The Effects of Spousal Education on Individual Earnings – A Study of Married Swedish Couples

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Abstract

A positive association between spousal education and individual earnings is a common empirical finding (e.g., Benham, 1974 and Rossetti and Tanda, 2000). The two most common explanations for this are sample selection and cross-productivity effects. Can spouses really benefit from each other's human capital in the labour market, or does the entire association stem from assortative mating? In this study, we control for time-invariant heterogeneity that may be correlated with the spouse's education level and use a rich data set that includes observations of individuals when they are single and when they are married. The results support the cross-productivity hypothesis for both males and females. Furthermore, couples with education within the same field experience even larger effects.

Keywords: Marriage, Education, Human capital spillover.

JEL Classification: J12, J24, I21

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1 Introduction

A well-known finding in empirical labour economics is that married men enjoy higher earnings than do unmarried men (Ribar, 2004). For women, the effect of marriage on earnings is not as clear; e.g., Korenman and Neumark (1992) find negative effects of marriage on female earnings, but Waldfogel (1997) and others find positive effects. Another common finding is that an individual's earnings are positively correlated with his/her spouse's education level (for instance, Benham, 1974 or Tiefenthaler, 1997). This positive correlation may stem from marital matching - i.e., men/women who are more productive, all other things being equal, marry women/men with more education. Whether this correlation is due to selection into marriage or is an outcome of married life remains unresolved. In this paper, we will study if and how individual earnings are affected by the educational level and educational field of the spouse. Using longitudinal data including observations of individuals before and after becoming married, we estimate the within-marriage interaction effect while controlling for the influence of marital matching.

In the literature on the relationship between spousal education and individual earnings, a majority of the studies only analyse the effect of the wife's education on the husband's earnings. Benham (1974) estimates an ordinary least squares Mincer (1974) wage model and finds that each additional school year for the female increases her husband's earnings by 3-4 percent. Using more recent data, Jepsen (2005) estimates a model similar to Benham's but includes more controls; however, she also finds a positive association between the wife's educational level and her husband's earnings. For Iran, Scully (1979) finds similar results; each school year completed by the wife raises her husband's earnings by 4 percent. Neuman and Ziderman (1992), using Israeli data from the 1970s, find that if the wife has graduated from high school, her

husband's earnings increase by 9 percent. The relationship between a woman's earnings and her husband's education has not been studied to the same extent. Tiefenthaler (1994) finds a positive relationship between individual productivity and spousal education for both men and women in Brazil. Rossetti and Tanda (2000), using Italian data, find a positive relationship between the educational level of the spouse and earnings for both men and women. Huang et al., (2009) find a positive association between the husband's education level and the wife's earnings in China.

Most of these studies rely on cross-sectional data, making it difficult to interpret the results. Men with higher earnings are more likely to get married; there is a positive selection into marriage. Additionally, highly educated individuals tend to marry other highly educated individuals, and high earners tend to marry each other (Mare, 1991; Smith, 1979; Lam, 1988 and Nakosteen et al., 2004). This implies that some of the correlation between a husband's earnings and a wife's education presumably comes from positive matching with regard to both education and earnings.

The explanation that is most often proposed for the positive correlation between a wife's education and her husband's earnings is cross-productivity effects; spouses may benefit from each other's human capital. An individual's stock of human capital and productivity (and thereby of earnings) is affected by a number of factors besides education and formal training. These can, for instance, include upbringing or parents' and friends' behaviour and influences. According to Manski (2000), our surroundings can affect our behaviour through three different channels: restrictions, expectations and preferences. A few previous studies have tried to separate the selection effect from the possible effect of cross-productivity. Liu and Zhang (1999) use cross-sectional data and find a positive relationship between the wife's education and the husband's earnings in Taiwan. When including the wife's education in the

husband's earnings equation, the coefficient of the individual's education level is close to zero, and the estimated coefficient of the wife's education is around 10%. They argue that this pattern is hard to explain using the cross-productivity hypothesis and that assortative mating is more important. Brynin and Francesconi (2004) use British panel data of married couples and find that the spouse's education has a positive effect on own earnings. However, because they do not observe the individuals when single and few individuals change their educational level after they get married, it is hard to distinguish the estimated effect from positive assortative mating. Huang et al., (2009) exploit survey data on Chinese twins to control for unobserved individual heterogeneity that may be correlated with the spouse's educational level. To further separate the mating effect from cross-productivity effects, they compare earnings at the time of the wedding and current earnings. They argue that at the time of the wedding, the possible cross-productivity effects should not have been realised yet. This implies that any estimated effects of spouses' education on individual earnings at this time are due to assortative mating and not to cross-productivity. Their findings indicate a cross-productivity effect of the husband's education on his wife's earnings, but no effect of the wife's education on her husband's earnings.

The contribution of this study lies to a large extent in the exploitation of longitudinal data collected over a period of time within which individuals experience both singlehood and marriage. This allows us to isolate the effect that arises within marriage from selection effects on the marriage market. We will employ a fixed effects model for earnings that accounts for unobservable time-invariant characteristics of the individuals. The next section briefly discusses how the educational attainment of a spouse may influence the earnings of his/her partner. Section three presents the data and section four the empirical model. The estimation results are reported in section five. The last section summarises the findings and concludes.

2 Education, marriage and earnings

Given a set of exogenous conditions in the marriage market, the matching of spouses is assumed to be governed by utility maximisation. An individual chooses to enter a marriage if the expected utility of being married is greater than the expected utility of staying single. Becker (1973) suggests positive matching based on characteristics such as intelligence, appearance and education, and the gain from marriage is assumed to increase with these complementary attributes. The effect of education can, however, be ambiguous (Becker et al., 1977). A highly educated couple may experience higher returns, relatively speaking, from marriage because both spouses become more productive both domestically and in the labour market. At the same time, it may be the case that the spouses do not specialise fully and thereby miss out on greater returns. The possibility of specialising or helping each other in the labour market is likely to depend on the two individuals' attributes and joint human capital.

Being married to a partner with a high education level can affect individual earnings in a number of different ways. Higher education is likely to result in an increased ability to process information, improved cognitive skills and an enhanced capacity to cope with change. For instance, returns to schooling are affected by the individual's peer group in school (Summers and Wolfe, 1977; Sacerdote, 2001), and the productivity of workers is positively affected by the presence of other workers with high levels of education (Moretti, 2004). One's immediate surroundings, including a partner, can influence both consumption choices as well as behaviour on the labour market. A spouse, whom for many is the absolutely closest peer, might influence behaviour through common areas of responsibility - e.g., house, car and children. The restrictions are different for married individuals than for unmarried ones and are influenced by the spouse's behaviour and individual characteristics. Married

spouses/cohabitants are also likely to affect each other through values, attitudes and the ability/inability to expose each other to new ideas and opportunities. In development economics, it has been found that an illiterate adult earns significantly more when living in a household with at least one literate member (Basu et al., 2001). A spouse with a higher education level might possess a better capacity to give advice and share information that could benefit his/her partner's career (Benham, 1974). It may be the case that a highly productive spouse counteracts the depreciation of the partner's human capital. Yet another possible mechanism is network effects; this is an important part of job searching and has been proven in other contexts, such as students' networks, to affect the likelihood of obtaining high-paying jobs (Marmaros and Sacerdote, 2002).

The educational levels of the spouses also affect the bargaining situation in the family. Higher education is, according to Lundberg and Pollak (2003), associated with higher bargaining power. This implies that decisions in the family about, for instance, division of labor, fertility, consumption and where to live are likely to depend on the educational levels of the spouses. All of these different aspects of married life can influence an individual's earnings.

Education does not just have direct economic benefits, such as higher earnings and a lower probability of unemployment; it also affects the individual in other areas of life. Individuals with higher education tend to be in better health (Grossman and Kaestner, 1997; Groot and Maassen van den Brink 2007), are more prone to engage in healthy behaviour and preventive care such as exercise and vaccination and are less likely to smoke (Cutler and Glaeser, 2005). The lifestyle and health choices of one's spouse may affect one's own health and thereby one's earnings. Having a spouse with a higher level of education is hence most likely associated with healthier behaviour, - e.g., less smoking and less excessive drinking (Monden et al., 2003) - and also with

lower mortality rates (Egeland et al., 2002). A high level of education also decreases the probability of engaging in criminal behaviour (Lochner and Moretti 2004), which is also associated with peer group effects (Glaeser et al., 1996).

3 Data

Two random samples of men and women, respectively, were drawn from a number of administrative registers kept by Statistics Sweden. The registers contain information on the entire Swedish population. The two samples pertain to ten percent of the men and women, respectively, who were married or cohabitating in 1997 and are set up as a panel consisting of yearly observations from 1990 to 2006. The individuals were born between 1946 and 1970 - i.e., they are between 20 and 60 years old. This yields samples of 89,622 males and 96,780 females. To identify the effect of spousal education with fixed individual effects, there needs to be variation in the educational levels of the spouses. However, very few individuals change their educational levels after marriage. To ensure variation in the educational levels of the spouses, we restrict the sample to individuals who were single for at least one year during the observed period. This results in final samples of 43,153 males and 42,546 females. If the individual was married in a certain year, the spouse's characteristics are assigned measured values for that year. For the years during which the individual was not married, the variables indicating the spouse's characteristics are set to zero. No age restriction applies for the spouse. Cohabitation is very common and socially accepted in Sweden. In the official data, unmarried cohabitant couples are only registered if they have a child in common. This means that we cannot observe when the couples actually became cohabitants. Because we are interested primarily in the effect of

spousal education on earnings and not in the formation of the couple itself, this should not pose a major concern for our interpretation of the empirical results.[1]

The dependent variable in the analysis is the logarithm of total annual earnings from employment, deflated by the Swedish Consumer Price Index and measured at the price level of the year 2000. Annual earnings rather than wages must be used because the data do not include information about hours or weeks worked. This means that the estimated effects on earnings can be both wage effects and labour supply/hours effects. The explanatory variables[2] account for differences in labour supply and demand. Children, parental leave, and student status are expected to control for labour supply, whereas variables indicating region of residence and employment sector account for differences in labour market characteristics that are related to both labour supply and demand.

Tables 1 and 2 present the sample means for females and males, respectively, conditioned on non-zero earnings and stratified by the educational level of the spouse. Comparing the sample means in columns 2 and 3 in Table 1 shows that women who are married to men with less than a university education are, on average, different from the women married to men with at least a university education. Women married to men with more education have higher average earnings. This may be explained partly by their higher levels of education; over 60 percent of the women with husbands who have university educations also have university educations themselves, whereas only around 24 percent of the females married to men with less than university educations are themselves university-educated.

[1] If the individuals are in reality married but we observe them as single, this will lead to an attenuation bias of the effects of spousal education.
[2] Detailed definitions of the variables are given in the Appendix .

Table 1. Sample means of variables observed in 1997, females.

Variable	Married to male with less than university-level education		Married to male with university-level education or greater	
	Mean	St. Dev.	Mean	St. Dev.
Years married	12.15	3.06	12.36	2.87
Total annual earnings (SEK 100)	1213.18	790.87	1469.29	1059.33
Own education				
Secondary school	0.61		0.33	
University	0.23		0.62	
Ph.D.	0.001		0.01	
Years of education	11.53	1.84	13.36	2.23
Spouse's education				
Secondary school	0.73			
University			0.95	
Ph.D.			0.05	
Years of education	10.39	1.84	14.92	1.15
Same educational field				
Broad Field	0.18		0.28	
Narrow Field	0.11		0.12	
Age	35.94	6.78	36.23	6.49
Children	0.83		0.82	
Parental benefits	0.60		0.61	
Unemployed	0.23		0.16	
Sector of employment				
Farming	0.008		0.005	
Manufacturing	0.12		0.09	
Construction	0.013		0.01	
Retail	0.20		0.14	
Private sector	0.11		0.16	
Public sector	0.52		0.56	
Region of residence				
Stockholm	0.20		0.31	
East Middle Sweden	0.17		0.15	
Smaland and the islands	0.09		0.06	
South Sweden	0.13		0.13	
West Sweden	0.20		0.19	
North Middle Sweden	0.11		0.07	
Middle Norrland	0.04		0.04	
Upper Norrland	0.06		0.05	
Number of observations	22,971		11,040	

Furthermore, it can be seen that women married to men with more education have been married longer and are older; fewer are unemployed, and they are more likely to have children. The sample means also show that the couples in which the husband has attained a university-level education are more likely to be educated within the same field. One explanation for this might be that the spouses are more likely to have met during the course of their education or at work. Official Swedish data show that among the professions that have more equal gender divisions, the majority require some university education (SCB, 2007).

The sample means for males show a similar pattern, presented in Table 2. Males married to women with a university education enjoy higher earnings and have achieved a higher level of education than have males married to women with less than a university education. This observed pattern of a positive relationship between spouses' education levels and individuals' education levels is in accordance with expectations and previous studies. Becker (1974) argues that in an efficient marriage market, there should optimally be positive matching with regard to education. In 1997, the correlation in years of education between the spouses is 0.44 for the sample of females and 0.45 for the males. This makes it obvious that there is a positive relationship between earnings and spousal education due to the return to an individual's own education.

Table 2. Sample means of variables observed in 1997, males.

Variable	Married to female with less than university-level education		Married to female with university-level education or greater	
	Mean	Std. Dev.	Mean	Std. Dev.
Years married	11.98	3.17	12.38	2.83
Total annual earnings (SEK 100)	2 075.65	1206.75	2 702.32	2 142.95
Own education				
Secondary school	0.59		0.34	
University	0.19		0.55	
Ph.D.	0.003		0.03	
Years of education	11.21	2.33	14.70	2.53
Spouse's education				
Secondary school	0.79			
University			0.99	
Ph.D.			0.01	
Years of education	10.57	1.89	14.70	0.87
Same educational field				
Broad Field	0.20		0.24	
Narrow Field	0.13		0.11	
Age	36.39	6.59	37.31	6.53
Children	0.86		0.83	
Parental benefits	0.47		0.47	
Unemployed	0.15		0.10	
Sector of employment				
Farming	0.02		0.01	
Manufacturing	0.31		0.22	
Construction	0.12		0.07	
Retail	0.27		0.19	
Private sector	0.12		0.21	
Public sector	0.15		0.29	
Region of residence				
Stockholm	0.20		0.28	
East Middle Sweden	0.17		0.16	
Smaland and the islands	0.10		0.07	
South Sweden	0.14		0.13	
West Sweden	0.20		0.19	
North Middle Sweden	0.10		0.07	
Middle Norrland	0.04		0.04	
Upper Norrland	0.05		0.06	
Number of observations	24,445		12,153	

Does spousal education matter for individual earnings, then, when one's own level of education is held constant? In Tables 3 and 4, the average annual earnings for men and women, respectively, are stratified by own and spouse's educational levels. The sample means below show that individual earnings seem to be systematically related to the educational level of the spouse. For females with less than a university education, the average earnings do not seem to depend on the educational level of the spouse. The means for earnings are roughly the same for females with a secondary school-level education who are married to males with compulsory-level education or lower (1185.21) compared to females married to males with a university-level education (1216.95) or a Ph.D. (1175.91). When the females have attained a university- or PhD-level education, earnings are higher when the education level of the husband is higher. This may indicate that it takes a higher individual education level to be able to benefit from the spouse's higher level of education.

Table 3. Female's earnings in 1997 conditioned on the husband's educational level.

	Own education			
Husband's education	Compulsory	Secondary	University	Ph.D.
Compulsory	1122.98 (1543)	1185.21 (3626)	1495.85 (1050)	1953.52 (5)
Secondary	1081.71 (2120)	1149.79 (10356)	1416.82 (4256)	1780.38 (15)
University	1138.05 (473)	1216.95 (3548)	1593.42 (6428)	2036.04 (88)
Ph.D.	1209.36 (14)	1175.91 (41)	1855.56 (372)	2471.70 (76)

Note: Number of observations within parentheses. The group "compulsory" includes individuals with an educational attainment level of compulsory of lower.

Table 4. Male's earnings in 1997 conditioned on the wife's educational level.

	Own education			
Wife's education	Compulsory	Secondary	University	Ph D
Compulsory	1750.09 (1855)	1823.83 (2656)	2448.34 (621)	3032.64 (13)
Secondary	1831.67 (3431)	2029.16 (11761)	2656.34 (4052)	3126.45 (56)
University	2020.66 (850)	2188.67 (4127)	3047.06 (6665)	3634.87 (369)
Ph.D.	252.73 (1)	1604.34 (10)	3141.64 (77)	3389.2 (54)

Note: Number of observations within parentheses. The group "Compulsory" includes individuals with an educational attainment level of compulsory or lower.

A similar pattern for men can be seen in Table 4. Given an individual's education level, the earnings are higher when the education level of the wife is higher. This relationship holds for all combinations except that of males married to women with doctoral degrees. However, there is no basis for strong conclusions because these groups consist of very few observations. The raw correlations between one's own earnings and spousal education, measured in years of schooling, are 0.1758 for females and 0.1885 for males.[3]

4 Empirical Model

It is likely that one's own education level and one's spouse's education level are correlated with unobservable characteristics that influence earnings. The selection hypothesis actually implies that there is a correlation between the omitted unobservable characteristics that lead to higher earnings and the

[3] Estimated for all years the individuals are married and have non-zero earnings. The estimated correlations are significantly different from zero.

spouse's educational level. To encompass this, we estimate the effects of spousal education using a fixed effects model:

$$\ln Y_{it} = \varphi + \beta_1' X_{it} + \beta_2' M_{it} + u_i + \eta_t + \varepsilon_{it}$$

Y_{it} is individual *i's* earnings at time *t*, and X_{it} is a vector of explanatory variables for individual *i* at *t*. The vector *M* includes the marriage related variables that are the focus of our study. *M* contains controls for marital status and spouse's educational level. Descriptive statistics indicate that the effect of spousal education might depend on the individual's own education level. It is plausible that it takes a higher level of education to be able to benefit from the spouse's higher education level, therefore an interaction variable between own educational level and spouses educational level is included. The possibility of two partners' helping each other in the labour market is also likely to depend on the individuals' fields of education. If there is a cross-productivity or network effect of spousal education, it should be bigger if the spouses share the same field of education. Dummy variables indicating if the two spouses' fields of education are the same are included to capture this. u_i is a time invariant individual effect. η_{tt}. represents time effects that are controlled for by time dummies. ε_{it} is the error term.

5 Results

Tables 5 and 6 present the results of the estimations of the effects of spousal education on individual earnings for men and women, respectively. For straightforward comparison with the results of previous studies, education is measured in years, and the first specification does not include any individual effects. Running the model with random effects (not presented here) yields a

Lagrange multiplier test that is highly significant, supporting the individual effects specifications. As can be seen in Tables 5 and 6, the results of all Hausman tests are highly significant, rejecting the random effects models in favour of the fixed effects models. This further shows that the hypothesis of there being no correlation between the individual effect and the explanatory variables must be rejected.[4] The estimated coefficient of the *Wife's education* in the earnings equation for males is positive and significant in the first specification - i.e., the education of his wife appears to have a positive effect on a man's own earnings. The estimated coefficient of 0.0174 is smaller than those found in previous studies, where the estimated coefficients vary between 3 and 4 percent.

This estimated association between one's own earnings and spousal education may stem from both cross-productivity effects and the marital matching of high earning men to women with higher levels of education. The second specification takes into account time-invariant unobservable characteristics of the individual affecting his/her earnings that may be correlated with the spouse's education. When including the fixed individual effects, the parameter estimate for *Wife's education* is reduced but still significant. This indicates that part of the estimated effect in the first specification is likely to be due to selection into marriage. Men with higher earnings are more likely to marry women with high education - i.e., men who are more productive irrespective of marriage status (who are more productive whether they are single or married) tend to be married to women with higher education levels.

[4]The random effects model requires that the individual effects be uncorrelated with the explanatory variables. A Hausman specification test evaluates the more efficient random effects model against a less efficient but always consistent fixed effects model to make sure that the efficient model also yields consistent results. After comparing the coefficients in the two models, one can accept or reject the random effects model. If the coefficients differ, the test rejects the random effects model in favour of the fixed effects specification.

Table 5. Estimated effects of wife's education on earnings for males.

	1	2	3	4	5
Marital status	-0.1696 *** (0.0082)	-0.0626 *** (0.0096)	-0.0209 ** (0.0099)	-0.0307 ** (0.0100)	-0.0344 *** (0.0100)
Education	0.0629 *** (0.0005)	0.0560 *** (0.0011)	0.0479 *** (0.0012)	0.0484 *** (0.0012)	0.0486 *** (0.0012)
Wife's education	0.0174 *** (0.006)	0.0096 *** (0.0008)	-0.0093 *** (0.0013)	-0.0084 *** (0.0013)	-0.0084 *** (0.0013)
Educational Interaction			0.0013 *** (0.0001)	0.0012 *** (0.0001)	0.0012 *** (0.0001)
Broad field				0.0285 *** (0.0047)	
Narrow field					0.0451 *** (0.0052)
Fixed Effects	NO	YES	YES	YES	YES
Hausman		6955.34	6958.78	6999.87	6990.88
R^2	0.296	0.277	0.277	0.276	0.276
Number of obs.	515,660	515,660	515,660	515,660	515,660

Note I: Included in all estimated models are variables indicating children, parental leave, unemployment, student status, sector of employment, region of residence, age, and yearly dummies. The estimated coefficients are available from the author. Note II: t-values in parentheses. */**/*** denotes that the coefficients are significant on a 10/5/1 percent level, respectively.

The positive and significant coefficient of *Wife's education* yields support for the hypothesis of a positive cross-productivity effect and indicates that there may be a causal effect of the wife's education level on the earnings of her husband.

Specifications 3-5 include an interaction variable to capture interdependence between the spouses' educational levels. The estimated coefficient of *Wife's education* changes sign and is now negative and significant, indicating that having a highly educated wife may lower a man's earnings. However, the coefficient of *Educational interaction* is positive and significant. This suggests that the combination of spouses' educational levels is crucial because of its positive effect on individual earnings. The earnings gain from being married to

someone with a high level of education is higher when one's own education level is higher.[5]

The earnings gain from having a highly educated spouse can be an outcome of a higher level of general knowledge that affects lifestyle choices. It may also be due to the partner's more specific knowledge and thereby his/her ability to help, support and provide networks that affect individual earnings in a more direct way. Relatively speaking, the general effect of education on health and lifestyle is likely to be closely associated with the spouse's level of education. In contrast, a common field of education should have a larger impact on cross-productivity. The possibility of providing direct help and specific knowledge is expected to be greater if the spouses each have a degree in the same field of education. Therefore, the earnings equation is extended by dummy variables for the spouses' fields of education being the same. Two alternative indicators are used. One, *Broad Field,* is a more general category made up of nine different fields - e.g., social sciences, humanities and health care and welfare. The second variable, *Narrow Field*, is on a more detailed level - for instance, journalism and business administration are two different groups within social science.[6]

The estimated coefficient of the *Broad Field* is positive and significant, implying that being married to a female within the same field of education increases a man's earnings by almost 3 percent. The coefficient of the more specialised field, *Narrow Field,* is also positive and significant. For men, the

[5]To allow for the possibility that the effect of spousal education is non-linear, alternative specifications in which educational levels are indicated by dummy variables have been estimated. The coefficient for *secondary*-level education on the part of the wife is negative and significant, compared to when the wife is only educated up to the compulsory level, whereas the estimated parameters for *University* and *Ph.D.* are positive and significant. With the inclusion of interaction variables between the educational levels, the coefficients of spouses' education are no longer significant. Among the interaction variables, only the combination "*university and university"* is positive and significant.

[6] See Table A2 in the Appendix for information on the different fields.

estimated coefficient is 0.0451, which indicates that earnings are 4.5 percent higher if the wife is educated within the same field. The estimated effect of the narrow field is larger than the estimated effect of the broad field, which supports the idea of field-specific knowledge and cross-productivity effects. Table 6 gives the total effect of spousal education on earnings for males, which is calculated from the estimated coefficients in specification 4 in Table 5. The total effects are positive overall, and the effect increases throughout as the educational levels of the spouses increase.

Table 6. Total effects of spousal education on earnings for males.

	Own education			
Wife's education	Compulsory	Secondary	University	Ph.D.
Compulsory	0.0216 (0.0013)	0.054 (0.0013)	0.0918 (0.0013)	0.1296 (0.0013)
Secondary	0.0288 (0.0013)	0.072 (0.0013)	0.1224 (0.0013)	0.1728 (0.0013)
University	0.0372 (0.0013)	0.093 (0.0013)	0.1581 (0.0013)	0.2232 (0.0013)
Ph.D.	0.0456 (0.0013)	0.114 (0.0013)	0.1938 (0.0013)	0.2736 (0.0013)

The estimates of the earnings equations for females, presented in Table 7, show a pattern similar to that of the results for males. The first specification without fixed effects yields a positive and significant coefficient for the *Husband's education*, indicating a positive effect of the spouse's education on female earnings. The coefficient of *Husband's education* decreases but is still significant when the time-invariant individual effects are included. This suggests that relatively more productive females, all other things equal, tend to marry men with higher education levels.[7]

[7] Specifications with dummy variables indicating educational level give positive and significant stimates for all levels of education above the compulsory level. These estimates remain positive and significant with the inclusion of interaction variables. Furthermore, there seem to be additional positive effects for women married to men with university degrees if the female herself has at least a university education.

Table 7. Estimated effects of husband's education on earnings for females**.**

	1	2	3	4	5
Marital status	-0.2706 ***	-0.2450 ***	-0.1933 ***	-0.2071 ***	-0.2099 ***
	(0.0084)	(0.0120)	(0.0125)	(0.0126)	(0.0126)
Education	0.0715 ***	0.0689 ***	0.0573 ***	0.0584 ***	0.0584 ***
	(0.0007)	(0.0014)	(0.0015)	(0.0016)	(0.0016)
Husband's education	0.0061 ***	0.0038 ***	-0.0203 ***	-0.0190 ***	-0.0189 ***
	(0.0007)	(0.0010)	(0.0019)	(0.0019)	(0.0019)
Educational. Interaction			0.0016 ***	0.0015 ***	0.0015 ***
			(0.0001)	(0.0001)	(0.0001)
Broad field				0.0563 ***	
				(0.0061)	
Narrow field					0.0719 ***
					(0.0066)
Fixed Effects	NO	YES	YES	YES	YES
Number of obs.	569 229	569 229	569 229	569 229	569 229
Hausman		4210.86	4276.86	4311.93	4309.68
R^2	0.21	0.20	0.20	0.20	0.20

Note I: Included in all estimated models are variables indicating children, parental leave, unemployment, student status, employment sector, region of residence, age, and yearly dummies. The estimated coefficients are available from the author. Note II: t-values in parentheses. */**/*** denotes that the coefficients are significant on a 10/5/1 percent level, respectively.

In specification 3, the parameter for *Educational interaction* is positive and significant and the coefficient of *Husband's education* changes sign and becomes significant. This indicates that being married to a male with a high level of education can have negative effects on individual earnings unless the female herself also has a high level of education.

Both *Broad Field* and *Narrow Field* have positive and significant coefficients. A female married to a male within the same narrow field experiences an earnings increase of more than 7 percent compared to women married to males in a different field. Again, the coefficient of the *Narrow Field* is larger than the

coefficient of the *Broad Field*, indicating that there are larger cross-productivity effects associated with more similar educational fields.

In Table 8, we see the total effect of the husband's education on earnings for females calculated from the estimated coefficients in specification 4 in Table 7. It appears that the total effect of the husband's education is negative for females with an education below the university level.

Table 8. Total effects of spousal education on earnings for females

	Own education			
Husband's education	Compulsory	Secondary	University	Ph.D.
Compulsory	-0.0495 (0.0019)	-0.009 (0.0019)	0.0383 (0.0019)	0.0855 (0.0019)
Secondary	-0.066 (0.0019)	-0.012 (0.0019)	0.051 (0.0019)	0.114 (0.0019)
University	-0.0853 (0.0019)	-0.0155 (0.0019)	0.06589 (0.0019)	0.1473 (0.0019)
Ph.D.	-0.1045 (0.0019)	-0.019 (0.0019)	0.0808 (0.0019)	0.1805 (0.0019)

Females with university educations seem to experience a gain in earnings regardless of the educational levels of their husbands. It is, however, important to remember that the coefficient of *Marital Status*[8] is -0.2071, such that the total effect of being married on earnings is negative. On the other hand, if the spouses are educated within the same field, the total effect is positive for women with a Ph.D.

To check the stability of the results with regard to the variation in spouses' educational levels and sampling restrictions, a robustness check was

[8] Because the data only include individuals who eventually got married, it is not possible to interpret the coefficient of *Marital Status* as is conventionally done in the literature on marriage premium or marriage penalty.

performed. To be able to identify the effect of spousal education, it is necessary to observe the individuals as single or that there be a change in the spouses' educational levels during the observation period. The hitherto-presented results are based on a sample including individuals who were single for at least one year during the sampling period. In a robustness check, we included only individuals who were single for at least five years during the period of observation. The results for this sample are very close to those presented here.

The results presented in Tables 5 through 8 are based on observations with non-zero earnings because we use the logarithm of earnings. Including observations with zero earnings and adding one before taking the logarithm does not change any of our results or interpretations above. Some observations of low income from labour may represent individuals mainly outside the labour force, which hypothetically may affect the results. Dropping all observations with earnings below 50,000 SEK does not change any major findings.

6 Summary and conclusion

The results of this study indicate a positive effect of spousal education on individual earnings. This holds for both men and women. The positive significant effect remains when including fixed effects. This indicates that selection on time-invariant attributes alone cannot explain the entire observed association and that there seems to be some sort of spill over or cross-productivity effect.

Further, the results for both men and women show that the earnings gain from spousal education seems to depend on the individual's own education as well

as the education of the spouse, i.e., the combination of educational levels. Having a husband with a high level of education may have a negative effect on the wife's earnings unless she has a higher level of education as well. Generally, the higher the level of an individual's education, the larger the gain of having a highly educated spouse. A possible explanation is that it takes a high level of education to be able to benefit from the productivity spill over effects from the partner.

The cross-productivity interpretation of the empirical results is strengthened by the analysis of the spouses' fields of education. On top of the general effect of spousal educational level, the results indicate an additional effect if the fields of education are the same. The cross-productivity effect should be larger when individuals are educated within the same field because this provides greater opportunities for cross-productivity effects to appear and makes it easier for one spouse to assist the other in the labour market.

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Appendix

Table A1. Definitions of variables.

Variable name	Description
Married	Dummy variable equal to one if the individual is married in year t, zero otherwise.
Years married	Number of years living as married.
Total annual earnings	Total gross wage earnings in 100 SEK, year 2000.
Age	Years.
Education	The levels of schooling as indicated in the registers of Statistics Sweden are transformed into years of schooling in the following way: 7 years for old compulsory schooling, 9 years for new compulsory schooling, 11 years for short upper-secondary school, 12 years for long upper-secondary school, 14 years for short university, 15.5 for long university and 19 years for a doctoral degree.
Spouse's education (in years)	Equal to the spouse's years of education if the individual is married, zero otherwise.
Broad Field	Equal to one if the individual is married and the spouses are educated within the same broad field, zero otherwise.
Narrow Field	Equal to one if the individual is married and the spouses are educated within the same narrow field and zero otherwise.
Children	Dummy variable equal to one if there are children under 18 years old living in the household; zero otherwise.
Parental benefits	Dummy variable equal to one if the individual receives any parental benefits; zero otherwise. Parental benefits are payable for 450 days for children born before 2002 to parents who stay out of work to look after a child. The parental benefit days are always shared equally between the two parents, but one parent may give up his/her parental benefits to the other parent. The amount that one receives is a function of one's annual income.
Self-employed	Dummy variable equal to one if the individual is self employed; zero otherwise.
Farming	Dummy variable equal to one if the individual is employed in farming; zero otherwise. According to SNI-92.
Manufacturing	Dummy variable equal to one if the individual is employed in manufacturing; zero otherwise. According to SNI-92.

To be continued

Table A1 continued

Variable name	Description
Construction	Dummy variable equal to one if the individual is employed in construction; zero otherwise. According to SNI-92.
Retail	Dummy variable equal to one if the individual is employed in retail; zero otherwise. According to SNI-92.
Private sector	Dummy variable equal to one if the individual is employed in the private service sector; zero otherwise. According to SNI-92.
Public sector	Dummy variable equal to one if the individual is employed in the public sector; zero otherwise. According to SNI-92.
Stockholm	Dummy variable equal to one if the individual lives in Stockholm; zero otherwise. According to NUTS 2.
East Middle Sweden	Dummy variable equal to one if the individual lives in East Middle Sweden; zero otherwise. According to NUTS 2.
Smaland and the islands	Dummy variable equal to one if the individual lives in Smaland and the islands; zero otherwise. According to NUTS 2.
South Sweden	Dummy variable equal to one if the individual lives in South Sweden; zero otherwise. According to NUTS 2.
West Sweden	Dummy variable equal to one if the individual lives in West Sweden; zero otherwise. According to NUTS 2.
North Middle Sweden	Dummy variable equal to one if the individual lives in North Middle Sweden; zero otherwise. According to NUTS 2.
Middle Norrland	Dummy variable equal to one if the individual lives in Middle Norrland; zero otherwise. According to NUTS 2.
Upper Norrland	Dummy variable equal to one if the individual lives in Upper Norrland; zero otherwise. According to NUTS 2.

Table A2. Fields of education.

Broad fields	Narrow fields
General Programmes	Basic/broad, general programmes Literacy and numeracy Personal skills
Education	Teacher training and education science
Social Sciences, Business and Law	Social and behavioural sciences Journalism and information Business and administration Law
Science, Mathematics and Computing	Life science Physical science Mathematics and statistics Computing
Engineering, Manufacturing and Construction	Engineering and engineering trades Manufacturing and processing Architecture and building
Agriculture and Veterinary	Agriculture, forestry and fishery Veterinary
Health and Welfare	Health Social services
Services	Personal services Transport services Environmental protection Security services