Education and Fertility through the Lenses of Four Censuses: Czech Republic 1980, 1991, 2001, and 2011

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Abstract

Besides age and gender as two fundamental demographic dimensions, educational attainment has been argued to be the most important socio-economic characteristic. However, the level of fertility by education is often not available from vital statistics using direct demographic methods. Therefore in this paper we make an effort to extract maximum information from the census data. Czech Republic has a tradition of well performed censuses providing highly detailed results. The question on the number of children the woman ever had was introduced already in 1930, and since 1980 the responses to this question can be combined with the characteristic of highest attained education. For four consecutive censuses 1980, 1991, 2001, and 2011 we thus have available detailed data on cohort, education, and number of children for women giving births across the whole twentieth century. We first use standard methodology of completed cohort fertility to study changes in level of fertility, and their decomposition due to changes in structure by education versus levels of fertility by education. We further proceed with the task to derive an information on the timing of cohort fertility. We evaluate three different methods: (1) deriving period fertility indicators from combination of *vital statistics* and the census data; (2) *pseudo-period* fertility rates that are derived solely from single census data; (3) method of estimating *intercensal* fertility rates and indicators. We chose the third method to be most clear and giving unbiased results, and with thus derived indicators we analyse the consequences of educational expansion after the Second World War, and the changing relation between education and fertility after the fall of communism in 1989. Last but not the least we hereby introduce data that will be part of the newly established online Cohort Fertility and Education Database at web page `www.eurrep.org`

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1 Introduction

While age and gender are the two fundamental demographic dimensions, there are many other biological and socio-economic characteristics that affect demographic behaviours. Among these, educational attainment has been argued to be the single most important one (Lutz et al., 1998; Lutz, 2010). Educational attainment captures the social and economic dimension of fertility, adding the "quality" dimension. Education is frequently regarded as one of the most important factors in fertility decline in recent decades (Skirbekk, 2008; Lutz and KC, 2011).

Czech Republic has a tradition of well performed censuses providing highly detailed results. The question on the number of children the woman ever had was introduced already in 1930, and continued in all other censuses that followed since 1950 in roughly 10-year period. Since 1980 the responses to this question can be combined with the characteristic of highest attained education. Thanks to the Czech Statistical Office we have available four censuses with detailed data on cohort, education, and number of children per woman. This data will be later included to the newly established online Cohort Fertility and Education Database at web page `www.eurrep.org`

The level of fertility by education is not available from vital statistics using direct demographic methods, therefore in this paper we intend to extract maximum information from the census data, looking not only on the completed cohort fertility but derive also information on the timing of cohort fertility, decomposition of fertility changes, and further proceed with the analysis of period fertility developments.

This will allow us to respond the following questions:

- How has the level (*quantum*) of fertility changed since the Second World War, and what were the driving forces behind the change?
- How has changed the timing (*tempo*) of fertility, what is the role of educational expansion?
- How has changed the link between education and fertility after the fall of communism in 1989, and how it developed through the 1990s until the most recent period?

The structure of the paper is like follows: In the second chapter we discuss the theory on the impact of educational attainment on fertility levels and timing. The third chapter describes the background of education, work, family policies and childrearing in the Czech Republic since the Second World War until recent times. In chapter 4 we evaluate available methods for deriving indicators of level and timing of fertility from census data. The methods that were found appropriate for our analysis are utilised in chapter 5, where the results are further analysed. Chapter 6 discusses the methods and results and concludes the paper.

2 Theory — The impact of educational attainment on fertility

The negative relationship between women's education and family formation is one of the most consistently reported findings in the literature (e.g. Blossfeld and Huinink, 1991; Hoem, 1986; Kravdal, 2004; Kreyenfeld, 2006; Liefbroer and Corijn, 1999; Marini, 1984; Rindfuss et al., 1980; Rindfuss and Brewster, 1996; Skirbekk, 2008). Education affects fertility in various mechanisms. On the individual level, prolonged education leads to the postponement of the transition to adulthood, family formation and first birth (Blossfeld and Huinink, 1991; Bhrolcháin and Beaujouan, 2012). Subsequently, their completed fertility is lower, not only because of later onset, but also due to other socio-economic mechanisms (Becker, 1960). The relationship between educational enrolment and attainment on one side and family formation on the other is dependent on several conditions: in particular, it depends on the level of incompatibility of education, work and family and on the division of gender roles in society.

Liefbroer and Corijn (1999) recognise two dimensions of incompatibility of education and labour and family formation: the cultural dimension is related to values and norms concerning the role of women in society, and the structural dimension refers to actual social opportunities and constraints on the roles of women. In societies with a higher incompatibility of the women's roles, the negative effect of education on family formation is expected to be stronger. In the Czech society, the relics of socialist state society interfere with the outcomes of fast market change accompanied by a broad change in values and attitudes in a post-modern world.

There are several reasons why women with higher education postpone childbearing to later ages. First, because schooling is generally incompatible with childbearing in most societies, there is a direct effect of educational enrolment, which is longer for those in higher education (Blossfeld and Huinink, 1991; Kravdal, 2004). In fact, this effect intensified recently as more women entered higher education and the enrolment period for distinct levels of education lengthened (Rindfuss and Brewster, 1996). Schooling on distinct levels themselves has prolonged through the recent past. Second, after finishing schooling women with higher education tend to get better jobs, which means that the opportunity costs to them of having children become higher (Becker, 1960; Gustafsson, 2001) and there is a fear that early withdrawal from the labour market could result in "status loss" (Kreyenfeld, 2006). This effect tends to diminish or disappear at older ages, suggesting that women with higher education postpone family formation rather than reduce it (Liefbroer and Corijn, 1999; Blossfeld and Jaeninchen, 1992; Oppenheimer, 1988; Kravdal and Rindfuss, 2008). Higher educated women put more emphasis on the quality rather than quantity of their children, their higher earning potential will lower the tendency to marry and bear children (Becker, 1960).

In the advanced industrial society, values have become more important than the economic factors (Inglehart, 1990), and people with higher education are regarded more 'post-materialistic'. Similarly, the second demographic transition concept (Lesthaeghe and van de Kaa, 1986) stresses the effects of social and economic factors, cultural (secularisation) and technologic (contraception). Better educated women usually have better knowledge about contraceptive use and better access to contraception generally (Cleland and Rodriguez, 1988).

Concerning the direction of causality between educational level and timing of birth, the reciprocal relationship was found to be dominated by the effect from education to age at first birth (Rindfuss et al., 1980; Bhrolcháin and Beaujouan, 2012). However, there is persistent indirect effect of withdrawing from the educational career due to unwanted/unplanned pregnancy at young ages (Marini, 1984).

In our analysis we expect results in accordance with discussed theoretical considerations — broad differences in fertility level between educational groups, along with strong postponement of timing of births among better educated. However, in Czech Republic context, we expect some specific findings: higher uniformity among educational groups during socialist era, and the fast unfolding of the changes after 1989, with the emphasis on the exclusion of the lowest educated group of women.

3 Background — Education, work, family policies and childrearing in the Czech Republic

Since the collapse of the communist regime in 1989, the Czech Republic has been passing through an intense economic and societal transition. The fast development triggered profound changes in demographic behaviour, which were especially intense in the first half of the 1990s. The decline in fertility and nuptiality rates and the postponement of family formation until higher ages has been analysed extensively by many authors (e.g. Fialová and Kučera, 1997; Rabušic, 2001; Sobotka et al., 2003, 2008). Czech society has been facing a rapid transformation of fertility and nuptiality behaviour accompanied by the weakening of the coupling of the two processes, a spread of cohabitation, an increase in non-marital childbearing, a decrease in the proportion of "shotgun" marriages, the substitution of abortion by modern contraception, and persistently high divorce rates.

The highly secularised and increasingly consumerist Czech society had already become tolerant towards certain forms of non-traditional family behaviour before 1990, generally accepting abortions[1],

[1] Abortion on request has been introduced in 1957.

premarital sex, and divorce. The opening and pluralisation of the society since 1990 have brought a modest growth in post-materialism accompanied by a change in the values and attitudes of individuals (Rabušic, 2001). Increasing tolerance towards deviations from the traditional patterns, such as homosexuality or extra-marital childbearing reflects the permissiveness of Czech society and the degree to which individualization proceeded (Sobotka et al., 2003).

3.1 Female labour participation

Economic activity of women during the socialism was generally high, and university educated had only limited possibilities of career building. This contributed to the egalitarian fertility behaviours (Rychtaříková, 2004). The two-child model along with the low childlessness was the typical model for all groups of population in communist Czech Republic.

This almost universal female labour force participation (see Table 1), has declined only slightly after 1989, to 50 percent of all women older than 15 years in 2012, with another 4 percent on parental leave and 3 percent being house-wives (CZSO, 2013). However, the economic activity has become strongly correlated to the educational attainment of women: While only 18 percent of low educated was economically active, the percentage among university educated was 71 percent. As opposed to the situation in Western Europe, a large majority of employed women work full-time — only 9.6 percent of all employed women worked part-time in 2012 (CZSO, 2013). This proportion is slightly higher (about 11 percent) among lower educated and among university graduates. The lack of opportunities for part-time employment constitutes a constraint for women who want to combine work and childcare. Labour force participation rate of mothers with child younger than 6 years is second lowest in Europe, only after Turkey.

Table 1: Background characteristics of women (at age 15+)

Variable	**1950**	**1961**	**1970**	**1980**	**1991**	**2001**	**2011**
Female labour force participation rate	41.8%	53.5%	56.4%	61.1%	60.6%	53.9%	50.6%
Proportion of primary educated	85.9%	82.6%	65.7%	54.3%	40.9%	29.1%	22.1%
Proportion of university educated	0.3%	0.9%	1.9%	3.2%	5.1%	8.4%	13.3%
Total Fertility Rate	2.80	2.13	1.91	2.10	1.86	1.15	1.43
Mean Age at First Birth	23.8	22.9	22.5	22.4	22.4	25.3	27.8

3.2 Family policies and childcare

The declining fertility over the 1950s and 1960s led the government to expand its family-related policies, with the objective of providing financial benefits and welfare incentives to encourage childbearing while enabling mothers to remain in the labour force (Sobotka et al., 2008). Paid maternity leave of 18 weeks was established in 1957, later extended to 28 weeks. Additional maternity leave lasting up to the child's first birthday was established in 1966, initially paid only for second and higher-order children, and subsequently expanded to two years in 1970 and three years in 1989. Child benefits were introduced, increasing progressively with the number of kids. Also retirement age for women was adjusted according to the number of children they had.

Other pronatalist measures in the beginning of the 1970s involved special loans for the newly-weds (partly amortized after each childbirth), massive housing construction, preferential distribution of housing to families with children, and development of childcare facilities. There was a high level of institutionalised childcare during the socialist period, making it easier for women to combine child-bearing (which occurred often at very young ages) with work. After 1990, the supply of nurseries for children younger than 3 years of age almost collapsed. In 2011 there were only 46 state-run nurseries, serving 1.8 thousand of children (IHIS, 2012), whereas kindergartens are still widely available for free and used by about 84 percent of children aged 3–5 years (Ministry of Education, 2012).

After 1989, family policies were transformed and they lost their previous pronatalist orientation. They ceased to be based on the number of children, being incorporated into broader social welfare policies aimed at reducing income inequality and poverty, and providing social security. Previously universal birth grant is now means-tested, only paid to low-income families with income less than 2.4 multiple of minimum subsistence level (480 EUR[2] for one child; 722 EUR for twins etc). During maternity leave women receive an allowance based on 70 percent of their previous salary (minimum 9 EUR and maximum 39 EUR daily) for 28 weeks[3]. Parents can then continue into parental leave with allowance of total amount of maximum 8150 EUR (also based on 70 percent of previous salary) to be distributed during chosen period of 19–48 months.

The paid parental leave in the Czech Republic is thus one of the longest in Europe, with three years of granted job position. The current social system is fairly generous and encourages mothers with young children to stay at home, contributing to the educational differences with regard to family formation: lower educated women with worse career prospects and lower wages tend to stay home with children, while better educated women postpone or forego childbearing on behalf of their professional careers. While women tend on average to utilise full 3 years of paid parental leave, and lower educated would prefer to stay in parental leave even longer and they return to work usually only for financial reasons, higher educated women tend to return to work from parental leave earlier than the lower educated, usually because of fear of status loss at employment, or because they are generally no satisfied with the status of women on parental leave (Chaloupková and Mitchell, 2009; Kuchařová et al., 2006). We also should mention, that the model of long parental leave, directly followed by another leave with second child, is since the 1970s strongly established in the Czech society. In 2006, 28 percent of women on parental leave with first child went directly to the leave with second child. This means that almost half of women with two children was on continual parental leave with first and then second child (Chaloupková and Mitchell, 2009).

However, although the job position is reserved by law, in reality young childless women often face discrimination during job interviews. Also, mothers face regression in job position and in wages after returning from parental leave (Kuchařová et al., 2006). On the other hand, it is disadvantageous for employer to keep the position open where he is uncertain when, and if, the employee will return to work. The proportion returning to the reserved position is again higher among better educated. Since 2001, parental leave can also be taken by the father of the child, but merely 1 percent of parental allowances are paid to men; interestingly, this proportion is higher among lower educated men (Kuchařová et al., 2006). The child allowances, paid to the child until it reaches the age of 15 (or until 26 when studying) are amongst the lowest in the EU, ranging from 18 to 26 EUR monthly depending on the age of the child.

The public in Czech Republic prefers direct financial payments to other measures of family policy. That is why the Czech government still concentrates on them, while most countries of EU now concentrate rather on policy measures leading to reconciliation of work and family. Czech family policies are unusually generous towards traditional breadwinner families (complete families with small children and one working parent). The public in Czech Republic is conservative in the opinion about labour force participation of mothers of young children (Testa, 2007), sharing popular Central-European belief, that small children suffer from parental absence (Mitchell, 2011).

3.3 Educational expansion through the twentieth century

Our analysis cover the cohorts 1920+, that lived most of their adult lives through the period since the Second World War. In this period profound changes in education of population took place in the then

[2]Values, actual for 2014, are expressed in euro (EUR), using exchange rate of 27 CZK to 1 EUR.

[3]This leave used to be longer (37 weeks) for lone mothers who confirmed they are not living with a partner, but was equalized in 2011. Duration of 37 weeks is kept for mothers of twins.

Czechoslovakia, and the Czech Republic (Fialová et al., 1990; Fialová, 2011). First census that covered educational attainment of population was that of 1950 (Bartoňová, 2007). Before that, in censuses 1890–1930, only the level of literacy has been recorded (*knows to read and write; knows just to read*) — the level was generally very high (more than 95 percent) already at that times. During the period of the *First Republic* (1918–1938), the previously common perception of secondary and tertiary education as a male domain gradually changed, as more female students was allowed to universities, and secondary and tertiary schools developed rapidly. Pre-war Czechoslovakia constituted formal equality of men and women in access to education, however, tertiary education was still rare. Compulsory basic school attendance was extended to eight years.

After the Second World War the educational reform took place, introducing uniform educational system under the full control of state. Education was provided for free, and centrally planned. Girls and boys followed different trajectories, with boys given higher quotas in blue-collar apprenticeship training and technical schools and universities, within the purview of "reproduction of blue-collar occupations" (Bartoňová, 2007), while girls being trained preferably for administration, health care and schooling. Number of female quotas on universities was always smaller than for male students. Since the 1970s the number of new universities has been established and the proportion of male and female there almost equalised, with considerable differences according to the subject of the study. However, under socialist egalitarian regime the application of human capital was possible only to limited extent.

After the system change in 1989, the university admission quotas were abolished, structure of study programmes has adapted (mainly from technical programs towards social and humanities curricula), and broad opportunities to study abroad have opened (Fialová, 2011). The perception of the importance of education has increased substantially. The economic transformation has generated the need for a highly educated workforce and the investment in education became economically advantageous because of the reduction in the risk of unemployment; and increasing income stratification. In 2012, the female unemployment rate of 8.2 percent (for male it was 6.0) was distributed extremely uneven through educational categories: among primary educated 25.9 percent of the female workforce were looking for a job, among secondary educated it was 8.7 percent, and among university educated only 3.4 percent were unemployed (CZSO, 2013). The wage level of university-educated employees rose from 134 percent of the average wage in 1988 to 157 percent in 2011 (CZSO, 2012), while the mean female wage was 79 percent of the mean male wage.

As found by Bhrolcháin and Beaujouan (2012), "the relationship between rising educational participation and the move to later fertility timing is almost certainly causal" (p. 1). Broader opportunities for higher education have led to the extension of the period spent by young people in education, but the education at certain levels also lengthened. Between 1995 and 2010, the number of expected years spent in education increased by 3.7 years to 18.0 years, 18.6 for male and 17.5 for female (OECD, 2012). Female participation in higher education rose faster than that of males — in the 2010–2011 academic year, 56 percent of students in Czech universities, and 60 percent of graduates, were women (Ministry of Education, 2012; Van Bavel, 2012). While in Census 2001, 17 percent of women at age 20–24 were students, in Census 2011 it was already 36 percent, and 4 percent at age group 25–29. The overall increase in the education of the female population is mirrored by the changing distribution of women by highest attained education (see Figure 4 lower).

3.4 Previous findings

The family formation of distinct educational classes was analysed by Kantorová (2004), Klasen and Launov (2006) and Pikálková (2003) using Family and Fertility Survey (FFS) data from 1997. Kantorová has found that women with an upper-secondary or university education have comparatively lower first-birth risks than lower educated women. Moreover, after 1990 the impact of women's education on the timing of entry into motherhood has intensified and the period between the completion of studies and entry into motherhood has lengthened, especially among university graduates. Also, according to Klasen and Launov, higher education has an increasingly strong impact on the postponement of births and there is also the positive relationship between the level of education and the probability of exit from childbearing after the first child is born. Pikálková found that the third-birth risk is more than twice higher for primary educated than for those with lower-secondary education, while the risk of university educated was about half.

Hamplová (2003) found that more educated women enter into marriage later, which can be however fully explained by their longer time of study. After completion of education, the rates of transition are the same as for lower levels of education.

Rychtaříková (2004) analysed the cohort fertility by education in censuses 1991 and 2001. She found highest completed cohort fertility of 2.22 children among women born in 1919, with very slow decline to 2.01 for women born in 1944. Further reverse increase came with the pronatalist policy in the beginning of 1970s. The pronatalist policies were used pragmatically by women with medium and high education, who reacted more sensitively than low educated women. Moreover, university educated women stay more often unmarried.

4 Data and Methods

In this section we first introduce the data, describing the census data in a detail, including the unknown cases, and how we deal with them. Then we introduce the methods, separately in following sections: First section deals with the completed cohort fertility and it's decomposition, second one with the period total fertility rates derived using vital statistics and the census data, third with the *pseudo-period* total fertility rates, that are derived solely from census data, and last one with the method of estimating *intercensal* fertility rates and indicators.

4.1 Data

All data used for fertility analysis in this article come from the Czech Statistical Office (CZSO). We use data from census 1980, 1991, 2001 and 2011, namely the tabulation of women by birth cohort, highest educational level attained, and number of children ever born[4]. The overview of the data and proportion of unknown cases is given in Table 2. It is notable that the proportion of unknown responses on the number of children question was considerable high in 2001 census (6.2 percent), and also in 2011 census (3.8 percent). As shown elsewhere (Zeman, 2013), it is very likely that a large majority of women who did not report their number of children were childless, and should be regarded as childless (for general evaluation of this problem see El-Badry, 1961). Proportion of unknown cohort is very small and we disregard this cases here. The proportion of unknown education has steadily increased through the last census (4.6 percent in 2011), but we have no other option than to drop these cases from analysis. Generally the quality of the censuses is very high and the response rate to the questions that are of our main interest (year of birth, educational attainment, number of children) is sufficiently high (Krausová, 2012).

Differential migration and mortality is disregarded in this paper, but we have in mind the higher mortality of women with lower education (Zeman, 2006; Bartoňová, 2007).

The definitions of attained educational level have been harmonised to ensure comparability across censuses and also to avoid too small educational groups. Initial 11, 11, 15 and 13 educational groups, respectively, were harmonised using the 1997 International Standard Classification of Education (ISCED97) into following four groups:[5]

1. Primary education: ISCED codes 0–2 (No education, primary and unfinished secondary school)

[4] In 1930, the question on the number of children was asked only to married women. In 1950, 1961 and 1970 the question was asked to all women at age 15 and older, but the cross-tabulation against education is not available. The question in 1980 to 2011 censuses followed UN recommendation: All women at age 15+ were asked "How many children have you ever born alive?"

[5] ISCED97 classification was first used in the Census 2001, however the categories used in previous censuses are fully convertible (Bartoňová, 2007).

2. Lower secondary education: ISCED code 3C (Apprenticeship training, Secondary technical without certificate)
3. Higher secondary education: ISCED codes 3A, 3B and 4 (Vocational school with certificate, Higher general or technical secondary school with certificate, Post-secondary non-tertiary)
4. University education: ISCED codes 5–6 (Higher technical school, University with bachelor, masters or doctoral degree)

Education is a time-constant variable — it captures the cultural and human capital, and earning potential, but not the actual socio-economic status (Hamplová, 2003). We do not dispose with data on educational enrolment[6], and there was no block on educational histories in Czech censuses.

Table 2: Overview of data from the censuses in the Czech Republic — women at age 15+

Census date	**Number of women**	**Birth cohort**	**Parity**	**Unknown parity**	**Unknown cohort**	**Unknown education**
1.11.1980	4,126,347	1880–1965	0–25	1.7%	0.1%	0.7%
3.3.1991	4,245,836	1881–1976	0–20	1.5%	0.0%	1.0%
1.3.2001	4,442,131	1894–1986	0–15	6.2%	0.0%	1.2%
26.3.2011	4,601,815	1910–1996	0–18	3.8%	0.3%	4.6%

4.2 Completed cohort fertility and the decomposition of it's changes

Completed fertility is the most frequently used and the best directly accessed aggregate fertility indicator from the census data. The number of children to women aged 50 or more is simply averaged, which gives us very accurate indicator of their total fertility. After age of about 85 the numbers begin to be less reliable, due to small numbers (depending on the population), and due to the increasing selection due to mortality and migration (United Nations, 1983). Education is usually finished at age 50 and we do not face problems with occurrence/exposure mismatch around ages of rapid educational changes (15–25), nor the problem of causality between education enrolment drop-out and childbirth.

Next to the *completed cohort fertility rate* (CCFR), we may derive more refined indicators, like the proportion of childless, CCFR by birth order, parity progression ratios. The development in CCFR itself can be decomposed in it's partial composites. Main reason for decomposition is analysis of the question, whether was it the change in *fertility* by educational levels itself, or rather the increase in education of population (i.e. change in *structure*). We also analyse decomposition by educational groups and by birth order.

In this paper we make decomposition of changes between cohort 1920 (C) and 1965 (C'). That are two cohorts well captured by available data: women of cohort 1920 were aged 60 at 1980 census and 71 at 1991 census; and cohort 1965 was about 45 years old in 2011, thus with already finished fertility career. Cohort behaviour captures the whole period of our interest, which is the period since the World War II until recent days.

We decompose the difference in the completed cohort fertility into the change in fertility levels $CCFR^{FERT}(c', c)$ and change in structure $CCFR^{STR}(c', c)$, where f is fertility rate, F is cumulated fertility rate, c is cohort, T is census date, x is age, i is birth order, $i+$ is open birth order category, EDU is educational category:

$$CCFRi(c,T) = \frac{Fi^{+}(c,T)}{F(c,T)} \tag{1}$$

[6]From Census 2011 data on parity of women by economic activity we can estimate that while non-students had on average 0.4 children at age 25, 1.0 child at age 30 and 1.6 children at age 35, for students the respective completed fertility was 0.0, 0.2 and 0.6.

$$CCFR(c,T) = \sum_{i=1}^{i_{max}} CCFRi(c,T) \tag{2}$$

$$CCFR(C') - CCFR(C) = \Delta CCFR(C',C) = \Delta CCFR^{STR}(C',C) + \Delta CCFR^{FERT}(C',C) \tag{3}$$

$$\Delta CCFR^{FERT}(C',C) = \sum_{EDU} [\Delta CCFR_{EDU}(C',C) \cdot \overline{STR}_{EDU}] \tag{4}$$

$$\Delta CCFR^{STR}(C',C) = \sum_{EDU} [\overline{CCFR}_{EDU} \cdot \Delta STR_{EDU}(C',C)] \tag{5}$$

where either structure or fertility levels are fixed on their mean value:

$$\overline{STR}_{EDU} = \frac{\sum_{c=C}^{C'} STR_{EDU}(c)}{C' - C + 1} \tag{6}$$

$$\overline{CCFR}_{EDU} = \frac{\sum_{c=C}^{C'} CCFR_{EDU}(c)}{C' - C + 1} \tag{7}$$

Table 3: Age, cohorts and periods covered by the CCFR indicator

Census	**Age**	**Cohort**	**Period**
1980	50–85	1895–1930	1910–1980
1991	50–85	1906–1941	1921–1991
2001	50–85	1916–1951	1931–2001
2011	50–85	1926–1961	1941–2011

4.3 Deriving education-specific fertility indicators of tempo from census data

As we have shown, the CCFR indicator is very reliable and clear. However, the analysis of fertility should consists apart of quantum analysis also from the analysis of tempo, and here we come to it's deficiency — CCFR conveys no information about timing (United Nations, 1983) and there is no direct way how to derive tempo indicators from CCFR. We are aware of censuses that ask, apart of the number of children, also for the date of birth of these children[7], and then one can make use of full timing information. However, this is not our case, and because the tempo of fertility is crucial for understanding the changes in fertility quantum, we have moved to indirect methods of deriving it, which will be discussed in further sections, namely the *vital statistics* based period total fertility rates, *pseudo-period* fertility rates, and *intercensal* fertility rates.

While the completed cohort fertility approach works with real cohorts, but synthesises their fertility over long period of women's fertile life (see Figure 1), the vital statistics-derived period approach works with synthetic cohort in period of single year, the year of the census. The pseudo-period approach, on the intersection of the two previous approaches, works with real cohorts, but synthesises their period behaviour in last 35 years. This allows to identify period-specific behaviours, especially in case of broad historical changes, like was the fall of communism in 1989. The intercensal approach captures the behaviour of cohorts between the two censuses; it is very well suitable for analysing fertility behaviour in the ten-years period, which is especially favourable for Czech Republic, where the periods of censuses coincide with major historical changes. The poor aspect of this method is that we cannot capture the exact timing of the events. For example we know how many children was

[7]Austria 1984, Switzerland 2000 (Burkimsher, 2011), Poland 2002 (Brzozowska, 2013), Belgium 1991 and 2001 (Neels and Wachter, 2010), France annual census surveys 2004–2009 (Davie and Mazuy, 2010), Spain 1991 (Requena and Salazar, 2014), or large-scale surveys in Britain (General Household Survey) and France (Family History Survey linked with the 1999 census) (Bhrolcháin and Beaujouan, 2012).

born to women of cohort 1976 between censuses 1991 and 2001, but we don't know the distribution of births during these ten years, i.e. during age 15–25. But we still can derive much of useful information from this approach, and we can especially concentrate on comparing behaviour in different educational categories, and it's evolution over time.

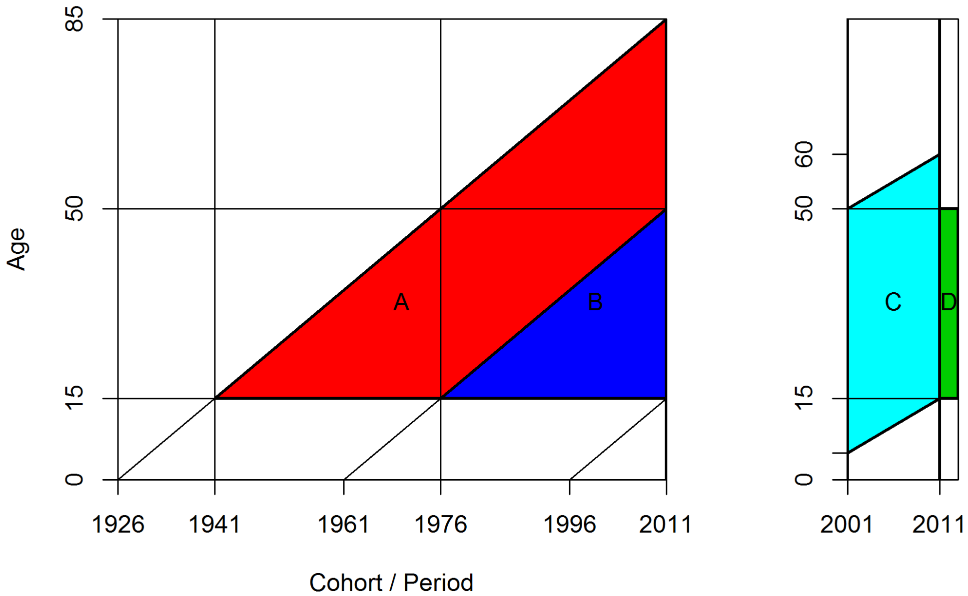

Figure 1: Lexis diagram of the time space covered by discussed approaches (related to census 2011)

Figure 1 illustrates the time-spaces covered by the above discussed approaches. The space A is covered by completed cohort fertility indicators, space D by period TFR derived from vital statistics on births and exposure from census, space B is covered by the pseudo-period approach and space C illustrates the intercensal approach (see Figure 2 for further details on intercensal time-space).

4.3.1 Period fertility rates using vital statistics

When both vital statistics and census data are available, one would incline to combine them in a way that the occurrences from the vital statistics (births by age of mother and her educational attainment, optionally by birth order) are related to the exposures from census (women by age and educational attainment, optionally by parity), as tried by Handcock et al. (2000) for England and Wales, Oliveira (2009) for Spain, Zeman (2007) for Czech Republic, and Šprocha and Potančoková (2010) for Slovakia. However, such approach has some harsh challenges. The most serious is the numerator/denominator bias, the mismatch of occurrence and exposure at young ages. At the age groups 15–24 the intensive education enrolment and school graduating leads to swift changes in numbers and proportions of women by education between single years of age, but also during the single years of age. While the number of primary educated drops rapidly in favour of secondary educated, secondary educated are entering, and gradually finishing, the tertiary education. The births to women of primary education usually leads to their drop-out from higher education, while the causation is leading to self-selection of such women. It is not clear whether to relate the births at young age, e.g. 15 or 16, to the number of women of primary education at the same age, when most of these will eventually switch later to secondary or tertiary education. Among the secondary and tertiary educated, births at their young age, when the exposure is still relatively small, leads to unnaturally high fertility rates. Even merging the single years into 5–year age groups does not solve all problems.

There is also a problem of causality (i.e. whether women do not progress into higher education because they are pregnant, or if they become pregnant at young age because they are of low education). Since educational enrolment and childcare are generally incompatible in the Czech Republic (Kantorová, 2004), we assume that most women completed their education before giving birth to their first child. In 1991-2005, only 5–7 percent of women with a higher education and 17 percent of those with a primary education at the time of entering motherhood further progressed in education before having a second child (Zeman, 2007).

Oliveira (2009) tried to estimate the period total fertility by education attainment for Portugal, using vital statistic data on births in 2000–2001 and census data on women by parity from 2001. Her solution is based on the mean age at which individuals complete their education in each educational group. Before this age, the total of the specific fertility rates is assumed to be zero; after this age, the rates are summed up for the period corresponding to the difference between the average age at the completion of education and the final of the corresponding age group (p.352).

Zeman (2007) was estimating "true" exposure by subtracting women who are still in education at the time of their entry into motherhood and who will eventually proceed to higher education, and adjusting for educational transfer during the year/age[8]. The results, published also in Sobotka et al. (2008), revealed that relative differences in mean age at entering motherhood in the Czech Republic are similar to those reported for many other European countries, e.g. Norway (Lappegård and Rønsen, 2005) and Austria (Städtner and Spielauer, 2002).

Currently there are efforts of Eurostat to produce harmonised fertility rates by educational attainment for the countries of EU (Corsini, 2012). Some of these data estimated from Labour Force Survey were used to determine the total fertility rate by educational attainment for number of European countries (Lanzieri, 2013). However, these results show very unstable and inconsistent patterns (Ibid., Table 6).

Because of many problematic and unsolved issues, we abstained from further using this method, and we further concentrate on methods of deriving fertility indicators solely from census data.

Table 4: Age, cohorts and periods covered by the period TFR approach

Census	**Age**	**Cohort**	**Period**
1980	15–50	1930–1965	1980
1991	15–50	1941–1976	1991
2001	15–50	1951–1986	2001
2011	15–50	1961–1996	2011

4.3.2 Pseudo-period fertility rates

Many works on estimating fertility indicators from census data, especially in developing countries, utilise the own-child method (Grabill and Cho, 1965). In developed countries, the own-child method was recently used in couple of works. Retherford et al. (2004) analyses trends in fertility by education in Japan, and Cicali and Santis (2002) in Italy. Davie and Mazuy (2010) use the French annual census surveys 2004–2009. However this method works with special tabulations of data on women cross the data on children living in the same household, that are different from our data. Besides, the own-child method itself suffers important problems, especially the omission of children living in other households, or those who have died (United Nations, 1983).

[8]Specifically, the paper attempted to overcome a potential overestimation of the number of women aged 15-20 who do not progress above the primary education level by: 1) adjusting exposure population for education reached during the year instead of at the beginning of the year and 2) adjusting the numbers of primary educated women aged 15-20 for those still enrolled in education who will eventually progress to the higher education category.

The so-called P/F method estimates current period TFR as based on current numbers on births, and census-derived parity composition of women (United Nations, 1983; Hobcraft et al., 1982). However, this method is not suitable for populations that face rapid postponement of fertility, where period fertility levels are much affected by tempo distortions and therefore they substantially differ from cohort fertility levels.

The idea how to still estimate age specific fertility rates from these data is to take take the proportions of female F in given parity and higher i^+, from age $x = 15$ to 50, and *decumulates* them to receive the pseudo-period rates pfi:

$$pfi(x) = CCFRi(x+1) - CCFRi(x) \tag{8}$$

$$pTFRi = CCFRi(50) \tag{9}$$

Their sum, the *pseudo-period TFR*, is from definition identical to completed cohort fertility of cohort that just reached age 50, but the focus of this method should be solely on timing, not quantum of fertility. Therefore we first tried to analyse the fertility schedule, the mean age of birth, and the proportion of fertility realised under/above age 30, all by birth order, and add it to the picture gained by other used methods. However finally we abstained from this method for several reasons: First, it is not clear how to deal with changes in education. Second, in the periods of changing timing of fertility this methods yield distorted results (United Nations, 1983). Together, we were not able to separate the impact of cohort educational change in structure, impact of period change in timing, and the real change in level of fertility, and we do not further use this method in the analytical part of this paper.

Table 5: Age, cohorts and periods covered by the pseudo-period approach

Census	**Age**	**Cohort**	**Period**
1980	15–50	1930–1965	1945–1980
1991	15–50	1941–1976	1956–1991
2001	15–50	1951–1986	1966–2001
2011	15–50	1961–1996	1976–2011

4.3.3 Intercensal fertility rates

This method comes from similar idea as pseudo-period method, but has several advantages over it. Most importantly, the derived fertility levels capture the behaviour in restricted periods, delimited by the two neighbouring censuses which is especially useful in our case, where we can distinguish between state-socialism period of 1980–1990; period of stormy development of free society and capitalism 1991-2000, and recent period of already well established liberal society structures with relatively high level of education of population (see Table 6). Contrary to the pseudo-period approach, this method is regarded robust to changing fertility (United Nations, 1983, p. 59).

The method was first developed by Arretx (1973) (cited and formalised in United Nations, 1983, Chapter II.C.), and later extended by Coale et al. (1985) with slightly different manner that we use it here. The estimation is based on the increment of cohort parities between two censuses. While Coale compared parities at same age (but different cohorts), and incorporated the rate of fertility increase between the censuses into the estimation, we rather concentrate on cohorts, and on the cohort parity, as described in United Nations (1983). In fact we use two different approaches, which both proceed from cohort parity comparisons. Figure 2 illustrates the time-space covered by the intercensal approaches. The left diagram illustrates the approach from the period perspective. Fertility schedule for intercensal period is derived from cohort parity increments and transformed to one-year dimension rates that represent transversal intercensal period rates:

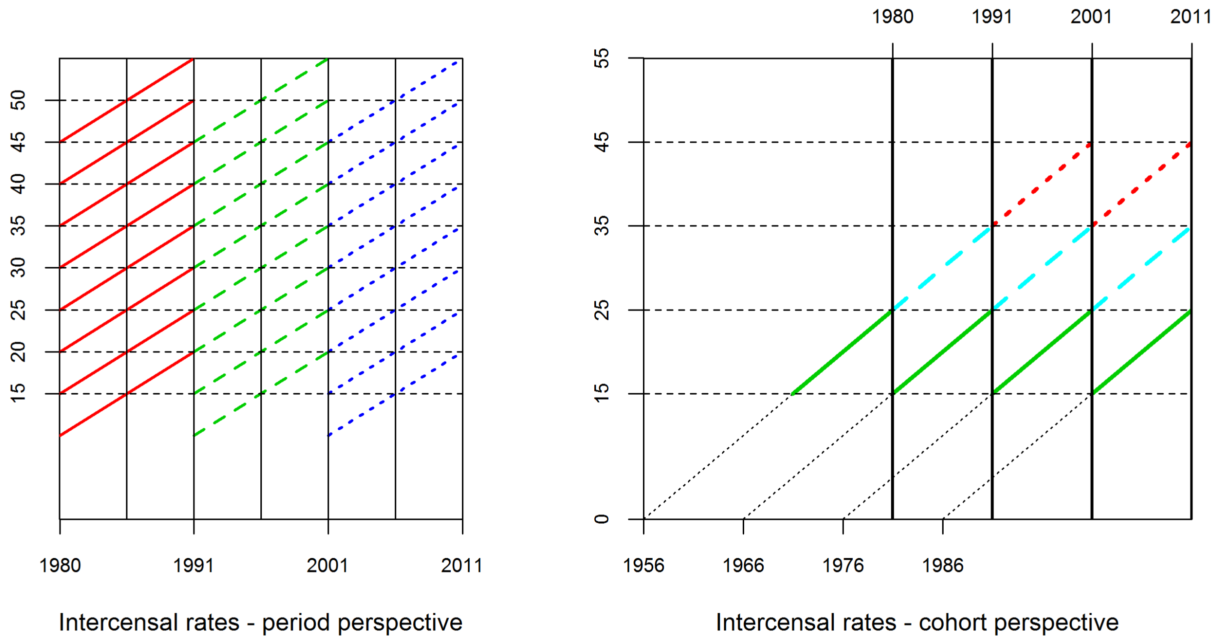

Figure 2: Lexis diagram of the time space covered by intercensal approach

$$ifi(c) = \frac{CCFRi(c,T') - CCFRi(c,T)}{T' - T} \tag{10}$$

$$iTFRi(T \rightarrow T') = \sum_{c=T-50}^{T'-15} ifi(c) \tag{11}$$

The right diagram of Figure 2 illustrates the approach from the pure cohort perspective. Given cohort (in our case cohorts 1956, 1966, 1976 and 1986) are followed through their lifetime. In 10-year periods — in census years — we record their cumulated fertility, which gives us the quantum of fertility realised at age 15–24, 25–34, and 35–44, which further gives us crude picture about the tempo of fertility:

$$\begin{aligned} iTFRi(c) = &[CCFRi(c,1980)] + [CCFRi(c,1991) - CCFRi(c,1980)] + \\ &[CCFRi(c,2001) - CCFRi(c,1991)] + [CCFRi(c,2011) - CCFRi(c,2001)] \end{aligned} \tag{12}$$

We can evaluate the accuracy of this approach by a simple experiment: We compute one set of intercensal fertility rates for the whole population (disregarding education), and second set using conventional vital statistic-based fertility rates for years between the two censuses. The comparison for 2001–2011 intercensal period revealed very close agreement of the two sets of fertility rates, with slight underestimation (about 5 percent) of rates after age 35. This gave us the proof that the method accurately estimates the real period fertility levels. When adding the dimension of education, there again arises the problem of changing level of education at young age. We argue that this potential source of mismatch is relaxed by three effects: First we compare real cohorts, where there is no danger of mixing up effect of changing parity with period effects. Second, we compare mean parities, i.e. averages, where the effect of eduction is already accounted for. And third, the problem of changing level of education is significant only at young age group 15–24, and does not affect estimation for older age groups 25–34 and 35–44.

Table 6: Age, cohorts and periods covered by the intercensal indicators

Census	**Age**	**Cohort**	**Period**
1980 → 1991	5–60	1930–1976	1980–1991
1991 → 2001	5–60	1941–1986	1991–2001
2001 → 2011	5–60	1951–1996	2001–2011

5 Results

5.1 Completed cohort fertility

Surprisingly, completed cohort fertility was declining between generations 1920–1965 only among primary educated; in other categories it was in fact increasing. While primary educated women from cohort 1920 had on average almost 2.5 children, the difference between the educational categories of women was huge, with only 1.5 children born to university educated women. However, at that time university education was quite exceptional, reached only by 2 percent of women born in 1920[9] (Table 8 and Figure 4). Two thirds of that generation ended with primary education, one quarter with lower secondary education, and just 9 percent with higher education. This begun changing after the Second World War, when substantially higher portion of generation 1930 reached lower secondary education. Since then we see gradual decline of proportion of primary educated, that first shifted to lower secondary education, but then increasingly to higher education. Proportion of lower secondary educated, which means apprenticeship training and technical schools, since then stagnates at around 35 percent, while the majority of women from cohort 1960 already graduated from some kind of higher secondary school with certificate. Tertiary education is on rise since the period of 1980s, but the real boom came only during the society change of 1990s and 2000s, which is already not covered by completed cohort fertility rate, because these women did not yet finish their fertility life span. For example, proportion of tertiary educated women as covered by census 2011 was 31 percent from generation 1980 and 37 percent of generation 1984. At the same time, primary educated are becoming more and more exclusive group[10], with current proportion of 9 percent in cohort 1965 and 6 percent of cohorts 1970 to 1980. Completed cohort fertility during this time converged towards values 1.8–2.2, i.e. down among primary educated, but upwards among better educated women (Table 7 and Figure 3).

This two distinct trends, one of fertility convergence and second of educational expansion, led in its result to the decline of period TFR from 2.8 in 1950 to 1.4–1.5 recently and to the drop in completed cohort fertility between cohorts born in 1920 and 1965 from 2.24 to 1.92. This drop was then driven entirely by changes in structure of population by education, especially by the decline in proportion of primary educated, as demonstrated by the means of decomposition in next section.

5.2 Decomposition of change in CCFR

Decomposition of the changes in the completed cohort fertility tells what is visible already from Figures 3 and 4: While the completed cohort fertility rate dropped between cohorts 1920 and 1965 by 0.32 (from 2.24 to 1.92), the core of this change lies in the changing proportions of female population by education (that made 0.30, or 95 percent of the change), while the change in education-specific CCFRs

[9] For comparison, in cohort 1900, where the proportion of university educated was just 0.4 percent, with 3 percent of higher secondary educated women, these women had completed cohort fertility 1.1; primary educated with proportion 89 percent had CCFR 2.0. We use later cohort 1920 because cohort 1900 is sufficiently covered only by census 1980, and even here women from this cohort were already 80 years old, where the selectivity due to mortality and migration by education can influence the results. For data for cohorts 1920-1965 we always use average value from relevant censuses.

[10] Not only socially, but also ethnically exclusive. Given the age and education structure recorded in Census 2011, while the proportion of Roma (Gypsies) in the Czech population is estimated at about 3 percent, among primary educated aged 30–40 it can be as much as 25 percent.

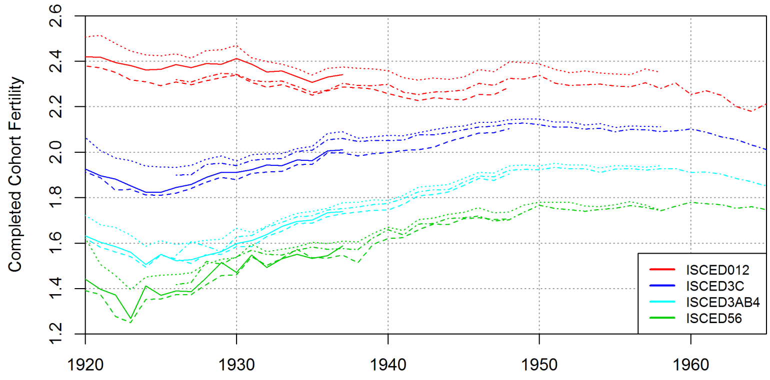

Figure 3: Completed Cohort Fertility by education in four consecutive censuses

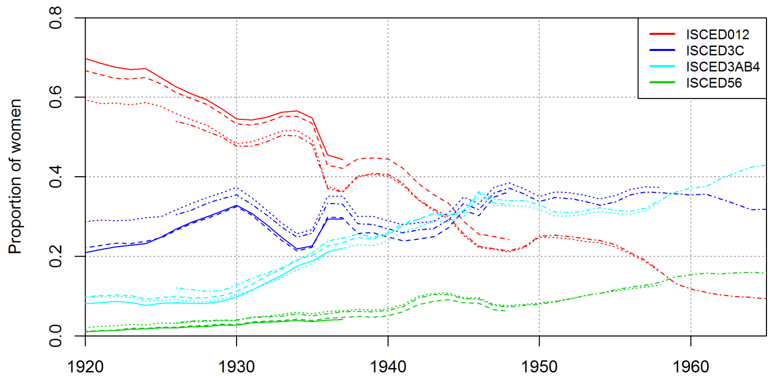

Figure 4: Proportion of women by education in four consecutive censuses

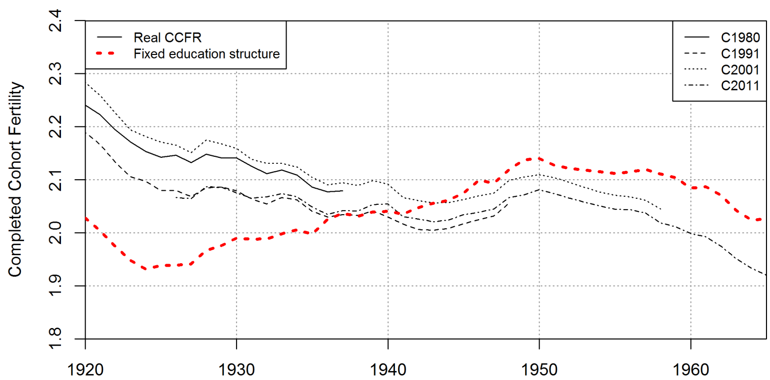

Figure 5: Completed Cohort Fertility — real and under condition of fixed educational structure

Table 7: Completed cohort fertility by cohort and educational attainment

Cohort	**ISCED012**	**ISCED3C**	**ISCED3AB4**	**ISCED56**	**TOTAL**
1920	2.44	1.97	1.66	1.49	2.24
1930	2.39	1.92	1.62	1.50	2.11
1940	2.30	2.03	1.77	1.64	2.06
1950	2.27	2.06	1.86	1.67	2.03
1960	2.30	2.11	1.92	1.77	2.01
1965	2.21	2.02	1.85	1.75	1.92
1965-1920	-0.22	+0.05	+0.19	+0.26	-0.32

Table 8: Proportion of women of given cohort by educational attainment

Cohort	**ISCED012**	**ISCED3C**	**ISCED3AB4**	**ISCED56**	**TOTAL**
1920	65%	24%	9%	2%	100%
1930	51%	35%	11%	3%	100%
1940	43%	26%	25%	6%	100%
1950	27%	34%	32%	7%	100%
1960	12%	36%	37%	15%	100%
1965	9%	32%	43%	16%	100%
1965-1920	-56%	+8%	+34%	+14%	—

itself was responsible for virtually zero drop. Also, from education-specific CCFRs, only drop among primary-educated was significant (–0.08), while among secondary-educated and university-educated the CCFR slightly increased by about 0.01 to 0.05.

When we turn to parity-specific fertility, it is obvious that the fertility change was concentrated among higher birth orders: While CCFR1 even slightly increased from 0.90 to 0.94 and CCFR2 increased from 0.72 to 0.74, it was CCFR3 that experienced sharp decline (from 0.35 to 0.18) and fertility of higher births became almost unimportant, vanishing from 0.27 to 0.06. Here we should also highlight big educational differences — for example childlessness of university educated was very high at cohort 1920, at 24 percent[11], and it was 18 percent among higher-secondary educated. With the diffusion of higher education among women the childlessness went down to natural levels of about 5–10 percent.

5.3 Intercensal fertility rates — Period perspective

The results, summarised in Table 10, and displayed in Figure 6 (and by birth order in Figures 8–9), show rapid development between the 1980s, 1990s and 2000s, in terms of fertility decline and postponement of fertility to higher ages. More importantly, the development shows broad differences between the educational groups. Among primary educated, there was virtually no change between the 1980s and 1990s — fertility level remained high, around replacement level values, with low mean age at birth. Only after 2001 the TFR declined to 1.68, while mean age at first birth stay still at around 21–22 years. On the contrary, higher secondary and university educated women experienced sudden decrease of fertility already in the 1990s, accompanied by stark increase in mean age at birth, by about two years per decade. Proportion of first births realised after age 30 (denoted as **i30p1**) increased substantially: While in the 1980s, 42 percent of higher secondary educated and 62 percent of tertiary educated had their first birth after age 30, in 2001–2011 it was already three quarters of higher secondary educated

[11] It was almost 40 percent in generation 1900.

Table 9: Decomposition of change in CCFR

Change in CCFR	**cohort 1920**	**cohort 1965**			
–.32	2.24	1.92			
Change in CCFR	fertility levels	structure	*interactions*		
–.32	+.00	–.30	*–.02*		
Change due to fertility	ISCED012	ISCED3C	ISCED3AB4	ISCED56	
+.00	–.08	+.01	+.05	+.02	
Change due to structure	ISCED012	ISCED3C	ISCED3AB4	ISCED56	
–.30	–1.30	+.16	+.60	+.23	
Change by birth order	BO1	BO2	BO3	BO4	BO5p
–.32	+.04	+.02	–.17	–.11	–.10

and almost 90 percent of university educated. When we compare these indicators with lower educated and primary educated women we see huge differences: Still three quarters of primary educated and more then half of lower secondary educated start their fertility career before age 30.

Table 10: Intercensal fertility indicators

Period	Education	iTFR	iTFR1	iTFR2	iTFR3p	iMAB	iMAB1	i30p	i30p1
1980–1991	ISCED012	2.17	0.89	0.75	0.53	22.99	20.50	0.43	0.22
1991–2001	ISCED012	2.09	0.83	0.64	0.62	24.71	21.58	0.50	0.24
2001–2011	ISCED012	1.68	0.72	0.55	0.42	23.79	21.06	0.48	0.26
1980–1991	ISCED3C	2.05	0.95	0.80	0.29	23.53	21.06	0.46	0.26
1991–2001	ISCED3C	1.61	0.77	0.60	0.25	24.83	22.15	0.54	0.32
2001–2011	ISCED3C	1.43	0.71	0.53	0.20	25.87	23.29	0.64	0.46
1980–1991	ISCED3AB4	1.91	0.96	0.78	0.17	24.73	22.87	0.57	0.42
1991–2001	ISCED3AB4	1.39	0.68	0.55	0.15	26.42	24.41	0.69	0.53
2001–2011	ISCED3AB4	1.31	0.68	0.50	0.13	28.07	26.19	0.82	0.73
1980–1991	ISCED56	1.77	0.96	0.71	0.11	26.73	25.12	0.73	0.62
1991–2001	ISCED56	1.29	0.64	0.53	0.13	28.82	27.10	0.87	0.78
2001–2011	ISCED56	1.39	0.70	0.54	0.15	30.40	28.79	0.94	0.89

5.4 Intercensal fertility rates — Cohort perspective

Figure 7 displays[12] the completed fertility of cohorts 1956, 1966, 1976 and 1986, allocated to the age of birth (15–24, 25–34, 35–44), which refers to the intercensal period 1980–1991, 1991–2001 and 2001–2011. What we see at the first glance is the decline in completed fertility. In more detailed view we see redistribution of fertility from young age 15–24 to more mature age group 25–34.

There has not been much change between cohorts 1956 and 1966. The change began looming towards cohort 1976, and even more until cohort 1986. Now let's concentrate on change 1966 to 1976. The overall drop from 1.9 to 1.5 varied very much between education groups. Primary educated saw rather moderate drop from 2.3 to 1.9, where still 74 percent of women have first child before age of 25. On the other side of educational spectrum we see university educated with drop of CCFR from 1.7 to 1.3. How much of the so-far not realised fertility is in fact *postponed* and can still be achieved?

[12]Further split by birth order (first versus second and higher) is available at Figures 10 and 11.

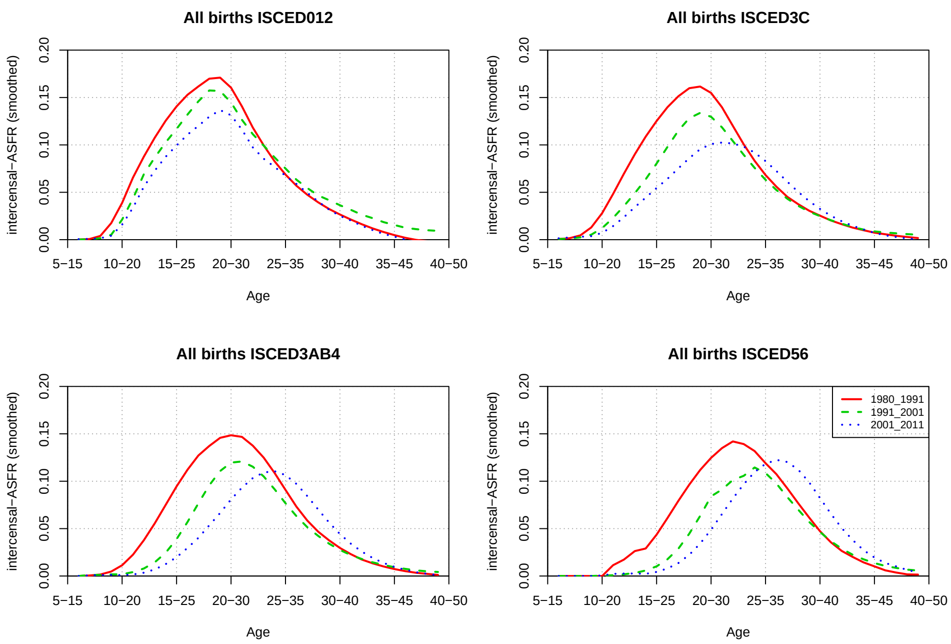

Figure 6: Intercensal age-specific fertility rates

In cohort 1966 it was 0.18. In period 2011 it was overall 0.21 and from combining vital statistics and census data we estimate the figure for university educated at 0.39. Even if this number would not further increase, the completed cohort fertility of university educated women of cohort 1976 would reach 1.7, same figure as for cohort 1966. Despite massive decline of period fertility, when women lived most of their fertility life span in the climate of lowest-low fertility, we still expect that their completed fertility will range between 1.7 of university educated and 2.1 of primary educated, and 1.8 in total.

6 Discussion, conclusions

At the beginning of this paper we posed three questions. Below we summarise findings that help to answer them:

- How has the level (*quantum*) of fertility changed since the Second World War, and what were the driving forces behind the change?

We have studied the change in completed cohort fertility between cohort 1920, that absolved school yet before and during the Second World War, and 1965, which is the last recorded cohort that already finished the fertility life span, and mostly finished the education just before the 1989 revolution.

During this time, educational boom in former Czechoslovakia led to substantial change of educational structure, when formerly minority higher-secondary education became majority, rare university education became norm, and primary education on the other hand became exceptional. At the same time, fertility level inside educational categories was declining only among primary educated; in other categories it was in fact increasing.

We concluded that completed cohort fertility drop from 2.24 to 1.92 was driven entirely by changes in structure of population by education, especially by the decline in proportion of primary educated. Overall decline in cohort fertility largely due to compositional effect was found also for Italy (Cicali

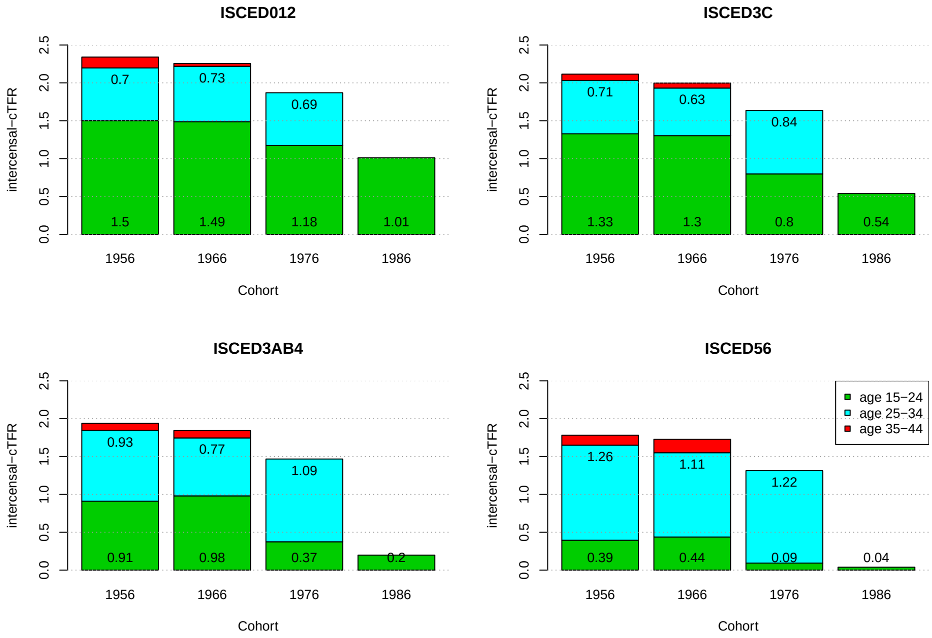

Figure 7: Intercensal fertility rates – cohort perspective

and Santis, 2002), for Poland (Brzozowska, 2013), or for Brazil (Lam and Duryea, 1999), while in Iran (Abbasi-Shavazi et al., 2008) and South Korea (Yoo, 2014) the effect of fertility decline prevailed. Bongaarts (2003) distinguishes in his work about the role of educational differences in fertility transition[13] two model patterns of the transition of fertility by level of education. In "leader–follower" model, the decline from high to low fertility follows the same trajectory over time in each education group, with the most educated women making this transition earlier than the least educated, but eventually levelling at the same fertility level. In the "permanent difference" model, differences between educational groups persist even during and after decline of fertility levels within the groups.

In the case of Czech Republic, we see yet different model model of transition, where the fertility levels are converging, but *upwards* to levels about 1.8–2.2, from range 1.5–2.4, and the overall decline is explained overall by change in structure. From the Completed Fertility and Education (CFE) database (Zeman et al., 2014) we can see that this pattern, for the development between cohorts 1920 and 1965, was similar also in some other Central-Eastern European countries — Croatia, Hungary, Poland (see also Brzozowska, 2013) and Romania. On the contrary, Switzerland followed the *permanent difference* model, while Austria and South Korea followed the *leader–follower* model (see also Yoo, 2014. The *leader–follower* model is evident also from the developments recorded in Italy (Breschi et al., 2013), and in Spain(Requena and Salazar, 2014).

In the background chapter we have shown some specific features of Czech population policy and labour market: long parental leave, egalitarian subsidies, low level of reconciliation of work and family, absence of under-3-year-age child-care, and lack of part-time contracts. We suggest that this can partly explain relative homogeneity of fertility behaviour in sense of fertility quantum, and it's convergence during the era of state socialism. However this hypothesis would need cross-national analysis, that would look for links between cohort fertility levels by education (possibly utilising CFE database), and

[13] Bongaarts used this model transitions for developing world but we use it here for categorisation of transitions in developed countries.

the particularities of national population policies and labour market settings.

- How has changed the timing (*tempo*) of fertility, what is the role of educational expansion?

We have tried to answer this question using intercensal approach from cohort perspective. As a representation of socialist model we took cohort 1956. For older cohorts we do not have adequate method for estimating fertility timing. Cohort 1956 was very similar to that of cohort 1966 in terms of both fertility timing and level (see Figure 7), which suggests that the population climate was very stable during the periods of 1970s to 1980s. Majority of fertility among primary and secondary educated women was concentrated to age group 15–24, and it were only university educated who concentrated fertility into the age group 25–34. This has changed rapidly after 1989, especially among secondary educated, while among primary educated the timing still concentrates toward youngest age group (despite the drop in level of fertility in all age groups), and among university educated the fertility at age below 25 almost vanished, to be replaced by increasingly important age group 35-44. Simultaneous postponement of childbearing among upper-secondary and university educated has accompanied the huge increase in educational opportunities, including study abroad, both formal and informal. Although studying was only one of the "new opportunities opening up since 1990 — to travel, to study, to make a career to run your own company, to switch jobs, to pursue various leisure activities" (Sobotka et al., 2003, p. 268) — we argue that educational expansion was one of the strong incentives for fertility postponement.

- How has changed the link between education and fertility after the fall of communism in 1989?

We have already discussed the cohort perspective of the change. From the period perspective we identified broad changes in fertility quantum and tempo between the decades of 1980s, 1990s, and 2000s (Table 10 and Figure 6). This developments are strongly related to educational attainment of mothers. While among primary educated, there was virtually no change in tempo among secondary and university educated we identified strong postponement of births that even intensified after 2000.

This leads us to the conclusion, that although fertility by education *converged* in the period since the Second World War, the educational differences are on the contrary *increasing* since the fall of the communism in 1989. The decline is broader among highly educated, the postponement is longer, and while primary educated are becoming increasingly exceptional group practising high and early fertility, university educated on the other side of the spectrum are shifting the fertility after age 30 and even 35.

Because *completed cohort fertility* approach does not allow for analysis of timing of fertility, and *vital statistics*-based period TFR suffers problems that lead to inconsistent results, we have switched to the alternative method of deriving indicators of fertility timing. The *intercensal approach* turned to be important source of relevant information. This method allowed us to distinguish intercensal periods that very appropriately fit the decades of 1980s, 1990s, and 2000s, as well as to identify differences in behaviour between cohorts living under the *socialist regime* (1956, 1966) and the young cohorts characterised by university educational boom and fertility postponement (1976, 1986). In analysing fertility behaviour during the socio-economic turnover after 1989, we identified important changes in fertility quantum and tempo, which are strongly related to educational attainment of mothers. In broader focus we found reversal in the overall trend of fertility levels by educational categories, from convergence in the 1950s-1980s period to the increase in differences in the last two decades.

Acknowledgements

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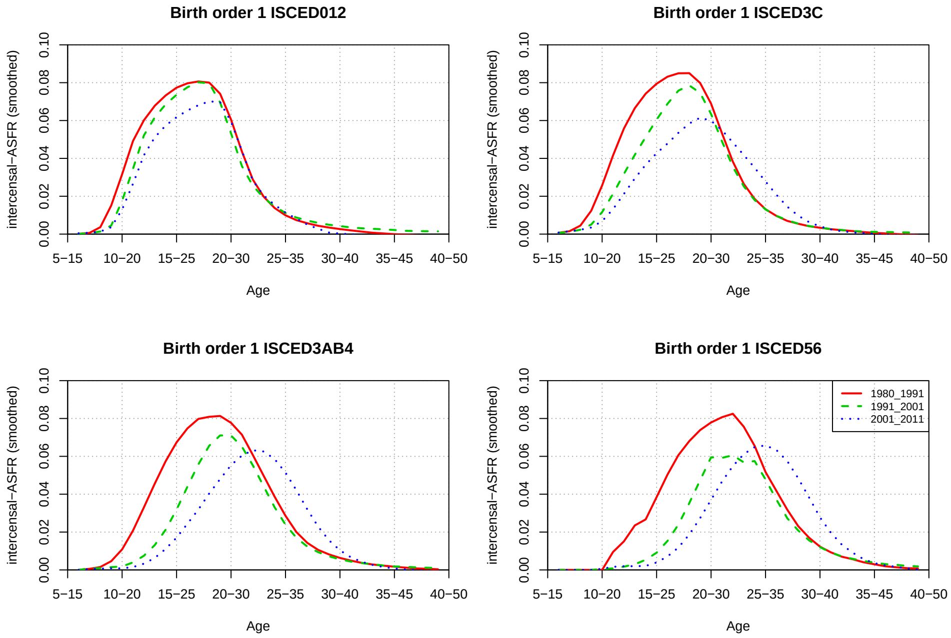

Figure 8: Intercensal age-specific fertility rates (first birth order)

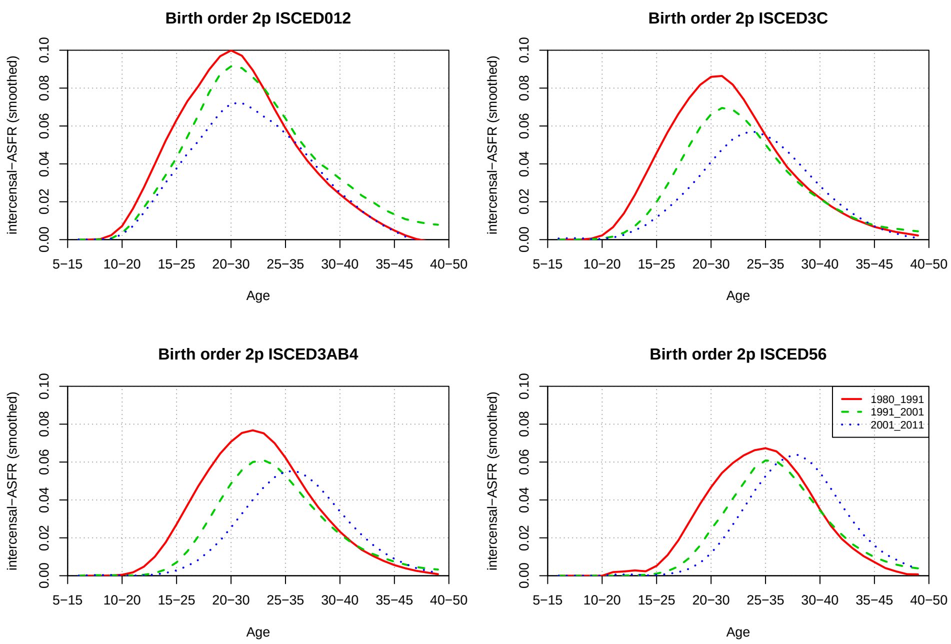

Figure 9: Intercensal age-specific fertility rates (second and higher birth order)

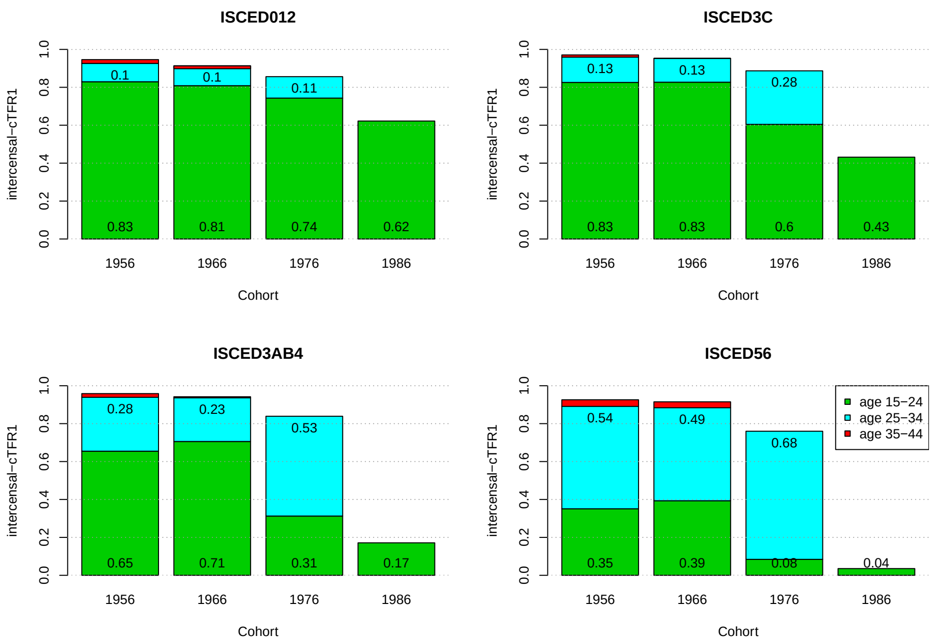

Figure 10: Intercensal fertility rates – cohort view (first birth order)

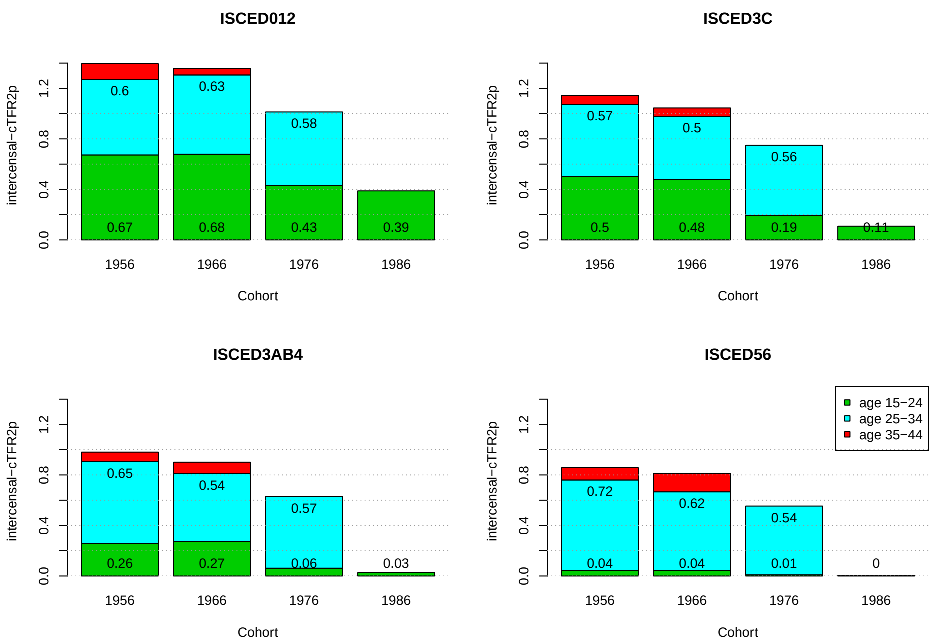

Figure 11: Intercensal fertility rates (second and higher birth order)

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