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Does Maternal Education Affect Childhood Immunization Rates? Evidence from Turkey

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Abstract

We study the causal effect of maternal education on childhood immunization rates. We use the Compulsory Education Law (CEL) of 1997, and the differentiation in its implementation across regions, as instruments for schooling of young mothers in Turkey. The CEL increased the compulsory years of schooling of those born after 1986 from 5 to 8 years. We find that education of mothers increases the probability of completing the full course of DPT and Hepatitis B vaccinations for their children. Furthermore, education increases the age of first marriage and birth, changes women`s and their spouse's labour market status, and significantly affects women`s attitude towards spousal violence against women and gender discrimination in a manner that empowers women.

Keywords: DPT (diphtheria, pertussis and tetanus), Hepatitis B, Maternal Education, Autonomy of Women, Fertility, Difference-in-Difference-in-Differences, Instrumental Variable

JEL Codes: H51; H52; I12

1. Introduction

Vaccination can save millions of lives. According to a report by the World Health Organization (WHO) and the United Nations Children's Funds (UNICEF)[1], some 8 million children under five die annually, 17 percent of those deaths could have been prevented if the children were vaccinated. The same report estimates that two to three million possible deaths from measles and diphtheria, pertussis (whooping cough) and tetanus (DPT) are prevented by vaccination each year. Children aged under 6 are most likely to perish or to develop chronic conditions when they fall ill. These deaths and complications could be easily prevented by timely vaccination. The potential gains from increased vaccination coverage are particularly large in less developed countries, where vaccination rates remain relatively low, especially in rural areas.

In Turkey, the percentage of children who are fully vaccinated increased from 46 percent in 1998 to 81 percent in 2008 (Table 1). The likelihood that a child will be vaccinated is closely correlated with the mother's level of education.

Table 1 Trend of full vaccination in Turkey

Mother's education	1998	2003	2008
No education/Primary incomplete	28.5	26.1	64.9
Primary school/First level	48.0	60.9	81.6
Primary school/Second level	64.0	61.2	84.4
Secondary and higher school		68.5	87.8
Total	45.7	54.2	80.5

Source: Author`s own calculation based on TDHS-1998, TDHS-2003, TDHS-2008

The role of maternal education thus seems to be an important determinant of whether infants complete the required vaccinations, as has been highlighted also in the previous

[1] World Health Organization and UNICEF: Global Immunization Data; July 2014. Accessible at http://www.who.int/immunization/monitoring_surveillance/global_immunization_data.pdf [cited on 24/07/2015].

literature.[2] However, all of these studies ignore the likely endogeneity of maternal education due to omitted variables bias, and any estimation not correcting for it is likely

Muthayya, 2009; Schultz, 2002; Vaahtera et al., 2001). A number of recent studies find maternal education to be positively associated with the complete-vaccination status of infants, even after controlling for various individual and community-level variables such as age of mother, income, ethnicity, socioeconomic status, parity, residence and religion (Abuya, Onsomu, Kimani, & Moore, 2011; Altınkaynak, Ertekin, Güraksın, & Kılıç, 2004; Fatiregun & Okoro, 2012; Schoeps et al., 2013; Singh, Haney, & Olorunsaiye, 2013; Streatfield, Singarimbun, & Diamond, 1990; Vikram, Vanneman, & Desai, 2012). This result is important because vaccination is accepted as the most cost-effective and efficient way to reduce child mortality and morbidity (Breiman et al., 2004; Maurice & Davey, 2009; Rainey et al., 2011).

Starting with knowledge as a potential channel, Streatfield et al. (1990) found, in Indonesian context, that mothers' knowledge regarding the benefits of vaccination was positively correlated with formal education. Children of more educated women, in turn, benefited slightly more from immunisation programs.

Previous research also suggests that formal education of mothers increases their age at first birth, their autonomy, and changes their attitude towards gender inequality and violence against women, which ultimately increases their well-being and that of their children (leading to better health outcomes and promoting longer years of schooling for their children) and, finally, decreases the chance of death at birth for themselves and their baby (UNICEF, 2006). Similarly, formal education has been found to increase women's decision-making autonomy (Babalola, 2009; Kritz and Makinwa-Adebusoye, 1999; Singh et al., 2013; Vikram et al., 2012. When the mother rather than the father is in control of the household budget, more resources tend to go towards family health, in particular, children's health (Thomas, 1990; Shroff et al., 2011; Mistry et al., 2009).

The research on the causal influences of education on child health, fertility choices, and the usage of prenatal health services frequently utilizes exogenous variation in availability and length of education. Currie and Moretti (2003) use the availability of two-year and four-year colleges in the US state where women lived at the age of 17 as an instrument for mothers' schooling.. They find that maternal education improves

February 1997, the National Security Council, dominated by the military, forced the government to resign. The reason behind this was the government's religious orientation, which the military saw as a threat to democracy and secularism in the Turkish Republic. The same meeting of the National Security Council decided to increase compulsory education from 5 to 8 years, which was implemented by the Turkish Parliament in August 1997.

increased the budget for primary school construction by 30 percent between 1996-97 and 1997-98.[3]

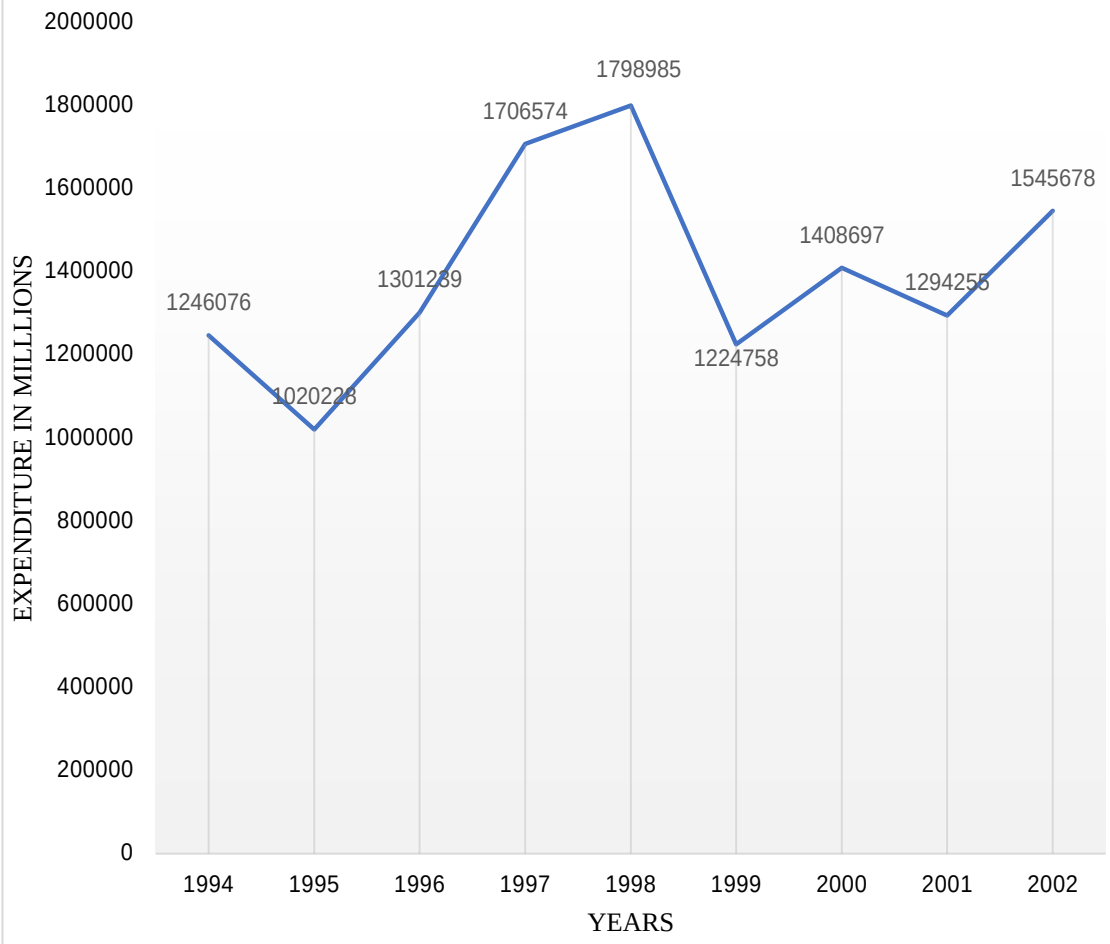
Education reform led to a substantial increase in overall enrolment: the number of students enrolled in grade six increased from 866 thousand in 1996-97 to 1.227 million in the 1997-98 academic year, a growth of more than 30 %. Moreover, in 1997-98, the enrolment rates for girls in the sixth grade in provinces with the highest gender inequalities, which are generally more conservative places, was 162 percent greater than in 1996-67. Finally, it is worth noting that the goal of CEL was to increase enrolment rates and there was almost no change in the curriculum or in other aspects of the quality of education (Dulger, 2004).

4. Data and Empirical Framework

The study's data mainly come from the last two rounds of the Turkey Demographic and Health Survey (TDHS-2003 and TDHS-2008). The survey aims to provide information on trends and levels of fertility, infant and child mortality, family planning, maternal and child health including preventive health measures (e.g. the childhood vaccination status) of ever-married women.[4] The TDHS surveys also include a wide range of information on women's socioeconomic characteristics, such as education (completed years of schooling and highest level of education attained), parents' education, employment status, ethnicity, women's status in the family etc. The survey also features demographic questions including age, gender, type of birth place (rural/urban), a region of birth, and the region of residence during childhood.

[3] This growth rate is based on the Ministry of Development's Investment Program statistics for 1996 and 1997, and is adjusted for inflation. For comparison, the overall public investment grew by 21 percent over

Figure 1. The Trend in the Public Expenditure on classroom construction in millions (1997 Prices) in Turkey



Source: Statistical Yearbook on Public Expenditure from 1994 to 2002, Turkish Ministry of Development. The years are academic, so that the 1996 figure corresponds to the 1996/97 academic year.

The women`s region of residence until the age of 12 allows us to identify the impact of the compulsory schooling reform on education of women, as it links the respondent's individual data with regional administrative data. Another two regional variables are instrumental for the analysis and the regional gross enrolment rates for junior high school.[5]

[5] The Turkish Statistical Institute divides Turkey into 26 sub-regions at Statistical Regional Classification Unit level (or level 2) (see Turkish Statistical Institute website: http://www.turkstat.gov.tr/Start.do). The

As childbearing outside of marriage is uncommon in Turkey, we only consider married women included in the TDHS. Our final sample consists of young mothers between the ages between 18 and 29 in the 2003 and 2008 TDHS. The mothers aged 18 to 21 form the treatment group and those aged 22 to 29 are the control group. After these adjustments, our final dataset has 3331 to 3382 observations.

4.1 Dependent variables

Two dichotomous variables are used to measure the completion of immunisation for children aged over six months, taking the value of one, if the children received the third and final dose of DPT (diphtheria, pertussis and tetanus) and Hepatitis B vaccines.[6]

In addition to the vaccination status of children, the channels potentially influencing the vaccination status of children by empowering women were measured using a number of dichotomous variables. Three variables measure the autonomy of women: (i) whether she is responsible for planning and controlling the household budget, (ii) whether she pays the bills and does other official work, and (iii) whether she could choose her husband with complete freedom or whether other family members seleculvariad2tr of10(e)4()3(rv40

women was justified if a woman: (i) wastes money, (ii) neglects children, (iii) refuses sex, (iv) burns food, and (v) argues with her husband. The index is constructed to range between 0 and 1, with 0.2 given for each affirmative answer to any of the aforementioned questions. Four questions are used to construct an index on gender inequality attitudes.

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Apart from the above explanatory variables, a dummy variable representing the child's gender is included in the regression to control for the impact of gender on the vaccination status of children. Finally, we include dummies for the baby's birth order to account for the fixed effects of the mother's previous birth experiences about vaccination.

To control for the unobserved time-invariant effect of the childhood environment (disparities in socio-economic developments among regions, inequalities in school and teacher quality and their availability in the pre-reform period) on schooling outcomes, we control for the childhood region, and place of residence (rural/urban) in which women spent most of their childhood until the age of 12. Ethnicity is also included. The fixed effects for the mother`s year of birth are used to account for the impact of various government programs and policies, as well as changes in the utilisation of healthcare services and education preferences among different cohorts, which were unrelated to the

4.3 Empirical Strategy

4.3.1 Difference in Difference in Differences

Turkish children used to have to attend primary school for at least 5 years. However, in August 1997, compulsory schooling increased from 5 to 8 years. The first cohort affected by this change were the children who started the fifth grade in the 1997-98 academic year. School enrolment in Turkey is determined according to calendar years, rather than schooling years.[11] Therefore, women who were born in or after 1987 (aged 10 or less in 1997) were affected by the education reform whereas the older women (aged 11 or more) were not.[12] Therefore, the identification strategy has to be based on the fact that the education reform sorts individuals into treatment and control groups according to their year of birth.

In this paper, we use the three-year exogenous change in educational attainment triggered by the timing of the education reform as an instrument for education. One of the requirements of a valid instrument is that it should not have any impact on outcome variable other than its influence through schooling. We believe that the education law reform meets this condition. Firstly, the compulsory schooling reform was caused by political events in 1997, so that it has no link with the outcome variables. Secondly, the factors typically blamed for causing endogeneity of education, such as ability bias and other background characteristics, are not likely to be linked to the year of birth.

[11] The law states that "A child who has completed 72 months by the end of the calendar year can be registered to the first degree of primary school", according to the law published in edition No. 21308 of the official newspaper of Turkish Republic on Friday, 7 August 1992.

[12] However, the implementation of the age cut off is not strict: some children who were born in early 1986 might start school in September 1991 instead of September 1992, while some other children might start school in September 1993. This means some of the pupils who were born in 1986 could have been

glance, the condition for the identification assumption seems to be satisfied as shown in Figure 2. To account for the potential unobserved time-invariant impact of childhood environment on the distribution of additional spending on classroom construction across regions, we account for the childhood region of residence and rural/urban characteristic. Moreover, we control for the interaction of year of birth fixed effect with the gross enrolment rate in 1996-1997 education year in the childhood region prior to the

remaining control variables are represented by . These are ethnicity, the interaction of year of birth with gross enrolment rate in 1996-97, and two dummies: (i) the birth order of the baby and (ii) the gender of the baby.

The correlation between schooling and the reform for the treatment group is estimated by whereas the same relationship for the control group is represented by . Therefore, captures the impact of the compulsory education reform on the formal schooling of the treatment group, if the control and treatment groups are equally influenced by the other determinants associated with the intensity variable. Assuming the reform was exogenous, measures the impact of the reform intensity variable on the schooling of treated mothers.

Up to now, the discussion has focused on the assumption that the exposure of women to the CEL is jointly determined by year of birth and region of childhood. This assumption implies that factors related to the intensity of public investment on classroom construction have identical influence on mothers in the treatment and control groups. However, if mothers' outcomes such as their use of preventive health measures for their children (e.g. vaccination) vary by age, any method that does not compare women in the same age group might be biased. The difference in difference methodology (DD) cannot account for the impact of age on the outcome of interest. For that reason, we use the Difference and

DDD, a sample of young mothers[17] between the ages of 18 and 29 is formed whereby the 2003 and 2008 TDHS cross section data are combined.[18] As a result, the DDD methodology proposed by Dinçer et al. (2014) could be applied in this setting with the combination of 2003 and 2008 TDHS so that Model 2 is structured as follows:

Note that, different symbols were used to differentiate variables of Models 1 and 2. In the above regression, stands for the age fixed effect; is the year of birth fixed effect; is the region of childhood fixed effect and 2008 is a dummy for the TDHS 2008 cross section. The year of birth fixed effect controls for general trends in the outcome of interest caused by other changes specific to age cohorts.[19] The age fixed effect, on the other hand, controls for the impact of the age on the outcome of interest.

, measures how the impact of the intensity of public spending on classroom construction varies between the young (aged 18-21) and old (aged 22-29) women who participated in the 2003 wave of the survey. On the other hand, denotes the impact of the reform intensity on the education of young mothers aged 18 to 21 who participated in TDHS 2008.

[17] If education causes births and teenage marriage to fall, using only ever-married woman may lead to sample selection bias. However, Kirdar, Tayfur, and Koç (2011) found that while CEL reduced

Source: Authors' cal

instrument for the schooling of mothers, so as to obtain, we can obtain unbiased estimates of the effect of education on the outcome considered.

Model 4 then is as follows:

Note that education was replaced by $\widehat{S_{ijt}}$, the predicted value of education. It is also important to note that instead of IV-Probit or Logit, this study uses conventional 2SLS estimation technique as suggested by Angrist (1991) and Angrist (2001) since the dependent and endogenous variables, as well as the instrument, are dichotomous. Under this condition, 2SLS estimates identify marginal treatment effect irrespective of the fact that the dependent variables are binary or continuous (Angrist & Pischke, 2009). There are plenty of examples of the usage of 2SLS estimates instead of IV-Probit or Logit in the previous literature (e.g. Breviero & Duflo, 2004; Chou et al., 2010; Mocan & Cannonier, 2012; Osili & Long, 2008).

OLS and 2SLS strategies are thus used to estimate structural equations in this study. All remaining explanatory variables, except the triple interaction term, are included in Model 4. Moreover, in the same way as with DDD estimates, in all regressions, standard errors are clustered at the level of regions of childhood for 26 regions.

Maternal Education and Channels Affecting Childhood Immunization Rates

The second objective of this paper is to study the effect of education on the various channels potentially affecting immunisation. We employ a similar strategy to that

mentioned for vaccination outcomes.[20] If education empowers women, this can serve as a channel through which education affects vaccination rates.

4.3.3. Reduced Form

A modification of Model 2 (the first stage regression) results in a reduced form (RF) estimates. To do this, the outcome of interest in the first stage is replaced with vaccination status and other relevant outcomes. Model 5 is thus as follows:

The reason for employing RF estimates is that the results of the estimation may differ because of the systematic difference between young and old cohorts or because of higher education as a result of the CEL. The RF model thus provides information related to the variation in the vaccination status of children and other outcomes due to the exogenous rise in public spending on classroom construction because of the CEL experienced by the treatment group (young) in 2008 (i.e. $treated * intensity * 2008$). The same control variables are used for RF estimates of childhood vaccination status. However, similarly with IV and OLS estimates of channels affecting immunisation, RF of these outcomes variables does not account for the gender and birth order dummies.

5 Results and Discussion

5.1 Difference in Difference in Differences Estimation Result

The results of the DDD analysis are presented in Table 3. Firstly, all DDD coefficients are positive and statistically significant as expected. More importantly, the F-statistics test of the joint significance of the triple interaction term (namely the instrument) is

[20] However, OLS and IV estimates do not control for gender and birth dummies of children for the outcome measures considered in this subsection.

more than 10 for almost all specifications. This indicates that the instrument is strong (Staiger & Stock, 1997). It is worth noting that the instruments used in the previous studies on Turkey were weak for years of education in all model specifications, and therefore the analyses were restricted to the effect of completing 8 years of education, on the outcome of interest (see Dinçer et al., 2014; Güneş, 2015).

The CEL has a strongly positive effect on education in all specification. The effect is significant not only statistically but also economically. Considering column 8, every additional 1 Turkish Lira (TL) of public spending per 1000 children raised primary school completion by 0.3 percentage points. The average increase in public expenditure on education was 40.36 TL. Each additional TL spent led to an increase in the probability of completing at least 8 years education by 12.1 percentage points (i.e. 0.3 multiplied by 40.36). Given that 17 percent of women attained 8 or more years of education in 2003, this would represent approximately a 70 percent increase in the share of women who completed primary school and above. Similarly, one additional Turkish Lira (TL) spent per 1000 children increases education by 0.011 years (column 4). As before, the average additional public expenditure on education is 40.36. Therefore, the education reform caused an increase in years of education by about 0.44 years (162 days). The average length of schooling for the young cohorts in 2003 is 4.91 years. The CEL thus lead to a 9 % increase in the years of education of the treatment group in 2003. To sum up, the education reform had a significant influence on the schooling of treated mothers in 2008.

5.2 Validation of treatment and control groups

As explained before, the treatment group is formed by young mothers between the ages of 18 and 21 in the 2003 and 2008 TDHS, whereas those in the age group of 22-29 in the same surveys constitute the control group for the sake of the analysis. Consistent with the strategy of previous studies, we test the validity of the treatment and control groups in this section (e.g. Güneş, 2015; Osili & Long, 2008). To do this, the three-way interaction terms in Model 2 is replaced by 12 separate interaction terms. This means that the treatment variable is turned into 12 dummies, one for each year of age. As expected, the estimates of the coefficients for mothers aged 22-29 are close to zero and statistically insignificant for both years of education and primary school completion (see Table 2.4). However, the coefficients are statistically significant and positive for women aged 18-21. This provides evidence supporting the construction of treatment and control groups.

5.3. Discussion of DDD Estimation Results

5.3.1 Parallel Path Assumption

A crucial assumption in the above DDD estimation is that of “Parallel Paths”. It states that the average differentiation in the control group shows the counterfactual differences in the treated group if the treatment group were not treated. However, the treatment group prior to treatment (i.e. young women in 2003 data) cannot be a priori assumed to be a true counterfactual. The data sets of this paper are cross sections collected in every 5 years. Therefore, there is an implicit 5-year shift forward (i.e. time trend) that might affect outcomes.

Table 4 The impact of CEL on the schooling of each age separately

	Dependent Variables	
Age in 2008	Completing 8 years of education	Years of education
18	0.004***	0.027***
	(0.001)	(0.008)

Comparison of pre-treatment characteristics can be used to ensure comparability. Table 2 reports summary statistics for the dependent variables, selected independent variables, and some family-related characteristics. Some of these variables could be seen as pre-determined factors. Comparing the average change in control and treatment group related to pre-determined factors should indicate potential violation or satisfaction of the parallel path assumption. The ethnicity of a woman, residence status during childhood, the literacy of a woman`s mother and father are classified as pre-determined factors.

We perform the t-tests to examine the hypothesis that the means of treatment group in 2003 and 2008 are equal for these pre-determined factors. The result suggest that there is no significant difference in the averages of these two groups. We also test whether the averages of the control group in 2003 are different from those in 2008. The t-tests again show no significant differentiation across groups, with the exception of urban-rural status. The control group in 2008 data are more likely to live in urban areas at one percent significance level. Overall, the t-tests show that some characteristics are largely pre-determined and similar across cohorts. [21]

This implies that even though there might be an implicit time trend in the economy and preferences because of 5-year shift forward, it seems that DDD results are valid as the differences in the pre-determined factors are small. We always control for fixed effects of a woman`s year of birth to account for the impact of various government programs and policies, as well as changes in the utilization of health care services, education and other factors across cohorts, which could be unrelated to the compulsory education reform but occurred within the same period, and, therefore, might cause a time trend. Therefore, it can be concluded that comparison of pre-determined characteristics and accounting for the year of birth fixed effects indicate that the treatment group of 2003

[21] The results of t-tests are available upon request.

TDHS can be used as counterfactual and, therefore, parallel path assumption is likely to hold in the construction of DDD estimation for this study.

5.3.2 Discussion of the First Stage F-statistics

This paper obtains larger first stage F-statistics for the years of education and completion of 8 years of education variables than the previous studies on Turkey such as Dinçer et al. (2014), who use a similar estimation technique to investigate the impact of the reform on education outcomes for Turkey. There could be four possible reasons behind our larger first stage F-statistics: (i) using a different measure of the regional intensity variable of the compulsory education reform to construct the instrument, (ii) the usage of different sub-samples, (iii) defining treated population differently, and (iv) using slightly different covariates in the estimated model.

To test whether our F-statistics are lower because of employing a monetary measure of the regional intensity variable of the education reform, or different sub-samples for the analysis, we replaced the construction expenditures with the the number of teachers employed after the reform as in Dinçer et al. (2014). Then, we re-estimated the models in column 4 and 8 in Table 3 with this intensity measure. We found that the value of the F statistics is 9.10 and 31.11 for the years of education and completing 8 years of education outcomes, respectively, as illustrated in the first row of Table 5. However, when the intensity of construction expenditure is used as an intensity measure, the F-statistics are 12.40 and 39.40 for the years of education and completing 8 years of education, respectively, as reported in the second row of Table 5. These F-statistics are greater than the values when teacher recruitment rates are exploited as a measure of the reform intensity. However, they are greater than those reported in Dinçer et al. (2014), as shown in the last row of Table 5.

Thirdly, Dinçer et al. (2014) also differ to this study as they define the treatment group as women aged 18 to 22 whereas only women aged 18-21 are included in this study. In other words, individuals who were born in 1986 (i.e. aged 22) are placed in the treatment group in their study, but not in this study. According to the compulsory

Table 5 Variation in the first stage F-statistics

	F-statistics
Intensity variables	

Small differences in the F-statistics could also be attributed to using slightly different covariates and difference in clustering robust standard errors. It can be seen from Table

evidence that vaccination rates may differ because of the systematic difference between young and old individuals, or because of receiving a higher education due to the reform.

Turning to the OLS coefficients, both years of education and primary school completion also have a positive and statistically significant effect, but size of the effect is modest. An additional year of maternal education is associated with 1.3 and 1.4 percentage points rise in the likelihood of complete immunisation status of infants for DPT3 and Hepatitis B3, respectively. Completing 8 years of formal schooling results in an increase in the probability of vaccination of around 5% for DPT3 and 7% for Hepatitis B. Nevertheless, the regression coefficients of primary school completion are significant only at ten and five percent levels, respectively.

However, it is likely that the results of the OLS estimates may be misleading. As previously argued, educational attainment may be endogenously determined by unobservable omitted variables affecting both the educational attainments of women and their preference for the use of vaccines for their children. If this is the case, it violates the exogeneity assumption of OLS as it implies a correlation between the education variable and the error term of the regression. We address this issue by employing the Instrumental Variable (IV) technique.

The IV estimates also indicate a positive and significant causal association between maternal education and the vaccination. Specifically, an additional year of schooling increases the probability of receiving the third dose of DPT and Hepatitis B by around 13% and 22%, respectively, and completion of 8 years of schooling leads to an increase in the probability of receiving the third dose of these vaccines by 55% growth for DPT 3 and by 92 % for Hepatitis B. Hence, maternal education has a strongly positive significant effect on their children’s vaccination rate.

Table 6

education increases the age of first marriage and age at first birth by around 0.15 and 0.03 years, respectively.

The IV estimates are again much larger than the OLS estimates. An additional year of formal education increases the age at first marriage and birth by 0.9 and 1.3 years, respectively, while a ten percent increase in the share of women with completed primary school education increases the age at first marriage by 0.33 and 0.50 years, respectively.[24]

Interestingly, the OLS estimates for the other outcome variables in Table 7 are mostly statistically significant at the one percent level (except mother`s working status) and have the expected signs for both years of education and completing 8 years of education. 2SLS estimates (both with the years of education and completing 8 years) indicate that the husbands of more educated women are more likely to be in the labour force, and that an increase in women completing 8 years of education has a negative impact on their labour force participation.

Lastly, the RF estimates are also statistically significant for the age of first marriage, first birth and labour market status of women and their husbands. However, the RF results for half of the dependent variables in Table 7 are statistically insignificant. This casts doubt on the usage of OLS estimates since this confirms that the IV results are substantially different and that endogeneity is an issue here.

Table 8, which represents the OLS, RF and IV estimates for attitudes on gender issues reveals similar conclusions. Specifically, the OLS coefficients for the years of education and completing 8 years of education show a correlation with the autonomy of the

[24] The results regarding the age of first marriage match those observed in earlier studies by Breirova and

woman, attitude towards gender inequality and violence against women. However, in almost half of these cases, IV estimates are statistically insignificant except for the women`s attitudes towards violence against women and gender discrimination.[25]

The IV estimates of both the attitude of women towards spouse violence against women and gender discrimination show that education decreases the probability of accepting domestic violence and gender inequality. Importantly, the magnitude of the IV effect is much larger than the OLS estimate, regardless of the education variable used. The RF estimates are also very small and insignificant for all variables other than the attitude of women towards spousal violence and gender discrimination.[26]

Women`s education thus seems to have a causal impact on the age of first marriage and first birth, employment status of women and their husbands, and women's attitude towards domestic violence against women and gender inequality. All of these channels are consistent with empowering women. Greater autonomy for women, in turn, can contribute to the improvements in the completion rates of the DPT and Hepatitis B vaccinations.[27]

[25] To the best of our knowledge, in addition to being first study estimating causality between maternal education and their children's vaccination status, this study is also in the category of few studies estimating the causal effect of education on the autonomy of women (e.g. Samaracoon & Parinduri, 2015).

[26] These findings are in line Dinçer et al. (2014) and Mocan and Cannonier (2012) who found that education improves women`s attitude towards spouse violence against women. In contrast, Dinçer et al. (2014) found an insignificant impact of education on gender discrimination. Samarakoon and Parinduri (2015) found no significant association between female education and a range of autonomy variables considered.

[27] In an unreported regression, this study estimated several reduced form regressions explaining vaccination with age at first marriage and birth, husband`s working status and attitudes towards spousal violence as well as other covariates used in main estimates in Table 6. Even after controlling for these covariates jointly or separately, RF estimates reported in Table 6 for vaccination status are still robust and have an almost identical coefficient for the instrument for various specifications.

However, the previous studies have failed to address the endogeneity of education. To the best of our knowledge, this paper is the first study providing evidence as to whether the observed correlation between maternal education and childhood immunisation rates implies causation. To do this, we use a natural experiment from Turkey: adoption of the Compulsory Education Law (CEL) which lead to an exogenous increase in the compulsory schooling from 5 to 8 years for those born after 1986. This, in turn, has led to an increase in spending on the

themselves, but also for their position in the society and for the health outcomes of the future generation.

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