, D_m = 1]$ is a weighted sum of the expectation of q_{f0} conditional on exogenous and endogenous separation, respectively:

$$\begin{aligned}
&\mathbb{E}[q_{f0}|q_{m0}, x_{m0}, S_m = 1, D_m = 1] = \\
&\frac{1}{P(S_m = 1|q_{m0}, x_{m0}, D_m = 0)} \Bigg[(1 - e^{-\delta\tau}) \int \mathbb{E}[q_{f0}|a(q_{m0}, x_{m0}, x_{f0}) \leq q_{f0} \leq b(q_{m0}, x_{m0}, x_{f0})] dG(x_{f0}) \\
&+e^{-\delta\tau} \int \frac{G(b(q_{m0}, x_{m0}, x_{f0})) - G(\max\{b(q_{m0} - d, x_{m0}, x_{f0}), a(q_{m0}, x_{m0}, x_{f0}))\})}{G(b(q_{m0}, x_{m0}, x_{f0})) - G(a(q_{m0}, x_{m0}, x_{f0}))} dG(x_{f0}) \\
&\int \mathbb{E}[q_{f0}|\max\{b(q_{m0} - d, x_{m0}, x_{f0}), a(q_{m0}, x_{m0}, x_{f0}))\} \leq q_{f0} \leq b(q_{m0}, x_{m0}, x_{f0})] dG(x_{f0}) \Bigg].
\end{aligned} \tag{27}$$

Using that for a random variable X, and $b \leq b'$, $a \leq a'$

$$\mathbb{E}[X|a \leq X \leq b] \leq \mathbb{E}[X|a' \leq X \leq b'], \tag{28}$$

it follows from (27) that

$$\mathbb{E}[q_{f0}|q_{m0}, x_{m0}, S_m = 1, D_m = 1] \;\; \geq \;\; \int \mathbb{E}[q_{f0}|a(q_{m0}, x_{m0}, x_{f0}) \leq q_{f0} \leq b(q_{m0}, x_{m0}, x_{f0})]dG(x_{f0}) \tag{29}$$

Moreover conditional on male type, (q_{m0}, x_{m0}), separation is independent of the type of the new partner, $q_{f\tau}$, and hence

$$\begin{aligned}
\mathbb{E}[q_{f\tau}|q_{m\tau}, x_{m\tau}, S_m = 1, D_m = 1] &= \mathbb{E}[q_{f\tau}|q_{m\tau}, x_{m\tau}, D_m = 1] \\
&= \int \mathbb{E}[q_{f\tau}|a(q_{m0} - d, x_{m0}, x_\tau) \leq q_{f0} \leq b(q_{m0} - d, x_{m0}, x_{f\tau})]dG(x_{f\tau})
\end{aligned}$$

From (29) and applying (28) we thus get

$$\mathbb{E}[q_{f\tau}|q_{m\tau}, x_{m\tau}, S_m = 1, D_m = 1] \leq \mathbb{E}[q_{f0}|q_{m0}, x_{m0}, S_m = 1, D_m = 1]$$

and hence

$$\mathbb{E}[q_{f\tau} - q_{f0}|S_m = 1, D_m = 1] = \mathbb{E}[\mathbb{E}[q_{f\tau} - q_{f0}|q_{m0}, x_{m0}, S_m = 1, D_m = 1]|S_m = 1, D_m = 1] \leq 0$$

Together with (26) we have established that

$$\mathbb{E}[q_{f\tau} - q_{f0}|S_m = 1, D_m = 1] \leq \mathbb{E}[q_{f\tau} - q_{f0}|S_m = 1, D_m = 0].$$

$\square$

Proof of proposition 4: We first show that PAM (1,1) implies $DE \geq 0$, while NAM (1,1) implies $DE \leq 0$. Using Proposition 2 it follows that

$$E[q_f|q_m, x_m] = \int E[q_f|a(q_m, x_m, x_f) \leq q_f \leq b(q_m, x_m, x_f), x_f]dG(x_f) \tag{30}$$

with a, b weakly increasing (weakly decreasing) in q_m under PAM (1,1) (NAM (1,1)). As the expectation of a truncated random variable is weakly increasing in the truncation bounds, $E[q_f|a(q_m, x_m, x_f) \leq q_f \leq b(q_m, x_m, x_f), x_f]$ and therefore $E[q_f|q_m, x_m]$ and DE are weakly increasing (weakly decreasing) in q_m under PAM (1,1) (NAM (1,1)).

Next, we establish that monotonicity of $G(x_m|q_m)$ in q_m together with PAM (1,2) or NAM (1,2) determines the sign of IE. In the following we prove that $IE \leq 0$ under PAM (1,2) and if $G(x_m|q_m)$ is weakly increasing in q_m. The other relationships follow analogously.

Given that $G(x_m|q_m)$ is weakly increasing in q_m, $G(x_m|q''_m)$ first order stochastically dominates $G(x_m|q'_m)$ implying that for any increasing function h

$$\int h(x_m) dG(x_m|q''_m) \geq \int h(x_m) dG(x_m|q'_m). \tag{31}$$

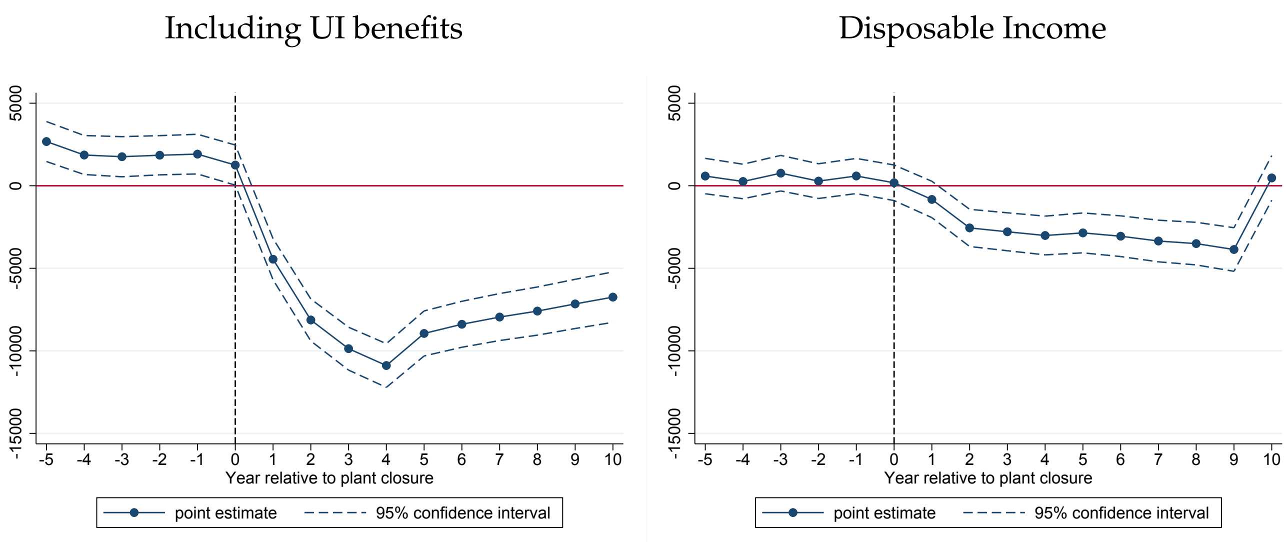
By (30) and since under PAM (1,2) a, b are weakly increasing in x_m,

$E[q_f|q_m, x_m]$ is increasing in x_m. By (31) we thus have $IE \leq 0$.

□

B Additional Figures and Tables

Figure 5: Income Loss around Displacement: Robustness



Notes: The graph shows the event study for labor income for two alternative definitions. In the first panel, we add UI benefits to gross labor income. In the second panel, we use a variable which contains disposable income, taking into account all sources of income as well as the full tax and transfer system.

C Conceptual Framework, Additional Material

C.1 Nash Bargaining Solution

Formally, assume that couples use transfers, t_f, to ensure that the individual participation constraints, $V_f(q_f|q_m) + t_f - W_f(q_f) \geq 0$ and $V_m(q_m|q_f) - t_f - W_m(q_m) \geq 0$ are satisfied. Under Nash Bargaining transfers are defined as the solution to the maximization

$$\max_{t_f}(V_f(q_f|q_m) + t_f - W_f(q_f))^{\mu_f}(V_m(q_m|q_f) - t_f - W_m(q_m))^{1-\mu_f},$$

where μ_f denotes female bargaining power. Solving the maximization yields

$$t_f = \mu_f(V_m(q_m|q_f) - W_m(q_m)) - (1 - \mu_f)(V_f(q_f|q_m) - W_f(q_f)).$$

The Nash bargaining solution yields that $V_f(q_f|q_m) + t_f - W_f(q_f) = \mu_f \cdot Z(q_f, q_m)$, where μ_f denotes female bargaining power. Female bargaining power, μ_f, thus controls the share of marital surplus that is allocated to the wife. Note that this implies that t_f, the transfer made from husband to wife, is increasing in female bargaining power and male surplus, and decreasing in female surplus.

C.2 Deriving marital surplus from household decision-making

To derive the match flow values specified in equations and we assume that matched model agents derive utility from private consumption, as well as directly from partner attributes. Utility directly derived from partner attributes can reflect homophily (see, e.g., Gihleb and Lang (2016)), i.e., the desire to match with a person with similar characteristics or status concerns (Cole, Mailath and Postlewaite (1992)).

Denote female and male private consumption by c_f and c_m, respectively. Note that as labor income is given (exogenously) by q_s ($s \in \{f, m\}$) the budget constraint for singles comes down to

$$c_s = q_s \ , \quad s \in \{f, m\},$$

i.e., singles consume their own income in any given period. Specifying single individuals utility function as $u(c_s) = \frac{1}{2}\ln(c_s)$ straightforwardly yields $h(q_s) = \frac{1}{2}\ln(q_s)$.

Matched couples face the joint budget constraint

$$c_f + c_m = q_f + q_m.$$

For the 1D specification of our model we assume agents utility function is given by

$$u(c_s, q_f, q_m) = \frac{\ln(c_s)}{2} + \gamma_{1D}\,\frac{q_f q_m}{2},$$

where the second summand can be interpreted as reflecting status concerns. Note that under transferable utility, optimizing behavior entails that matched couples maximize the sum of their private utilities, which yields the match flow value, f. They then distribute the utility by setting transfers, t_f, according to the Nash-Bargaining solution. A matched couple of type (q_f, q_m) thus obtains match flow value

$$\begin{aligned} f_{1D}(q_f, q_m) &= \max_{c_f, c_m} \frac{\ln(c_f) + \ln(c_m)}{2} + \gamma_{1D}\, q_f q_m \\ &\quad \text{s.t.} \quad c_f + c_m = q_f + q_m, \end{aligned}$$

which yields $f(q_f, q_m) = \ln(\frac{q_f + q_m}{2}) + \gamma_{1D}\, q_f q_m$. For the 2D specification of our model we assume agents utility function is given by

$$u(c_s, q_f, q_m, x_f, x_m) = \ln(c_s) + \gamma_{2D}\, q_f q_m - \kappa_{2D}(x_m - x_f)^2\,,$$

where the second and third summand can be interpreted as reflecting status concerns and homophily, respectively. By analogous reasoning as in the 1D case we obtain

$$\begin{aligned} f_{1D}(q_f, x_f, q_m, x_m) \quad &= \quad \max_{c_f, c_m} \frac{\ln(c_f) + \ln(c_m)}{2} + \gamma_{2D}\, q_f q_m + \kappa_{2D}\,(x_f - x_m)^2 \\ &\quad\quad \text{s.t.} \quad c_f + c_m = q_f + q_m, \end{aligned}$$

and thus $f(q_f, q_m) = \ln(\frac{q_f + q_m}{2}) + \gamma_{2D}\, q_f q_m + \kappa_{2D}\,(x_f - x_m)^2$.

C.3 Equilibrium characterization

The equilibrium is characterized by the following set of equations:

$$\begin{aligned} s_m(x) &= \frac{n_m(x)}{1 + \frac{\lambda}{\delta} \int s_f(y)\alpha(x,y)\mathrm{d}y} \\ s_f(y) &= \frac{n_f(y)}{1 + \frac{\lambda}{\delta} \int s_m(x)\alpha(x,y)\mathrm{d}x} \\ V_m^0(x) &= \frac{f_m(x) + \frac{\lambda\beta}{r+\delta} \iint \max\left\{z + f(x,y) - s_f(y), s_m(x)\right\} \mathrm{d}G(z) s_f(y)\mathrm{d}y}{1 + \frac{\lambda\beta}{r+\delta} S_f} \\ V_f^0(y) &= \frac{f_f(y) + \frac{\lambda(1-\beta)}{r+\delta} \iint \max\left\{z + f(x,y) - s_m(x), s_f(y)\right\} \mathrm{d}G(z) s_m(x)\mathrm{d}x}{1 + \frac{\lambda(1-\beta)}{r+\delta} S_m}. \end{aligned} \tag{32}$$

D Policy Simulations, Additional Material