Aggregate effects on the marriage market of a big increase in educational attainment*

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Abstract

Policies increasing educational attainment affect the equilibrium of the marriage market in two ways: first, individuals with more education become more attractive partners; second, there is a general equilibrium effect, as competition amongst educated individuals searching for partners increases. This paper estimates a matching model to study how a large educational intervention in Indonesia affected the size of the returns to education in the marriage market. I show that market clearing conditions influence how the marital surplus is divided between partners; as a result, a shock to the schooling distribution will affect the utility people of different education levels obtain from marriage. I obtain structural estimates of the utility individuals obtain from each partner alternative, which depends on their own education as well as their partner's. Based on these values I can estimate marital returns to education for many different marriage markets delimited by ethnicity, geographical location, and cohort of birth. I find that the return in the marriage market to finishing primary school decrease for women, mainly due to the higher availability of female primary school graduates.

1 Introduction

Marriage is a long term contract. When choosing whom to marry, people think about the attributes of a potential spouse, including his or her education. Therefore, the effect of education is not limited to the labor market, but will also affect returns in the marriage market.[1] Positive assortative

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[1]See, for instance, Kaufmann, Messner and Solis (2013), Goldin (1997)) or Oreopoulos and Salvanes (2011).

matching by education is prevalent (Boulier and Rosenzweig (1984); Behrman, Rosenzweig and Taubman (1994); Pencavel (1998), Smits, Ultee and Lammers (1998)), so the distribution of schooling in an individual's cohort will be related to the outcomes of the marital matching process.[2] However, this relationship remains poorly understood for several reasons. First, despite nearly all educational interventions affecting wide swaths of the population, the current analysis has been performed within a partial equilibrium context. Second, the literature has focused mainly on the quality of the match, ignoring the allocation of resources between the couple once the match occurs.[3]

In this paper, I estimate a marital matching model to assess the effect of a large educational intervention in Indonesia. I extend the model by Chiappori, Salanié and Weiss (2012) to multiple marriage markets per cohort, thereby exploiting the unique characteristics of Indonesian marriage markets. The estimation of this model yields structural estimates of the utility individuals would obtain from each of their partner alternatives. I then study the effect of an exogenous shock to the schooling distribution, arising from a large school construction program, on the utility people obtain from marriage. The analysis of the effects of this policy intervention is guided by the market clearing conditions I add to the original matching model, which explain how supply and demand forces affect the "price" -in terms of the intra-household allocation- that individuals have to pay for partners in the marriage market. I find that the return in the marriage market to finishing primary school decreases for women, mainly due to the higher availability of female primary school graduates.

The first challenge I face is to measure the gains couples derive from marriage, commonly known as the *marital surplus*, and the share corresponding to each partner. These quantities are difficult to capture because of unobservable benefits and the challenges of measuring intra-household resource allocation. To deal with this issue, I adapt the matching model that Chiappori et al. (2012) estimate for the United States to the Indonesian context. In this model, individuals with heterogeneous preferences over partner education match to maximize the utility they derive from marriage. Conditions over the shares of the marital surplus are derived to ensure a stable equilibrium - an assignment where no two unmatched individuals would prefer to be matched to each other or a married person would prefer to be single. As a result, structural estimates of the utilities people derive from the each possible match can be obtained.

I add market clearing conditions to the original model to obtain predictions about how a shift in the distribution of education affects the equilibrium marriage matching. The interplay between

[2]There are examples of other variables defining the environment under which marriage markets develop whose effect has been more widely studied. For instance, Angrist (2002), Stopnitzky (2012), Lafortune (2013) explore the effects of changes in sex ratios.

[3]Some examples of studied measures of quality are test scores (Kaufmann et al. (2013)), income (Goldin (1997)), and the probability of being married (Oreopoulos and Salvanes (2011)).

supply of and demand for partners imposes conditions on the incentives to marry into different educational levels, which are directly related to the way surplus is divided. Hence, the model predictions describe how the division of surplus must adjust in order to eliminate any excess demand for partners of a given educational category. In particular, members of gender-specific education groups that have expanded (contracted) should see their surplus shares shrink (rise), while those of their partners should rise (shrink). For example, if the percentage of primary schooled women increases, their share of the marital surplus should decrease, while the share corresponding to their potential partners would increase.

The Indonesian context is ideally suited to estimating this matching model and studying the effects of a shift in the distribution of education. The INPRES school construction program, executed countrywide in the 1970s, provides a large exogenous shock to the schooling distribution.[4] The Indonesian government built more than 61,000 schools between 1972 and 1979, considerably increasing educational attainment at the primary school level.[5] Evidence also shows that women benefited more from the program than men did. A program with these characteristics is very likely to perturb the marriage market conditions of the cohorts involved, and therefore provides an appropriate environment to study the equilibrium effects mentioned above. Additionally, cultural barriers against inter-ethnic marriage and limited inter-district marriage rates define markets that are well delimited by ethnicity and geographical location, increasing the number of markets involved in the estimation of the parameters that characterize marital choices.[6]

I exploit these unique characteristics of the Indonesian context to estimate the shares of the surplus corresponding to each partner, and then assess the effect of the intensity of the school construction program on those shares. First, I take advantage of the wide variety of marriage markets to get precise estimates of the shares of marital surplus according to education level of each partner, for each district, ethnicity and birth cohort. The key assumption of the model is that the complementarity between partners in terms of surplus depends only on their education levels. This assumption allows a two-sided market to be transformed into a model of decentralized individual matching decisions, where observing matching patterns across education levels are enough to identify the average utilities derived from each option for partner's education. I then use the variation at the district- and cohort-level on the intensity of the school construction program to estimate the effect of an increase in schooling on marital surplus and the way it is divided. Under the assumption

[4] Although this program was not randomized, its execution had a random component as explained in Duflo (2001) and Duflo (2004).

[5] See Duflo (2001) for a more detailed description of INPRES.

[6] The original model (Chiappori et al. (2012)) defines marriage markets only by birth year, affecting the number of observations available and the way parameters vary across markets.

that the only way INPRES affected the marriage market was through changes in the population distribution of education,[7] the estimated effect can be interpreted as the consequence of the shifts the program caused in each gender's schooling distribution.

Consistent with my model, I find that the share of the marital surplus that men obtain from marrying primary school educated women goes up, and so does the share accruing to women who did not finish primary school. As a consequence of these changes, female marital returns to primary education decrease in areas with more intense school construction. The main intuition behind this result is that primary school women become more abundant, while non-educated women become more scarce; hence, the women's return in the marital market for completing primary school has to decrease for the market to clear.

The empirical and theoretical results suggest that a general equilibrium approach is necessary to understand the entire effect of increased access to education for women. In particular, I show that a partial equilibrium analysis would overstate the returns to primary education for women, and would ignore spill-overs to other education groups. Proper analysis of the effects of a large shift in the education distribution will improve the understanding of who are the winners and losers of interventions of this magnitude.

The paper is organized as follows. Section 2 will lay out the model necessary to measure the utility people get from different partner options, as well as the market clearing conditions that will guide the empirical analysis. In Section 3 I explain how the effect of the school construction program will be estimated and under which conditions this effect is identified. Section 4 describes the characteristics that make the Indonesian context ideal for assessing my research question. Section 5 presents the results of the estimation of the matching model, as well as the impact of INPRES on marriage market outcomes. I address the main concerns about the empirical strategy in Section 6, to finally conclude in Section 7.

2 Marriage market framework

I present a model of endogenous matching that emphasizes the importance of education for sorting into couples, where the only partner attribute that matters for spouse choice is their education level.[8] I extend the model of Chiappori et al. (2012)[9] to incorporate multiple marriage markets per cohort

[7] Section 6 will present evidence against other channels through which the school construction could theoretically affect marriage markets.

[8] Since the seminal work of Becker (1973), economists have developed innumerable ways of modeling marriage markets. See Browning, Chiappori and Weiss (2010) for a good survey of the available models.

[9] Similar models in the literature include Chiappori, Iyigun and Weiss (2009), Choo and Siow (2006), and Dagsvik (2000).

and derive market clearing conditions for each type of partner. This approach takes advantage of the limits that Indonesian geography and ethnic norms impose on marriage markets, as I will explain later on.

Section 2.1 describes the way people sort into couples. Section 2.2 explains how to take the model to the data. Then I introduce market clearing conditions in Section 2.3 to study the effect of a cohort's education distribution on the utility obtained from marriage. These conditions allow me to use comparative statics to produce the testable predictions that guide the empirical analysis.

2.1 The marriage decision

In order to concentrate on the relation between education levels and marriage market outcomes, the way potential partners are evaluated is restricted to preferences over spouse's education. Education will be a discrete variable, which will facilitate the understanding of the underlying competition for partners.[10]

The marriage market is assumed to be frictionless, abstracting from the process of how partners are found and putting the focus on the final outcome. This assumption takes attention away from the decision of when to marry, which is very interesting on its own but out of the scope of this study. Given the Indonesian context, where divorce and remarriage are not as important as in places like the United States, dynamic considerations are also avoided by considering a static model.

The marriage of man i and woman j generates a surplus z_{ij}, which represents the *additional* utility the couple generates, compared to both of them staying single. The existence of a positive surplus for some couples constitutes the motivation to get married. Surplus is decomposed in three components as shown in Equation 1:

$$z_{ij} = Z^{IJ} + \alpha_i^{IJ} + \beta_j^{IJ}. \tag{1}$$

The first component, Z^{IJ}, represents the gains expected from the expansion of consumption possibilities due to complementarities, family public goods, and income pooling. This component depends only on the education of both partners, with I corresponding to the education of man i and J the education of woman j. The second and third terms on the right hand side of equation 1, α_i^{IJ} and β_j^{IJ}, capture the heterogeneity in individual preferences for partner's education. α_i^{IJ} represents the idiosyncratic utility that man i, with education I, obtains from marrying a woman in education

[10] I will consider three education levels: Did not finish primary school, finished primary but not secondary school, and secondary school graduate. Given the lumpiness of the observed educational attainment, this modeling decision does not distance ourselves too much from reality.

group J. Similarly, β_j^{IJ} indicate the utility that woman j, with education J, derives from marrying a man in education group I. These gains are heterogeneous across individuals, but do not vary according to their partner's identity beyond their partner's education level.

If man i marries woman j, the surplus is split between them, with u_i going to the husband and v_j going to the wife:

$$z_{ij} = u_i + v_j. \tag{2}$$

The way the surplus is divided will determine the incentives people have to get married to each potential partner.

A *stable equilibrium* is defined as a matching assignment and an allocation of surplus under which no two people would strictly prefer to be married to each other, and no person would strictly prefer to be single. Utility is assumed to be transferable, which implies that in any stable equilibrium the sum of the surpluses generated will be maximized.[11] This assumption will also imply that the division of surplus will fully reflect the effect of the competition for partners, since people can bargain about the way they divide the gains from marriage to clear the market.

The stable equilibrium in this context is characterized through the following Proposition.

Proposition 1 (Chiappori et al. (2012))**.** *For any stable matching, there exist numbers* U^{IJ} *and* V^{IJ}, $I =, ..., N$, $J = 1, ..., N$, *with*

$$U^{IJ} + V^{IJ} = Z^{IJ}$$

satisfying the following property: for any matched couple (i, j) *such that* $i \in I$ *and* $j \in J$,

$$u_i = U^{IJ} + \alpha_i^{IJ}$$

and

$$v_j = V^{IJ} + \beta_j^{IJ}.$$

Proposition 1 establishes a way to describe the surplus division introduced by equation 2 for a stable equilibrium. More importantly, it shows that the utility a person gets does not depend on her or his partner's identity beyond his or her education level. U^{IJ} can be interpreted as the average utility a man of education I obtains if he were to marry a woman of education J. Similarly, V^{IJ} illustrates the average utility a woman of education J if she were to marry a man of education I. These utility measures are free of selection bias, hence they represent the options people face,

[11] Shapley and Shubik (1971).

independently of their observed choices. In other words, U^{IJ} is not the average utility of a man that ends up marrying a woman in J, but the utility of a man would get if he were forced to marry a woman with education J. The difference between these utilities arises due to individuals endogenously selecting into marrying women in J according to their individual preferences α_i^{IJ}.

Proposition 2 use the fact that the relevant utilities for partner choice u_i and v_j do not depend on partner's identity once education is controlled for to establish the necessary and sufficient conditions for a stable equilibrium.

Proposition 2 (Chiappori et al. (2012))**.** *A set of necessary and sufficient conditions for stability is that*

1. *for any matched couple* $(i \in I, j \in J)$

$$\alpha_i^{IJ} - \alpha_i^{IK} \geq U^{IK} - U^{IJ} \qquad \forall K,$$

$$\alpha_i^{IJ} \geq -U^{IJ},$$

and

$$\beta_j^{IJ} - \beta_j^{KJ} \geq V^{KJ} - V^{IJ} \qquad \forall K,$$

$$\beta_j^{IJ} \geq -V^{IJ},$$

2. *for any single man* $i \in I$

$$\alpha_i^{IJ} \leq -U^{IJ} \qquad \forall J,$$

3. *for any single woman* $j \in J$

$$\beta_j^{IJ} \leq -V^{IJ} \qquad \forall J.$$

The main consequence of Proposition 2 is that a stable equilibrium in this two sided market can be characterized as a group of single-agent decisions. Individuals can be modeled as if they were choosing partners independently according to their education level. The shares of the surplus obtained within each union and the preferences for education levels will determine the spousal choice. Standard discrete choice models can be used to estimate the average utilities U^{IJ} and V^{IJ} from data on observed choices by education group.

2.2 Implementation

The model presented in the previous section provides a platform to estimate the marriage market outcomes we are interested in, namely U^{IJ} and V^{IJ}. Individuals will choose between their potential partners to maximize their utility, u_i for men and v_j for women. From Proposition 2, the percentage of men in education group I that choose to marry women with education J will be given by

$$s^{J|I} = \int \mathbf{1}(U^{IJ} + \alpha_i^{IJ} \geq U^{IK} + \alpha_i^{IK}, \forall K)\mathbf{1}(U^{IJ} + \alpha_i^{IJ} \geq 0)d\alpha_i^{I\cdot}. \tag{3}$$

To obtain a closed form expression for $s^{J|I}$ I need to make parametric assumptions about the distribution of α_i^{IJ}. This will also be the case also for β_j^{IJ} when computing $s^{I|J}$. Suppose α_i^{IJ} and β_j^{IJ} are such that

$$\alpha_i^{IJ} = \sigma^I \bar{\alpha}_i^{IJ},$$

$$\beta_j^{IJ} = \rho^J \bar{\beta}_j^{IJ}.$$

where $\bar{\alpha}_i^{IJ}$ and $\bar{\beta}_j^{IJ}$ follow a Type I extreme value distribution.[12] Under these assumptions,

$$s^{J|I} = \frac{\exp(U^{IJ})}{1 + \sum_K \exp(U^{IK})}. \tag{4}$$

Equivalently, the decision process for women implies that

$$s^{I|J} = \frac{\exp(V^{IJ})}{1 + \sum_L \exp(V^{LJ})}. \tag{5}$$

Equations 4 and 5 can be inverted to obtain

$$U^{IJ} = \sigma^I \ln\left(\frac{s^{J|I}}{s^{0|I}}\right) \tag{6}$$

and

$$V^{IJ} = \rho^J \ln\left(\frac{s^{I|J}}{s^{0|J}}\right), \tag{7}$$

where $s^{0|I}$ and $s^{0|J}$ are the percentage of single men in group I and the percentage of single women in group J, respectively. The "market shares" $s^{I|J}$ and $s^{J|I}$ can be easily estimated; hence, once I estimate the variance parameters σ^I and ρ^J, these two equations will produce estimates of how couples divide the marital surplus as a function of their education levels.

[12] This distribution is also known as $Gumbel(-k, 1)$ with k equal to the Euler constant.

Notice that the variance parameters are not identified from the choices of individuals belonging to a given education level. The variance of the term capturing preference heterogeneity just scales up or down all utility levels without changing the implied choices. Identification will come from the fact that a man and a woman that choose to marry each other will have to divide the surplus corresponding to their education levels; hence, utilities have to be re-scaled by the variance parameters to make them comparable. To capture the implication of surplus division, from Proposition 1 we know that $U^{IJ} + V^{IJ} = Z^{IJ}$, hence

$$Z^{IJ} = \sigma^I \ln\left(\frac{s^{J|I}}{s^{0|I}}\right) + \rho^J \ln\left(\frac{s^{I|J}}{s^{0|J}}\right). \tag{8}$$

The availability of data for multiple marriage markets will enable the estimation of the parameters σ^I and ρ^J, as well as of the marital surplus Z^{IJ}. Whereas Chiappori et al. (2012) define marriage markets according solely to birth cohorts, I can define a wider range of marriage markets incorporating two additional dimensions. First, Indonesia's ethnic diversity, added to the cultural institution that impose barriers to inter-ethnic marriages, allows me to separate marriage markets according to the participants' ethnicity. Second, the vast size of the country, along with low inter-district marriage rates, enable divisions by district of birth as well. Section 4.1 will explain in more detail the characteristics of the data in this respect.

To take advantage of these marriage market divisions, I have to specify how Z^{IJ}, σ^I, and ρ^J vary across markets. For instance, if I assume Z^{IJ} to be constant I can estimate σ^I and ρ^J by choosing values $\hat{\sigma}^I$, $\hat{\rho}^J$, and $\hat{Z}^{IJ}$ for σ^I, ρ^J, and Z^{IJ} that minimize the difference between the left and right hand side of equation 8. However, this assumption would not be flexible enough to accommodate differing marriage market conditions. Let m denote the marriage market defined by cohort c, ethnicity e, and region r. To introduce some flexibility in Z^{IJ}, Chiappori et al. (2012) assume the marital surplus for market m is given by

$$Z_m^{IJ} = \zeta_m^I + \xi_m^J + Z^{IJ},$$

where ζ_m^I and ξ_m^J are (education) category-specific drifts that allow the surplus to vary across markets as long as the "degree of complementarity" $(Z^{IJ} - Z^{KJ}) - (Z^{IL} - Z^{KL})$ is the same for all markets.

The degree of complementarity is a key concept in this model. It compares the benefits of marrying someone with a higher education level for two people with different schooling. If the benefit is higher for the person with higher education, it means that an individual's education has

higher returns the higher her partner's education is. Consider the degree of complementarity taking the highest education level (secondary school) as a reference for men ($I = 3$) and women ($J = 3$)

$$D_2 Z^{IJ} \equiv (Z_m^{33} - Z_m^{I3}) - (Z_m^{3J} - Z_m^{IJ}).$$

If $D_2 Z^{IJ} > 0$, the extra surplus generated by marrying a secondary school educated men, instead of a man of education I, is greater for a secondary school educated woman ($Z_m^{33} - Z_m^{I3}$) than for a woman of lower education J ($Z_m^{3J} - Z_m^{IJ}$). Given that a stable equilibrium maximizes the sum of the surpluses z_{ij}, the sign of $D_2 Z^{IJ}$ is directly related to the assortativeness of the match, i.e. whether the matching assignment respects education rankings by gender.

To accommodate for time and regional factors that can influence the complementarity between partners' schooling, I will assume that the degree of complementarity will have time and geographic components. More formally,

$$D_2 Z_m^{IJ} = \phi_c^{IJ} + \theta_r^{IJ}. \tag{9}$$

This assumption provides great flexibility for the estimation of the deterministic components of the marital surplus Z^{IJ}. Unlike Chiappori et al. (2012), the degree of complementarity can change across cohorts.

The next step is to determine how the variance of preferences varies across markets. Different cultural traditions might translate into different degrees of heterogeneity in preferences for specific levels of education, hence I will let the variance parameters be different across ethnicities. Under these assumptions, equation 8 becomes

$$Z_m^{IJ} = \sigma_e^I \ln\left(\frac{s_m^{J|I}}{s_m^{0|I}}\right) + \rho_e^J \ln\left(\frac{s_m^{I|J}}{s_m^{0|J}}\right).$$

Subtracting this expression from the equivalent expression for $J = 3$

$$Z_m^{I3} - Z_m^{IJ} = \sigma_e^I \ln\left(\frac{s_m^{3|I}}{s_m^{J|I}}\right) + \rho_e^3 \ln\left(\frac{s_m^{I|3}}{s_m^{0|3}}\right) - \rho_e^J \ln\left(\frac{s_m^{I|J}}{s_m^{0|J}}\right),$$

and subtracting this expression from the equivalent expression for $I = 3$

$$\phi_c^{IJ} + \theta_r^{IJ} = \sigma_e^3 \ln\left(\frac{s_m^{3|3}}{s_m^{J|3}}\right) - \sigma_e^I \ln\left(\frac{s_m^{3|I}}{s_m^{J|I}}\right) + \rho_e^3 \ln\left(\frac{s_m^{3|3}}{s_m^{I|3}}\right) - \rho_e^J \ln\left(\frac{s_m^{3|J}}{s_m^{I|J}}\right). \tag{10}$$

From equation 10, the parameters ϕ_c^{IJ}, θ_r^{IJ}, σ_e^I, and ρ_e^J can be estimated by minimizing the sum

over all markets of the difference between the left and right hand side of the equation.[13] Once these parameters have been estimated, I can get estimates for U^{IJ} and V^{IJ} by using equations 6 and 7.

2.3 Market clearing

The way men and women sort into marriage depends on the utility they derive from the available options, i.e. U^{IJ} and V^{IJ}. For given values of these utilities, I can compute the number of men (women) that want to marry women (men) in each education category using equations 5 and 4. The "demand" implied by this computations will be equaled to the supply to obtain market clearing conditions for each education category and gender.[14]

Call M^I and F^J the number of men in education group I and the number of women in education group J, respectively. Equation 11 captures the market clearing condition, obtained by equating the demand for and supply of women in group J

$$\sum_K M^K s^{J|K}(U^{K\cdot}) = F^J(1 - s^{0|J}(V^{\cdot J})). \tag{11}$$

Intuitively, the market clears via adjustments in the division of surplus. In this context, you can think of the division of surplus as the price in any other market. For instance, if there is excess demand for educated women, the share of surplus they get to keep will increase, lowering the number of men that want to marry them. The division of surplus reflects the tensions between supply and demand in the marriage market.

To assess the effect of changes in female education on the gains from marriage, I differentiate equation 11 with respect to F^J

$$\sum_K M^K \frac{\partial s^{J|K}}{\partial U^{K\cdot}} \cdot \frac{\partial U^{K\cdot}}{\partial F^J} = (1 - s^{0|J}) - F^J \frac{\partial s^{0|J}}{\partial V^{\cdot J}} \cdot \frac{\partial V^{\cdot J}}{\partial F^J}.$$

Assuming the change in the proportion of women that want to stay single is smaller than the proportion of women who want to marry, I obtain that

$$\sum_K M^K \left[\frac{\partial s^{J|K}}{\partial U^{KJ}} \frac{\partial U^{KJ}}{\partial F^J} + \sum_{L \neq J} \frac{\partial s^{J|K}}{\partial U^{KL}} \frac{\partial U^{KL}}{\partial F^J} \right] > 0. \tag{12}$$

[13] Although in theory we should have a strict equality for equation 10, imperfect marriage market delimitation and sampling error will translate into a difference between the two sides of the equation.

[14] The market clearing condition derived in this section are similar in spirit to the ones Choo and Siow (2006) derive for a similar model. However, the absence of an exogenous shock in their set-up prevents them from testing them empirically.

Remember from equation 4 that $\frac{\partial s^{J|K}}{\partial U^{KJ}} > 0$, as well as $\frac{\partial s^{J|K}}{\partial U^{KL}} < 0$ for all $L \neq J$. Hence, when the number of women in education category J increases, equation 12 implies that the incentives to marry women in group J have to increase ($\frac{\partial U^{KJ}}{\partial F^J} > 0$), and/or incentives to marry other women have to decrease ($\frac{\partial U^{KL}}{\partial F^J} < 0$). Notice though that there are several combinations of effects over the marital gains for which equation 12 holds. Hence, it is an empirical question what the magnitudes of the derivatives are.

Changes in women's education also affect market clearing conditions for the men's side of the market. Just as with equation 11, the demand for men of education I has to be equal to its supply:

$$\sum_L F^L s^{I|L}(V^{\cdot K}) = M^I(1 - s^{0|I}(U^{I\cdot})), \tag{13}$$

differentiating with respect to F^J

$$s^{I|J} + \sum_L F_L \frac{\partial s^{I|L}}{\partial V^{\cdot L}} \frac{\partial V^{\cdot L}}{\partial F_J} = M_I \frac{\partial s^{0|I}}{\partial U^{I\cdot}} \cdot \frac{\partial U^{I\cdot}}{\partial F_J}.$$

Since the proportion of single men is already small, changes in it will be small relative to $s^{I|J}$, hence

$$s^{I|J} + \sum_L F_L \left[\frac{\partial s^{I|L}}{\partial V^{IL}} \frac{\partial V^{IL}}{\partial F_J} + \sum_{K \neq I} \frac{\partial s^{I|L}}{\partial V^{KL}} \frac{\partial V^{KL}}{\partial F_J} \right] \approx 0. \tag{14}$$

Equation 14 shows that the increase in demand for men in I, due to the additional demand from new women in J ($s^{I|J}$ in the equation), has to be compensated by changes in the incentive structure to marry men in I ($\frac{\partial V^{KL}}{\partial F_J}$ in the equation). Given the sign of the derivatives $\frac{\partial s^{I|L}}{\partial V^{IL}}$ and $\frac{\partial s^{I|L}}{\partial V^{KL}}$ from equation 5, changes in incentives can take two forms: first, the utility women perceive from marrying men in I, i.e. V^{IL}, should decrease, or, second, the utility from marrying other men, V^{KL} with $K \neq I$, has to increase. Once again, the specific effect of a change in the women's education distribution is an empirical question that must be addressed empirically.

3 Empirical strategy

There is a vast literature analyzing the importance of the gender composition of the marriage market. These papers (Lafortune (2013), Seitz (2009), Angrist (2002), Abramitzky, Delavande and Vasconcelos (2011), to name a few) analyze the effect of changing sex ratios on the marriage market. However, the effects of composition by education levels have not been widely studied, despite the strong evidence for assortative matching by educational achievement.

The goal of this paper is to explore the relation between the distribution of education and the outcomes of the marriage market. To do so, I will use the INPRES school construction program in Indonesia as a source of exogenous variation in the distribution of education. The definition of multiple marriage markets according to people's location, ethnicity and age will allow me to exploit the variation at the district level in the program's intensity to identify the reduced-form effect on the marriage outcomes introduced by Section 2.

Consistent with the outlined strategy, I will start by estimating the marriage market parameters and outcomes as described in Section 2.2. This procedure will allow me to construct a dataset where each observation corresponds to a market, defined by a combination of district, ethnicity and cohort of birth. Data on the intensity of the program is then attached, which will allow me to examine how marital outcomes change according to the intensity of the INPRES program in particular districts. In particular, I will estimate the reduced-form effect of the program using a difference in differences approach that compares districts with different program intensity, before and after the program:[15]

$$U_{d,e,t}^{IJ} = \alpha_d^{IJ} + \beta_t^{IJ} + (P_d T_t)\gamma^{IJ} + (X_d T_t)\delta^{IJ} + \varepsilon_{d,e,t}^{IJ}, \tag{15}$$

where $U_{d,e,t}^{IJ}$ corresponds to the average utility perceived by a man of education I if he were to marry a woman with education J, in the marriage market defined by district d, ethnicity e, and cohort t; α_d and β_t are district and cohort fixed effects; P_d is the program intensity (schools built per 1,000 children) in district d; T_t is a dummy for whether people are part of the young (treated) cohort; and X_d are control variables that influenced program allocation, i.e. district enrollment and number of children in district d in 1971.

The main identification assumption behind this approach is that, once we control for the variables that influenced program allocation (i.e. enrollment and number of children in 1971), the intensity of the school construction program is not correlated with other factors that might influence the outcomes of the marriage market. If the school construction program affects the marriage market *only* through changes in the distribution of schooling for each gender, the γ^{IJ} coefficients measure changes in men's utility caused by the shifts on the distribution of education generated by INPRES.

The model outlined in Section 2 allows for the distribution of preferences to vary according to the decision-maker's schooling. This heterogeneity in preferences can accommodate the endogeneity of schooling,[16] since people sorting into schooling levels would imply different distribution of preferences

[15] This specification is the district-level equivalent to the one used by Duflo (2001) to assess education changes at the individual level.

[16] Chiappori et al. (2009) describe in detail the theoretical consequences of endogenous schooling choice in the context of this model.

across education groups. While it is entirely reasonable to think that educational decisions are made with an eye towards the effect in the marriage market, I argue that changes in education induced by this school construction program were so large and unprecedented in Indonesia in this time period, that the magnitude of the changes in the marriage market returns was largely unforecastable. Moreover, the effect of the school construction program is probably dominated by the reduction in costs implied by having a closer school, making the additional marriage markets incentives a second order issue. These assumptions mean that I can interpret the γ^{IJ} coefficients from equation 15 as the effect of changes in the schooling distribution over marriage market outcomes.

This paper is part of a nascent stream of the literature that uses structural models of the marriage market to analyze empirically the implications of changes in the conditions under which people match. Chiappori et al. (2012) use their model to explain the evolution of gender gap in college attendance in the US. Brandt, Siow and Vogel (2009) use the model in Choo and Siow (2006) to analyze the effects on the marriage market of the Chinese famine of the end of the 1950s. To my knowledge, my paper is the first that analyzes the effect of changes in the education distribution. Additionally, I estimate the causal effect of changes in the marriage market conditions, unlike the mentioned papers that had a more descriptive approach.

4 Data

As seen in the empirical strategy, the marriage market model will be identified out of the observed "market shares" within each narrowly defined marriage market. Therefore, I require data to measure those shares as accurately as possible, the more people in each ethnicity-region-cohort cell the better. A natural choice given such requirements is the Indonesian Census Data from 2010.[17] This dataset contains information about district of birth, ethnic group, education, and birth year,as required by the empirical strategy. It also has the advantage that the cohorts that need to be compared to identify the effect of INPRES are old enough to consider their marital choices as already made.[18]

4.1 Markets definition

As stated previously, markets will be delimited by three variables: ethnicity, location, and birth year. In this section I will present the characteristics of the dataset in these three dimensions, which

[17] I use the 10% sample available through IPUMS (`http:\international.ipums.org`, Min (2013)).

[18] Previous papers analyzing the long-run effects of INPRES, such as Breierova and Duflo (2004), face some limitations because even the early cohorts benefited by INPRES are not old enough to consider their fertility or marriage cycles to be over.

make Indonesia a well suited context to carry out this study.

Regarding ethnicity, I will work 30 ethnic groups.[19] Traditionally, people tend to marry partners that belong to the same ethnicity, as the high intra-ethnic marriage rates in Figure 1 suggest. However, we also need these ethnic barriers to be stable across time. There are many reasons to think that is the case in Indonesia. First, as Buttenheim and Nobles (2009) and Malhotra (1991) argue, traditional marriage rules seem to persist despite changes on who effectively makes the marriage decisions (individuals vs. parents). Second, the data on the evolution of intra-ethnic marriage rates by cohort, shown in Figure 1, also supports the stability claim.

Regarding geographical divisions, Indonesia had 509 districts in 2010, up from 271 in 1971 when INPRES started. I delimit marriage markets geographically by district of birth, hence I use district classification from 1971. Figure 2 shows that the percentage of people who marry to someone born in the same district is higher than 80% for non-educated and primary educated people, and higher than 60% for secondary school graduates.[20] The same graph shows that the intra-district marriage are very stable across time, hence we do not have to worry about varying market limits.

With respect to age, individuals born before 1955 will not be considered in order to avoid sample selection related to death. On the other side of the age spectrum, the sample will not include anyone born after 1980, since people younger than 30 might still be active in the marriage market.

Even though the original sample contains more than 20 million observations, the number of individuals in each region-ethnicity-cohort cell by gender can get small. Noisy measures of the market shares should be avoided. On top of that, zero market shares are problematic since discrete choice models with error terms distributed extreme-value cannot rationalize such behavior. For these reasons, cohorts are grouped to encompass 5 birth years (e.g. 1970 to 1974) and marriage markets with less than 20 people in any of the education groups are dropped. After this procedure we are left with 1759 marriage markets, defined by combinations of ethnicity, district of birth and birth cohort.

This sample is not representative of all Indonesian marriage markets. The selection criteria imposed by technical aspects of the estimation ignores markets with a reduced number of people. Hence, the results obtained would be informative of what happens in the context of ethnic groups that have an important presence in a given district, across all educational levels, but not of very thin

[19] The census questionnaire actually records more than 900 ethnic groups. However, working with a classification so disaggregated would reduce drastically the number of people belonging to each of group, which in turn would introduce a lot of noise in the measures of market shares. Hence, I use a classification included in the census documentation to create the groups which reduces the number of ethnic groups to 30.

[20] Although the percentage for the higher educated women might seem low, it is immensely higher than the percentage for any other specific district. The matching patterns for that 60% will dictate the way the marriage market works for the whole group.

markets. The selected markets are less likely to suffer from problems due to migration and other ways to mitigate the difficulty to find partners locally.

The estimation of the marriage market parameters through equation 10, requires men and women cohorts to be matched. Figure 3 shows the median age difference between partners for different levels of education, for cohorts from 1955 to 1980. There are two main messages from this graph. First, the median age difference for each cohort is around 5 years. Second, the median, as well as the 25th and 75th percentile are quite stable across time. These two facts imply that matching women cohorts to the 5-year-older men cohort from the corresponding district ethnicity captures well the relevant group of potential partners.

4.2 Descriptive statistics

Before analyzing changes in the education distribution brought by INPRES, it is important to have an idea of what the education distribution looked like before and after the program. I will use three education groups throughout this paper: 1) individuals who did not complete primary school, usually referred to as non-educated, 2) individuals who graduated from primary school but did not finish secondary school, and 3) individuals who graduated from secondary school. Figure 4 shows the distribution between these three groups for the cohorts born in 1955 and 1980. The first of these cohorts was too old to benefit from the program, they were already out of school when the program started. The second one had not started primary school when INPRES was put in practice.

As the graph shows, Indonesia's primary and secondary school completion rates have increased. Men and women have benefited from such improvements, and the gender gap seems to be closing. Section 2 described the theoretical consequences of shifts in education distributions; the hypotheses produced will be tested in Section 5.

It is also important to have an idea of what the matching patterns in Indonesia are. What is the degree of assortative matching? How frequently do people "marry up" or "down"? Are these patterns stable across time? Figure 5 presents the Indonesian female matching patterns across education levels, according to birth cohort. Each panel shows the observed partner choices for the women in the education group specified at the top.

As expected, there is clear evidence of positive assortative matching: women tend to marry partners in the same educational level. However, the degree of assortativeness varies according to the education level. Women who graduated from secondary school seem to marry more within their education group than other women. There have also been important changes with time: the

percentage of women marrying men more educated than them has increased steadily since 1950. These facts seem to indicate that the marriage market can respond to changes in the conditions under which it takes place, such as shifts in the distribution of schooling. Figure 6 shows the matching patterns from the men's perspective. As expected, they follow a similar pattern since this is just the other side of the same market.

It is clear that just from observing the trends in educational distribution and matching patterns it is impossible to establish the relationship between them. The model described in Section 2 helps us to understand the mechanisms operating in the marriage market that connect education distributions to outcomes of the marriage market. Meanwhile, the school construction program provides the necessary exogenous variation to shed some light on what changes in the marriage market can be attributed to changes in education.

5 Results

I will start by presenting the estimated parameters that describe the marriage market, which are the building blocks to construct the measures of surplus and marital shares. I then show how INPRES changed the distribution of education for each gender. Finally, I will describe the impact of the school construction program on marital surplus and the way it is divided. The impact of INPRES on schooling will be instrumental to interpret the effect on the outcomes of the marriage market.

5.1 Estimation of marriage market parameters

The first step is to estimate the marriage market parameters from equation 10. I stack the observations for all markets and combinations of (I, J) to run one regression, allowing the coefficients to vary according to the corresponding education groups. The first set of estimates, included in Table 10 in Appendix A, correspond to the ethnicity-specific variance of the heterogeneity in preferences over partner's education. Even though these coefficients are not restricted to be positive, most of them are, consistent with them being measures of variance. Also, there is some variation across ethnicities, which highlights the importance of letting these parameters take different values according to this variable.

The other set of parameters estimated from equation 9 describe the complementarity -in terms of the marital surplus- of education levels ($D_2 Z^{IJ}$ in equation 9). The highest complementarity ($Z^{33} - Z^{31} - Z^{13} + Z^{11}$) is normalized to one, hence the complementarity measures for other combinations of schooling will be lower than one. Additionally, the estimates for $D_2 Z^{IJ}$ are always positive, hence

education levels are actually complements. This result is consistent with the evidence in favor of assortative matching.[21]

From these estimates, I can estimate the utilities U^{IJ} and V^{IJ} that individuals perceive from a match (I, J) by using equations 6 and 7. To illustrate what this process does, I will use the marriage market for Sunda people born in Bandung as an example. Figure 7 shows the matching patterns across time for this market for men and women. As was the case for Indonesia as a whole, there is evidence of assortative matching, although there have been some changes across time in the matching patterns. The percentage of same-education marriages have decreased. Non-educated people and primary school educated people marry more secondary school graduates than they used to. The percentage of single people seems also to be on the rise.

The estimates for U^{IJ} and V^{IJ} are plotted in Figure 8. Remember these utility levels represent how people divide the surplus, which is the extra utility compared to being single. There is an increase in single people for all educational levels, hence utility gains from marriage decrease with time. The higher assortativeness of secondary school educated people is reflected on the graph by a higher gap between utilities from different option for secondary school graduates. The increasing percentage of primary school educated people matching to a secondary school educated partner, in detriment of a primary school educated one, means that the utilities they get from these options are getting closer to each other, as the graphs show.

As can be seen from this example, U^{IJ} and V^{IJ} contain much information about the situation in the marriage market. These quantities also have the advantage of describing the available options for each person entering the market, allowing a more structural analysis of changes in the conditions under which the matching process occurs.

5.2 Impact on distribution of education

Before introducing the results regarding marriage market outcomes, I will present the impact INPRES had on the schooling distribution for each gender. Since this is the mechanism through which the school construction program affects the marriage market, these results must be kept in mind when interpreting the results which follow.

I will use a specification similar to the one described in Section 3 to measure the effects of INPRES on education (see equation 15). Identification comes from the comparison between an old cohort not benefited by the program (control group) and a young cohort for which schools were already built when they reached school age (treatment group). I estimate the following equation for

[21] Given the large number of districts involved, the estimated values for $D_2 Z^{IJ}$ are not included in the paper.

each education level l

$$Y^l_{d,e,t} = \alpha_d + \beta_t + (P_d T_t)\gamma + (X_d T_t)\delta + \varepsilon_{d,e,t}, \tag{16}$$

where $Y^l_{d,e,t}$ corresponds to the percentage of people from district d, ethnicity e, born in year t, that belong to education group l; α_d and β_t are district and cohort fixed effects; P_d is the program intensity (schools built per 1,000 children) in district d; T_t is a dummy for whether people are part of the young (treated) cohort; and X_d are control variables that influenced program allocation, i.e. district enrollment and number of children in district d in 1971.

Tables 1 and 2 report estimates for the γ coefficient from equation 16 for the three education groups considered: non-educated, primary school, and secondary school. For women, Table 1 shows that for each additional school built per thousand children in the district, the percentage of non-educated people decreases around 3 percentage points, while the corresponding percentage for primary school increases by 5 percentage points. These results were expected given the characteristics of the program; INPRES is helping children to complete primary school.

The new schools, however, do not seem to be increasing the percentage of women that graduate from secondary school. On the contrary, the percentage of women in this group goes down with INPRES. Although it is hard to explain such a result, it might be due to reallocation of resources within districts or changes in the dynamics of secondary schools caused by the new primary school graduates. Further investigation is needed to fully explain this result.[22]

Table 2 reports the results for men. As was the case for women, INPRES moves men from no education to primary school, however the effect is about half the size. As a consequence, the education gender gap is reduced and the composition of the marriage market in terms of education is altered. The effect on secondary school is positive but insignificant.

In general, we can characterize the INPRES school construction program as a policy which increased the population that completed primary school, but did not increase secondary school completion rates. The increase was higher for women, so the impact of the program was to generate relatively more primary school girls.

5.3 Impact on marriage market outcomes

The next question is how the changes in education distribution induced by INPRES affected the outcomes of the marriage market. In particular, I am interested in how the utility that men and women get from marriage change with the school construction program. I will start by computing

[22] Duflo (2001) finds a result in a similar direction for men.

the effect of INPRES on the utility levels U^{IJ} and V^{IJ} for each combination of education levels (I, J). Consistent with the specification in the the empirical strategy section, I will estimate the following equation for each pair (I, J)

$$U^{IJ}_{d,e,t} = \alpha^{IJ}_d + \beta^{IJ}_t + (P_d T_t)\gamma^{IJ} + (X_d T_t)\delta^{IJ} + \varepsilon^{IJ}_{d,e,t}, \tag{17}$$

where $U^{IJ}_{d,e,t}$ corresponds to the average utility perceived by a man of education I if he were to marry a woman with education J, and the other variables are defined as in equation 16.

Table 3 reports the coefficients γ_{IJ}, which measure the effect of each school per thousand children built in a district. Panels summarize the results by men's education level (I), while columns correspond to each women's schooling level (J). For instance, the utility non-educated men will get from marrying a non-educated women will increase by 0.0034 for each school (per 1,000 children) built. To give an idea of the magnitude of the effects, the header for each panel in Table 3 reports the average over ethnic groups of the preferences variance parameter σ^I.

As predicted by the model, the utility men get when marrying a primary school educated woman increases due to INPRES, as the coefficients in the second column of each panel show. Higher levels of utility for husbands are necessary to increase their demand for primary school graduates, compensating this way the new supply of this type of women to equilibrate the market.

Secondary school educated men also see their utility levels rise, as evidenced by the coefficients in the third panel. According to the framework presented in Section 2.3, this result is explained by an increase in demand for men in this category, brought about by an increase in primary school educated women, who have a higher preference for this type than non-educated women. This increase in demand is not compensated by an increase in the supply of male secondary school graduates, since the school construction program did not have a significant effect on the share of men in this group.

In a similar fashion, I compute the effect on women's utility by estimating regressions of the form

$$V^{IJ}_{d,e,t} = \alpha^{IJ}_d + \beta^{IJ}_t + (P_d T_t)\gamma^{IJ} + (X_d T_t)\delta^{IJ} + \varepsilon^{IJ}_{d,e,t}$$

for each combination (I, J). Table 4 summarizes the results. The average over ethnic groups of the preferences variance parameter ρ^J is reported in the header of each panel for comparison purposes. In this case, non-educated women seem to be the group that benefits the most. The reduction in the supply of women in this education level creates an excess demand which will force their "price" up.

Estimating structural parameters has the advantage that parameters can be used to produce other measures of welfare. Remember that U^{IJ} represents the average utility men of education I get if they are "forced" to marry a woman of education J. However, individuals in this model can choose their partners, so they will choose optimally who they marry. Therefore, the *unconditional* utility $\bar{u}^I$ obtained by a man in education group I is given by the maximum utility he can get from his potential partners, including his idiosyncratic preferences α_i^{IJ}. Hence,

$$\bar{u}^I = \underset{i \in I}{E}[\max_K \{U^{IK} + \sigma^I \alpha_i^{IK}\}]$$

Given the assumptions about the distribution of α_i^{IK}, this utility can be expressed as

$$\bar{u}^I = -\sigma^I \ln s^{0|I}$$

This measure reflects the final utility people get, taking into account that men that end up marrying women in J might prefer women in this group more strongly than other men. Table 5 shows how the intensity of INPRES affects $\bar{u}^I$, using a specification equivalent to equation 15. The unconditional utility of secondary school educated men increases as a consequence of higher conditional utilities but also because there are more primary educated women now that they can marry.

Similarly, the average unconditional utility for women of education J is given by

$$\bar{v}^J = \underset{j \in J}{E}[\max_K \{V^{KJ} + \rho^J \beta_j^{KJ}\}] \tag{18}$$

$$= -\rho^J \ln s^{0|J}. \tag{19}$$

Table 6 shows the effect of the school construction program on the unconditional utility for women, for each education level. Although primary and secondary school educated women seem to be worse off in areas were more schools were built, the effect is not significant.

Changes in the utilities for different education levels might alter the incentives to pursue primary and secondary school in the future. Based on the unconditional utilities that I have already computed, the marital returns to education can be defined as the gains from "jumping" to the next education level. Hence, the return to primary school for men can be measured as

$$R_P^M = \bar{u}^1 - \bar{u}^0,$$

while for secondary school we have

$$R_S^M = \bar{u}^2 - \bar{u}^1.$$

Equivalently, we can define the returns for women as

$$R_P^F = \bar{v}^1 - \bar{v}^0, \qquad R_S^F = \bar{v}^2 - \bar{v}^1.$$

Table 7 shows the estimates for the effect of INPRES on all these measures. The first column shows that returns to finishing primary school decrease for women. Since primary school educated women are increasing in number, while uneducated women are decreasing, the return they get in the marriage market decreases.

I can also compute the average surplus for married couples with education I and J: $E[z_{ij}|(i,j) \in \Omega]$, where $\Omega = \{(i,j) : i \text{ is married to } j\}$. From Proposition 1,

$$\begin{aligned} E[z_{ij}|(i,j) \in \Omega] &= E[Z^{IJ} + \sigma^I \alpha_i^{IJ} + \rho^J \beta_j^{IJ} | (i,j) \in \Omega] \\ &= \underset{i \in I}{E}[U^{IJ} + \sigma^I \alpha_i^{IJ} | argmax_K\{U^{IK} + \sigma^I \alpha_i^{IK}\} = J] + \\ &\quad \underset{j \in J}{E}[\{V^{KJ} + \rho^J \beta_j^{KJ} | argmax_K\{V^{KJ} + \rho^J \beta_j^{KJ} = I\}], \end{aligned}$$

which given the assumptions on the error distribution turns into[23]

$$E[z_{ij}|(i,j) \in \Omega] = \bar{u}^I + \bar{v}^J.$$

Hence, the share of the surplus that goes to the wife is given by

$$\frac{\bar{v}^J}{\bar{u}^I + \bar{v}^J}.$$

The effect of the school construction program on these shares is summarized by Table 8. Non-educated wives see their share increase by INPRES, consistent with the results for conditional utilities. Their share of the surplus that they get when they marry primary or secondary school educated men increases by 1.5% for each school built (per 1,000 kids in the district). On the other hand, the share of the surplus that secondary school women get when marrying uneducated men decreases 1% for each school built.

[23] See Chiappori et al. (2012), page 42.

6 Robustness checks

There are other ways in which marriage markets can adjust to changing conditions, such as the shift in education studied here. People can look for partners in other districts, marry younger (or older) partners, or adjust dowries and/or bride prices. In this section I will present some evidence that Indonesian marriage markets are not adjusting in these dimensions in response to INPRES.

A commonly cited way in which markets can adjust is by changes in the age gap between partners (Sautmann (2011), Foster and Khan (2000)). Figure 3 in Section 4.1 shows that age gaps do not seem to change across time on average. Did INPRES affect age gaps in the districts in which it was intensively implemented? To address this issue, I estimate the effect of the school construction program on the age difference between the members of a couple, using the same methodology used to measure the effect on the marriage market outcomes (see equation 15 in Section 3), albeit at the individual level. The first column of Table 9 shows the results of this exercise. The coefficient is small in size and not significant, hence there is no evidence that people marry older or younger parters in response to the changes in the education distribution.

Another possibility is that school construction made migration easier because skilled-labor markets are less local. If this is the case, the partners considered by an individual in a district where many schools were built would be more spread out. The second column of Table 9 shows the effect of INPRES on whether an individual lives in the same district he or she was born. The effect is not significant, providing no support for the hypothesis that the relevant marriage market geographical limits depend on the intensity of the educational intervention.

Education can also change people's opinion about inter-ethnic marriages, especially if public education puts together in a classroom individuals from different ethnic groups. Column 3 of Table 9 presents the impact of each additional school built (per thousand children) on whether the members of a couple belong to the same ethnicity. Despite the considerable sample size, the coefficient on the program intensity is not significant at the 5% level. Its size can be considered very small, hence the program is not altering this characteristic of the marriage market. Ethnicity barriers are the same for low and high construction areas.

7 Conclusions

Education is a key concern for policy makers in developing countries. In the context of the Millennium Development Goals, many countries are trying to push a big portion of their inhabitants into

higher schooling levels. Changes of such magnitude are expected to have equilibrium effects that affect the returns people get from pursuing higher education, hence it is important to measure how those large shifts affect the returns to schooling.

Although most of the literature on returns to schooling focuses on the labor market returns, economists have begun to examine the importance of returns in the marriage market. In this context the task at hand presents many challenges. This paper adapts the model by Chiappori et al. (2012) to measure this dimension of the returns, to then study how these returns change when a big educational shift occurs.

Large interventions that alter the educational distribution have equilibrium effects on the market and non-market returns to education. Analyses which ignore these effects can miss important dimensions of the welfare changes caused by the policy. In the case of the Indonesian school construction program, the primary beneficiaries - the women who achieved a primary education as a consequence of the program - experienced a decline in the returns they captured in the marriage market, while non-educated women benefited from increased marital returns.

The findings of this paper lay a foundation for future studies of how changes in bargaining power affect other household decisions. Time and resources invested in children's health and education depend heavily on the division of power within the household. Thus, this paper constitutes a first step toward understanding how educational transitions around the world affect the intergenerational transmission of human capital. Furthermore, this study contributes insights that will advance future research on how changes in women's empowerment within the household impact fertility and labor participation decisions.

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Figure 1: Marriages within the same ethnicity, by wife's education

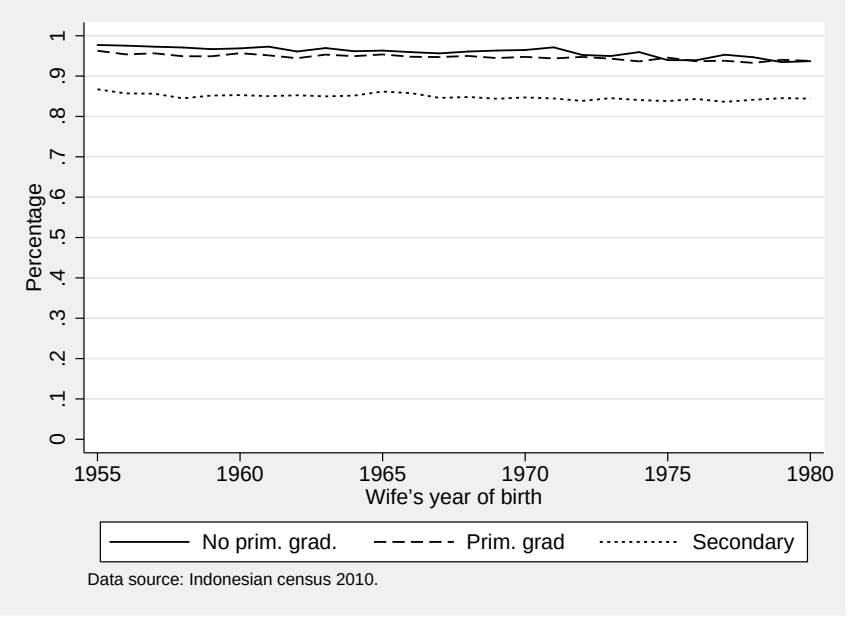


Figure 2: Marriages within the same district, by wife's education

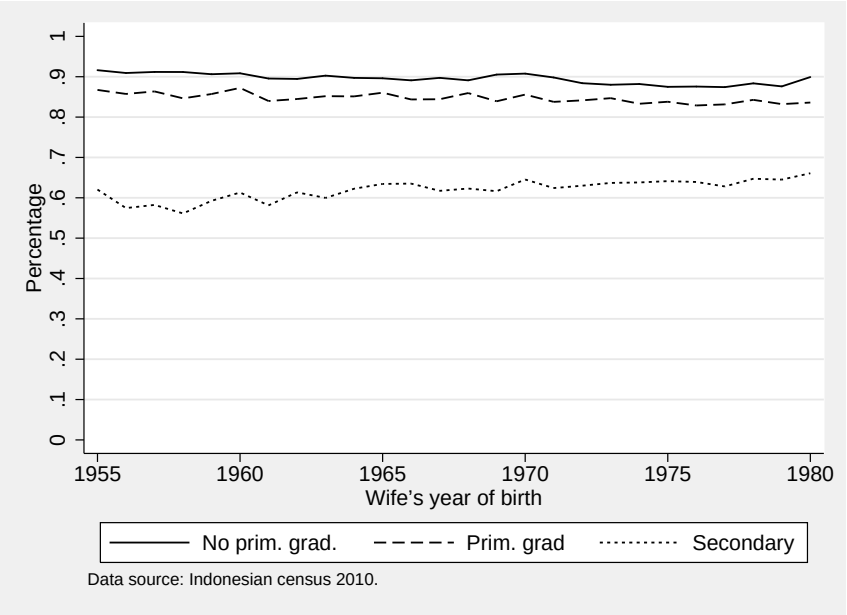


Figure 3: Spouses age difference (by wife's education)

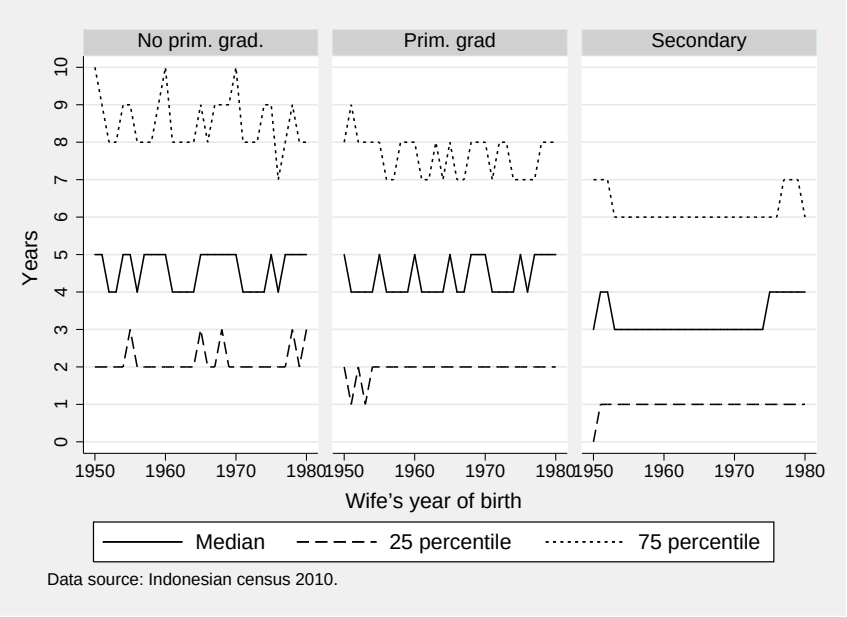


Figure 4: Completed education by cohort

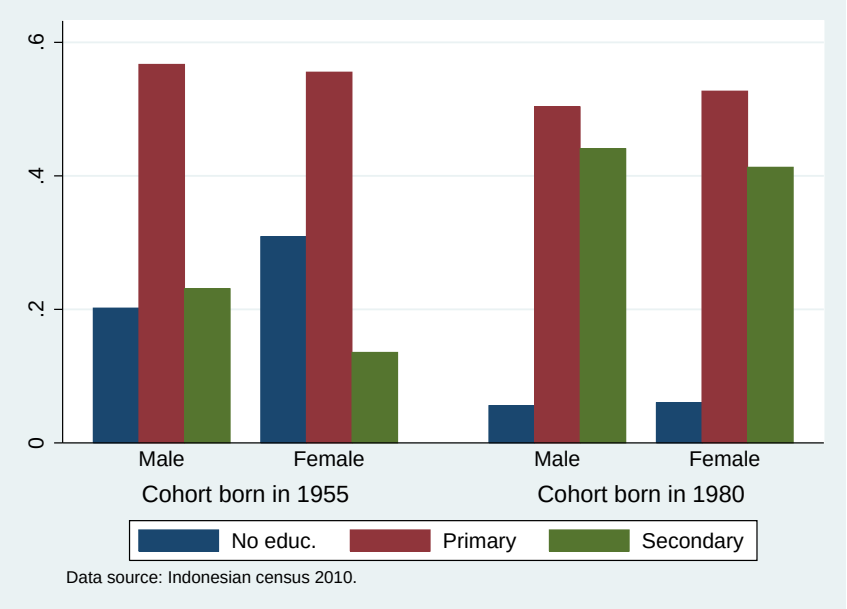
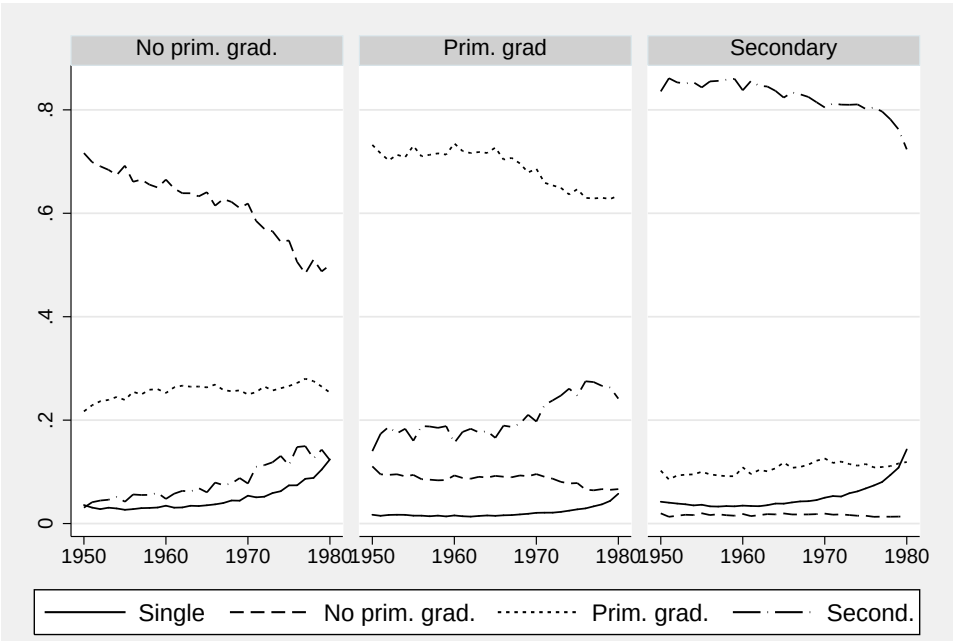
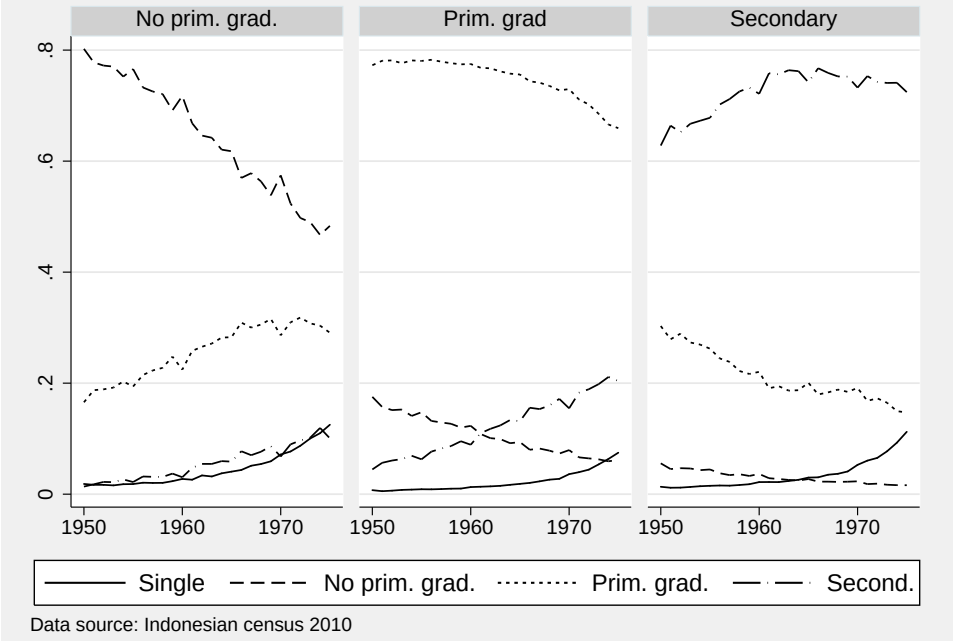


Figure 5: Female matching patterns



Data source: Indonesian census 2010

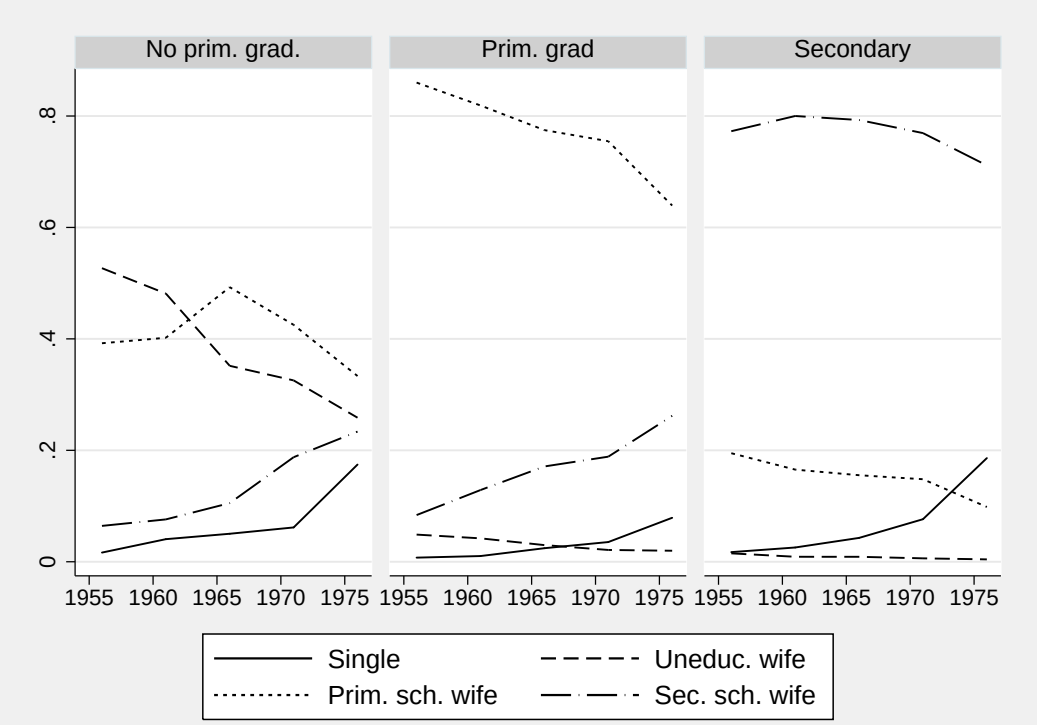
Figure 6: Male matching patterns



Data source: Indonesian census 2010

Figure 7: Matching patterns - Sunda people from Bandung

(a) Men (by education level)



(b) Women (by education level)

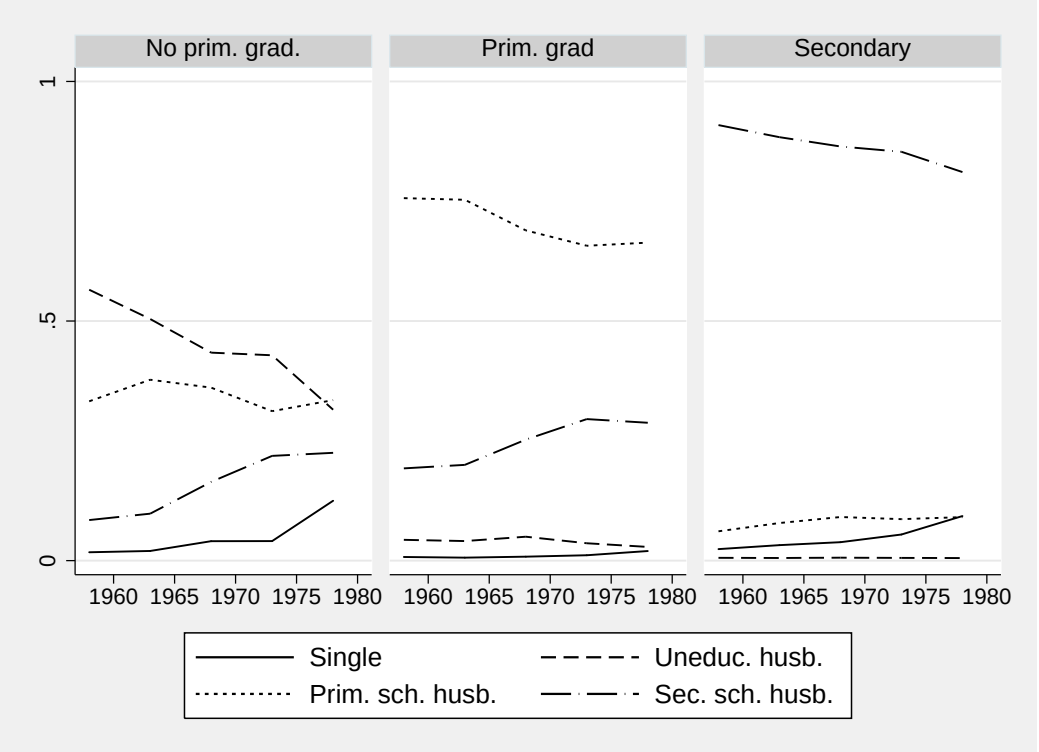
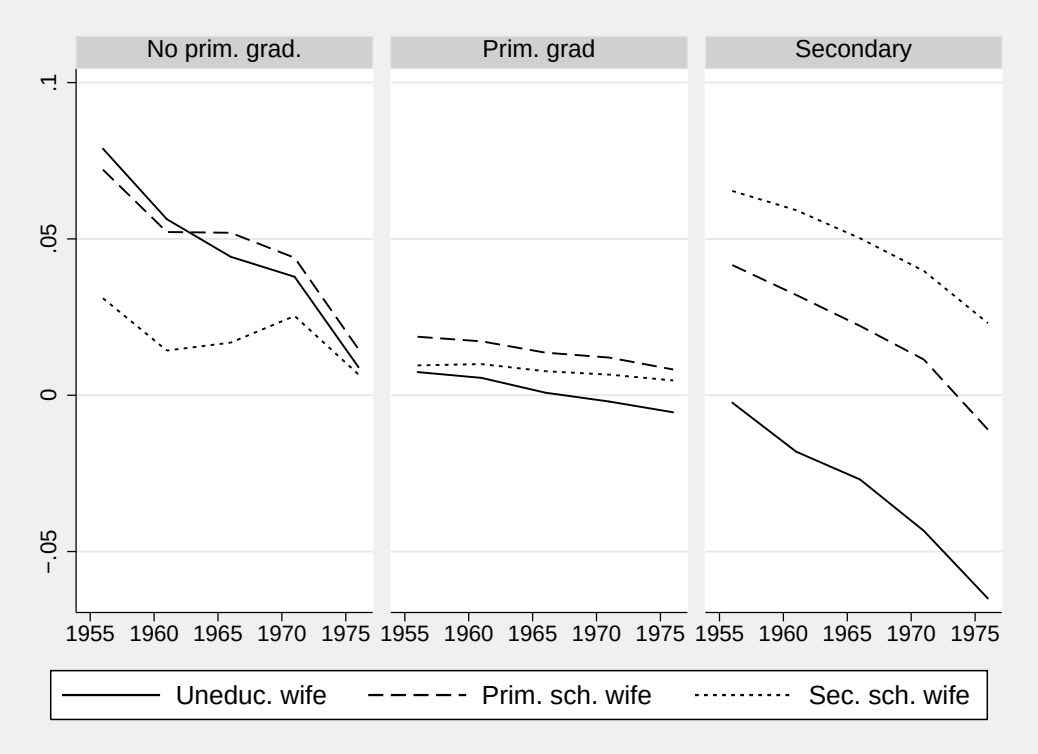


Figure 8: Utility from marriage - Sunda people from Bandung

(a) Husband's utility - U^{IJ}



(b) Wife's utility - V^{IJ}

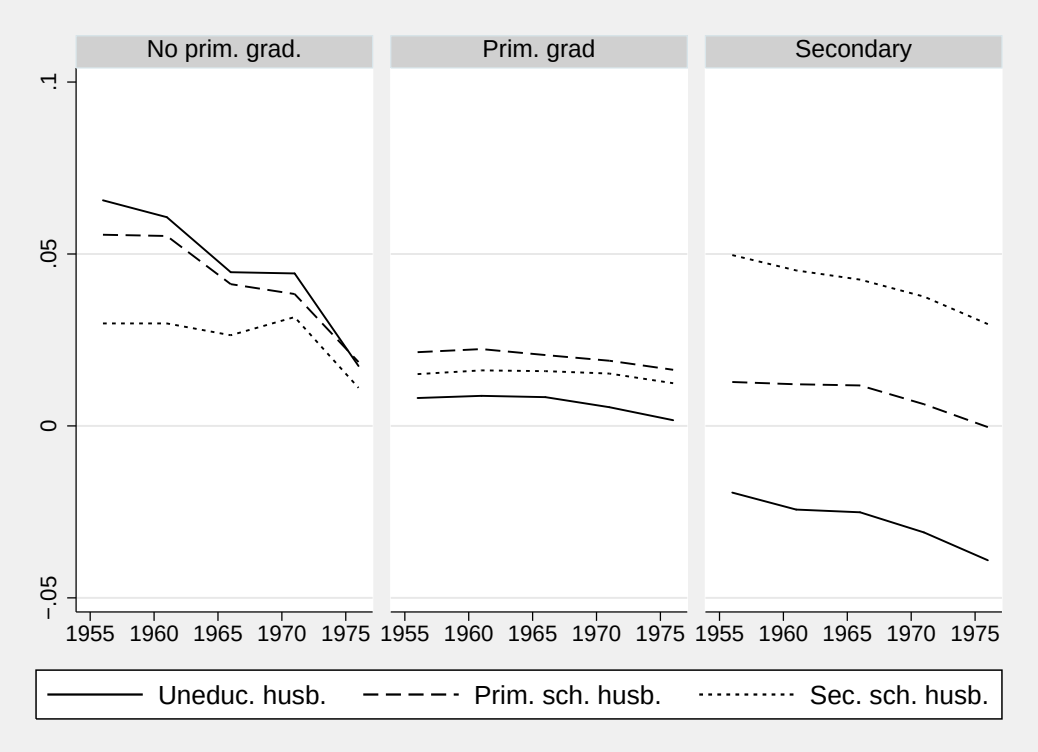


Table 1: Dif. in dif. estimates of INPRES effect on women's education distribution

	Perc. women in each educ. level		
	No educ.	Primary	Second.
Schools built (per 1,000 children) x Young cohort	-0.033***	0.050***	-0.017***
	(0.003)	(0.004)	(0.003)
Ethnicity-district FE	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes
Observations	1456	1456	1456
R square	0.955	0.917	0.974

Each observation corresponds to a marriage market, which are delimited by ethnicity, district of birth, and birth cohort. All regressions control for the intensity of the program and its interaction with the district's enrolment rate and number of children for 1971.

Coefficients estimated by OLS, standard errors in parentheses. *: significant at 5%, **: significant at 1%, ***: significant at 0.5%.

Table 2: Dif. in dif. estimates of INPRES effect on men's education distribution

	Perc. men in each educ. level		
	No educ.	Primary	Second.
Schools built (per 1,000 children) x Young cohort	-0.029***	0.025***	0.004
	(0.002)	(0.003)	(0.003)
Ethnicity-district FE	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes
Observations	1462	1462	1462
R square	0.951	0.940	0.978

Each observation corresponds to a marriage market, which are delimited by ethnicity, district of birth, and birth cohort. All regressions control for the intensity of the program and its interaction with the district's enrolment rate and number of children for 1971.

Coefficients estimated by OLS, standard errors in parentheses. *: significant at 5%, **: significant at 1%, ***: significant at 0.5%.

Table 3: Dif. in dif. estimates of INPRES effect on husband's utility

Panel A: Non-educated men ($\bar{\sigma}^I = 0.0450$)			
	Wife's schooling		
	No educ.	Primary	Secondary
Schools built x young cohort	0.0034	0.0077**	0.0007
	(0.0033)	(0.0029)	(0.0035)
Obs.	680	680	647
Panel B: Primary school educated men ($\bar{\sigma}^I = 0.0141$)			
	Wife's schooling		
	No educ.	Primary	Secondary
Schools built x young cohort	0.0036*	0.0029*	0.0010
	(0.0016)	(0.0013)	(0.0011)
Obs.	689	689	689
Panel C: Secondary school educated men ($\bar{\sigma}^I = 0.0225$)			
	Wife's schooling		
	No educ.	Primary	Secondary
Schools built x young cohort	0.0125***	0.0093***	0.0047*
	(0.0034)	(0.0026)	(0.0021)
Obs.	686	695	695

Dependent variable: Utility from marriage corresponding to the husband (U^{IJ}), given both partners educational levels. Each observation corresponds to a marriage market, which are delimited by ethnicity, district of birth, and birth cohort. All regressions control for the intensity of the program and its interaction with the district's enrolment rate and number of children for 1971. Fixed effects for ethnicity-district and for cohort are included in all regressions.
Coefficients estimated by OLS, standard errors in parentheses. *: significant at 5%, **: significant at 1%, ***: significant at 0.5%.

Table 4: Dif. in dif. estimates of INPRES effect on wife's utility

Panel A: Non-educated women ($\bar{\rho}^J = 0.0370$)			
	Husband's schooling		
	No educ.	Primary	Secondary
Schools built x young cohort	0.0038 (0.0021)	0.0063** (0.0021)	0.0055** (0.0020)
Obs.	723	723	715
Panel B: Primary school educated women ($\bar{\rho}^J = 0.0152$)			
	Husband's schooling		
	No educ.	Primary	Secondary
Schools built x young cohort	-0.0002 (0.0009)	-0.0005 (0.0008)	-0.0001 (0.0007)
Obs.	711	712	712
Panel C: Secondary school educated women ($\bar{\rho}^J = 0.0213$)			
	Husband's schooling		
	No educ.	Primary	Secondary
Schools built x young cohort	-0.0002 (0.0022)	0.0027 (0.0014)	-0.0005 (0.0012)
Obs.	710	745	745

Dependent variable: Utility from marriage corresponding to the wife (V^{IJ}), given both partners educational levels. Each observation corresponds to a marriage market, which are delimited by ethnicity, district of birth, and birth cohort. All regressions control for the intensity of the program and its interaction with the district's enrolment rate and number of children for 1971. Fixed effects for ethnicity-district and for cohort are included in all regressions.
Coefficients estimated by OLS, standard errors in parentheses. *: significant at 5%, **: significant at 1%, ***: significant at 0.5%.

Table 5: Dif. in dif. estimates of INPRES effect on unconditional men's utility

	Education level		
	No educ.	Primary	Second.
Schools built (per 1,000 children) x Young cohort	0.000	0.002	0.005*
	(0.003)	(0.001)	(0.002)
Ethnicity-district FE	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes
Observations	680	689	695
R square	0.956	0.958	0.984

Each observation corresponds to a marriage market, which are delimited by ethnicity, district of birth, and birth cohort. All regressions control for the intensity of the program and its interaction with the district's enrolment rate and number of children for 1971.

Coefficients estimated by OLS, standard errors in parentheses. *: significant at 5%, **: significant at 1%, ***: significant at 0.5%.

Table 6: Dif. in dif. estimates of INPRES effect on unconditional women's utility

	Education level		
	No educ.	Primary	Second.
Schools built (per 1,000 children) x Young cohort	0.003	-0.000	-0.000
	(0.002)	(0.001)	(0.001)
Ethnicity-district FE	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes
Observations	723	712	745
R square	0.968	0.986	0.984

Each observation corresponds to a marriage market, which are delimited by ethnicity, district of birth, and birth cohort. All regressions control for the intensity of the program and its interaction with the district's enrolment rate and number of children for 1971.

Coefficients estimated by OLS, standard errors in parentheses. *: significant at 5%, **: significant at 1%, ***: significant at 0.5%.

Table 7: Dif. in dif. estimates of INPRES effect on marital returns to education

	Women		Men	
	Primary	Second.	Primary	Second.
Schools built (per 1,000 children) x Young cohort	-0.006*	0.000	-0.002	0.002
	(0.002)	(0.001)	(0.004)	(0.002)
Ethnicity-district FE	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes
Observations	687	702	627	672
R square	0.965	0.985	0.940	0.974

Dependent variable: Returns to education in the marriage market, for the gender and level specified in each column. Each observation corresponds to a marriage market, which are delimited by ethnicity, district of birth, and birth cohort. All regressions control for the intensity of the program and its interaction with the district's enrolment rate and number of children for 1971.

Coefficients estimated by OLS, standard errors in parentheses. *: significant at 5%, **: significant at 1%, ***: significant at 0.5%.

Table 8: Dif. in dif. estimates of INPRES effect on female share of surplus

Panel A: Non-educated women			
	Husband's schooling		
	No educ.	Primary	Secondary
Schools built x young cohort	0.0052	0.0125***	0.0146***
	(0.0034)	(0.0032)	(0.0041)
Obs.	665	652	595
Panel B: Primary school educated women			
	Husband's schooling		
	No educ.	Primary	Secondary
Schools built x young cohort	-0.0027	0.0025	0.0039
	(0.0026)	(0.0028)	(0.0026)
Obs.	621	622	568
Panel C: Secondary school educated women			
	Husband's schooling		
	No educ.	Primary	Secondary
Schools built x young cohort	-0.0104**	-0.0045	-0.0038
	(0.0037)	(0.0033)	(0.0029)
Obs.	613	612	607

Dependent variable: Percentage of the gains for marriage corresponding to the wife, given both partners educational levels. Each observation corresponds to a marriage market, which are delimited by ethnicity, district of birth, and birth cohort. All regressions control for the intensity of the program and its interaction with the district's enrolment rate and number of children for 1971. Fixed effects for ethnicity-district and for cohort are included in all regressions.
Coefficients estimated by OLS, standard errors in parentheses. *: significant at 5%, **: significant at 1%, ***: significant at 0.5%.

Table 9: Robustness checks

	Couple age diff.	Migration	Couple same ethn.
Schools built (per 1,000 children) x Young cohort	0.010	0.002	0.004
	(0.037)	(0.002)	(0.002)
District FE	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes
Observations	114,101	282,176	112,700
R square	0.024	0.106	0.096

For columns 1 and 3, each observation corresponds to a couple. For column 2, each observations corresponds to an individual. All regressions control for the intensity of the program and its interaction with the district's enrolment rate and number of children for 1971.

Coefficients estimated by OLS, standard errors in parentheses. *: significant at 5%, **: significant at 1%, ***: significant at 0.5%.

A Variance of preferences by ethnicity

Table 10: Variance of preferences by ethnicity

	Men			Women		
	No Educ.	Prim. School	Sec. School	No Educ.	Prim. School	Sec. School
Bali	0.032	0.006	-0.003	0.023	0.008	-0.010
	(0.009)	(0.007)	(0.012)	(0.012)	(0.011)	(0.012)
Banjar	0.040	0.014	0.029	0.036	0.020	0.021
	(0.007)	(0.008)	(0.008)	(0.009)	(0.011)	(0.007)
Batak	0.053	-0.004	0.028	0.047	0.039	0.055
	(0.011)	(0.011)	(0.010)	(0.016)	(0.012)	(0.010)
Betawi	0.103	0.049	0.080	0.065	0.006	0.036
	(0.008)	(0.009)	(0.007)	(0.009)	(0.011)	(0.007)
Bugis	0.047	0.012	0.012	0.041	0.019	0.022
	(0.007)	(0.008)	(0.006)	(0.009)	(0.010)	(0.007)
Cirebon	0.039	0.019	0.070	0.055	0.009	0.094
	(0.013)	(0.011)	(0.013)	(0.014)	(0.012)	(0.013)
Dayak	0.045	0.025	0.033	0.032	0.010	0.019
	(0.007)	(0.008)	(0.007)	(0.008)	(0.012)	(0.006)
Gorontalo	0.022	0.032	-0.003	0.048	0.005	-0.031
	(0.013)	(0.025)	(0.013)	(0.012)	(0.018)	(0.017)
International	0.051	0.025	0.048	0.020	-0.013	0.018
	(0.018)	(0.023)	(0.020)	(0.021)	(0.025)	(0.018)
Jawa	0.053	0.027	0.065	0.046	0.014	0.038
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)
Madura	0.052	0.022	0.054	0.051	0.055	0.036
	(0.004)	(0.005)	(0.004)	(0.005)	(0.007)	(0.004)
Makassar	0.046	0.014	0.018	0.030	0.014	0.017
	(0.008)	(0.009)	(0.008)	(0.011)	(0.014)	(0.007)
Melayu	0.043	0.003	0.029	0.036	0.032	0.033
	(0.007)	(0.006)	(0.006)	(0.007)	(0.008)	(0.005)
Minahasa	0.051	0.011	0.002	0.027	0.004	-0.021
	(0.048)	(0.060)	(0.054)	(0.050)	(0.052)	(0.064)
Minangkabau	0.033	0.003	-0.008	0.020	0.008	-0.015
	(0.010)	(0.012)	(0.011)	(0.010)	(0.011)	(0.011)
Nias	0.045	0.003	-0.039	0.020	0.012	0.011
	(0.010)	(0.012)	(0.021)	(0.022)	(0.037)	(0.011)
Sasak	0.014	-0.007	-0.031	0.041	0.018	0.000
	(0.010)	(0.010)	(0.013)	(0.014)	(0.021)	(0.009)
Other Nusa Teng. Barat	0.033	0.002	-0.018	0.027	0.010	0.002
	(0.016)	(0.012)	(0.021)	(0.020)	(0.024)	(0.016)
Other Aceh	0.047	0.018	0.030	0.032	0.025	0.034
	(0.013)	(0.014)	(0.011)	(0.011)	(0.012)	(0.010)
Other Banten	0.058	0.019	0.066	0.057	0.046	0.070
	(0.007)	(0.009)	(0.008)	(0.009)	(0.010)	(0.008)
Other Jambi	0.044	0.005	0.023	0.043	0.015	0.027
	(0.018)	(0.014)	(0.012)	(0.018)	(0.019)	(0.012)
Other Kalimantan	0.048	0.018	0.023	0.022	0.007	0.022
	(0.011)	(0.011)	(0.009)	(0.014)	(0.017)	(0.007)

	Men			Women		
	No Educ.	Prim. School	Sec. School	No Educ.	Prim. School	Sec. School
Other Lampung	0.046	0.006	0.050	0.044	0.018	0.040
	(0.031)	(0.022)	(0.018)	(0.019)	(0.026)	(0.018)
Other Maluku	0.044	0.016	0.001	0.017	0.004	0.020
	(0.031)	(0.020)	(0.017)	(0.028)	(0.031)	(0.018)
Other Nusa Teng. Timur	0.035	0.011	-0.004	0.026	0.014	-0.001
	(0.008)	(0.007)	(0.008)	(0.009)	(0.013)	(0.006)
Other Papua	0.011	0.006	-0.024	0.057	0.005	-0.017
	(0.012)	(0.018)	(0.016)	(0.017)	(0.033)	(0.008)
Other Sulawesi	0.046	-0.016	-0.008	0.018	0.013	0.013
	(0.006)	(0.007)	(0.007)	(0.007)	(0.010)	(0.006)
Other Sumatera Selatan	-0.048	0.018	-0.039	0.034	0.007	0.032
	(0.007)	(0.008)	(0.006)	(0.009)	(0.011)	(0.006)
Other Sumatera	0.053	-0.019	-0.033	0.035	0.017	0.019
	(0.011)	(0.010)	(0.011)	(0.012)	(0.017)	(0.008)
Sunda	0.068	0.015	0.074	0.063	0.017	0.066
	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)

Coefficients' standard errors in parentheses. Number of observations: 6,770, $R^2 > 0.99$.