

Jacek Liwiński  
University of Warsaw

## **The Impact of Compulsory Schooling on Earnings. Evidence from the 1999 Education Reform in Poland**

### **Abstract**

In 1999, a reform of education was introduced in Poland, which added one year to the shortest available educational path, leading to the acquisition of basic vocational education. In the new system, students choosing this path acquire one more year of general education, which, according to the authors of the reform, should improve their position in the labor market, as the inadequate general skills were identified as the main deficit of basic vocational education prior to the reform.

Using the regression discontinuity design and data from the Polish LFS, I find that an additional year of general education has led to an increase in hourly wages of males who completed basic vocational schools, by more than 50%. This effect is much higher than in similar studies referring to other countries. This may be due to the fact that the extension of compulsory schooling in Poland affected individuals with relatively low general skills and abilities, who were willing to finish their formal education as soon as possible, i.e. at the minimum school-leaving age.

## Introduction

In recent years, the regression discontinuity design (RDD) has been quite frequently used as a method of estimating the wage premium from formal education, with respect to changes in the compulsory schooling age. This method allows for estimating the local average treatment effect (LATE) resulting from the lengthening of compulsory schooling. Some empirical studies using this method point to a fairly high wage premium from an additional year of education, of about 10% (Oreopoulos 2008), but there are also studies showing a zero premium (Devereux and Hart 2010, Grenet 2013). So far, the empirical evidence has been coming mainly from the Western European countries, the United States and Asia. The RDD method has not been used in relation to education reforms implemented in the Central and Eastern European countries (CEEC), yet.

The reform of education instituted in Poland in 1999 seems to be a good example of a reform of education in a CEEC, which can be used to estimate the wage premium from compulsory education. The basic change was a shift from a two-tiered education system (primary + secondary school) to a three-tiered one (primary + lower secondary + secondary school). The introduction of a an entirely new school type: the lower secondary school - called "gymnasium" - to the education system in Poland was most visible to the public, therefore gymnasiums have become a symbol of the education reform of 1999. For pupils wishing to pursue secondary education, the number of years of schooling throughout the education path did not change. At the same time, the shortest available education path, leading to the basic vocational education, was extended from 11 to 12 years. In the new education system, those who choose the shortest path have to study for one year longer in comprehensive schools, which, according to the reformers, should improve their position in the labour market, as the relatively low general skills acquired in basic vocational school were considered to be an obstacle in the future career development.

Drucker and Horn (2016) attempted to evaluate the impact of the 1999 reform on the position of individuals in the labour market. They found that the reform led to an increase in earnings by 3% on average. It seems, however, that the attribution of this effect to the educational reform may not be fully justified, because the first cohort of pupils covered by the reform was also the first cohort to attend two-cycle (3+2) studies. The situation of HEI graduates in the labour market can therefore be affected by both these reforms. Thus, we restrict our analysis to those only who have completed the shortest education path, leading to the basic vocational education, as they had to study for a year longer as a result of the reform. Secondly, Drucker and Horn (2016) used the DID method, which is justifiable for reforms which are implemented progressively, i.e. at different times in different administrative units. To evaluate the effects of reforms implemented simultaneously in all schools across the country, the RDD is most commonly used, and this is the method we use in our study. Thirdly, our research is based on a different database.

Drucker and Horn (2016) used data from the EU-SILC database for the period 2005-2013 with a total of 48,557 observations. Owing to the availability of unit data from the Polish LFS for the period of 2000-2015, we were able to use a database of 55,157 observations, having reduced it to individuals with basic vocational education.

We find that the additional year of general education resulting from the 1999 reform has led to a more than 50-percent increase in hourly wages for men with basic vocational education. The effect is much higher than reported in similar studies for other countries. This may be due to the fact that compulsory education was extended for individuals with relatively low abilities and general skills, who, had the reform not occurred, would have studied one year less.

The paper is structured as follows. The first section describes the reform of education introduced in Poland in 1999. In the second section, we briefly review the empirical literature on the wage premium from compulsory education, with a focus on the methodologies and the findings. In sections 3 and 4 we present the method and data used in our analysis. Finally, in the last two sections we present the results and the most important conclusions.

# 1. The 1999 education reform in Poland

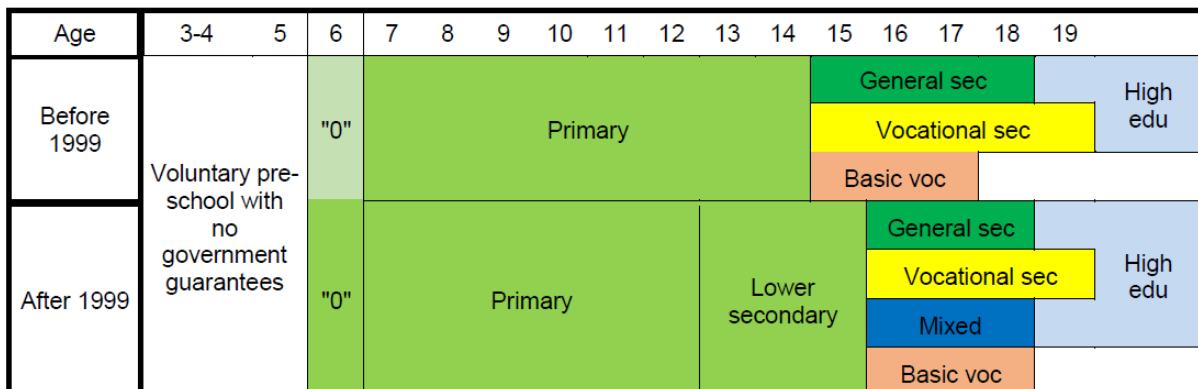
The reform of education, launched in 1999, had three main objectives: 1) to improve the quality of education; 2) to raise the level of education of the society by increasing the percentage of young people pursuing secondary and tertiary education; and 3) to insure equal educational opportunities, especially by improving the opportunities of the youths in rural areas.

## The scope of the reform

The reform was comprehensive in its nature, as it introduced changes in many areas, including: the structure of the education system, curriculums, the system of examinations, the system of professional promotion and remuneration of teachers, school management and financing, as well as supervision of school work. For our analysis, the first of these changes, i.e. the structural reform, was crucial.

**The structural reform** replaced the two-tiered education system (8 + 4) with a three-tiered one (6 + 3 + 3) (see Figure 1). In the old system, children aged 7 were obliged to start education in an eight-year primary school, after which they could continue at a secondary school (4 years of comprehensive secondary school or 5 years of vocational secondary school) or at a basic vocational school (3 years). In the new system, compulsory general education was extended from 8 to 9 years and divided into two stages - 6 years of primary school and 3 years of lower secondary school, called gymnasium. Those who complete gymnasiums may choose to attend secondary school or basic vocational school. The education cycle in secondary schools is one year shorter than in the old system (3 years in a comprehensive secondary school and 4 years in a vocational secondary school). In addition, a new type of a secondary school – a profiled comprehensive school - was created, in which the education cycle takes three years. The basic vocational school remained a three-year school.

Figure 1. Changes to the Polish school system over time.



Source: adapted from Jakubowski (2015).

In the new education system, the length of education paths leading to the completion of a secondary comprehensive or secondary vocational school remained the same as before the reform - 12 and 13 years, respectively. But at the same time, the shortest available education path, leading to the basic vocational education, has been extended from 11 to 12 years. Those who choose the shortest path have to study for one year longer in comprehensive schools, which, according to the reformers, should improve their position in the labour market, where general competencies are required as those enabling one to acquire new knowledge and skills throughout the professional career. Previously, the relatively low general skills provided by basic vocational schools were considered to be the main deficit of this type of education.

**The curricular reform** was a necessary result of the structural changes to the education system, but it also introduced substantial qualitative changes. First of all, several curricula were created for each subject, giving a teacher the opportunity to choose one of them or to use a self-developed curriculum, subject to approval by the regional educational authorities. Curricula have, however, to be consistent with the country-wide "Curricular basis" and "Standards of requirements" that define the essential knowledge and skills that a student should possess. Secondly, in the new curricula the emphasis was placed on the formation of skills, while limiting the necessity to memorize facts. Thirdly, the curricula were to allow for a holistic acquiring of knowledge and skills (Zahorska 2009).

**The reform of examination system** consisted of introducing a system of uniform external test examinations at the end of each educational stage (primary, lower secondary, secondary school). They replaced two previously existing exams, where no comparability existed: the secondary school entrance exams and the maturity exam (taken at the end of secondary school). In the new examination system, the tests developed by the Central Examination Board (CKE) are identical across the country, which ensures comparability of scores. In addition, the students' achievements at each educational stage provide a basis for calculating the so-called Educational Value Added (EWD) for individual lower secondary and secondary schools. The widespread availability of information about the results of the examinations and the EWD provides motivation for schools to improve the quality of education.

**The changes to the system of professional promotion of teachers** also aimed at improving the quality of education. In place of the previous two degrees of promotion, four degrees were introduced. In order to motivate teachers for professional development, a significant progression of wages along with career advancement was guaranteed: the rates to be paid to those who have achieved the highest status were set at 225% of the initial wage.

## **The implementation schedule**

The structural reform of the education system was launched on September 1, 1999. The students who completed the sixth grade of primary school began their first grade of gymnasium (instead of going to the seventh grade of primary school). This means that the reform affected children born on or after 1 January 1986, while children born until 31 December 1985 continued their education in the old system. The first cohort affected by the reform entered secondary schools in 2002 and completed them in 2005 (comprehensive secondary schools and basic vocational schools) or 2006 (secondary vocational schools). The first students who undertook university education having completed the new secondary schools could have graduated from the first degree in 2008 at the earliest, while from the second degree or unified master's degree – in 2010 at the earliest.

The final examinations after primary school (sixth grade exam) and gymnasium (gymnasium exam) were first held at the end of the school year 2001/2002, and the first maturity exam after the completion of the new secondary school (the new *matura*) took place in the school year 2004/2005. The first three cohorts covered by the reform (1986-1988) took only two new exams (after gymnasium and secondary school) but starting from the fourth cohort (1989) all the three new exams were taken (including the sixth grade exam).

In the initial period of the reform, there were problems with the implementation of new curricula. The rapid pace of curriculum development in gymnasiums resulted in errors and gaps. Textbooks were printed at the last moment, so teachers often used to "buy sight unseen". Furthermore, some textbooks were not sent to schools on time (Zahorska 2009). These problems were, however, transient, so one can expect that in spite of them the curricular reform has contributed to the quality of education.

## **The expected effects of the reform**

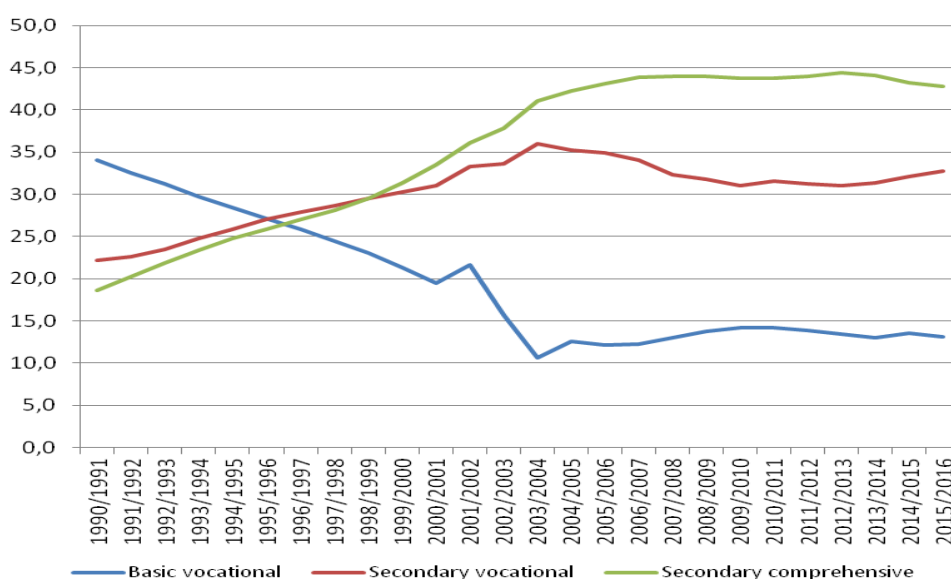
One of the main aims of the reform was to improve the quality of education, so as to achieve an increase in the general competences of secondary school graduates, and thereby increasing their readiness to acquire new knowledge and skills in further education (higher education) and / or at work. All the changes were expected to contribute to this effect, the main contributors being: 1) the extension of compulsory general education by one year, 2) skill development oriented curricula, and 3) an external examination system.

It is argued that a spectacular improvement of the results obtained by 15-year-old Poles in the international PISA test of competencies between 2000 and 2006 was a tangible effect of the 1999 education reform (Jakubowski et al. 2010). In 2000, the PISA test was taken by pupils attending the first grade of post-primary schools (secondary comprehensive, secondary vocational and basic vocational schools) who were educated in the old system, while in 2003 and 2006 the test was taken by pupils learning in the new system, who were

attending the third grade of gymnasium. The results of the math test were 470, 490 and 495 points in 2000, 2003 and 2006, respectively, while the results from the reading test were 479, 490 and 508, respectively. While the reading test result obtained in 2000 was below the OECD average, in 2003 it reached the OECD average level, and in 2006 it exceeded the OECD average, giving Poland the ninth place in the world. Jakubowski et al. (2010) report that this improvement was mainly owing to better results obtained by students of vocational schools (basic and secondary). The authors argue, that the improvement demonstrated by vocational school students may be a result of the additional year of comprehensive education introduced by the reform, which translated into more teaching hours of Polish language and mathematics. However, it is also possible that the improvement in PISA test scores was influenced by the introduction of external tests as an element of the reform. The students who participated in the PISA test in 2000 were not familiar with the test solving technique, while those taking the PISA test in 2003 were no strangers to this method, as they had been solving tests while preparing for the gymnasium exam. What is more, the pupils taking the PISA test in 2006 had even more experience in solving tests, as they had already passed the sixth grade test and then had been prepared for the gymnasium exam.

The second expected effect of the reform was an increase in the percentage of young people choosing secondary and higher education. In fact, a gradual growth of the young people's educational aspirations has been observed since the early 1990s (see Figure 2). The reform was intended to intensify this process. The reformers assumed that within 10 years, the percentage of basic vocational school students would drop to 20%, while the percentage of students attending secondary schools and higher education institutions would reach 80% and 50%, respectively.

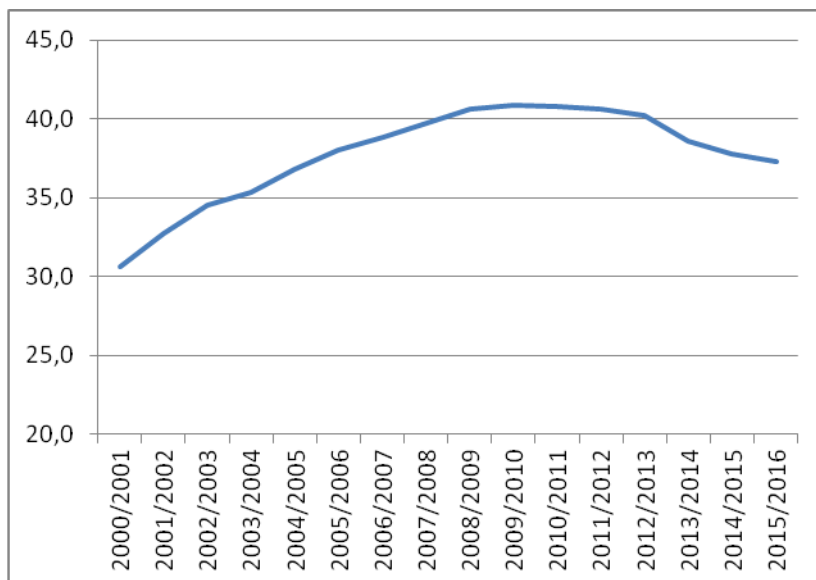
Figure 2. Net enrolment ratio in post-primary and post-gymnasium schools in Poland in 1990-2015



Source: author's analyses based on data from GUS (1992,...,2015).

The first of these aims was achieved in the school year 2000/2001 already, when the last cohort of the eighth-graders passed to secondary schools. This was when the net enrollment ratio in basic vocational schools dropped to 19.5% (from 21.3% in the school year 1999/2000). In the school year 2002/2003, when the first cohort of gymnasium certificate holders passed to post-gymnasium schools, the rate dropped even further, to 15.7%, to stabilize at the level of 12-14% in the subsequent years. At the same time, the percentage of young people attending secondary schools increased, with the total net enrollment ratio growing from 61.7% in the school year 1999/2000 to 78% in the school year 2005/2006 – the first year, when secondary schools were attended by gymnasium certificate holders only. When cohorts affected by the reform left secondary schools and passed to higher education institutions, the net enrollment rate in higher education increased slightly - from 38% in the academic year 2005/2006 to 40.9% in the academic year 2009/2010, when it reached its maximum level (see Figure 3).

Figure 3. The net enrollment ratio in higher education in Poland in 2000-2015



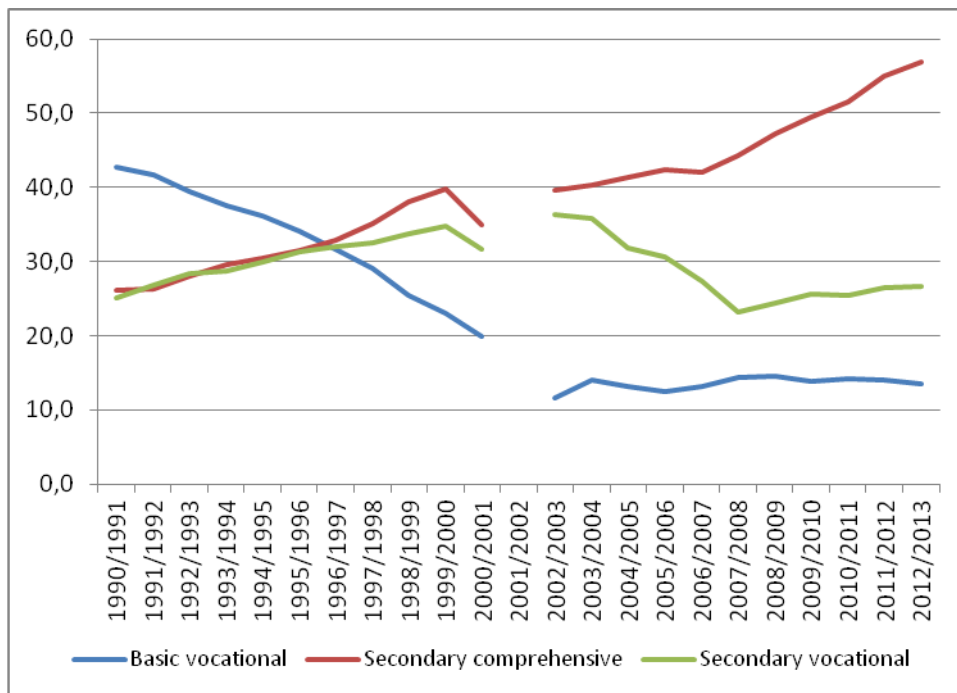
Source: author's analyses based on data from GUS (1992,...,2015).

Obviously, the above changes in the enrollment ratios do not prejudge the occurrence of causal relationships. Causal dependence can be expected in the case of enrollment ratios in basic vocational and secondary schools, as the reform reduced the difference between the years of schooling in secondary vocational and basic vocational schools from two years to one year. After the reform, getting a secondary vocational diploma requires only one year of schooling more than getting a basic vocational diploma, not two years more as before. Thus, the alternative cost of obtaining a secondary vocational diploma dropped, which could have motivated some of the gymnasium certificate holders to choose secondary vocational schools instead of basic vocational ones. This is confirmed by data from tracer studies of graduates of the primary schools under the old system and gymnasiums. While in the school



year 2000/2001, when the last cohort of eighth grade certificate holders passed to post-primary schools, about 20% of them decided to go to basic vocational schools. Two years later, when the first gymnasium certificate holders had to choose a post-gymnasium school, only 12% of them chose a basic vocational school. Hence, the reform triggered a sharp and significant decline in interest to attend basic vocational schools (see Figure 4).

Figure 4. Percentage of the old type primary school certificate holders and gymnasium certificate holders who continued formal education, by school types, in 1990-2012



Source: author's analyses based on data from GUS (1992,...,2015).

However, as far as the change in the enrollment ratio in higher education is concerned, it does not seem possible to identify the causal effect, as the recruitment for higher education of the first cohort of gymnasium certificate holders, conducted in the academic year 2005/2006, coincided with the introduction of two-cycle (3+2) studies (Kwiek, 2014). Hence, the increase in the enrollment ratio in higher education in 2005-2009 could be attributed both to the better preparation of secondary school leavers to study, as well as to their higher motivation to pursue studies resulting from the possibility of obtaining a university diploma after three years (a BA degree) and not after five years, as it was before the implementation of the Bologna system (an MA degree).

To conclude, the analysis of the impact of compulsory education on earnings seems to be justified only for those who have completed formal education after obtaining a basic vocational school diploma. One can expect a positive impact of the additional year of general education on their earnings. Due to the comprehensive nature of the reform, earnings could be affected not only by the extended schooling but also by the improved quality of

education achieved owing to the new curriculums, the external examination system and the new teacher compensation system. Regrettably, it is not possible to separate the impact of each of these two factors on earnings. It is worth noting, however, that while the increase in the compulsory years of schooling occurred immediately after the introduction of the reform, the improvement of the quality of education was gradual.

## 2. Review of literature

The research of the wage effects of compulsory education was originated over 20 years ago and the methods used have undergone some evolution since then. Initially, the instrumental variable (IV) method was used, following the Harmon and Walker (1995). The method boils down to estimating the Mincer wage equation, in which the years of schooling are instrumented by the compulsory school age. The average effect of extending the compulsory period of formal education is estimated as the ratio of the increase in earnings to the increase in years of schooling between the cohorts before and after the reform. In fact, this is an effect that applies to those only who, as a result of the reform, learn longer than they would have learned in the absence of reform, which is called the local average treatment effect (LATE) (Imbens and Angrist 1994).

The disadvantage of the above method is that it does not take into account the wage effect of changes in years of schooling which resulted from other reasons than the educational reform that increased the minimum school-leaving age. The positive wage premium may be due to the fact that regardless of the reform, the years of schooling are growing in successive cohorts of young people and so are the wages. So, two other approaches are used that eliminate this problem.

The first approach is the DID method, which can be used when the educational reform is not implemented simultaneously across the country, but gradually, i.e. at different time in different administrative units (Oosterbeek and Webbink 2004; Meghir and Palme 2005; Pischke and von Wachter 2008; Pekkarinen et al. 2009; Fischer et al. 2016). Pupils from units where the reform was introduced at the beginning are the treatment group, while those from units where the reform was introduced later are a control group. The average causal effect of the reform is estimated as the difference between wage growth rates in the treatment and control groups. In order for LATE to be consistent, the implementation of the education reform cannot be correlated with the implementation of other reforms or with any of the characteristics of the administrative units which influence the explanatory variable. So if, for example, the education reform will be implemented first in dynamically growing regions where wages are rising rapidly, the estimator of the wage premium will be biased.

The second approach is to estimate the regression discontinuity design (RDD) (Oreopoulos 2006, Devereux and Hart 2010, Grenet 2013, Ou 2013, Fuwa and Korwatanasakul 2015, Chib et al. 2016). This involves comparing the years of schooling in formal education and the earnings of the first cohort affected by the reform and the last cohort preceding the reform. LATE is estimated as the ratio of the earnings growth to the increase in the years of schooling.

The results of the studies vary considerably, depending on the method used and the reform case being analyzed. The studies using the IV method usually show a positive effect of compulsory schooling on earnings. For example, Harmon and Walker (1995), analyzing the education reforms introduced in England and Wales in 1947 and 1972, report that both reforms led to a significant increase in earnings (15%). In later studies using the same method, the positive effect of compulsory schooling on earnings was also found in other countries (Levine and Plug (1999) for the Netherlands; Vieira (1999) for Portugal; Callan and Harmon (1999) for Ireland; Brunello and Miniaci for Italy, Pons and Gonzalo (2002) for Spain).

The studies using the DID method show little or no overall wage premium from compulsory education. Meghir and Palme (2005), analyzing the effects of extending the compulsory years of schooling in Sweden from 7-8 to 9 years in the 1949-1962 period, show that in general the reform did not affect earnings but it only led to a 3.4% increase in the earnings of individuals with unqualified fathers. Pischke and von Wachter (2008) report that the extension of compulsory years of schooling from 8 to 9 years, which was gradually introduced in Germany between 1949 and 1970, had no impact on earnings. Oosterbeek and Webbink (2007) show no wage effects of mandatory extension of years of schooling at secondary vocational schools from 3 to 4 years, introduced in the Netherlands in 1975. Pekkarinen et al. (2009) analyzed the effects of the education reform implemented in Finland between 1972 and 1975. They found that the extension of mandatory comprehensive education by three years had brought the wage benefits to individuals coming from families of low social status. In turn, Fischer et al. (2016) studied the effects of two educational reforms introduced in Sweden in the years 1930-1950. The first reform extended compulsory education from 6 to 7 years, while the second one extended the school year from 34.5 / 36.5 to 39 weeks. These reforms were not introduced at the same time in all schools, which allowed for separating the effect of each of them. It was found that both reforms brought wage benefits, but only to women - an additional year of schooling increased their wages in the initial period of their careers by 2%, and the extending of the school year led to a 4-5% increase in wages.

The studies using the RDD method also find that the effects of compulsory schooling are lower than the studies using the IV method show. Three of them concern the wage benefits of raising the compulsory schooling age in the UK from 14 to 15 years, which is the same reform that Harmon and Walker (1995) analyzed. Oreopoulos (2008) shows that this reform led to a 10% increase in earnings, while Devereux and Hart (2010) indicate that the earnings growth was much lower - only 3% - and only for men. In turn, Chib and Jacobi (2016) using a fuzzy regression discontinuity design model estimate the increase in earnings at 5-6%. In all the three studies, the wage premium is lower than that found by Harmon and Walker (1995). In turn, Grenet (2013) conducted a comparative study of the effects of raising the compulsory school age from 15 to 16 years in France and in England and Wales. He

found that in France the reform did not affect wages, while in England and Wales the hourly rate increased by 6-7%. The author links the positive impact of the reforms in England and Wales to the fact that it led to an increase in the proportion of young people completing formal education with a diploma confirming their competences, which was not the case in France. Eble and Hu (2016) show that the extension of compulsory primary education by one year in China in 1980 led to an increase in wages on average by 2%, with a slightly higher wage premium obtained by individuals coming from low-income families. Finally, Fuwa and Korwatanasakul (2015) report that the extension of compulsory primary schooling from 4 to 6 years, which was introduced in 1978 in Thailand, resulted in a ca. 8% increase in wages.

To sum it up, the results obtained differ, depending on the method used. In particular, the wage premium estimated using the DID and RDD is lower than the one estimated using instrumental variables. Many studies using these first two methods, however, show a positive impact of compulsory schooling on wages. In some studies - for example those referring to the education reforms introduced in Sweden in the 1950s and in Finland in the 1970s - the estimated wage premium cannot be attributed solely to increased years of compulsory schooling, as the reforms introduced also some changes to curricula.

### 3. Method

As the 1999 reform of education was implemented simultaneously across the country, the RDD is the most appropriate method for analyzing its effects .

The discontinuity lies in the fact that individuals born until 31 December 1985 were able to obtain a basic vocational school certificate after 11 years of schooling, while those born on 1 January 1986 or later had to study for 12 years to obtain the same certificate, as the reform extended comprehensive education by one year. Based on the theory of human capital, one could expect that an additional year of education will lead to an increase in general skills of students completing basic vocational schools and, consequently, to an increase in their productivity and earnings.

The strength of the above relationship may be impacted by two phenomena resulting from the decline in the net enrollment ratio in basic vocational schools, i.e. a growing negative selection of individuals attending basic vocational schools and a decrease in the supply of individuals completing these schools. As regards the first of these phenomena, it should be noted that the declining net enrollment ratio in basic vocational schools since 1990 was accompanied by a growing interest in attending secondary vocational and secondary comprehensive schools (see Figure 2). It seems natural to assume that, because the entrance exams to secondary schools (both comprehensive and vocational ones) are obligatory, those who attend these schools are relatively more able. Thus, from the early 1990s, as well as throughout the implementation of the education reform, the negative selection of candidates to basic vocational schools was increasing. This negative selection can be expected to diminish the economic benefits from an additional year of education, including the wage premium.

The drop in the supply of basic vocational school certificate holders resulted from the declining net enrollment ratio as well as from the fact that due to the reform there was no recruitment for basic vocational and secondary schools in the school year 2001/2002. Therefore, in the school year 2003/2004 only 40 thousand people completed basic vocational schools, while in the previous year – 142 thousand (GUS 2004). The first cohort covered by the reform left basic vocational schools in the school year 2004/2005, with 75 thousand completion certificates issued. Theoretically, one might expect that the decline in the number of graduates and thus the decrease in the labor supply of individuals with basic vocational education would lead to higher wages in this group. It seems, however, that this effect should not affect the results of the analysis, for two reasons. Firstly, the drop in the number of basic vocational school completion certificates issued in the school year 2003/2004 by about 70,000 with respect to the trend line is negligible when compared to the total number of working-age population with this education level, which amounts to approximately 8 million people (it was less than 1%). Secondly, the increase in earnings due

to the decrease in labor supply should affect all the individuals with basic vocational education and not only the cohorts covered by the reform.

Based on previous studies performed using the fuzzy RDD (Oreopoulos 2006, Devereux and Hart 2010, Grenet 2013, Fuwa and Korwatanasakul 2015) we estimated the first stage equation and the reduced-form effect of the raising of the minimum school-leaving age by means of a global polynomial approximation. This methodology involves using the whole sample and choosing a high-order polynomial to fit the relationship between the outcome variable  $Y_i$  (number of years of education, earnings) and the forcing variable  $X_i$  (school cohort), allowing for an intercept shift at the cut-off, i.e. at the first cohort affected by the reform.

The first stage equation takes the form:

$$SCH_i = \alpha_0 + \alpha_1 REF_i + g(X_i - 1986) + \varepsilon_i \quad (1)$$

where: dependent variable  $SCH_i$  is the number of years of formal education,  $REF_i$  represents the fact of being covered by the education reform (it takes value 0 for individuals born up to 1985 and 1 for individuals born in 1986 or later),  $g(.)$  is a quartic polynomial function,  $X_i$  - the respondent's year of birth, and  $\varepsilon_i$  is a random error. In equation (1), the key parameter is  $\alpha_1$ , which measures the average treatment effect (ATT) of the increase in compulsory school-leaving age on the years of schooling of individuals born in 1986.

The reduced form of the wage equation takes the form:

$$\ln W_i = \beta_0 + \beta_1 REF_i + g(X_i - 1986) + v_i \quad (2)$$

where: the dependent variable  $\ln W_i$  is the logarithm of hourly earnings,  $REF_i$  represents the fact of being covered by the education reform,  $g(.)$  is a quartic polynomial,  $X_i$  - the respondent's year of birth, and  $v_i$  is a random error. In equation (2), the key parameter is  $\beta_1$ , which shows the average treatment effect (ATT) of the increase in compulsory school-leaving age on the hourly earnings of individuals born in 1986.

Finally, in order to identify the effect of the increase in compulsory school-leaving age on hourly earnings, the following equation was estimated using 2SLS:

$$\ln W_i = \gamma_0 + \gamma_1 SCH_i + g(X_i - 1986) + \mu_i \quad (3)$$

where the variable which represents the fact of being covered by the education reform ( $REF_i$ ) was used to instrument the years of formal schooling ( $SCH_i$ ). In equation (3), the key parameter is  $\gamma_1$ , which can be interpreted as LATE, i.e. it represents the wage premium from an additional year of comprehensive education obtained by individuals born in 1986 who studied a year longer because of the reform. Such an interpretation requires the monotonicity assumption to be met (Imbens and Angrist 1994), which means that the increase of compulsory school-leaving age should prompt some of the individuals covered by

the reform to study longer, but at the same time it should not induce anyone to shorten their schooling. It seems that in the case of individuals deciding to study in basic vocational schools this condition is met.

Since the age of respondents is a discrete variable, it needs to be taken into account when estimating standard errors, that observations within individual cohorts are not independent of each other. Therefore, as suggested by Lee and Card (2008), robust standard errors were obtained by clustering at the cohort level.



## 4. Data

The analysis of the 1999 education reform impact is based on individual data from the Polish Labor Force Survey (LFS) for years 2001-2015, carried out by the Central Statistical Office (GUS).

The sample consists of school certificate holders only, who are defined as individuals who completed formal education at least 12 months prior to the study and were not continuing schooling at the time of the study. In addition, the sample is limited to those who have completed basic vocational school at the most. Therefore, the sample includes also those who were continuing their education in a three-year secondary vocational school for graduates of basic vocational schools provided that they have completed the secondary vocational school and thus their highest education level completed is the basic vocational one. The years of schooling were computed by subtracting seven years, that is the age at which children are obliged to start primary education, from the age at which the respondent completed his / her last school.

The sample is limited to individuals born between 1980 and 1991 who completed formal education at the age of 16-25. The sample defined like this includes basic vocational school certificate holders from the new education system who were surveyed at most 10 years after leaving school, while some of the respondents studying in the old system were surveyed more than 10 years after leaving school. In order to improve the comparability of the two groups, the sample was limited to those who completed formal education at most 10 years prior to the LFS survey.

In addition, for the purpose of estimating the wage premium from an additional year of education, the sample is limited to the employed who reported the amount of earnings and working hours they had on the month prior to the survey.<sup>1</sup> Therefore, the analysis of wage premium does not cover the self-employed, because they are not asked to report the amount of income in the LFS. The descriptive statistics of the sample are shown in Table 1.

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<sup>1</sup> The earnings were corrected for inflation using CPI.

Table 1. Descriptive statistics of the sample

Variable	Number of observations	Mean	Standard deviation	Min	Max
School certificate holders, total					
Hourly earnings (PLN from 1995) ( $W_i$ )	13795	12.36	5.43	0.42	122.54
Employment rate ( $E_i$ )	55157	0.600	0.490	0	1
Covered by the education reform ( $REF_i$ )	55157	0.363	0.481	0	1
Year of birth ( $X_i$ )	55157	1985	3	1980	1991
Years of schooling ( $SCH_i$ )	55157	11.3	0.8	9	18
Age	55157	24.1	2.6	17	35
Tenure	55157	5.7	2.6	1	10
Female	55157	0.339	0.473	0	1
Towns	55157	0.677	0.877	0	2
Survey year	55157	2009	4	2001	2016
School certificate holders covered by the reform					
Hourly earnings (PLN from 1995) ( $W_i$ )	4222	14.54	5.66	5.17	67.31
Employment rate ( $E_i$ )	20029	0.635	0.481	0	1
Covered by the education reform ( $REF_i$ )	20029	1	0	1	1
Year of birth ( $X_i$ )	20029	1988	2	1986	1991
Years of schooling ( $SCH_i$ )	20029	11.6	0.8	9	18
Age	20029	23.8	2.2	18	30
Tenure	20029	5.2	2.3	1	10
Female	20029	0.311	0.463	0	1
Towns	20029	0.632	0.867	0	2
Survey year	20029	2012	2	2004	2016
School certificate holders not covered by the reform					
Hourly earnings (PLN from 1995) ( $W_i$ )	9573	11.40	5.04	0.42	122.54
Employment rate ( $E_i$ )	35128	0.580	0.494	0	1
Covered by the education reform ( $REF_i$ )	35128	0	0	0	0
Year of birth ( $X_i$ )	35128	1982	2	1980	1985
Years of schooling ( $SCH_i$ )	35128	11.2	0.8	9	18
Age	35128	24.2	2.8	17	35
Tenure	35128	6.0	2.7	1	10
Female	35128	0.355	0.479	0	1
Towns	35128	0.702	0.881	0	2
Survey year	35128	2007	3	2001	2015

Source: author's own analysis based on unit data from the Polish LFS for 2001-2015.

## 5. Results

As a starting point for analyzing the impact of the education reform, the wage equation was estimated using OLS on a full sample of the basic vocational school certificate holders. The hourly wages were regressed on the number of years of education, the quartic polynomial of school cohort and the dummy variables for each survey year. The obtained naive estimator of the wage premium from a year of schooling was used as a benchmark for later estimations of the causal effect of the reform. The results for men and women separately are presented in column 1 of Table 2. They show that hourly earnings are not correlated to the years of schooling, both for men and women.

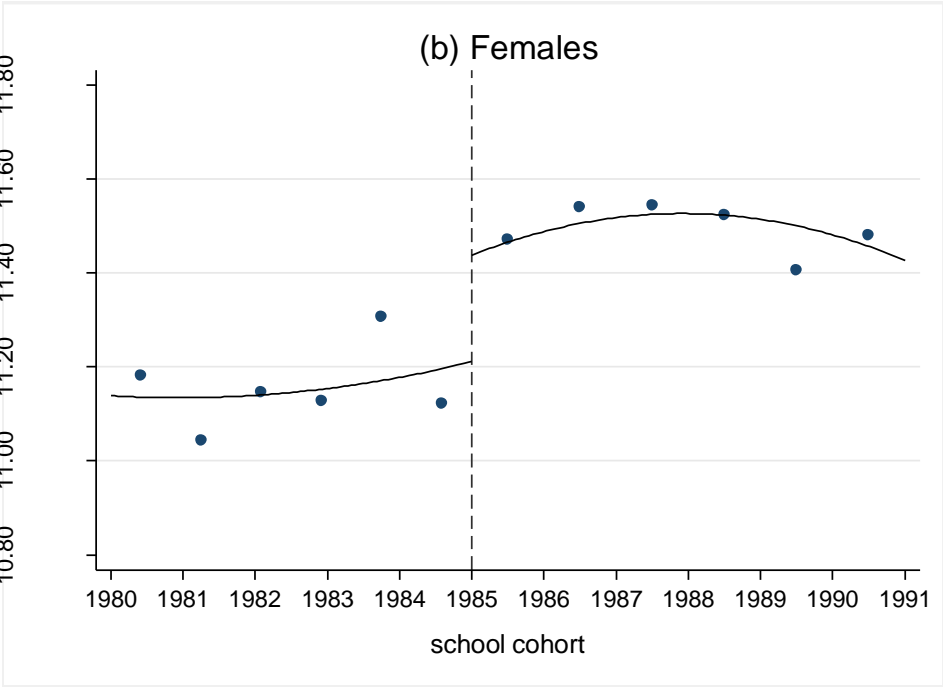
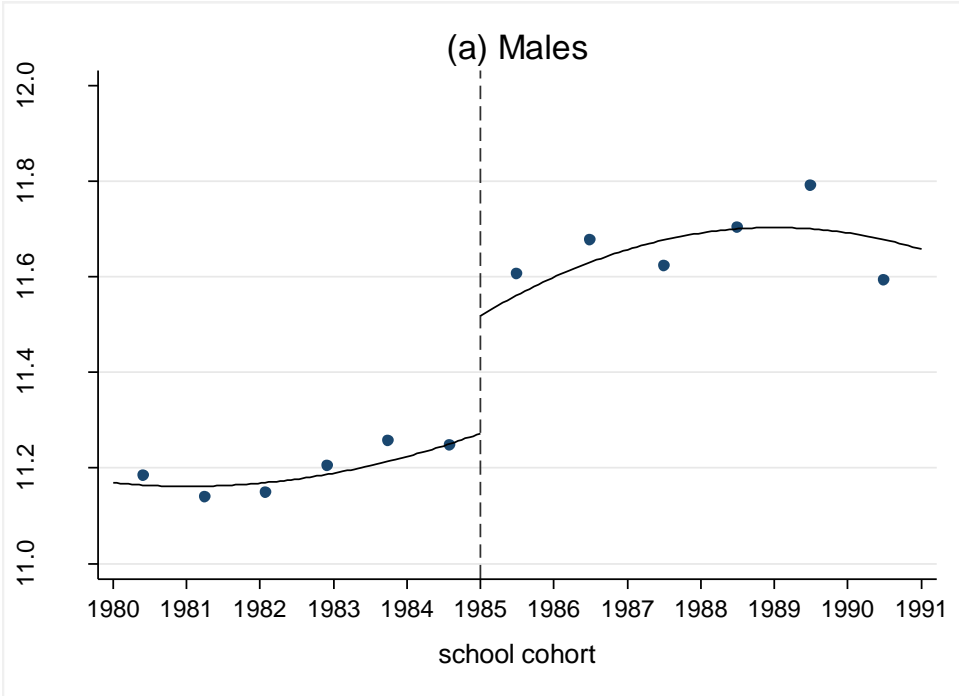
Column 2 in Table 2 presents the results of estimating the first-stage equation. They show that the 1999 education reform, which added one year to the education path leading to the basic vocational school certificate, had in fact a positive impact on the years of schooling of those completing this path. Both men and women covered by the reform studied on average 0.27 years more to get the certificate (column 2).

The positive impact of the reform on years of schooling is also evidenced on Figure 1. The solid lines show the fitted values from a local quadratic polynomial on each side of the cutoff. The visual inspection suggests that the average basic vocational school leaving age exhibits a substantial jump at the cut-off point.

Figure 2 plots the evolution of the log of hourly earnings across school cohorts, separately for males and females. It shows that there is a positive jump in the hourly earnings of males at the cutoff, while in case of females there is no earnings discontinuity. The econometric analysis confirms this visual impression. The results of the reduced-form equation, presented in column 4 in Table 2, show a positive impact of the reform on the hourly wages, but only for men who completed a basic vocational school. Those covered by the reform earn 7% more than those who were studying in the old system. As evidenced in column 6, however, the reform did not affect the employment rate of the basic vocational school certificate holders, neither women, nor men.

Finally, column 7 presents the 2SLS estimates, showing a positive impact of an additional year of schooling on the hourly wages for both men and women, amounting to 56 and 75 logarithm points, respectively. These results can be interpreted as LATE, that is as an increase in hourly wages obtained by individuals who extended their formal education by one year as a result of the reform.

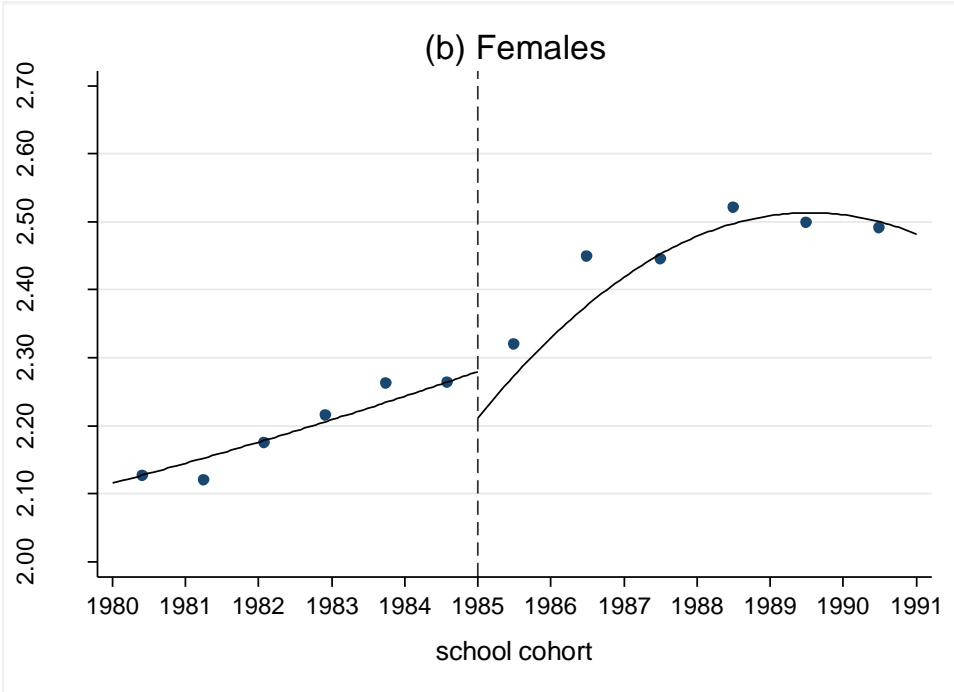
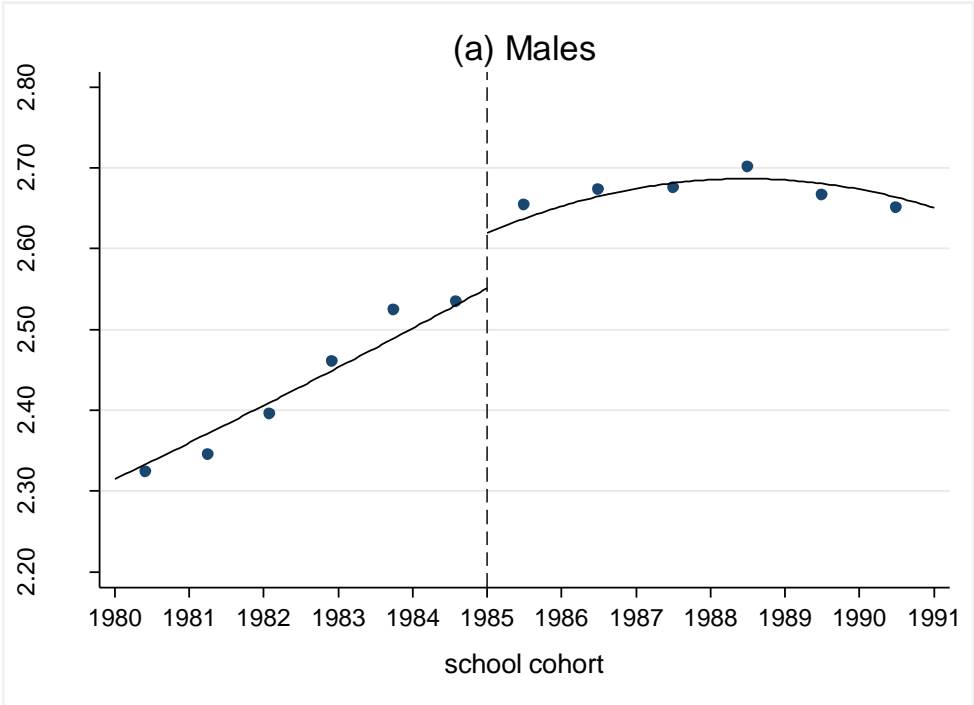
Figure 1. The impact of the 1999 reform on the average years of schooling, calculated separately males and females (school cohorts 1981-1990)



Note: The dots show the average age of leaving basic vocational school grouped at the school cohort cell for female and male wage earners who were born between 1980 and 1991. The solid lines represent the fitted values from a local quadratic polynomial regression, allowing for an intercept shift at the 1985 school cohort.

Source: author's own analysis based on unit data from the Polish LFS for 2001-2015.

Figure 2. The impact of the 1999 reform on the log of hourly earnings, calculated separately males and females (school cohorts 1981-1990)



Note: The dots show the average age of leaving basic vocational school grouped at the school cohort cell for female and male wage earners who were born between 1980 and 1991. The solid lines represent the fitted values from a local quadratic polynomial regression, allowing for an intercept shift at the 1985 school cohort.

Source: author's own analysis based on unit data from the Polish LFS for 2001-2015.

Table 2. The estimation of the 1999 education reform impact on the years of schooling, the hourly wages and the employment rate of graduates with basic vocational education

Gender		OLS	First stage		Reduced form			2SLS	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Hourly wage rate	Years of schooling	Years of schooling	Hourly wage rate	Hourly wage rate	Employment rate	Hourly wage rate	Hourly wage rate
Male	Coefficient	0.004	0.272***	0.320***	0.068***	0.022*	0.012	0.557***	0.734***
	(std. error)	(0.005)	(0.040)	(0.045)	(0.020)	(0.010)	(0.015)	(0.060)	(0.092)
	N	10327	10327	10327	10327	10327	37009	10327	10327
Female	Coefficient	0.003	0.273*	0.283*	0.001	-0.017	-0.014	0.749***	0.779***
	(std. error)	(0.008)	(0.132)	(0.145)	(0.047)	(0.032)	(0.013)	(0.105)	(0.142)
	N	3468	3468	3468	3468	3468	19194	3468	3468
	Potential years of employment	None	None	Quartic	None	Quartic	None	None	Quartic

Notes: 1) The survey year was added to each specification, and the age and age square were additionally included in specification (1); 2) \*\*\* / \*\* / \* denote 1%, 5% and 10% significance level, respectively.

Source: author's own analysis based on unit data from the Polish LFS for 2001-2015.

It can be expected that the wage premium from an additional year of compulsory schooling may depend on the years in employment, which are not the same in the treatment and control group. To minimize this problem, as previously mentioned, the control group is limited to those who completed formal education at most 10 years before the survey. The descriptive statistics of the sample show that individuals covered by the reform are on average 0.4 years younger than those studying in the old system and they have on average 0.8 years less of potential employment, measured as the period after the completion of formal education. The fact that difference in terms of potential years in employment is greater than that in terms of age, is probably due to the longer period of schooling of those covered by the reform. Anyway, we can expect that the slightly shorter potential years in employment of those covered by the reform will result in underestimation of the wage premium, especially when we take into account that earnings are rising relatively quickly during the initial stage of career. In order to eliminate this bias, the global quartic polynomial of potential years of employment was included in the model. The results are presented in columns 3, 5 and 8 in Table 2. As expected, the wage premium is higher when the potential years of employment are included in the model, reaching 73% for males and 78% for females.

The stability of the results obtained was checked in several ways. Firstly, their sensitivity to the functional form of the model was tested. In the related literature, the RDD method is usually used with a global quartic polynomial (Oreopoulos 2006, Devereux and Hart 2010, Grenet 2013, Fuwa and Korwatanasakul 2015). Gelman and Imbens (2016), however, claim that high-order polynomials should not be used in the RDD method and they recommend the use of linear local functions and quadratic polynomials. Therefore, we estimated the model using global and local functions, both linear and polynomial of the second and third order. However, for almost all functional forms tested, the results did not change qualitatively (see Table A1 in the Appendix).

Secondly, the analysis was performed for two other bandwidths of the forcing variable, that is for a broader bandwidth than the baseline, covering 1978-1993 cohorts, and for a narrower one, covering 1982-1989 cohorts. In both cases, the results are not qualitatively different from those obtained for the baseline bandwidth, i.e. 1980-1991 cohorts (see Table A2 in the Appendix).

Thirdly, the so-called placebo tests were done, that is we tested for the discontinuity of changes in the years of schooling at other points in time than the year 1999 when the reform was implemented. As suggested by Imbens and Lemieux (2007), the occurrence of discontinuity was tested both for the period before and after the reform. We tested for discontinuity in 1983, which is the median of school cohorts preceding the reform (1980-1985) and in 1989, which is the median of school cohorts covered by the reform (1986-

1991). The results show that there are no jumps in the years of schooling in both cases (see Table A3 in the Appendix).

## 6. Conclusions

The aim of the study was to determine, whether the education reform of 1999, which added one year to the shortest available education path, had any impact on the hourly earnings of those completing this path. Using the RDD method and the Polish LFS data, we find that an additional year of comprehensive education has resulted in a more than 50% increase in the hourly earnings of men holding basic vocational school certificates. This effect is much higher than those reported in similar studies in other countries, where the wage premium from an additional year of formal education is found to remain under 15% percent. The higher wage premium identified in our analysis may be due to the fact that our study did not address all the young people covered by the reform, but it focused on the holders of basic vocational school certificates only, i.e. those who, in order to complete formal education as soon as possible, had to attend a comprehensive school one year more as a result of the reform. It is also important that individuals, who considered attending a basic vocational school or a secondary vocational school, were more strongly motivated to study in a secondary vocational school as a result of the reform. While in the old system it took two years more to graduate from a secondary vocational school than from a basic vocational school, in the new system the difference was reduced to one year only, while the certificate of a secondary vocational school is evidently more valued by employers. It seems then, that those who decided to study at basic vocational schools under the new system, were even more determined to complete formal education as soon as possible. The results show that for this particular group, the effects of longer comprehensive education are strongly positive. However, this group represents only approximately 15% of the youths, so it is very likely that if we extended our study onto all those youth covered by the reform, we could find no impact on earnings, as many studies on the effects of education reforms in Western European countries do.

What is common for this study and the studies conducted for Western European countries, is the higher value of the wage premium estimated using 2SLS than with OLS. Such a result is usually interpreted as evidence of the compensatory role of increased compulsory schooling, as it shows benefits from compulsory schooling obtained by those who would not extend their years of schooling in the absence of such an obligation.

The results obtained are also consistent with those reported by Jakubowski and others (2010) on educational effects of the 1999 reform. The authors argue that the spectacular improvement of the results obtained by Polish students in the 2000-2006 PISA test is primarily due to the improvement of performance of the least able students. In the



light of these findings, the reform seems to be of a compensatory nature, as it leads to a reduction in the stratification of educational outcomes and, as a consequence, a decrease in wage differentials.

Obviously, it is puzzling why, with such a high wage premium from an additional year of schooling, basic vocational students are willing to finish formal education as soon as possible. There are a few potential explanations. Firstly, they may have no information on the magnitude of potential economic benefits from education. Secondly, obtaining these benefits in the future is not certain. Thirdly, for individuals with relatively low abilities, formal education may involve high mental costs.

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## Appendix

Table A1.

The estimation of the 1999 education reform impact on the years of schooling, the hourly wages of graduates with basic vocational education

Birth cohort controls		Male			Female		
		First stage	Reduced form	2SLS	First stage	Reduced form	2SLS
		(1)	(2)	(3)	(4)	(5)	(6)
		Years of schooling	Hourly wage rate	Hourly wage rate	Years of schooling	Hourly wage rate	Hourly wage rate
Global quartic	Coefficient	0,272***	0,068***	0,557***	0,273*	0,001	0,749***
	(std. error)	(0,040)	(0,020)	(0,060)	(0,132)	(0,047)	(0,106)
Global cubic	Coefficient	0,276***	0,061**	0,557***	0,239*	0,014	0,769***
	(std. error)	(0,040)	(0,021)	(0,059)	(0,132)	(0,056)	(0,110)
Global square	Coefficient	0,366***	0,098***	0,559***	0,321***	0,060	0,773***
	(std. error)	(0,017)	(0,012)	(0,066)	(0,080)	(0,045)	(0,123)
Global linear	Coefficient	0,364***	0,055	0,557***	0,298***	0,060	0,781***
	(std. error)	(0,017)	(0,048)	(0,066)	(0,097)	(0,036)	(0,119)
Local quartic	Coefficient	0,520***	0,223***	0,548***	0,993**	0,081*	0,707***
	(std. error)	(0,009)	(0,007)	(0,061)	(0,326)	(0,037)	(0,088)
Local cubic	Coefficient	0,460***	0,163***	0,555***	0,721***	0,127***	0,716***
	(std. error)	(0,022)	(0,011)	(0,059)	(0,144)	(0,015)	(0,088)
Local square	Coefficient	0,264***	0,051	0,557***	0,234	0,012	0,773***
	(std. error)	(0,045)	(0,029)	(0,061)	(0,152)	(0,031)	(0,113)
Local linear	Coefficient	0,365***	0,072***	0,560***	0,309***	0,058	0,771***
	(std. error)	(0,034)	(0,018)	(0,066)	(0,091)	(0,038)	(0,122)
	N	10327			3468		

Notes: 1) The survey year was added to each specification, and the age and age square were additionally included in specification (1); 2) \*\*\* / \*\* / \* denote 1%, 5% and 10% significance level, respectively.

Source: author's own analysis based on unit data from the Polish LFS for 2001-2015.

Table A2.

The estimation of the 1999 education reform impact on the years of schooling, the hourly wages of graduates with basic vocational education

Birth cohort range		Male			Female		
		First stage	Reduced form	2SLS	First stage	Reduced form	2SLS
		(1)	(2)	(3)	(4)	(5)	(6)
		Years of schooling	Hourly wage rate	Hourly wage rate	Years of schooling	Hourly wage rate	Hourly wage rate
1980-1991	Coefficient	0,272***	0,068***	0,557***	0,273*	0,001	0,749***
	(std. error)	(0,040)	(0,020)	(0,060)	(0,132)	(0,047)	(0,106)
	N	10327			3468		
1978-1993	Coefficient	0,311***	0,076***	0,608***	0,265**	0,015	0,815***
	(std. error)	(0,035)	(0,014)	(0,056)	(0,102)	(0,051)	(0,108)
	N	13687			4657		
1982-1989	Coefficient	0,362***	0,104***	0,480***	0,322***	0,015	0,613***
	(std. error)	(0,036)	(0,011)	(0,046)	(0,110)	(0,037)	(0,108)
	N	6788			2255		

Notes: 1) The survey year was added to each specification, and the age and age square were additionally included in specification (1); 2) \*\*\* / \*\* / \* denote 1%, 5% and 10% significance level, respectively.

Source: author's own analysis based on unit data from the Polish LFS for 2001-2015.

Table A3.

The results of placebo tests

Discontinuity cohort		Male			Female		
		First stage	Reduced form	2SLS	First stage	Reduced form	2SLS
		(1)	(2)	(3)	(4)	(5)	(6)
		Years of schooling	Hourly wage rate	Hourly wage rate	Years of schooling	Hourly wage rate	Hourly wage rate
1983	Coefficient	0,008	-0,005	1,593***	-0,252***	-0,030***	0,377***
	(std. error)	(0,011)	(0,009)	(0,238)	(0,046)	(0,006)	(0,141)
	N	7048			3468		
1989	Coefficient	0,061	0,047***	0,110	0,079	0,114***	0,143
	(std. error)	(0,125)	(0,09)	(0,096)	(0,058)	(0,023)	(0,533)
	N	3279			943		

Notes: 1) The survey year was added to each specification, and the age and age square were additionally included in specification (1); 2) \*\*\* / \*\* / \* denote 1%, 5% and 10% significance level, respectively.

Source: author's own analysis based on unit data from the Polish LFS for 2001-2015.