LIFE COURSE PERSPECTIVE ON ECONOMIC SHOCKS AND INCOME INEQUALITY THROUGH AGE-PERIOD-COHORT ANALYSIS: EVIDENCE FROM FINLAND

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Utilizing age-period-cohort analysis, this paper examines the development of income distribution across periodic economic fluctuations in relation to cohorts and age groups. The empirical analysis is based on the Finnish Income Distribution Statistics and Household Expenditure Surveys covering the period of 1966–2015. The findings suggest that the period and cohort effects can be identified as the main effects on relative income, while the age effects have no meaningful impact when the control variables are taken into account. This result reveals a connection between the effects of economic shocks and cohort placement on labor market entry. Additionally, absolute income analysis suggests that economic shocks create stagnation points in income development, which are especially detrimental to cohorts who are transitioning into labor markets. Additionally, middle-income attainment has not changed due to periodic shocks but rather is related to inter-cohort inequalities and relative income differences, where the baby boomer generation is a clear winner.

1. INTRODUCTION

Research on economic inequality usually focuses on income dynamics analyzed through the lenses of age and period characteristics. Cohorts are often ignored because of methodological limitations and the lack of appropriate data. Although there is a wide range of evidence for age and period effects on income dynamics, there is less information on the generational pattern of the relationship between income and cohorts. We argue that shifting our focus to cohort differences in relation to age and period may reveal significant differences in income dynamics across households (see also Lim and Zeng, 2016). The questions are whether there are inter-cohort inequalities and whether some cohorts hold a better economic position than others.

In Finland, the trend of income inequality since the 1960s can be divided into five periods (Blomgren *et al.*, 2014). *First*, the era of welfare state expansion in the 1960s and 1970s decreased income inequality regardless of the income concept.

Second, from the mid-1970s to the economic recession of the early 1990s, market income inequality increased but, due to income transfers, gross and disposable income inequality remained constant. *Third*, the recession of the 1990s increased inequality in market income but not in gross and disposable income. *Fourth*, whereas market income inequality since the mid-1990s has been constant, inequality in gross and disposable income increased towards the early 2000s. From a comparative perspective, the increase in income inequality was exceptionally fast and steep in Finland during the period between 1995 and 2002 (OECD, 2008, 2011). *Fifth*, since the turn of the millennium, the development of income inequality has been rather stable.

The Finnish evidence suggests that since the 1990s, changes in income inequality have been associated with the economic cycle. Income inequality increased during periods of economic growth and decreased during economic downturns. However, the development of income inequality on the aggregate level cannot reveal the intricacies of income dynamics in terms of inter-cohort inequalities. This situation calls for a life course perspective that would identify—separately—the effects of age, time and generation. In this study, we define life course as life events, transitions and trajectories with cohort variation in development (Elder, 1997). Life course here is defined as developmental patterns that are structured by events and other biological and social constraints and that vary by historical time. The individual is defined as part of a certain historical period or an event by his/her birth year. The impact of a historical event is contingent on the point of intersection of the life stage of the cohort (Elder, 1997). Such a perspective emphasizes that economic shocks could lead to an accumulating effect for certain cohorts. Hence, the Finnish case, combined with the long time-series data utilized in this study, provides an ideal context in which to focus on age-period-cohort effects in income distribution and, specifically, to chart the effects of the economic cycle. Prior research shows that there are significant generational differences in economic measures such as income, consumption and wealth (Jappelli, 1999; Berloffa and Villa, 2010; Lim and Zeng, 2016). In addition, empirical evidence from various countries supports the concern that younger generations are falling behind compared to older ones in regard to the evolution of household income (e.g. Smeeding and Sullivan, 1998; Gosling *et al.*, 2000; Beaudry and Green, 2000; Fitzenberger *et al.*, 2001; Grenier, 2003; Osberg, 2003; OECD, 2011; Ostry *et al.*, 2014; Chetty *et al.*, 2017).

We approach our research questions from the perspective of the concepts of relative and absolute income. In practice, this means that we analyze income distribution from the "detrended" perspective, which will determine which birth-cohorts and age groups have benefitted the most in terms of relative income. This perspective alone does not illuminate how inter-cohort income has developed over time in an absolute fashion; thus, we address this question in our "trended" approach, which measures how absolute income has developed over time in regard to cohort and age groups. Finally, we put absolute and relative income into the context of the "optimal" income class by measuring the attainment of middle-income according to the dimensions of age, period and cohort. Hence, our main contribution to the literature is to examine the effects of economic cycles on inter-cohort income inequality in an absolute and relative manner, taking into account the three dimensions of age, time and cohort. In contrast, previous studies have mostly included only two of these three factors.

This study aims to improve upon previous studies in multiple ways. *First*, this study will assess how income distribution has developed across periodic economic fluctuations in relation to cohorts and age groups. The central interest lies in how economic shocks and cycles affect income through inter-cohort income dynamics. *Second*, this study utilizes register-based datasets with significant periodic range, which are capable of revealing the long-term effects of various economic cycles. Cohort studies have usually been conducted on data that do not have a satisfying yield in statistical years. Finland is a unique case, with its economic history that contains four distinct economic shocks. Therefore, the Finnish case offers the opportunity to observe multiple points of economic fluctuation over time. *Third*, the main drawback of previous research on income inequality and the distributional effects of economic cycles is that this research has usually used narrower models, which only take two factors of the age-period-cohort triad into account, whereas we consider all three factors at the same time. What makes our contribution stronger is our use of a relatively new method of age-period-cohort modeling, which is capable of measuring relative and absolute changes in income distribution.

This paper is organized as follows. Section 2 discusses related studies. Section 3 presents the data and descriptive facts about age-period-cohort (APC) profiles that motivate the specification of the statistical APC models in Section 4. Section 5 presents the empirical results of our age-period-cohort analysis of income distribution in Finland during the period between 1966 and 2015. Analyses provide illustrated graphs and tables of the estimates for both the detrended and trended APC models. Finally, Section 6 offers concluding remarks and discussion.

2. Related Studies and the Framework of Analysis

A generation carries a unique "scar" that it acquires through shared socialization, as seen in how different birth-cohorts grow up in a similar historical period (Mannheim, 1928). In an economic context, this can be described as inequality because some cohorts may have a smoother entry into the labor market due to their specific economic situation. Thus, an economic up- or downturn can play an enormous role in how a given generation is able to establish itself during changing market situations. For example, cohorts that have become adults during economic booms are more likely to profit from that favorable market situation. Conversely, cohorts who are "scarred" by an economic downturn may be more risk-averse and have a more disadvantaged economic trajectory from a life course perspective (Malmendier and Nagel, 2011). These observations have created building blocks for the life course hypothesis and paved the way for new developments of the theory whose main themes revolve around the idea of systematic cycles of advantaged and disadvantaged generations (Myles, 2002, p. 138). This approach was pioneered by many researchers (e.g. Campbell *et al.*, 1976; Clark and Oswald, 1994; Kahneman *et al.*, 1999; Frey and Stutzer, 2002; Helliwell, 2003; Layard *et al.*, 2012) who focused on how well-being is affected by other outcomes such as income, employment and educational qualifications.

Changes in income trajectories and distribution can be tracked through outward stimuli, for example, through macro-economic shocks (Mayer, 2005). Periodic

change indicates how socio-political reactions against economic downturns have changed the income dynamics between generations. Mayer (2005) argues that these cohort changes are key to creating a more solid picture of how different mechanics of inequalities across generations are constructed. Regarding the external stimuli that Mayer mentions, there have been various alternating phases of economic downturns and growth in Finnish economic history. The cycle of 1970 to 1974 was linked to the 1973 oil crisis, which was followed by a phase of economic growth from 1980 to 1990. The period from 1990 to 1995 was the most significant shock that Finland has ever faced and has largely been considered "the great depression". These shocks offer excellent effects through which to observe the influence of economic cycles on inter-cohort income dynamics.

Results from previous cohort studies examining income inequality can be summarized in three observations. *First*, it seems that the "baby boomer" generation has benefitted most from its birth cohort compared with other generations. Studies have researched the impact of cohort membership on disposable income in European welfare states and the United States (Chauvel, 2013; Chauvel and Schröder, 2015; Freedman, 2017). These studies show that there are discrepancies in income accumulation between cohorts, which means that having been born in the "baby boomer" generation seems to give an advantage. *Second*, economic shocks have been identified as a major influence on inter-cohort income inequality. The main hypothesis states that cohorts that enter the job market during times of austerity and economic downturn are—compared to cohorts born during an economic upturn—in a more disadvantaged position with regard to attaining similar career options. For example, younger generations have an 8 percent lower expected income in Italy than older generations, which is a result of the economic situation and different socio-political reforms (Berloffa and Villa, 2010). Additionally, research on income and wealth inequality has reported that younger generations have lower living standards than their parents did at similar ages in Great Britain (Crawford *et al.*, 2015), Europe (OECD, 2011), the United States (Chetty *et al.*, 2017), Canada (Kershaw, 2015) and Australia (Daley and Wood, 2014). *Third*, one effect is the role of educational expansion, which is linked to the profits gained from certain educational fields (Pekkala and Lucas, 2004). Older generations had the opportunity to work towards higher education but also benefitted from growing job markets and low competition within the same educational field. As educational expansion advanced, the younger generations had to compete with an ever-growing pool of highly educated individuals for the same jobs. Thus, according to supply and demand, higher degrees hold less profit-making value for younger generations than for older generations, who reaped the benefits of starting their careers in an optimal job market situation while also gaining work experience.

The Finnish context tells a similar story. Riihelä (2006) found that the younger generation, who faced an economic shock, attained a lower income level than what would be expected according to the life-cycle hypothesis. This result illustrates how the role of economic cycles affects income trends between generations. These cycles are linked to periodic changes in the market, and certain birth cohorts occur to be at the "right place at the wrong time". Additionally, there are indications that inter-generational income mobility did not increase much beyond the levels achieved among the "baby boomer" cohorts born in 1945–1950, although these older

cohorts benefitted from educational expansion and a more advantageous labor market situation (Pekkala and Berman, 2002; Pekkala and Lucas, 2007). Overall, relative income mobility has decreased over time among young adults. However, the decrease is related to the rise of permanent income inequality (Suoniemi, 2012). Additionally, the development of pension policy has particularly strong impacts on both poverty cycles and economic well-being among the elderly (Jäntti *et al.*, 1996; Kangas and Palme, 2000).

3. Data, Variables and Stylized Facts

Our empirical analyses are based on the Finnish Income Distribution Statistics (IDS) and the Finnish Household Expenditure Surveys (HES) provided by Statistics Finland. Both datasets belong to the series of the Official Statistics of Finland (OSF) and the European Statistical System (ESS). HES provide data on incomes and expenditures in 1966, 1971, 1976, 1981 and 1985. The data are partially derived from interviews, and since the 1971 survey, they have been derived from official registers. IDS provide data on incomes, and the data have been collected annually since 1987. Thus, the period of analysis in this study is 1966-2015. In both cases, the income data are collected from tax and other registers and are generally considered to be of high quality. The data are harmonized to be a representative sample of the Finnish population. The basic unit of analysis is the household. The sample size varies from 4,471 households in 1966 to 10,620 households in 2015. The mean sample size is 10,216 households. The data are multiplied to the level of total population by special weights included in the household surveys. In the household assets, the person with the highest personal income is chosen as the household's reference person, which serves as a proxy for demographic and background status. The income variables measure the household's income and individual income of the household's reference person.

The descriptive statistics of the merged data are shown in Table A.1. In regard to dependent variables, the income metric is the annual household disposable income, which includes monetary income items and benefits in kind connected to employment relationships, but does not include imputed income items such as imputed rent (see OSF, 2015). Household income is not top coded. The dependent variable is the logged equivalized annual household disposable income, which is adjusted for inflation. As a common practice for empirical application, we have bottom-coded all of the negative income values as zeroes, because in equivalization it makes little sense to apply equivalization to negative values (see OECD, 2012, 2015).

Conceptually, we measure disposable household income in the form of relative income, absolute income and attainment of middle income. Relative income reveals how income is in relation to other households of society, weighing it against the standards of the given period, whereas absolute income reflects the total amount of a household's earnings received in a given period. Attainment of middle income is annual income, which is transformed as income deciles and derived as a dummy variable: the first and second quintiles equal zero, and the third to fifth quintiles equal one. The aim is to measure the attainment of income class, which exceeds the threshold of the middle-income level.

Age, cohort and period profiles
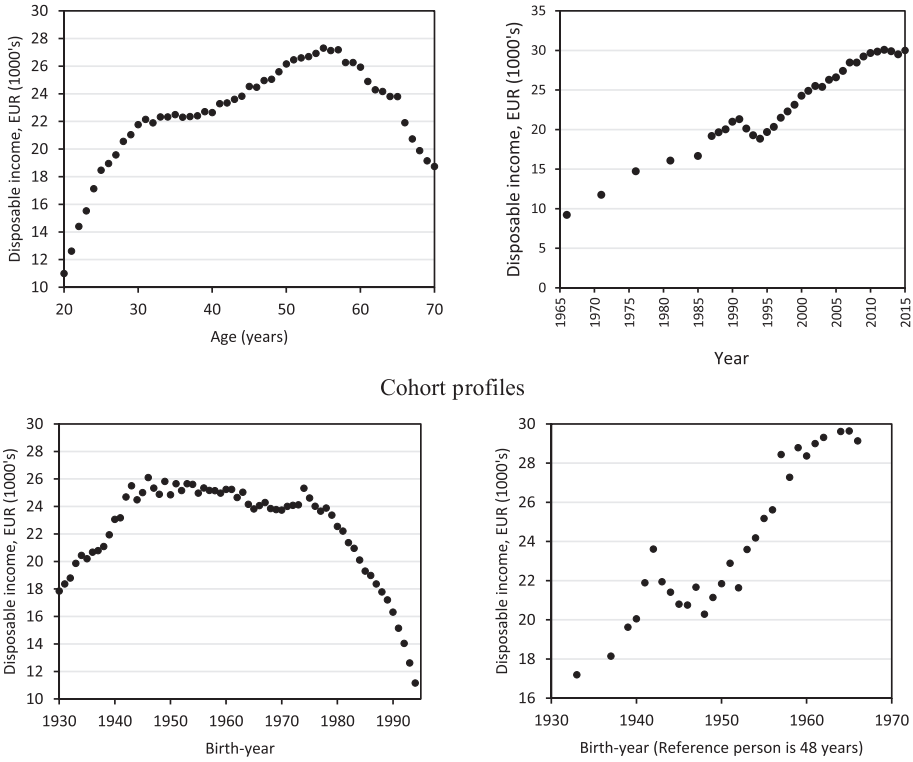

Cohort profiles

Figure 1. Stylized Facts of Age-Cohort-Period Profile

This research uses the equivalence scale, which is a variant of the Oxford scale. The equivalence scale is constructed with the formula m = 1 + a(A-1) + bL, where A is the number of adults and L is the number of children in the household. The value of parameter a is 0.5, and b is 0.3. Because of the inadequate information on children's ages, this paper uses the equivalence scale, where the reference is 18 years old or above, unlike the Oxford scale, in which the reference person of the household is 14 years old or over.

For the purposes of this study, the analyses are limited to the population aged 20 through 70 years. The rationale for excluding the 18- and 19-year-old age groups is the requirement for conscription in the Finnish Defense Force (6-12 months) and the requirement for civilian service (12 months). For example, conscription usually occupies approximately 14000 people annually. Thus, excluding this age group will also provide a more neutrally distributed sample.

Cohort variables were constructed to be consistent with previous studies and with the orthogonal requirements of the age-period-cohort models (Chauvel, 2011; Chancel, 2014; Chauvel and Schroder, 2015). We conducted sensitivity tests to find the optimal cut-off values for the APC variable grouping (not shown here) and decided to use 5-year intervals to maintain acceptable observation size and

measurement accuracy for each group. This choice was also made to mitigate possible volatility connected to measurement range and observation sizes within groups (see Luo *et al.*, 2016). Cohorts were cut in 5-year intervals spanning the period from 1945 to 1995. The formed variables were constricted by the age factor of 20- to 70-year-olds to restrict the range to the active working population. The period variables were formed between 5-year intervals. The reasoning behind this decision was the rhythm of economic cycles.

Figure 1 illustrates the average disposable incomes by age-period-cohort profiles. The profile of disposable income across different age groups takes the form of an upside-down U-shape, although those between 30-40 years of age have a slight lag before their income trajectory takes off more rapidly. The cohort profiles show an aggregate trend in which persons born from 1940 to 1960 share almost the same level of disposable income. After this point, younger cohorts fall off the horizontal, as expected, because their educations are in progress and their transition to the job market is not yet complete. When the reference person of the birth-year is 48 years old, the income trajectory is uniform against the period estimates.

A limitation of the dataset is the absence of a variable for gender. During the measured time period, Finland saw an increase in female labor force participation, which not only affected the incomes of households in which women were working but also the (relative) position of households in which women were not working. Taking this trend into account would be relevant.

Previous research has indicated that education plays a tremendous role in income development (OECD, 2015; Psacharopoulos, 1994). Educational expansion explains a large part of income development; especially important are an increased amount of monetary support from the state and the availability of free higher education. Figure A.1 shows a clear shift from lower education to higher education. This educational expansion is relevant because it illustrates one of the key aspects of Finnish socio-political mechanisms. Education has been a major political investment, especially since the crisis of the 1990s, and has partly hastened the evolution of income development. In particular, the amount of polytechnic and tertiary education has risen significantly, which means that almost half of the population has a higher education degree (Statistics Finland, 2015).

4. Statistical Model

4.1. *Age-Period-Cohort Conundrum*

Age-period-cohort models are designed to estimate inter-cohort income trajectories through the effects of age, period and cohort from two contextual viewpoints: the relative and absolute contexts. Cohorts are the key research unit but also the main object of study in research on inter-cohort differences. Although many papers have proposed that answers lie in the empirical estimations and effects of age (*a*), period (*p*) and cohort (*c*), there is an underlying predicament with regard to retrieving results. One major problem has been the "identification problem," which arises from the equation $c = p - a$. The variables are collinear to each other, so when two variables of age, period or cohort are known, the third is also known. Collinearity between regressors indicates that the statistical

model produces an infinite number of possible solutions for the least squares or maximum likelihood estimators (Yang *et al.*, 2004). Thus, the main dilemma is that the model does not hold a unique solution, and such a solution cannot be identified.

Age-period-cohort models are an attempt to grasp the identification problem. The model aims to explain outcomes through three components: the individual's age a (α_a), membership in a cohort c (γ_c) and statistical period p (π_p). Thus, the equation can be stated as follows:

(1) $$y^{apc} = \mu + \alpha_a + \pi_p + \gamma_c$$

The key function of the APC model is to detect "how" an outcome is explained by the position in the life cycle (age), date of birth (cohort) and the time of the statistical measurement (period).

Previous research has solved the identification problem by imposing special restrictions on the model (Mannheim, 1928; Ryder, 1965; Mason *et al.*, 1973; Hobcraft *et al.*, 1982; Yang *et al.*, 2004; O'Brien, 2011). These restrictions are built to constrain the coefficients of some variables. An example of this is the Constrained Generalized Linear Model estimator (CGLIM), which uses a theoretical foundation wherein constraints use extra information to constrain coefficients based on theory. The CGLIM's reliance on external information is problematic because such information often does not exist and CGLIM is sensitive to the choice of constraints, as Glenn (1976) notes. This problem is one of the reasons why the intrinsic estimator model (IE) was created by Yang *et al.* (2004, 2008).

The IE uses—as its core—principal component analysis to reduce the collinear APC dimensions to a bidimensional plane. Additionally, this solution is criticized by O'Brien (2011) and Luo (2013), who note that the intrinsic constraint is as arbitrary as in any other CGLIM. For example, O'Brien (2011) and Chauvel (2013) have shown that the model fails empirical tests such as that of detecting educational levels (see the discussion in Pelzer *et al.*, 2015).

Instead of utilizing the "intrinsic" models, this paper uses a variation, the APC "detrended" and "trended" method, which was developed by Chauvel (2011, 2012). These models have been used in empirical research and have produced reliable estimates (see Chauvel, 2010, 2013; Chancel, 2014; Chauvel and Scröder, 2015; Freedman, 2017).

4.2. *Age-Period-Cohort "Detrended" and "Trended" models*

The APCD model recognizes that because of the identification problem, linear trends in APC models cannot be robustly attributed to age, period and cohort. Instead, the "detrended" approach will focus on how the effects of age, period and cohort fluctuate around a linear trend, which this approach absorbs. In a more expressive manner, APCD is a "bump" detector that shows how different cohorts differ from the linear trend. The APCD model uses a set of constraints on the zero-sum, zero-slopes and on the domain of estimation of the cohort effects that excludes the first and the last cohort. Examples of excluded observations are the oldest age group of the first period and the youngest of

the last period that appear once in the model. This method allows the model to become identifiable, obtain better estimates and provide a unique solution.

The APCD model can be illustrated with OSL expressions. In this model, y^{apc} stands for the dependent variable but also for the independent variables of age (a), period (p) and cohort (c). The APC effects are the following: period effect π_p fits the categorical period, α_a is the coefficient for the non-linear age changes, γ_c is the estimates for the cohort effects, β_0 denotes the general intercept, and $\beta_j x_j$ are coefficients for the control variables. Rescale (a) and rescale (c) are linear functions that rescale the indexes a and c, which transforms the coefficients α_0 and π_0 in a standardized form to a scale of -1 to $+1$. Both rescale (a) and rescale (b) absorb the linear trend. Finally, if γ_c, as the cohort effect coefficient, is zero, this means that the cohort does not show any unique cohort-specific behavior and that it maintains homogenous behavior or effect. The detrended version of the age-period-cohort model is stated as follows:

$$
(2) \quad
\begin{cases}
y^{apc} = \alpha_a + \pi_p + \gamma_c + \alpha_0 \, rescale\,(a) + \pi_0 \, rescale\,(p) + \beta_0 + \sum_j \beta_j x_j + \varepsilon_i \\
\begin{cases}
\sum_a \alpha_a = \sum_p \pi_p = \sum_c \gamma_c = 0 \\
Slope_a(\alpha) = Slope_p(\pi_p) = Slope_c(\gamma_c) = 0 \\
\min(c) < c < \max(c)
\end{cases}
\end{cases}
$$

The APCD model splits trends into two categories: the first category is based on the linear trend, and the second category is based on the non-linear trend on the fluctuations around the linear trend. The model works around the traditional identification dilemma by calculating the constrained trend with zero-sum and zero-slope parameters that are compared against a unique decomposition of a, p and c, which contain the estimated fluctuations (Chauvel, 2011). Briefly, when at least one coefficient has a difference to zero-slope coefficient, the APCD model will show the variations. When choosing the appropriate model between AP and the APC, it is practical to compare (Raftery, 1986) BIC values between the models to estimate which model has better explanatory power.

With disposable income as the dependent variable, there are multiple reasons to analyze deviations from the linear trends. The APCD distinguishes the relative share of period variations between cohorts but cannot take the unconformity of changing living standards into account in an absolute manner. Thus, the APCT is developed as an instrument to measure absolute declines and progressions. The main modification to the APCD model is to remove the zero-slope constraint from the cohort coefficients and thus suppress the γ_0 rescale(c)-term.

The period fluctuations are controlled in the same way in both APCD and APCT; however, rather than absorbing the long-term linear trend, the parameter γ_c acts as a trended cohort effect in the APCT-model. This trended effect denotes per-cohort change while being controlled. Thus, the APCT will estimate the progression that controls for period fluctuations at a given age without being affected by the long-run period trends.

Hence, the APCT will illustrate how inflation-adjusted disposable income changes between cohorts but will not show whether the change arises from cohort

effects or period effects. The model is flawed in the sense that it cannot reveal whether the trend will continue on its path or whether there is a chance for a long, overarching period change[1] (see, e.g. Chauvel, 2016; Freedman, 2017). The APCT formula is defined as follows:

$$
(3) \quad
\begin{cases}
y^{apc} = \alpha_a + \pi_p + \gamma_c + \alpha_0 \, rescale\,(a) + \beta_0 + \sum_j \beta_j x_j + \varepsilon_i \\
\begin{cases}
\sum_a \alpha_a = \sum_p \pi_p = \sum_c \gamma_c = 0 \\
Slope_a(\alpha) = Slope_p(\pi_p) = 0 \\
\min(c) < c < \max(c)
\end{cases}
\end{cases}
$$

4.3. Age-Period-Cohort Estimations on Disposable Income

First, in both cases of APC-variants, we estimate an uncontrolled model of logarithmic disposable income for household reference person i of a (age), c (cohort) and p (period):

$$
(4) \quad \log(DI)_i^{apc} = \mu_0 + \alpha_a + \pi_p + \gamma_c + \varepsilon_i
$$

where μ_0 is the intercept for the logarithmic disposable income, α_a is the coefficient on age, π_p is the period coefficient, γ_c is the cohort coefficient and ε_i is a random error with $E(\varepsilon_i) = 0$. Thus, the disposable income of each household is predicted by the age of the reference person of the household, the date of birth and the statistical year, including the random error.

After measuring the uncontrolled effects, we introduce the control variables of education level, primary economic activity, number of persons in the household and unemployment level in the model, where β_j is the coefficient for control variable x_j:

$$
(5) \quad \log(DI)_i^{apc} = \mu_0 + \alpha_a + \pi_p + \gamma_c + \sum_j \beta_j x_j + \varepsilon_i
$$

Additionally, we estimate the attainment of middle-income MI_i by using a dummy variable, where disposable income is split into quintiles in which $QU_1 - QU_2$ equals 0 and $QU_3 - QU_5$ equals 1. We do not use the logit model, which has methodological problems. Instead, we use a linear model with a dependent dummy variable, which is equivalent in results to the marginal effects (Mood, 2010). Thus, the uncontrolled and controlled APC-models are stated as follows:

$$
(6) \quad E(MI_i)^{apc} = \mu_0 + \alpha_a + \pi_p + \gamma_c + \varepsilon_i
$$

$$
(7) \quad E(MI_i | X_j)^{apc} = \mu_0 + \alpha_a + \pi_p + \gamma_c + \sum_j \beta_j x_j + \varepsilon_i
$$

[1]An APCH is a "hysteresis" model, which aims to solve these concerns by estimating the lasting scarring effects (Chauvel, 2016). However, a hysteresis model estimator yields only a summary estimate of variation and cannot help in identifying the shape of life cycle dynamics (see, e.g. Freedman, 2017).
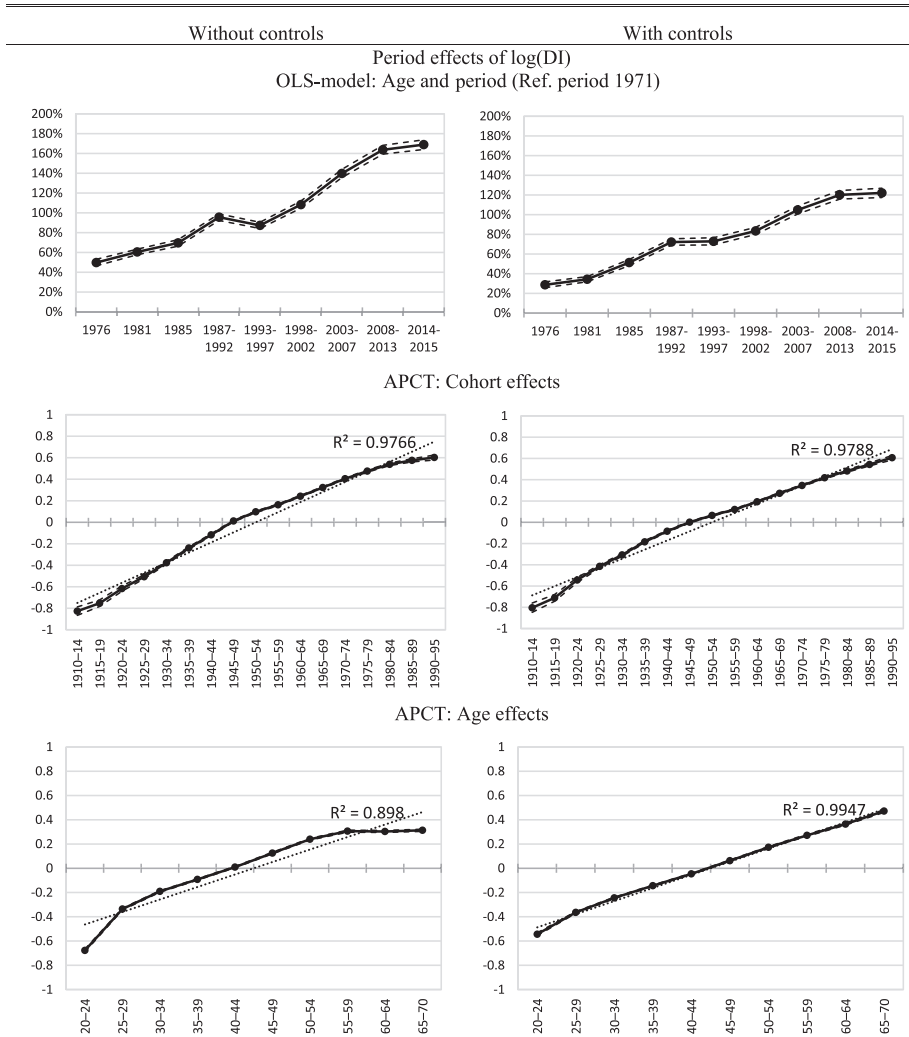
Figure 2. Results of APCT Models and Periodic Linear Regression (solid lines) of the Disposable Household Income (Reference period is 1971 instead of 1966 because education information is missing from the oldest dataset due to older data collection principles.)

Note: Controlled models—both APCT and OLS—are adjusted by education, main economic activity, unemployment level and number of persons in a household. In OLS-model, vertical axis is linear regression coefficient (Results shown as the percentage change in relation to the reference group, which is calculated by logarithmic transformation of coefficients: $((\exp(\beta)-1)*100)$), and horizontal axis shows range of measurement period. In APCT-models, vertical axis is APCT coefficient, and horizontal axis shows range of each APC component. Dotted lines represent 95 percent confidence intervals.

In conclusion, the identification principle in our study is to observe whether the age, period or cohort coefficients of the models statistically significantly deviate from zero, which will confirm that there is an age, period or cohort effect on disposable income. In the controlled model, the effects that deviate from zero indicate that there are effects on the three APC dimensions that do not depend on

the control variables. Last, when observing age, period and cohort effects, we can determine whether control variables "suppress" one or more of these dimensions (see, e.g. Yang and Land, 2013). In an ideal case, this would isolate the effects towards one or two factors of the APC triad, giving the model more explanatory power and also providing an estimation of which control variable explains this change.

5. Results

5.1. *"Trended" age-period-cohort effects*

Figure 2 shows the results of trended age, period and cohort effects on income, where the periodic zero-sum trend is freed from constraints to show the absolute income trajectory. Thus, the APCT-model will reveal how absolute income has developed across age, period and cohort. The APCD model shows the same relative periodic effects as the APCT model. Thus, it does not provide any new information about periodic effects. This lack of new information is a limitation of the APCT period effects, which remain bound to the zero-sum trend. Therefore, we utilize a linear regression model, which illustrates how the periodic development of disposable income has changed in an absolute fashion. The limitation of this estimation is that the model is restricted to age and period, which means that it does not take into account possible cohort effects. The choice of the AP model over the CP model was verified with the VIF-test, which measured the AP model as less collinear, with VIF values under 5 instead of 10.

The periodic OLS-model reveals that overall absolute income has increased over time, although the economic shocks of the 1990s and the financial crisis of 2007/08 have created a period of income stagnation. Absolute income rose steadily from 1976 to 1992 until the economic shock of the early 1990s. The effect of the shock can be observed from 1993 to 1997, when income levels dropped in the uncontrolled model. Additionally, in the controlled model, income level does not decrease, but its linear development stops and the trend stagnates, whereas there is only 1 percentage point of growth between the years 1987–1997. It is also evident that income development has been halted by the financial crisis. Levels of disposable income rose during the 2003–2013 period but did not rise in 2014. This stagnation was created by the financial crisis and can be compared to the economic stagnation of the 1990s because both periods show a growth level of 2 percentage points during the period of stagnation.

When comparing the relative changes (APCD-model) to the absolute changes (OLS-model), the periodic stagnation points show where income development has been halted. These phases indicate the positions of the life course in which different birth cohorts have faced different economic shocks. For example, negative estimates in both models for the birth cohorts of 1975–1995 could explain why income development has become negative. The reason is economic stagnation in the shock points that occurred at critical phases of the life course. In addition, the analysis shows that absolute income development did not stagnate at the time of the 1973 oil crisis. This indicates that that particular economic shock did not affect

the income development of the older generations even though it occurred during the same phase of the life course.

The results of the trended analysis show that overall income has increased over time. Absolute income in Finland has been rising steadily, and inequalities are found more clearly in relative income (see, e.g. Suoniemi, 2012).

It is apparent that the disposable income of cohorts matches relatively well with general increases in the disposable income. The disposable income deviates from the general development of the disposable income (R^2 value is 0.975). The APCT model with control variables included shows that cohort incomes remain close to general increases in disposable incomes. The model shows that the level of absolute income has been rising steadily from generation to generation. The R^2 between general increases in incomes and cohort-based incomes is 0.979. The cohort effects show the rising income from older to younger birth cohorts, although the detrended effects show that there are relative cohort differences. This result indicates that income inequality in Finland is more relative than absolute, which is a result of rapid economic growth, a strong union presence in policy making and educational expansion (see, e.g. Suoniemi, 2012).

In regard to age effects, the non-linear slope follows a classic inverted U-shape slope, where income rises after graduation at the beginning of the life cycle and falls again in the retirement phase. After introducing control variables, the age effects follow a linear trend, showing a steady increase throughout the life course.

In the uncontrolled model of age, the most notable differences are found at the extremities of the slope. The group of 20- to 24-year-olds shows clear growth in income compared to 25- to 29-year-olds. The age effects cross the zero coefficient line at the age of 43 years, which lands right on the point of the middle-income level by age group in this dataset. In the uncontrolled model, the age effects stop growing within the age group of 50- to 70-year-olds, which is a period of transition into retirement. The controlled age effects are revealed in the effects of the APCD-model in the context of periodic change. The deviations in the uncontrolled model are explained by the addition of control variables when the age effects form an almost perfect line ($R^2 = 0.99$) with the linear trend, without any anomalies. In line with the APCD-model above, the effect of education and main economic activity reduce the differences in all of the age groups (Table A.2). The income development between age groups shows an ideal trajectory in the absolute sense, whereas the intergenerational distributions are identified in the cohort effects, which show income variance in the controlled model.

In relation to the APCT-model, it can be stated that absolute disposable income has, overall, been rising in the dimensions of age, period and cohort. This result indicates periodic development of income in the dimensions of time and birth cohorts, whereas individuals are expected to see rises in income through the life cycle. Although the development of income has stagnated due to economic shocks, this stagnation has not halted the overall growth trend. The trended model shows which age, period and cohort groups have the highest absolute income but does not reveal how income has changed in a relative sense, which we will address next with the trended model.
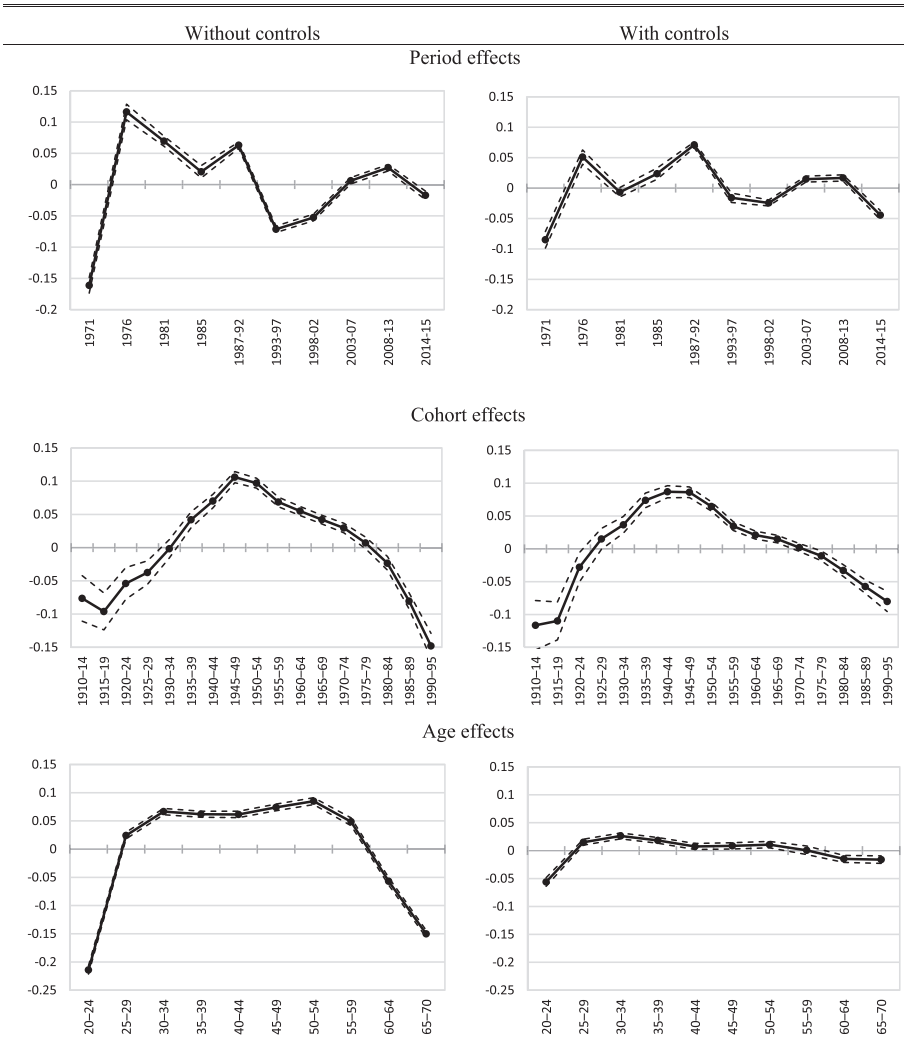
Figure 3. Results of APCD Models (solid lines) of the Disposable Household Income
Note: (Statistical years were coded as representative 5-year periods for methodological reasons (see Section 3). All periods are presented as actual statistical years in all figures. Chosen period years are centered on the technical period representative year and to match known economic cycles in Finnish history.) Controlled model is adjusted by education, main economic activity, unemployment level and number of persons in household. Vertical axis shows APCD coefficient, and horizontal axis shows range of each APC component. Dotted lines represent 95 percent confidence intervals.

5.2. "Detrended" age-period-cohort effects

Figure 3 shows the results of the age-period-cohort "detrended" analysis. The analysis shows relative changes in income in relation to the linear trend, revealing which age, period or cohort category benefitted most compared to other groups. This analysis offers an answer to the research question on relative income in three different ways: which cohort group has the more privileged

position, how age variations reveal overall life course effects on income, and whether certain periodic shocks negatively affected the progress of incomes.

The uncontrolled period effects show the relative effects of economic fluctuations. The periodic effects illuminate the dramatic effect of the 1990s economic downturn. Additionally, the most recent data point shows a relative decline in incomes under the linear trend. This same effect can be observed in the controlled model, in which the nonlinear slope maintains the same overall shape. The relative estimates show that the economic shock of the early 1990s still maintains its position as the most severe influence on income development. In addition, the lowest coefficient is in 1971.

The periodic coefficients are consistent with the historical development of income inequality in Finland. Income inequality declined in the early 1970s, which, in turn, is shown as a rapid increase in periodic coefficients in the APCD-model. Subsequently, inequality remained almost constant until the economic shock of the 1990s. This effect can be observed in 1981 with no deviation from the linear trend and with a steady rise in incomes until the economic downturn of the early 1990s. The periodic effects show a substantial decline in incomes to negative levels, under the linear trend. In the first five years after the economic downturn, income inequality rose but steadily recovered to present levels at the turn of the millennium. Additionally, the APCD-model shows that income levels increased from negative to positive, crossing the linear trend. After the depression of the early 1990s, the periodic income effects rise above the linear trend during the period of 2003–2007 and continue their rise until the period of 2008–2013. After that, the periodic effects decline below the linear trend by 2014–2015.

In addition to the economic cycles, the period effects are explained by the educational expansion that was illustrated in Figure A.1. Both the uncontrolled and controlled period models show a profound rise in income during the period from 1971 to 1976. When control variables are absorbed, the impact of the periods decreases notably, which can be explained by the increased incomes of the relatively small group with higher education during that time period. In contrast, the period between 1981 and 1992 has the most dramatic "spike" after the controls, which could be explained mainly by economic growth.

The results of the cohort effects show that the baby boomer generation indeed benefited the most from their birth cohort, whereas younger generations are falling behind (see also Berloffa and Villa, 2010; Chauvel and Schröder, 2015). Additionally, these findings are connected to periodic shock effects, which supports the hypothesis that cohorts that enter the labor market during economic downturns are in a more disadvantaged position than cohorts that enter the labor market during economic upturns.

The cohort effect without controls shows a peak in the birth years from 1945 to 1949, which deviates by approximately 11 percent from the linear trend. The strongest negative effects are located at the extremes of the cohort distribution, on the birth cohorts of 1915–1919 (-10 percent) and 1990–1995 (-15 percent). The point at which the older cohorts crossover from negative to positive is seen in the birth cohort of 1930–1934, and the decline back to negative coefficients is seen in the birth cohort of 1980–1985.

When education, primary economic activity, household size and unemployment are controlled, the peak of income widens and is located between the birth cohorts of 1940–1949. The most influential change is the drop between the birth cohorts of 1955–1979. These cohorts more closely follow the linear trend, with an effect on the oldest cohort of 4 percent and an effect on the youngest cohort of -0.3 percent. Controls also affect the youngest generation, where the strong negative slope is evened out towards the linear trend. For example, the effects on the birth cohort of 1990–1994 are halved in the controlled model. Thus, when the control variables are taken into account, the youngest generation does not have the maximum negative deviation, which is now located in the older generations, although the number of observations makes the estimates more unstable.

The interpretation of relative income decline in the younger generations is most likely connected to economic shocks. The timing of the Finnish economic downturn of the early 1990s and the financial crisis of 2007/08 had particular effects on the birth cohorts that were born in 1975 and later. For example, the birth cohort of 1975–1980 was at its earliest point of transition into the job market during the economic downturn of the 1990s. For this cohort, the financial crisis—which occurred when this group was 28-33 years of age—is also an important factor for income development. Additionally, the younger cohorts are affected by the indirect effects of economic shock through their parents.

In light of these findings, it is plausible that the children of older generations will have lower relative income than their parents (see also Chetty *et al.*, 2017). Regarding relative income, the results show that the birth cohorts of 1940 to 1949 enjoy the most lucrative generational position. This can be explained by the period of high economic growth, expanding educational opportunities, abundance of available jobs and—foremost—the lack of periodic economic shocks, all of which have contributed to positive income development.

The main findings with regard to age effects are important for the APC-model because they reveal the effects of age and cohort as dominant components of relative income, whereas the dominant economic activity functions as a suppressive control mechanism (see Table A.2). This finding shows that relative income effects are due to periodic and inter-cohort changes, whereas age effects do not play a major role in this dynamic. Additionally, in contrast to what previous research has indicated, education, as a control variable, does not have a primary impact on the age effects.

The age effects show a convex life course, where middle-age acts as an income peak and the youngest and oldest age groups are the most disadvantaged in terms of income levels. Interestingly, the uncontrolled model shows a stagnation phase between the ages of 30 and 40. The estimates show an increase in incomes after entry into the labor market. After this transition, income growth slows down relative to the linear trend.

Introduction of control variables into the model creates a drastic change for the age effects. The main economic activity suppresses the age coefficients, such that they follow the linear trend. Education itself does not possess the power to nullify the relative age effect: even if the main economic activity is introduced without education, the coefficients follow the linear trend. Still, minor deviations remain. The youngest age group is below the linear trend, but the level of income increases
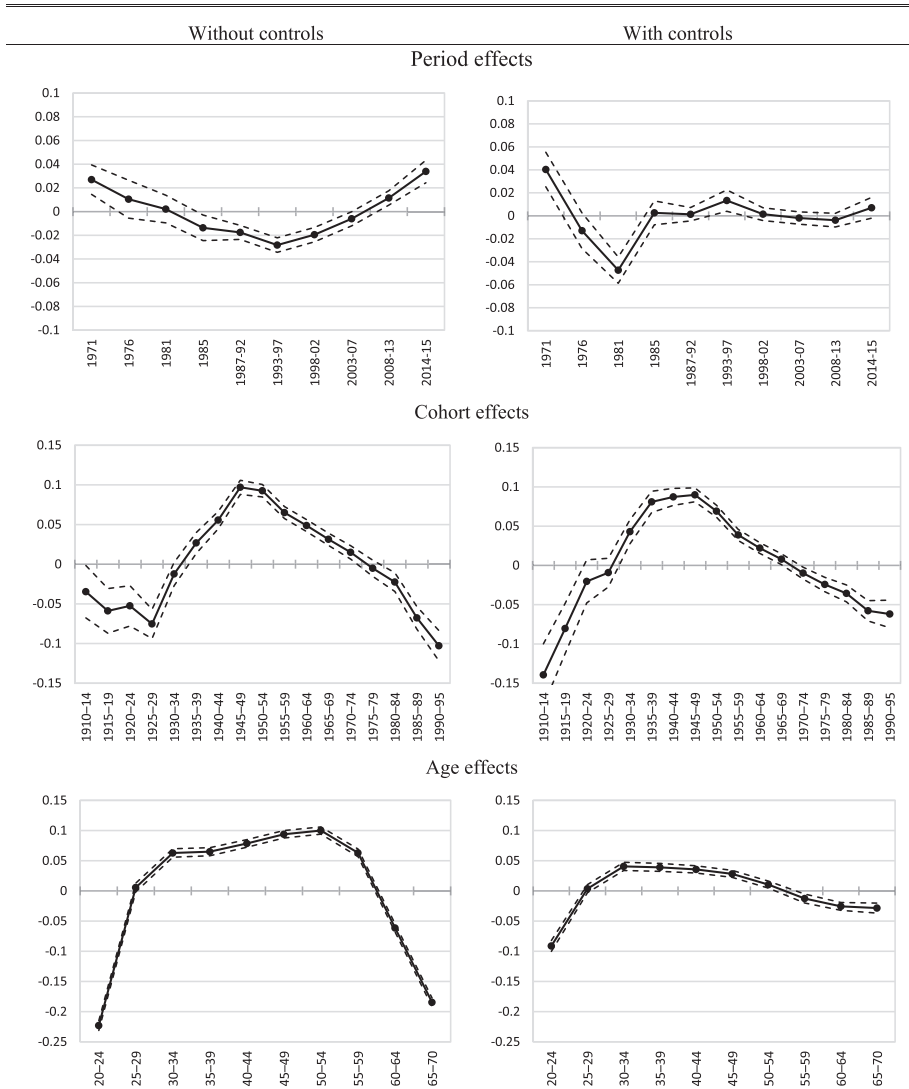
Figure 4. Results of APCD Models on Attainment of Middle Income (0/1).
Note: Controlled model is adjusted by education, main economic activity, unemployment level and number of persons in household. Vertical axis shows APCD coefficient, and horizontal axis shows range of each APC component. Dotted lines represent 95 percent confidence intervals.

steadily between the ages of 25 and 34. After this point, income will adhere to the linear trend, and later, it crosses the zero line, entering the negative region during the period of transition to pension. In the uncontrolled model, the relative peak of incomes is located in the age group of 50- to 54-year-olds. When controls are introduced, it seems that young people at age 30 to 34 are to some extent in a more beneficial position than other age groups, yet the estimates are modest (See Table A.2).

This suppression of age coefficients offers interesting insights because it identifies the main explanatory effect of cohort and periodic outcomes and provides an

explanation of how income inequality varies in the triad of age, period and cohort. Regarding relative income, the analysis suggests that a person's birth cohort and the effects of economic cycles during the life course—not belonging to a certain age group—are the factors that indicate changes in income distribution. Still, the detrended and trended approaches do not answer the question of whether and how inter-cohort inequalities change in the context of achieving average income class. The following section will put relative and absolute income changes into the context of achieving "optimal" income class by measuring the attainment of middle-income.

5.3. *Attainment of middle-income over age, period and cohort*

Figure 4 shows the results of the probability of attaining middle-income, which will help us put our previous results into the context of achieving "optimal" and societally valued income class. The periodic results show that middle-income attainment is not strongly connected to periodic income changes. This finding suggests that economic cycles do not have a dramatic effect on the probability of achieving middle-income status, which identifies the dimensions of cohort and age as the main components of middle-income attainment.

The periodic changes in the uncontrolled model shows a moderate U-shape pattern. The minimum periodic effect is at its most intensive level during the economic shock of the early 1990s (-2.3 percent in 1995). The most beneficial times at which to achieve middle income were in the early 1970s and from 2008 onwards, where periodic effects were approximately 3 percent. The periodic effects are rather weak from the year 1985 onward and closely follow the linear trend, excluding the slight deviation in the period 1993–1997. In conclusion, the controlled model indicates that the year 1970 was the optimal time to attain middle-income, and the worst time was in 1980, with a difference of 8 percentage points between these two years.

We conducted robustness tests on our measure of middle-income attainment by calculating estimates for the upper 5th quintile and the quintile range of $QU_3 - QU_4$ (not reported here), which revealed that the periodic anomaly during the period of 1976–1985 was caused by the upper 5th quintile. By taking this deviation into account, the periodic effects follow the reference trend almost completely. In other words, these results indicate that age and cohort effects dominate the period effects in middle-income attainment: all of the differences in middle-income attainment are identified as age or cohort effects. The periodic anomaly of the 5th quintile is explained by low income inequality during the growth years of 1970–1984. Taking these deviations into account, middle-income attainment has been rather stable in relation to the linear trend, whereas the effects stay weak.

Middle-income attainment and cohort effects have overlapping results related to relative income, where higher income raises the probability of a certain birth cohort being among the group of individuals who achieve middle-income. Again, the results show that the baby boomers are the generation in the most beneficial position with regard to attaining middle-income. As previously stated, period effects are suppressed after introducing control variables, which indicates that the impact on the attainment of middle-income has a strong foundation in generational effects.

The cohort effects on the uncontrolled model have analogous peaks, as in the previous models that measured logarithmic income as a dependent variable (see Figure 3). The highest probability of reaching middle-income is found in the birth cohort of 1945–1949, with the deviation from the linear trend being 10 percent. The cohort effects do not change their intensity between the uncontrolled and controlled models, although the range of the optimal birth cohort for middle-income attainment expands. However, the birth cohort of 1945–1949 is the most advantaged cohort for reaching middle-income—with a 10 percent probability—but the peak is greater, even where the birth cohorts of 1935–1950 are relatively close to each other. In contrast, the most disadvantaged cohort is, unsurprisingly, the birth cohort of 1990–1995, with a -10 percent deviation. In the controlled model, the lowest point has drastically shifted to the other end of spectrum, where the oldest birth cohort of 1910–1914 has a minimum coefficient of -14 percent from the linear trend. The birth cohort of 1970–1974 is at the zero-sum line, which marks the point after which all birth cohorts have a negative probability of middle-income attainment; this point is 5 years earlier than in the uncontrolled model. Additionally, the cohorts from 1980 onwards show a major change—in a downward trend—compared to the cohorts of 1955–1979.

This downward change could be explained by the economic shocks of the early 1990s and the financial crisis of 2007/08. First, the recession of the early 1990s could have an indirect impact through parental effects, and after this, the financial crisis is timed precisely when the young cohorts of 1985–1990 are supposed to enter the job market. The results also indicate that cohorts from 1975 onwards face more difficulties in reaching middle-income compared with their older counterparts. It is to be noted that our tests indicated that there were no clear periodic effects on attainment of middle-income, which means that economic shocks do not work as a clear explanatory framework. Instead, it is likely that economic shocks impact income levels, which will have effects on the cohorts or age groups that are more likely to achieve middle-income. Attaining middle-income is associated with the income levels of cohorts: when a certain cohort's income is high, this raises the probability that that cohort will surpass middle-income. In conclusion, it can be stated that individual choices about education and placement in the labor market dictate possible income margins, which will determine how likely it is for a certain age and cohort group to attain middle-income; however, all time periods are equal with regard to attaining middle-income status.

The age effect has an inverted U-shape, which indicates that the attainment of middle-income rises steadily from age 20 (-23 percent) to 35 (7 percent) and then rises at a more nominal level. After that, the attainment level stays the same, although the high point is observed among 50- to 54-year-olds, at 10 percent above the linear trend. In other words, middle-income attainment increases rapidly from a young age after graduation and remains relatively the same, with a slight rising trend through the later years. Finally, the transition to retirement entails dropping out of middle-income attainment (See also Riihelä, 2006; Nummi et al., 2012).

The controlled age effects show a moderate version of the reverse U-shape of the uncontrolled model. The model shows how age effects are relatively stable during the life course and how the deviations from the linear trend follow life cycle changes, such as education and retirement. Having middle-income status is more

probable when one is at the active working stage of the life cycle. The effects are weak and follow the linear trend rather closely, which shows that middle-income attainment is not heavily age-related in Finland.

The overall consensus of this analysis is that middle-income attainment in Finland is most likely for the baby boomer generation, which is related to that generation's higher relative income. Additionally, the results show that periodic changes do not influence the probability of achieving middle-income status, which is related more strongly to life cycle and cohort effects. The spikes in periodic effects are fully explained by the affluence of the 5th quintile, and age effects do not have a strong impact on middle-income attainment compared to cohort effects.

6. Conclusions

The main objective of this study was to assess how economic shocks affect income trends and inter-cohort income dynamics. The findings suggest that period and cohort effects have the main effects on relative income in the context of APC-method, whereas age effects have no meaningful impact when control variables are taken into account. This result reveals a clear emphasis on the relationship between the effects of economic shocks and cohort placement on labor market entry, whereas the occupational position attained explains all of the age variations. For example, those who were born in 1970 were entering the labor market at the brink of the economic shock of 1993 (at the age of 23) and have no income development in relation to the linear trend; in addition, all of the cohorts born after 1975 have a negative relative income effect. Additionally, absolute income analysis reveals that economic shocks create stagnation points in income development, which, with regard to cohort incomes, are especially detrimental to cohorts who are in the process of transitioning into the labor markets. Whereas older cohorts experienced no such effect during the oil crisis, younger generations seem to suffer birth-positional disadvantages from the economic stagnation caused by both the periodic shock of the 1990s and the financial crisis. Additionally, our research illustrates how middle-income attainment has not changed due to periodic shocks but rather is related to inter-cohort inequalities and relative income differences, where the baby boomer generation is a clear winner. Regarding economic shocks, the oil crisis in Finland did not have the same impact on cohort incomes as did the 1990s economic depression and the financial crisis of 2007/08.

The unique severity of the Finnish economic crisis of the 1990s highlights how income trajectories can change in fairly short order, especially in the international context. Compared to other Nordic countries, Finland did suffer from a significant drop in GDP per capita during the economic depression of the 1990s, whereas after the financial crisis, Finland struggled to end economic stagnation. This situation called for stronger economic and social policy solutions, which will in return impact income trends and especially those people who are located on distribution tails. Compared to a previous cohort study (Osberg, 2003), Finland seems to have a similar effect on declining incomes in Generation X as Sweden and Germany during the 1990s, although the data range is limited to year 1995. The

study does not answer why between-cohort inequalities are rising but speculates on the importance of possible institutional context on market forces.

Our results show that the younger cohorts are in a more disadvantaged economic position than the older "baby boomer" cohorts in the case of relative income and attainment of middle-income but not in the case of absolute income. In our study, the main economic activity is the key explanatory factor. The result is particularly interesting because previous studies have emphasized the role of educational expansion, which is associated with the profits gained from certain educational fields (Pekkala and Lucas, 2004). This finding supports, to some extent, a signaling theory (Spence, 1973). Education plays a role in occupational attainment, but education itself does not suppress the age effects in the same way that the main economic activity does. In other words, gained positional outcome in the labor market is more essential, but a solid foundation in education is needed to reach positions that offer higher income. These positions or "outcomes" are therefore more directly influential than education itself.

In addition, the time period of 1945–1980 was a time of great economic growth. The cohorts of 1930–1950 entered the labor market during the 1960s and 1970s, which was a time of economic prosperity and high employment. These labor market changes and increased educational opportunities formed an optimal platform for social mobility: higher education offered high returns in a growing labor market, where the supply and demand ratio for the educated workforce was in favor of educated workers. The younger generations, in turn, have been facing the economic recession of the early 1990s and the financial crisis of 2007/08. The scarring effects on these cohorts are visible in the cohort effects of lower relative income and middle-income attainment, where those born later than the 1970s do not share similar positions and opportunities as earlier cohorts.

Methodologically, APC-modeling offers a unique perspective on the life course theory of Meyer (2005), which emphasizes the importance of cohorts as an object of research. Our research suggests that the assertion is valid: in every model, cohort variations are strong, which suggests the relevance of inter-cohort effects on income that are affected through periodic macro-economic shocks. The APC framework in our study takes a different methodological perspective compared to previous research. APC-models are useful when measuring the "dominance" effects among age, period and cohort when different control variables are taken into account (see, e.g. Yang and Land, 2013). Previous studies based on Chauvel's (2011) APC-model have not been utilized to identify which combinations of age, period or cohort are meaningful to the dependent variable or to uncover the main independent variable that is responsible for this "suppression" effect (e.g. Chauvel, 2013; Chauvel and Schröder, 2015; Freedman, 2017). From a theoretical perspective, by identifying the "suppression" effect on cohorts, our finding supports Meyers (2005) notion about the importance of cohorts in life course research. Our study used this point of reference to gain access to the substance of economic cycles and to see whether income fluctuations are due to shock effects. Thus, taking into account modeling limitations, this methodological approach offered a major advantage in terms of untangling the age-period-cohort conundrum with regard to income, whereas traditional models only utilize two factors out of the three APC components.

In terms of policy implications, the paper has emphasized the importance of inequalities between cohorts in the context of economic cycles. We suggest that policy instruments should be aimed at younger generations—especially those who are entering in labor markets—to alleviate negative effects of economic shocks. Potential solutions could include taxation reforms where income transfers are aimed at younger age groups to support employment, similar to what Atkinson (2015) suggests to control economic outcomes. Additionally, governments could support employers for hiring early-career workers by implementing market support mechanism to finance a part of wage expenditures. In further research, it would be fruitful to use individual-level register-based datasets in a panel framework and to use microsimulation models to study how different policy models affect inter-cohort income distribution, which could offer some societal implications on how welfare policies could be optimized to also combat intergenerational income erosion.

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Supporting Information

Additional supporting information may be found in the online version of this article at the publisher's web site:

Figure A.1: Share of Individuals Between Periods by Educational Level in the Data Sample

Table A.1: Descriptive Statistics

Table A.2: Trended and Detrended Age-Period-Cohort Effects; AP-OLS-Models